STORM WATER

Master Plan

for *City of Stayton*

May 2008

FINAL DRAFT

For City Council Approval

KELLER associates

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SECTION 1 – EXECUTIVE SUMMARY

1.0 STUDY OBJECTIVES

Effective management of storm water has become a matter of increasing concern and focus in recent years. Recognizing the existing challenges and emerging issues, the City of Stayton commissioned this storm water master plan to formally identify the challenges and to develop practical solutions. The primary objectives of this Storm Water Master Plan are:

- Establish storm system design and planning criteria.
- Evaluate the existing storm system using computer hydraulic modeling.
- Summarize existing system deficiencies and propose improvements to enhance system serviceability.
- Recommend improvements needed to service future growth.
- Develop a Capital Improvement Plan and an appropriate System Implementation Strategy.

1.1 STUDY AREA

The City of Stayton is located in Marion County, Oregon approximately 12 miles southeast of Salem.

The city consists of approximately 2.7 square miles of land. The study area includes additional land outside of Stayton's urban growth boundary which contributes to storm runoff flows to the city's storm water system. The study area, the city limits, and Stayton's urban growth boundary are illustrated in Figure 1 in Appendix A.

The city's current population is estimated to be over 7,700 people, and the build-out of the urban growth boundary correlates to a population projected at 19,200.

The climate of the study area is characterized by mild, wet winters and warm, dry summers. According to the Western Regional Climate Center, Stayton sees an average annual rainfall of 53 inches and average temperatures ranging from 65 °F to 41 °F during the summer and winter months, respectively.

The predominant soil types within the study area play an important role in watershed characterization and storm water runoff. The soil types in Stayton are classified as having moderate to slow infiltration rates and moderate to high runoff potential. Figure 2 in Appendix A displays the predominant hydrologic soil types based on Natural Resources Conservation Service (NRCS) Soil Survey Data.

Another important watershed characteristic is land use because it affects the quality, quantity, and timing of the runoff from rainfall events over the drainage basin. Figure 4 in Appendix A illustrates the land use designations as established by Stayton's comprehensive plan.

1.2 DESIGN CRITERIA

A Technical Review Committee (TRC) was established early in the process for the purpose of developing and approving the design criteria for the master plan and public works storm water design standards. The TRC is comprised of representatives from Keller Associates, Tetra-Tech KCM, and Stayton Public Works including the consulting city engineer, Ed Sigurdson. Additionally, the Santiam Water Control District provided valuable input.

Several assumptions were made based on the design criteria in the creation of the storm water model which was used to evaluate the city's storm water system. The basic assumptions are:

- Catch basins capture all storm water.
- Pipes, ditches, and catch basins are clean.
- Detention facility discharges are clear of debris.
- Future development follows the existing land use plan.

1.3 COMPUTER MODEL

The storm water modeling software XP-SWMM v10.5 was used to project storm water runoff from the study area using the USDA's TR55 Urban Hydrology Method. Additionally, XP-SWMM was used to dynamically route the hydrologic model runoff through a hydraulic model representing the existing storm water network. Hydrologic and hydraulic model parameters and calibration are further discussed in Section 4.

1.4 EXISTING STORM DRAINAGE SYSTEM CONDITION AND EVALUATION

Stayton's existing storm drain system is illustrated in Figure 5 of Appendix A. The existing system is composed of roughly 15 miles of pipe, 8 miles of open channel excluding the Salem Ditch, Power Canal, and Mill Creek. There are also about 650 catch basins, 20 detention facilities, and 38 major outfalls to receiving water bodies.

The storm drain system was delineated into six major drainage basins as shown in Figure 6. These six major basins were further divided into sub-basins which are shown in Figure 7 in Appendix A. The current storm water problem areas for each of the six major drainage basins are summarized in Figure 10.

1.5 WATER QUALITY CONDITION AND EVALUATION

Storm water management has historically emphasized flood control. However, in recent years the focus has shifted to include water quality management. Three of the regulatory programs applicable to Stayton's storm water include the Underground Injection Control (UIC) program, the National Pollutant Discharge Elimination System (NPDES) program, and the Willamette Basin Total Maximum Daily Load (TMDL).

The UIC program relies on voluntary reporting and registration. The City of Stayton is currently in the process of registering the two known storm water underground injection systems. The NPDES Phase II regulations on storm water do not apply to Stayton because the population is less than 10,000. However, the city has expressed the desire to be in a position to meet those requirements. Stayton has been listed as a Designated Management Agency (DMA) in the Willamette Basin TMDL and was required to submit a TMDL implementation plan in 2008.

Initial testing of Stayton's storm water quality indicates the discharge from the city's system is relatively clean. Details of the storm water quality analysis are included in Appendix D.

1.6 RECOMMENDED IMPROVEMENTS AND CAPITAL IMPROVEMENT PROGRAM

The capital improvement plan was developed and prioritized based on factors such as flooding frequency, potential or recurring damage to property, and time sensitive opportunities. There are currently not any regulatory demands for these improvements to be made - however, the nature of the improvements, their related costs, and Stayton's continued development make it a prudent decision to begin implementing the master plan. Figure 11 illustrates all recommended improvements, and Figure 12 separates these recommendations into prioritized improvements. These improvements are summarized in Table 1.1 followed by a brief description of the proposed improvements. Further detail regarding the capital improvement plan is provided in Section 9.

Table 1.1
Capital Improvement Plan Summary

Prioritization	Cost*
Priority 1A Improvements	$3.3M
Priority 1B Improvements	$5.2M
Priority 2 Improvements	$5.0M
Priority 3 Improvements	$2.2M
Priority 4 Improvements	$0.5M
Future Improvements**	$9.7M
Rounded Total	$26M

* All costs in 2007 Dollars and include engineering and contingencies.

** Timing depends on when growth occurs.

Priority 1A Improvements:

- *Wetland Preservation:* Purchase 25-acre wetlands west of Cascade Highway and preserve for treatment and detention. Time sensitive opportunity.
- *Shaff Road Detention Basin:* Drains the largest portion of the city. Provide detention prior to discharge to reduce discharge rates and improve water quality. Time sensitive opportunity.
- *10th Ave Detention Basin:* Provide detention prior to discharge to reduce discharge rates and improve water quality. Time sensitive opportunity.
- *Storm Water Standards:* Draft storm water standards presented in this report are intended to serve as guidelines and should be updated and finalized by the City. Keller Associates recommends that stakeholders, including Marion County and the Santiam Water Control District (SWCD), be included in this process.

Priority 1B Improvements:

- *Industrial Detention Site Improvements:* Resolve problem with detention flooding into the neighboring farm.
- *Shaff Road Basin Pipeline Improvements:* Upsize conveyance to eliminate flooding in downtown area.
- *10th Avenue Pipeline Improvements:* Upsize conveyance to eliminate flooding along 10th Avenue.
- *Norpac NE Detention Site:* Provide intermediate detention to reduce discharge rates and improve water quality.
- *Monitoring Manholes:* Provide five manholes with monitoring equipment at strategic points throughout the system to begin tracking quantity and quality parameters.

Priority 2 Improvements:

- *Fir to Regis through Regis HS Parking Lot:* Upsize conveyance to eliminate flooding near high school.
- *Evergreen Ave to Norpac SW Detention Site:* Purchase detention site for future interceptor south of Salem Ditch.
- *3rd and Jefferson to Library Detention Site:* Construct interceptor north of Salem Ditch to combine existing outfalls into one. Provide detention to reduce discharge rates and improve water quality.
- *Millstream Woods to Norpac SW Detention Site:* Intercept existing outfalls south of Salem Ditch and combine into one.

Priority 3 Improvements:

- *Sylvan Meadows Subdivision :* Upsize conveyance to eliminate flooding in Sylvan Meadows.
- *Gardner Road-Regis High School:* Potential improvements pending.
- *Wedgewood Place:* Upsize conveyance to eliminate flooding.
- *Western Avenue:* Upsize conveyance to eliminate flooding.

Priority 4 Improvements:

- *Library Improvements:* Combine outfalls, and route through detention site.
- *Washington Street Area:* Provide detention to reduce discharge rates and improve water quality.
- *1st Avenue:* Upsize the existing storm water pipe along 1st Avenue from Florence to the discharge into the Power Canal with a new 15-inch storm pipe
- *North Peach Street:* Upsize conveyance to eliminate flooding.

Future Improvements:

- *Pacific Court:* Combine outfalls and route through detention site.
- *Fern Ridge Street Area:* Upsize conveyance and provide detention.
- *Dozler Property Area:* Upsize conveyance and provide detention for both existing and future development.
- *Phillips Property Area:* Provide drainage and detention for property and neighboring areas.
- *Larch Avenue:* Upsize the existing storm water pipe along the north portion of Larch Avenue that discharges into the Salem Ditch with a new 15-inch storm pipe.
- *Detention Facilities & Pipelines:* Provide adequate conveyance, treatment, and detention for all future development. Coordinate regional detention sites or provide on-site detention per master plan.

1.7 STORM WATER FUNDING

In addition to capital improvements, a storm water assets replacement program is recommended. This consists of a plan to regularly replace all deteriorated components of the storm water system. Because this is such a large undertaking, it is recommended that this program and the priority improvements be phased in over time as resources are built up through both the SDC and the storm water utility.

The annual costs for the priority improvements, system replacement program, and O&M are summarized in Table 1.2. A detailed analysis of the funding mechanisms to provide for these costs is contained in a supplemental report provided by Economic and Financial Analysis in Appendix G.1.

Table 1.2
Annual Operations, Maintenance, and Replacement Budget

Task	Cost	Frequency
Seasonal Maintenance	$30,000	per year (2 seasonal workers)
FTE City Staff	$87,500	per year (1.25 FTE time at 70k/yr)
Water Quality Lab Fees	$12,000	per year (contracted price)
Equipment and Supplies	$22,400	per year
System Replacement Program	$192,000	per year (excludes CIP projects)
Total Rounded Cost*	**$344,000**	**per year**

1.8 STUDY LIMITATIONS

The scope of this study was limited to the major pipelines and conveyance systems within the City of Stayton and did not include an evaluation of waterways owned and operated by the Santiam Water Control District (SWCD). Keller Associates recognizes that the storm water runoff from the City to the SWCD could make up a significant component of the total flow in waterways owned and operated by the SWCD. Implementing the improvements of this master plan would result in future flows at or below existing flows and improved water quality from discharges into waterways of the SWCD. As the City moves forward in implementing design standards and capital improvements, Keller Associates recommends coordination with the SWCD to more fully address their concerns (such as liability, maintenance, permitting, and management) in receiving nonagricultural runoff.

SECTION 2 – STUDY AREA

2.0 GENERAL

This section discusses the study area and its physical characteristics. Also discussed are pertinent land use and planning criteria, as well as population and demographics.

2.1 STUDY AREA

The 2005 city limits of the City of Stayton encompass an area of approximately 1,768 acres between Highway 22, also known as Santiam Highway, and the North Santiam River. The study area roughly corresponds to the Urban Growth Boundary (UGB) which includes an additional 1,440 acres of land, for a total of 3,208 acres. The UGB represents the expected areas of growth and development. Figure 1 in Appendix A illustrates the city limits, the study area, and the UGB.

2.2 LAND USE

The City of Stayton includes lands designated as commercial general; commercial retail; industrial; industrial agriculture; industrial commercial; light industrial; interchange development; low, medium and high density residential; and public/semi-public zoning inside city limits. Figure 4 in Appendix A graphically reflects the land use distribution adopted by the city. Table 2.1 summarizes the breakdown in acreage for each land use type.

Table 2.1
Existing Land Use Inside Stayton City Limits (2005)

Stayton		
Land Use	Acres	% of Total
Commercial General	104	6%
Commercial Retail	47	3%
Industrial Agriculture	60	3%
Industrial Commercial	17	1%
Light Industrial	320	18%
Low Density Res.	709	40%
Medium-High Density Res.	273	16%
Public and Semi-Public	238	13%
Total Acreage	**1,768**	

A Land Use Compatibility Statement (LUCS) is the process used by DEQ to verify that permits and other approvals that affect land use are in agreement with local comprehensive land use plans. Oregon state law requires a LUCS for nearly all DEQ permits, some general permits, and other approvals that affect land use. A LUCS was completed in 2004 as part of the Mill Creek sewer project.

2.2.1 Future Land Use

Keller Associates worked with the TRC and Stayton planning personnel in developing future land use outside the existing city limits, but within the urban growth boundary (UGB). Future land uses assumed for this study are illustrated in Figure 4 of Appendix A.

A corridor of light industrial use is expected along the west urban growth boundary of Stayton. Most of the remaining growth area is designated as low density residential with medium-high density residential areas scattered throughout. Some of the public lands correspond to potential areas identified by the city and school district as future school sites and parks.

The development densities for residential areas illustrated in Table 2.2 were developed as targets for future residential development based on consultation with city planners.

Table 2.2
Average Household Residential Densities

Low Density Residential (ERUs/ac)	Med-High Density Residential (ERUs/ac)	Household Size (people/ERU)
3.5	6	2.7

*ERU refers to the Equivalent Residential Unit

2.3 POPULATION

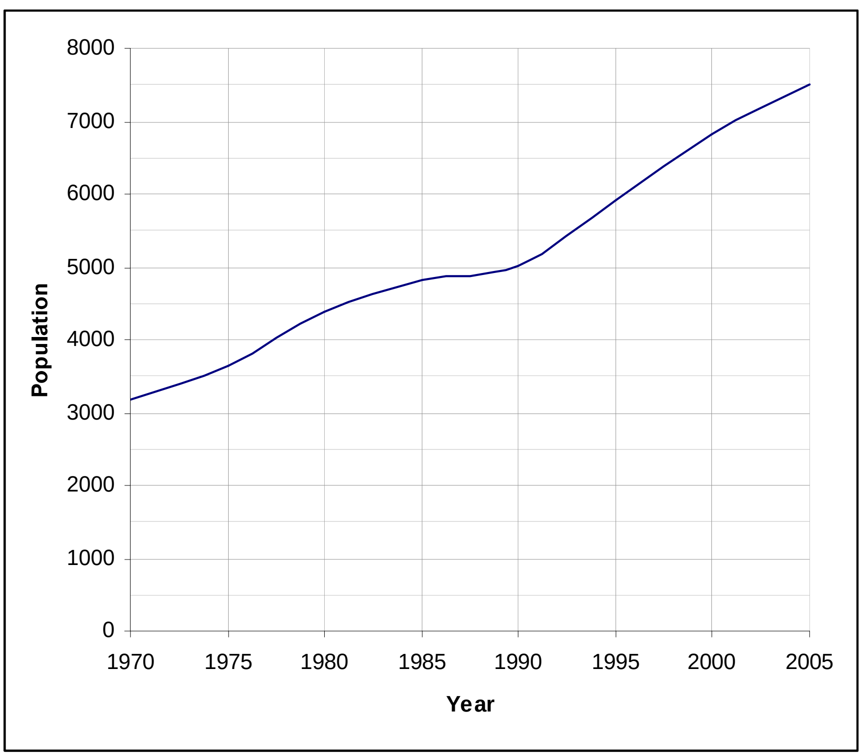
The estimated July 2006 population for the City of Stayton, as reported by the Portland State Population Research Center, was approximately 7,700. Historical population in the City of Stayton and in Marion County retrieved from census data is shown in Table 2.3.

Table 2.3
Stayton and Marion County Historical Population

Year	Office of Economic Analysis, State of Oregon and US Census—Marion Co.	Stayton Population Census Data	Marion County Growth Rate	Stayton % of Marion County	Stayton Annual Growth Rate
1970	151,309	3,170		2.10%	
1975	171,700	3,650	2.56%	2.13%	**2.86%**
1980	204,692	4,396	3.58%	2.15%	**3.79%**
1985	213,019	4,815	0.80%	2.26%	**1.84%**
1990	228,483	5,011	1.41%	2.19%	**0.80%**
1995	260,600	5,907	2.67%	2.27%	**3.34%**
2000	284,834	6,816	1.79%	2.39%	**2.90%**
2005	302,135	7,505	1.19%	2.48%	**1.94%**

As can be seen from the preceding table, the annual growth rate in Stayton declined between 1980 and 1990 and then rose sharply after 1990. The average annual growth rate for Stayton was 2.9% between 1995 and 2000, and 1.94% from 2000 to 2005. The growth rate in Stayton has generally been higher than Marion County. Chart 2.1 illustrates historical population trends.

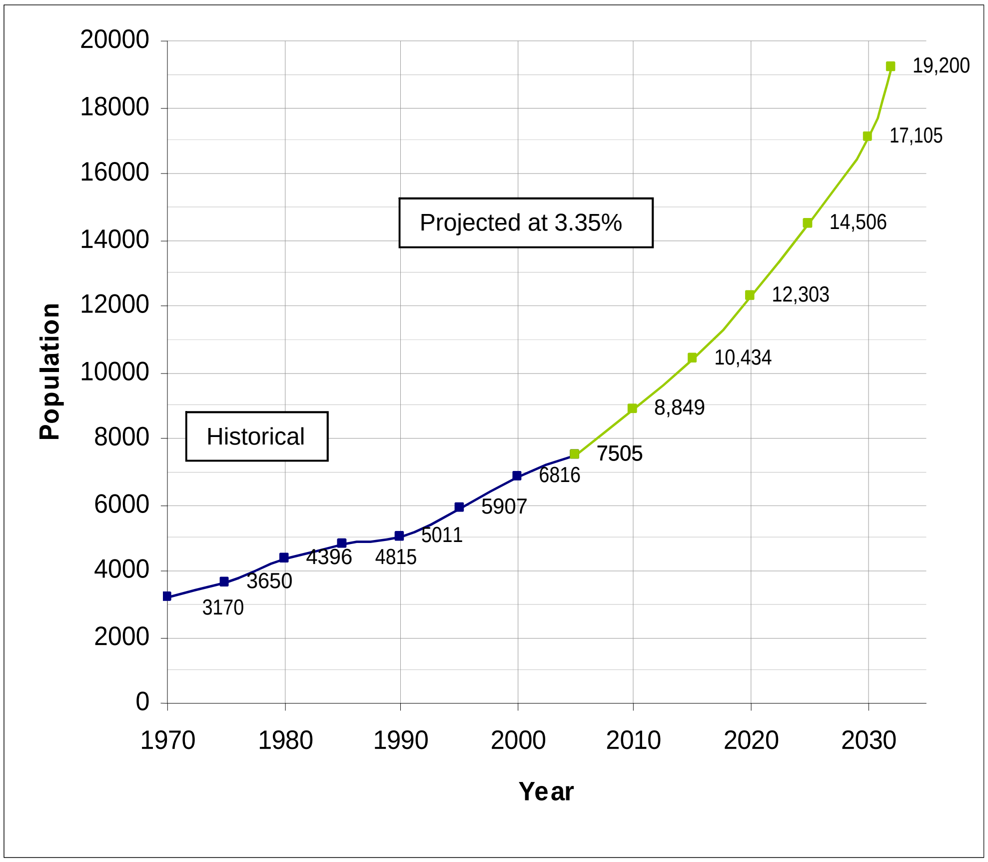
Chart 2.1
City of Stayton Historical Population



2.3.1 Population Projection

Growth projections are based on a continued growth of 3.35%. Build-out of the UGB using a growth rate of 3.35% will occur sometime around 2032. These growth projections are consistent with those used in the Water and Waste Water master plans previously completed.

Chart 2.2
City of Stayton Population Projections



2.4 PHYSICAL ENVIRONMENT

This section provides a review of the physical environment of the study area including climate, soils, geology, water resources, vegetation, etc., and its impact on project development.

2.4.1 Climate

Stayton lies within the Willamette Valley which has a relatively mild climate throughout the year, characterized by cool wet winters and warm dry summers. A summary of climate data for Stayton is shown in Table 2.4.

Table 2.4
Climatological Data (1971-2000) - Stayton, Oregon

	Jan	Feb	Mar	Apr	May	June	July
Precipitation (in)	7.17	6.46	5.37	4.26	3.31	2.42	0.87
Mean Temp. (°F)	40.3	43.0	46.5	50.0	55.6	61.2	66.8
Snowfall (in)	0.8	0.9	0	0	0	0	0
	Aug	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	
Precipitation (in)	1.15	2.18	4.03	8.16	8.00	4.45	
Mean Temp. (°F)	67.0	62.2	52.9	45.2	40.2	52.6	
Snowfall (in)	0	0	0	0	0.6	0.19	

2.4.2 Soils

In general, soils within the Stayton area are either a silty clay loam or silt loam. Slopes vary from 0 to 30 percent. Soils data from the area was obtained from the NRCS website. A soils map and listing of soils within the Stayton area can be found in Figure 2 in Appendix A. The specific soil types and their descriptions found in Stayton are included in Appendix B.

2.4.3 Geologic Hazards

Potential geologic hazards in the Stayton area would be either landslides or earthquakes. There are no volcanoes near enough to cause any volcanic hazard. According to GIS data supplied by Marion County there is a low hazard of landslides in this area. Also, the return time of earthquakes within a 50km distance is approximately 1,000 years. Hazard maps for landslides and seismic activity can be seen in Appendix B.

2.4.4 Public Health Hazards

Keller Associates is not aware of any existing public health hazards in the Stayton area.

2.4.5 Energy Production and Consumption

The U.S. Army Corps of Engineers has predicted that demand for electric power in the Pacific Northwest will grow an average of 4.5 percent per year for the next ten years. Projections from the Oregon Department of Energy indicate that total energy usage will increase approximately 2.9 percent per year over the next 20 years.

2.4.6 Water Resources

Water resources in the area include the North Santiam River, Stayton Ditch, Salem Ditch, Mill Creek, Valentine Creek, Lucas Ditch and the Main Canal. The Santiam River is part of the Willamette River Basin structure draining approximately 790 square miles of the western slope of the Eastern Cascade Mountains.

The City of Stayton draws its raw water for the potable water system from two sources: the North Santiam River, via the Power Canal; and two shallow collector wells. The Water Treatment Plant utilizes the Power Canal intake for all but a few days a year. The city's ability to utilize the Santiam River for potable water supply the majority of the year is a direct indication of the river's high quality even during periods of high precipitation and spring snowmelt, which could produce higher turbidities. When the Santiam River becomes turbid due to heavy precipitation or some other disturbance of the watershed, the city utilizes two shallow collector wells.

2.4.7 Flora and Fauna

A list of threatened or endangered plant and animal species that may occur within the state of Oregon has been provided in Appendix B. The most likely species to be encountered within the Stayton/Sublimity area would be the Chinook salmon in the N. Santiam River.

2.4.8 Air Quality and Noise

Stayton lies within the Willamette Valley air shed. This valley is bordered on the east by the Cascade Mountain Range and on the west by the Coast Range. The valley is closed off on the north and south as the two ranges come together. The prevailing wind direction is from the southwest in the winter and from the north in the summer. Due to these geologic features, pollution generated in the valley becomes trapped. Pollution comes from industry, automobile emissions, field burning, slash burning, and other agricultural practices. Air quality data monitored by the EPA is shown in Table 2.5.

Table 2.5
Air Quality Report 2006 - Stayton, Oregon

CO (ppm)		O_3 (ppm)		
2nd Max 1-hr	2nd Max 8-hr	2nd Max 1-hr	2nd Max 8-hr	EPA Region
4.5	3.2	0.095	0.075	10

DEQ sound controls and Marion County policy will ensure that indoor and outdoor noise levels are within acceptable limits. The county will consider noise impacts when developments are proposed near a noise source, such as the Santiam Highway. The City of Stayton addresses sound pollution through the plan review process.

2.4.9 Topography

Ground elevations in the study area range from a low of approximately 405 feet above mean sea level near the northwest boundary, to approximately 665 feet above mean sea level near the city's eastern boundary. A bench that varies from 100-200 feet tall exists generally parallel and south of the Santiam Highway. Areas of the city located along and on the bench have slopes as steep as 25+%. The topography of the remainder of the city is flatter (0.35-0.45% slopes) and generally slopes from east to west. The area topography is shown in Figure 3 in Appendix A .

2.5 SOCIO-ECONOMIC ENVIRONMENT

2.5.1 Economic Conditions and Trends

According to 2000 Census data the median income for a household in the city was approximately $34,004 and the median income for a family was $41,389. According to the Marion County Comprehensive Plan, the labor force participation rates will increase by between 47 and 54 percent caused largely by increasing female entry into the labor force. The largest source of growth in employment is likely to be those in retail trade and services. Employment will shift towards white collar occupations as demand for workers declines in manufacturing and construction.

2.6 STORM WATER DRAINAGE SHEDS

Storm water from the study area generally drains into three different receiving streams: Power Canal, Salem Ditch, and Mill Creek. The land areas that drain to each of these receiving streams is delineated in Figure 6 in Appendix A and the approximate percentages are summarized in Table 2.6.

Table 2.6
Percent of City Draining to Receiving Streams

Salem Ditch	Power Canal	Mill Creek / Lucas Ditch	Other
48%	4%	45%	3%

The Power Canal is an irrigation canal that is diverted from the North Santiam River southeast of the downtown Stayton area. The Power Canal generally flows from east to west along the southern portion of the city and ultimately discharges back into the North Santiam River. In addition to receiving some storm water from the southern part of the City of Stayton, it also delivers water to agricultural areas west of the city.

The Salem Ditch is also an irrigation canal that is diverted from the North Santiam River southeast of the downtown Stayton area. The Salem Ditch also generally flows from east to west along the southern portion of the city just north of the Power Canal. Towards the western edge of the city, the Salem Ditch alignment shifts to the northwest and flows towards the Mill Creek into which it discharges northwest of Stayton. The reported capacity of the Salem Ditch from the Santiam Control District is 120 cubic feet per second (cfs). In addition to receiving some storm water from the southern part of the City of Stayton, it also delivers water to agricultural areas west of the city. The Salem Ditch receives more storm water runoff from Stayton than any other receiving body of water.

Mill Creek is a natural water body that collects groundwater, irrigation wastewater and storm water from the area including portions of the city of Stayton. A majority of the storm water that discharges into Mill Creek from Stayton comes from the Lucas Ditch which discharges into Mill Creek northwest of the intersection of Cascade Highway and Shaff Road. Mill Creek generally meanders along the north boundary of the city near the Santiam Highway. Mill Creek has a mapped 100-year floodplain as illustrated in Figure 8.

The North Santiam River receives runoff storm water from a small area located in the east part of town. A small irrigation ditch receives runoff storm water from the Industrial Park on the far west part of town as shown on Figure 8.

SECTION 3 – STORM WATER SYSTEM DESIGN CRITERIA

3.0 GENERAL

Storm water system design criteria encompass the fundamental principles applied in evaluating the existing system and planning for future expansion of the system. The design criteria applied in this study come from sources such as neighboring communities, industry standards, and state and federal storm water regulations.

The aim of the design criteria is to accurately define the system demands in order to mitigate existing deficiencies and prevent future problems. Design criteria address design storm events, hydrologic methods, and hydraulic calculation methods. Storm water quality standards are addressed in Section 7 of this report.

As part of this master plan, the city's Storm Water Design Standards manual was reviewed and several changes have been recommended. These changes were accepted by the TRC and updated as part of this master plan. The details of the specific design criteria and BMPs for storm water system components are included in Appendix F.

3.1 DESIGN STORM

The design storm is the storm event for which the storm water facilities are designed. It essentially becomes the standard used to measure the functionality of the storm drain system. The design storm is a theoretical storm event with typical characteristics for storms in a given region.

One parameter of the design storm is the total depth of rainfall expected to occur over a given time period. Another parameter is the recurrence interval, or the average interval between successive events. For example, a 100 yr storm has occurred an average of once every 100 years. The Nation Oceanic and Atmospheric Administration (NOAA) has published isopluvial charts showing rainfall depths for a range of recurrence intervals over geographic areas. Table 3.1 contains the values for the City of Stayton as obtained from the NOAA isopluvial charts for the sate of Oregon.

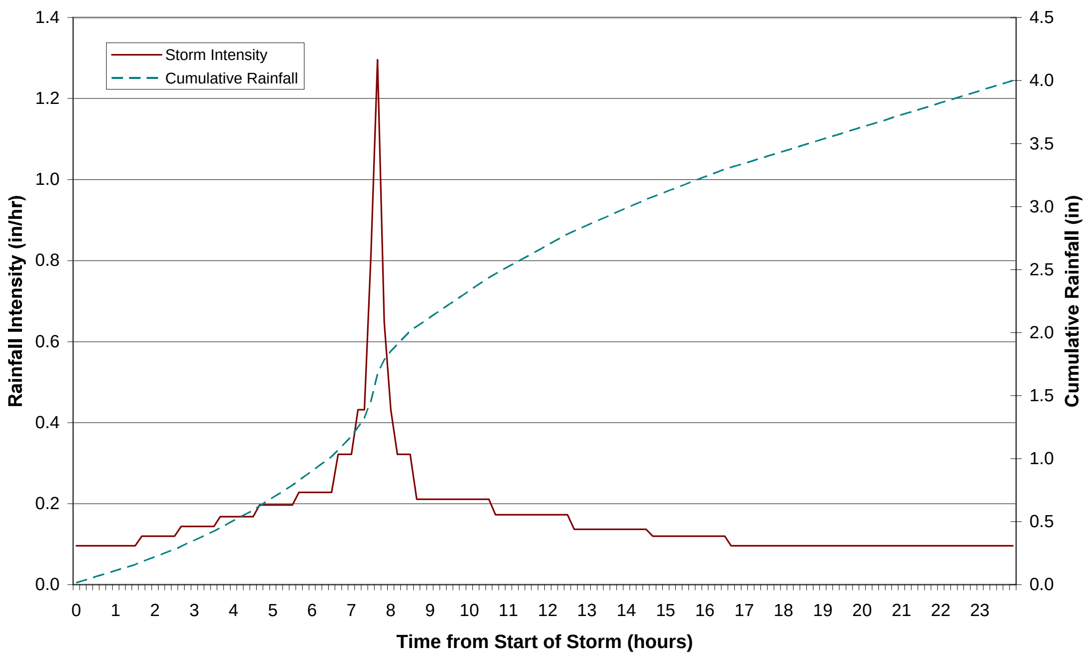
Table 3.1
24-Hour Storm Depths

Storm Event	Precipitation (in)*
2 year	2.5
5 year	3.0
10 year	3.5
25 year	4.0
50 year	4.5
100 year	4.6

*NOAA Atlas 2, Volume X

Another parameter of a design storm is how the given amount of precipitation is distributed over the duration of the storm (temporal distribution). A hyetograph illustrates the typical temporal distribution of a storm. The hyetograph shape is theoretical and is based on historical data collection and extrapolation. The Natural Resource Conservation Service (NRCS) has developed region-specific hyetographs for the state of Oregon. For Stayton, the NRCS recommends the use of a Type 1A distribution. The 25-year storm hyetograph is illustrated in Chart 3.1.

Chart 3.1
Stayton 25-year Storm Hyetograph



Selection of a design storm is a matter that balances level of service with economic feasibility. Through a series of meetings, the TRC establish the 25-yr storm event as the design storm for conveyance (pipes) and up to the 50-yr storm event as the design storm for detention facilities.

More specifically, the storm water lines should be capable of carrying the runoff from the contributing area for the 25-yr storm event without flooding. The existing system was evaluated by this standard and areas which showed flooding under the 25-yr event were marked as areas in need of improvement.

For detention facilities, the post-development runoff from the 50-yr storm cannot exceed the pre-development runoff from the 50-yr storm. In addition to the 50-yr storm, the detention facility should serve the same function for smaller storm events such as the 25-yr event, and the 2-yr event.

3.2 HYDROLOGIC METHODOLOGY

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

There are several acceptable methods for defining basin characteristics. According to the recently published Central Oregon Storm Water Manual, the following methods are deemed acceptable:

- The NRCS Urban Hydrograph Method
- The Santa Barbara Urban Hydrograph Method
- The Level Pool Routing Method
- The Rational Method
- The Modified Rational Method (Bowstring Method)

For this master plan, the NRCS Urban Hydrograph Method was employed. The specifics of this method and its parameters are covered in Section 4, Model Development.

3.3 STANDARDS COMPARISONS

Practical and useful information can be found in the experiences of Stayton's neighboring communities and their standards. In an effort to glean some of this information, a storm water policy survey was conducted for this master plan. As a result of the survey, the city has updated its policies to be consistent with neighboring communities, industry standards, and state and federal storm water regulations. The results of this survey have been recorded and are summarized in Table 3.2.

Table 3.2
Storm Drainage Design Criteria Comparison

Item	Stayton (Recommended)	Marion County	ODOT	Salem	Albany	Portland
Storm Distribution	NRCS 1A	NRCS 1A	NRCS 1A	As Approved by Director	NRCS 1A	NRCS 1A
24 hr Storm Precipitation	NOAA	NOAA	NOAA	As Approved	OCS	NOAA
Model Approach	NRCS- TR55	NRCS-TR55	SBUH	As Approved	NRCS-TR55	Various
Minimum Tc	10 min	10 min	5 min	None Specified	None Specified	5 min
PVC "n" value	0.013	0.013	0.013	0.009 - 0.013	0.013	0.013
Min. Pipe Diameter	12"	12"	12"	12"	12"	12"
Design Storm: For Conveyance	25 yr	10 yr	50 yr	25 yr	25 yr	25 yr
Design Standards: For Detention Facilities on New Developments	50 yr	100 yr	10 yr vol with 100 yr emergency overflow	50 year Vol with Overflow to Appvd Discharge Point	Detain 25 yr post dev vol, 100 yr emergency overflow	Maximum Practicable
Detention Facilities Allowed Inside Floodway/ Flood Plains?	Floodway: No Floodplain: with Approval	As Approved	Floodway: No Floodplain: Yes	As Approved	Floodway: No Floodplain: with Approval	Floodway: No Floodplain: No
Infiltration Policy	Not Allowed	Not Allowed	Not Allowed	As Approved	Not Allowed	Allowable
Roof Drains to Gutter or Yard?	Yard	Gutter	Gutter	Yard	Gutter	Gutter

NRCS = Natural Resource Conservation Service
NOAA = National Oceanic & Atmospheric Adm.
SBUH = Santa Barbara Unit Hydrograph

Tc = Time of Concentration
n value = Manning's roughness coefficient

SECTION 4 – MODEL DEVELOPMENT

4.0 GENERAL

An accurate computer model of the storm water system serves as planning tool and provides the basis for a solid storm water master plan. The model also provides insight into potential improvements to address existing deficiencies, and can be used to effectively plan for future development within the study area.

A storm water model correlates interactions of natural events and natural systems, (hydrologic parameters) with manmade systems (hydraulic parameters). Because there are countless variables with broad ranges of values in each system, a well coordinated and strategic data collection effort is required, along with practical assumptions and good judgment for data that cannot be feasibly obtained. This section outlines the model construction and calibration process beginning with data collection on the existing systems, and how key assumptions were incorporated to construct the final calibrated model of Stayton's storm water system.

4.1 EXISTING SYSTEM OVERVIEW

Prior to this study much of the storm water system was unmapped. Because an accurate base map is necessary to evaluate the existing system and create a master plan, a significant effort was put into mapping the existing storm water system. Data on the existing system was obtained from a combination of record drawings, survey data, GPS data, site visits, and field testing. The resulting storm water system base map is illustrated in Figure 5 in Appendix A. The following sub-sections briefly describe the existing system components and their general conditions.

4.1.1 Storm Water Inlets

The location and approximate elevation of catch basins and other storm water inlets was gathered with the aid of GPS units. Data on approximately 540 storm water inlets or catch basins was gathered through this survey. Other catch basins and storm water inlets have been added from successive field surveys and other sources of base map data.

From general observation and reporting from city staff it has been found that many of the catch basins are undersized, sparsely spaced, aged, and filled with sediment and debris.

4.1.2 Open Drainage Channels

Both natural and manmade open drainage ways are an integral part of the city's storm water system. The majority of the city's runoff is carried to the Salem Ditch, which in turn converges with Mill Creek in the northwest corner of the city's urban growth boundary. A large portion of the remaining runoff enters Mill Creek directly through a variety of pathways. A small portion of runoff drains to the North Santiam River, the Power Canal, and an irrigation ditch west of the urban growth boundary.

Portions of the constructed storm drain system run through stretches of biofiltration swales prior to re-entering the piped storm water system or discharging to a receiving body of water. Known bio filtration swales have been identified on the storm water base map.

Visual inspection of most of the open drainage ways shows high vegetation, and minimal meandering.

4.1.3 Storm Water Lines

There are roughly 15 miles of pipe in the city's storm drain system. The condition, age, and material of the lines vary considerably. Although the age of the lines is largely unknown, most lines are assumed to be 30 or more years old. A survey crew has collected storm water manhole rim elevations, invert elevations, and diameters on the major trunk lines included in the model.

Line sizes, layouts, and slopes for smaller lines shown on the base map come from the city's library of record drawings, and site visits. The focus of this study was on the main lines and key connectors. Much of the data for the smaller lines shown on the base map is from record drawings which have been found to be inaccurate in several cases.

4.1.4 Storm Water Detention Facilities

Detention facilities are designed to collect runoff from a designated area and control the discharge into the regional storm drain system. Detention facilities include a storage facility and usually include flow control structures such as weirs and orifices. These facilities both delay and attenuate the peak runoff events from their respective drainage area. Detention facilities may also be designed to improve water quality by acting as settling basins or be equipped with cleanouts and other water quality features.

The existing detention facilities in the study area are shown on Figure 5 in Appendix A. There are approximately 20 detention facilities currently in the system. The larger detention facilities that have a significant bearing on the upstream and downstream sections of the system have been modeled and evaluated for effectiveness under the 50 year storm event.

The modeling results evaluation is presented in Section 5, and recommendations from these evaluations are covered in Section 9.

4.1.5 Underground Injection Control Systems

According to DEQ, systems regulated by the underground injection control program are defined as any man-made design, structure or activity which discharges below the ground or subsurface. These are commonly referred to as UICs. A few specific examples of such systems pertinent to storm water are drywells, trench drains, sumps, perforated piping, floor drains, and drill holes. Due to the drainage conditions in the city, Stayton does not generally utilize subsurface drainage and no UICs were included in the model or future planning.

4.1.6 Storm Water Outfalls

Storm water outfalls are points at which the storm water system discharges into a receiving body of water. If an outfall is submerged or otherwise restricted, it affects the upstream hydraulics. Survey crew collected water surface elevation data for the large outfalls modeled in this study. This data was used to model submerged discharge outfalls where water levels exceeded outfall inverts.

There are numerous small outfalls and roof drains throughout the system, but these outfalls affect smaller, individual sites and were therefore not inventoried. However, larger diameter outfalls in the city's system were inventoried, mapped, and modeled. In summary, there are approximately 24 major outfalls to the Salem Ditch, 6 to the Power Canal, 7 to the Lucas Ditch, and 1 to an irrigation ditch west of the urban growth boundary.

4.2 MODEL PARAMETERS

The storm water model consists of two parts, a hydrologic model and a hydraulic model. The hydrologic model consists solely of drainage basins, or geographic areas that drain to a specific point. Each drainage basin is characterized by various input parameters. These input parameters essentially define the basin in terms of how much rainfall is converted to runoff and when the runoff reaches the outlet point. The hydraulic model then routes the runoff through the storm drain network of open channels, detention ponds, and pipelines.

Each of the two parts of the storm water model requires a number of input parameters to sufficiently simulate the actual rainfall events and the resulting effects on storm water sewers. The parameters and input assumptions are explained and summarized in this section.

The area within the Stayton's urban growth boundary was delineated into six major drainage basins as shown in Figure 6. These six major basins were further divided into minor basins which are shown in Figure 7 in Appendix A. The basin parameters for each of the minor basins are summarized in Table 4.1, followed by descriptions of each parameter and how it is calculated.

Table 4.1
Drainage Basin Parameters

Basin	Area (acre)	Avg. Slope (ft/ft)	CCN	Tc (min)	Basin	Area (acre)	Avg. Slope (ft/ft)	CCN	Tc (min)
1	53.8	0.0051	73	133	50	38.5	0.0064	78	125
2	53.7	0.0046	76	44	51	15.8	0.0039	90	15
3	45.5	0.0047	81	89	52	13.9	0.0054	87	77
4	30.9	0.0042	88	107	54	31.6	0.0089	75	62
5	63.9	0.0077	73	158	55	3.2	0.0045	72	97
6	35.5	0.0038	80	133	56	7.3	0.0329	75	25
7	56.4	0.0038	84	177	57	15.2	0.0220	76	25
8	43.1	0.0044	71	164	58	25.4	0.0038	81	75
9	26.7	0.0036	83	33	59	18.8	0.0050	73	133
10	53.0	0.0050	79	121	60	18.5	0.0056	73	146
11	48.9	0.0040	88	113	61	7.2	0.0113	73	126
12	40.5	0.0050	75	108	62	9.4	0.0063	73	142
13	20.8	0.0022	81	26	63	23.1	0.0078	61	118
14	19.7	0.0025	83	27	64	6.9	0.0147	73	45
15A	28.1	0.0052	77	152	65	4.0	0.0036	77	55
15B	25.9	0.0069	66	175	66	18.7	0.0074	72	49
15C	17.4	0.0059	88	118	67	17.3	0.0107	72	33
16	51.9	0.0031	74	107	68	34.9	0.0345	82	15
17	54.4	0.0244	60	78	69	35.6	0.0301	92	20
18	42.3	0.0065	61	37	70	12.2	0.0046	85	15
19	62.4	0.0008	86	199	71	13.2	0.0040	91	92
20	33.1	0.0057	89	27	72	3.8	0.0047	92	4
21	29.7	0.0049	89	90	73	4.8	0.0032	92	9
22	30.4	0.0452	81	5	74	24.9	0.0465	72	34
23	35.8	0.0239	83	4	75	25.2	0.0467	78	20
24	9.7	0.0194	83	47	76	17.9	0.0026	85	25
25	12.3	0.0156	90	32	77	24.9	0.0069	92	70
26	16.6	0.0344	77	33	78	5.1	0.0172	88	20
27	59.1	0.0471	76	50	79	4.7	0.0114	65	21
28	148.0	0.0277	77	90	80	5.9	0.0070	92	7
29	72.0	0.0051	81	146	81	5.8	0.0025	92	15
30	11.6	0.0074	93	17	82	9.8	0.0059	84	63
31A	38.3	0.0047	90	17	83	28.8	0.0521	79	35
31B	14.1	0.0081	89	11	84	9.5	0.0575	82	20
31C	17.4	0.0032	89	94	85	11.8	0.0166	75	44
31D	17.3	0.0063	82	75	86	17.7	0.0398	63	73
32	7.1	0.0029	92	56	87	9.4	0.0371	92	35
33	15.8	0.0048	90	62	88	28.5	0.0093	60	85
34	13.2	0.0052	93	10	89	104.4	0.0296	88	40
35	4.0	0.0067	90	30	90	16.3	0.0660	81	50
36	19.3	0.0036	90	30	91	20.2	0.0529	70	41
37	7.7	0.0027	92	14	92	12.0	0.0494	75	92
38A	3.1	0.0013	92	22	93	12.4	0.0590	75	72
38B	1.5	0.0041	92	8	94	11.2	0.0031	75	60
39	15.0	0.0044	92	11	95	7.8	0.0041	74	63
40	40.7	0.0035	74	84	96	13.3	0.0109	72	38
41	11.2	0.0018	82	70	97A	23.3	0.0359	70	18
42	40.5	0.0017	75	100	97B	8.8	0.0686	72	79
43	47.1	0.0040	75	62	98	12.1	0.0050	73	79
44	11.7	0.0082	75	55	99	12.3	0.0086	70	90
45	3.0	0.0036	87	16	100	9.5	0.0076	72	59
46	8.4	0.0085	72	34	101	10.3	0.0032	70	137
47	14.7	0.0086	85	27	102	10.2	0.0354	70	19
48	11.1	0.0078	72	46	103	15.3	0.0169	74	46
49	15.5	0.0017	86	60	104	34.0	0.0711	73	33
					105	20.3	0.0117	75	67

Tc = Time of Concentration
CCn = Composite Curve Number

4.2.1 Area

The basin area is all of the area that collects and contributes runoff to the basin's outlet point. The basins areas were delineated with the use of two foot contours as shown in Figure 3 in Appendix A. Other physical boundaries such as roads and storm lines were also considered during the basin delineation process. After the basins were delineated, the areas for each of the basins were calculated with the use of a scaled drawing of the city.

4.2.2 Slope

The slope is the average slope along the time of concentration flow path. The slope is computed by dividing the difference between the beginning and ending elevation, by the flow path length. This parameter is given in feet per feet.

4.2.3 Time of Concentration

The time of concentration can be defined as the time at which outflow from a basin is equal to inflow. This state of equilibrium occurs because the drainage basin is assumed to be saturated at the time of concentration and all of the precipitation is going straight to runoff.

The time of concentration is calculated as the sum of the times of travel within the basin. Travel times represent various forms of flow within the basin. The following equations were used to calculate the times of travel for each of the flow types.

- Sheet flow (flow path less than 300 feet): $\mathbf{Ts=0.007*(nL)^{0.8}/(P_2)^{0.5}s^{0.4}}$
  Where: Ts=travel time for sheet flow (hr)
  n=Manning's roughness coefficient (Table 4.2)
  L=flow length (ft)
  P_2=2-year, 24-hour rainfall (in)
  s=slope of a hydraulic grade line (ft/ft)

- Shallow Concentrated Flow (flow path greater than 300 feet):

  - Slopes greater than 0.005: **Tsc=L/V**
    Where: Tsc=travel time for shallow concentrated flow with slopes less than 0.005 (sec)
    L=flow length (ft)
    V=flow velocity (ft/sec) determined from Marion County Chart included in Appendix C.

  - Slopes less than 0.005: $\mathbf{Tss=L/20.3282s^{0.5}}$

Where: Tss=travel time for shallow concentrated flow with slopes less than 0.005 (seconds)
L=flow length (ft)
s=slope of a hydraulic grade line (ft/ft)

- Pipe Flow: **Tp=L/2.0**
  Where: Tp=travel time for pipe flow (seconds)
  L=flow length (ft)
  Assumed: Pipe flow velocity = 2.0 ft/sec

- Total Time of Concentration**: Tc=Ts+Tsc+Tss+Tp**

As can be seen in the preceding equations, several parameters affect the time of concentration. One of the more significant parameters in the time of concentration calculations is the roughness value commonly referred to as Manning's n. The n values listed in the Table 4.2 were utilized in calculating the times of concentration for the various basins.

Table 4.2
Roughness Coefficients
(Manning's n) for Sheet Flow

Surface Description	Manning's n[1]
Smooth Surfaces (Concrete, Asphalt, Gravel or Bare Soil)	0.011
Fallow (No Residue)	0.05
Cultivated Soils:	
Residue Cover $\leq$ 20%	0.06
Residue Cover > 20%	0.17
Grass:	
Short Grass Prairie	0.15
Dense Grasses[2]	0.24
Bermuda Grass	0.41
Range (Natural)	0.13
Woods:[3]	
Light Underbrush	0.40
Dense Ynderbrush	0.80

Notes:
1) The n values are a composite of information compiled by Engman (1986).
2) Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3) When selecting n, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow.

4.2.4 Composite Curve Number

There are several acceptable and well established methods to define a drainage basin's hydrologic character. Use of a curve number implies the application of the principles from the TR-55 Method. The USDA's

"Urban Hydrology for Small Watersheds Technical Release 55" (TR-55) outlines the process for computing the NRCS Curve Number (CN) for minor basins. The CN is used as an index of the potential runoff from a storm event over a given basin. The general relationship between the CN and predicted runoff is the higher the CN, the greater the runoff.

The curve number is based on the hydrologic soil group, ground cover, percent impervious and land use. Table 4.3 from TR-55 shows average CN for a variety of land uses, hydrologic soil groups and ground cover.

In order to accurately assign a CN, it is necessary to determine the percentage of the minor basin area that is impervious or pervious. Pervious surfaces are those which are covered primarily with vegetation and permit the infiltration of water. Impervious areas are those which inhibit infiltration of water, such as pavement, roadways, sidewalks, and roofs. An aerial image of the city was used to directly measure the percent impervious area for typical land use designations such as low density residential, commercial, and industrial areas.

The percent impervious is a key parameter used to determine a composite CN and Tc. Generally, as the percent impervious increases the infiltration decreases, resulting in more rapid runoff, shorter Tc, and greater CN. All of these factors combined lead to higher peak runoff rates.

In addition to land use designations, the permeability of each of the basins is also a function of soil types.

The predominant soil types within each of the minor basins were obtained from the USDA's soil survey data base. Figure 2 in Appendix A depicts a soils map of the City of Stayton. There are four general hydrologic soil groups. Group A soils are defined as soils having high infiltration rates and low runoff rates. Group B soils have moderate infiltration rates. Group C soils have slow infiltration rates. Group D soils have very slow infiltration rates and therefore higher runoff values.

Table 4.3 displays the effects of various land use types and soils groups on curve number values. Modified curve number values specifically calculated for Stayton were used in creating the model, but the values shown in Table 4.3 served as a starting point in assigning curve numbers to the various drainage basins.

Table 4.3
Runoff Curve Numbers For Urban Areas

Land Use	Cover Description		CN for Hydrologic Soil Group			
	Cover Type and Hydrologic Condition	Average % Imp.	A	B	C	D
	Fully Developed urban Areas (Vegetation Established)					
Public/ Semi - Public	Open Space (Lawn, Parks, Golf Courses, Cemeteries, Etc.)[3]					
	Poor Condition (Grass Cover <50%)		68	79	86	89
	Fair Condition (Grass Cover 50% to 75%)		49	69	79	84
	Good Condition (Grass Cover >75%)		39	61	74	80
	Impervious Areas:					
	Paved Parking Lots, Roofs, Driveways, Etc. (Excluding right-of-way)		98	98	98	98
	Streets and Roads: Paved; Curbs and Storm Sewers (including right-of-way)		98	98	98	98
	Paved; open ditches (Including right-of-way)		83	89	92	93
	Gravel (Including right-of-way)		76	85	89	91
	Dirt (Including right-of-way)		72	82	87	89
	Western Desert Urban Areas:					
	Natural Desert Landscaping (pervious areas only)		63	77	85	88
	Artificial Desert Landscaping (Impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Industrial/ Commercial	Urban Districts:					
	Commercial and Business	85	89	92	94	95
	Industrial	72	81	88	91	93
Residential	Residential District by Average Lot Size:					
	1/8 acre or Less (town houses)	65	77	85	90	92
	¼ Acre	38	61	75	83	87
	1/3 acre	30	57	72	81	86
	½ Acre	25	54	70	80	85
	1 Acre	20	51	68	79	84
	2 Acres	12	46	65	77	82
	Developing Urban Areas					
	Newly Graded Areas (pervious area only, no vegetation)		77	86	91	94

4.2.5 Hydraulic Parameters

The hydraulic parameters for the model are the parameters relating to how the runoff from the drainage basin is routed through the network of storm water lines, open channels, and detention facilities. These parameters are calculated from input data on pipe diameter, length, roughness, slope, outfall conditions, and depth below surface. Survey data and record drawings provided most of the necessary input data, and a roughness value of 0.014 was assumed. For unknown pipe inputs, values such as length and slopes were interpolated using know upstream, downstream, and ground elevation data.

The storm water modeling focused on the major storm water lines in the system and other portions of the system which were considered to play an important role in system functionality. The modeled storm water lines are illustrated in Figure 9 in Appendix A.

4.3 MODEL CALIBRATION

This section covers the measures taken to calibrate the storm water model. Typically, calibration for a storm drain model involves more unknowns than for a water or wastewater model. There are a number of reasons for this.

First, the quantity of fluid going into a water or wastewater system is relatively well-defined with meters at pump stations, lift stations, and treatment plants. In contrast, influent into a storm system can be only generally related to precipitation and groundwater and spring water discharge. Many soil, vegetation, climatic, and topographical factors control the relationship between these elements and inflow into a storm drain system.

Second, the quantity of fluid exiting a water and wastewater system is also relatively well-defined with meters on residential and commercial services for water systems and meters at wastewater treatment plants. In contrast, very few storm systems have flow locations that are measured on a regular basis.

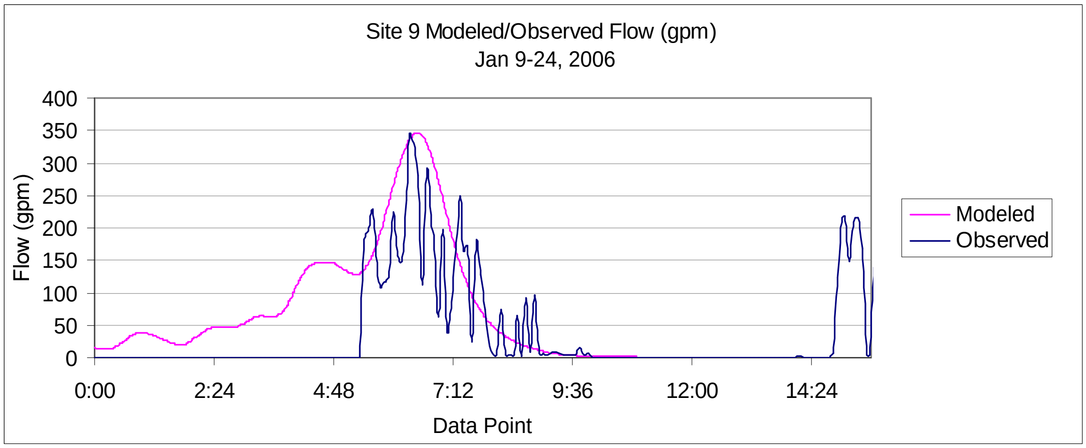
Thirdly, water and wastewater flows are much more regular and predictable. Storm drain flows are dependent on the weather which is much less predictable. Given these considerations, methods that would provide a reasonable assurance that the model accurately reflects field conditions were implemented.

The first method used to calibrate the model involved extensive storm water flow monitoring at ten sites throughout the storm water system. The monitoring was performed during winter months to ensure larger storm events. The rainfall during these events was also recorded in 15-minute increments. Portions of the data collected for both rainfall and flow appeared to be flawed due to instrument malfunctions or other problems. In all cases, the flawed data sets were either thrown out or recollected. The data collected for both pipe flow and rainfall was carefully reviewed for reliability and only reliable data for each of the sites was used.

The same amount and temporal distribution of rainfall for the recorded events was simulated over the applicable basins in the storm water model. The adjustable parameters such as the CN and Tc were used to calibrate the model to actual observed events. Although these parameters are adjustable, they were kept with the bounds of reasonability. Increasing the CN to an unlikely value to match an observed peak flow ignores other potential factors which leads an inaccurate model. To avoid this kind of error, the adjustable parameters were bound within reasonable ranges.

The initial calibration resulted in a very good correlation between modeled and observed flows as shown in Chart 4.1 Calibration Results. The calibration results for the other sites along with a site map have been included in Appendix C.

Chart 4.1
Sample Calibration Results



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Following initial model calibration against observed results at known sites, typical storm events were imposed on the model. The modeled storm events resulted in flooding in specific areas throughout the city. The observed flooding points were reviewed by city staff to provide a reality check. City staff indicated whether or not flooding would actually be observed during storm events in those areas predicted by the model. For areas inconsistent with what the staff had observed, field and survey data were collected in order to validate the model or correct inaccuracies. This process was repeated several times, including gathering input from city council members and the Santiam Water Control District, in order to achieve the desired level of calibration. By design, the flow predictions err on the conservative side of higher peaks and higher volumes.

The final product of the calibration process is shown in Figure 10, Problem Areas. This figure illustrates areas of concern for the storm water system based on model results for the 25 year storm event. The details of the issues surrounding these areas are covered in the Section 5.

SECTION 5 – EXISTING SYSTEM CONDITIONS

5.0 GENERAL

The City of Stayton storm drainage system generally consists of surface flow to catch basins, a subsurface network of pipes, detention facilities, and open channels. Frequent rains combined with the natural drainage characteristics of Stayton result in high runoff volumes which tax the existing system beyond capacity. As a result, flooding and puddling are common occurrences. The majority of the runoff conveyed by the system ultimately drains to Mill Creek through various routes. The evaluation of the storm water system was conducted based upon the design criteria and model parameters established in previous sections.

5.1 DRAINAGE BASIN ASSESSMENTS

This section discusses the general conditions of the storm water system in the city's six major drainage basins. These assessments are based on computer modeling results of the design storm and input from city staff. Figure 6 outlines the major drainage basins discussed in this section, Figure 7 outlines the minor drainage basins, and Figure 10 illustrates some of the problem areas.

As a general note, the city has begun a prioritized television inspection program targeting key segments of the storm water system to verify connectivity and to assess the condition of the lines. The results of the TV inspection will aid the city in further assessing the condition of the existing system.

5.1.1 Mill Creek Basin

The Mill Creek basin occupies the northwestern portion of the urban growth boundary and is largely undeveloped. The hydrologic characteristics of this basin include a high groundwater table, poorly drained soils, relatively open flat lands, and groundcover consisting mostly of natural grasses and agricultural crops.

The combination of these basin characteristics results in high runoff volumes. The runoff generally drains to the Mill Creek through open ditches and sheet flow. The creek runs northwest through the basin. In winter months, areas near the creek's floodplain are saturated. The flat slopes and high ground water in the area present a challenge to installing a traditional subsurface storm drain and detention system. Development in this basin will require a significant amount of attention to the storm water system.

5.1.2 Salem Ditch Shaff Road Basin

The Shaff Road basin contains the majority of the existing storm water system and drains approximately 440 acres, which is the largest portion of the developed area within the urban growth boundary. The drainage basin is nearly all developed and has large areas of commercial and light industrial development. The basin's 48-inch diameter outfall at Shaff Road also carries the largest discharge of all other outfalls in system.

The backbone to the existing storm water network runs northwest through the basin and discharges directly to the Salem Ditch without prior detention or treatment. A few of the drainage problems in this basin include flooding at the intersection of 6th Ave & E. Pine, along Hollister, along 1st Avenue, at the Regis High School gymnasium, at St. Mary's School, and in the Quail Run subdivision as illustrated in Figure 10.

Most of the flooding is caused by inadequate conveyance capacity, but in some cases results from maintenance issues such as catch basins or pipelines being clogged. There is also limited access to maintain the storm lines due to a lack of manholes and catch basins. The existing system is riddled with segments of shallow to adverse slope and minimal ground cover. There are a handful of onsite detention facilities which reduce small portions of the discharge rate, but the runoff is generally undetained and untreated.

5.1.3 Industrial Basin

The Industrial drainage basin is well developed and consists of nearly all industrial land use with the exception of a small high density residential section in the southeast corner. Most of the 94-acre basin drains to an irrigation ditch managed by the Santiam Control District. From the industrial area, the ditch runs northeast to out of the urban growth boundary. This basin has high runoff volumes due to the amount of impervious area.

One of the problems in this basin is that the detention basin in the northwest corner of the basin has an eroded berm. This allows runoff from the neighboring farm to flow into the detention basin, and also allows runoff out of the detention pond into the farm. This can be problematic for both parties because the farm runoff is likely high in nutrients which leads to water quality problems, and it uses capacity needed for runoff from the industrial area. Additionally, the runoff detention from the industrial area could cause damage to the agricultural land and its crops if not properly detained. The other detention ponds in the basin appear to be functioning well.

There are some potential flooding locations under the 25-yr event due to inadequate conveyance, and there are several direct outfalls to the Salem Ditch which have no treatment or detention.

5.1.4 Salem Ditch North, Downtown, and West Basins

The North basin is largely undeveloped agricultural area. The Downtown and West drainage basins make up the south central area of the urban growth boundary and cover about 446 acres. The basins consist of medium to high density residential housing and contain the majority of commercial land use in the city. There is very little undeveloped area and the basin is largely covered by impervious surfaces.

The storm water runoff is collected and discharged to the Salem Ditch through one of the several outfalls located in this basin.

Problems in this basin included undersized conveyance, multiple outfalls, little or no detention, and flooding as shown in Figure 10.

5.1.5 East Stayton Basin

The East Stayton basin is about 540 acres of mostly undeveloped land. The majority of the developed portion of the basin is low to medium density residential housing. The undeveloped area is mostly agricultural land. The future zoning designation for this area is public lands and low density residential housing.

The runoff from the developed portion of the basin drains southwest to the Salem Ditch, and the undeveloped portion drains south to the North Santiam River. The conveyance on 10th Avenue is undersized for the amount of runoff received and flooding is observed at the intersection of 10th Ave and Santiam Street. There is one detention facility at the upstream end of the basin, but no detention on the southern half. The area on the southeast side of the hospital does not appear to have a piped drainage system after the outfall near Robidoux Street where flooding has been reported. The line depths near the south end of the basin on 10th Avenue are as deep as 10 feet in some areas. A segment of the swale constructed behind the lots on Virginia Street is filled in and overgrown.

5.1.6 Lucas Ditch Basin

The Lucas Ditch basin occupies 690 acres in the northeast corner of the urban growth boundary. This basin is mostly undeveloped and collects drainage from rural areas beyond the urban growth boundary. The typical ground cover is natural grass or agricultural crop. The southeast portion has fairly steep slopes, but flattens out to the northwest. The largest detention facility connected to the system is in this basin on the upstream end.

The majority of the runoff discharges to the Lucas Ditch. The Sylvan Springs and Sylvan Meadows developments have wetlands and biofiltration swales which improve the quality of the storm water runoff. There is an onsite detention facility in Sylvan Meadows, but it is undersized for the 50-yr event. The conveyance in the basin is mostly adequate, but there is some flooding expected on Fern Ridge Road and in Sylvan Meadows under the 25-yr event. The Lucas Ditch basin benefits from detention, treatment, and overflow capacity provided by the existing wetland on the west side of Cascade Highway.

5.1.7 Power Canal Basin

The Power Canal basin occupies roughly 116 acres in the southwest corner of the urban growth boundary. This basin is mostly developed and collects drainage from medium to high density residential areas.

The majority of the runoff discharges to the Power Canal through a number of separate outfalls. There are no known storm water detention or water quality facilities in this basin.

SECTION 6 – SUMMARY OF ALTERNATIVE IMPROVEMENTS

6.0 GENERAL

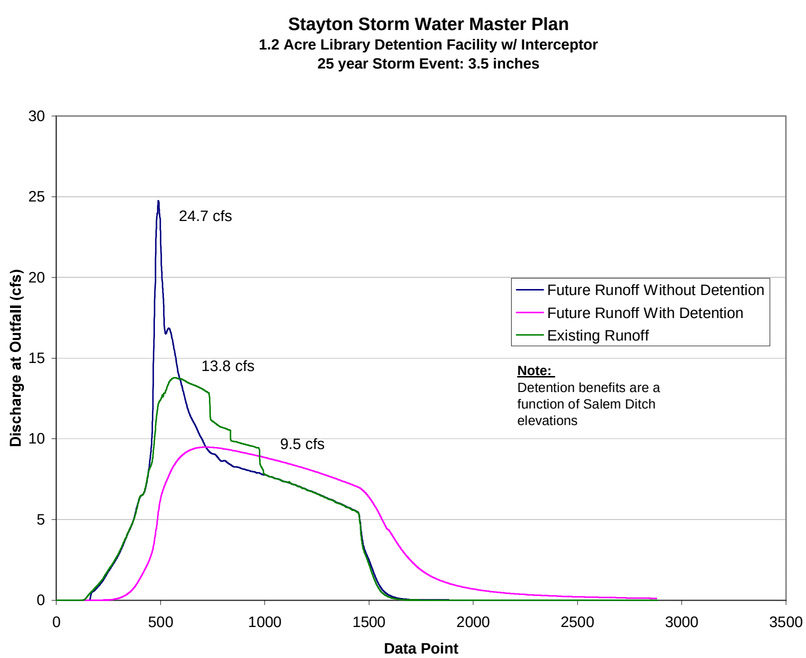
Problem areas or challenges discussed in Section 5 are summarized in Figure 10 in Appendix A. This section summarizes improvement alternatives and their respective costs. These alternatives are organized by drainage basin. The costs for improvements required to eliminate flooding for the 25-year storm are presented.

6.1 NORTH DOWNTOWN DRAINAGE BASIN

As shown in Figure 13, storm water from most of the downtown area from Cascade Highway to 7th Street and Washington Street to Florence Street is discharged directly into the Salem Ditch without either water quality mitigation or detention. During a 25-year storm event, it is estimated that a peak of flow approximately 14 cfs of storm water discharges into the Salem Ditch. Under these conditions, the conveyance pipe network in this area is undersized and flooding occurs in the area. However, if the conveyance pipe network is expanded to eliminate flooding, the storm water flows into Salem Ditch will be larger and more extreme.

Outlined below are two alternatives that were considered to address the storm water flooding in the downtown area. Chart 6.1 shows the effects of detention after improvements are implemented.

Chart 6.1
North Downtown Drainage Alternatives



The **first alternative** is to upsize the existing lines or add parallel pipes to provide adequate conveyance capacity in order to eliminate flooding. Additionally, each discharge into the Salem Ditch would be equipped with water quality mitigation measures. A hydraulic model was constructed to simulate this alternative, and the model predicted that the peak storm water runoff into the Salem Ditch would increase from 14 cfs to approximately 25 cfs. Since the reported capacity of the Salem Ditch is only 120 cfs, this alternative was not considered acceptable and was not pursued further.

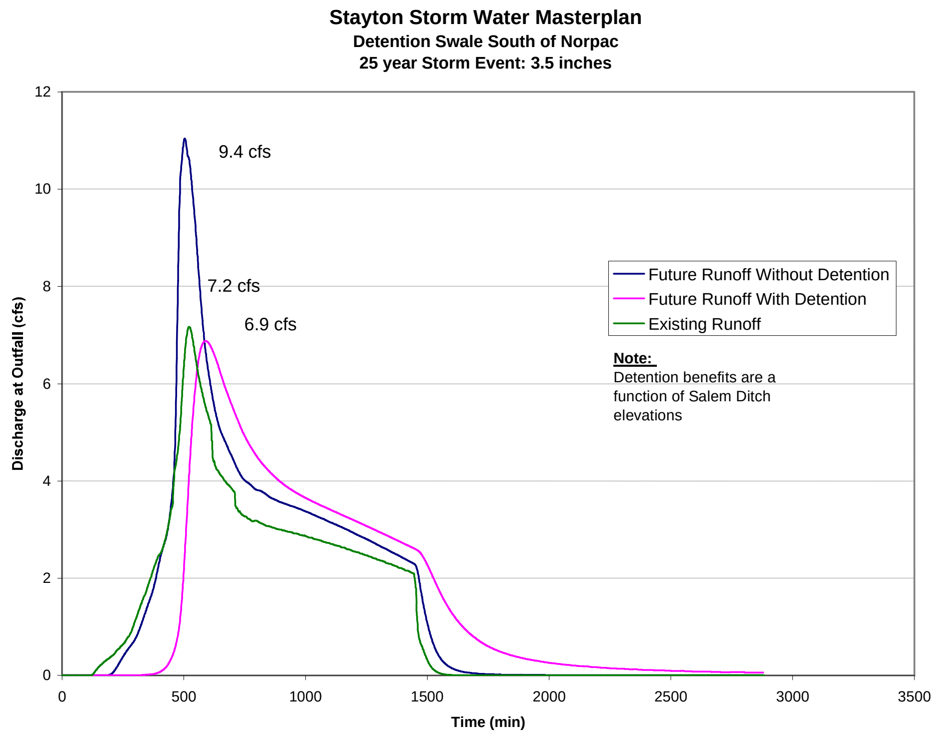
The **second alternative** is to construct a new storm water pipeline that would interceptor the storm water lines that have historically discharged into the Salem Ditch as shown on Figure 12. The new storm water pipeline would discharge into a new regional detention pond located on the Library property that contains approximately 3 ac-ft of storage volume. The detention pond should be designed in such a manner as to provide both water quality and water quantity treatment. Other improvements required include re-sloping the existing storm water pipelines between Salem Ditch and Marion Street to flow north to the new storm water line instead of into Salem Ditch. With the pipeline upgrades shown on Figure 12, the peak flow into the Salem Ditch during a 25-year storm event would be reduced from 25 cfs to 10 cfs because of the proposed detention facility near the Library. The estimated cost for this alternative is $2,115,000.

<u>Recommendation:</u> Based on the information presented above, Keller Associates recommends that the city adopt the **second alternative** as the best solution to the drainage problems in this area. While the first alternative is less expensive, the quantity of storm water inflow into the Salem Ditch exceeds the capacity allotment. Consequently, the first alternative is not feasible. Groundwater modeling at the proposed detention site should be conducted now to provide groundwater trend information during the pre-design phase of the detention facility at the Library.

6.2 SOUTH DOWNTOWN DRAINAGE BASIN

Currently, storm water from most of the downtown area from Cascade Highway to 4th Street and Salem Ditch to Water Street is discharged directly into the Salem Ditch without either water quality mitigation or detention. During a 25-year event, a peak flow approximately 7 cfs of storm water discharges into the Salem Ditch. Under these conditions, the conveyance pipe network in this area is undersized and flooding occurs in the area. Consequently, if the conveyance pipe network is expanded to eliminate flooding, the storm water flows into Salem Ditch will be larger and more extreme. Outlined below are two alternatives that were considered to address the storm water flooding in the downtown area. Chart 6.2 shows the peak reductions expected from the detention facility.

Chart 6.2
South Downtown Drainage Alternatives



The **first alternative** is to upsize the existing lines or add parallel pipes to provide adequate conveyance capacity in order to eliminate flooding. Additionally, each discharge into the Salem Ditch would be equipped with water quality mitigation measures. A hydraulic model was constructed to simulate this alternative, and the model predicted that the peak storm water runoff into the Salem Ditch would increase from 7 cfs to approximately 9 cfs. Since the reported capacity of the Salem Ditch is only 120 cfs, this alternative was not considered acceptable and was not pursued further.

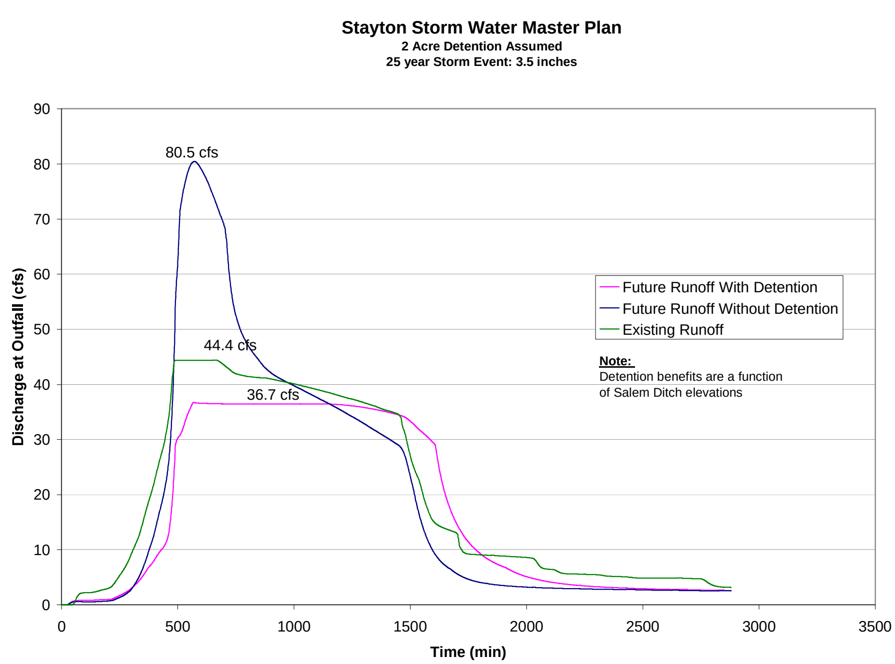
The **second alternative** is to construct a new storm water pipeline that would interceptor the storm water lines that have historically discharged into the Salem Ditch as shown on Figure 13. The new storm water pipeline would discharge into a new regional detention pond that contains approximately 2 ac-ft of storage volume located on property currently owned by Norpac Foods. The detention pond should be designed in such a manner as to provide both water quality and water quantity treatment. Other improvements required include re-sloping the existing storm water pipelines between Ida Street and the Salem Ditch to flow south to the new storm water line instead of into Salem Ditch. With the pipeline upgrades shown on Figure 13 and under a 25-year storm event, the peak flow into the Salem Ditch would be reduced from 9 cfs to 7 cfs because of the proposed detention facility on the Norpac Food site. The estimated cost for this alternative is $1,975,400.

Recommendation: Based on the information presented above, Keller Associates recommends that the city adopt the **second alternative** as the best solution to the drainage problems in this area. While the first alternative is less expensive, the quantity of storm water inflow into the Salem Ditch exceeds the capacity allotment. Consequently, the first alternative is not feasible. However, due to the cost of this improvement in comparison to the benefit, this improvement has been assigned a lower priority. Groundwater modeling at the proposed detention site should be conducted now to provide groundwater trend information during the pre-design phase of the detention facility at the Norpac Foods site. The city should also begin negotiations with property owners to secure property and/or easements for the detention facility site.

6.3 SHAFF ROAD DRAINAGE BASIN

The Shaff Road drainage basin collects storm water from nearly 50% of the city and is a critical component of the storm water conveyance system. This drainage basin discharges into the Salem Ditch at the intersection of the Salem Ditch and Shaff Road. Most of the area in the drainage basin is already developed. Much of the conveyance system in this drainage basin is currently undersized as illustrated in Figure 11. Consequently, if the conveyance pipe network is expanded to eliminate flooding, the storm water flows into Salem Ditch will be larger and more extreme. In order to ensure the flows discharged into Salem Ditch do not exceed the available capacity, detention measures are necessary. Outlined below are two alternative locations considered for the detention facility to address the storm water flooding in the Shaff Road drainage area. Chart 6.3 shows the peak reductions expected from the detention facility.

Chart 6.3
Shaff Road Basin Drainage Alternatives



The **first alternative** location for the detention facility was an area located on the west edge of the Regis High School property near the intersection of the Regis Street and Cascade Highway. At this location there is an existing large depression area in the grassy area north of the baseball fields. Under large storm events, this area would provide temporary storage volume until the large storm event passes and then water in this area would flow back into the conveyance system and on to the Salem Ditch. It was hoped that this interim detention facility would provide enough reduction of the peak flows in the conveyance downstream to eliminate the need to upsize the conveyance system downstream. While this would provide interim detention, this detention facility would not eliminate the need for end-of-the-line detention. The hydraulic model was used to simulate this alternative. Based on the model results, the existing area did not provide nearly enough detention to eliminate flooding in the conveyance system downstream. Consequently, this alternative was not considered acceptable and was not pursued further.

The **second alternative** is to upsize the entire conveyance system with either larger pipes or parallel pipes to convey the peak 25-year storm event through the conveyance system. After upsize the conveyance system, the peak storm flows at Salem Ditch increase from 44 cfs to 81 cfs. Consequently, a detention facility with a storage volume of 10.4 ac-feet near Salem Ditch is required. The proposed location of this facility is shown on Figure 11. The detention pond should be designed in such a manner as to provide both water quality and water quantity treatment. With the detention facility and under a 25-year storm event, the peak flow into the Salem Ditch would be reduced from 81 cfs to 37 cfs. The estimated cost for this alternative is $5,330,200.

Recommendation: Based on the information presented above, Keller Associates recommends that the city adopt the **second alternative** as the best solution to the drainage problems in this area. While the first alternative is less expensive, the quantity of storm water detention at the Regis High School site is not adequate to eliminate the need to upsize the conveyance pipelines downstream. Consequently, the first alternative is not cost effective. Groundwater modeling at the proposed detention site should be conducted now to provide groundwater trend information during the design phase of the detention facility near Salem Ditch. Furthermore, property and/or easements should be pursued for the detention facility site.

6.4 GENERAL DETENTION ALTERNATIVES

Three general types of detention alternatives are regional detention, local detention, and onsite detention. A regional detention facility would detain runoff from several minor basins, while a local detention facility detains runoff from one minor basin, and onsite detention would be designed to detain runoff from a single development within a minor basin. These three types can be effective individually, or in a variety of combinations depending on the major and minor basin characteristics. Each of the major and minor drainage basins was evaluated for which type of detention facility would best suit the specific area both on the local level and the regional level. Figure 11 in Appendix A summarizes the master plan recommendations for which type of detention facility works best for each area in the system.

For minor basins 12, 13, and 15A, show in Figure 7, a regional detention site was recommended because these basins would not otherwise drain effectively given their proximity to the Mill Creek, the relatively flat slopes, and high water table. Minor basins 6, 7, and 8A were also best suited to a regional site because their runoff is naturally routed to the same outfall point on Mill Creek, and the land at that point is available for a regional site. A few of the other basins with regional detention include the northern section of the Shaff Road basin, the southern section of the Shaff Road basin, and the southeast portion of the Lucas Ditch basin.

Minor basin 11 is the bordered by Mill Creek on the north and it does not have enough cover above the water table to feasibly collect runoff from other upstream basins, therefore local detention was the best option for this minor basin. The same is true for minor basins15C, 15B, and 19.

The city currently has a policy of requiring onsite detention for redevelopment and commercial developments, which is recommended as a continued practice. The runoff from these developments could either discharge directly to the receiving waters or continue through the storm system to a local or regional detention facility. This policy assists in reducing pollutants through the use of BMPs and further mitigates flooding impacts.

SECTION 7 – WATER QUALITY

7.0 GENERAL

Storm water management has historically emphasized flood control. However, in recent years the focus has shifted to include water quality management. Storm water quality in Oregon is regulated by three main programs. This section summarizes these programs and Stayton's current position with regard to each of them. This storm water master plan provides the framework for the city to be prepared to meet all regulatory requirements.

7.1 REGULATORY PROGRAMS

7.1.1 UIC Program

The Underground Injection Control (UIC) Program was enacted in 1974 for management of fluid injection underground, in order to protect groundwater aquifers from contamination. The primary goal of the UIC Program is to preserve groundwater for beneficial uses such as drinking water. The Oregon Department of Environmental Quality (DEQ) has been delegated primacy to administer the UIC program for Oregon.

The DEQ administers the UIC program under Oregon Administrative Rule (OAR) 340-044. According to this rule, underground injection activities must be authorized through DEQ, either by registering the injection system and meeting general regulatory requirements ("rule authorized") or by obtaining a permit.

A strict definition of a UIC is "any system, structure, or activity that is created to emplace fluid directly into the subsurface." A few examples of storm water UICs are drywells, trench drains, sumps, perforated piping, floor drains, and drill holes. Single residential roof or footing drains that receive only storm water are exempt from UIC requirements.

The DEQ has developed guidance documents and forms to facilitate compliance with the UIC program. A document titled *UIC Program Information* has been prepared as part of this master plan to provide guidance for the city relating to underground injection systems and it can be found in Appendix D.5.

The known UICs in the storm water system in are in the registration or decommissioning process. Given the general ground water and soil characteristics in Stayton, it is recommended that underground injection be used only if all other storm water discharge options have been ruled out.

7.1.2 NPDES Program- Phase II

Point source discharges to waters of the U.S., including storm water, are regulated through NPDES permits issued by the U.S. Environmental Protection Agency (EPA) or by authorized states. In Oregon, NPDES permits are issued and implemented by the DEQ. The Water Pollution Control Act (Oregon Revised Statute 468B) is the primary Oregon State law protecting water quality.

DEQ combines the federal NPDES regulations with pertinent state regulations and issues combined permits that regulate discharges to waters of the U.S. and waters of the state. These permits are designed to meet NPDES permit requirements and state law under the Water Pollution Control Act. Waters of the state include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, and the Pacific Ocean within the territorial limits of the State of Oregon. In general, the waters of state include all bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except private waters which do not combine with surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.

The storm water portion of the federal NPDES regulations has been implemented in two phases. Phase I addressed storm water discharges by large and medium municipal separate storm sewer systems (MS4s) and certain industrial activities, including construction sites disturbing more than 5 acres (The term “separate” means that wastewater such as sewage is not combined with storm water runoff). The Phase I storm water regulations were published in 1990. Phase II addressed MS4s in smaller municipalities and construction sites disturbing between 1 and 5 acres; those regulations were adopted in 1999. Municipalities with a population of 10,000 or more are candidate Phase II communities. Stayton is not currently designated as a Phase II community.

DEQ requires Phase II municipalities to adopt ordinances and implement minimum measures and BMPs equivalent to those in the federal guidance and in DEQ’s Internal Management Directive—Phase II MS4 General Permit: Storm Water Management Program Plan Framework (June 2003). Under the Phase II rules, municipalities may be subject not only to the requirements of MS4 owners and operators, but also to two other components of the federal NPDES storm water program, also delegated to DEQ for implementation:

- The Industrial Storm Water General Permit as an operator of regulated industrial activity

- The Construction Storm Water General Permit as an operator of regulated construction activity disturbing more than 1 acre of land disturbed.

Each of the three components of the NPDES storm water program (municipal, industrial and construction) has its own requirements and permits.

Although Stayton is currently not required to meet NPDES Phase II requirements, the city has expressed the desire to be in a position on to meet these requirements. A separate document titled *Stormwater NPDES Phase II Program Plan* was prepared by Tetra Tech KCM as part of this master plan to provide the framework necessary for the city to meet Phase II requirements when required. This document can be found in Appendix D. In addition the preparing the city to meet phase II requirements, the program's approach will serve as a springboard to meet the requirements of the Willamette River TMDL program.

7.1.3 Total Maximum Daily Load Program

The Federal Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be established when a water body does not meet water quality standards. The majority of Stayton's runoff eventually discharges to the Mill Creek which has been listed as water quality impaired under the Willamette Basin TMDL. The DEQ adopted a TMDL for the Willamette Basin in September 2006, and Stayton was identified as a "designated management agency" (DMA) in the Willamette River TMDL. A designated management agency is held responsible to mange water quality within their jurisdiction. As such, Stayton is required to develop a TMDL Implementation Plan to address TMDL allocations within their jurisdiction. TMDL Implementation Plans are due within 18 months from the date of the Notification Letters that DEQ sends to DMAs, permitees, and other affected parties. The Notification Letters were sent out by DEQ within 20 days of the TMDL being issued as an Order by DEQ. For Stayton, the final implementation plan must be submitted to the DEQ by March 2008.

The pollutants of concern in the Willamette Basin TMDL are temperature, bacteria, and mercury. The required elements for TMDL implementation plans are defined in OAR 340-042-0080(3). In summary, the requirements are:

- Develop and implement best management practices (BMPs) or other management strategies to achieve TMDL load allocations.

- Develop a timeline for implementation and a schedule for completing measurable milestones.

- Develop a monitoring plan to determine whether:

  - BMPs are being implemented
  - Individual BMPs are effective
  - TMDL load allocations are being met
  - Water quality criteria are being met

- Evidence of compliance with applicable statewide land use requirements.

- DMAs also will have to include a storm water management component in their TMDL Implementation Plans.

- DMAs with a population between 10,000 and 50,000 will have to address the six minimum control measures identified in the NPDES Phase II program.

- DMAs with a population less than 10,000 are expected to give considerations to any of the measures that are relevant.

To assist the city in getting started on the TMDL program, a document titled *Strategies for Reducing Pollutants in Surface Waters* was prepared by Tetra Tech KCM as part of this master plan. This document identifies the pollutants of concern and lists several BMPs which could be applied. This document can be found in Appendix D.4.

7.2 STORM WATER DRAINAGE STANDARDS

The storm water drainage standards for the city are contained in a separate document which provides guidance to developers building within Stayton's urban growth boundary. The standards touch on all aspects of water quantity and water quality management including conveyance, detention, and minimum BMP requirements. As Stayton continues to grow, this document serves as the rule by which the future storm drainage system will be constructed. It is, therefore, imperative for this document to be consistent with the city's goals for effective storm water management.

In connection with this master plan, Stayton's storm water drainage standards were found lacking in light of the city's storm water needs. The standards were carefully reviewed by Tetra Tech KCM and several improvements were recommended to the Technical Review Committee. These improvements were approved by the committee and incorporated into the draft set of standards. One of the most notable changes to the standards is the expansion of the water quality practices, and BMPs listed in the appendices of the draft standards. The draft revisions to the Storm Water Drainage Standards have been included in Appendix F.

The recommended revisions to the design standards have been developed to meet the city's goal of being prepared to meet future storm water regulatory requirements and target the specific needs of the city based in its geographic location and hydrologic conditions. Additionally, the recommendations are consistent with industry standards, neighboring communities, and regional practices.

The recommended revisions were specifically compared with the standards in the recently published *Central Oregon Stormwater Manual* (COSM). This manual was developed through a coordinated effort of cities and counties in Central Oregon and provides storm water guidance in such a way that a managing agency could wholly adopt the manual as their storm water design standards. However, the standards contained in COSM are geared to the climatic and hydro-geologic conditions of central Oregon rather than those found in Stayton. Therefore, not all of the recommendations in COSM should be directly applied to Stayton's storm water standards. Nevertheless, the principal methods and BMPs that can be applied in either region are consistent with the recommended improvements in the Draft Stayton Storm Water Drainage Standards.

7.3 INITIAL WATER QUALITY TESTING

In March of 2007, four storm water samples were collected from two inlet and outlet points to the storm water system. The points were chosen on the basis of their ability to provide a "before and after" picture of the storm water as it passes through the city's system. The samples were tested for Biochemical Oxygen Demand, Chemical Oxygen Demand (COD), Orthophosphate-phosphorus, Specific Conductivity, Total Solids, Total Suspended Solids (TSS), Turbidity, Hardness, pH, Phosphorus, and Ecoli.

A copy of the original laboratory report has been included in Appendix D, and the results have been summarized in Table 7.1. The results show that the water quality appears generally quite good with very little if any degradation. The COD, solids, and phosphorus concentrations all decreased from inlet upstream of Stayton to outlet downstream of Stayton.

More testing over an extended period will be required before any firm conclusions can be drawn on the storm water quality, but initial testing appears promising. There are currently not any regulatory mandates for the city to perform storm water quality testing. However, if testing is continued, the Willamette Basin TMDL parameters of temperature, bacteria, and mercury should be given first priority for monitoring and in defining BMP implementations. Other pollutants which are often a concern with storm water include zinc, copper & lead, COD, and TSS, so if expanded testing is to be done these pollutants may be considered as second priority. Little to no degradation through Stayton several water quality parameters actually improving downstream (Keller Associates recommends that additional samples be gathered in future)

Table 7.1
Initial Water Quality Test Results

Constituent	Upstream Concentration	Downstream Concentration
Copper	ND	ND
Lead	ND	ND
Magnesium	1.09 mg/L	1.16 mg/L
Zinc	ND	ND
Mercury	ND	ND
BOD	ND	ND
COD	5.12 mg/L	ND mg/L
E. Coli	6.3 mpn/100 ml	14.8 mpn/100 ml
Orthophosphate – Phosphorus	ND	ND
Phosphorus	0.0498 mg/L	0.0225 mg/L
TSS	20 mg/L	ND
Turbidity	3.22 NTU	2.13 NTU
pH	7.33 pH units	7.31 pH units

SECTION 8 – OPERATION, MAINTENANCE, AND REPLACEMENT

8.0 GENERAL

Proper maintenance enables the storm water system to function as designed; however, it requires dedication of significant resources. This section covers recommendations for the operation, maintenance, and replacement programs for the storm water system. The costs associated with these programs are also evaluated and summarized. The specifics of financing and total system costs are covered more completely in a supplementary report provided by Economic and Financial Analysis found in Appendix G.1.

8.1 O&M TASKS

The City of Stayton's storm water conveyance system consists of approximately 20 detention facilities and an estimated 15 miles of pipe ranging from 6 to 48 inches in diameter. The system also includes roughly 650 catch basins and several small to medium sized biofiltration swales and open channels summing to nearly 8 miles in length excluding the Power Canal, Salem Ditch, and Mill Creek.

Operation and maintenance of the city's storm water system includes, but is not limited to:

- Daily implementation and tracking of Best Management Practices as outlined in the forthcoming TMDL implementation plan.
- Regular water quality sampling. (not required by regulating agencies, but recommended).
- Annual TMDL Implementation Plan reporting.
- Annual review and revision of storm water master plan and implementation plan enforcement of storm water standards and plans through development construction plan review.
- Preparing budgets and implementing improvements.
- Public outreach and education.
- Code enforcement and construction storm water prevention plan monitoring.
- Annual catch basin cleaning.

- Regular TV inspection and cleaning of storm lines.
- Equipment Maintenance and coordination.
- Routine open channel maintenance.
- Routine detention basin maintenance.
- System inspection.

A detailed discussion of these tasks and the accompanying replacement programs is covered in the following subsections.

8.2 BEST MANAGEMENT PRACTICES (BMPS)

The forthcoming TMDL Implementation Plan will outline the specific BMPs the city will follow. While the majority of these BMPs will be targeted at reducing the TMDL pollutants, they will also address storm water in general with the intent of ensuring a properly functioning system.

Each of the BMPs listed in the TMDL Implementation Plan will have a benchmark associated with it, and a means for tracking the effectiveness of the particular BMP. If, for example, street sweeping is a BMP, the amount of sediment picked up would be tracked and recorded to compare its effectiveness to other BMPs. The tracking and implementation would need to be summarized and reported annually to DEQ.

There will need to be coordination, planning, and enforcement behind the BMPs to ensure they are implemented correctly and that they are an effective use of the city's resources. The majority of the cost associated with this task will come from the additional staffing requirements.

8.3 SYSTEM MAINTENANCE

The storm water conveyance system involves significant and regular maintenance to ensure that pipelines, catch basins, and detention sites facilitate flows during the design storm event. Different maintenance tasks and programs for the system are outlined below.

8.3.1 Overview of Cleaning Program

Pipelines. It is necessary to provide regular TV inspection to determine pipeline conditions and then clean and repair the pipelines as needed. Sediment build-up in the pipelines reduces their capacity and increases the potential for flooding. Sediment build-up also results in higher pollutant concentrations flushed out during large storm events. Other problems that could reduce the conveyance capacity of the storm water lines are broken or cracked pipelines, offset joints, root intrusion, and other blockage. A regular cleaning and TV program for the storm water pipelines will enable the city to identify and prioritize the pipelines in need of maintenance.

Records and notes of conditions and corrective actions should be kept. The records will aid the city in tracking maintenance problem areas. These areas can then be evaluated for potential source elimination. It is recommended that all the storm water pipelines be cleaned every 3 years or more regularly if TV records justify a higher cleaning frequency. Annual cleaning is recommended for lines with significant root intrusion. The cleaning and TV inspection work has been subcontracted out in the past. The cost of pipeline cleaning and inspection depends on if the work is contracted out or performed by city staff. Subsection 8.3.3 reviews and compares these costs.

Catch Basins & Sand/Grease Traps. Some of the catch basins, particularly in the older parts of town, are damaged and need to be replaced. New catch basins may also need to be added where drainage and slopes are not adequate. At a minimum, catch basins need to be cleaned when sediment or debris blocks more than 1/3 of the pipe. Sand/grease traps need to be cleaned when 1 inch of sediment has accumulated in the sand trap, or when 1 inch of oil/grease has accumulated in the grease trap.

Records and notes of conditions and corrective actions should be kept. According to a study titled *Evaluation of Catch Basin Performance for Urban Stormwater Pollution Control* (Aronson et al, 1983. EPA-600/2-83-043), it is recommended that all catch basins be cleaned at least annually. A catch basin's effectiveness increases with more frequent cleanings.

Catch basin cleaning can be coordinated with line cleaning and TV inspection. If lines are cleaned and inspected every three years, approximately 1/3 of the lines and catch basins will be cleaned yearly. This leaves 2/3 of the catch basins to be cleaned independently of the storm lines.

The cost of cleaning the catch basins is evaluated in subsection 8.3.3 which compares the cost of contracting the work out and performing it in-house with city equipment and city employees.

Detention Facilities and Open Channels. Many of Stayton's detention facilities have grates on both the inlet and outlet pipes. Grates should be cleaned regularly and the control structures should be inspected and cleaned as well. The areas around the detention facilities should be sprayed for weeds. The timing and type of spray used for this should be such that it does not impair water quality or damage vegetation used for sediment filtering. Open detention facilities should be cleared of any trash or debris on a regular basis.

If detention facilities have a vegetative cover, mowing and other maintenance will be required during growing seasons. The base of the detention facilities are generally designed to be 6" below the outlet. If sediment accrual causes the base elevation to be level with or exceed the outfall elevation the detention facility will no longer function properly. When this occurs, the facility should be dredged. Similar maintenance should be performed on and around biofiltration swales and open channels.

The mowing and spraying is currently budgeted through other departments, but all aspects of the storm system maintenance should be paid for through the storm utility fees. For equipment used in multiple departments, the cost should be allocated to each department according to usage.

After reviewing the storm water O&M tasks with the TRC, Keller Associates estimates that it will require two seasonal workers working approximately 6 months per year at an estimated $15/hr without benefits. In addition to the labor cost, there are the equipment and supply costs associated with these tasks which have been summarized in Table 8.1.

Table 8.1
Detention Basin and Open Channel Maintenance

Equipment and Supplies	Rounded Annual Cost
Tractor ($23K/15yrs)	$1,600
Flail Mower ($10K/5yrs)	$2,000
Chemical Sprays	$2,500
Equipment fuel	$1,000
Equipment maintenance	$1,000
Seasonal Labor Cost	
Pond/Swale Maintenance	$30,000
Rounded Total	**$38,000**

Street Sweeping. In Stayton, the street sweeping is performed by the streets department. While staff support and equipment costs have not been included for street sweeping in this report, street sweeping is an important part of the storm water operation and maintenance procedures in pollution prevention and control. The sweeping frequency necessary will vary from one area to the next. Keller Associates recommends the city keep records of the quantity of debris removed (tons/year) by the street sweeping equipment. These records should be reviewed periodically to identify higher maintenance areas which may require more frequent cleaning or erosion control measures.

8.3.2 Overview of Flow Monitoring Program

Flow and water quality monitoring at strategic locations will enable the city to document both water quality and water quantity impacts to the receiving streams including the Power Canal, Salem Ditch, Mill Creek, and the North Santiam River.

Keller Associates recommends that periodic flow and water quality monitoring programs be initiated and continued indefinitely. To be successful in this effort, the city will need additional staff. Water quality monitoring equipment has been recommended as part of the capital improvement plan. Keller Associates recommends pulling samples at least quarterly. For planning purposes, a quarterly sample routine was assumed for 15 locations testing mercury, bacteria, and other pollutants of concern. Based on these assumptions, the annual cost for water quality monitoring is $12,000. Testing for additional parameters can increase the cost significantly.

8.3.3 Ownership versus Contracting

According the contractor currently performing the storm line cleaning and inspection for the city, a two-man crew can clean and TV storm lines at the rate of 3,000 feet per day for regularly maintained lines. For poorly maintained lines, which typify the current state of the city's system, the pace slows to 400 feet per day or less. In addition to sediment build-up, another factor affecting the cost of cleaning the storm lines is root intrusion. Hollister, between 6th and 1st, and Gardner between Regis and Shaff, are two examples of storm lines severely impacted by tree roots. Root cutting is an additional maintenance item with rates ranging from 1,000 ft per day to 3,000 ft per day.

The initial time required for cleaning, TV inspecting, and root cutting may be extremely high based on work already performed by the city's contractor. However, once the system is under control and annual maintenance is performed, the time and effort required will drop considerably. For planning purposes, a cleaning and TV rate of 3,000 ft/day will be used.

The city currently has its own cleaning rig, but it is reportedly too old to be used or feasibly repaired. According to a recent survey of suppliers, fully equipped cleaning and inspection rigs cost approximately $300,000. Assuming the cost is split between the storm water and wastewater budgets, the annualized capital cost of the TV equipment for the storm systems portion would be about $14,400 per year based on a 15 year equipment life and 5% interest rate.

A 3-year cleaning and TV cycle requires 5 miles of the total 15 to be cleaned annually which, based on a 3,000 ft/day estimate, amounts to approximately 20 man-days per year (based on 2-man crew at 10 days). The estimated cost of about $270 per working day per FTE yields the annual cost of $5,400 per year to clean and TV the lines.

Assuming the cost for catch basin cleaning would be essentially equivalent for either contracted price or in-house price, the annual catch basin cleaning cost would be $16,500.

Therefore, total annual labor and equipment cost for cleaning and TV inspection for the city to do the work would be approximately $36,500 per year.

Current subcontracted cleaning and TV costs are about $0.43/ft assuming the lines are regularly maintained. Poorly maintained lines can cost up to $5/ft. Based on a 3-year cleaning and TV inspection cycle it would cost the city approximately $11,500 per year to subcontract these services and an additional $3,500 per year for root cutting or additional cleaning costs for high maintenance lines. The estimated annual contracted cost is $15,000.

According to the contractor currently cleaning catch basins for the city, the cost for catch cleaning varies depending on unit size and conditions, but on average the cost is about $25.00 per catch basin, which totals about $16,500 annually.

Therefore, total estimated contracted cost for cleaning, televising, and catch basin cleaning is $31,500.

At this time, it is more cost effective for the city is to hire the work out than to purchase equipment and set aside personnel dedicated to the storm water system. However, as the storm water and wastewater systems grow, the cost effective solution will be for the city to purchase the equipment and perform its own cleaning and TV inspection.

One additional reason why the city should consider purchasing their own equipment in the more immediate future, would be to give the city the flexibility to clean and TV monitor without scheduling it with a third party. City staff could respond more quickly to debris blockages that may cause flooding or ponding during storm events.

The city's current plan is to purchase TV equipment as part of the waste water capital improvement plan. In light of the additional benefit from using the TV equipment for the storm water system, the city could justify making the purchase of the equipment a higher priority. Keller Associates recommends the city assume the cleaning in 2011 and hire additional staffing with the acquisition of the new equipment.

8.3.4 Storm Water System Replacement Program

As broken or offset pipe sections are identified through TV monitoring and flow monitoring, Keller Associates recommends that these areas be documented and included in a replacement program. Pipeline and manhole replacement and rehabilitation needs will only increase as the storm water conveyance system ages.

The replacement program is based on the total amount of pipe not included in the priority improvements and its estimated useful life. There are approximately 13 miles of storm lines not already included in the capital improvement plan that were considered for the replacement program. Assuming an average of a 40-year remaining useful life, the replacement program should target approximately 1,716 feet of pipe, 14 catch basins and 6 manholes per year. Assuming an average pipe replacement cost of $85/ft, a catch basin cost of $1,800 each, and a manhole cost of $3,500 each, the city would need an annual replacement budget of about $192,000. Table 8.2 summarizes the annual replacement program targets and the associated costs.

Table 8.2
Summary of Annual Replacement Costs

Facilities	Units	Unit Cost	Total Cost
Lineal Feet of Storm Lines	1,716	$85/ft	$145,900
Number of Catch Basins	14	$1,800 EA	$25,200
Number of Manholes	6	$3,500 EA	$21,000
Rounded Total Annual Replacement Cost @ 40 yrs			**$192,000**

8.3.5 System Replacement and Management

As the system is replaced, maintained, and updated, there are several issues to consider. Among these are coordination with other utility and roadway improvements, replacement methods, low maintenance systems, continuous updates to the storm system base map, and system inventory measures.

Rehabilitation Techniques. Rehabilitation techniques may include a combination of traditional and emerging trenchless techniques.

Appropriate techniques will vary from one project to the next. Some of these techniques include:

- Open cut replacements are recommended when pipeline grade corrections are needed, when spot repairs are needed, or when previously planned surface restoration / disturbance make it cost effective.

- Trenchless technologies include pipe lining and pipe bursting. Pipe lining may include slip lining with a smaller pipe, instituform, fold-in-form, and similar technologies. These approaches are cost effective where an open cut approach results in extensive surface repairs or high excavation and backfill costs. Trenchless technologies are typically faster and require less surface disturbance than traditional open cut approaches and are sometimes used when minimizing traffic disruptions is critical to the project.

- Pipe bursting entails pulling a continuous HDPE pipe through an existing sewer pipe using a bursting tool. Bursting is especially cost effective for pipelines 12-inch and smaller and may result in a 20% construction savings. Pipe bursting can also be used for pipeline upsizing (typically, upsize is limited to 1 larger nominal pipe diameter). Other considerations with this method include pipe depth, soil type, and utility interference.

- Manhole and catch basin rehabilitation techniques include special liners, special grouting, and replacement.

- It should be noted that there are many locations inside the storm water service area where there is inadequate access to the storm water conveyance system. This condition is particularly true in the downtown area. Consequently, it is recommended that during rehabilitation projects, catch basins and storm water manholes be added as needed to provide more access for cleaning and video equipment.

- As storm lines are replaced, it is recommended that root intrusion technologies be considered where roots are an existing problem or are likely to become a problem in the future. These technologies often include either a polymer plate or plastic sheeting as a liner in the trench.

Keller Associates has had success on rehabilitation projects by allowing open cut and trenchless technologies to be competitively bid against each other.

Base Map Management. As portions of the system are replaced, abandoned, altered, or discovered the storm water base map created as part of this master plan should updated on a monthly basis. Accurate base maps will serve as a powerful tool for effective system maintenance and management.

System Inventory. Keller Associates recommends that the city track system conditions and problems via a GIS or maintenance management software such as Oasis, Hansen, or custom program using the city's existing GIS. Logging conditions over time will help prioritize replacement projects and plan for replacement needs.

Low Maintenance Systems. New storm water system products become available on a regular basis. New equipment may reduce maintenance time requirements and yield significant cost savings in the long run. For this purpose, the storm water system manager should make an effort to stay current with emerging technologies.

Improvement Coordination. Estimated costs for improving the storm water system can be reduced considerably through coordinating multiple improvements at one time such as streets and other utilities.

8.3.6 Staffing

Until the city purchases the cleaning and inspection equipment, much of the maintenance work will be contracted out. Therefore, the staffing recommendation in this scenario is two seasonal employees to handle the water quality sampling, and the cleaning, mowing, and spraying of the detention facilities and swales. There will also need to be a 0.25 FTE in a management position to manage the seasonal workers, coordinate work with the contractor, and complete the reporting and tracking requirements of the TMDL implementation plan.

Once the city purchases the cleaning and inspection equipment, a two-man crew will need to be hired in addition to the existing storm water staff. This two-man crew would spend 50% of their time on the storm water system, and 50% of their time on the waste water system. Table 8.4 summarizes the current and future staffing recommendations.

Table 8.3
Staffing Recommendations

Staffing	Comments
2.0 PTE	Two seasonal workers for 6 months of the year.
0.25 FTE	One storm water manager spending 25% time on the storm system.

0. 25 FTE	**Total until 2011**
2.0 PTE	
2 PTE	Two seasonal workers for 6 months of the year.
0.25 FTE	One storm water manager spending 25% time on the storm system.
1 FTE	Storm cleaning and maintenance (part of a 2 man crew spending 50% time on the storm water system)
1.25 FTE	**Total after 2011**
2.0 PTE	

8.4 ANNUAL O&M AND REPLACEMENT COST SUMMARY

The costs presented in previous subsections are summarized in Table 8.4. The costs are largely based on quantities and will therefore need to be updated as the system grows and as unit costs change. Budgeting updates should be performed at least annually to ensure the storm water master plan implementation is on track.

Table 8.4
Annual Operations, Maintenance, and Replacement Budget

Task	Cost	Frequency
Seasonal Maintenance	$30,000	per year (2 seasonal workers)
FTE City Staff	$87,500	per year (1.25 FTE time at 70k/yr)
Water Quality Lab Fees	$12,000	per year (contracted price)
Equipment and Supplies	$22,400	per year
System Replacement Program	$192,000	per year (excludes CIP projects)
Total Rounded Cost*	**$344,000**	**per year**

***** The costs shown in Table 8.3 do not include the annual costs associated with the capital improvement plan which specifically targets priority improvements intended to bring the storm water system to the standards established by the TRC. The capital improvement plan is presented in Section 9.

****** The costs shown in Table 8.3 also do not include potential management fees assessed by other jurisdictions (i.e. county or Santiam Water Control District).

SECTION 9 – CAPITAL IMPROVEMENT PLAN

9.0 GENERAL

This section summarizes the recommended capital improvements and their associated costs. Recommended improvements are illustrated in Figure 12 in Appendix A.

9.1 CAPITAL IMPROVEMENT PLAN

The capital improvement plan costs were prioritized based on their urgency to mitigate existing deficiencies and for servicing anticipated growth. Figure 10 in Appendix A illustrates the problem areas for the 2-year, 5-year, and 10-year storm events. *Probable cost estimates are in 2007 dollars for improvements necessary to correct flooding for the 25-year storm event have been summarized below.* Details of the costs estimates presented below for each project can be found in Appendix E.

9.1.1 Priority 1

Priority 1A improvements were considered most urgent and include improvements that will improve both water quantity and water quality discharges into various receiving streams. Priority 1B improvements correct flooding problems that pose substantial and immediate threat to property for the largest portions of the city. The total estimated project cost for all the Priority 1 Improvements is $8,518,300. All of the improvements are illustrated in Figure 12 and are color-coded by priority.

1A Improvements:

- Establish a wetland preserve area just south of the Cascade Highway Interchange on Hwy 22. This wetland preserve will provide a plant and wildlife refuge as well as water quality benefits for runoff routed through the area prior to discharging to Mill Creek. This improvement includes the purchase of approximately 35 acres. The land purchase price for this area is anticipated to range from $18,000 to $20,000 per acre. <u>Estimated Project Cost = $792,000</u>

- Construct a regional detention facility near the intersection of Shaff Road and the Salem Ditch. This detention facility should provide a minimum of 10.4 ac-ft of storage volume and be designed to also provide water quality treatment in the basin and the outlet structure. This facility will provide detention for the majority of the storm water collected by the system, and will reduce peak storm water runoff into the Salem Ditch from 25 cfs to 10 cfs. The detention facility could also be designed to double as a recreation area during dry periods. Estimated Project Cost = $1,754,700

- Construct a regional detention facility in the existing City Park area off Marion Street. This detention facility should provide a minimum of 8 ac-ft of storage volume and be designed to provide water quality treatment in the basin and the outlet structure. This facility will provide detention for storm water collected from a majority of the southeast portion of the city and reduce peak storm water runoffs from 28 cfs to 15 cfs into the Salem Ditch. The detention facility could be designed to double as a recreation area also during dry periods. Estimated Project Cost = $765,100

1B Improvements:

- Divert runoff from the agricultural field directly west of the industrial detention facility by constructing a berm and conveying agricultural runoff to an existing drain. Retrofit water quality features to the existing outlet structure. The existing detention facility is not sized to handle agricultural runoff. Estimated Project Cost = $95,000

- Increase the conveyance capacity of the Shaff Road Basin conveyance system by upsizing sections of pipe and installing parallel pipes as illustrated in Figure 12. The detention facility off Shaff Road outlined in the section 1A Improvements is necessary prior to this improvement. Estimated Project Cost = $3,575,500

- Increase the conveyance capacity of the 10th Avenue Basin conveyance system by upsizing sections of pipe and installing parallel pipes as illustrated in Figure 12. The detention facility in the City Park area outlined in the section 1A Improvements is necessary prior to this improvement. Estimated Project Cost = $818,500

- Construct a regional detention facility on property currently owned by Norpac located near the intersection of Evergreen Street and Washington Street. This detention facility should provide a minimum of 3 ac-ft of storage volume and be designed to also provide water quality treatment in the basin and the outlet structure. The detention facility could also be designed to double as a recreation area during dry periods. Estimated Project Cost = $620,800

- Install 5 storm water quality monitoring manholes at strategic points throughout the system. The water quality manholes include the cost of installing a new manhole and the cost of automated, refrigerated sampling equipment withy the accompanying operational software. The samples pulled at these manholes can be an effective way to track the bottom-line benefits from the implementation of various BMPs and provide the city with solid data supporting their efforts to reach TMDL load allocations. The capital improvement plan already accounts for storm water quality monitoring manholes at discharge points downstream of future and existing detention facilities. The intent of these additional manholes is to provide the city some flexibility should the need arise to monitor water quality at points in the system other than those already designated. Estimated Project Cost = $96,700

9.1.2 Priority 2 Improvements

Priority 2 improvements correct problems that pose a smaller and less immediate threat to human health and property. Priority 2 improvements predominantly correct flooding and capacity problems in the downtown area and are estimated to cost $5,024,800.

- Construct a parallel 36-inch storm pipe from Fir to Regis Street through the Regis High School parking lot. This improvement is necessary to eliminate flooding in the school parking lot. Estimated Project Cost = $358,800

- Increase the conveyance capacity of the conveyance system that will discharge into the proposed Priority 1B regional lift station near the intersection of Evergreen and Washington streets by constructing parallel 12-inch pipes. The regional detention facility outlined in the section 1B Improvements is necessary prior to this improvement. Estimated Project Cost = $575,600

- Implement the best apparent alternative improvements outlined in Section 6 for the North Downtown Drainage Basin by constructing a regional detention facility near the library and rerouting all the storm water lines that discharge directly into Salem Ditch with a new large storm line along Marion Street. This detention facility should provide a minimum of 3.6 ac-ft of storage volume and be designed to provide water quality treatment also. This facility will reduce peak storm water runoffs from 25 cfs to 10 cfs into the Salem Ditch. The detention facility could be designed to double as a recreation area also during dry periods. Estimated Project Cost = $2,115,000

- Implement the best apparent alternative improvements outlined in Chapter 6 for the South Downtown Drainage Basin by constructing a regional detention facility on property owned by Norpac north of Holly Avenue and rerouting all the storm water lines that discharge directly into Salem Ditch with a new large storm line along Ida Street. This detention facility should provide a minimum of 2 ac-ft of storage volume and be designed to also provide water quality treatment. This facility will reduce peak storm water runoff into the Salem Ditch from 9 cfs to 7 cfs. The detention facility could also be designed to double as a recreation area during dry periods. Due to the large project cost in comparison to the relatively small benefit, this improvement would have a lower priority than other Priority 2 improvements. Estimated Project Cost = $1,975,400

9.1.3 Priority 3 Improvements

Priority 3 improvements correct problems that pose less immediate threat to health or property. Priority 3 improvements predominantly correct flooding and capacity problems under the 25-year storm event in the northwest part of town and are estimated to cost $2,178,900.

- Construct a parallel 12-inch storm pipe in the Sylvan Meadows subdivision to adequately convey storm water to the detention pond. The detention pond overflow elevation should be surveyed to determine if it is too high and thereby causing flooding at the Storm Water manhole rim in the walking path located south east of the pond. To prevent upstream flooding in the walking path, the weir elevation should be at least 1 foot lower than the upstream manhole rim elevation. If the weir needs to be lowered, the potential for expanding the pond area to make up for the lost volume should be investigated. Estimated Project Cost = $72,100

- Increase the conveyance capacity of the conveyance system along Locust Street and Gardner Road by installing parallel lines on Locust from the High School to Gardner, and on Gardner from Locust to Regis. These improvements are based on the assumption there are no storm lines through the high school property connecting Locust to Gardner or Regis. Flow tests performed by Keller Associates and city staff indicate there may be some interconnections, but this could not be verified through TV inspection. If connecting lines are found at some future date, these recommended improvements could be reduced or even eliminated. Estimated Project Cost = $637,800

- Construct a parallel 24 to 30-inch storm pipe starting in Wilshire Drive to just west of Wilco Road. Sections of this alignment are in the back of residential lots. Estimated Project Cost = $736,600

- Construct a parallel storm pipes in portions of the Westtown Park Subdivision. Sections of this alignment are in the back of residential lots. Estimated Project Cost = $732,400

9.1.4 Priority 4 Improvements

Priority 4 improvements predominantly correct flooding and capacity problems under the 25-year storm event in the south part of town and are estimated to cost $470,900.

- Construct a new 15-inch storm pipe in the area west of the Library property to intercept multiple direct discharges into Salem Ditch and redirect this runoff into the proposed detention basin on the site. This improvement will provide water quantity and quality mitigation. The detention basin in Priority 2 improvements is a prerequisite to this improvement. Estimated Project Cost = $49,500

- Upsize the existing storm water pipe along 1st Avenue from Florence to the discharge into the Power Canal with a new 15-inch storm pipe. Estimated Project Cost = $122,300

- Construct a regional detention facility on the site on the southeast corner of the intersection of Washington Street and the Salem Ditch that will mitigate water quality and water quantity challenges for storm water runoff. This detention facility should provide a minimum of 1.5 ac-ft of storage volume and be designed to provide water quality treatment. Existing storm water piping should be modified to redirect storm water into the proposed detention facility and then discharged into Salem Ditch through the existing discharge pipe. The detention facility could also be designed to double as a recreation area during dry periods. Negotiations for easements or land acquisition for the site should be initiated now. Estimated Project Cost = $216,600

- Upsize the existing storm water pipe along the undeveloped portion of North Peach Street to the discharge into the Salem Ditch with a new 18-inch storm pipe. Estimated Project Cost = $82,500

9.1.5 Future Improvements

Future improvements are necessary to expand the storm water utility to the undeveloped property inside the urban growth boundary. The future improvements summarized below are estimated to cost $9,746,700. Because these improvements are largely development driven they should be development financed.

- Upsize the storm water pipe along Pacific Court with a single 24-inch storm line with a new alignment to consolidate the outfalls in this area. Estimated Project Cost = $349,600

- Improvements to expand the city's storm water facilities along Fern Ridge Road to accommodate undeveloped lands in the area include parallel pipes and regional detention facilities as shown in Figure 12. The location, sizing, and alignment of these facilities should be coordinated and verified during the development review process. Estimated Project Cost = $1,701,400

- Improvements to expand the city's storm water facilities to the Dozler property include conveyance pipelines and a regional detention facility with a detention volume of approximately 5 acre-feet. The location, sizing, and alignment of these facilities should be coordinated and verified during the development review process. Estimated Project Cost = $740,800

- Improvements to expand the city's storm water facilities to the Phillips property include conveyance pipelines and a regional detention swale as shown on Figure 12. The location, sizing, and alignment of these facilities should be coordinated and verified during the development review process. These facilities should be sized to accommodate existing runoff from the Quail Run Subdivision area. Estimated Project Cost = $1,991,900

- Upsize the existing storm water pipe along the north portion of Larch Avenue that discharges into the Salem Ditch with a new 15-inch storm pipe. Estimated Project Cost = $130,200

- Improvements necessary to expand the city's storm water facilities to other undeveloped lands in the urban growth boundary include conveyance storm water pipelines and regional detention facilities as shown in Figure 12. The location, sizing, and alignment of these facilities should be coordinated and verified during the development review process. Estimated Project Cost = $3,402,000

- Establish a fund for pipeline upsize costs. For planning purposes, sizes over 18" have been considered eligible for upsize cost subsidies. Estimated Project Cost = $1,430,800

9.1.6 Improvements Summary

A summary of the recommended improvements organized by priority is presented below. A graphical illustration of each improvement is provided on Figure 12, and each improvement has been labeled with the priority number presented in Table 9.1.

Table 9.1
Capital Improvement Plan

Item (2007 Project Costs*)	Priority 1	Priority 2	Priority 3	Priority 4	Future	Total
Priority 1 (2008)						
1A						
Wetland Preservation	$792,000					
Shaff Road Detention Basin and piping	$1,754,700					
10th Ave Detention Basin and piping	$765,100					
PRIORITY 1A SUBTOTAL	$3,311,800					
1B						
Industrial Detention Site Improvements	$95,000					
Shaff Road Basin Pipeline Improvements	$3,575,500					
10th Avenue Pipeline Improvements	$818,500					
Norpac NE Detention Site	$620,800					
5 Additional Manhole Monitoring Equipement	$96,700					
PRIORITY 1B SUBTOTAL	$5,206,500					
Total Priority 1	***$8,518,300***					
Priority 2 (2010)						
Fir to Regis through Regis HS Parking Lot		$358,800				
Evergreen Ave to Norpac Dtn Site		$575,600				
3rd and Jefferson to Library Dtn Site		$2,115,000				
Millstream Woods to Norpac SW Dtn Site		$1,975,400				
Total Priority 2		***$5,024,800***				
Priority 3 (2015)						
Sylvan Meadows Subdivision			$72,100			
Gardner Road-Regis High School			$637,800			
Wedgewood Place			$736,600			
Western Avenue			$732,400			
Total Priority 3			***$2,178,900***			
Priority 4 (2020)						
Library Improvements				$49,500		
1st Avenue				$122,300		
Washington Street Area				$216,600		
North Peach Street				$82,500		
Total Priority 4				***$470,900***		
Future*						
Pacific Court					$349,600	
Fern Ridge Street Area					$1,701,400	
Dozler Property Area					$740,800	
Phillips Property Area					$1,991,900	
Larch Avenue					$130,200	
Detention Facilities					$3,402,000	
Pipeline Upsize Costs (over 18")					$1,430,800	
Total Future					***$9,746,700***	
TOTAL (rounded)	**$8,518,300**	**$5,024,800**	**$2,178,900**	**$470,900**	**$9,746,700**	**$25,939,600**

* All costs in 2007 Dollars. Costs include engineering and contingencies.
** Timing depends on when growth occurs. Development participation anticipated.

SECTION 10 – STORM WATER SYSTEM FUNDING

10.0 GENERAL

Stayton's existing storm water system is in need of several improvements which require a substantial amount of funding. In addition to the previously identified improvements, the storm water system requires regular maintenance and replacement. The City of Stayton currently pays for storm water operations and maintenance from a combination of general funds, wastewater funds, water funds, park funds, street funds, and contributions from private developers.

Keller Associates' subconsultant Economic & Financial Analysis (EFA) has reviewed the city's current financing practices and has recommended several changes which are summarized in this section. An evaluation of potential funding sources, and details of the financial analysis have been included in a supplemental report found in Appendix G.1

10.1 STORM WATER FINANCING

Because a storm water utility does not exist as a financial entity, it does not accumulate cash savings or earn interest on investments. The storm water utility existed in the General Fund until fiscal year 2006-07, when it was transferred to the sewer fund, as part of the sanitary sewer utility. Under these current financial conditions, necessary repairs and maintenance of the system tend to compete with other capital projects such as street repairs. As such, it is recommended the city create a separate storm water utility.

The annual storm water budget should cover the phased costs for funding the replacement program, capital improvements, and O&M. The capital improvement costs are covered in Section 9, the replacement costs along with the operation and maintenance costs are covered in Section 8.

The total annual operation, maintenance, and replacement cost is estimated at $344,000. In addition to these recurring annual costs, the necessary capital improvements to the storm water system total $26 million dollars. It is recommended that the portion of this total cost that will go to projects benefiting future development be funded from a system development charge (SDC). The SDC will ensure each future development pays its proportionate share of the capital improvement costs. The remaining costs not covered by the SDC will have to be paid by all of the city's residents and businesses through a storm water utility fee.

10.2 OTHER POTENTIAL STORM WATER FUNDING SOURCES

Outside of funds gathered by the city through the recommended SDCs and storm water utility fees, there are other sources of funding from private and government programs which may be available for the city to aid in the implementation of this master plan.

With the aid of the Boise State University Environmental Finance Center, twenty-five sources of potential funding have been identified as having specific application to Stayton's storm water system financing. It is recommended that the city review the application requirements for each of these sources and apply for as many as possible. These potential sources are listed in Appendix G.2

Appendix A
Figures

FIGURES:

KELLER associates

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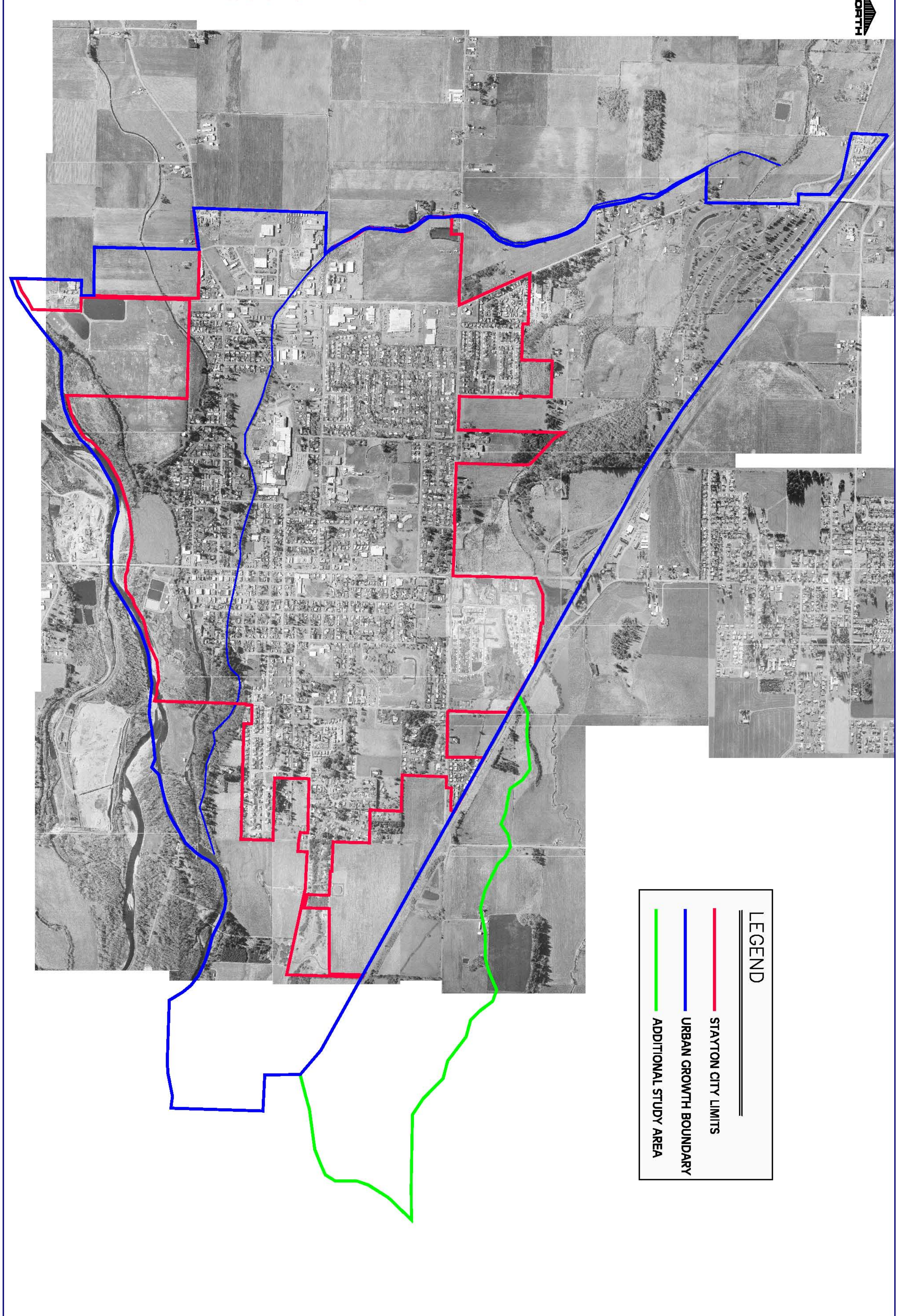
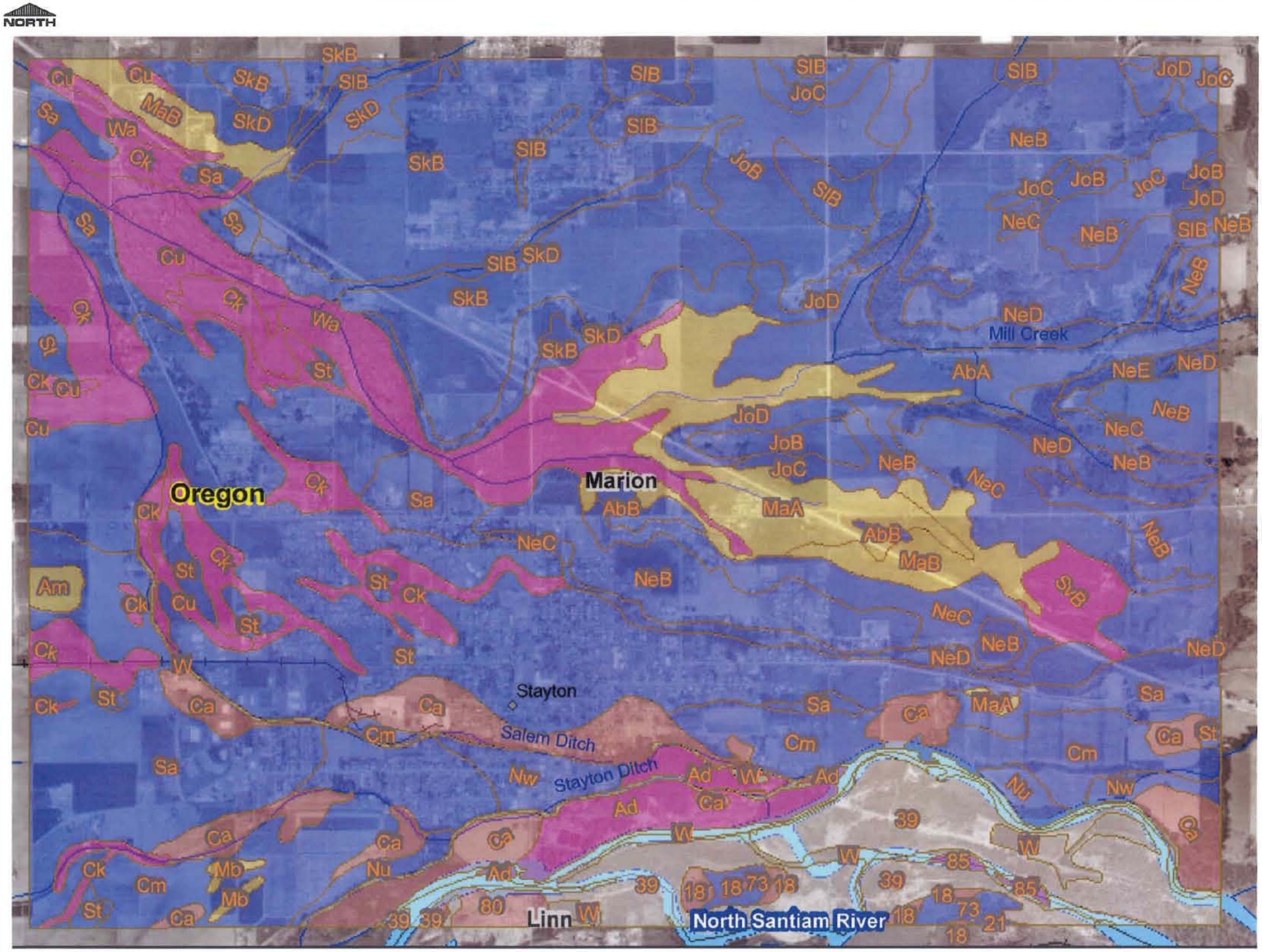


FIGURE 1	Study Area	Storm Water Master Plan Stayton, OR	KELLER ASSOCIATES	KA:104037 FIG-1.dwg



LEGEND

A
INCLUDES SOIL TYPES: Ca

B
INCLUDES SOIL TYPES: AbA, AbB, Cm, JoB, JoC, JoD, NeB, NeC, NeD, NeE, Nu, Nw, Sa, SkB, SkD, SlB, St

C
INCLUDES SOIL TYPES: Am, MaA, MaB, Mb

D
INCLUDES SOIL TYPES: Ad, Ck, Cu, SvB, Wa

NR/NA

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FIG-2.dwg

KELLER ASSOCIATES

Storm Water Master Plan
Stayton, OR

Soil Types

FIGURE 2

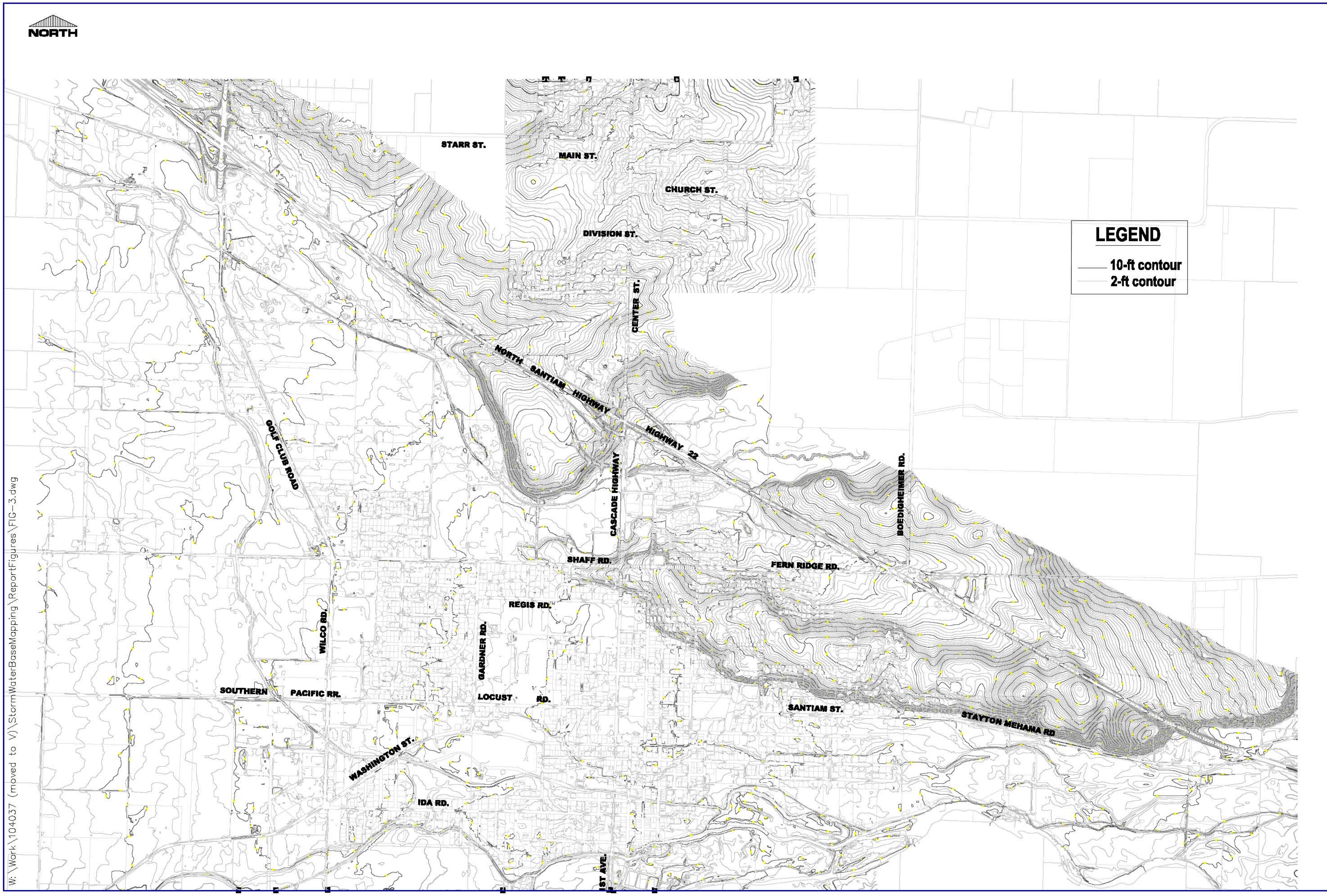

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FIG-3.dwg

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CITY OF STAYTON

Storm Water Master Plan
Stayton, OR

TOPOGRAPHY

FIGURE 3

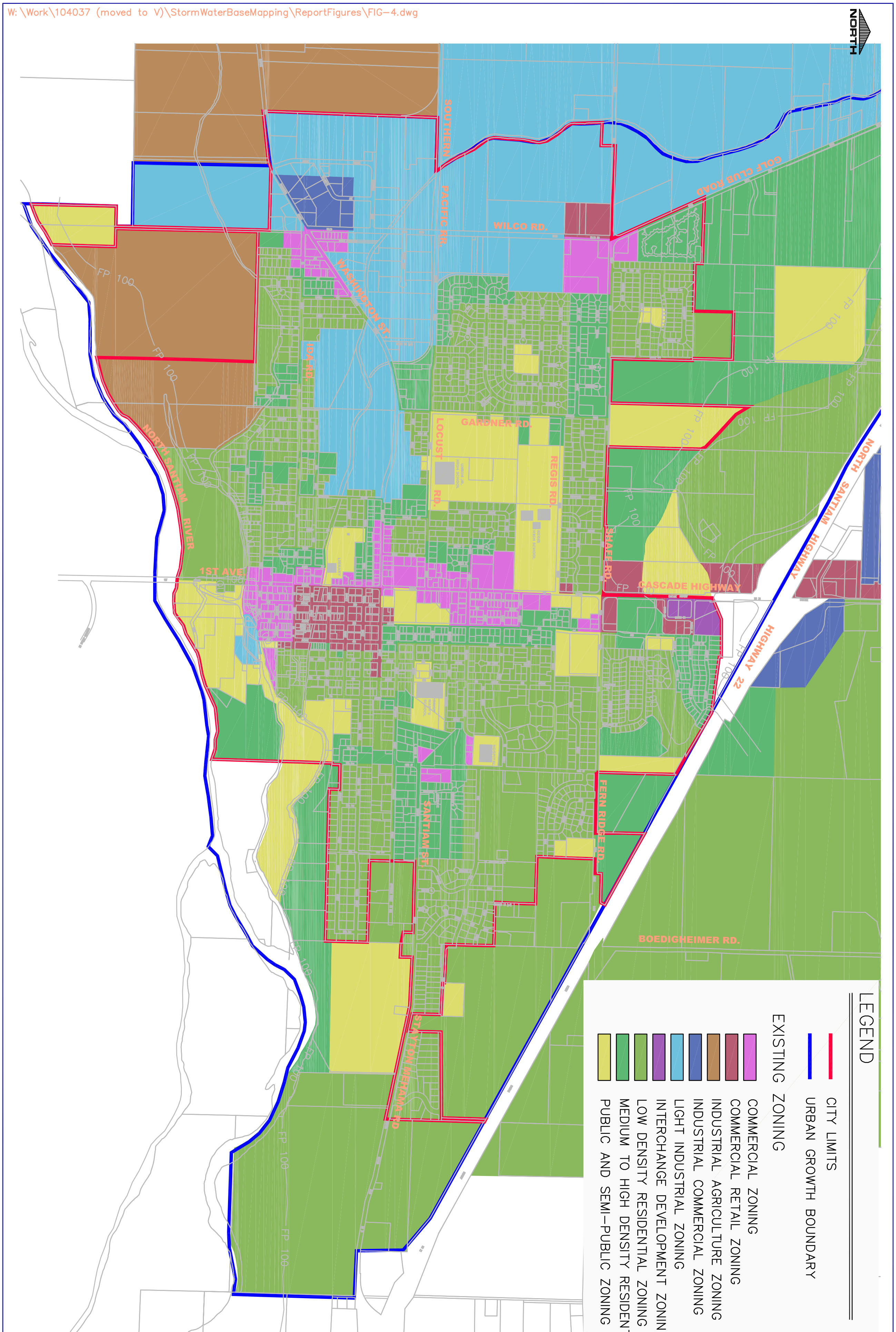

FIGURE 4

Land Use

Storm Water Master Plan
Stayton, OR

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FIG-4.dwg

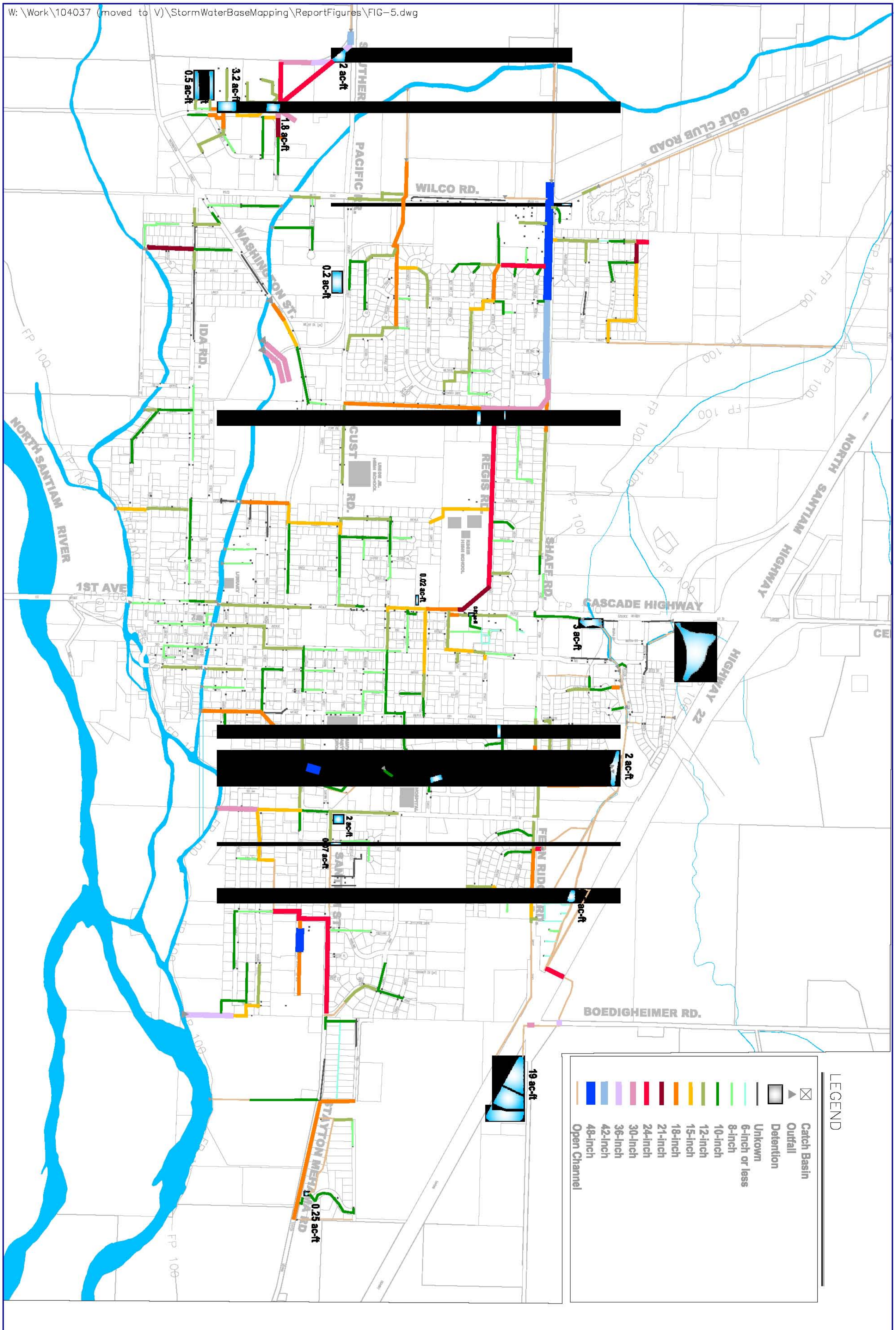

FIGURE 5

Existing Storm System

Storm Water Master Plan
Stayton, OR

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FIG-5.dwg

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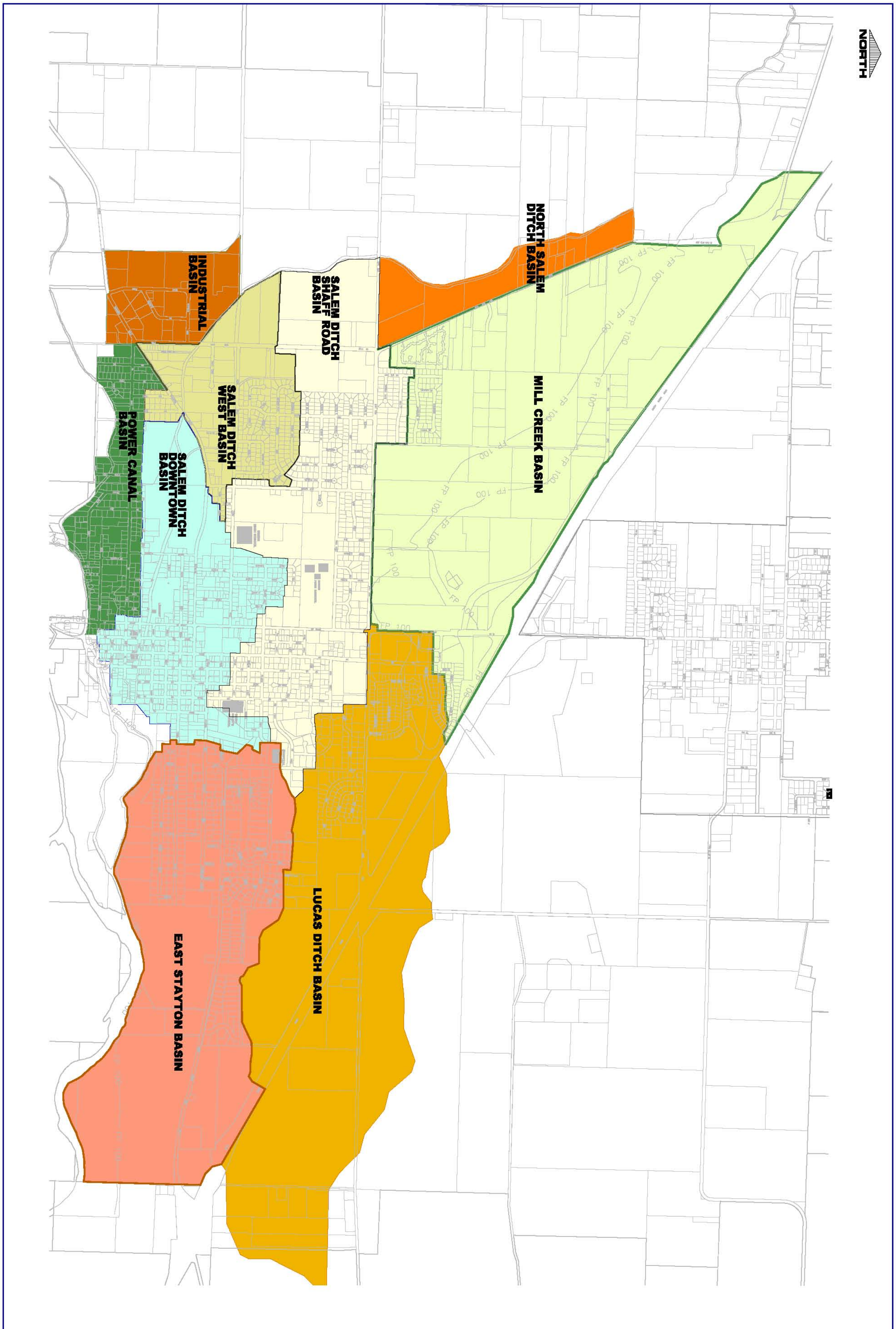

FIGURE 6 | Major Drainage Basins | Storm Water Master Plan Stayton, OR | KELLER ASSOCIATES | KA:104037 FIG-6.dwg

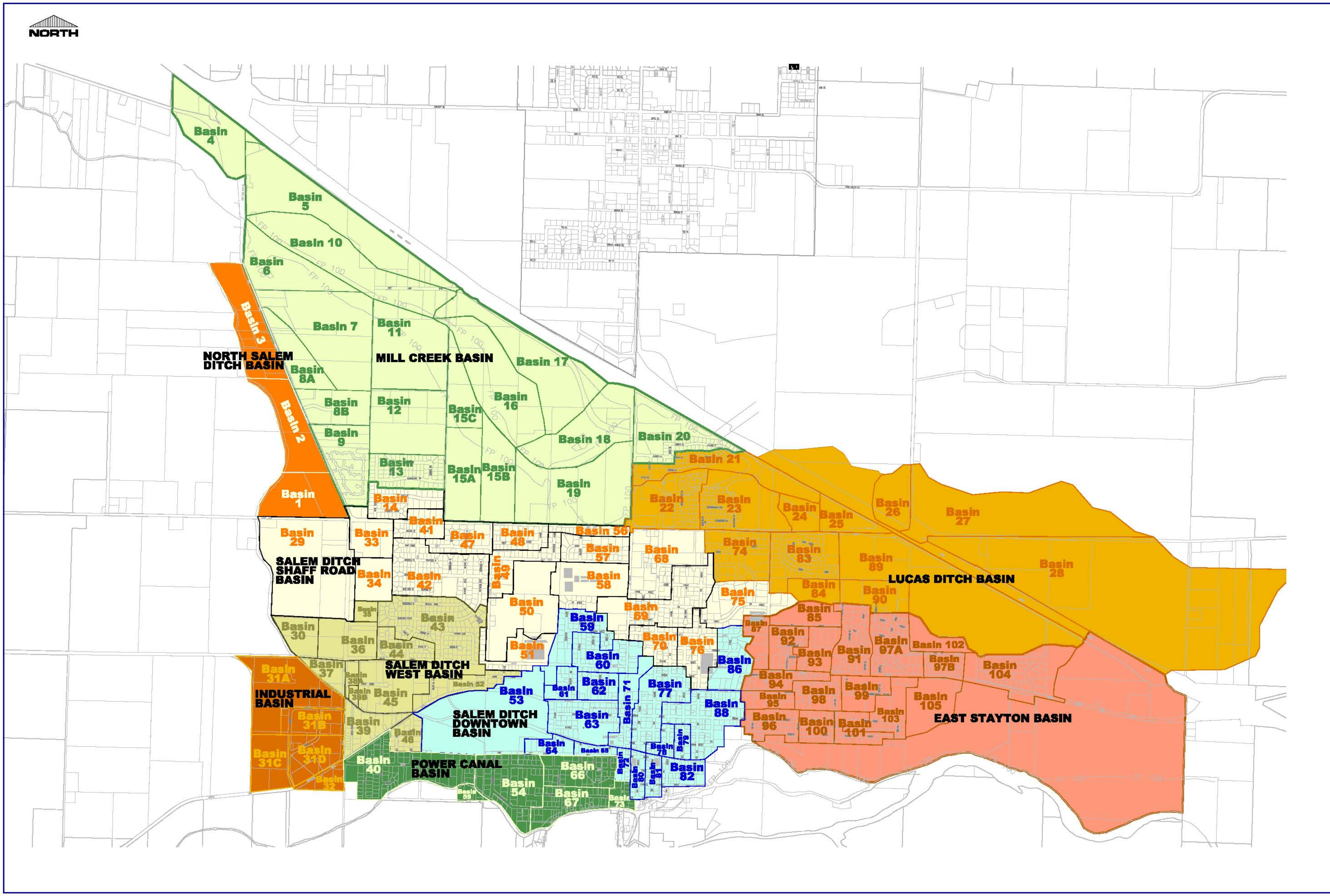

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FIG-7.dwg

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CITY OF STAYTON

Storm Water Master Plan

Stayton, OR

Minor Drainage Basins

FIGURE

7

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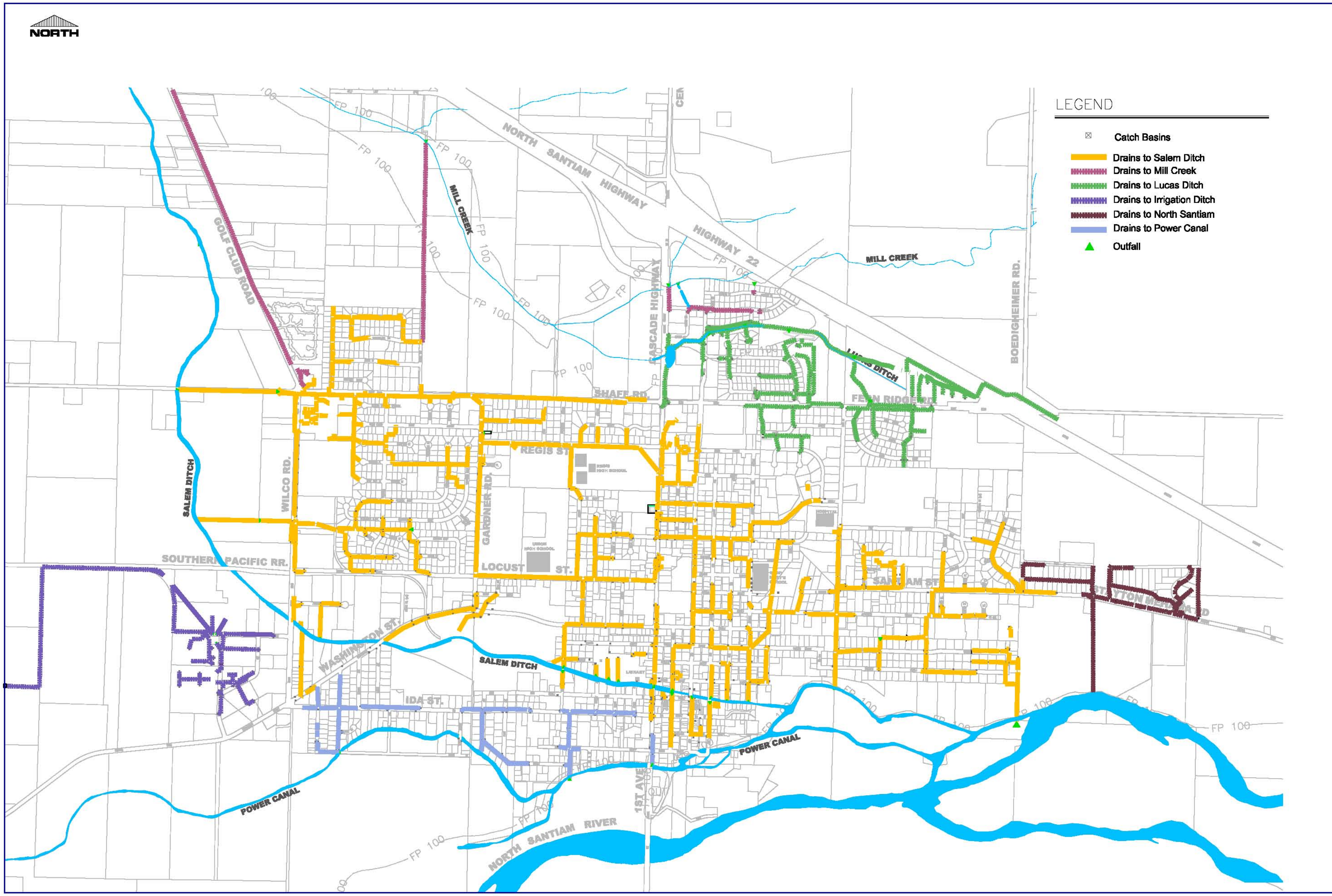

Storm Water Master Plan
Stayton, OR

Existing Drainage Areas

FIGURE 8

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FIG-8.dwg

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CITY OF STAYTON

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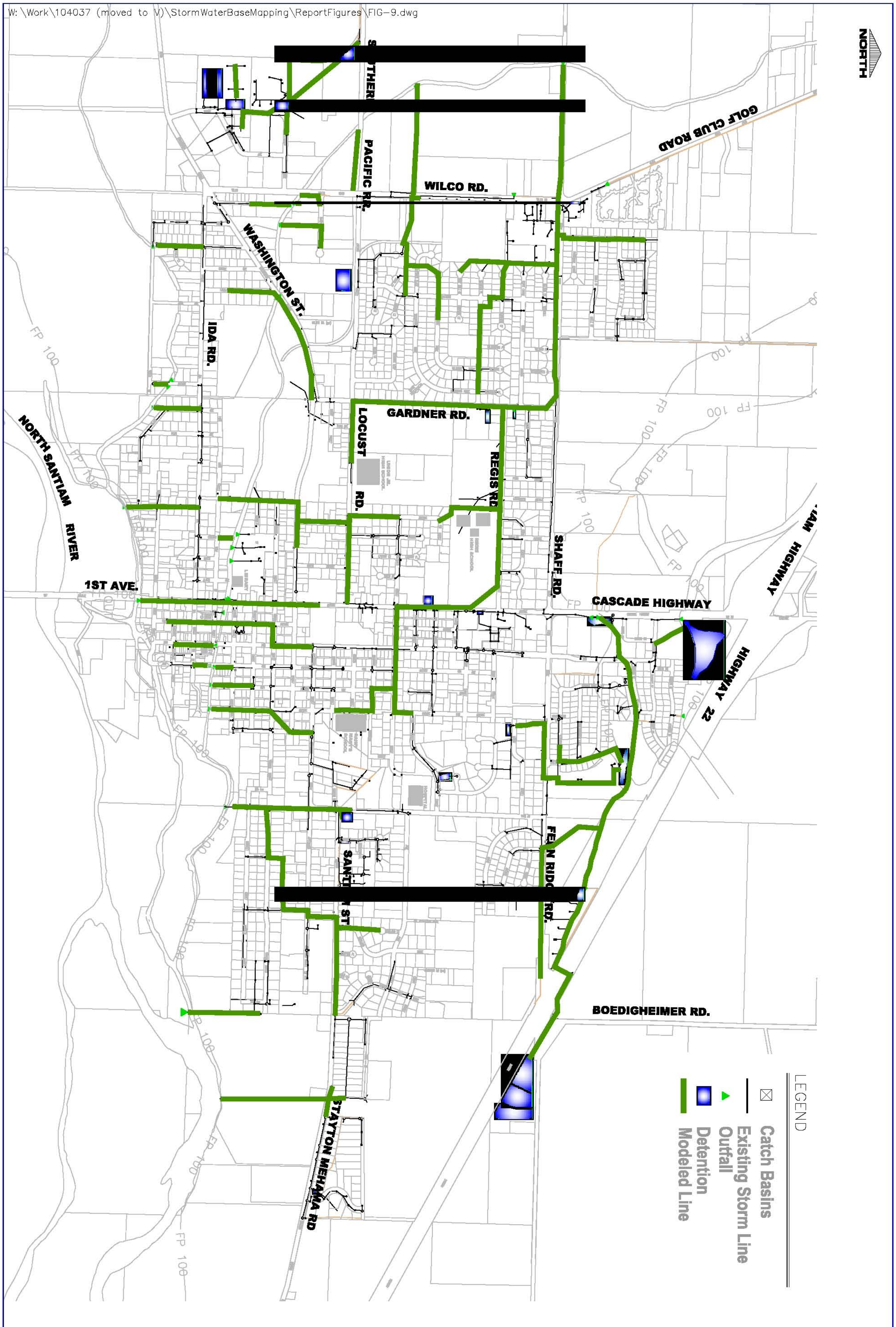

FIGURE 9

Modeled Lines

Storm Water Master Plan
Stayton, OR

KELLER ASSOCIATES

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FIG-9.dwg

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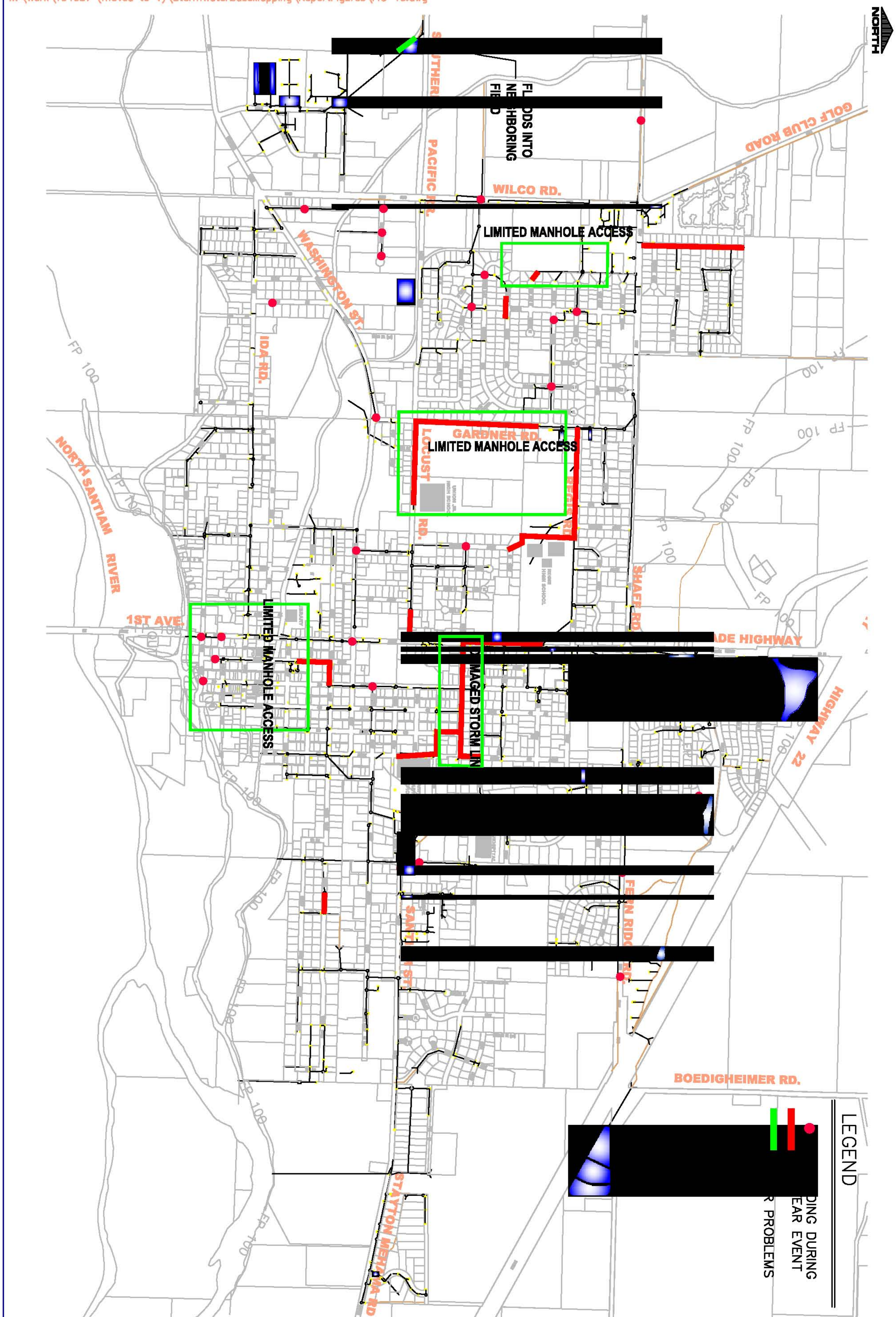

FIGURE 10

Problem Areas

Storm Water Master Plan
Stayton, OR

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FIG-10.dwg

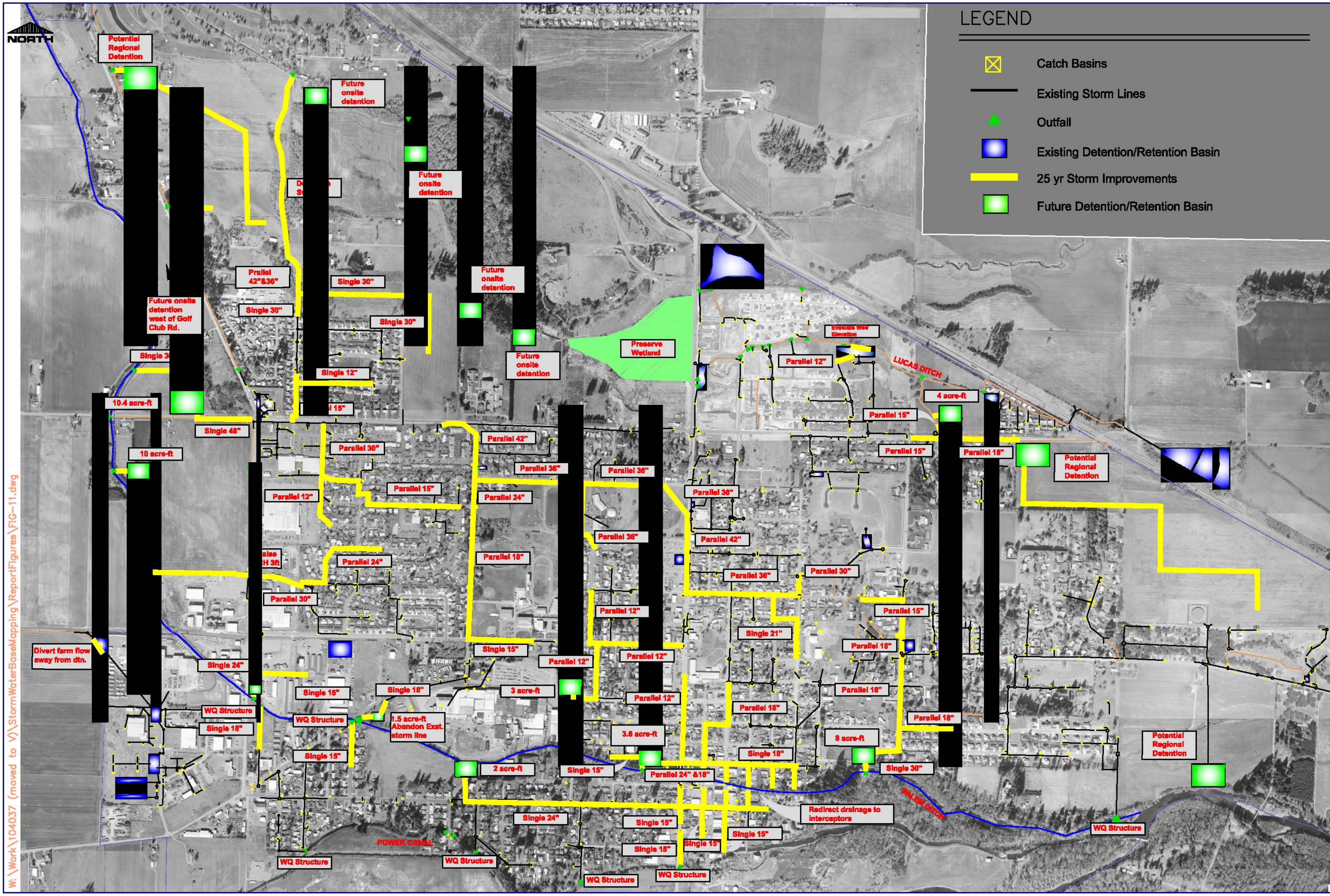

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FIG-11.dwg

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Storm Water Master Plan
Stayton, OR

Recommended Improvements

FIGURE 11

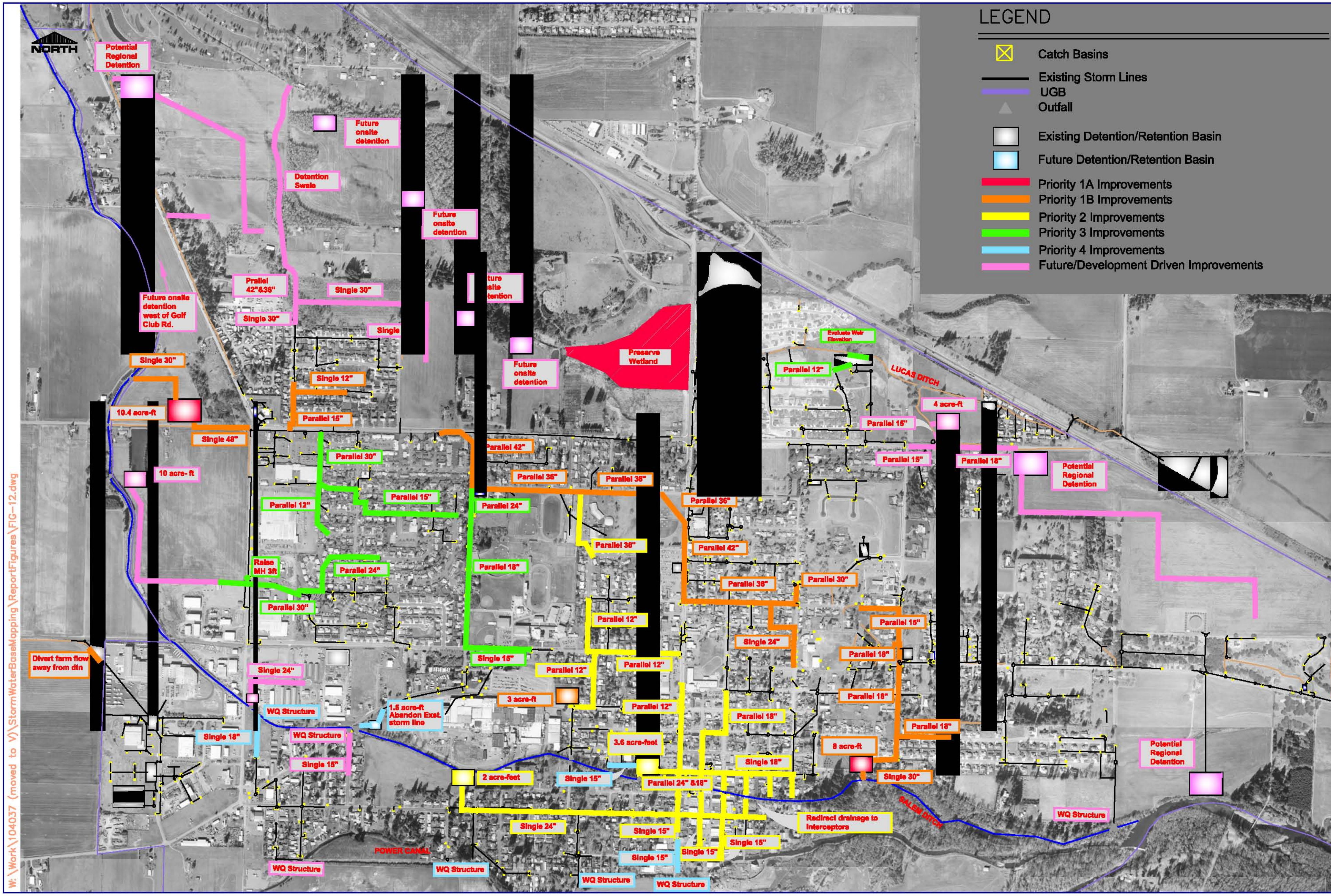


FIGURE 12

Prioritized Improvements

Storm Water Master Plan
Stayton, OR

KELLER ASSOCIATES

KA:104037
FIG-12.dwg

Appendix B

Study Area Data

B.1 - Land Use Compatibility Statement
B.2 - Soil Types and Descriptions
B.3 - Environmental Characteristics
B.4 - Oregon Natural Heritage Information
B.5 - Marion County Standards
B.6 - Threatened and Endangered Species
B.7 - Cultural Resources Review

Appendix B.1

Land Use Compatability Statement

KELLER associates

MILL CREEK SANITARY SEWER PROJECT

COPY

Department of Environmental Quality
LAND USE COMPATIBILITY STATEMENT (LUCS)

DEQ

State of Oregon Department of Environmental Quality

WHAT IS A LUCS? The Land Use Compatibility Statement is the process used by the DEQ to determine whether DEQ permits and other approvals affecting land use are consistent with local government comprehensive plans.

WHY IS A LUCS REQUIRED? Oregon law requires state agency activities that impact land use be consistent with local comprehensive plans. DEQ Division 18 administrative rules identify agency activities or programs that significantly affect land use. These programs must have a process for determining local plan consistency.

WHEN IS A LUCS REQUIRED? A LUCS is required for nearly all DEQ permits, some general permits, and certain approvals of plans or related activities that affect land use. These activities are listed in this form. A single LUCS can be used if more than one DEQ permit/approval is being applied for concurrently.

A permit modification requires a LUCS when any of the following applies:

1. physical expansion on the property or proposed use of additional land;
2. a significant increase in discharges to water;
3. a relocation of an outfall outside of the source property; or
4. any physical change or change of operation of an air pollutant source that results in a net significant emission rate increase as defined in OAR 340-200-0020.

A permit renewal requires a LUCS if one has not previously been submitted, or if any of the above four permit modification factors apply.

HOW TO COMPLETE A LUCS:

Step	Who Does It	What Happens
1	Applicant	Completes Section 1 of the LUCS and submits it to the appropriate city or county planning office.
2	City or County Planning Office	Determines if the business or facility meets all local planning requirements, and returns to the applicant the signed and dated LUCS form **with findings of fact for any local reviews or necessary planning approvals.**
3	Applicant	Includes the completed LUCS with **findings of fact** with the DEQ permit or approval submittal application to the DEQ.

WHERE TO GET HELP: Questions about the LUCS process can be directed to the region staff responsible for processing the permit or approval. Headquarters and regional offices may also be reached using DEQ's toll-free telephone number 1-800-452-4011.

SECTION 1 - TO BE FILLED OUT BY APPLICANT *(may be filled in electronically using Tab key to move to each field)*

1. **Applicant Name:** City of Stayton — **Contact Person:** Mike Faught
   Location Address: 362 N. Third Ave — **Mailing Address:** 362 N. Third Ave
   City, State Zip: Stayton, OR 97383 — **City, State Zip:** Stayton, OR 97383
   Telephone: 503-769-2919 — **Tax Account No:** Various — **Tax Lot No:** See attached map
   Township: ____ — **Range:** ____ — **Section:** ____
   Latitude: ____ — **Longitude:** ____

   *Use the **DEQ Location Finder** (http://deq12.deq.state.or.us/website/findloc) to determine latitude/longitude.*

2. **Describe the type of business or facility and services or products provided:**
   Sanitary sewer pipelines and lift station.

3. Check the type of DEQ permit(s) or approval(s) being applied for at this time.

☐ Air Notice of Construction	☐ Pollution Control Bond Request	☑ Clean Water State Revolving Fund Loan Request
☐ Air Discharge Permit *(excludes portable facility permits)*	☐ Solid Waste Compost Registration - Permit	☐ Water Quality NPDES/WPCF *Permit (for onsite construction-installation permits use DEQ's Onsite LUCS form)*
☐ Title V Air Permit	☐ Solid Waste Letter Authorization Permit	☑ Wastewater/Sewer Construction Plan/Specifications *(includes review of plan changes that require use of new land)*
☐ Parking/Traffic Circulation Plan	☐ Solid Waste Material Recovery Facility Permit	☐ Water Quality Storm Water General Permit
☐ Air Indirect Source Permit	☐ Solid Waste Transfer Station Permit	☐ Other Water Quality General Permit *(Generals: 600 (if mobile), 700, 1200CA, 1500, 1700 (if mobile) are exempted))*
☐ Solid Waste Disposal Permit	☐ Solid Waste - Waste Tire Storage Permit	
☐ Solid Waste Treatment Permit	☐ Hazardous Waste/PCB Storage/ Treatment/Discharge Permit	☐ Federal Permit - Water Quality 401 Certification

4. This application is for: ☐ permit renewal ☑ new permit ☐ permit modification ☐ other ____________

SECTION 2 - TO BE FILLED OUT BY CITY OR COUNTY PLANNING OFFICIAL

5. The facility proposal is located: ☒ inside city limits ☒ inside UGB ☐ outside UGB

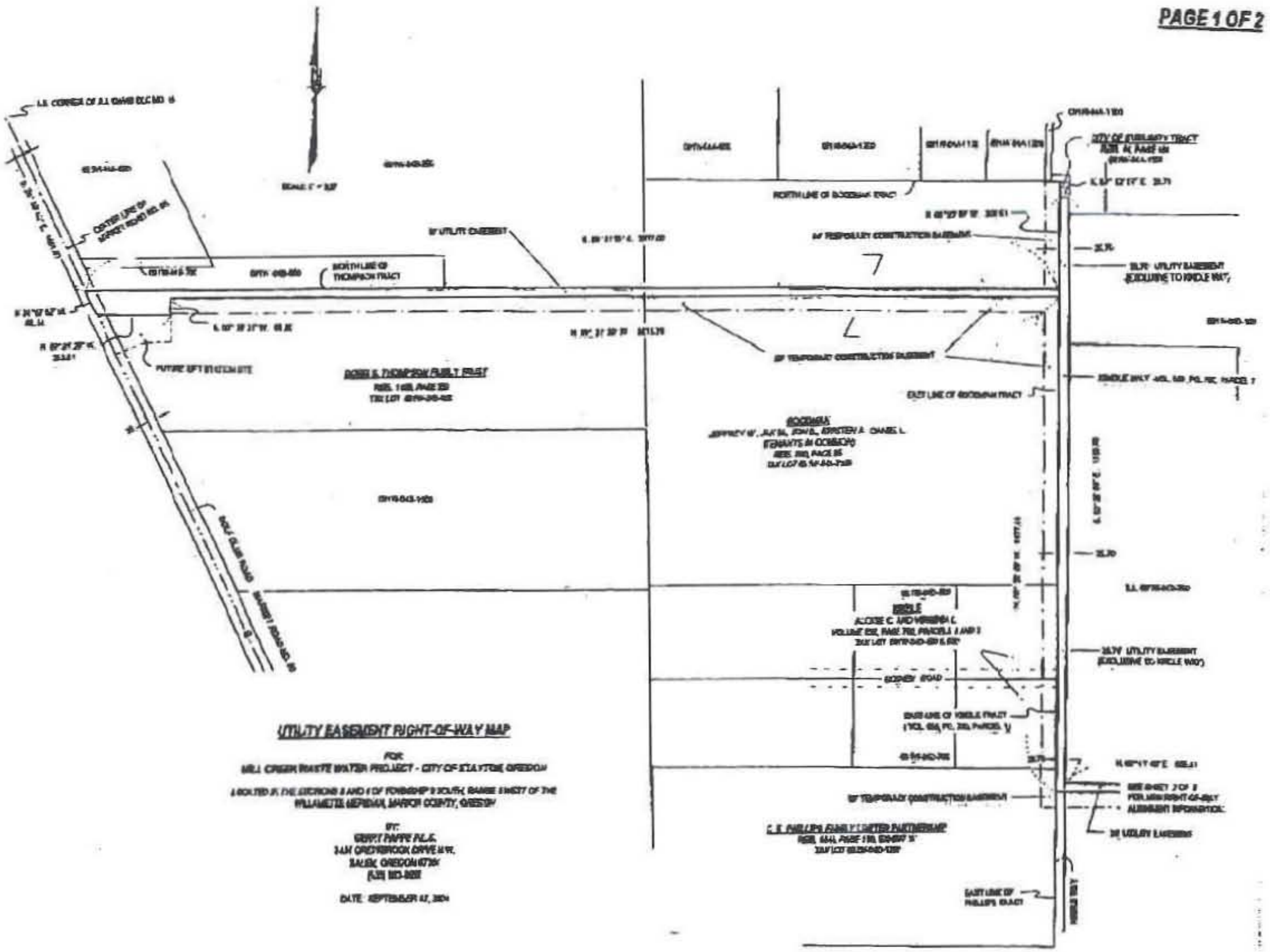
state cultural resources protection laws. ORS 358.920 prohibits the excavation, injury, destruction, or alteration of an archeological site or object, or removal of archeological objects from public and private lands without an archeological permit issued by the State Historic Preservation Office. 16 USC 470, Section 106, National Historic Preservation Act of 1966 requires a federal agency, prior to any undertaking, to take into account the effect of the undertaking that is included on or eligible for inclusion in the National Register. For further information, contact the State Historic Preservation Office at 503-378-4168, extension 232.

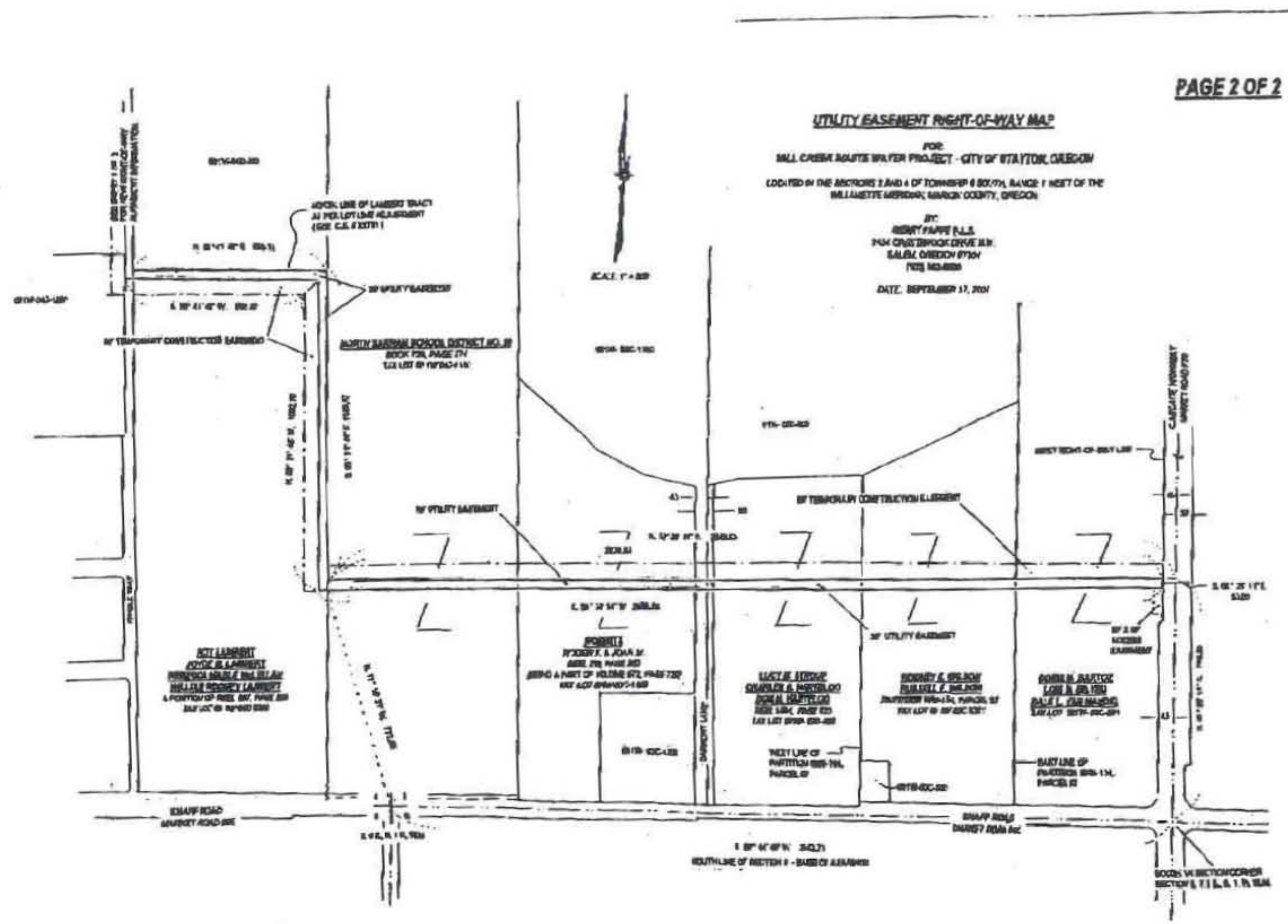
The proposal meets the following City of Stayton Comprehensive Plan Goals and Policies:

PF-1 The City of Stayton shall be the ultimate provider of the following urban services within the Stayton urban growth boundary: 1) municipal water supply; 2) sanitary sewage collection and treatment; 3) storm sewers; 4) police protection; 5) parks and recreational facilities; and 6) library services.

PF-2 The City of Stayton shall use its Master Utilities Plan and Capital Improvement Program to direct the provision of public facilities within the urban growth boundary.

Encourage urban development in areas with existing services and in those areas where future extensions of those services can be provided in the most feasible, efficient, and economical manner.


PAGE 1 OF 2
UTILITY EASEMENT RIGHT-OF-WAY MAP
FOR
DATE:


PAGE 2 OF 2
UTILITY EASEMENT RIGHT-OF-WAY MAP
FOR
CITY OF STAYTON, OREGON
MARION COUNTY, OREGON
BY:
DATE: SEPTEMBER 17,

Appendix B.2

Soil Types and Description

Soil Survey of Marion County Area OR643

Map Unit Symbol	Map Unit Name
91D	Alspaugh clay loam, 15 to 30 percent slopes
92E	Andic Cryaquepts, moderately steep
92F	Andic Cryaquepts, steep
93F	Aschoff-Brightwood complex, 60 to 90 percent slopes
94E	Fernwood very gravelly loam, 30 to 60 percent slopes
95C	Hardscrabble silt loam, 7 to 20 percent slopes
96E	Highcamp very gravelly loam, 30 to 60 percent slopes
97F	Highcamp-Rock outcrop complex, 50 to 90 percent slopes
98D	Highcamp-Soosap complex, 5 to 30 percent slopes
99D	Kinzel-Divers complex, 5 to 30 percent slopes
99E	Kinzel-Divers complex, 30 to 60 percent slopes
100E	Springwater loam, 30 to 60 percent slopes
101D	Wilhoit-Zygore gravelly loams, 5 to 30 percent slopes
102F	Xerochrepts and Haploxerolls, very steep
103E	Zygore-Wilhoit gravelly loams, 30 to 60 percent slopes
AbA	Abiqua silty clay loam, 0 to 3 percent slopes
AbB	Abiqua silty clay loam, 3 to 5 percent slopes
Ad	Alluvial land
Am	Amity silt loam
Ba	Bashaw clay
Ca	Camas gravelly sandy loam
CeC	Chehalem silt loam, 2 to 12 percent slopes
HEF	Henline very stony sandy loam, 30 to 55 percent slopes
HEG	Henline very stony sandy loam, 55 to 80 percent slopes
Ho	Holcomb silt loam
HRD	Horeb loam, 2 to 20 percent slopes
HSC	Horeb gravelly silt loam, gravelly substratum, 0 to 15 percent slopes
HSE	Horeb gravelly silt loam, gravelly substratum, 15 to 35 percent slopes
HTD	Hullt clay loam, 2 to 20 percent slopes
HTE	Hullt clay loam, 20 to 30 percent slopes
HTF	Hullt clay loam, 30 to 60 percent slopes
HuB	Hullt clay loam, 2 to 7 percent slopes
HuD	Hullt clay loam, 7 to 20 percent slopes
JoB	Jory silty clay loam, 2 to 7 percent slopes
JoC	Jory silty clay loam, 7 to 12 percent slopes
JoD	Jory silty clay loam, 12 to 20 percent slopes
JoE	Jory silty clay loam, 20 to 30 percent slopes
KCD	Kinney cobbly loam, 2 to 20 percent slopes

KCF	Kinney cobbly loam, 20 to 50 percent slopes
KCG	Kinney cobbly loam, 50 to 70 percent slopes
La	Labish silty clay loam
MaA	McAlpin silty clay loam, 0 to 3 percent slopes
MaB	McAlpin silty clay loam, 3 to 6 percent slopes
Mb	McBee silty clay loam
McB	McCully clay loam, 2 to 7 percent slopes
McC	McCully clay loam, 7 to 12 percent slopes
McD	McCully clay loam, 12 to 20 percent slopes
McE	McCully clay loam, 20 to 30 percent slopes
MID	McCully stony clay loam, 2 to 20 percent slopes
MmE	McCully very stony clay loam, 2 to 30 percent slopes
MUE	McCully clay loam, 2 to 30 percent slopes
MUF	McCully clay loam, 30 to 50 percent slopes
MUG	McCully clay loam, 50 to 70 percent slopes
MYB	Minniece silty clay loam, 0 to 8 percent slopes
NeB	Nekia silty clay loam, 2 to 7 percent slopes
NeC	Nekia silty clay loam, 7 to 12 percent slopes
NeD	Nekia silty clay loam, 12 to 20 percent slopes
NeE	Nekia silty clay loam, 20 to 30 percent slopes
NeF	Nekia silty clay loam, 30 to 50 percent slopes
NkC	Nekia stony silty clay loam, 2 to 12 percent slopes
NsE	Nekia very stony silty clay loam, 2 to 30 percent slopes
NsF	Nekia very stony silty clay loam, 30 to 50 percent slopes
Nu	Newberg fine sandy loam
Nw	Newberg silt loam
PITS	Pits
Sa	Salem gravelly silt loam
SCE	Steiwer and Chehulpum silt loams, 3 to 40 percent slopes
SkB	Salkum silty clay loam, 2 to 6 percent slopes
SkD	Salkum silty clay loam, 6 to 20 percent slopes
SIB	Salkum silty clay loam, basin, 0 to 6 percent slopes
SnA	Santiam silt loam, 0 to 3 percent slopes
SnB	Santiam silt loam, 3 to 6 percent slopes
SnC	Santiam silt loam, 6 to 15 percent slopes
So	Semiahmoo muck
St	Sifton gravelly loam
SuC	Silverton silt loam, 2 to 12 percent slopes
SuD	Silverton silt loam, 12 to 20 percent slopes
SvB	Stayton silt loam, 0 to 7 percent slopes
SwB	Steiwer silt loam, 3 to 6 percent slopes
SwD	Steiwer silt loam, 6 to 20 percent slopes
Sy	Stony rock land
Te	Terrace escarpments
W	Water
Wa	Waldo silty clay loam
Wc	Wapato silty clay loam
WHE	Whetstone stony loam, 3 to 25 percent slopes
WHF	Whetstone stony loam, 25 to 55 percent slopes
WHG	Whetstone stony loam, 55 to 75 percent slopes

WlA	Willamette silt loam, 0 to 3 percent slopes
WlC	Willamette silt loam, 3 to 12 percent slopes
WtE	Witzel very stony silt loam, 3 to 40 percent slopes
WuA	Woodburn silt loam, 0 to 3 percent slopes
WuC	Woodburn silt loam, 3 to 12 percent slopes
WuD	Woodburn silt loam, 12 to 20 percent slopes

are defined in the Glossary. The acreage and proportionate extent of the mapping units are shown in table 7. The location of the soils in the Marion County Area is shown on the detailed soil map at the back of this survey.

Abiqua Series

The Abiqua series consists of well-drained soils that have formed in alluvium. These soils have slopes of 0 to 5 percent. They occur on low foothills, along small streams and in drainageways, at elevations of 250 to 1,000 feet.. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, native grasses, and shrubs. Abiqua soils are associated with McAlpin and Waldo soils.

In a typical profile, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsurface layer is also very dark brown silty clay loam and is about 15 inches thick. The upper part of the subsoil is dark reddish-brown silty clay that extends to a depth of about 54 inches. The lower part of the subsoil is dark-brown silty clay loam that extends to a depth of 72 inches or more.

The Abiqua soils are used mainly for small grains, grass grown for seed, orchards, and pastures. When irrigated, they are used for other crops.

Abiqua silty clay loam, 0 to 3 percent slopes (AbA).This soil is along streams and in drainageways of the Salem and Waldo Hills. The areas are small.

Representative profile 85 feet east and 60 feet south of road intersection (in the corner of SW1/48W1/4NE1/4 sec. 2, T. 9 S., R. 1 W.)

Ap-0 to 6 inches, very dark brown (10YR 2/2) silty clay loam, dark brown (7.5YR 3/2) when dry; moderate, very fine, granular structure; friable, hard, slightly plastic and slightly sticky; many roots; many interstitial pores; medium ,acid (pH 5.8) ; abrupt, smooth boundary. (5 to 7 inches thick.)

A3-6 to 21 inches, very dark brown (10YR 2/2) silty clay loam, dark brown (7.5YR 3/2) when dry; moderate, fine and very fine, subangular blocky structure; firm, hard, plastic and sticky; many roots; many, fine, tubular pores; thin, patchy, darker colored coatings on ped surfaces; medium acid (pH 5.6); clear, smooth boundary. (13 to 17 inches thick.)

B21-21 to 36 inches, dark reddish-brown (5YR 2/2) silty clay, dark reddish brown (5YR 3/4) when dry; weak, prismatic structure breaking to moderate, medium, subangular blocky structure; firm, very hard, very plastic and very sticky; common roots; many, fine and very fine, tubular pores; thin, continuous, slightly darker colored coatings on ped surfaces; strongly acid (pH 5.4); diffuse, smooth boundary. (10 to 20 inches thick.)

B22-36 to 54 inches, dark reddish-brown (5YR 3/2) silty clay, reddish brown (5YR 4/4) when dry; very weak, prismatic structure breaking to moderate, medium, subangular blocky structure; firm, very hard, very plastic and very sticky; few roots; many, fine and very fine, tubular pores; thin, continuous, dark reddish-brown (5YR 3/4) coatings on ped surfaces when dry; common, fine and very fine fragments of weathered rock; strongly acid (pH 5.3); diffuse, smooth boundary. (13 to 23 inches thick.)

B3-54 to 72 inches, dark-brown (7.5YR 3/2) silty clay loam, reddish brown (5YR 4/3) when dry; moderate, medium, subangular blocky structure; firm, hard, plastic and sticky; very few roots; many, fine and very fine, tubular pores; many fine and very fine fragments of weathered rock; strongly acid (pH 5.3).

Color of the A horizon is dark brown or very dark brown, and texture of that horizon ranges from silt loam to silty clay loam. Color of the B horizon ranges from dark brown to dark reddish brown. Texture of the B horizon ranges from silty clay to clay, except that the B3 horizon is silty clay loam in many places. In some areas a few angular pebbles are scattered throughout the profile.

Included with this soil in mapping were small areas that contain a layer of gravel below a depth of 40 inches. Also included were small areas of McAlpin and Waldo soils.

The available water capacity is 10 to 11 inches, permeability is moderately slow, and fertility is moderate. Runoff is slow, and the hazard of erosion is only slight. Where additions of organic matter are regularly supplied, workability of this soil is good. Depth to which roots can penetrate is not restricted.

This soil is used mainly for small grains, grass grown for seed, orchards, and pasture, but small areas are still in Douglas-fir. When this soil is irrigated, it is used for most of the crops commonly grown in the survey area. It is well suited to most crops, but it is not well suited to potatoes and carrots. (Capability unit I-1; not placed in a woodland suitability group)

Abiqua silty clay loam, 3 to 5 percent slopes (AbB).This soil has a profile similar to the one described for Abiqua silty clay loam, 0 to 3 percent slopes, except that material washed from higher slopes has been deposited on the surface in a few places. Runoff is medium, and the hazard of erosion is slight.

This soil is used for about the same crops as Abiqua silty clay loam, 0 to 3 percent slopes. (Capability unit IIe-2; not placed in a woodland suitability group)

Alluvial Land

Alluvial land (Ad) occurs mostly along the Santiam, North Santiam, and Willamette Rivers, on or near the bed of the main stream, in overflow channels, and on islands or bars. It consists mostly of loose sand, gravel, and cobblestones, but it includes some small areas of silt loam. This material is frequently shifted by floodwaters, for this land type is subject to overflow in winter and spring.

In places this land type supports a good stand of cottonwoods, but use of these trees for timber is restricted by the very severe hazard of erosion if the trees are cut. Other areas have a cover of Douglas-fir. Still other small areas are bare, except for scattered willows. (Capability unit VIIw-1; not placed in a woodland suitability group)

Amity Series

The Amity series consists of somewhat poorly drained soils that have formed in mixed alluvial silts. These soils have slopes of 0 to 2 percent. They occur on broad valley terraces at elevations of 150 to 350 feet. The average annual precipitation is between 40 and 45 inches. The average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly grasses, shrubs, hardwoods, :and scattered, Douglas-firs. Amity soils are associated with Dayton and Concord soils.

In a typical profile, the surface layer is very dark grayish-brown silt loam that is mottled in the lower part and is about 17 inches thick. The subsurface layer is mottled dark-gray silt loam about 7 inches thick. The subsoil is mottled grayish-brown silty clay loam about 13 inches thick. A substratum of mottled olive-brown silt loam underlies the subsoil.

The Amity soils are used mainly for cereal grains, grass grown for seed, and pasture. When irrigated, areas that are drained can be used for all the crops commonly grown in the survey area.

Amity silt loam (Am).-This is the only soil of the Amity series mapped in the survey area. It occupies slightly convex or nearly level areas on terraces consisting of Willamette silts.

Representative profile 30 feet east of a paved road (SW1/2SE1/4 sec. 10, T. 5 S., R. 2 W.)

Ap-0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; abundant fine roots; many interstitial pores; medium acid (pH 6.0); clear, smooth boundary. (5 to 8 inches thick.)

A1-7 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam grayish brown (10YR 5/2) when dry; common, fine, faint, reddish-brown mottles; moderate, medium, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; abundant fine roots; common interstitial pores and few, fine and medium, tubular pores; common, fine and medium, reddish-brown concretions; medium acid (pH 6.0); clear, smooth boundary. (5 to 10 inches thick.)

A2-17 to 24 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; common, fine, faint, reddish-brown mottles; weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common fine roots; common interstitial pores and common, fine and medium, tubular pores; common, fine and medium, brown concretions; medium acid (pH 6.0); clear, wavy boundary. (4 to 8 inches thick.)

B21t-24 to 29 inches, grayish-brown (2.5Y 5/2) silty clay loam, light brownish gray (10YR 6/2) when dry; common, fine, distinct, reddish-brown mottles; weak, medium, prismatic structure breaking to moderate, coarse, subangular blocky structure; friable, hard, sticky and plastic; few fine roots; common, medium, tubular pores; thin, patchy clay films in pores, on vertical surfaces of peds, and on some horizontal surfaces of peds; common, fine, red and black concretions; slightly acid (pH 6.2); gradual, wavy boundary. (4 to 9 inches thick.)

B22t-29 to 37 inches, grayish-brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) when dry; common, fine, distinct, light yellowish-brown and black mottles; weak, medium, prismatic structure breaking to moderate, coarse, subangular blocky structure; friable, hard sticky and plastic; few fine roots; few, medium and fine, tubular pores; thin, patchy clay films in pores and on vertical and horizontal surfaces of peds; many, fine, reddish-brown and few, fine, black concretions; slightly acid (pH 6.2); diffuse boundary. (5 to 14 inches -thick.)

C-37 to 60 inches, olive-brown (2.5Y 4/4) silt loam, light yellowish brown (2.5Y 6/4) when dry; common, fine, faint, brown mottles; massive; friable, hard, slightly sticky and slightly plastic; few fine roots; few fine and medium pores; thick clay films in pores; slightly acid (pH 6.4).

When the soil is moist, color of the A horizon ranges from dark brown to very dark grayish brown. Texture of the B horizon is heavy silt loam in some areas, and the structural grade of that horizon; is moderate in places. In some places the lower part of the B horizon is weakly to moderately brittle. Bedrock is at a depth of more than 60 inches.

Included with this soil is mapping were small areas of soils that are in drainageways and depressions and that have slopes of 2 to 5 percent. Also included were small areas of Woodburn and Concord soils.

The available water capacity ranges from 9 to 12 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is not a hazard or is only a slight hazard. The depth to which roots can penetrate is moderately restricted by wetness, partly caused by a high water table that is near the surface during winter and spring. Workability is good, but this soil compacts easily if it is cultivated when wet.

Undrained areas of this soil are used for small grains, pasture, and grasses grown for seed, but drainage is needed for berries, vegetables, and specialty crops. If this soil is drained and irrigated, it can be used for all the crops commonly grown in the survey area. Evan after drainage is installed, however, there are slightly restrictions to use of this soil for deep-rooted crops that cannot tolerate excessive moisture. Nevertheless, response to drainage and fertilizer is generally good. (Capability unit IIw-2; not placed in a woodland suitability group)

Bashaw Series

The Bashaw series consists of poorly drained and very poorly drained soils that have formed in alluvium. These soils are in backwater areas of the flood plains and in drainage channels of silty alluvial terraces. They have slopes of 0 to 1 percent. Elevations range from 100 to 400 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly annual and perennial grasses, wild blackberries, sedges, rushes, willows, and a few ash and oak trees. Bashaw soils are associated with Wapato soils.

In a typical profile, the surface layer is about 31 inches thick and consists of mottled very dark gray clay in the uppermost 3 inches and of mottled black clay below. The upper part of the substratum, just beneath the surface layer, is very dark gray clay that extends to a depth of 48 inches. The lower part of the substratum is dark grayish-brown clay or sandy clay that extends to a depth of 60 inches or more. The substratum is mottled throughout.

The Bashaw soils are used mainly for pasture.

Bashaw clay (Ba).-This is the only soil of the Bashaw series mapped in the survey area. It occupies concave backwater areas adjacent to silty alluvial terraces, and it is also in drainage channels on the terraces. The areas are small.

Representative profile (NW1/4SW1/4NE1/4 sec. 9, T. 6 S., R.1 W.)

A11--0 to 3 inches, very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) when dry; many, fine, distinct, yellowish-red (5YR 4/6) mottles, moderate, medium and fine, subangular blocky structure; firm, very hard, very sticky and very plastic; common roots; many very fine pores; medium acid (pH 5.8); abrupt, smooth boundary. (0 to 4 inches thick.)

A12g-3 to 14 inches, black (N 2/0) clay, very dark gray (N 3/0) when dry; few, fine, distinct, yellowish-red (5YR 5/6) mottles; massive when wet; weak, coarse, prismatic structure breaking to weak, coarse, angular blocky structure when moist or dry; very firm, very hard, very sticky and very plastic; common very fine roots; many very fine pores; common, fine, red and black concretions; few small slickensides; medium acid (pH 6.0); clear, smooth boundary. (6 to 15 inches thick.)

A13g-14 to 31 inches, black (N 2/0) clay, very dark gray (N 3/0) when dry; few, fine, distinct, yellowish-red (5YR 4/6) mottles; massive; very firm, very hard, very plastic and very sticky; few slickensides; few very fine roots; few very fine pores; common, fine, red and black concretions; neutral (pH 6.6); gradual, smooth boundary. (14 to 20 inches thick.)

C1g-31 to 48 inches, very dark gray (N 3/0) clay, dark gray (N 4/0) when dry; common, medium, faint, light olive-brown (2.5Y 5/6) mottles; massive; very firm, very hard, very sticky and very plastic; common large slickensides; common, fine, light-colored fragments; few roots; few very fine pores; neutral (pH 7.0); abrupt, smooth boundary. (10 to 20 inches thick.)

C2g-48 to 60 inches, dark grayish-brown (2.5Y 4/2). clay or sandy clay, light brownish gray (2.5Y 6/2) when dry; many, medium, distinct, dark-brown (7.5YR 3/2) and dark reddish-brown (5YR 3/2) mottles and few, medium, faint, dark-gray (N 4/0) mottles; massive; firm, very hard, sticky and plastic; no roots; common very fine pores; neutral (pH 7.0).

When this soil is moist, the A12g and A13g horizons are generally black, but their color ranges to very dark gray in some areas. In the uppermost 3 to 4 inches of the soil profile, the structure is weak to strong granular or very fine subangular blocky. Texture in the uppermost 3 to 8 inches of the profile ranges from clay to silty clay or silty clay loam. The soil material between depths of 8 and 40 inches is more than 60 percent clay. Reaction ranges from neutral to medium acid in the uppermost 10 to 15 inches of the profile, and it is slightly acid to neutral below.

Included with this soil in mapping were small areas of moderately fine textured soils that have a very dark grayish-brown surface layer. Also included were areas of clayey soils that have a thin, black surface layer.

The available water capacity ranges from 8 to 10 inches. Permeability is very slow, and fertility is moderate. Runoff is very slow to ponded, and the hazard of erosion is slight. Some material is deposited on the surface each year in areas not protected and not drained. Workability is poor. Because of the annual high water table and the very fine texture of the soil material, only a few roots penetrate to depths greater than 31 inches, but roots can penetrate to a depth of about 48 inches.

This soil is used mainly for pasture, but it can be used for spring barley, wheat, improved pasture, and hay if surface drainage is provided. Although drainage is needed, outlets are generally inadequate for surface drainage, and this soil is unsuitable for tile drains, because of its fine texture and very slow permeability. For only short periods is it dry enough to cultivate. (Capability unit IVw-2; not placed in a woodland suitability group)

Camas Series

The Camas series consists of excessively drained soils that formed in recent alluvium derived mainly from basic igneous and sedimentary rocks. These soils have slopes of 0 to 3 percent. They occur on bottom lands of the large streams. Elevations range from 125 to 500 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly ash, oak, alder, rose, blackberry, annual weeds, and grasses. Camas soils are associated with Newberg and Cloquato soils.

In a typical profile, the surface layer is dark-brown gravelly sandy loam about 9 inches thick. The substratum, just beneath the surface layer, is dark yellowish-brown very gravelly sand that extends to a depth of 60 inches or more.

The Camas soils are used mainly for small grains, for pasture, or as woodland. When irrigated, they are used for all the crops commonly grown in the survey area.

Camas gravelly sandy loam (Ca).-This soil occupies small areas along Butte Creek and the Willamette, North Santiam, and Santiam Rivers. It is the only soil of the Camas series mapped in the survey area.

Representative profile (SW1/4SE1/4 sec. 11, T. 9 S., R. 1W.)

A1-0 to 9 inches, dark-brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; friable, slightly hard, nonsticky and nonplastic; many roots; many, fine, interstitial pores; slightly acid (pH 6.1); gradual, smooth boundary. (7 to 11 inches thick.)

C-9 to 60 inches, dark yellowish-brown (10YR 4/4) very gravelly sand, light yellowish brown (10YR 6/4) when dry; single grain; loose, nonsticky and nonplastic; common roots; many interstitial pores; medium acid (pH 6.0).

When the soil is moist, color of the A horizon ranges from very dark grayish brown to dark brown. Texture of the A horizon ranges from silt loam to loamy sand, and texture of the C horizon ranges from very gravelly loamy sand to very gravelly sand or cobbly sand. More than 50 percent of the C horizon, by volume, is coarse fragments. Reaction of the A horizon ranges from neutral to medium acid. Reaction of the C horizon ranges from medium acid to slightly acid.

Included with this soil in mapping were small cobbly areas and other small areas that have a surface layer of silt loam.

The very gravelly or cobbly substratum near the surface restricts the available water capacity, which is 3 inches or less. It also restricts the depth to which roots can penetrate. Permeability is very rapid, and fertility is low. Runoff is very slow, and erosion is generally only a slight hazard. Areas adjacent to streams are moderately susceptible to erosion because they are usually flooded at least once each year. Workability is poor.

This soil is used mainly for small grains, for pasture, or as woodland. When irrigated, it is used for all the crops commonly grown in the survey area, although it is poorly suited to root crops and to many other crops. (Capability unit IVw-3; not placed in a woodland suitability group

Chehalem Series

The Chehalem series consists of somewhat poorly drained soils that have formed in alluvium. These soils have slopes of 2 to 12 percent. They occur on alluvial fans at elevations of 150 to 300 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In noncultivated areas the vegetation is mainly ash, cottonwood, willow, oak, sedges, reeds, and grasses. Chehalem soils are associated with Woodburn soils.

In a typical profile, the surface layer is very dark brown silt loam about 16 inches thick. The subsoil is mottled silty clay about 44 inches thick. The upper part of the subsoil is very dark grayish brown, the middle part is dark grayish brown, and the lower part is olive brown. The Chehalem soils are used mainly for small grains, pasture, hay, and native hardwoods. Mainly irrigated, a small acreage is used for vegetables, improved pasture, and caneberries.

Chehalem silt loam, 2 to 12 percent slopes (CeC).This is the only soil of the Chehalem series mapped in the survey area. It occupies small areas on foot slopes of the Salem and Waldo Hills.

Representative profile (SE1/4SW1/4 sec. 23, T. 9 S., R. 3 W.).

Ap-0 to 8 inches, very dark brown (10YR 2/2) heavy silt loam, very dark grayish brown (10YR 3/2) when dry; moderate, coarse, subangular blocky structure; friable, hard, sticky and plastic; common roots; many, fine, tubular pores; medium acid (pH 5.8); clear, smooth boundary. (6 to 8 inches thick.)

A1-8 to 16 inches, very dark brown (10YR 2/2) heavy silt loam, very dark grayish brown (10YR 3/2) when dry; moderate, coarse, subangular blocky structure breaking to fine, subangular blocky structure; friable, hard, sticky and plastic; common roots; many, fine, tubular pores; medium acid (pH 5.6); abrupt, smooth boundary. (4 to 8 inches thick.)

B21-16 to 31 inches, very dark grayish-brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) when dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium and coarse, subangular blocky structure; firm, very hard, very sticky and very plastic; few roots; many, very fine, tubular pores; medium acid (pH 5.6); gradual, smooth boundary. (6 to 15 inches thick.)

B22 31 to 42 inches, dark grayish brown (2.5Y 4/2) silty clay, light yellowish brown (2.5Y 6/4) when dry; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, prismatic structure; very firm, extremely hard, very sticky and very plastic; few roots; common, fine, tubular pores; many particles the size of fine shot; medium acid (pH 5.8); gradual, smooth boundary. (8 to 15 inches thick.)

IIB3-42 to 60 inches, olive-brown (2.5Y 4/4) silty clay, light olive brown (2.5Y 5/4) when dry; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, coarse, prismatic and weak, coarse, angular blocky structure; very firm, extremely hard, sticky and plastic; few roots; common, fine, tubular pores; many manganese stains; many sand-size fragments of rock; medium acid (pH 6.0).

Texture of the A horizon ranges from silt loam to clay loam or silty clay loam. In places the A horizon is dark brown. Color of the B2 horizons ranges from very dark brown to dark grayish brown or very dark grayish brown, and mottling in those horizons ranges from faint to distinct. Weathered coarse fragments of sedimentary rock are common throughout the profile. They make up as much as 40 percent of the lower B horizons. In places the profile also contains fragments of basalt.

Included with this soil in mapping were small areas of a soil along Butte Creek that has a lighter colored surface layer and a more permeable subsoil than this soil. The subsoil of the included soil is silty clay loam.

The available water capacity is 10 to 11 inches. Permeability is slow, and fertility is moderate. Runoff is medium, and the hazard of erosion is slight. This soil is subject to seepage and runoff from higher areas. The depth to which roots can penetrate is restricted by wetness during winter and spring. Workability is fair.

This soil is used mainly for small grains, pasture, hay, and native hardwoods. When irrigated, a small acreage is used for vegetables, improved pasture, and caneberries. (Capability unit IIIe-5; not placed in a woodland suitability group)

Chehalis Series

The Chehalis series consists of well-drained soils that have formed in alluvium. These soils are nearly level or gently undulating, and they occur on bottom lands that are traversed by old overflow channels and sloughs. Elevations range from 100 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is about 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly alder, ash bigleaf maple, oak, and an understory of vine maple, wild blackberry, vines, and shrubs. Chehalis soils are associated with Cloquato and Newberg soils.

In a typical profile, the surface layer is dark-brown silty clay loam about 9 inches thick. The subsoil is also dark-brown silty clay loam and is about 28 inches thick. The substratum is silty clay loam that is dark brown in the upper part and dark yellowish brown in the lower part. It extends to a depth of 80 inches or more.

The Chehalis soils are used mainly for pasture, hay, cereal grains, grass grown for seed, and orchards. When irrigated, they are used extensively for vegetables and berries.

Chehalis silty clay loam (Ch).-This is the only soil of the Chehalis series mapped in the survey area. It occupies the higher parts of bottom lands along the larger streams. Overflow occurs only about once in 50 years.

Representative profile (W1/2SE1/4NE1/4 sec. 20, T. 6 S., R. 1 W.)

Ap-0 to 9 inches, dark-brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) when dry; weak, fine, subangular blocky structure; friable, slightly hard, sticky and plastic; many roots; many fine pores; slightly acid (pH 6.6); abrupt, smooth boundary. (6 to 10 inches thick.)

B2-9 to 37 inches, dark-brown (10YR 3/3) silty clay loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; friable, slightly hard, sticky and plastic; many roots; many very fine and fine pores; slightly acid (pH 6.4); gradual, smooth boundary. (22 to 40 inches thick.)

C1-37 to 63 inches, dark-brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) when dry; weak, medium, subangular blocky structure; friable, slightly hard, sticky and plastic; few roots; many very fine and fine pores; slightly acid (pH 6.4); gradual, smooth boundary.

C2-63 to 80 inches, dark yellowish-brown (10YR 3/4) silty clay loam, dark grayish brown (10YR 4/2) when dry; massive; friable, slightly hard, sticky and plastic; many fine pores; slightly acid (pH 6.4).

Texture of the Ap horizon is dominantly silty clay loam, but it ranges to heavy silt loam.

Included with this soil in mapping were small areas of Cloquato, Newberg, and Camas soils, and small areas of a steep soil on breaks.

The available water capacity is 11 to 12 inches. Permeability is moderate, and fertility is high. Runoff is slow, and the hazard of erosion is slight. Depth to which roots can penetrate is not restricted. This soil is generally in good tilth if regular additions of organic matter are provided.

This soil is used mainly for pasture, hay, cereal grains, grass grown for seed, and orchards. When irrigated, it is used extensively for vegetables and berries, but it is also used for all the crops commonly grown in the survey area, except potatoes and carrots. (Capability unit I-1; not placed in a woodland suitability group)

Chehulpum Series

The Chehulpum series consists of well-drained soils formed in mixed material that contains loess and is underlain by sandstone or shale. Bedrock is within 20 inches of the surface. These soils have slopes of 3 to 40 percent. They occur on foot slopes and on low foothills at elevations of 300 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. The vegetation is mainly oak, poison-oak, wild rose, and grasses. Chehulpum soils are associated with Steiwer soils.

In a typical profile, the surface layer is very dark brown silt loam about 12 inches thick. This is covered with a thin layer of decomposing grass and leaves. The underlying bedrock, at a depth of about 12 inches, is horizontally bedded, fine-grained sandstone.

The Chehulpum soils are used mostly for pasture. In this survey area, the Chehulpum soils were mapped only in an undifferentiated unit with Steiwer soils. A detailed technical profile of a Chehulpum soil is described in the Steiwer series under Steiwer and Chehulpum silt loams, 3 to 40 percent slopes.

Clackamas Series

The Clackamas series consists of somewhat poorly drained soils that have formed in gravelly mixed alluvium. These soils have slopes of 0 to 3 percent. They occur on terraces at elevations of 175 to 650 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hazel, brackenfern, wild rose, and grasses. Clackamas soils are associated with Sifton and Salem soils.

In a typical profile, the surface layer is very dark grayish-brown gravelly loam about 6 inches thick. The subsurface layer is also very dark grayish-brown gravelly loam, and it is about 9 inches thick. The subsoil is mottled very dark gray and dark reddish-brown gravelly clay loam about 9 inches thick. The substratum is mottled. It consists of dark-brown and strong-brown very gravelly clay loam that extends to a depth of 60 inches or more.

Clackamas soils that are neither drained nor irrigated are used mainly as woodland and for pasture, hay, and cereal grains. When irrigated, the drained areas are used for pole beans, bush beans, sweet corn, berries, squash, and cucumbers.

Clackamas gravelly loam (Ck).-This is the only soil of the Clackamas series mapped in the survey area. It is on terraces between Stayton, Jefferson, and Salem, and along Abiqua Creek, northeast of Silverton. The areas are of medium size.

Representative profile 50 feet east of a paved road (NE1/4SE1/4 sec. 1, T. 8 S., R. 3 W.)

Ap-0 to 6 inches, very dark grayish-brown (10YR 3/2) gravelly loam, dark grayish brown (10YR 4/2) when dry; moderate, medium and fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many very fine and fine pores medium acid (pH -5.6); abrupt, smooth boundary. (5 to 7 inches thick.)

A3-6 to 15 inches, very dark grayish-brown (10YR 3/2) gravelly loam, dark grayish brown (10YR 4/2) and brown (10YR 4/3) when dry; common, fine and medium, black and reddish-brown mottles; moderate, medium, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; many roots; many, very fine and fine, tubular pores; common, fine (1 millimeter in diameter), light-colored fragments; medium acid (pH 5.8); clear, smooth boundary. (7 to 11 inches thick.)

B2tg-15 to 24 inches, mottled very dark gray (10YR 3/1) and dark reddish-brown (2.5YR 3/4) gravelly clay loam, grayish brown (10YR 5/2) and yellowish red (5YR 5/6) when dry; moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; many roots; many fine and medium pores; common moderately thick clay films in pores and on the surfaces of pebbles, and a few on the surfaces of peds; medium acid (pH 5.6); abrupt, smooth boundary. (8 to 10 inches thick.)

IICg-24 to 60 inches, mottled dark-brown (10YR 3/3) and mottled strong-brown (7.5YR 5/6) very gravelly clay loam, light brownish gray (10YR 6/2), pale brown (10YR 6/3), and light yellowish brown (10YR 6/4) when dry; massive; firm, very hard, slightly sticky and slightly plastic; few pores; 80 to 90 percent gravel and cobblestones; strongly acid (pH 5.4).

Color of the A horizon ranges from black to very dark grayish brown. Color of the B horizon is highly variegated. In places texture in the lower part of the B horizon ranges to very gravelly light silty clay. Depth to the gravelly lower part of the B horizon or to the very gravelly C horizon ranges from 20 to 36 inches.

Included with this soil in mapping were small areas of Courtney soils and small areas that have a surface layer of clay loam. These included areas make up as much as 15percent of the acreage in the mapping unit.

The available water capacity is 4 to 5 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and the hazard of erosion is only slight. This soil has a seasonal high water table. In some irrigated areas, there is a permanent high water table as the result of overirrigation and seepage from irrigation ditches. Depth to which roots can penetrate is restricted to about 24 inches by the compact, very gravelly substratum. Workability is poor.

Areas of this soil that are neither drained nor irrigated are used for pasture, hay, and cereal grains, and they are also used as woodland. Areas that are drained are used for pole beans, bush beans, sweet corn, berries, squash, and cucumbers when they are irrigated. If this soil is irrigated and properly fertilized, it is well suited to all the commonly grown crops. (Capability unit IIIw-1; not placed in a woodland suitability group)

Cloquato Series

The Cloquato series consists of well-drained soils that have formed in alluvium. These soils are nearly level and gently undulating, and they are on flood plains of the major streams. The areas are traversed by overflow channels and sloughs. Elevations range from 100 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is fir, cottonwood, bigleaf maple, Oregon white oak, ash, and an understory of vine maple, wild blackberry, vines, shrubs, and grasses. Cloquato soils are associated with Chehalis and Newberg soils.

In a typical profile, the surface layer is dark-brown silt loam about 9 inches thick. The subsoil, which is also dark brown silt loam, is about 56 inches thick. The substratum is dark-brown fine sandy loam that extends to a depth of 83 inches or more.

Cloquato soils that are not irrigated are used mainly for small grains, orchards, pasture, hay, and grass grown for seed. When irrigated, these soils are used for all the crops commonly grown in the survey area.

Cloquato silt loam (Cm).-This is the only Cloquato soil mapped in the survey area. It occupies large areas along the Willamette, Pudding, and Santiam Rivers and along Butte Creek.1 Representative profile (E1/2SE1/4 sec. 20, T. 6 S., R.

Ap-0 to 9 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium and coarse, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many, fine and very fine, tubular pores; medium acid (pH 6.0); clear, smooth boundary. (6 to 10 inches thick.)

B2-9 to 41 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common roots; many, very fine, tubular pores; slightly acid (pH 6.2); gradual, smooth boundary. (15 to 35 inches thick.)

B3-41 to 65 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; very weak, coarse, subangular blocky structure; very friable, slightly hard. slightly sticky and nonplastic; few roots; many, fine, tubular pores; slightly acid (pH 6.4); clear, smooth boundary. (0 to 25 inches thick.)

C-65 to 83 inches, dark-brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) when dry; massive; very friable, soft, nonsticky and nonplastic; no roots; many fine pores; slightly acid (pH 6.4).

Texture of the B2 horizon is dominantly silt loam, but this horizon contains thin layers of sandy material in places. This sandy material is generally below a depth of 30 inches.

Included with this soil in mapping were small areas of Chehalis, Newberg, and Camas soils, and small areas in which the substratum is gravelly. Also included were areas of steeper soils that have short slopes and that are adjacent to sloughs and old stream channels. The included areas make up from 10 to 15 percent of the acreage in this mapping unit.

The available water capacity is 12 to 14 inches. Permeability is moderate, and fertility is high. Runoff is slow, but the hazard of erosion is slight to moderate as the result of periodic overflow. Overflow generally occurs about once in 3 or 4 years, but it occurs two or more times in some years. Roots can penetrate to a depth of 5 feet or more. Workability is very good.

This soil is used mainly for small grains, orchards, pasture, hay, and grass grown for seed. When irrigated, it is used for all the crops commonly grown in the survey area.

This soil is well suited to all the commonly grown crops. Floodwaters leave debris, and they can erode deep holes in orchards and in areas occupied by other permanent crops. (Capability unit IIw-3; not placed in a woodland suitability group).

Concord Series

The Concord series consists of poorly drained soils that have formed in alluvium of mixed mineralogy. These soils are on broad valley terraces, in slightly concave depressions and in drainageways. They have slopes of 0 to 2 percent. Elevations range from 125 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly rushes, sedges, wild blackberry, hazel, annual grasses, and ash trees. Concord soils are associated with Amity and Dayton soils.

In a typical profile, the surface layer is very dark grayish-brown silt loam about 6 inches thick. The subsurface layer is mottled dark-gray silt loam about 9 inches thick. Just below the subsurface layer is a layer of mottled gray and dark-gray silty clay about 4 inches thick. The subsoil is about 10 inches thick. It consists of mottled grayish-brown silty clay in the upper part and of mottled dark grayish-brown silty clay in the lower part. The substratum of mottled dark grayish-brown silt loam extends to a depth of 60 inches or more.

Concord soils that are neither drained nor irrigated are used mainly for cereal grains, pasture, hay, and grass grown for seed. When irrigated, the drained areas are used mainly for berries and vegetables.

Concord silt loam (Co).-This is the only soil of the Concord series mapped in the survey area. It occupies narrow strips along and at the heads of drainageways, and it is also in depressions on terraces. In most places the slope is less than 2 percent.

Representative profile at the eastern edge of the Baldock Freeway, 200 feet north of the overpass (NE1/4NE1/4NW1/4 sec. 33, T. 5 S., R. 2 W.)

Ap--0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry; moderate, fine, subangular blocky structure breaking to moderate, fine, granular structure; friable, hard, sticky and plastic; abundant fine roots; many interstitial pores and wormholes; common, fine, brown concretions; medium acid (pH 6.0); abrupt, smooth boundary. (5 to 7 inches thick.)

A21-6 to 9 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; common, fine, distinct, dark brown (7.5YR 4/2) mottles; moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; abundant fine roots; many, very fine and few, fine, tubular pores; common, fine, very dark brown concretions; medium acid (pH 5.8); clear, smooth boundary. (1 to 6 inches thick.)

A22-9 to 15 inches, dark-gray (10YR 4/1) heavy silt loam, light gray (10YR 7/1) when dry; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; few fine roots; many, very fine and common, fine, tubular pores; common, fine, very dark brown concretions; medium acid (pH 6.0); clear, smooth boundary. (4 to 9 inches thick.)

A&B-15 to 19 inches, gray (10YR 5/1) and dark-gray (10YR 4/1) light silty clay, light gray (10YR 7/1 and 10YR 6/1) when dry; darker colors in ped interiors; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; few fine roots; many, very fine, tubular pores; many, fine, very dark brown concretions; slightly acid (pH 6.2); clear, smooth boundary. (2 to 7 inches thick.)

IIB2t-19 to 24 inches, grayish-brown (2.5Y 5/2) heavy silty clay, light brownish gray (2.5Y 6/2) when dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; strong, fine, prismatic structure breaking to strong, medium and fine, angular blocky structure; firm, extremely hard, very sticky and very plastic; very few roots; many, very fine and few, fine and medium, tubular pores; few thin and moderately thick clay films on ped surfaces and in pores; many, fine, very dark brown and few black concretions; slightly acid (pH 6.4); clear, wavy boundary. (4 to 12 inches thick.)

IIB3t 24 to 29 inches, dark grayish-brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) when dry; many, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; massive: firm, very hard, sticky and plastic; few fine roots; common fine pores; common moderately thick clay films along lines of weakness, and few clay films in pores; few, fine, dark-brown and black concretions; neutral (pH 6.6); gradual, smooth boundary. (3 to 9 inches thick.)

IIIC-29 to 60 inches, dark grayish-brown (2.5Y 4/2) silt loam, light gray (2.5Y 7/2) when dry; many, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; friable, hard, sticky and plastic; massive; common, very fine, tubular pores; few black stains; neutral (pH 6.6).

The Ap horizon is dominantly silt loam, but the texture ranges to silty clay loam. In places texture of the IIB2t horizon is clay. Soil reaction ranges from medium acid in the A horizon to slightly acid and neutral in the B and C horizons.

Included with this soil in mapping were small areas of Dayton soils. These included soils make up from 5 to 10 percent of the acreage in the mapping unit.

The available water capacity ranges from 9 to 12 inches. Permeability is slow, and fertility is low. Runoff is slow, and ponding occurs in some areas, especially in depressions. The hazard of erosion is slight. Depth to which roots can penetrate is restricted by the silty clay in the subsoil. It is also restricted by wetness, caused by the poor drainage and by the seasonal high water table. This soil is easily worked, but it tends to compact if it is cultivated when too moist.

Areas of this soil that are neither drained nor irrigated are used for spring small grains, pasture, hay, and grass grown for seed. When irrigated, drained areas are used for berries and vegetables. This soil is well suited to vegetables, small grains, pasture, and hay. (Capability unit IIIw-2; not placed in a woodland suitability group)

Courtney Series

The Courtney series consists of poorly drained soils that have formed in alluvial deposits of different ages. These soils are on gravelly alluvial terraces, where they occur in shallow depressions and in drainageways. Slopes range from 0 to 2 percent, and elevations range from 175 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly ash, vine maple, hazel, wild rose, blackberry, rushes, sedges, and annual and perennial grasses. Courtney soils are associated with Salem and Clackamas soils.

In a typical profile, the surface layer is about 12 inches thick, and it consists of mottled, black gravelly silty clay loam in the upper part and of mottled, very dark gray gravelly silty clay loam in the lower part. The subsoil is mottled dark-gray gravelly clay about 12 inches thick. The substratum consists of a layer of dark grayish-brown very gravelly clay loam, about 25 inches thick, that grades to mottled, dark-brown very gravelly sand, which extends to a depth of 57 inches or more.

Undrained areas of Courtney soils are used mainly for pasture, hay, and grass grown for seed. The drained areas are used for these crops and also for small grains.

Courtney gravelly silty clay loam (Cu).-This soil is on terraces between Stayton and Salem. It is in depressions and in narrow drainageways. This is the only soil of the Courtney series mapped in the survey area.

Representative profile (NW1/4SE1/4 sec. 6, T. 8 S., R. 2 W.).

A11-0 to 4 inches, black (10YR 2/1) gravelly silty clay loam, dark gray (10YR. 4/1) when dry; few, fine, distinct, dark-brown (7.5YR 4/4) mottles; strong, medium and fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, very fine and fine, interstitial pores; iron stains in root channels; 20 to 25 percent coarse pebbles; strongly acid (pH 5.4); clear, smooth boundary. (2 to 6 inches thick.)

A12-4 to 12 inches, very dark gray (7.5YR 3/0) gravelly silty clay loam, very dark gray (10YR 3/1) when crushed and dark gray (10YR 4/1) when dry; common, medium, distinct, strong-brown (7.5YR 4/4) mottles; strong, medium and fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, very fine, tubular pores; iron stains in root channels; 30 percent pebbles; medium acid (pH 5.8); abrupt, smooth boundary. (7 to 10 inches thick.)

IIB2t-12 to 24 inches, dark-gray (10YR 4/1) gravelly clay, gray (10YR 5/1) when dry; few, fine, distinct mottles; weak, coarse, prismatic structure; firm, very hard, very sticky and very plastic; few roots; 30 percent pebbles and a few cobblestones; slightly acid (pH 6.4); clear, smooth boundary. (10 to 20 inches thick.)

IIIC1-24 to 49 inches, dark grayish-brown (10YR 4/2) very gravelly clay loam, gray (10YR 5/1) when dry; massive; firm, hard, sticky and plastic; iron stains; 85 percent pebbles; few cobblestones; slightly acid (pH 6.2); abrupt, smooth boundary. (24 to 48 inches thick.)

IVC2-49 to 57 inches, mottled dark-brown (7.5YR 3/2) very gravelly sand, strong brown (7.5YR 5/6) when moist; massive; friable, soft, nonsticky and nonplastic; many, medium, interstitial pores; neutral (pH 6.7).

Color of the A horizon ranges from black or very dark brown to very dark gray, and texture of that horizon ranges from silty clay loam or clay loam to silty clay. In some places the B horizon is very dark gray, and it is gravelly silty clay in some areas. The amount of gravel in the B horizon ranges from 20 to 30 percent. Depth to the very gravelly C horizon ranges from 24 to 36 inches. The C horizon is stratified. Both the thickness of the different layers in the C horizon and the amount of gravel and cobblestones in that horizon are highly variable.

Included with this soil in mapping were small areas that have a surface layer of very dark gray silt loam.

Above the clay subsoil, the available water capacity is less than 3 inches. Permeability is very slow, and fertility is moderate. Runoff is ponded or very slow, and the hazard of erosion is slight. The depth to which roots can penetrate is restricted by the claypan in the subsoil, but it ranges from 12 to 16 inches. Workability is fair.

Undrained areas of this soil are used for pasture, hay, and grass grown for seed. The drained areas are used for these crops and also for spring small grains and winter wheat. When irrigated, the drained areas are used for sweet corn, berries, and beans. This soil is used for these irrigated crops because it occupies only small areas and extends through and is managed like the adjacent Sifton, Salem, and Clackamas soils. Courtney soils are poorly suited to row crops and root crops. (Capability unit IVw-1; not placed in a woodland suitability group)

Cumley Series

The Cumley series consists of moderately well drained soils that have formed in glacial till and colluvium. These soils are on mountain foot slopes, and they have slopes of 2 to 20 percent. Elevations range from 800 to 2,000 feet. The average annual precipitation is between 55 and 75 inches, the average annual air temperature is 48° to 51° F., and the length of the frost-free season is 165 to 190 days. The vegetation is mainly Douglas-fir, maple, alder, brackenfern, and grasses. Cumley soils are associated with McCully, Kinney, and Minniece soils.

In a typical profile, the surface layer is dark-brown silty clay loam about 9 inches thick. This is covered with a thin layer of decomposing leaves, stems, and twigs. The subsoil is about 37 inches thick and is dark reddish-brown silty clay in the upper part, dark-brown heavy silty clay in the middle part, and mottled brown clay in the lower part. The substratum is mottled, olive-brown clay. Bedrock is at a depth of more than 5 feet.

The Cumley soils are used mainly for timber and for watershed.

Cumley silty clay loam, 2 to 20 percent slopes (CLD) -This is the only soil of the Cumley series mapped in the survey area. It occurs in small areas on foot slopes and within slump areas of McCully soils.

Representative profile 25 feet northwest of a logging road (NE1/4NE1/4 sec. 25, T. 9 S., R. 2 E.)

O1 and O2-1 inch to 0, layer of duff consisting of partly decomposed leaves, stems. and twigs.

A11-0 to 4 inches, dark-brown (7.5YR 3/2) silty clay loam, dark brown (7.5YR 4/2) when dry; moderate, fine, granular structure; friable, hard, sticky and plastic; many, fine, interstitial pores; many roots; medium acid (pH 6.0); gradual, smooth boundary. (3 to 7 inches thick.)

A12-4 to 9 inches, dark-brown (7.5YR 3/2) silty clay loam, dark brown (7.5YR 4/2) when dry; moderate, fine and medium, subangular blocky structure; friable, hard, sticky and plastic; many, fine and very fine, tubular pores; many roots; slightly acid; clear, smooth boundary. (4 to 8 inches thick.)

B1-9 to 15 inches, dark reddish-brown (5YR 3/4) silty clay, dark brown (7.5YR 4/3) when dry; moderate, medium, subangular blocky structure; firm, very hard, sticky and plastic; common, very fine and fine, tubular pores; many roots; medium acid (pH 5.8); clear, smooth boundary. (4 to 9 inches thick.)

B21t-15 to 25 inches, dark-brown (7.5YR 3/4) heavy silty clay, dark brown (7.5YR 4/4) when dry; moderate, coarse, subangular blocky structure; firm, very hard, very sticky and very plastic; common, very fine and fine, tubular pores; many roots; common thin and moderately thick clay films; common, fine, brown and black concretions; medium acid (pH 5.6). (8 to 14 inches thick.)

B22t-25 to 46 inches, brown (7.5YR 4/4) clay, brown (7.5YR 5/4) when dry; many, coarse, prominent, grayish brown (2.5Y 5/2) mottles; moderate, coarse, subangular blocky structure; very firm, very hard, very sticky and very plastic; common, very fine and fine, tubular pores; common roots; nearly continuous, thin and moderately thick clay films; few coarse fragments of basalt; strongly acid; clear, smooth boundary. (17 to 25 inches thick.)

C-46 to 60 inches, olive-brown (2.5Y 4/4) clay, grayish brown (2.5Y 5/2) when dry; many, coarse, strong-brown (7.5YR 4/4) mottles; massive; firm, very hard, very sticky and very plastic; few roots; few coarse fragments of basalt; common, very fine and fine, tubular pores; strongly acid.

Texture of the A horizon ranges from silty clay loam to silty clay. In places the A horizon is very dark brown. Mottling in the B22t horizon is distinct in some places. In some areas the entire profile contains a few pebbles, cobblestones, and other stones.

Included with this soil in mapping were small areas of Minniece soils and stony soils.

The available water capacity ranges from 9 to 12 inches. Permeability is moderately slow, and fertility is low. Runoff is medium, and the hazard of erosion is slight. The depth to which roots can penetrate is restricted by wetness and by the layer of clay at a depth of 46 inches.

This soil is used mainly for growing Douglas-fir to which it is moderately well suited. Where cleared, it can be used for small grains, pasture, hay, and grass grown for seed. If this soil is drained and irrigated, it is suitable for some vegetable and berry crops. (Capability unit IIIe-2; woodland suitability group 3c4)

Dayton Series

The Dayton series consists of soils that are poorly drained. These soils have formed mainly in old mixed alluvium, but their upper layers may have been influenced, to some extent, by loess. The soils are on broad valley terraces, and they occur in drainageways and in shallow depressions. Slopes range from 0 to 2 percent, and elevations range from 125 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly annual and perennial grasses, wild rose, and scattered ash trees. Dayton soils are associated with Amity and Concord soils.

In a typical profile, the surface layer is very dark grayish-brown silt loam about 7 inches thick. The subsurface layer is mottled dark-gray silt loam about 6 inches thick. The subsoil is mottled and consists of a layer of clay about 33 inches thick. It is dark gray in the upper part and is grayish brown in the lower part. The substratum is mottled grayish-brown silty clay loam that extends to a depth of 60 inches or more.

The Dayton soils are used mainly for small grains, pasture, hay, and grass grown for seed.

Dayton silt loam (Da).-This soil is on terraces, where it occupies small areas in drainageways and depressions. It is the only soil of the Dayton series mapped in the survey area.

Representative profile (SW1/4NE1/4 sec. 16, T. 6 S., R. 2 W.).

Ap-0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry; few, fine, faint, yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky and granular structure; friable, hard, slightly sticky and slightly plastic; many roots; many, fine, interstitial pores; few, medium, black and red concretions; medium acid (pH 5.6); clear, smooth boundary. (5 to 9 inches thick.)

A2-7 to 13 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; common, fine, faint, brownish-yellow (10YR 6/6) mottles; moderate, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; common, very fine, tabular pores; few black and red concretions; medium acid (pH 5.8); abrupt, smooth boundary. (4 to 15 inches thick.)

IIB21t-13 to 25 inches, dark-gray (10YR 4/1) clay, gray (10YR 5/1) when dry; moderate, medium, prismatic structure breaking to coarse and medium, subangular blocky structure; very firm, very hard, very sticky and very plastic; few roots; few, fine, tubular pores; thick, continuous clay films; few black and red concretions; slightly acid (pH 6.4); gradual, smooth boundary. (10 to 24 inches thick.).

IIB22t-25 to 46 inches, grayish-brown (10YR 5/2) clay, light brownish gray (10YR 6/2) when dry; few, fine, faint, yellowish-brown (10YR 5/6) mottles; massive; firm, very hard, very plastic and very sticky ; few roots; few, fine, tubular pores; slightly acid (pH 6.4); gradual, smooth boundary.

IIIC-46 to 60 inches, grayish-brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) when dry; common, medium, faint, light olive-brown (2.5Y 5/6) mottles; massive; friable, hard, sticky and plastic; few, fine, tubular pores; slightly acid (pH 6.2).

Color of the Ap horizon ranges from dark gray to very dark grayish brown when the soil is moist, and from light gray to light brownish gray when the soil is dry. Texture of the Ap horizon ranges from silt loam to silty clay loam.

Included with this soil in mapping were small areas of a Concord soil. The included areas make up as much as 5 percent of the acreage in the mapping unit.

The available water capacity above the clay subsoil is 3 to 6 inches. Permeability is very slow, and fertility is low. Runoff is very slow to ponded, and the hazard of erosion is slight. Roots can penetrate to the claypan, which is at a depth of only 12 to 24 inches. Workability is good, but this soil tends to puddle and compact if it is cultivated when too moist.

Undrained areas of this soil are used for small grains, pasture, hay, and grass grown for seed, and the drained areas are used for corn and for winter and spring small grains. When irrigated, this soil is used for sweet corn and bush beans. Even where it is drained, it is not suited to deep-rooted crops, many perennial crops, and crops that cannot tolerate excessive moisture. (Capability unit IVw1; not placed in a woodland suitability group)

Hazelair Series

The Hazelair series consists of moderately well drained soils that formed in material weathered from sandstone and shale. These soils have slopes of 2 to 20 percent. They are on foot slopes adjacent to the valley floor, at elevations of 250 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that have not been cultivated, the vegetation is mainly Oregon white oak, poison-oak, rose, annual weeds and grasses, and a few Douglas-firs. Hazelair soils are associated with Steiwer soils.

In a typical profile, the surface layer is very dark brown silt loam about 12 inches thick. The subsoil is very dark grayish-brown silty clay loam about 6 inches thick. The substratum, about 20 inches thick, is mottled and is dark grayish brown throughout. It is silty clay in the upper part and clay in the lower part. Sandstone bedrock is at a depth of about 38 inches.

The Hazelair soils are used as woodland and for small grains, pasture, hay, and grass grown for seed.

Hazelair silt loam, 2 to 6 percent slopes (HaB).This soil occupies small areas on the foot slopes of red foothills south of Salem. It also occurs near Scotts Mills.

Representative profile 40 feet south of a gravel road (NE1/4NE1/4 sec. 25, T. 9 S., R. 3 W)

Ap-0 to 6 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium and fine, granular structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; common, very fine and fine, tubular and interstitial pores; common, fine, rounded concretions or fragments of rock; medium acid (pH 5.8); abrupt, smooth boundary. (6 to 10 inches thick.)

A1-6 to 12 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, medium, subangular blocky structure breaking to strong, very fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; many, very fine and fine, tubular pores; common gray silt coatings on ped surfaces; medium acid (pH 5.6); clear, smooth boundary. (3 to 6 inches thick.)

B2-12 to 18 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry; weak, medium, prismatic structure breaking to strong, fine and very fine, subangular blocky structure; firm, hard, plastic and sticky; few roots; many, very fine and fine, tubular pores; slightly acid (pH 6.2); clear, smooth boundary. (3 to 10 inches thick.)

IIC1-18 to 28 inches, dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) when dry; few, faint, dark yellowish-brown (10YR 4/4) and few, distinct, light brownish-gray (10YR 6/2) mottles; strong, medium, angular blocky structure; firm very hard, very sticky and very plastic; few fine roots; common, very fine, tubular pores; many slickensides; many, fine and very fine, black concretions; slightly acid (pH 6.2); gradual, wavy boundary. (5 to 10 inches thick.)

IIC2-28 to 36 inches, dark grayish-brown (2.5y 4/2) clay, grayish brown (2.5Y 5/2) when dry; many, medium and fine, distinct, dark yellowish-brown (10YR 4/4) and few, distinct, light brownish-gray (10YR 6/2) mottles; moderate, very coarse and coarse, angular blocky structure; firm, very hard, very sticky and very plastic; no roots; few, very fine, tubular pores; common slickensides; few fine fragments of weathered sandstone; slightly acid (pH 6.4 gradual, wavy boundary. (5 to 8 inches thick.)

IIC3-36 to 38 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) when dry; many, medium and fine, distinct, yellowish-brown (10YR 4/4) mottles; weak to moderate, coarse, angular blocky structure; firm, very hard, very sticky and very plastic; few, very fine, tubular pores; common slickensides; common, fine, black concretions; many fine and medium fragments of weathered sandstone; slightly acid (pH 6.4) abrupt, slightly wavy boundary. (0 to 4 inches thick.)

IIIR-38 inches, dark yellowish-brown (10YR 4/4), hard, fractured, fine-grained sandstone that is horizontally bedded.

Texture of the A horizon ranges from silt loam to silty clay loam. Mottles that are faint or distinct are within 20 inches of the surface. Depth to the C horizon ranges from 12 to 24 inches.

Included with this soil in mapping were small stony areas, and other areas where bedrock is at a depth of 4 to 5 feet.

The available water capacity is 4 to 7 inches. Permeability is slow, and fertility is low. Runoff is slow, and the hazard of erosion is slight. The depth to which roots and water can penetrate is restricted by the layer of dense clay at some depth below 12 to 24 inches. Workability is fair. If this soil is cultivated when too moist, however, it tends to puddle and a tillage pan forms readily.

This soil is used mainly for small grains, pasture, hay, and grass grown for seed. It is not suitable for fruit trees and deep-rooted crops, unless it is irrigated. When this soil is irrigated, small areas are used for pole beans, sweet corn, strawberries, and caneberries. (Capability unit IIIe-3 ; not placed in a woodland suitability group)

Hazelair silt loam, 6 to 20 percent slopes (HaD).-This soil has slopes of 6 to 12 percent in as much as 85 percent of the acreage. Runoff is medium, and erosion is a moderate hazard. Small grains, pasture plants, hay, and grass grown for seed are the main crops. (Capability unit IVe-2; not placed in a woodland suitability group)

Hazelair silty clay loam, 2 to 15 percent slopes, eroded (HcD2).-This soil has a profile similar to the one described for Hazelair silt loam, 2 to 6 percent slopes. It has lost as much as three-fourths of the original surface layer through erosion, however, and the present surface layer is very dark grayish-brown, slightly acid silty clay loam. Sheet erosion has caused most of the soil losses, but gully erosion has caused formation of a few shallow gullies. Runoff is medium, and further erosion is a moderate hazard. The available water capacity is only 2 to 3 inches.

Included with this soil in mapping were small areas in which slopes are steeper than 15 percent.

Areas of this Hazelair soil that have not been cleared are used mainly as woodland or for woodland pasture. The small areas that have been cleared are used for improved pasture. Because this soil is droughty, the amount of forage produced is small. (Capability unit VIe-1; not placed in a woodland suitability group)

Henline Series

The Henline series consists of well-drained very stony soils that have formed in colluvium from basalt or agglomerate. These soils have slopes of 6 to 80 percent. They occur on mountainous uplands at elevations of 3,000 to 5,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41° to 45° F., and the length of the frost-free season is 90 to 110 days. The vegetation is mainly noble fir, hemlock, Douglas-fir, and an understory of blue huckleberry, Oregongrape, pathfinder, and beargrass.

In a typical profile, the surface layer is very dark brown very stony sandy loam about 10 inches thick. This is covered with a thin layer of decomposing plant remains. The substratum, just beneath the surface layer, is dark-brown very stony sandy loam. Bedrock of fractured basalt is at a depth of about 30 inches.

The Henline soils are used mainly for producing timber, and for watershed and wildlife habitat.

Henline very stony sandy loam, 6 to 30 percent slopes (HEE).-This soil is on foot slopes of the Cascade Mountains.

Representative profile 100 feet north of a logging road (SE1/4NE1/4 sec. 21, T. 9 S., R. 4 E.)

O1-1/2 inch to 0, patchy, partly decomposed plant and animal matter.

Al-0 to 10 inches, very dark brown (10YR 2/2) very stony sandy loam, dark grayish brown (10YR 4/2) when dry; very weak, coarse, subangular blocky structure; very friable, loose, nonsticky and nonplastic; many roots; many very fine pores; 60 to 70 percent coarse fragments; slightly acid (pH 6.4); diffuse, smooth boundary. (5 to 15 inches thick.)

C-10 to 30 inches, dark-brown (10YR 3/3) very stony sandy loam, brown (10YR 5/3) when dry; massive, readily breaking to single grain; very friable, loose, nonsticky and nonplastic; many roots; many interstitial pores; 60 to 70 percent coarse fragments; slightly acid (pH 6.4); clear, wavy boundary. (15 to 30 inches thick.)

IIR-30 inches, fractured basalt.

The content of coarse rock fragments in the soil profile ranges from 50 to 80 percent. In places part of the A horizon has granular structure. Depth to bedrock ranges from 20 to 40 inches.

Included with this soil in mapping were a few rock outcrops and small areas of Whetstone and Kinney soils. These included areas make up as much as 10 percent of the acreage in this mapping unit.

The available water capacity is 3 inches or less. Permeability is moderately rapid, and fertility is low. Runoff is medium, and the hazard of erosion is moderate. Roots can penetrate only to the basalt or agglomerate, at a depth of 20 to 40 inches.

This soil is well suited to forest trees, and it is used mainly for producing timber. It is too stony to be suitable for cultivated crops. (Capability unit VIs-1; woodland suitability group 3o2)

Henline very stony sandy loam, 30 to 55 percent slopes (HEF).-Steep slopes and rapid runoff make this soil highly susceptible to erosion. Rock outcrops are common, and there are a few escarpments.

This soil is used mainly for producing timber. It is more difficult to manage, however, than Henline very stony sandy loam, 6 to 30 percent slopes. Roads are hard to build and are difficult to maintain. (Capability unit VIs-1; woodland suitability group 3r3)

Henline very stony sandy loam, 55 to 80 percent slopes (HEG).-This soil is highly susceptible to erosion because of its very steep slopes and the very rapid runoff. Rock outcrops are numerous, and escarpments are common.

This soil is used mainly for producing timber, but management is extremely difficult. Roads are difficult to build and to maintain. (Capability unit VIIs-1; woodland suitability group 3r4)

Holcomb Series

The Holcomb series consists of somewhat poorly drained soils that are nearly level. These soils have formed mainly in mixed alluvial silts and clays, but they have some loess in the upper layers. They are on terraces. Elevations range from 125 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly grasses, wild blackberry, rose, and oak. Holcomb soils are associated with Amity and Dayton soils.

In a typical profile, the surface layer is silt loam about 18 inches thick. It is very dark brown in the upper part and is very dark grayish brown in the lower part. The subsurface layer is mottled, dark-brown light silty clay loam about 6 inches thick. The subsoil, about 18 inches thick, is mottled, dark grayish-brown clay in the upper part and is dark grayish-brown silty clay in the lower part.

The Holcomb soils are used mainly for small grains, pasture, hay, and grass grown for seed.

Holcomb silt loam (Ho).-This silty soil occupies small areas adjacent to drainageways on old alluvial terraces. It is the only soil of the Holcomb series mapped in the survey area.

Representative profile (SW1/4SW1/4SE1/4 sec. 4, T. 9 S., R. 2 W.).

Ap-0 to 6 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, coarse, subangular blocky structure breaking to moderate, fine, granular structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many very fine pores; medium acid (pH 5.6); gradual, smooth boundary. (3 to 9 inches thick.)

A1-6 to 18 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, coarse, subangular blocky structure breaking to fine subangular blocky structure; friable, slightly hard, sticky and slightly plastic; many roots; many very fine pores; medium acid (pH 5.8); clear, smooth boundary. (9 to 15 inches thick.)

A2-18 to 24 inches, dark-brown (10YR 3/3) light silty clay loam, light brownish gray (10YR 6/2) when dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, fine subangular blocky structure; firm, hard, sticky and plastic; common roots; common fine pores; common grains of clean silt and sand on ped surfaces; slightly acid (pH 6.2); abrupt, smooth boundary. (2 to 7 inches thick.)

IIB2tg-24 to 34 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (2.5Y 5/2) when dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, angular blocky structure breaking to strong, fine, angular blocky structure; very firm, very hard, very sticky and very plastic; few roots; few very fine pores; common thin clay films on ped surfaces; neutral (pH 6.6); clear, smooth boundary. (8 to 12 inches thick.)

IIB3tg-34 to 42 inches, dark grayish-brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) when dry; weak, fine, angular blocky structure; firm, very hard, very sticky and very plastic; no roots; common very fine pores; common thin clay films on ped surfaces; common, medium, black concretions; neutral (pH 6.6).

When the soil is moist, color of the A1 horizon ranges from very dark brown to very dark grayish brown. Depth to the upper part of the B horizon ranges from 20 to 30 inches. In places the lower part of the B horizon is gravelly. In most places a gravelly substratum is within 5 feet of the surface.

Included with this soil in mapping were areas in which the surface layer is dark brown.

Within the root zone, the available water capacity is 4 to 6 inches. Permeability of the subsoil is very slow, and fertility is moderate. Runoff is slow, and erosion is only a slight hazard. Workability is good, but a tillage pan develops if this soil is cultivated when too moist. Roots can penetrate to depths of 20 to 30 inches.

This soil is well suited to small grains, pasture plants, hay, and grass grown for seed, and it is used mainly for those crops. Small areas are drained. When irrigated, these drained areas are used for pole beans, corn, and blackberries. (Capability unit IIIw-1; not placed in a woodland suitability group)

Horeb Series

The Horeb series consists of moderately well drained and well drained soils that have formed in glacial till and colluvium. These soils have slopes of 0 to 35 percent. They occur on terraces and on mountain foot slopes at elevations of 1,600 to 3,500 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 46° to 50° F., and the length of the frost-free season is 120 to 165 days. The vegetation is mainly Douglas-fir, vine maple, brackenfern, swordfern, huckleberry, and sedges. Horeb soils are associated with Kinney soils.

In a typical profile, the surface layer is loam that is very dark brown in the upper part and is very dark grayish brown in the lower part. This is covered with a thin layer of decomposing leaves, needles, and twigs. The subsoil is about 17 inches thick, and it consists of gravelly loam that is dark brown in the upper part and dark yellowish brown in the lower part. The upper part of the substratum is mottled, light olive-brown gravelly loam about 5 inches thick. The lower part of the substratum is mottled, dark grayish-brown cobbly loam that extends to a depth of 60 inches or more.

The Horeb soils are used mainly for growing timber, for watershed, and as habitat for wildlife.

Horeb loam, 2 to 20 percent slopes (HRD).-Some areas of this soil are on foot slopes of the Cascade Mountains. Others occupy old slide or slip, areas in these mountains.

Representative profile (NE1/4NW1/4 sec. 15, T. 9 S., R. 3 E.).

O1-2 inches to 0, organic litter consisting of needles, fern leaves, twigs, and other residue from plants.

A11-0 to 9 inches, very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) when dry; moderate, fine, granular structure; very friable, slightly hard, nonsticky and nonplastic; many, fine and very fine, interstitial pores; many roots; 5 percent fine and medium pebbles; strongly acid (pH 5.2); gradual, wavy boundary. (6 to 12 inches thick.)

A12-9 to 14 inches, very dark grayish-brown (10YR 3/2) loam, brown (10YR 5/3) when dry; moderate, fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many, fine and very fine, interstitial pores; many roots; 10 percent fine and medium pebbles; strongly acid (pH 5.4); clear, wavy boundary. (4 to 7 inches thick.)

B21-14 to 24 inches, dark-brown (10YR 4/3) gravelly loam, light yellowish brown (10YR 6/4) when dry; moderate, fine subangular blocky structure; friable, hard, slightly sticky and slightly plastic; common roots; common very fine pores; 20 percent pebbles; very strongly acid (pH 4.8); clear, wavy boundary. (8 to 14 inches thick.)

B22-24 to 31 inches, dark yellowish-brown (10YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) when dry; weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; many very fine pores; 25 percent pebbles; very strongly acid (pH 4.8); clear, wavy boundary. (5 to 10 inches thick.)

C1-31 to 36 inches, light olive-brown (2.5Y 5/4) gravelly loam that contains common, medium, distinct, yellowish-brown (10YR 5/6) mottles; pale yellow (2.5Y 8/4) when dry; weak, coarse, subangular blocky structure or massive; friable, slightly hard, slightly sticky and slightly plastic; few roots; common very fine pores; 25 percent pebbles; very strongly acid (pH 4.8); clear, wavy boundary. (4 to 8 inches thick.)

C2-36 to 60 inches, dark grayish-brown (2.5Y 4/2) cobbly loam that contains common, medium, distinct, yellowish-brown (10YR 5/6) mottles; pale yellow (2.5Y 8/4) when dry; massive; firm, hard, sticky and plastic; few roots; many very fine and few medium pores; 15 percent pebbles, and 20 percent cobblestones; very strongly acid (pH 4.8).

Texture of the A horizon ranges to silt loam in some places. Color of the B horizon ranges from dark brown to dark yellowish brown. In some areas as much as 15 percent of the solum consists of fragments coarser than 3 inches in diameter. Thick ness of the solum ranges from 24 to 40 inches. Below a depth of 40 inches, the soil material is cobbly loam to very gravelly sand and the content of coarse fragments ranges from 25 to 85 percent.

Included with this soil in mapping were small areas of a steep Kinney soil, and areas that lack a cobbly or gravelly substratum.

The available water capacity is 5 to 7 inches. Permeability is moderate, and fertility is low. Runoff is medium, and the hazard of erosion is slight to moderate. This soil receives extra water that seeps from higher areas. Depth to which roots can penetrate is restricted by wetness caused by seepage and by the cobblestones and gravel in the substratum. Workability is good.

This soil is fairly well suited to use as woodland, and it is especially well suited to Douglas-fir. It is also suited to cultivated crops. (Capability unit IIIe-2; woodland suitability group 1o1)

Horeb gravelly silt loam, gravelly substratum, 0 to 15 percent slopes (HSC).-This is a well-drained soil on terraces. The depth to which roots can penetrate is restricted to about 40 inches by the very gravelly sand in the substratum. Runoff is slow, and the hazard of erosion is slight. Workability is fair.

Included with this soil in mapping were small areas where material from adjacent higher areas has been deposited on the surface of this soil. These included areas have a reddish color.

This Horeb soil is well suited to forest trees. It is used mainly for growing Douglas-fir, but small areas have been cleared and are used for pasture. Small grains, hay, berries, and vegetables could be grown. (Capability unit IIIe-4; woodland suitability group 2c1)

Horeb gravelly silt loam, gravelly substratum, 15 to 35 percent (HSE).-This soil is on abrupt breaks of terrace fronts. Runoff is rapid, and the hazard of erosion is moderate to severe. Included in mapping in some places were a few, small, very gravel-, and cobbly areas.

This Horeb soil is used mainly for growing Douglas-fir. It is poorly suited to many of the commonly grown cultivated crops, but it can be used for small grains and pasture. (Capability unit IVe-1; woodland suitability group 2c1)

Hullt Series

The Hullt series consists of well-drained soils that have formed in colluvium derived from sandstone. These soils have slopes of 2 to 60 percent. They occur on the margins of mountainous foot slopes at elevations of 800 to 1,200 feet. The average annual precipitation is 55 to 75 inches, the average annual air temperature is 49° to 51° F., and the length of the frost-free season is 165 to 190 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hemlock, maple, brackenfern, salal, ocean-spray, hazel, snowberry, thimbleberry, strawberry, and trailing blackberry. Hullt soils are associated with Nekia and McCully soils.

In a typical profile, the surface layer is very dark brown clay loam about 9 inches thick. The subsurface layer is variegated dark-brown clay loam about. 6 inches thick. The subsoil is about 40 inches thick and is silty clay loam throughout. The upper part of the subsoil consists of a layer that is dark reddish brown and that is underlain by a layer that is reddish brown; the middle part of the subsoil is yellowish red; and the lower part is dark brown The substratum is variegated strong-brown to yellowish red, strongly weathered sandstone.

The Hullt soils are used mainly for small grains, pasture, hay, grass grown for seed, trees that grow in wooded areas, acid watershed.

Hullt clay loam, 2 to 7 percent slopes (HuB).-This soil is on the lower foot slopes of the Cascade Mountains.

Representative profile (SW1/4NE1/4 sec. 26, T. 6 S., R. 1 E.).

Ap-0 to 9 inches, very dark brown (7.5YR 2/2) clay loam, dark brown (7.5YR 4/4) when dry; weak, coarse and medium, subangular blocky structure breaking to weak, very fine, subangular (blocky structure; friable, hard, sticky and plastic; many roots; many very fine pores; few, very fine, black and reddish-colored concretions; medium acid (pH 5.8); abrupt, wavy boundary. (8 to 10 inches thick.)

A3-9 to 15 inches, variegated dark-brown (7.5YR 3/2 and 3/4) clay loam, brown (7.5YR 4/4) when dry; weak, coarse, prismatic structure breaking to weak, fine and very fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, fine and very fine, tubular pores; common worm casts; strongly acid (pH 5.4); clear, smooth boundary. (0 to 8 inches thick.)

B1-15 to 22 inches, dark reddish-brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) when dry; weak, coarse and medium, subangular blocky structure; friable, hard, sticky and very plastic; common roots; many, very fine and few, fine, tubular pores; strongly acid (pH 5.4); clear, smooth boundary. (5 to 9 inches thick.)

B21-22 to 33 inches, reddish-brown (5YR 4/4) silty clay loam, reddish brown (5YR 5/4) when dry; weak, medium, subangular blocky structure; friable, hard, sticky and very plastic; common roots; common fine and very fine pores; very strongly acid (pH 5.0); clear, smooth boundary. (9 to 13 inches thick.)

B22-33 to 46 inches, yellowish-red (5YR 4/6) silty clay loam, yellowish red (5YR 5/6) when dry; weak, medium and fine, subangular blocky structure; firm, very hard, sticky and very plastic; few roots; common, fine and very fine, tubular pores; very strongly acid (pH 5.0); gradual, smooth boundary. (10 to 16 inches thick.)

B3--46 to 55 inches, dark-brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) when dry; common, faint, medium and coarse, reddish-brown (5YR 4/4) mottles; weak, coarse, subangular blocky structure; firm, hard, sticky and very plastic; few roots; common, fine and very fine, tubular pores; few, black, medium stains; very strongly acid (pH 5.0); clear, wavy boundary. (6 to 20 inches thick.)

C-55 inches, variegated strong-brown (7.5YR 5/6 and 5/8), pinkish-gray (7.5YR 6/2), and yellowish-red (5YR 4/6), strongly weathered sandstone; massive; clay films along fractures; very strongly acid (pH 4.8).

Color of the horizon ranges from very dark brown to dark reddish brown. In places the A horizon is silty clay loam. Depth to weathered sandstone ranges from 40 to 60 inches.

Included with this soil in mapping were small eroded areas, where weathered sandstone is less than 30 inches from the surface. These areas make up about 5 percent of the acreage in this mapping unit. Also included were small areas of Nekia and McCully soils that make up from 5 to 10 percent of the acreage in the mapping unit.

The available water capacity is 8 to 10 inches. Permeability is moderately slow, and fertility is low. Runoff is slow, and the hazard of erosion is slight. The depth to which roots can penetrate ranges from 40 to 60 inches. Workability is fair, but it becomes progressively poorer as the content of moisture drops below field capacity.

This soil is well suited to most of the crops commonly grown in the survey area. It is used mainly for small grains, pasture, hay, and grass grown for seed, and it is also used as woodland. In addition, a small acreage is used for pole beans, sweet corn, caneberries, strawberries, and specialty crops. Irrigation is needed if pole beans and sweet corn are to be grown commercially. (Capability unit IIe-3; woodland suitability group 2o1)

Hullt clay loam, 7 to 20 percent slopes (HuD).-In about 60 percent of the acreage, this soil has slopes steeper than 12 percent. Runoff is medium, and erosion is a moderate hazard.

This soil is used for about the same crops as Hullt clay loam, 2 to 7 percent slopes, except that sweet corn is not grown. Tilling of row crops is difficult, and using mechanical methods for harvesting berries and vegetables is not feasible. (Capability unit IIIe-2; woodland suitability group 2o1)

Hullt clay loam, 2 to 20 percent slopes (HTD).-Runoff from this soil is medium, and the hazard of erosion is moderate. Where cleared, this soil is suitable for cultivated crops. It is used mainly as woodland. (Capability unit. IIIe-2; woodland suitability group 2o1)

Hullt clay loam, 20 to 30 percent slopes (HTE).-Runoff from this soil is rapid, and the hazard of erosion is severe. This soil is used mainly as woodland and for small grains, pasture, hay, and grass grown for seed. Small areas are also used for strawberries and cherries. Cultivating and harvesting most crops is difficult. (Capability unit IVe-1; woodland suitability group 2o1)

Hullt clay loam, 30 to 60 percent slopes (HTF).-Runoff from this soil is rapid, and the hazard of erosion is severe. This soil is not suitable for cultivated crops. It is used mainly for pasture, as woodland, and for grass grown for seed. (Capability unit VIe-2; woodland suitability group 2c2)

Jory Series

The Jory series consists of well-drained soils that have formed in colluvium from tuffs and basalt. These soils are on low, red foothills that are deeply dissected by drainageways and streams. They have slopes of 2 to 30 percent. Elevations range from 300 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, scattered Oregon oaks, and an understory of poison-oak and rose bushes. Jory soils are associated with Nekia soils.

In a typical profile, the surface layer is dark reddish-brown silty clay loam about 8 inches thick. The subsurface layer is also dark reddish-brown silty clay loam and is about 7 inches thick. The upper part of the subsoil consists of a layer of dark reddish-brown silty clay about 21 inches thick. The lower part of the subsoil is dark reddish-brown clay. Basalt is at a depth of more than 5 feet.

The Jory soils are used for small grains, orchards, pasture, hay crops, and grass grown for seed, and they are also used as woodland, for watershed, for wildlife habitat, and as homesites. Some areas are irrigated and are used for truck crops and vegetables.

Jory silty clay loam, 2 to 7 percent slopes (JoB).-This soil is on low foothills south and east of Salem.

Representative profile west of the Salem bypass (U.S. No. 99) and south of the secondary road running east from Grabenhorst Corners (NW1/4NW1/4NE1/4 sec. 13, T. 8 S., R. 3 W.; profile No. 1 in table 9 in the section "Laboratory Data.")

Ap1-0 to 4 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) when dry; strong, medium and fine, granular structure; very friable, slightly hard, plastic and sticky; common, soft, fine, spherical pellets (shot); common roots; many, fine and very fine, interstitial pores; medium acid (pH 5.9); clear, smooth boundary. (4 to 8 inches thick.)

Ap2-4 to 8 inches, dark reddish-brown (5YR 3/3) silty clay loam, color the same when dry; weak, fine and very fine, subangular blocky structure; friable, slightly hard, sticky and plastic; few, soft, fine, spherical pellets; common roots; many, fine and very fine, interstitial pores; strongly acid (pH 5.5); clear, smooth boundary. (4 to 12 inches thick.)

A3--8 to 15 inches, dark reddish-brown (5YR 3/3) silty clay loam, color the same when dry; moderate, fine and very fine, subangular blocky structure; friable, slightly hard, very sticky and very plastic; few, soft, fine, spherical pellets; common roots; many, fine and very fine, interstitial and tubular pores; strongly acid (pH 5.5); gradual, smooth boundary. (4 to 7 inches thick.)

B1t-15 to 20 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/3) when dry; moderate, fine, angular blocky structure breaking to strong, very fine, angular blocky structure; friable, hard, very sticky and very plastic; thin, continuous clay films; common roots; many, very fine, tubular pores; strongly acid (pH 5.2); gradual, smooth boundary. (0 to 8 inches thick.)

B21t-20 to 28 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/3) when dry; moderate, medium and fine, angular blocky structure; friable, hard, very sticky and very plastic; thin, continuous clay films; common roots; many, very fine, tubular pores; very strongly acid (pH 5.0); clear, smooth boundary. (6 to 15 inches thick.)

B22t-28 to 36 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/3) when dry; moderate, medium and fine, angular blocky structure; friable, hard, very sticky and very plastic; thin, continuous clay films; few black splotches 1 to 3 millimeters in diameter; few roots; many, very fine, tubular pores; very strongly acid (pH 4.9); clear, smooth boundary. (8 to 20 inches thick.)

B23t-36 to 50 inches, dark reddish-brown (2.5YR 3/4) clay, reddish brown (2.5YR 4/4) when dry; strong, fine and very fine, angular blocky structure; very firm, very hard, plastic and sticky; common black splotches and concretions 3 to 8 millimeters in diameter; thin, continuous clay films; very few roots; many, very fine, tubular pores; very strongly acid (pH 4.9) ; gradual, smooth boundary. (10 to 20 inches thick.)

B24t-50 to 63 inches, dark reddish-brown (2.5YR 3/4) clay, reddish brown (2.5YR 4/4) when dry; moderate, fine. angular blocky structure; firm, hard, plastic and sticky; few black splotches 3 to 8 millimeters in diameter; thin, continuous clay films; very few roots; many, very fine, tubular pores; very strongly acid (pH 4.9).

Thickness of the A horizon ranges from 12 to 20 inches. Color of the B horizon ranges from dark reddish brown to dark red. The content of clay in the B horizon ranges from about 40 to 60 percent, but the soil material has a coarser feel when rubbed between the fingers. In some places these soils contain a discontinuous stone line at a depth of 2 to 12 feet. In places a few basalt boulders are in all parts of the profile.

Included with this soil in mapping were small areas of a Nekia soil.

The available water capacity is 7 to 10 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is only a slight hazard. Roots can penetrate to a depth of 5 feet or more. Workability is fair, but it becomes progressively poorer when the content of moisture drops below field capacity.

This soil is used mainly for small grains, orchards (fig. 7), pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, pole beans, sweet corn, caneberries, and specialty crops. When irrigated, this soil is used for most of the crops commonly grown in the survey area. Water for irrigation is obtained from reservoirs and ponds. (Capability unit IIe-3; woodland suitability group 3c1)

Jory silty clay loam, 7 to 12 percent slopes (JoC).-In most places this soil has slopes steeper than 9 percent. Runoff is medium, and the hazard of erosion is moderate. This soil is used for about the same crops as Jory silty clay loam, 2 to 7 percent slopes. (Capability unit IIIe-6; woodland suitability group 3c1)

Jory silty clay loam, 12 to 20 percent slopes (JoD).Runoff from this soil is medium, and erosion is a moderate hazard. This soil is used for about the same crops as Jory silty clay loam, 2 to 7 percent slopes. Sweet corn is not grown, however, because of the difficulty of using machinery for harvesting the crop. (Capability unit IIIe-2; woodland suitability group 3c1)

Jory silty clay loam, 20 to 30 percent slopes (JoE).Runoff from this soil is rapid. The hazard of erosion is severe. This soil is used mainly for small grains, pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, for cherries, and as woodland. (Capability unit IVe-1; woodland suitability group 3cl)

Kinney Series

The Kinney series consists of well-drained soils that have formed in glacial till over basic igneous tuffaceous agglomerate. These soils have slopes of 2 to 70 percent. They occur on mountain foot slopes at elevations of 1,000 to 3,500 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 46° to 50° F., and the length of the frost-free season is 120 to 165 days. The vegetation is mainly Douglas-fir, hemlock, alder, Oregongrape, salal, vine maple, and rhododendron. Kinney soils are associated with Horeb, McCully, and Henline soils.

In a typical profile, the surface layer is very dark brown cobbly loam about 10 inches thick. This is covered by a thin layer of partly decomposed ferns, fir needles, leaves, and twigs, and by a thin layer of well-decomposed, black organic matter. The subsoil is about 30 inches thick. It consists of dark-brown cobbly clay loam in the upper part and of dark yellowish-brown cobbly clay loam in the lower part. The substratum is dark yellowish-brown cobbly loam about 13 inches thick. It is underlain by variegated light olive-brown to dark-red, weathered, basic igneous agglomerate.

The Kinney soils are used mainly for growing timber and for watershed.

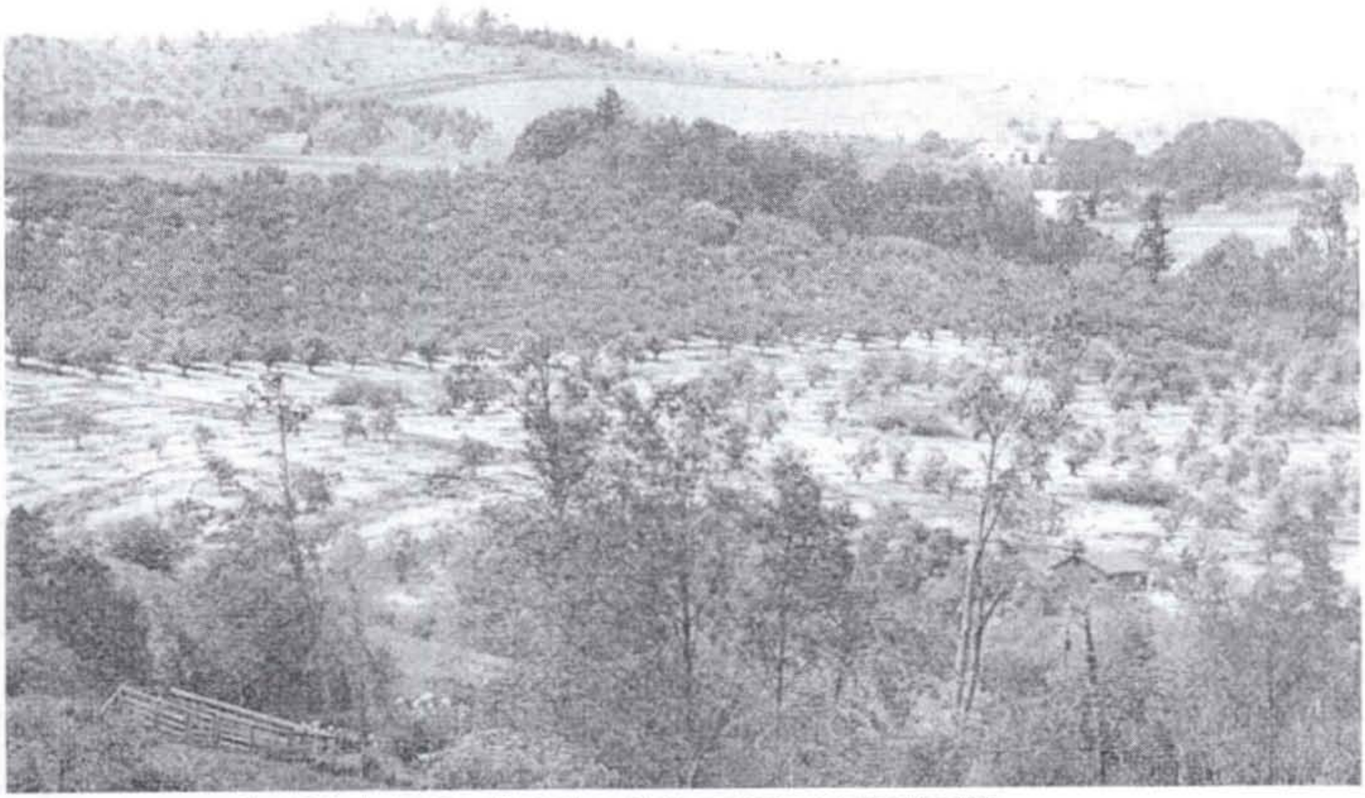


Figure 7.-Orchard on Jory silty clay loam, 2 to 7 percent slopes, in the Salem Hills.

Kinney cobbly loam, 2 to 20 percent slopes (KCD).This soil occupies broad ridges on foot slopes of the Cascade Mountains.

Representative profile about 3 miles southeast of South Burn Guard Station; 60 feet north of South Burn Road (NW1/4NE1/4SE1/4 sec. 31, T. 8 S., R. 2 E.)

O1-2 inches to 1 inch, partly decomposed fern leaves, fir needles, other leaves, and twigs.

O2-1 inch to 0, well-decomposed, black, friable organic matter.

A11-0 to 4 inches, very dark brown (10YR 2/2) cobbly loam, dark brown (10YR 4/3) when dry; moderate, fine, granular structure; friable, slightly hard, slightly sticky and slightly plastic; many fine and medium roots; many, fine, interstitial pores; many medium and fine particles of shot; 25 percent pebbles and angular cobble-size fragments; strongly acid (pH 5.3); clear, smooth boundary. (4 to 6 inches thick.)

A12-4 to 10 inches, very dark brown (10YR 2/2) cobbly loam, dark brown (10YR 4/3) when dry; moderate, medium and fine, granular structure; friable, slightly hard, slightly sticky and slightly plastic; many fine roots; many, fine, interstitial pores; many medium and fine particles of shot; 25 percent pebbles and angular cobble-size fragments; Strongly acid (pH 5.1); abrupt, wavy boundary. (4 to 6 inches thick.)

B1-10 to 15 inches, dark-brown (10YR 3/3) cobbly clay loam, dark brown (10YR 4/3) when dry; weak, fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many medium roots; many, very fine, tubular pores; thin, patchy cutans; many medium and fine particles of shot; 30 percent coarse fragments; strongly acid (pH 5.5); clear, wavy boundary. (2 to 6 inches thick.)

B21-15 to 20 inches, dark-brown (7.5YR 3/4) cobbly clay loam, brown (7.5YR 5/4) when dry; weak, medium, subangular blocky structure; friable, slightly hard, sticky and plastic; common roots; many, very fine, tubular pores; thin, continuous cutans on peds, and thin, continuous clay films in root channels and in the larger pores; many, coarse, sand-size particles of material that resembles quartz; 30 percent pebbles and angular cobblestones; very strongly acid (pH 4.6); gradual, smooth boundary. (4 to 20 inches thick.)

B22-20 to 40 inches, dark yellowish-brown (10YR 4/4) cobbly clay loam, yellowish brown (10YR 5/4) when dry; weak, coarse and medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common roots; many, very fine, tubular pores; moderately thick clay films in some of the larger pores; common, coarse, sand-size particles of material that resembles quartz; 35 percent pebbles and angular, cobble-size fragments of rock; very strongly acid (pH 4.6); clear, wavy boundary. (10 to 25 inches thick.)

C-40 to 53 inches, dark yellowish-brown (10YR 4/4) cobbly loam, light yellowish brown (10YR 6/4) when dry; massive or very weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; many very fine pores; many, coarse, sand-size particles of material that resembles quartz; 35 percent pebbles and angular, cobble-size fragments of rock; very strongly acid (pH 4.8); abrupt, irregular boundary. (0 to 13 inches thick.)

IIR-54 inches, variegated light olive-brown (2.5Y 5/4), pale yellow (2.5Y 7/4), yellow (2.5Y 7/6), and dark-red (2.5YR 3/6), highly weathered, basic igneous agglomerate; very strongly acid (pH 4.8).

The A horizon is dark brown in some places. The predominant color of the B2 horizon is dark yellowish brown, but the color ranges to strong brown or slightly redder in some areas. Thickness of the solum ranges from 40 to 60 inches, but it is generally between 40 and 48 inches. In places pebbles, cobblestones, and other stones constitute as much as 25 to 50 percent of the solum. The upper part of the profile contains pumice in some areas. Weathered basic igneous agglomerate is at a depth of only 40 to 60 inches in many places, but it is at a much greater depth in some places where the layer of till is many feet thick. Rock crops out in some areas.

Included with this soil in mapping were small areas of McCully and Horeb soils. These included areas make up less than 5 percent of the acreage in the mapping unit.

The available water capacity is 5 to 9 inches. Permeability and fertility are both moderate. Runoff is medium, and erosion is only a slight hazard. Depth to which roots can penetrate ranges from 40 to 60 inches.

This soil is used mainly for growing Douglas-fir to which it is well suited. It is not suited to field crops. (Capability unit VIe-2; woodland suitability group 3o1)

Kinney cobbly loam, 20 to 50 percent slopes (KCF).This soil contains more rock outcrops than Kinney cobbly loam, 2 to 20 percent slopes. Bedrock commonly crops out along slope breaks between the two soils. Runoff is rapid, and the hazard of erosion is moderate to severe.

This soil is used and is managed about the same as Kinney cobbly loam, 2 to 20 percent slopes. (Capability unit VIe-2; woodland suitability group 3r1)

Kinney cobbly loam, 50 to 70 percent slopes (KCG).Runoff from this soil is very rapid. The hazard of erosion is very severe.

This soil is used in about the same way as Kinney cobbly loam, 2 to 20 percent slopes. It is not managed, except to harvest the natural stands of timber. Constructing logging roads and performing logging operations are difficult. (Capability unit VIIe-1; woodland suitability group 3r2)

Labish Series

The Labish series consists of poorly drained soils that have formed in mixed mineral and organic material. These soils have slopes of 0 to 1 percent. They occur on the bottoms of former shallow lakes at elevations of 150 to 175 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 53° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly sedges, tussocks, and . willows. Labish soils are associated with Semiahmoo soils.

In a typical profile the surface layer is black and is about 7 inches tick. It consists of silty clay loam in the upper part and of silty clay in the lower part. The next layer is very dark brown silty clay about 9 inches thick. Below this is very dark gray clay that extends to a depth of 60 inches or more.

The Labish soils are used mainly for onions, small grains, pasture, and hay.

Labish silty clay loam (La).-This is the only soil of the Labish series mapped in the survey area. Nearly all of the acreage is in Lake Labish Bottom and in intermittent drainageways that have their outlets in Lake Labish Bottom.

Representative profile (NE1/4SW1/4 sec. 14, T. 6 S., R. 2 W.)

Ap1-0 to 3 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) when dry; strong, fine, granular structure; friable, very hard, sticky and plastic; many roots; many, fine, interstitial pores; slightly acid (pH 6.4); abrupt, smooth boundary. (3 to 6 Inches thick.)

Ap2-3 to 7 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) when dry; weak, coarse, subangular blocky structure; firm, very hard, sticky and plastic; common roots; many, fine and medium, tubular pores; medium acid (pH 5.6); abrupt, smooth boundary. (3 to 5 inches thick.)

AC1g-7 to 16 inches, very dark brown (10YR 2/2) silty clay, very dark gray (10YR 3/1) when dry; moderate, coarse, prismatic structure; firm, very hard, very sticky and very plastic; few roots; common, very fine, tubular pores; very strongly acid (pH 4.8); clear, smooth boundary. (7 to 11 inches thick.)

AC2g-16 to 30 inches, very dark gray (N 3/0) clay, very dark gray (N 3/0) when dry; weak, coarse, prismatic structure, massive when wet; very firm, extremely hard, very sticky and very plastic; few very fine pores; common fibrous roots; very strongly acid (pH 4.6); gradual, smooth boundary. (11 to 17 inches thick.)

C1g-30 to 48 inches, very dark gray (N 3/0) clay, very dark gray (N 3/0) when dry; massive; very firm, extremely hard, very sticky and very plastic; few very fine pores; common, medium-sized, light-colored, porous, soft fragments; very strongly acid (pH 4.6); abrupt, smooth boundary. (5 to 25 inches thick.)

C2g-48 to 60 inches, very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) when dry; massive; very firm, extremely hard, very sticky and very plastic; few very fine pores; neutral (pH 7.0).

In most places the content of organic matter in the A horizon is between 10 and 25 percent. The content of organic matter is so high in some places, however, that the A horizon is almost muck. In a few places, thin layers of peat are within 5 feet of the surface.

Included with this soil in mapping were small areas of Wapato and Semiahmoo soils.

The available water capacity is 12 to 15 inches. Permeability is slow, and fertility is high. Workability is only fair. Runoff is very slow to ponded, and erosion is not a hazard or is only a slight hazard. Depth to which roots can penetrate is limited by the high water table. Annual flooding is a hazard to crops.

This soil is used mainly for onions, small grains, pasture, and hay. When irrigated, drained areas are used for vegetables and specialty crops. (Capability unit IIIw-2; not placed in a woodland suitability group)

McAlpin Series

The McAlpin series consists of moderately well drained and somewhat poorly drained soils that have formed in mixed alluvium. These soils are on alluvial fans and alluvial bottoms of small streams and in drainageways that traverse the low foothills. They have slopes of 0 to 6 percent. Elevations range from 250 .to 1,000 feet. The average annual precipitation is between 40 and 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, with some ash, rosebush, and grasses. McAlpin soils are associated with Abiqua and Waldo soils.

In a typical profile, the surface layer is dark-brown silty clay loam about 8 inches thick. The subsurface layer is dark reddish-brown silty clay loam about 6 inches thick. The subsoil is dark reddish-brown silty clay loam in the upper part; mottled, dark reddish-brown silty clay in the middle part; and mottled, dark-brown silty clay in the lower part. It extends to a depth of 65 inches or more.

The McAlpin soils are used mainly for small grains, hay, pasture, and grass grown for seed.

McAlpin silty clay loam, 0 to 3 percent slopes (MaA).This soil is along streams and intermittent drainageways of the Salem, Waldo, and Silverton Hills. The areas are small.

Representative profile 425 feet east and 270 feet north of a road intersection (SE1/4NW1/4SE1/4 sec. 17, T. 9 S., R. 2 W.) .

Ap1-0 to 5 inches, dark-brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) when dry; moderate, fine and very fine, granular structure; friable, slightly hard, slightly plastic and slightly sticky; many roots; many interstitial pores, few, medium and fine, reddish-brown concretions; strongly acid (pH 5.5); abrupt, smooth boundary. (4 to 8 inches thick.)

Ap2-5 to 8 inches, dark-brown (7.5Y 3/2) silty clay loam, brown (7.5YR 4/4) when dry; massive; very firm, hard, slightly plastic and slightly sticky; common roots; few very fine pores; few, medium and fine, reddish-brown concretions; medium acid (pH 5.6); clear, smooth boundary. (0 to 4 inches thick.)

A3-8 to 14 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) when dry; weak, coarse, prismatic structure breaking to moderate, coarse and fine, granular structure; friable, slightly hard, slightly plastic and slightly sticky; few roots; many, very fine, tubular pores; common, medium and fine, reddish-brown concretions; medium acid (pH 5.7); gradual, smooth boundary. (3 to 9 inches thick.)

B1-14 to 23 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/4) when dry; weak, coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; friable, hard, plastic and sticky; few roots; many, very fine, tubular pores; thin, very dark brown coatings on ped surfaces; common, medium and fine, reddish-brown concretions; medium acid (pH 5.8); gradual, smooth boundary. (6 to 12 inches thick.)

B21-23 to 37 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; common, fine, faint mottles; weak, coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; firm, hard, plastic and sticky; few roots; many, very fine, tubular pores; thin, very dark brown coatings on ped surfaces and in pores; common, fine and medium, black and reddish-brown concretions; medium acid (pH 5.9); gradual, smooth boundary. (9 to 15 inches thick.)

B22-37 to 51 inches, dark-brown (7.5YR 3/2) silty clay, brown (7.5YR 5/2) when dry; common, medium and fine, faint, brown (10YR 5/3 and 7.5YR 5/2) and gray (10YR 5/1) mottles when moist; moderate, fine, subangular blocky structure; firm, hard, very plastic and very sticky; few roots; many, fine and very fine, tubular pores; thick, dark coatings in root channels and in wormholes; common, fine and medium, black and reddish-brown concretions; medium acid (pH 5.9); clear, smooth boundary. (12 to 16 inches thick.)

B3-51 to 65 inches, dark-brown (7.5YR 4/2) silty clay, brown (7.5YR 5/4) when dry; many, coarse and medium, distinct mottles of light yellowish brown (10YR 6/4), brown (10YR 5/3), and strong brown (7.5YR 5/8) when moist; moderate, fine subangular blocky structure; firm, hard, very plastic and very sticky; many, very fine and fine, tubular pores; many, fine and medium, black and reddish-brown concretions; medium acid (pH 5.9).

Color of the A horizon ranges from dark brown or very dark brown to dark reddish brown. Color of the B horizon ranges from dark reddish brown. In places the B horizon contains faint mottles below a depth of 20 inches and distinct mottles below a depth of 30 inches. In some areas a few pebbles are scattered throughout the solum.

Included with this soil in mapping were small areas of Abiqua and Waldo soils. These included soils make up less than 5 percent of the acreage in the mapping unit.

The available water capacity is 9 to 11 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is not a hazard or is only a slight hazard. Depth to which roots can penetrate is restricted by a seasonal high water table. Workability is fair.

When not irrigated, this soil is used for small grains, hay, pasture, and grass grown for seed. When irrigated, it is used for all the crops commonly grown in the survey area, except potatoes and carrots. This soil is well suited to most of the commonly grown crops, but drainage is needed for deep-rooted crops. Outlets for drainage are adequate in most places, and this soil can be readily drained. (Capability unit IIw-1; not placed in a woodland suitability group)

McAlpin silty clay loam, 3 to 6 percent slopes (MaB).This soil receives runoff from higher areas, and as a result, additional soil material is deposited on its surface. Runoff is medium, and the hazard of erosion is moderate.

About the same kinds of crops are grown on this soil as are grown on McAlpin silty clay loam, 0 to 3 percent slopes: (Capability unit IIe-1; not placed in a woodland suitability group)

McBee Series

The McBee series consists of moderately well drained, undulating soils that formed in mixed alluvium. These soils have slopes of 0 to 3 percent. They occur on flood plains that are traversed by sloughs and old overflow channels. Elevations range from 100 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, alder, ash, big-leaf maple, oak, and an understory of vine maple, blackberry, shrubs, and grasses. McBee soils are associated with Wapato and Chehalis soils.

In a typical profile, the surface layer is very dark brown silty clay loam about 10 inches thick. The subsoil is about 32 inches thick and is mottled throughout. It is very dark brown silty clay loam in the upper part; dark brown, very dark brown, and very dark grayish-brown silty clay loam in the middle part; and dark grayish-brown clay loam in the lower part. The substratum is mottled, dark gray clay loam that extends to a depth of 65 inches or more.

McBee soils that are not irrigated are used mainly for small grains, orchards, pasture, hay, and grass grown for seed. They are used mostly for row crops when irrigated.

McBee silty clay loam (Mb).-This is the only soil of the McBee series mapped in the survey area. It occurs along Butte Creek and along the Willamette, Pudding, and Santiam Rivers, and it is subject to frequent overflow.

Representative profile (SE1/4SE1/4 sec. 6, T. 6 S., R. 1 E.).

Ap-0 to 7 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; moderate, coarse, medium and fine, granular structure; friable, slightly hard, plastic and sticky; many, medium, fine and very fine, interstitial pores; common very fine roots; medium acid (pH 6.0); abrupt, smooth boundary. (6 to 8 inches thick.)

A1-7 to 10 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; few, faint, dark-brown mottles; weak, coarse and medium prismatic structure breaking to moderate, medium and fine, subangular blocky structure; friable, slightly hard, plastic and sticky; common very fine roots; many, very fine, tubular pores; slightly acid (pH 6.2)m ; clear, smooth boundary. (2 to 5 inches thick.)

B1-10 to 22 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; common, fine, faint mottles of dark brown; moderate, medium, prismatic structure breaking to strong, fine and very fine, subangular blocky structure; friable, slightly hard, plastic and sticky; many, very fine, tubular pores; few roots; many worm casts; slightly acid (pH 6.2); gradual, smooth boundary. (9 to 15 inches thick.)

B2-22 to 35 inches, faintly mottled, dark-brown (10YR 3/3) , very dark brown (10YR 2/2) , and very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 4/2) and brown (10YR 4/3) when dry; weak, medium, prismatic structure breaking to moderate, coarse and medium, subangular blocky structure; friable, slightly hard, plastic and sticky; many, very fine and few, fine, tubular pores; few very fine roots; slightly acid (pH 6.4); gradual, smooth boundary. (10 to 16 inches thick.)

B3-35 to 42 inches, dark grayish-brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) when dry; many, fine and medium, very dark brown (10YR 2/2), brown (10YR 3/3), and dark yellowish-brown (10YR 4/4) mottles and common, fine, strong-brown mottles; medium and fine, subangular blocky structure; friable, slightly hard, plastic and sticky; very few roots; many, very fine and few, fine, tubular pores; slightly acid (pH 6.4); gradual, smooth boundary. (5 to 11 inches thick.)

Cg-42 to 65 inches, dark-gray (10YR 4/1) clay loam; many, medium and fine, distinct, very dark brown (10YR 2/2) and dark-brown (10YR 3/3) mottles; massive; no roots; many very fine and few fine pores; slightly acid (pH 6.4).

Texture of the A horizon ranges from heavy silt loam to silty clay loam. Depth to mottling ranges from 6 to 24 inches, but mottles are at a depth of 18 inches in many places. Mottles in the A1 and BI horizons appear to be relic. Coarse fragments are commonly absent to a depth of 40 inches. In some places, however, the content of coarse fragments is as high as 20 percent at depths below 35 inches and it is as high as 50 percent at depths below 40 inches.

Included with this soil in mapping were small areas of a soil that has a layer of gravelly material below a depth of 3 feet. Also included were small areas of Wapato and Chehalis soils.

The available water capacity is 12 to 14 inches or more. In many places the drainage has been improved by lowering the water table and by improving outlets. Depth to which roots can penetrate is still restricted, however, by a seasonal high water table. Permeability and fertility are both moderate, and runoff is slow. Because of the frequent overflow, erosion is a moderate hazard. Workability is good, but regular additions of organic matter are needed to keep the soil structure from deteriorating and to keep tillage from becoming more difficult.

When not irrigated, this soil is used mainly for small grains, orchards, pasture, hay, and grass grown for seed. When irrigated, it is used for caneberries, sweet corn, beans, and hops. Drainage is not necessary for many crops, but it is needed if maximum use is to be made of this soil and if best returns are to be realized. Where this soil is drained, it is suited to all the crops commonly grown in the survey area. (Capability unit IIw-5; not placed in a woodland suitability group)

McCully Series

The McCully series consists of well-drained soils that have formed in till or colluvium underlain by basic igneous tuffaceous agglomerate. These soils have slopes of 2 to

70 percent. They occur on the margins of mountainous foot slopes at elevations of 800 to 2,000 feet. The average annual precipitation is 55 to 75 inches, the average annual air temperature is 48° to 51° F., and the length of the frost-free season is 165 to 190 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hemlock, vine maple, salal, brackenfern, snowberry, trailing blackberry, and wild strawberry. McCully soils are associated with Jory, Hullt, and Kinney soils.

In a typical profile, the surface layer is dark reddish-brown clay loam about 6 inches thick. This is covered with a thin layer of decomposing fern leaves, fir needles, other -leaves, and twigs. The subsurface layer is dark reddish-brown clay loam about 4 inches thick. The subsoil is dark reddish-brown clay about 47 inches thick. A substratum of variegated dark-brown, dark yellowish-brown, and very dark grayish-brown gravelly loam that is mostly weathered agglomerate extends to a depth of 108 inches or more.

The McCully soils are used mainly for timber, watershed, pasture, hay, orchards, small grains, and grass grown for seed. When irrigated, they are used mainly for row crops.

McCully clay loam, 2 to 7 percent slopes (McB).-This soil occurs along the margins of the lower foot slopes of the Cascade Mountains.

Representative profile 0.2 mile southeast of the South Burn guard station, 100 feet east of South Burn Road (SW1/4SE1/4SW1/4 sec. 26, T. 8 S., R.1 E.)

O1&O2-1 inch to 0, partly decomposed fern leaves, fir needles, other leaves, and twigs.

Al-0 to 6 inches, dark reddish-brown (5YR 3/2) clay loam, dark brown (7.5YR 4/4) when dry; strong, medium and fine, granular structure; friable to firm, slightly hard, slightly sticky and slightly plastic; many roots; many, fine, interstitial pores; many medium concretions; many, coarse, sand-size fragments of rock ; strongly acid (pH 5.4); abrupt, smooth boundary. (6 to 8 inches thick.)

A3-6 to 10 inches, dark reddish-brown (5YR 3/2) clay loam, dark brown (7.5YR 4/4) when dry; strong, medium and fine, granular structure; friable, slightly hard, sticky and plastic; many roots; many, fine, interstitial pores; few thin cutans ; common, medium, reddish concretions; common, coarse, sand-size, light-colored fragments of rock; strongly acid (pH 5.2); clear, wavy boundary. (4 to 6 inches thick.)

B21-10 to 24 inches, dark reddish-brown (5YR 3/4) clay, yellowish red (5YR 4/6) when dry; weak, medium, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, very fine, tubular pores; few thin cutans ; few small concretions; few, coarse, sand-size fragments of light-colored rock; very strongly acid (pH 4.6); clear, smooth boundary. (9 to 15 inches thick.)

B22-24 to 49 inches, dark reddish-brown (5YR 3/4) clay, yellowish red (5YR 4/6) when dry; weak, coarse and medium, subangular blocky structure; firm, hard, sticky and plastic; common roots; many, very fine, tubular pores; continuous, thin cutans ; few concretions; very strongly acid (pH 4.6); gradual, smooth boundary. (14 to 30 inches thick.)

B3-49 to 57 inches, dark reddish brown (5YR 3/4) clay, reddish brown (5YR 4/4) when dry; weak, medium and fine, subangular blocky structure; friable, hard, sticky and plastic; few roots; many, very fine, tubular pores; few thin cutans; few small concretions; very strongly acid (pH 4.6); clear, wavy boundary. (7 to 10 inches thick.)

IIC-57 to 108 inches, variegated dark-brown (10YR 4/3), dark yellowish-brown (10YR 4/4), dark-brown (7.5YR 4/4), and very dark grayish-.brown (2.5Y 3/2) gravelly loam that is mostly weathered rock; massive; very strongly acid (pH 4.6); many feet thick.

In some places the A horizon is stony. Rock outcrops are absent from some areas and are common in others. In places a few large boulders are on the surface and angular fragments of rock the size of cobblestones make up from 5 to 15 percent of the A and B horizons. The solum is predominantly dark reddish brown, but the color ranges from dark brown in the A horizon to dark red in the B horizon. In places the B2 horizon is silty clay. The solum ranges from 40 to 60 inches in thickness, but it is commonly 40 to 48 inches thick. Depth to weathered agglomerate ranges from 40 inches to 12 feet. The entire profile is strongly acid or very strongly acid.

Included with this soil in mapping were small areas of Kinney and Cumley soils.

The available water capacity is 8 to 10 inches. Permeability is moderately slow, and fertility is low. Runoff is slow, and the hazard of erosion is slight. The depth to which roots can penetrate is 40 to 60 inches or more. Workability is fair, but it becomes progressively poorer as the content of moisture decreases to below field capacity.

This soil is well suited to pasture plants, hay, orchards, small grains, and grass grown for seed, and it is used mainly for those crops. Much of the acreage has been cleared and is used extensively for crops that require cultivation. A small acreage is used for strawberries, and other small acreages are used for pole beans, sweet corn, berries, and specialty crops. A limited supply of water for irrigation is available from reservoirs and ponds. (Capability unit IIe-3; woodland suitability group 2o1)

McCully clay loam, 7 to 12 percent slopes (McC).-This soil has slopes of more than 9 percent in most places. Runoff is medium, and the hazard of erosion is moderate. Bedrock crops out in a few places.

This soil is used for about the same crops as McCully clay loam, 2 to 7 percent slopes. More careful management is needed, however, to control erosion. (Capability unit IIIe-6; woodland suitability group 2o1)

McCully clay loam, 12 to 20 percent slopes (McD).-This soil contains a few stony areas. Runoff is medium, and erosion is a moderate hazard.

In general, this soil is used for about the same crops as McCully clay loam, 2 to 7 percent slopes. Sweet corn is not grown, however, because of the difficulty of harvesting the crop. Tilling and irrigating row crops so that soil losses will not be excessive is difficult. Mechanical harvesting of vegetables and berry crops is not feasible. (Capability unit IIIe-2; woodland suitability group 2o1)

McCully clay loam, 20 to 30 percent slopes (McE).-In a few places, this soil contains rock outcrops. Runoff is rapid, and the hazard of erosion is severe.

This soil is used mainly as woodland and for small grains, pasture, hay, and grass grown for seed. A small acreage is used for strawberries and cherries. Crops are difficult to cultivate and harvest. For row crops, practices that help to prevent excessive soil losses are necessary, but those practices are difficult to apply without damaging the crop. (Capability unit IVe-1; woodland suitability group 2o1)

McCully clay loam, 2 to 30 percent slopes (MUE).-In a few places, bedrock crops out in areas of this soil. Runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly for growing Douglas-fir. Where cleared, it is suitable for cultivated crops. Logging is best done in summer, when this soil is drier than at other times. (Capability unit IVe-1; woodland suitability group 2o1)

McCully clay loam, 30 to 50 percent slopes (MUF).-In this soil, bedrock crops out in a few places. Runoff is rapid. The hazard of erosion is severe.

This soil is not suitable for crops that require cultivation, and nearly all of the acreage is in Douglas-fir, Small areas are used for improved pasture and for grass grown for seed, although this soil is poorly suited to these uses. (Capability unit VIe-2; woodland suitability group 2c2)

McCully clay loam, 50 to 70 percent slopes (MUG).-Runoff from this soil is very rapid, and the hazard of erosion is very severe. In places small areas that have a stony surface layer were included in mapping.

This McCully soil is used mainly for growing Douglas-fir. Except for harvesting the timber, management is not feasible. Logging is best done in summer, when this soil is drier than at other times. (Capability unit VIIe-1; woodland suitability group 2c3)

McCully stony clay loam, 2 to 20 percent slopes (MID).-Angular pebbles, one-half inch to 3 inches in diameter, make up from 20 to 30 percent, by volume, of the surface layer of this soil. Rock outcrops are common, and small areas of this soil are shallow over bedrock. Runoff is medium, and erosion is a moderate hazard. The available water capacity is moderate.

This soil is used mainly for pasture and for grass grown for seed, but some areas are used for cultivated crops. Tillage is more difficult than for less sloping, less stony McCully soils. In areas to be tilled, the larger stones are usually removed by hand. (Capability unit IIIe-4; woodland suitability group 2o1)

McCully very stony clay loam, 2 to 30 percent slopes (MmE).-From 45 to 55 percent of this soil, by volume, consists of angular fragments of rock. The fragments range from 1 to 9 inches in diameter. Rock outcrops are common. The available water capacity is low.

Because of the stones in the surface layer, this soil is not suitable for crops that require cultivation, and it is used mainly for growing Douglas-fir. Logging is best done in summer, when the soil is drier than at other times. (Capability unit VIs-1; woodland suitability group 3c2)

Minniece Series

The Minniece series consists of deep, somewhat poorly drained and poorly drained soils that have formed in colluvium and alluvium from basic igneous tuffs or agglomerate. These soils have slopes of 0 to 8 percent. They occur in seepage areas and in drainage channels at elevations ranging from 800 to 3,000 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 47° to 50° F., and the length of the frost-free season is 145 to 190 days. The vegetation is mainly alder, maple, swordfern, skunkcabbage, and sedges. Minniece soils are associated with McCully, Horeb, and Kinney soils.

In a typical profile, the surface layer is very dark grayish-brown silty clay loam about 10 inches thick. The subsoil is mottled throughout and is about 22 inches thick. It is dark grayish-brown silty clay loam in the upper part, dark grayish-brown silty clay in the middle part, and gray clay in the lower part. The substratum is gray clay that extends to a depth of 60 inches or more. The substratum, like the subsoil, is mottled.

The Minniece soils are used mainly for producing timber and for watershed.

Minniece silty clay loam, 0 to 8 percent slopes (MYB).-This soil occupies small seep areas and small areas in drainageways on the lower slopes of the Cascade Mountains. It is the only soil of the Minniece series mapped in the survey area.

Representative profile 50 feet west of logging road (SW1/4NE1/4 sec. 22, T. 9 S., R. 3 E.)

A1-0 to 5 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry; moderate, fine, granular structure; friable, hard, slightly sticky and plastic; many roots; many, fine, interstitial pores; medium acid (pH 5.8); clear, smooth boundary. (3 to 7 inches thick.)

A3-5 to 10 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry; moderate, medium, subangular blocky structure; firm, hard, sticky and plastic many roots; common, very fine and few, medium, tubular pores; medium acid (pH 5.8); clear, smooth boundary, (3 to 7 inches thick.)

B1-10 to 15 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) when dry; common, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; firm, hard, sticky and plastic; common roots; common, very fine, tubular pores; few thin clay films; medium acid (pH 5.8); clear, smooth boundary. (3 to 7 inches thick.)

IIB21tg-15 to 19 inches, dark grayish-brown (10YR 4/2) silty clay, light gray (10YR 7/2) when dry; many, medium, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure breaking to strong, medium, subangular blocky structure; firm, very hard, sticky and plastic; common roots; common, very fine and few, fine, tubular pores; few thin clay films; ped surfaces coated with white (10YR 8/1) particles of silt medium acid (pH 5.8); clear, smooth boundary. (2 to 6 inches thick.)

IIB22tg-19 to 32 inches, gray (10YR 5/1) clay, light gray (10YR 6/1) when dry; many, medium, distinct, strong brown (7.5YR 5/6) mottles; moderate, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; very firm, extremely hard, very sticky and very plastic; few roots; few, very fine and fine, tubular pores; common thin clay films medium acid (pH 5.8); clear, smooth boundary. (14 to 16 inches thick.)

IICg-32 to 60 inches, gray (10YR 5/1) clay, light gray (10YR 6/1) when dry; common, medium, distinct, strong-brown (7.5YR 5/6) mottles-, massive; very firm, extremely hard, very sticky and very plastic; few roots; few, very fine, tubular pores; medium acid (pH 5.8); few black stains.

Color of the A horizon ranges from very dark brown to very dark grayish brown. Color of the B horizon ranges from dark grayish brown to gray. In some places the entire solum contains mottles. A few stones are scattered throughout the solum in some areas.

Included with this soil in mapping were small stony areas.

The available water capacity ranges from 6 to 8 inches. Permeability is very slow, and fertility is low. Runoff is slow to medium, and the hazard of erosion is slight. Depth to which roots can penetrate varies because of differences in the height of the water table, but the root depth is generally shallow. This soil receives additional water as the result of seepage from higher areas. Therefore, it is wet during most of the year.

This soil is used mainly for growing alder and maple to which it is moderately well suited. Small areas have been cleared and are used for pasture. The difficulties of building roads and of conducting logging operations are limitations to use of this soil for producing timber. Because the areas are small, however, roads can generally be built around them. Drainage is needed in areas used for pasture, and response is generally good where drainage has been established. Under the present management, draining areas of this soil to be used for timber is not economically feasible. (Capability unit VIw-1; not placed in a woodland suitability group)

Nekia Series

The Nekia series consists of well-drained soils that have formed in material weathered from tuffs and basalt. These soils are on low, red foothills that are dissected by drainage channels and streams. They have slopes of 2 to 50 percent. Elevations range from 300 to 1,000 feet. The normal annual precipitation is 40 to 60 inches, the normal annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, but it includes a few scattered oaks and an understory of poison-oak, rose, and brackenfern. Nekia soils are associated with Jory soils.

In a typical profile, the surface layer is dark reddish-brown silty clay loam about 9 inches thick. The subsoil is dark reddish-brown clay about 27 inches thick. Basalt bedrock underlies the subsoil at a depth of about 36 inches.

The Nekia soils are used mainly as woodland and for small grains, orchards, pasture, hay, and grass grown for seed. Some areas are irrigated.

Nekia silty clay loam, 2 to 7 percent slopes (NeB).-This soil is in the Salem, Waldo, and Silverton Hills.

Representative profile 150 feet south of a paved road (NW1/4SW1/4NW1/4 sec. 17, T. 8 S., R. 1 W.)

Ap-0 to 9 inches, dark reddish-brown (5YR 2/2) silty clay loam, reddish brown (5YR 4/3) when dry; moderate, medium and fine, granular structure; friable, slightly hard, plastic and sticky; many roots; many, fine, interstitial pores; medium acid (pH 5.6); abrupt, wavy boundary. (5 to 10 inches thick.)

B1-9 to 18 inches, dark reddish-brown (5YR 3/3) clay, reddish brown (5YR 4/4) when dry; weak, medium, prismatic structure breaking to weak, very fine, granular structure; friable, slightly hard, plastic and sticky; common roots; many, very fine, tubular pores; strongly acid (pH 5.5); clear, smooth boundary. (3 to 12 inches thick.)

B21t-18 to 24 inches, dark reddish-brown (5YR 3/3) clay, reddish brown (5YR 4/4) when dry; weak, very coarse, prismatic structure breaking to moderate, fine and very fine, subangular blocky structure; friable, hard, plastic and sticky; common roots; many, very fine, tubular pores; few thin clay films on ped surfaces and in pores; strongly acid (pH 5.4) ; clear, smooth boundary. (4 to 18 inches thick.)

B22t-24 to 36 inches, dark reddish-brown (5YR 3/4) clay, yellowish red (5YR 4/6) when dry; very weak, coarse, prismatic structure breaking to moderate fine and very fine, subangular blocky structure; firm, hard, very plastic and very sticky; few roots; many, very fine, tubular pores; many moderately thick clay films on ped surfaces and in pores; very few, faint, black coatings on ped surfaces; very few, fine, black concretions; many, coarse, sand-size fragments; strongly acid (pH 5.3); clear, wavy boundary. (8 to 18 inches thick.)

R1-36 to 45 inches, fractured bedrock, the fractures filled with reddish-brown (5YR 4/4) clay, reddish brown (5YR 5/3) when dry; weak, fine and very fine, subangular blocky structure; firm, hard, very plastic and very sticky; few large roots; many, very fine, tubular pores, few thick clay films on stone surfaces and in pores; variegations in color caused by weathering of the fragments of rock; many, medium, black coatings on stone surfaces; few, medium, black concretions; 90 percent of horizon is fractured, hard rock; strongly acid (pH 5.3); clear, wavy boundary.

R2-45 inches, basalt bedrock.

Color of the A horizon ranges from dark brown to dark reddish brown. Color of the B2 horizon ranges from dark reddish brown to yellowish red, but it is dominantly dark reddish brown. In places the B2 horizon is silty clay. The content of coarse fragments of hard basalt in the A horizon ranges from 0 to 15 percent, but the content of coarse fragments in the B22t horizon is as high as 50 percent. Depth to bedrock ranges from 20 to 40 inches. Bedrock is at a depth of more than 30 inches in most places.

Included with this soil in mapping were small areas of Jory and McCully soils. These included soils make up from 10 to 15 percent of the acreage in the mapping unit.

The available water capacity is 4 to 7 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is only a slight hazard. The depth to which roots can penetrate ranges from 20 to 40 inches, but it is more than 30 inches in most places. Workability is only fair, and it becomes progressively poorer as the content of moisture drops below field capacity.

This Nekia soil is well suited to the commonly grown crops. Nonirrigated areas are used mainly for small grains, orchards, pasture, hay, and grass grown for seed, but small acreages are used for strawberries, field corn, caneberries, and specialty crops. When irrigated, this soil is used for pole beans and sweet corn (fig. 8). Irrigation water is obtained from reservoirs and ponds. (Capability unit IIe-3; woodland suitability group 3c1)

Nekia silty clay loam, 7 to 12 percent slopes (NeC).- This soil has slopes that are mainly steeper than 9 percent. Bedrock crops out in a few places. Runoff is medium, and erosion is a moderate hazard.

Included with this soil in mapping were areas of Jory, McCully, and Witzel soils. These included soils make up from 5 to 10 percent of the acreage in this mapping unit.

This Nekia soil is used for about the same crops as Nekia silty clay loam, 2 to 7 percent slopes, but irrigation and tillage of row crops are more difficult. Mechanical harvesting of vegetables and berries is not feasible. (Capability unit IIIe-6; woodland suitability group 3c1)

Nekia silty clay loam, 12 to 20 percent slopes (NeD).-This soil contains a few stony areas and areas of rock outcrop. Runoff is medium. The hazard of erosion is moderate.

Included with this soil in mapping were areas of Jory, McCully, and Witzel soils. These included soils make up from 5 to 10 percent of the acreage in this mapping unit.

This Nekia soil is used for about the same crops as Nekia silty clay loam, 2 to 7 percent slopes, except that sweet corn is not grown. Row crops are grown on a small acreage but it is difficult to till and irrigate them. Mechanical harvesting of vegetables and berries is not feasible. (Capability unit IIIe-2; woodland suitability group 3c1)

Nekia silty clay loam, 20 to 30 percent slopes (NeE).-On steep breaks a few small areas of this soil are stony and rock crops out in places. Runoff is rapid, and the hazard of erosion is severe.

Included with this soil in mapping were areas of Witzel soils. These included areas make up about 5 percent of the acreage in the mapping unit.

This Nekia soil is used mainly for small grains, pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, for cherries, or as woodland. The crops

Figure 8.-Irrigated sweet corn on Nekia silty clay loam, 2 to 7 percent slopes, near Stayton.

are difficult to cultivate and to harvest. If row crops are grown, practices required to prevent excessive soil losses are difficult to apply without damaging the crop. (Capability unit IVe-1; woodland suitability group 3c1)

Nekia silty clay loam, 30 to 50 percent slopes (NeF).-In a few places, this soil contains small stony areas that lie below tile few areas of rock outcrop. Runoff is rapid or very rapid, and the hazard of erosion is severe.

Included with this soil in mapping were areas of Witzel soils. These included areas make up less than 5 percent of the acreage in the snapping unit.

This Nekia soil is used mainly for pasture or as woodland. (Capability unit VIe-2,; woodland suitability group 3c3)

Nekia stony silty clay loam, 2 to 12 percent slopes (NkC).-This soil has a profile similar to the one described for Nekia silty clay loam, 2 to 7 percent slopes, except that the surface layer is stony and bedrock crops out in a few places. The stones hinder tillage and make this soil slightly droughty. The available water capacity is 2 1/2 to 7 inches. Runoff is medium, and erosion is a moderate hazard.

Included with this soil in mapping were areas of Witzel soils. These included areas make up from 5 to 10 percent of the acreage in this mapping unit.

This Nekia soil is used for about the same crops as Nekia silty clay loam, 2 to 7 percent slopes, but irrigation and tillage of row crops are more difficult. Mechanical harvesting of vegetables and berries is feasible where the slopes are less than 5 percent. (Capability unit IIIe-4; woodland suitability group 3c1)

Nekia very stony silty clay loam, 2 to 30 percent slopes (NsE).-This soil has a profile similar to the one described for Nekia silty clay loam, 2 to 7 percent slopes, except that the surface layer is very stony and rock outcrops are common. The available water capacity is 2 1/2 to 5 1/2, inches. Runoff is medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping were areas of Witzel soils. These included areas make up from 10 to 15 percent of the acreage in this mapping unit.

This Nekia soil is not suited to cultivated crops, and it is used mainly for woodland-grass pasture and as woodland. The wooded areas are within or adjacent to fields where grass is grown for seed. When these fields are burned over each year, extreme care is necessary to protect the wooded areas from fire. (Capability unit VIs-1 ; woodland suitability group 3c2)

Nekia very stony silty clay loam, 30 to 50 percent slopes (NsF).-This soil has a profile similar to the one; described for Nekia silty clay loam, 2 to 7 percent slopes, except that the surface layer is very stony and rock outcrops are common. Runoff is rapid, and the hazard of erosion is severe.

Included with this soil in mapping were areas of Witzel soils. These included areas make up from 5 to 10 percent of the acreage in this mapping unit.

This Nekia soil is not suited to cultivated crops, and it is used mainly as woodland and for woodland-grass pasture. The wooded areas are within or adjacent to fields where grass is grown for seed. When these fields are burned over each year, extreme care is necessary to protect the wooded areas from fire. (Capability unit VIs-1; woodland suitability group 3c3)

Newberg Series

The Newberg series consists of somewhat excessively drained soils that have formed in mixed alluvium over sandy or gravelly material. These soils are on flood plains that are traversed by old, meandering overflow channels and sloughs, and they are subject to frequent overflow. Slopes range from 0 to 3 percent, and elevations range from 100 to 650 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly ash, oak, Douglas-fir willow, rose, blackberry, annual grasses, and weeds. Newberg soils are associated with Cloquato, Chehalis, and Camas soils.

In a typical profile, the surface layer is very dark grayish-brown fine sandy loam about 10 inches thick. The substratum, just beneath the surface layer, is dark yellowish-brown sandy loam that extends to a depth of 60 inches or more.

The Newberg soils are used mainly for small grains, orchards, pasture, row crops, and grass grown for seed.

Newberg fine sandy loam (Nu).-This soil is along the channels of Butte Creek and the Willamette, Pudding, and Santiam Rivers.

Representative profile (NE1/4SE1/4 sec. 24, T. 9 S., R. 2 W.).

Ap-0 to 10 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) when dry; weak, medium and fine, subangular blocky structure; very friable, soft, nonsticky and nonplastic; many, fine and very fine, tubular pores; many roots; medium acid (pH 6.0); clear, smooth boundary. (7 to 12 inches thick.)

C-10 to 60 inches, dark yellowish-brown (10YR 3/4) sandy loam, grayish brown (10YR 5/2) when dry; massive; very friable, soft, nonsticky and nonplastic; many roots; many, fine, interstitial pores; neutral (pH 6.6).

Texture of the A horizon ranges from fine sandy loam to silt loam. When the soil is moist, the color of the A horizon is as dark or darker than dark brown. Color of the C horizon ranges from dark grayish brown to dark yellowish brown. In some places the C horizon is structureless, and in others it has weak, subangular blocky structure. Depth to sand and gravel is more than 40 inches. In some areas as much as 15 percent of the material between depths of 10 and 40 inches is coarse fragments.

Included with this soil in mapping were small areas that have a few pebbles in the surface layer and that have a gravelly subsoil. Also included were small areas of Camas, Cloquato, and Chehalis soils.

The available water capacity is 5 to 7 inches. Permeability is moderately rapid, and fertility is moderate. Roots can penetrate to a depth of 5 feet or more. Runoff is slow, and the hazard of erosion is moderate. Even where management is poor, workability of this soil is excellent, for the texture and structure of the soil material are difficult to change.

This soil is well suited to small grains, orchards, pasture, and grass grown for seed, and it is used mainly for those crops. When irrigated, it is used for all the crops commonly grown in the survey area. (Capability unit IIw-4; not placed in a woodland suitability group)

Newberg silt loam (Nw).-This soil has a profile similar to the one described for Newberg fine sandy loam, except that the surface layer is finer textured and is dark brown. Because of this finer texture of the surface layer, the range of moisture content within which this soil can be satisfactorily worked is narrower than for Newberg fine sandy loam. Also, the infiltration rate is reduced, and movement of water is slower through the surface layer to the coarser textured material below. The available water capacity is 6 to 7 inches.

This soil is used for about the same crops as Newberg fine sandy loam, except that it is not used for crops that are harvested late in fall. Irrigation is difficult because areas of this soil are small and are within larger areas of Cloquato and Chehalis soils. (Capability unit IIw-6; not placed in a woodland suitability group)

Salem Series

The Salem series consists of well-drained soils that are nearly level. These soils have formed in gravelly alluvium that is of mixed mineralogy and contains a large amount of basaltic pebbles. They occur on terraces at elevations of 100 to 600 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, oak, maple, wild rose, and grasses. Salem soils are associated with Sifton and Clackamas soils.

In a typical profile, the surface layer is very dark brown gravelly silt loam about 9 inches thick. The subsoil is about 21 inches thick and is very dark brown gravelly silty clay loam in the upper part and is dark-brown gravelly clay loam in the lower part. The substratum is grayish-brown very gravelly sand that extends to a depth of 60 inches or more.

The Salem soils are used mainly for small grains, pasture, vegetables, orchards, and berries.

Salem gravelly silt loam (Sa).-This is the only soil of the Salem series mapped in the survey area. It is along the margins of gravelly terraces, adjacent to the alluvial bottoms of the North Santiam and Santiam Rivers.

Representative profile 100 feet south of the Marion to West Stayton highway (SE1/4NW1/4SW1/4 sec. 14, T. 9 S., R. 2 W.).

Ap-0 to 9 inches, very dark brown (10YR 2/2) gravelly silty loam, dark grayish brown (10YR 4/2) when dry; cloddy and has weak, medium and fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many, very fine, tubular pores; 15 percent pebbles; slightly acid (pH 6.2); gradual, smooth boundary. (6 to 12 inches thick.)

B2t-9 to 18 inches, very dark brown (10YR 2/2) gravelly silty clay loam, brown (10YR 4/3) when dry; moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, fine and very fine, tubular pores; 15 percent pebbles; few thin and moderately thick clay films; slightly acid (pH 6.4); abrupt, smooth boundary. (8 to 20 inches thick.)

B3t-18 to 30 inches, dark-brown (10YR 3/3) gravelly clay loam; brown (10YR 5/3) when dry; massive; firm, hard, slightly sticky and plastic; common roots; common, fine and very fine, tubular pores; thin clay coatings on sand grains; 45 percent pebbles; neutral (pH 6.6) ; clear, smooth boundary. (0 to 14 inches thick.)

IIC-30 to 60 inches, grayish-brown (10YR 5/2) very gravelly sand, pale brown (10YR 6/3) when dry; single grain; very friable, loose, nonsticky and nonplastic; few roots; many, medium, interstitial pores; 60 percent pebbles; slightly acid (pH 6.2) ; many feet thick.

Texture of the A horizon ranges from gravelly silt loam to gravelly loam. Texture of the B horizon ranges from gravelly clay loam to gravelly silty clay loam. The content of pebbles and cobblestones in the A and B horizons ranges from 10 to 50 percent, but it is less than 35 percent in most places. In the C horizon, the content of coarse fragments, mostly pebbles, ranges from 35 to 80 percent. Depth to the very gravelly sand of the C horizon ranges from 20 to 40 inches.

Included with this soil in mapping were small areas in which the content of pebbles in the surface layer is less than 15 percent. Also included were areas of a soil that is shallow over very gravelly sand and has a surface layer of dark-brown loam.

The available water capacity is 5 to 6 inches. Permeability and fertility are both moderate. Runoff is slow, and erosion is not a hazard. Depth to which roots can penetrate is restricted by the gravelly substratum. Workability is generally good, but some small areas that have a gravelly surface layer are hard to cultivate.

This soil is used mainly for cereal grains, pasture, caneberries, strawberries, vegetables, and orchards. Irrigation is necessary if vegetables and berries are to be grown commercially. (Capability unit IIs-1; not placed in a woodland suitability group)

Salkum Series

The Salkum series consists of well-drained soils that have formed in weathered gravelly alluvium. These soils have slopes of 0 to 20 percent. They occur on remnants of old, high terraces at elevations of 300 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 200 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, poison-oak, and rose. Salkum soils are associated with Nekia and Jory soils.

In a typical profile, the surface layer is very dark brown silty clay loam about 14 inches thick. The subsoil is dark brown and is about 26 inches thick. The upper part of the subsoil is silty clay loam, and the lower part is mottled silty clay. The upper part of the substratum is variegated light-gray, yellowish-red, brown, and strong-brown silty clay loam to a depth of about 48 inches. The lower part of the substratum is mottled, variegated strong-brown and dark-brown gravelly and cobbly clay loam or silty clay loam that extends to a depth of 65 inches or more.

The Salkum soils are used mainly for small grains, orchards, pasture, hay, and grass grown for seed.

Salkum silty clay loam, 2 to 6 percent slopes (SkB).This soil is on high terraces north of Mill Creek. The areas are between Sublimity and Aumsville.

Representative profile along the Stayton-Sublimity Highway and 35 feet east of the center of the highway (SW1/4NE1/4 sec. 3, T. 9 S., R. 1 W.)

Ap-0 to 5 inches, very dark brown (7.5YR 2/2) silty clay loam, dark brown (10YR 4/3) when dry; weak, very coarse, prismatic structure breaking to moderate, fine and very fine, granular; friable, slightly hard, plastic and sticky; abundant roots; many, fine and very fine, interstitial pores; strongly acid (pH 5.2); abrupt, smooth boundary. (5 to 9 inches thick.)

A1-5 to 14 inches, very dark brown (7.5YR 2/2) silty clay loam, dark brown (7.5YR 4/4) when dry; weak, very coarse, prismatic structure breaking to weak, medium and coarse, subangular blocky structure that breaks, in turn, to moderate, fine and very fine, granular structure; friable, slightly hard, plastic and sticky; many roots; few thin clay films; common, very fine and fine, tubular pores; very strongly acid (pH 5.0); clear, smooth boundary. (0 to 9 inches thick.)

B1t-14 to 20 inches, dark-brown (7.5YR 4/4) heavy silty clay loam, brown (7.5YR 5/4) when dry; weak, very coarse, prismatic structure breaking to moderate, coarse and medium, subangular blocky structure; firm; slightly hard, very plastic and sticky; thin, nearly continuous clay films; common worm casts; very strongly acid (pH 5.0); clear, smooth boundary. (6 to 12 inches thick.)

B2t-20 to 29 inches, dark-brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) when dry; moderate, coarse and medium, subangular blocky structure; firm, hard, very plastic and sticky; moderately thick, continuous clay films; few, coarse, and common, fine and very fine, tubular pores; few roots; very strongly acid (pH 5.0); clear, smooth boundary. (6 to 15 inches thick.)

B3t-29 to 40 inches, dark-brown (7.5YR 4/4) silty clay, strong brown (7.5YR 5/6) when dry; few to common, fine, light-gray mottles and few, fine, strong-brown specks; weak, coarse, subangular blocky structure; firm, hard, very plastic and sticky; many thin clay films; few roots; few, fine and very fine, tubular pores; strongly acid (pH 5.2); clear, smooth boundary. (0 to 12 inches thick.)

C1-40 to 48 Inches, variegated light-gray (7.5YR 7/1), yellowish-red (5YR 4/6), brown (7.5YR 5/2), and strong brown (7.5YR 5/8) silty clay loam, reddish yellow (7.5YR 6/6) when dry; firm, very hard, plastic and sticky; thin, patchy clay films; few, fine and very fine, tubular pores; no roots; very strongly acid (pH 5.0); gradual, smooth boundary. (0 to 15 inches thick.)

IIC2-48 to 65 inches, finely variegated strong-brown (7.5YR 5/8) and dark-brown (7.5YR 3/2 and 4/4) gravelly and cobbly clay loam or silty clay loam, very pale brown (10YR 7/4) when dry; few, fine, reddish-brown mottles; massive; firm, extremely hard, plastic and sticky; no roots; very few, fine and very fine, tubular pores; thin, patchy clay films; very strongly acid (pH 5.0); the cobblestones and pebbles are so strongly weathered that they can be broken easily in the hand.

The solum ranges from 24 to 50 inches in thickness over weathered gravel, but it is more than 30 inches thick in most places. In places the A horizon is dark brown. The IIC2 horizon contains weathered pebbles of basalt and a few pebbles of hard quartzite as much as 1 inch in diameter.

Included with this soil in mapping were small areas of Nekia and Jory soils.

The available water capacity ranges from 9 to 12 inches. Permeability is slow, and fertility is low. Runoff is slow, and the hazard of erosion is slight. Roots can penetrate to a depth of 4 to 5 feet. Workability is fair, but it becomes progressively poorer as the content of moisture drops below field capacity.

This soil is used mainly for cereal grains, orchards, pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, field corn, caneberries, and specialty crops. When irrigated, this soil is used for pole beans and sweet corn. (Capability unit IIe-3; woodland suitability group 3c1)

Salkum silty clay loam, 6 to 20 percent slopes (SkD).In nearly 70 percent of the acreage, this soil has slopes of less than 12 percent. Runoff is medium, and erosion is a moderate hazard. Mapped with this soil were a few areas in which the surface layer is gravelly.

This Salkum soil is used for about the same crops as Salkum silty clay loam, 2 to 6 percent slopes, but tilling the small acreage of row crops so that excessive losses of soil are prevented is more difficult on this soil. Mechanical harvesting of vegetables and berries is not feasible. (Capability unit IIIe-2; woodland suitability group 3c1)

Salkum silty clay loam, basin, 0 to 6 percent slopes (SlB).-This soil is on foot slopes and in drainageways of old, high terraces. In winter it sometimes receives additional soil material washed from higher lying soils that are not protected by a cover crop. This material is deposited in a thin layer on the surface of this soil. Fertility is moderate, and this soil is well drained. In winter and spring, however, the additional water received from higher areas causes the water table to rise to the lower part of the subsoil. In some places small areas of McAlpin, Waldo, or Stayton soils block runoff from this soil. As a result, the water table is high for short periods during storms of high intensity. Nevertheless, water moves rapidly through this soil, and wetness is not a serious hazard to crops. Included with this soil in mapping were small areas of McAlpin, Waldo, and Stayton soils.

This Salkum soil is used for about the same crops as Salkum silty clay loam, 2 to 6 percent slopes. To make this soil more suitable for strawberries, and to make farming easier, the runoff from higher areas should be intercepted and safely diverted to other areas before it reaches this soil. (Capability unit IIe-1; woodland suitability group 3c1)

Santiam Series

The Santiam series consists of moderately well drained soils that formed in silty material over weathered gravelly alluvium or weathered basalt. These soils occur on remnants of old, high terraces along the foot slopes of low, red foothills. They have slopes of 0 to 15 percent. Elevations range from 300 to 375 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 53° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, vine maple, poison-oak, hazel, ocean-spray, trailing blackberry, wild strawberry, thimbleberry, brackenfern, and grass. Santiam soils are associated with Silverton soils.

In a typical profile, the surface layer is dark-brown silt loam about 6 inches thick. The subsurface layer is mottled, dark-brown silt loam about 7 inches thick. The subsoil is mottled, dark yellowish-brown silty clay loam about 17 inches thick. The substratum is mottled, dark grayish-brown and brown silty clay or clay that extends to a depth of 60 inches or more.

The Santiam soils are used for small grains, orchards, pasture, vegetables, berries, and grass grown for seed. They are also used as woodland.

Santiam silt loam, 0 to 3 percent slopes (SnA).-This soil occupies terrace remnants along the foot slopes of the Salem, Waldo, and Silverton Hills. It is adjacent to the valley floor.

Representative profile 15 feet south of the center of a gravel road and 475 feet east of the corner of the road (NW1/4SE1/4 sec. 1, T. 10 S., R. 3 W.)

Ap-0 to 6 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 6/3) when dry; moderate, medium and fine, granular structure; friable, slightly hard, plastic and sticky; many roots; many, very fine and fine, interstitial pores; medium acid (pH 5.6); abrupt, smooth boundary. (4 to 7 inches thick.)

A3-6 to 13 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 6/3) when dry; contains common, fine and very fine, faint, very dark grayish-brown (10YR 3/2) mottles when moist; weak, very coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; friable, slightly hard, plastic and sticky; many roots; many, fine and very fine, tubular pores; few pebbles; medium acid (pH 5.6) ; abrupt, smooth boundary. (6 to 10 inches thick.)

B21t-13 to 22 inches, dark yellowish-brown (10YR 4/4) silty clay loam, pale brown (10YR 6/3) when dry; contains many, medium and fine, faint, dark grayish-brown mottles; common, fine, black stains and concretions; weak, very coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; friable, hard, plastic and sticky; common roots; many, fine and very fine, tubular pores; few pebbles; few thin clay films; peds thinly coated with gray silt and very fine sand; strongly acid (pH 5.4) ; gradual, wavy boundary. (6 to 10 inches thick.)

B22t-22 to 30 inches, dark yellowish-brown (10YR 4/4) heavy silty clay loam, light yellowish brown (10YR 6/4) when dry; contains common, fine and medium, faint, dark-brown (10YR 3/3) mottles and common black mottles; thick, grayish-brown (10YR 5/2), silty coatings on ped surfaces, light gray (10YR 7/2) when dry; weak, fine, prismatic structure breaking to moderate, fine and medium, subangular and angular blocky structure; firm, very hard, plastic and sticky; few roots; many, medium, fine and very fine, tubular pores; few pebbles; common, moderately thick clay films; strongly acid (pH 5.2) ; clear, smooth boundary. (8 to 14 inches thick.)

IIC-30 to 60 inches, dark grayish brown (10YR 4/2) and brown (10YR 4/3) silty clay or clay, pale brown (10YR 6/3) and light gray (10YR 7/1) when dry; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; massive; firm, very hard, very plastic and very sticky; few roots; common, fine and very fine, tubular pores; medium and coarse, light-colored sand grains and few medium-sized pebbles that increase in number with depth; strongly acid (pH 5.2).

The A horizon ranges from dark brown to brown in color. The B horizon is dark brown to dark yellowish brown, and it contains mottles that range from faint to distinct in contrast. In places the color of the A and B horizons is slightly redder than shown in the typical profile. Texture of the B horizon ranges from silty clay loam to light silty clay or clay, with a weighted average of 35 to 42 percent clay. In places strongly weathered and unweathered pebbles make up as much as 15 percent, by volume, of the lower part of the B horizon. Depth to the C horizon ranges from 24 to 40 inches, and depth to bedrock is more than 40 inches. In places the C horizon consists of highly weathered basalt tuffs, or of gravelly material that has a matrix of clay.

Included with this soil in mapping were small areas that have a strong-brown surface layer, and small areas of a well-drained soil.

The available water capacity ranges from 8 to 11 inches. Permeability is moderately slow in the B horizon and slow in the C horizon. Fertility is moderate. This soil receives extra water as the result of seepage from higher areas, and it contains a perched water table in winter and spring. Runoff is slow, and erosion is not apparent. Below 22 to 30 inches, the depth to which roots can penetrate is restricted by excess moisture and by the clayey texture of the soil material. Workability is good.

When not irrigated, this soil is used mainly for small grains, orchards, pasture, and grass grown for seed, and it is also used as woodland. It is used for pole beans, sweet corn, caneberries, and strawberries when irrigated. Because of the extra moisture received as the result of seepage, this soil is not well suited to deep-rooted crops and to crops that cannot tolerate excessive moisture. (Capability unit IIw-1; not placed in a woodland suitability group)

Santiam silt loam, 3 to 6 percent slopes (SnB).-This soil has slightly better drainage than Santiam silt loam, 0 to 3 percent slopes, but it is used for about the same crops. Runoff is slow, and the hazard of erosion is slight. Drainage is needed for deep-rooted crops and for crops that cannot tolerate excessive moisture. (Capability unit IIe-1; not placed in a woodland suitability group)

Santiam silt loam, 6 to 15 percent slopes (SnC).-This soil has better drainage than Santiam silt loam, 0 to 3 percent slopes. Runoff is medium, and erosion is a moderate hazard.

This soil is used mainly for small grains, pasture, hay, and grass grown for seed, but a small acreage is used as woodland or for orchards, vegetables, and berries. Growing row crops or tilling so that excessive soil losses are prevented is difficult, and mechanical harvesting of vegetables and berries is not feasible. Drainage is needed for deep-rooted crops and for crops that cannot tolerate excessive moisture. (Capability unit IIIe-1; not placed in a woodland suitability group)

Semiahmoo Series

The Semiahmoo series consists of poorly drained organic soils that formed in partly decomposed organic material. These soils occur on the bottoms of former shallow lakes at elevations of 130 to 150 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 53° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly sedges, tussocks, and willows. Semiahmoo soils are associated with Labish soils.

In a typical profile, the surface layer is black muck about 9 inches thick. The next layer consists of very dark brown peaty muck about 21 inches thick. Below this is a layer of peat that extends to a depth of 60 inches or more.

The Semiahmoo soils are used mostly for growing vegetables.

Semiahmoo muck (So).-This soil is on the Labish Bottom. It is the only soil of the Semiahmoo series mapped in the survey area.

Representative profile one-fourth mile north of Labish Center, 100 feet east of road, and 200 feet south of Labish Ditch (NW1/4SW1/4 sec. 22, T. 6 S., R. 2 W.)

1-0 to 2 inches, black (10YR 2/1) muck, very dark gray (10YR 3/1) when dry; weak, very fine, granular structure; very friable, loose, nonsticky and nonplastic; many roots; many, fine, interstitial pores; medium acid (pH 6.0); abrupt, smooth boundary. (0 to 4 inches thick.)

2--2 to 9 inches, black (10YR 2/1) muck, very dark gray (10YR 3/1) when dry; weak, medium, subangular blocky structure; very friable, loose, nonsticky and nonplastic; many roots; many fine pores; medium acid (pH 6.0); clear, smooth boundary. (6 to 10 inches thick.)

3-9 to 30 inches, very dark brown (10YR 2/2) peaty muck; massive; very friable, soft, nonsticky and nonplastic; many pores; slightly acid (pH 6.2); gradual, smooth boundary. (10 to 30 inches thick.)

4-30 to 60 inches, variegated peat; massive; very friable, slightly hard, nonsticky and nonplastic; slightly acid (pH 6.4); many feet thick.

Included with this soil in mapping were small areas that have a surface layer of peaty muck; areas in which a layer of clay is at a depth of 14 to 15 inches; and areas along the boundary between the soil and mineral soils where the depth to mineral material in the substratum is less than 5 feet.

The available water capacity ranges from 13 to 30 inches. Permeability is moderate, acid fertility is high. Runoff is slow, and the hazard of erosion is moderate. The depth to which roots can penetrate is limited by the high water table. This is subject to annual flooding. Workability is excellent.

This soil is well suited to onions and to other shallow-rooted crops, and it is used mainly for growing onions. A minor acreage is used for pole beans, sweet corn, mint, pasture, hay, and blackberries. Drainage is needed to keep the water table below the root zone. (Capability unit IIIw-3; not placed in a woodland suitability group

Sifton Series

The Sifton series consists of excessively drained soils that are underlain by gravelly sand. These soils are nearly level. They occur on alluvial terraces at elevations of 100 to 600 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, vine maple, hazel, ocean-spray, poison-oak, blackberry, and brackenfern. Sifton soils are associated with Clackamas and Salem soils.

In a typical profile, the surface layer is black gravelly loam about 17 inches thick. The subsoil is dark-brown gravelly loam about 7 inches thick. The substratum is dark-brown very gravelly and cobbly sand that extends to a depth of 60 inches or more.

The Sifton soils are used for small grains, pasture, vegetables, and caneberries, and they are also used as woodland.

Sifton gravelly loam (St).-This is the only soil of the Sifton series map in the survey area. It is on terraces along the North Santiam River and Mill Creek.

Representative profile beside old farm buildings (SE1/4SW1/4 sec. 6, T. 9 S., R. 1 W.)

Ap-0 to 7 inches, black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) when dry; moderate, fine, granular structure-, friable, soft, slightly plastic and very slightly sticky; many roots: very many, fine and very fine, interstitial pores; high content of organic matter; neutral (pH 6.9); abrupt, smooth boundary. (4 to 8 inches thick.)

A1-7 to 17 inches, black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) when dry; coarse and very coarse, subangular blocky structure; friable, soft, slightly plastic and slightly sticky; common, fine, tubular pores; few roots; common worm casts; high in content of organic matter; neutral (pH 6.9); clear, wavy boundary. (4 to 12 inches thick.)

B2-17 to 24 inches, dark-brown (10YR 3/3) gravelly loam, dark brown (10YR 4/3) when dry; weak, coarse, subangular blocky structure breaking to moderate.

fine, subangular blocky structure; friable, soft, plastic and slightly sticky; many, medium, fine and very fine, tubular pores; few roots; slightly acid (pH 6.2); gradual, wavy boundary. (7 to 10 inches thick.)

IIC-24 to 60 inches, dark-brown (10YR 4/3) very gravelly and cobbly sand that is mostly of basaltic origin, brown (10Y R 5/3) when dry; massive; loose, nonsticky and nonplastic; medium acid; most of the soil material and fragments of basalt are at least moderately magnetic.

Color of the A horizon ranges from black to very dark brown. In places the A horizon is gravelly silt loam, and in some places the B horizon is gravelly very fine sandy loam. Pebbles and cobblestones in the solum constitute from 25 to 40 percent of the soil mass in some areas. Depth to the very gravelly material in the substratum ranges from 20 to 30 inches.

Included with this soil in mapping were small areas of Clackamas soils and small areas of cobbly, brown soils.

The available water capacity is 4 to 5 inches. Permeability is moderately rapid in the solum and very rapid in the substratum. Fertility is low. Runoff is very slow, and erosion is not a hazard. Roots can penetrate to depths of only 20 to 30 inches. Workability is only fair because of the gravel in the surface layer. Even though this soil is intensively used, it does not become compacted and the rate of infiltration remains high.

This soil is used mainly as woodland and for cereal grains, pasture, pole beans, bush beans, sweet corn, and caneberries. When irrigated, it is well suited to forage crops and other crops that require little cultivation. This soil is poorly suited to root crops, and it is unsuitable for mechanical harvesting of root crops. Tillage is hindered by the gravel in the surface layer. Irrigation is needed for adequate growth of most crops. It is essential for growing vegetables and berries, and for extending the use of pastures during the dry, warm summers. (Capability unit IIIs-1; not placed in a woodland suitability group)

Silverton Series

The Silverton series consists of well-drained soils that have formed in silty material over fine-textured material that contains gravel. These soils are on dissected terraces or on the foot slopes of low foothills. They have slopes of 2 to 20 percent. Elevations range. from 225 to 300 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, vine maple, hazel, poison-oak, ocean-spray, thimbleberry, blackberry, strawberry, pathfinder, brackenfern, and bentgrass. Silverton soils are associated with Santiam and Nekia soils.

In a typical profile, the surface layer is dark-brown silt loam about 7 inches thick. The subsurface layer is dark-brown heavy silt loam about 9 inches thick: The upper part of the subsoil consists of a layer of dark-brown silty clay loam about 9 inches thick. The lower part of the subsoil is dark-brown gravelly silty clay about 12 inches thick. The substratum is fractured and partly weathered, consolidated basalt bedrock.

The Silverton soils are used mainly as woodland and for pasture, hay, orchards, caneberries, and grass grown for seed.

Silverton silt loam, 2 to 12 percent slopes (SuC).-This soil occupies remnants of old, high terraces along the foot slopes of low foothills. It is in areas adjacent to the terraces of Willamette silts.

Representative profile 2,640 feet south of the city limits of Silverton and 65 feet west of the highway that leads from Silverton to Stayton (in northeast corner of SW1/4NW1/4 sec. 3, T. 7 S., R.1 W.)

Ap-0 to 7 inches, dark-brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) when dry; moderate, medium, subangular blocky structure breaking to moderate, very fine, granular structure; friable, slightly hard, slightly plastic and slightly sticky; many roots; many interstitial pores; few, medium and fine, distinct, black concretions; medium acid (pH 5.8) ; clear, smooth boundary. (6 to 8 inches thick.)

A3-7 to 16 inches, dark-brown (7.5YR 3/3) heavy silt loam, brown (7.5YR 5/4) when dry; weak, medium, subangular blocky structure breaking to moderate, fine and very fine, subangular blocky structure; friable, slightly hard, slightly plastic and slightly sticky; many roots; many interstitial pores, and many, very fine, tubular pores; common gray coatings of silt on some vertical surfaces of peds; few, medium and fine, dark-colored concretions; common, medium, black sand grains; 3 percent, by volume, fine pebbles; medium acid (pH 6.0) ; clear, smooth boundary. (4 to 10 inches thick.)

B21t-16 to 25 inches, dark-brown (7.5YR 3/3) silty clay grains; 3 percent, by volume, fine pebbles; medium loam, brown (7.5YR 5/4) when dry; moderate, fine and very fine, subangular blocky structure; firm, hard, plastic and sticky; many roots; few coatings of silt on the surfaces of peds; many, fine and very fine, tubular pores; few thin clay films in pores; common, medium and fine, dark-colored concretions; common, medium, black sand grains; 3 percent, by volume, fine pebbles and cobblestones; medium acid (pH 5.9); clear, wavy boundary. (5 to 12 inches thick.)

IIB22t-25 to 37 inches, dark-brown (7.5YR 4/3) gravelly silty clay, light brown (7.5YR 6/4) when dry; moderate, medium, subangular blocky structure breaking to strong, very fine, subangular blocky structure; firm, very hard, plastic and sticky; few roots; many, fine and very fine, tubular pores; thin, nearly continuous clay films; common coarse and medium sand grains; 20 percent, by volume, pebbles and partly weathered cobblestones; medium acid (pH 5.8); abrupt, wavy boundary. (5 to 15 inches thick.)

IIIR-37 inches, fractured and partly weathered, consolidated basalt bedrock.

Depth to the nonconforming IIB22t horizon ranges from 15 to 30 inches. As much as 50 percent of this horizon is coarse fragments that are mostly strongly weathered. Depth to weathered basalt ranges from 20 to 40 inches, but it is more than 30 inches in most places.

Included with this soil in mapping were small areas of Jory and Nekia soils.

The available water capacity is 5 to 7 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and the hazard of erosion is slight. Roots can penetrate to depths of 20 to 40 inches. Workability is generally good, but it is variable where this soil is near areas of Jory and Nekia soils.

This soil is used mainly as woodland and for pasture, orchards, caneberries, and grass grown for seed. When irrigated, a small acreage is used for strawberries, sweet corn, and pole beans. (Capability unit IIe-3; woodland suitability group 3c1)

Silverton silt loam, 12 to 20 percent slopes (SuD).Runoff from this soil is medium, and erosion is a moderate hazard. Included in mapping were small areas of Witzel soils.

This Silverton soil is used mainly for small grains, pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, for cherries, or as woodland. Crops are difficult to cultivate and harvest. Cultivation and harvesting of row crops require practices that are difficult to apply without causing excessive soil losses and damage to the crops. The strong slopes and the water received from higher areas intensify the hazard of erosion. (Capability unit IIIe-2; woodland suitability group 3c1)

Stayton Series

The Stayton series consists of well-drained soils that have formed in alluvium underlain by basalt. These soils are on foot slopes and in drainageways of the red foothills. They have slopes of 0 to 7 percent. Elevations range from 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50° to 53° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly oak, vine maple, sedges, and grass. Stayton soils are associated with Nekia and Jory soils.

In a typical profile, the surface layer is black silt loam about 17 inches thick. Just below the surface layer is a layer of dark reddish-brown silt loam about 3 inches thick. Hard basalt bedrock is at a depth of about 20 inches.

The Stayton soils are used mainly for pasture, for grass grown for seed, and as woodland.

Stayton silt loam, 0 to 7 percent slopes (SvB).-This soil is in drainageways and on foot slopes of the red foothills. It is the only soil of the Stayton series mapped in the survey area.

Representative profile 150 to 200 yards north of Drift Creek where that creek flows under Drift Creek Road; about 1 1/2 miles south of Drift Creek Falls (NW1/4SW1/4 sec. 17, T. 8 S., R.1 E.)

A11-0 to 12 inches, black (5YR 2/1) silt loam, dark reddish brown (5YR 3/3) when dry; moderate, very fine, granular structure; very friable, slightly hard, slightly sticky and slightly plastic; plentiful roots; many, very fine, interstitial pores; medium acid (pH 5.6); gradual wavy boundary. (7 to 14 inches thick.)

A12-12 to 17 inches, black (5YR 2/1) silt loam, dark reddish brown (5YR 3/3) when dry; weak, very fine and fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; plentiful roots; few fine pores and common very fine pores; medium acid (pH 5.8); clear, wavy boundary. (3 to 8 inches thick.)

AC-17 to 20 inches, dark reddish-brown (5YR 3/2) silt loam, reddish brown (5YR 4/4) when dry; weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common fine roots; few medium pores and common very fine pores; medium acid (pH 5.8); abrupt, wavy boundary. (0 to 6 inches thick.)

IIR-20 inches, hard basalt bedrock.

Color of the A horizon ranges from black to very dark brown. Depth to bedrock ranges from 15 to 20 inches. Where the solum is shallowest over bedrock, the AC horizon is thin or absent. Where the profile lacks an AC horizon, the A horizon rests directly on bedrock. In places bedrock crops out at the surface. A few fragments of rock the size of pebbles are scattered throughout the solum.

The available water capacity ranges from 2 to 4 inches. Permeability and fertility are both moderate. Runoff is medium, and erosion is a moderate hazard. Roots can penetrate to a depth of only 15 to 20 inches.

This soil is used for pasture, for grass grown for seed, and as woodland. It is well suited to forage plants grown for pasture and to early maturing grasses grown for seed. This soil is droughty, however, and forage plants grow well only in spring. (Capability unit VIe-1; not placed in a woodland suitability group)

Steiwer Series

The Steiwer series consists of well-drained soils on foot slopes and on low foothills. These soils have formed in a thin mantle of material consisting partly of silty alluvium and colluvium and partly of sedimentary material derived from the underlying bedrock. They have slopes of 3 to 40 percent. Elevations range from 250 to 650 feet. The average annual precipitation is between 40 and 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly oak, wild rose, poison-oak, annual bromegrass, and velvetgrass. Steiwer soils are associated with Chehulpum and Hazelair soils.

In a typical profile, the surface layer is about 17 inches thick and consists of very dark brown silt loam in the upper part and of very dark grayish-brown silt loam in the lower part. A subsurface layer of dark-brown silt loam, about 4 inches thick, is just beneath the surface layer. The subsoil is dark yellowish-brown silty clay loam about 11 inches thick. Fine-grained sandstone is at a depth of about 32 inches.

Steiwer soils are used mainly as woodland and for small grains, pasture, hay, and grass grown for seed.

Steiwer silt loam, 3 to 6 percent slopes (SwB).-This soil is on low foothills and on foot slopes of the Salem and Waldo Hills.

Representative profile in a field just south of a barn, about 30 feet south of the center of a road (NW1/4NE1/4 sec. 25, T. 9 S., R. 3 W.)

Ap1-0 to 5 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; cloddy, breaking to very weak, coarse, granular structure; friable, hard, slightly plastic and slightly sticky; common roots; many interstitial pores; many wormholes and worm casts; common, very fine, black concretions; common very fine fragments of weathered rock; medium acid (pH 5.6); abrupt, smooth boundary. (4 to 8 inches thick.)

Ap2--5 to 8 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; massive, breaking to very weak, coarse, subangular blocky structure; friable, hard, slightly plastic and slightly sticky; few, very fine and fine, tubular pores; common, very fine, black concretions; common fine fragments of weathered rock; medium acid (pH 5.9); clear, smooth boundary. (0 to 4 inches thick.)

A1-8 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium, prismatic structure and moderate to strong, coarse and medium, subangular blocky structure; very friable, slightly hard, slightly plastic and slightly sticky; few roots; common, very fine and fine, tubular pores; very few, fine, black concretions; medium acid (pH 5.9); clear, smooth boundary. (0 to 10 inches thick.)

A3--17 to 21 inches, dark-brown (10YR 3/3) silt loam; pale brown (10YR 6/3) when dry; weak, coarse, prismatic structure and moderate, medium, subangular blocky structure; very friable, slightly hard, slightly plastic and slightly sticky; few roots; common, very fine and fine, tubular pores; medium acid (pH 5.8); clear, smooth boundary. (0 to 8 inches thick.)

B21-21 to 29 inches, dark yellowish-brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) when dry; weak, coarse, prismatic structure breaking to moderate, coarse and medium, subangular blocky structure; firm, hard, plastic and sticky; few roots; many, very fine and fine, tubular pores; dark grayish-brown (10YR 4/2) coatings on ped surfaces; few, fine, black concretions; common medium and fine fragments of sandstone; medium acid (pH 5.9); clear, smooth boundary. (6 to 15 inches thick.)

B22-29 to 32 inches, dark yellowish-brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) when dry; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; firm, hard, plastic and sticky; few roots; many, very fine and fine, tubular pores; dark grayish-brown (10YR 4/2) coatings on ped surfaces; few very fine concretions; many, coarse, medium and fine fragments of sandstone; slightly acid (pH 6.2); abrupt, wavy boundary. (3 to 12 inches thick.)

R-32 inches, dark yellowish-brown (10YR 4/4), hard, fractured, fine-grained sandstone that is horizontally bedded.

When the soil is moist, color of the A horizon ranges from very dark grayish brown to very dark brown or dark brown, and color of the B horizon ranges from dark brown to dark yellowish brown. Texture of the A horizon ranges from silt loam to silty clay loam, and texture of the B horizon ranges from clay loam to heavy silty clay loam. The number of fragments of siltstone, sandstone, and shale ranges from few in the upper part of the solum to many (as much as 30 percent) in the lower part of the B horizon. Depth to sedimentary bedrock ranges from 20 to 40 inches, but the depth is generally between 24 and 32 inches. Where bedrock is at the greatest depth, these soils contain a clayey horizon, as much as 4 inches thick, that lies just above the bedrock.

Included with this soil in mapping were small areas of Hazelair soils.

The available water capacity ranges from 4 to 8 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and the hazard of erosion is slight. Roots can penetrate to a depth of 20 to 40 inches.

This soil is well suited to winter cereal grains, forage crops, and early maturing grasses grown for seed. It is used mainly for those crops and for improved or woodland-grass pasture. The small irrigated acreage is used to grow pole beans, sweet corn, blackberries, and strawberries. (Capability unit IIIe-3; not placed in a woodland suitability group)

Steiwer silt loam, 6 to 20 percent slopes (SwD).-This soil has slopes that are mainly steeper than 12 percent. Runoff is medium, and the hazard of erosion is moderate. Included in mapping were some areas of sandstone outcrops, and small areas of Chehulpum soils.

This Steiwer soil is used mainly for small grains, grass grown for seed, cleared pasture, hay, and woodland pasture. (Capability unit IVe-2; not placed in a woodland suitability group)

Steiwer and Chehulpum silt loams, 3 to 40 percent slopes (SCE).-This undifferentiated unit consists of gently sloping to steep Steiwer and Chehulpum soils that are moderately deep and shallow over bedrock. Some areas consist wholly of Steiwer soils, others consist wholly of Chehulpum soils, and still others consist of both soils. The soils are on foot slopes and foothills. In areas that are not cultivated, the vegetation is mainly velvetgrass, annual bromegrass, poison-oak, rose, and oak trees.

The profile of the Steiwer soil is similar to the one described as typical for Steiwer silt loam, 3 to 6 percent slopes, except that bedrock is at a depth of only 20 to 24 inches. A representative profile of the Chehulpum soil follows

Representative profile 25 feet south of county road NE1/4NE1/4NE1/4 sec. 25, T. 9 S., R,. 2 W.)

01&02-1/2 inch to 0, grass and leaves in varying degrees of decomposition.

A11-0 to 4 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium, subangular blocky and moderate, fine, granular structure; friable, slightly hard, sticky and plastic; many roots; many, very fine, interstitial and tubular pores; medium acid (pH 5.9) ; clear, smooth boundary. (2 to 6 inches thick.)

A12-4 to 12 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium and fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, very fine and fine, tubular pores; common fine fragments of sandstone; medium acid (pH 5.9); abrupt, smooth boundary. (6 to 14 inches thick.)

IIR-12 inches, horizontally bedded, fine-grained sandstone.

Texture throughout the profile ranges from silt loam to loam., In places the A horizon is dark brown. Depth to bedrock ranges from 10 to 20 inches.

Included with these soils in mapping were small areas of Hazelair, Witzel, and Nekia soils, and many areas of rock outcrops.

The available water capacity of the Steiwer soil of this undifferentiated unit is 4 to 5 inches, and that of the Chehulpum soil is 2 to 4 inches. Permeability of the Steiwer soil is moderately slow, and that of the Chehulpum soil is moderate. Runoff is medium to rapid, and the hazard of erosion is severe. Roots can penetrate to a depth of 20 to 24 inches in the Steiwer soil, but to a depth of only 10 to 20 inches in the Chehulpum soil.

This undifferentiated unit is mainly in native pasture (fig. 9) and in wooded areas. Most of the forage is produced in spring, for the forage plants make little growth in summer and fall. These soils are not suited to Douglas-fir. Douglas-fir grows only where additional soil material has been deposited on the surface of these soils, or it grows on deeper included soils. (Capability unit VIe-1; not placed in a woodland suitability group)

Stony Rock Land

Stony rock land (Sy) is a miscellaneous land type in which 25 percent or more of the acreage is nearly bare and very stony or consists of outcrops of basalt. This land type is nearly level to very steep. Except where some areas have a sparse cover of forage plants or of stunted trees that grow where there are small pockets of soil material, the land has no value for farming. (Capability unit VIIIs-1; not placed in a woodland suitability group)

Terrace Escarpments

Terrace escarpments (Te) consists of gravelly and silty alluvium that is too variable in characteristics to be classified as soil. It is moderately steep or steep and occurs along the sidewalls of the major streams, on terrace scarps, and on the side slopes bordering channels of intermittent streams. The vegetation is mainly Douglas-fir, maple, hazel, swordfern, brackenfern, poison-oak, tussock, sedges, and grasses.

This land type is suitable for pasture and for use as woodland. The short, steep slopes make tillage impracticable. (Capability unit VIe-2; not placed in a woodland suitability group

Waldo Series

The Waldo series consists of poorly drained soils that have formed in alluvium. These soils are nearly level. They are on bottom lands along small streams and in drainageways that dissect low foothills. Elevations range from 250 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly sedges, grasses, willow, cottonwood, ash, and oak. Waldo soils are associated with Abiqua and McAlpin soils.

In a typical profile, the surface layer is very dark grayish-brown silty clay loam that is mottled in the lower part and is about 10 inches thick. The subsoil is mottled throughout and is about 36 inches thick. It is very dark grayish-brown clay in the upper part, dark-gray clay in the middle part, and gray silty clay in the lower part. The substratum is mottled gray silty clay that extends to a depth of 60 inches or more.

The Waldo soils are used mainly for small grains, pasture, and grass grown for seed.

Waldo silty clay loam (Wa).-This is the only soil of the Waldo series mapped in the survey area. It occupies narrow strips along small streams and in drainageways of the Salem, Waldo, and Silverton Hills.

Representative profile 475 feet west and 175 feet south of the center of a gravel road that crosses over Beaver Creek (SE1/4NE1/4 sec. 29, T. 8 S., R. 1 W.)

Ap1-0 to 2 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 4/2) when dry; moderate, very fine, granular structure; friable, slightly hard, plastic and sticky; many interstitial pores; many, fine, reddish-brown and black concretions; medium acid (pH 5.6); abrupt, smooth boundary. (0 to 3 inches thick.)

Ap2-2 to 7 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 4/2) when dry; cloddy, breaking to very weak, fine, granular structure; very firm, very hard, plastic and sticky; few roots; few interstitial and very fine, tubular pores; many, fine, reddish-brown and black concretions ; medium acid (pH 5.7) ; abrupt, smooth boundary. (4 to 7 inches thick.)

A1-7 to 10 inches, very dark grayish-brown (10YR, 3/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; common, medium, distinct, dark gray (10YR 4/1), very dark gray (10YR 3/1), and red (2.5YR 4/8) mottles; strong, medium and fine, granular structure; friable, hard, plastic and sticky; common roots; many interstitial pores; many, coarse, medium and fine, reddish-brown and black concretions; medium acid (pH 5.8); abrupt, wavy boundary. (2 to 4 inches thick.)

B1-10 to 15 inches, very dark grayish-brown (10YR 3/2) clay, gray (10YR 5/1) when dry; common, medium, distinct, very dark gray (10YR 3/1) and yellowish-red (5YR 5/8) mottles; strong, coarse, subangular blocky structure breaking to strong, very fine, subangular blocky structure; firm, very hard, very plastic and very sticky; common roots; many, very fine and fine, tubular pores; ; thin coatings of silt on the surfaces of peds ; many, fine and very fine, reddish-brown and black concretions; slightly acid (pH 6.1); clear, wavy boundary. (3 to 8 inches thick.)

B21g-15 to 23 inches, dark-gray (N 4/0) clay, gray (N 5/0) when dry; common, medium, distinct, strong-brown (7.5YR 5/8) mottles; strong prismatic structure breaking to strong, coarse, subangular blocky structure; very firm, very hard, very plastic and very sticky; common roots; many, very fine and fine. tubular pores; thin coatings of silt on the surfaces of peds; many, fine, reddish-brown and black concretions; medium acid (pH 5.9); clear, smooth boundary. (6 to 10 inches thick.)

B22g-23 to 37 inches, dark-gray (N 4/0) clay, gray (N 5/0) when dry; many, medium, prominent, strong-brown (7.5YR 5/8) mottles; strong prismatic structure breaking to moderate coarse, subangular blocky structure; firm, very hard, very plastic and very sticky; common roots; many, very fine and fine, tubular pores; few, fine, reddish-brown and black concretions; medium acid (pH 5.8) gradual, smooth boundary.

B3g-37 to 146 inches, gray (N 5/0) silty clay, gray (N 6/0) when dry; many, prominent, strong-brown (7.5YR 5/8) and yellowish-red (5YR 4/8) mottles; weak, coarse, subangular blocky structure; firm, very hard, very plastic and very sticky; few roots; few, very fine, tubular pores; few, moderately thick, gray clay films in the larger pores; few, fine, reddish-brown and black concretions; medium acid (pH 5.7); gradual, smooth boundary. (6 to 12 inches thick.)

Cg-46 to 60 inches, gray (N 5/0) silty clay, gray (N 6/0) when dry; many, medium, prominent, strong-brown (7.5YR 5/8) mottles; massive; friable, very hard, very plastic and very sticky; very few roots; common, very fine, and very few, medium, tubular pores; thick, continuous clay films in cracks, pores, and root channels; few, medium, black concretions; medium acid (pH 5.7).

In the A horizon and the upper part of the B horizon, thickness of the soil material that is as dark as very dark grayish brown is less than 24 inches. Color of the B horizon ranges from very dark grayish brown to gray. Structure in the B1 and B2 horizons ranges from moderate to strong prismatic and subangular blocky or blocky. Depth to the clay or silty clay of the B horizon is less than 25 inches. In some places mottling is near the surface. In others it is at a depth of as much as 15 inches.

Included with this soil in mapping were small areas of McAplin soils and small areas of very poorly drained soils.

The available water capacity is 9 to 11 inches. Permeability is slow, and fertility is moderate. Runoff is slow, and erosion is not a hazard. Depth to which roots can penetrate is limited by a seasonal high water table. Workability is fair, but it becomes progressively poorer as the content of moisture drops below field capacity.

This soil is used mainly for small grains, pasture, and grass grown for seed. When irrigated, areas that are drained are used for pole beans and sweet corn. Surface drainage and subsurface drainage are both needed, but establishing outlets is necessary in most places. Even after adequate surface drainage has been installed, subsurface drainage it still difficult. (Capability unit IIIw-2; not placed in a woodland suitability group)

Wapato Series

The Wapato series consists of poorly drained soils that have formed in mixed alluvium. These soils are nearly level. They occur in depressions and overflow channels on flood plains at elevations of 100 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is about 53° F., and the length of the

Figure 9.-Clearing an area for pasture on Steiwer and Chehulpum silt loams, 3 to 40 percent slopes. Typical vegetation on these soils is oak trees and annual grasses.

frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly willow, ash, tussocks, sedges, and grasses. Wapato soils are associated with McBee and Bashaw soils.

In a typical profile, the surface layer is mottled very dark brown silty clay loam about 16 inches thick. The subsoil is mottled very dark grayish-brown silty clay loam about 20 inches thick. The substratum is mottled dark-brown silty clay loam that extends to a depth of 60 inches or more.

The Wapato soils are used mainly for pasture, hay, small grains, vegetables, and caneberries.

Wapato silty clay loam (Wc).-This is the only soil of the Wapato series mapped in the survey area. It occurs in backwater areas of the flood plains, in most places adjacent to the terraces.

Representatives profile (SE1/4NE1/4 sec. 15, T. 6 S., R. 1 W.).

Ap-0 to 6 inches, very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) when dry; few, fine, faint, yellowish-brown (10YR 5/4) mottles; cloddy; moderate, fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; common, fine, tubular pores; few reddish-brown and black concretions; slightly acid (pH 6.2); clear, smooth boundary. (6 to 9 inches thick.)

A1-6 to 16 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; common, fine, distinct, dark reddish-brown (5YR 3/4) mottles; moderate, medium, subangular blocky structure; firm, hard, sticky and plastic; many roots; many, fine, tubular pores; many reddish-brown concretions; slightly acid (pH 6.4); gradual, smooth boundary. (6 to 10 inches thick.)

B2-16 to 36 inches, very dark grayish-brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 5/2) when dry; few, fine, faint, dark-gray (10YR 5/1) mottles; weak, coarse, subangular blocky structure; firm, hard, sticky and plastic; common roots; many, fine, tubular pores; few, fine, reddish-brown and black concretions; slightly acid (pH 6.2); clear, smooth boundary. (14 to 20 inches thick.)

C-36 to 60 inches, dark-brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) when dry; many, medium, prominent, grayish-brown (2.5Y 5/2) mottles; massive; friable, hard, sticky and plastic; many, fine, tubular pores; common black concretions and stains; slightly acid (pH 6.2).

Color of the A horizon ranges from very dark brown to very dark grayish brown. In places the B horizon is dark grayish brown. Texture of the B horizon ranges from silty clay loam to light silty clay. Texture of the C horizon ranges from clay loam or silty clay loam to light silty clay. In some places this soils is mottled at or near the surface. In others mottling is at depths of as much as 12 inches.

Included with this soil in mapping were small areas of better drained soils, and small areas of a soil that has a surface layer of silt loam.

The available water capacity is 10 to 12 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow and erosion is not a hazard or is only a slight hazard. The depth to which roots can penetrate is restricted by a high water table during winter and spring. Workability is good where the content of organic matter is adequate. Overflow occurs during winter and early in spring.

Undrained areas of this soil are used for pasture and hay. Drained areas are used for small grains, sweet corn, pole beans, hops, and blackberries. Irrigation is needed for vegetables to be grown commercially. It is also needed to make this soil better suited to forage plants and to extend the period during with these plants produce forage. Drainage is needed for most crops. Adequate outlets for surface runoff are needed. Subsurface tile drainage is needed to lower the water table for deep-rooted crops and to make tillage possible early in spring. Providing drain age for deep-rooted crops is of questionable value in most areas, however, for adequate drainage generally cannot be maintained during winter and spring. (Capability unit IIIw-2; not placed in a woodland suitability group)

Whetstone Series

The Whetstone series consists of well-drained soils that have formed in till -and colluvium from basalt and tuffs. These soils are on mountainous uplands. They are underlain by basalt and have slopes of 3 to 75 percent. Elevations range from 3,000 to 4,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41° to 45° F., and the length of the frost-free season is 90 to 110 days. The vegetation is mainly noble fir, silver fir, hemlock, Douglas-fir, blue huckleberry, rhododendron, fireweed, and beargrass. Whetstone soils are associated with Henline, Kinney, and Horeb soils.

In a typical profile, the surface layer is dark-gray stony sandy loam that is only about 1 inch thick. This is covered with a thin layer of undecomposed and partly decomposed tree limbs, twigs, leaves, needles, and grass. The subsoil is about 18 inches thick, and it consists of dark reddish-brown stony loam in the upper part and of dark-brown stony loam in the lower part. The substratum is dark yellowish-brown stony loam. It is underlain by basalt bedrock at a depth of about 38 inches.

Whetstone stony loam, 3 to 25 percent slopes (WHE).-This soil occupies large areas on the middle slopes of the slopes of the Cascade Mountains. Some of the areas are steep.

Representative profile 50 feet north of a steel gate at junction of roads (NE1/4NE1/4 sec. 9, T. 8 S., R. 3 E.)

O1-4 to 2 inches, undecomposed limbs, twigs, leaves, needles, and grass.

O2-2 inches to O, partly decomposed plant and animal matter.

A2-0 to 1 inch, dark-gray (5YR 4/1) stony sandy loam, gray (5YR 5/1) when dry; single grain; friable, soft, nonsticky and nonplastic; many, fine, interstitial pores; many roots; extremely acid (pH 4.0); abrupt, wavy boundary. (1/2 to 1 1/2 inches thick.)

B21ir-1 to 5 inches, dark reddish-brown (5YR 3/3) stony loam, reddish brown (5YR 4/4) when dry; massive; weakly cemented; firm, hard, slightly sticky and nonplastic; common roots; 20 percent, by volume, cobblestones, other stones, and pebbles; common fine and very fine pores dark coatings of iron on incipient surfaces of peds; dark reddish-brown (2.5YR 2/4) stains of organic matter; extremely acid (pH 4.2); abrupt, wavy boundary. (3 to 8 inches thick.)

B22ir-5 to 19 inches dark-brown (7.5YR 3/2) stony loam, brown (7.5YR 5/4) when dry; massive; friable, hard, slightly sticky and nonplastic; common roots; common fine and very fine pores; 30 percent, by volume, cobblestones, other stones, and pebbles; bands of iron accumulation 1 to 2 inches thick along planes of weakness of incipient surfaces of peds; many, dark reddish-brown, firm nodules 5 to 25 millimeters in diameter; very strongly acid (pH 4.6); clear, wavy boundary. (12 to 16 inches thick.)

C-19 to 38 inches, dark yellowish-brown (10YR 4/4) stony loam, brown (10YR 5/3) when dry; massive; friable, slightly hard, slightly sticky and nonplastic; few roots; common fine and very fine pores; 40 percent, by volume, cobblestones, other stones, and pebbles; very strongly acid (pH 4.6).

R-38 inches, basalt bedrock.

The A2 horizon appears to be intermittent because it has been destroyed by burning or logging in many places. It is present wherever the original surface layer is present. The B horizon ranges from dark reddish brown to dark brown in color, and it has firm or friable consistence. Thickness of the B horizon ranges from 15 to 24 inches. The content of cobblestones, other stones, and pebbles in that horizon is less than 50 percent. Depth to bedrock ranges from 20 to more than 40 inches.

Included with this soil in mapping were areas that are deeper over bedrock than typical and that have only a trace of the dark-gray surface layer remaining. Also included were areas where the dark-gray surface layer is missing. Other inclusions consist of a few rock outcrops.

The available water capacity is 3 to 6 inches. Permeability is moderate, and fertility is low. Runoff is medium, and the hazard of erosion is moderate. Roots can penetrate to a depth of 20 to 40 inches.

This soil is well suited to forest trees, and it is used mainly for growing timber. It is not suited to cultivated crops. Snow usually covers the surface in winter and early in spring. (Capability unit VIe-2; woodland suitability group 3o2)

Whetstone stony loam, 25 to 55 percent slopes (WHF).-Runoff from this soil is rapid, and the hazard of erosion is severe. Rock outcrops are common.

Included with this soil in mapping were areas of Henline soils. The included areas make up from 5 to 10 percent of the acreage in this mapping unit.

This Whetstone soil is used mainly for growing timber. (Capability unit VIe-2; woodland suitability group 3r3)

Whetstone stony loam, 55 to 75 percent slopes (WHG).-Runoff from this soil is very rapid, and the hazard of erosion is very severe. Rock outcrops are numerous, and rock escarpments are common.

Included with this soil in mapping were areas of Henline soils. The included areas make up from 10 to 15 percent of the acreage in this mapping unit.

This Whetstone soil is used mainly for growing timber. (Capability unit VIIe-1; woodland suitability group 3r4)

Willamette Series

The Willamette series consists of deep, well-drained soils that have formed in silty alluvium. These soils are on low, broad valley terraces. They have slopes of 0 to 12 percent. Elevations range from 150 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 50° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly oatgrass and other native grasses, hazel, blackberry, Oregon white oak, and Douglas-fir. Willamette soils are associated with Woodburn soils.

In a typical profile, the surface layer is very dark grayish-brown silt loam about 12 inches thick. A subsurface layer that also consists of very dark grayish-brown silt loam and that is about 5 inches thick is just beneath the surface layer. The upper part of the subsoil is dark-brown silt loam about 7 inches thick; the middle part of the subsoil is dark-brown silty clay loam about 14 inches thick; and the lower part is dark-brown silt loam about 16 inches thick. A substratum of dark yellowish-brown silt loam underlies the subsoil, and it extends to a depth of 65 inches or more.

The Willamette soils are used mainly for small grains, pasture, hay, orchards, berries, and vegetables.

Willamette silt loam, 0 to 3 percent slopes (WIA).-This soil is on broad valley terraces that lie between the flood plains of the North Santiam, Santiam, and Willamette Rivers and the red foothills. The areas are between Marion and Aurora.

Representative profile (NW1/4NE1/4SE1/4 sec. 22, T. 5S.,R.1W.):

Ap-0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many, fine, tubular pores; few reddish-brown and black concretions; slightly acid (pH 6.1); clear, smooth boundary. (5 to 7 inches thick.)

A1-6 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, coarse and medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; common, very fine and fine, tubular pores; iron stains along root channels; common, fine, reddish-brown and black concretions; slightly acid (pH 6.1); clear, smooth boundary. (4 to 8 inches thick.)

A3-12 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; common roots; common, very fine and fine, tubular pores; common, medium and fine, reddish-brown and black concretions; slightly acid (pH 6.2); clear, smooth boundary. (3 to 12 inches thick.)

B1t-17 to 24 inches, dark-brown (10YR 3/3) silt loam, dark brown (10YR 4/3) when dry; moderate, medium, subangular blocky structure; friable, hard, sticky and slightly plastic; common roots; common, very fine and fine, tubular pores; few thin clay films; common, medium and fine, reddish-brown and black concretions; strong-brown (7.5YR 3/2) coatings on ped surfaces; few black stains; slightly acid (pH 6.2) ; gradual, smooth boundary. (7 to 11 inches thick.)

B2t-24 to 38 inches, dark-brown (10YR 3/3) silty clay loam, dark yellowish brown (10YR 4/4) when dry; moderate, coarse, subangular blocky structure; friable, hard, sticky and plastic; common roots; common, very fine, tubular pores; medium, continuous clay films; dark-brown (10YR 4/3) mottles and common gray coatings of silt on ped surfaces (10YR 5/1); few reddish-brown and black concretions; slightly acid (pH 6.2); gradual, smooth boundary. (10 to 14 inches thick.)

B3t-38 to 54 inches, dark-brown (10YR 3/3) silt loam, dark yellowish brown (10YR 4/4) when dry; moderate, coarse, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; few roots; common, very fine, tubular pores; medium, patchy clay films; few reddish-brown and black concretions; slightly acid (pH 6.4); gradual, smooth boundary. (6 to 18 inches thick.)

C-54 to 65 inches, dark yellowish-brown (10YR 4/4) silt loam, brown (10YR 5/3) when dry; massive; friable. hard, slightly sticky and slightly plastic; common, very fine, tubular pores; slightly acid (pH 6.5).

The A horizon ranges from 15 to 25 inches in thickness and from very dark brown or dark brown to very dark grayish brown in color. The B horizon ranges from silty clay loam to silt loam in texture and from moderate or weak, medium, prismatic to moderate subangular blocky in structure. In places the B horizon contains faint mottles in the lower part, and distinct mottles below a depth of 40 inches. The C horizon is mainly silt loam or silty clay loam that is massive, but in places it contains thin layers that have other texture or structure.

Included with this soil in mapping were areas of Amity and Woodburn soils. The areas of Amity soils make up less than 2 percent of the total acreage in the mapping unit. Those of Woodburn soils make up as much as 15 percent.

The available water capacity is 12 to 14 inches. Permeability is moderate, and fertility is high. Runoff is slow, and no apparent erosion has taken place. Internal drainage is medium. Roots can penetrate to a depth of 5 feet or more.

This soil is used mainly for small grains, field corn, orchards, pasture, hay, caneberries, strawberries, and vegetables, but it is suited to all the crops commonly grown in the survey area. Irrigation makes this soil even better suited to crops, and it improves the quality of most crops. (Capability unit I-1; not placed in a woodland suitability group)

Willamette silt loam, 3 to 12 percent slopes (WIC).-This soil has slopes of 3 to 7 percent in about 70 percent of the acreage; Runoff is slow to medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping were small areas of Woodburn soils, and small areas in which slopes are as steep as 20 percent.

This Willamette soil is used mainly for small grains, pasture, hay, and orchards, but a moderate acreage is used for vegetables and berries. This soil is less suitable for vegetables and berries than Willamette silt loam, 0 to 3 percent slopes. Mechanical harvesting of crops is difficult on slopes steeper than 5 percent. (Capability unit IIe-2; not placed in a woodland suitability group)

Witzel Series

The Witzel series consists of well-drained, very stony soils on breaks in red foothills. These soils have formed partly in loess but mainly in colluvium from basic igneous rock. They have slopes of 3 to 40 percent. Elevations range from 300 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52°

to 54° F., and the length of the frost-free season is 190 to 200 days. The vegetation is mainly grass, poison-oak, rose, oak, and scattered Douglas-firs. Witzel soils are associated with Nekia and Jory soils.

In a typical profile, the surface layer is dark-brown very stony silt loam about 4 inches thick. The subsoil is about 15 inches thick, and it consists of dark-brown very stony silty clay loam in the upper part and of dark reddish-brown very stony silty clay loam in the lower part. Partly fractured basalt bedrock is at a depth of about 19 inches.

The Witzel soils are used mainly for pasture and as woodland.

Witzel very stony silt loam, 3 to 40 percent slopes (ME).-This is the only soil of the Witzel series mapped in the survey area. It is on slope breaks and in red foothills. The dominant slopes are less than 12 percent.

Representative profile (NE1/4SE1/4 sec. 8, T. 8 S., R. 2W.):

A1--0 to 4 inches, dark-brown (7.5YR 3/2) very stony silt loam, brown (7.5YR 5/4) when dry; moderate, fine, granular structure; friable, hard, slightly sticky and slightly plastic; 60 percent roots; many, very fine and fine, interstitial pores; many coarse fragments; medium acid (pH 6.0); clear, smooth boundary. (2 to 6 inches thick.)

B21-4 to 9 inches, dark-brown (7.5YR 3/2) very stony silty clay loam, brown (7.5YR 5/4) when dry; moderate, fine, subangular blocky structure; firm, hard, sticky and plastic; many roots; common, very fine, tubular pores; 60 percent coarse fragments; medium acid (pH 6.0); gradual, wavy boundary. (3 to 10 inches thick.)

B22-9 to 19 inches, dark reddish-brown (5YR 3/4) very stony silty clay loam, reddish brown (5YR 5/4) when dry; weak, medium, subangular blocky structure; friable, hard, sticky and plastic; many roots; common, very fine, tubular pores; 60 percent coarse fragments; medium acid (pH 6.0); clear, smooth boundary, (2 to 6 inches thick.)

IIR-19 inches, partly fractured basalt bedrock.

The A horizon ranges from silt loam to silty clay loam or clay loam in texture, and in places the B horizon is clay loam. Color of the B horizon ranges from dark brown to dark reddish brown. Thickness of the solum over basalt bedrock ranges from 12 to 20 inches. The content of coarse fragments of rock in the soil mass ranges from 50 to 75 percent.

Included with this soil in mapping were some areas in which bedrock is as deep as 30 inches.

The available water capacity is 1 to 3 inches. Permeability is moderately slow, and fertility is low. Roots can penetrate to a depth of 12 to 20 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high.

This soil is not used for cultivated crops, but it is used mainly for native pasture and as woodland. The high content of stones, low available water capacity, and hazard of erosion make this soil poorly suited to use for pasture. (Capability unit VIs-1; not placed in a woodland suitability group)

Woodburn Series

The Woodburn series consists of moderately well drained soils that have formed in silty alluvium and loess of mixed mineralogy. These soils are on broad valley terraces. They have slopes of 0 to 20 percent. Elevations range from 150 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly grass and Douglas-fir. Woodburn soils are associated with Willamette soils.

In a typical profile, the surface layer is about 17 inches thick and is very dark brown silt loam in the upper part and dark-brown silt loam in the lower part. The subsoil is about 37 inches thick. It is dark yellowish-brown silty clay loam in the upper part; mottled dark-brown silty clay loam in the middle part; and mottled, dark-brown silt loam in the lower part. The substratum is dark-brown silt loam that extends to a depth of 68 inches or more.

The Woodburn soils are used mainly for small grains, pasture, hay, orchards, berries, and vegetables.

Woodburn silt loam, 0 to 3 percent slopes (WuA).-This soil is on broad terraces of Willamette silts.

Representative profile about 200 feet west of the paved road to Champoeg (SW1/4SE1/4SE1/4 sec. 2, T. 4 S., R. 2 W.; profile No. 5 in table 9 in the section "Laboratory Data.") .

Ap-0 to 9 inches, very dark brown (10YR 2/2) silt loam, brown (10YR 5/3) when dry; cloddy and has very weak, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many, fine and very fine, tubular pores; few, fine, interstitial pores; common, medium and fine, reddish-brown and black concretions; medium acid (pH 5.9); abrupt, smooth boundary. (6 to 10 inches thick.)

A1-9 to 17 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; moderate, medium, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; common clean silt and sand grains on ped surfaces; many roots; many, very fine, tubular pores; few, thin, darker (10YR 2/2) coatings on ped surfaces; few reddish-brown and black concretions; slightly acid (pH 6.2), smooth boundary. (3 to 8 inches thick.)

B21t-17 to 25 inches, dark yellowish-brown (10YR 3/4) silty clay loam, brown (7.5YR 5/4) when dry; moderate, coarse and medium, subangular blocky structure; friable, hard, sticky and plastic; common roots; many, very fine, tubular pores; few thin clay films on peds; few reddish-brown and black concretions; few black stains on ped surfaces; medium acid (pH 6.0); clear, smooth boundary. (7 to 9 inches thick.)

B22t-25 to 32 inches, dark-brown silty clay loam, brown (10YR 5/3) when dry; few, fine and medium, distinct, dark-gray (10YR 4/1) mottles, light brownish gray (10YR 6/2) when dry; moderate, medium and coarse, subangular blocky structure; friable, hard, brittle, sticky and plastic; common roots; many, very fine, tubular pores; continuous, moderately thick clay films on ped surfaces and in pores; few, fine, black concretions and stains on ped surfaces; medium acid (pH 5.8); abrupt, smooth boundary. (6 to 10 inches thick.)

B31t-32 to 39 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) when dry; distinct, dark grayish-brown (10YR 4/2) mottles in a few root channels; thin, dark grayish-brown (10YR 4/2) coatings on plane surfaces, light gray (10YR 7/2) when dry; nearly massive; some planes of weakness that are indistinct; vertical planes are more distinct than horizontal planes; very firm, very hard, brittle, slightly sticky and slightly plastic; few roots; many, fine and very fine, tubular pores; continuous, moderately thick clay films on plane surfaces and in some root channels and pores; few, fine and medium, black concretions and few, black coatings on plane surfaces; medium acid (pH 5.7); gradual, smooth boundary. (7 to 10 inches thick.)

B32t-39 to 54 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; nearly massive, and has some indistinct vertical planes of weakness; very firm, very hard, brittle, slightly sticky and slightly plastic;

no roots; many, fine and very fine, and few, medium, tubular pores; continuous, thin clay films in pores and in old root channels; few black concretions, and some patchy, black coatings on plane surfaces; medium acid (pH 5.9); gradual, wavy boundary. (11 to 17 inches thick.)

C-54 to 68 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive; very firm, very hard, brittle, slightly sticky and slightly plastic; no roots; many, very fine, tubular pores; common moderately thick clay films in larger pores and in old root channels or worm channels; few black coatings in pores and in channels; medium acid (pH 5.9); gradual, wavy boundary. (14 to 16 inches thick.)

When the soil is moist, color of the A horizon ranges from dark grayish brown to very dark brown or dark brown, and color of the B2 horizon ranges from very dark grayish brown or dark brown to dark yellowish brown or strong brown. In all areas the A horizon is thicker than 10 inches. The B2 horizon ranges from heavy silt loam to silty clay loam in texture. Structure of the B2 horizon ranges from weak to moderate, medium or coarse, prismatic to moderate, fine to coarse, subangular blocky. Distinct mottling occurs at a depth above 30 inches. In some places the B3 horizon has weak to moderate subangular blocky or prismatic structure. In others it is massive and has vertical planes of weakness. Consistence of the B3 horizon is firm or very firm when the soil is moist. The substratum is stratified. It ranges from silty clay loam or silt loam to very fine sandy loam or fine sandy loam in texture.

Included with this soil in mapping were small areas of Amity and Willamette soils, and small areas of a somewhat poorly drained soil. The areas of Amity soils occupy less than 5 percent of the acreage in this mapping unit. The areas of Willamette soils occupy as much as 10 percent.

The available water capacity is 11 to 13 inches. Permeability is moderate in the upper part of the subsoil, and it is slow in the lower part. Fertility is high. Depth to which roots can penetrate is restricted by a seasonal perched water table and as the result of the type of structure. Runoff is slow, and no apparent erosion has taken place.

This soil is used mainly for small grains, field corn, orchards, pasture, hay, caneberries, and vegetables. Areas that are drained are used for all the crops commonly grown in the survey area. Because of the perched water table, drainage is needed for crops that cannot tolerate excessive moisture. (Capability unit IIw-1; not placed in a woodland suitability group)

Woodburn silt loam, 3 to 12 percent slopes (WuC).-This soil has slopes of 3 to 5 percent in about 60 percent of the acreage. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping were small areas that have a thin surface layer and that have distinct mottling within 12 inches of the surface.

This Woodburn soil is used for about the same crops as Woodburn silt loam, 0 to 3 percent slopes. It is less suitable for vegetables and berries, however, because of the difficulty of cultivating those crops so that erosion is controlled without damaging the crop. Mechanical harvesting of vegetables and berries is difficult where slopes are steeper than 5 percent. (Capability unit IIe-1; not placed in a woodland suitability group)

Woodburn silt loam, 12 to 20 percent slopes (WuD).-Where this soil occurs along creeks, intermittent drainageways, and terrace fronts, its slopes are short and abrupt. Runoff is rapid, and the hazard of erosion is moderate.

Included with this soil in mapping were small areas that hve a thin surface layer and that have distinct mottling within 12 inches of the surface.

This Woodburn soil is used mainly for pasture, hay, and small grains, although some small areas are used for row crops and orchards. This soil is poorly suited to row crops; for the slopes are too short and steep for mechanical harvesting of vegetables, berries, and other row crops to be feasible. Tilling row crops so that excessive soil losses are avoided is also difficult. (Capability unit IIIe-1; not placed in a woodland suitability group)

Formation and Classification of Soils

Soils of the Marion County Area differ in fertility, in physical and chemical properties, and in productivity. These differences are the result of differences in parent material and of local differences in the environment under which the soils have formed. This section describes some factors in the environment, and major processes that have affected the formation of soils of the Marion County Area. It also defines the current system, for classifying soils and shows the classification of the soils by series and by higher categories.

Formation of Soils

Soil is a natural body on the surface of the earth. It consists of mixtures of rocks and minerals that have been subjected to various degrees of weathering and that contain greatly varying amounts of organic matter, water, and air. Soils have more or less distinct horizons that have developed under the influence of local factors in the environment. The soil-forming processes that produce different kinds of soils are parent material, which affects the physical and chemical composition of the soils; climate, principally precipitation and temperature; biological forces., or the plant and animal life in and on the soil; relief, or topography; and the time in which the soil-forming processes have acted on the parent material. These five factors, in many different combinations and intensities, produce soils that differ from place to place. The influence of each soil-forming factor on the soils of the Marion County Area is described in the following paragraphs.

Parent material

Soils in the survey area have formed in eight major kinds of parent material. These are (1) recent alluvium, (2) gravelly alluvium, (3) young, silty terrace alluvium, (4) weakly consolidated, old gravelly alluvium, (5) basic colluvium from basalt and massive tuffs, (6) sedimentary alluvium and colluvium derived from tuffaceous sandstone and shale, (7) glacial till, and (8) deposits of organic material. The soils in about 80 percent of the survey area have formed in recent alluvium (Willamette silts); in basic igneous material (basic colluvium derived from basalt and massive tuffs); or in glacial till. Figure 10 shows the approximate distribution of the different kinds of parent materials in the survey area. This figure is based only partly on the results of geologic studies, and therefore it cannot be called a geologic map. The distribution shown is the result of combining information obtained

Appendix B.3
Environmental Characteristics

Water Quality Limited Streams Database

The following records match your search criteria. Select a **Record ID** to view details of the waterbody:

Record ID	Waterbody Name	Sub-Basin	River Mile	Parameter	Season	List Date	Listing Status
8854	North Santiam River	NORTH SANTIAM	0 to 10	Temperature	Summer	2002	303(d) List
8856	North Santiam River	NORTH SANTIAM	0 to 10	Temperature	September 1 - June 30	2002	303(d) List
8857	North Santiam River	NORTH SANTIAM	10 to 26.5	Temperature	September 15 - June 30	2002	303(d) List

There are 3 records in the table.

Download CSV file: Client630.csv

For additional information, please contact Karla Urbanowicz at (503) 229-6099.

Table 4. Listed, Candidate, and Species of Concern and the Determination of Effect from the Biological Assessment for Expansion, Operation and Maintenance of the Geren Island WTF

Common name	Scientific name	Federal status[1]	Jurisdiction
Oregon chub	*Oregonichthys crameri*	Endangered	USFWS
Winter steelhead	*Oncorhynchus mykiss*	Threatened	NOAA[2]
Spring chinook salmon	*Oncorhynchus tshawytscha*	Threatened	NOAA[2]
Bald eagle	*Haliaeetus leucocephalus*	Threatened	USFWS
Fender's blue butterfly	*Icaricia icarioides fenderi*	Endangered	USFWS[3]
Golden Indian paintbrush	*Castilleja laevisecta*	Threatened	USFWS[2]
Willamette daisy	*Erigeron decumbens* var. *decumbens*	Endangered	USFWS[2]
Howellia	*Howellia aquatilis*	Threatened	USFWS
Bradshaw's lomatium	*Lomatium bradshawii*	Endangered	USFWS
Kincaid's lupine	*Lupinus sulphureus* var. *kincaidii*	Threatened	USFWS[2]
Nelson's checker-mallow	*Sidalcea nelsoniana*	Threatened	USFWS
Candidate Species			
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate	USFWS[3]
Oregon spotted frog	*Rana pretiosa*	Candidate	USFWS[2]
Taylor's checkerspot	*Euphydras editha taylori*	Candidate	USFWS[3]
Streaked horned lark	*Eremophila alpestris strigata*	Candidate	USFWS[3]
Pacific lamprey	*Lampetra tridentata*	Sp. of Concern	USFWS
Northern red-legged frog	*Rana aurora aurora*	Sp. of Concern	USFWS
Foothill yellow-legged frog	*Rana boylii*	Sp. of Concern	USFWS
Northwestern pond turtle	*Clemmys marmorata marmorata*	Sp. of Concern	USFWS
Little willow flycatcher	*Empidonax traillii brewsteri*	Sp. of Concern	USFWS
Band-tailed pigeon	*Columba fasciata*	Sp. of Concern	USFWS[3]
Olive-sided flycatcher	*Contopus cooperi (=borealis)*	Sp. of Concern	USFWS[3]
Yellow-breasted chat	*Icteria virens*	Sp. of Concern	USFWS[3]
Acorn woodpecker	*Melanerpes formicivarus*	Sp. of Concern	USFWS[3]
Oregon vesper sparrow	*Pooecetes gramineus affinis*	Sp. of Concern	USFWS[3]
Purple martin	*Progne subis*	Sp. of Concern	USFWS[3]
Silver-haired bat	*Lasionycteris noctivagans*	Sp. of Concern	USFWS[3]
Long-eared myotis	*Myotis evotis*	Sp. Of Concern	USFWS
Fringed myotis	*Myotis thysanodes*	Sp. Of Concern	USFWS
Long-legged myotis	*Myotis volans*	Sp. Of Concern	USFWS
Yuma myotis	*Myotis yumanensis*	Sp. Of Concern	USFWS
Pacific western big-eared bat	*Plecotus townsendii townsendii*	Sp. Of Concern	USFWS
Camas pocket gopher	*Thomomys bulbivorus*	Sp. of Concern	USFWS[3]
Oregon giant earthworm	*Megascolides macelfreshi*	Sp. of Concern	USFWS
White top aster	*Aster curtus*	Sp. of Concern	USFWS
Peacock larkspur	*Delphinium pavonaceum*	Sp. of Concern	USFWS

[1] Federal Status

Endangered: Species that are in danger of becoming extinct within the foreseeable future throughout all or a significant portion of their range.

Threatened: Species that are likely to become endangered within the foreseeable future.

Candidate: Species considered for threatened or endangered listing, but not yet the subject of a proposed rule

Species of Concern: Species that are currently under review for listing.

Shaggy horkelia	*Horkelia congesta* spp. *Congesta*	Sp. of Concern	USFWS
Thin-leaved peavine	*Lathyrus holochlorus*	Sp. of Concern	USFWS[3]

[1] Federal Status

Endangered: Species that are in danger of becoming extinct within the foreseeable future throughout all or a significant portion of their range.

Threatened: Species that are likely to become endangered within the foreseeable future.

Candidate: Species considered for threatened or endangered listing, but not yet the subject of a proposed rule

Species of Concern: Species that are currently under review for listing.

[2] Status changed since preparation of the Biological Assessment
Source: AAI and SPCA 1996

[3] Status change since 1996 Source: USFWS, October 2003

ENCLOSURE A

FEDERALLY LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CANDIDATE SPECIES AND SPECIES OF CONCERN THAT MAY OCCUR WITHIN THE AREA OF THE CITY OF SALEM WATER MANAGEMENT PLAN PROJECT
1-7-03-SP-0684

LISTED SPECIES[1/]

Birds		
Bald eagle[2/]	*Haliaeetus leucocephalus*	T
Fish		
Steelhead (Upper Willamette River)[3/]	*Oncorhynchus mykiss*	**T
Chinook salmon (Upper Willamette River)[4/]	*Oncorhynchus tshawytscha*	**T
Oregon chub	*Oregonichthys crameri*	E
Invertebrates		
Fender's blue butterfly[5/]	*Icaricia icarioides fenderi*	E
Plants		
Golden Indian paintbrush[6/]	*Castilleja levisecta*	T
Willamette daisy[5/]	*Erigeron decumbens var. decumbens*	E
Howellia	*Howellia aquatilis*	T
Bradshaw's lomatium	*Lomatium bradshawii*	E
Kincaid's lupine[5/]	*Lupinus sulphureus var. kincaidii*	T
Nelson's checker-mallow	*Sidalcea nelsoniana*	T

PROPOSED SPECIES

None

CANDIDATE SPECIES[7/]

Birds	
Yellow-billed cuckoo[8/]	*Coccyzus americanus*
Streaked horned lark	*Eremophila alpestris strigata*
Amphibians and Reptiles	
Oregon spotted frog	*Rana pretiosa*
Invertebrates	
Taylor's checkerspot	*Euphydryas editha taylori*

SPECIES OF CONCERN

Mammals	
Pacific western big-eared bat	*Corynorhinus (=Plecotus) townsendii townsendii*
Silver-haired bat	*Lasionycteris noctivagans*
Long-eared myotis (bat)	*Myotis evotis*
Fringed myotis (bat)	*Myotis thysanodes*

Long-legged myotis (bat)	*Myotis volans*
Yuma myotis (bat)	*Myotis yumanensis*
Camas pocket gopher	*Thomomys bulbivorus*
Birds	
Band-tailed pigeon	*Columba fasciata*
Olive-sided flycatcher	*Contopus cooperi (=borealis)*
Yellow-breasted chat	*Icteria virens*
Acorn woodpecker	*Melanerpes formicivorus*
Oregon vesper sparrow	*Pooecetes gramineus affinis*
Purple martin	*Progne subis*
Amphibians and Reptiles	
Northwestern pond turtle	*Emys (=Clemmys) marmorata marmorata*
Northern red-legged frog	*Rana aurora aurora*
Foothill yellow-legged frog	*Rana boylii*
Fish	
Pacific lamprey	*Lampetra tridentata*
Coastal cutthroat trout (Upper Willamette)	*Oncorhynchus clarki clarki*
Invertebrates	
Oregon giant earthworm	*Driloleirus (=Megascolides) macelfreshi*
Plants	
White top aster	*Aster curtus*
Peacock larkspur	*Delphinium pavonaceum*
Shaggy horkelia	*Horkelia congesta* ssp. *congesta*
Thin-leaved peavine	*Lathyrus holochlorus*

(E) - Listed Endangered *(T) - Listed Threatened* *(CH) - Critical Habitat has been designated for this species*
(PE) - Proposed Endangered *(PT) - Proposed Threatened* *(PCH) - Critical Habitat has been proposed for this species*
(S) - Suspected *(D) - Documented*

Species of Concern - Taxa whose conservation status is of concern to the Service (many previously known as Category 2 candidates), but for which further information is still needed.

(CF) - Candidate: National Marine Fisheries Service designation for any species being considered by the Secretary for listing for endangered or threatened species, but not yet the subject of a proposed rule.

*** Consultation with National Marine Fisheries Service may be required.*

1/ U. S. Department of Interior, Fish and Wildlife Service. October 31, 2000, <u>Endangered and Threatened Wildlife and Plants</u>, 50 CFR 17.11 and 17.12

2/ Federal Register Vol. 60, No. 133, July 12, 1995 - Final Rule - Bald Eagle

3/ Federal Register Vol. 64, No. 57, March 25, 1999, Final Rule - Middle Columbia and Upper Willamette River Steelhead

4/ Federal Register Vol. 64, No. 56, March 24, 1999, Final Rule - West Coast Chinook Salmon

5/ Federal Register Vol. 65, No. 16, January 25, 2000, Final Rule-Erigeron decumbens var. decumbens, Lupinus sulphureus ssp. kincaidii and Fender's blue butterfly

6/ Federal Register Vol. 62, No. 112, June 11, 1997, Final Rule-Castilleja levisecta

7/ Federal Register Vol. 67, No. 114, June 13, 2002, Notice of Review - Candidate or Proposed Animals and Plants

8/ Federal Register Vol. 66, No. 143, July 25, 2001, 12-Month Finding for a Petition To List the Yellow-Billed Cuckoo

Appendix B.4

Oregon Natural Heritage Information

KELLER associates

OREGON NATURAL HERITAGE INFORMATION CENTER

Institute for Natural Resources

OREGON STATE UNIVERSITY
1322 SE Morrison Street
Portland, Oregon 97214-2423

August 25, 2004

Justin R. Walker
Keller Associates, Inc.
131 SW 5th Avenue, Suite A
Meridian, ID 83642

Dear Mr. Walker:

Thank you for requesting information from the Oregon Natural Heritage Information Center (ORNHIC). We have conducted a data system search for rare, threatened and endangered plant and animal records for your Stayton Water Management and Conservation Plan Project in Township 9 South, Range 1 West, Sections 11 and 13, W.M.

Twenty-five (25) records were noted within a two-mile radius of your project and are included on the enclosed computer printout. A key to the fields is also included.

Please remember that the lack of rare element information from a given area does not mean that there are no significant elements there, only that there is no information known to us from the site. To assure that there are no important elements present, you should inventory the site, at the appropriate season.

This data is confidential and for the specific purposes of your project and is **not to be distributed.**

If you need additional information or have any questions, please do not hesitate to contact me.

Sincerely,

Cliff Alton
Conservation Information Assistant

encl.: invoice (H-082404-CWA4)
computer printout and data key

Oregon Natural Heritage Information Center

Institute for Natural Resources

Oregon State University
1322 SE Morrison Street
Portland, Oregon 97214-2423

Invoice Number: H-082404-CWA4
Index: RNR105

INVOICE

TO: Keller Associates, Inc.
131 SW 5th Avenue, Suite A
Meridian, ID 83642

ATTN: Accounts Payable

DATE: August 25, 2004

RE: Data system search for rare, threatened and endangered plants and animals in the vicinity of Township 9 South, Range 1 West, Sections 11 and 13, W.M. Requested by Justin R. Walker for the Stayton Water Management and Conservation Plan Project.

For services and products:		
Computer records (25 @ $0.50/record)		$ 12.50
Computer fee (flat rate)		$ 20.00
Staff time (0.75 hours @ $50.00/hour)		$ 37.50
	TOTAL DUE:	**$ 70.00**

Please make checks payable to: **Oregon Natural Heritage Information Center**

Please include invoice number at top of page with payment.

Terms: **Net 30**

Scientific Name: ***Rana aurora aurora***
Common Name: **Northern red-legged frog**
Federal Status: SOC GRANK: G4T4 NHP List: 4 Category: Vertebrate Animal
State Status: SV/SU SRANK: S3S4 HP Track: N ELCODE: AAABH01021
EO ID: 19241 First Obs: 1996-04-07 Last Obs: 1996-04-07 Confirmed:
Directions: GEREN ISLAND (STAYTON ISLAND). POND EXCAVATED IN 1979 TO OBSERVE GROUND WATER LEVELS. EAST OF SLOW SAND FILTERS IN AREA TO BE EXCAVATED FOR MORE SAND FILTERS. ALSO SMALL FORESTED WETLAND JUST EAST OF THE SLOW SAND FILTER COMPLEX.

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Marion	WV	Polygon [Areal - Delimited (8 m)]

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
009S001W	13		44122-G7	Stayton	1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type	Owner Comments	Managed Area Name
CITY; COUNTY	CITY OF SALEM, MARION COUNTY	

EO Type: Minimum Elev.(m): 143 Annual Observations
EO Data: 1996: POND - 2 EGG MASSES HATCHING WITH SEVERAL ADULTS. FORESTED WETLAND SITE - 1 ADULT ONLY, NO EGGS.
EO Comments: ARTIFICIAL POND AND SMALL FORESTED WETLAND. ROUGH SKINNED NEWT, NORTHWESTERN SALAMANDER EGGS AND GARTER SNAKE IN POND.
Protection:
Management: LOTS OF BULLFROGS AT POND AND WETLAND.
General: OBSERVER: PRISCILLA STANFORD

Scientific Name: ***Rana pretiosa***
Common Name: **Oregon spotted frog**
Federal Status: C GRANK: G2 NHP List: 1 Category: Vertebrate Animal
State Status: SC SRANK: S2 HP Track: Y ELCODE: AAABH01180
EO ID: 5019 First Obs: 1937-10-13 Last Obs: 1937-10-13 Confirmed:
Directions: AUMSVILLE, ALONG MILL CREEK

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Marion	WV	Point [Areal - Estimated (8050 m)]

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
008S002W	36		44122-G7	Stayton	1709000506 - NORTH SANTIAM RIVER, LOWER 1709000701 - MILL CREEK 1709000907 - SILVER CREEK

Owner Name/Type	Owner Comments	Managed Area Name

EO Type: Minimum Elev.(m): 107 Annual Observations
EO Data: 1937: ONE ADULT FEMALE COLLECTED
EO Comments: LOW, EMERGENT MARSH
Protection:
Management:
General: COLLECTOR: H.S. FITCH MVZ#25288

Scientific Name: ***Haliaeetus leucocephalus***
Common Name: **Bald eagle**
Federal Status: LT GRANK: G4 NHP List: 4 Category: Vertebrate Animal
State Status: LT SRANK: S4B,S4N HP Track: Y ELCODE: ABNKC10010
EO ID: 26095 First Obs: 2003 Last Obs: 2003 Confirmed:
Directions: S. of Stayton, along the North Santiam River.

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Marion	WV	Point [Areal - Estimated (50 m)]

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
009S001W	16		44122-G7	Stayton	1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type	Owner Comments	Managed Area Name

EO Type: Minimum Elev.(m): Annual Observations
EO Data: See annual observations. * 2003 - 1 downy nestling

EO Comments:
Protection:
Management:
General: Isaacs and Anthony nest 1128.

Scientific Name: ***Eremophila alpestris strigata***
Common Name: **Streaked horned lark**

Federal Status: C	GRANK: G5T2	NHP List: 1	Category: Vertebrate Animal
State Status: SC	SRANK: S2B	HP Track: Y	ELCODE: ABPAT0201L
EO ID: 1181	First Obs: 1999-05-19	Last Obs: 1999-05-19	Confirmed:

Directions: APPROX. 1.5 MI SE OF KINGSTON.

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Linn	WV	Point [Areal - Estimated (200 m)]

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
009S001W	26		44122-G7	Stayton	1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type	Owner Comments	Managed Area Name
PRIVATE		

EO Type: Minimum Elev.(m): 183 Annual Observations
EO Data: 1999: 1 BIRD OBSERVED.
EO Comments:
Protection:
Management:
General:

Scientific Name: ***Progne subis***
Common Name: **Purple martin**

Federal Status: SOC	GRANK: G5	NHP List: 2	Category: Vertebrate Animal
State Status: SC	SRANK: S2B	HP Track: Y	ELCODE: ABPAU01010
EO ID: 20254	First Obs: 1998-07-23	Last Obs: 1998-07-23	Confirmed:

Directions: FROM STAYTON TAKE KINGSTON-JORDAN RD. CROSS THE RIVER AND RAILROAD TRACKS. TURN LEFT ON KINGSTON-LYONS RD, AND GO 1.5 MI. TURN LEFT AT THE SIGN "BIRDHAVEN", GO UP THE GREAVEL LANE. THE NESTBOXES ARE NEAR THE GARDENS AND DOWN BELOW THE HOUSE IN THE MOWN F

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Linn	WV	Point [Areal - Estimated (50 m)]

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
009S001E	18		44122-G6	Stout Mountain	1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type	Owner Comments	Managed Area Name
PRIVATE	FARM	

EO Type: Minimum Elev.(m): 226 Annual Observations
EO Data: 1998: 15 PAIRS NESTING IN BOXES.
EO Comments:
Protection:
Management:
General:

Scientific Name: ***Pooecetes gramineus affinis***
Common Name: **Oregon vesper sparrow**

Federal Status: SOC	GRANK: G5T3	NHP List: 2	Category: Vertebrate Animal
State Status: SC	SRANK: S2B,S2N	HP Track: Y	ELCODE: ABPBX95011
EO ID: 13494	First Obs: 1999-05-26	Last Obs: 1999-05-26	Confirmed:

Directions: SW of Wisner Cemetery.

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Linn	WV	Point [Areal - Estimated (50 m)]

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
009S001W	26		44122-G7	Stayton	1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type	Owner Comments	Managed Area Name
PRIVATE		

EO Type: Minimum Elev.(m): 168 Annual Observations
EO Data: 1999: 1 bird observed.

EO Comments:
Protection:
Management:
General:

Scientific Name: ***Pooecetes gramineus affinis***
Common Name: **Oregon vesper sparrow**
Federal Status: SOC GRANK: G5T3 NHP List: 2 Category: Vertebrate Animal
State Status: SC SRANK: S2B,S2N HP Track: Y ELCODE: ABPBX95011
EO ID: 26250 First Obs: 1999-07-02 Last Obs: 1999-07-02 Confirmed:
Directions: Approx. 1mi SE of Kingston.

County Name: Linn
Ecoregion: WV
Source Feature [Uncertainty Type (Distance)]: Point [Areal - Estimated (50 m)]

Town-Range	Sec	Note	QuadCode	QuadName
009S001W	24		44122-G7	Stayton

Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type: Private
Owner Comments
Managed Area Name

EO Type: Minimum Elev.(m): 198 Annual Observations
EO Data: 1999: 1 male singing.
EO Comments:
Protection:
Management:
General:

Scientific Name: ***Ammodramus savannarum***
Common Name: **Grasshopper sparrow**
Federal Status: GRANK: G5 NHP List: 2 Category: Vertebrate Animal
State Status: SV/SP SRANK: S2B HP Track: Y ELCODE: ABPBXA0020
EO ID: 12542 First Obs: 1999-06-09 Last Obs: 1999-06-23 Confirmed:
Directions: APPROX. 1 MI SE OF STAYTON ISLAND.

County Name: Linn
Ecoregion: WV
Source Feature [Uncertainty Type (Distance)]: Point [Areal - Estimated (50 m)]

Town-Range	Sec	Note	QuadCode	QuadName
009S001W	24		44122-G6	Stout Mountain

Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type: PRIVATE
Owner Comments
Managed Area Name

EO Type: Minimum Elev.(m): 213 Annual Observations
EO Data: 1999: 1 MALE SINGING.
EO Comments:
Protection:
Management:
General:

Scientific Name: ***Oncorhynchus tshawytscha pop. 23***
Common Name: **Chinook salmon (Upper Willamette River ESU, spring run)**
Federal Status: LT GRANK: G5T2Q NHP List: 1 Category: Vertebrate Animal
State Status: SRANK: S2 HP Track: Y ELCODE: AFCHA02052
EO ID: 94 First Obs: Last Obs: 1999-PRE Confirmed:
Directions: MILL CREEK & TRIBUTARIES

County Name: Marion
Ecoregion:
Source Feature [Uncertainty Type (Distance)]: Data currently not available.

Town-Range	Sec	Note	QuadCode	QuadName
			44122-G7	Stayton
			44122-G8	Turner
			44122-H8	Salem East
			44123-H1	Salem West

Watershed: 17090007 - Middle Willamette

Owner Name/Type
Owner Comments
Managed Area Name

EO Type: REARING & MIGRATION - fish Minimum Elev.(m): Annual Observations
EO Data: SPRING RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFWS DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF CHINOOK IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus tshawytscha pop. 23***
Common Name: **Chinook salmon (Upper Willamette River ESU, spring run)**
Federal Status: LT GRANK: G5T2Q NHP List: 1 Category: Vertebrate Animal
State Status: SRANK: S2 HP Track: Y ELCODE: AFCHA02052
EO ID: 5008 First Obs: Last Obs: 1999-PRE Confirmed:
Directions: VALENTINE CREEK

County Name: Marion
Ecoregion:
Source Feature [Uncertainty Type (Distance)]: Data currently not available.

Town-Range Sec Note
QuadCode QuadName: 44122-G6 Stout Mountain
Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type
Owner Comments
Managed Area Name

EO Type: REARING & MIGRATION - fish Minimum Elev.(m): Annual Observations
EO Data: SPRING RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFWS DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF CHINOOK IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus tshawytscha pop. 23***
Common Name: **Chinook salmon (Upper Willamette River ESU, spring run)**
Federal Status: LT GRANK: G5T2Q NHP List: 1 Category: Vertebrate Animal
State Status: SRANK: S2 HP Track: Y ELCODE: AFCHA02052
EO ID: 18370 First Obs: Last Obs: 1999-PRE Confirmed:
Directions: SANTIAM RIVER & TRIBUTARIES

County Name: Linn, Marion
Ecoregion:
Source Feature [Uncertainty Type (Distance)]: Data currently not available.

Town-Range Sec Note
Watershed: 17090005 - North Santiam

QuadCode	QuadName
44122-F3	Lawhead Creek
44122-F4	Mill City South
44122-F8	Crabtree
44122-G3	Elkhorn
44122-G4	Mill City North
44122-G5	Lyons
44122-G6	Stout Mountain
44122-G7	Stayton
44122-G8	Turner
44123-F1	Albany

Owner Name/Type
Owner Comments
Managed Area Name

EO Type: SPAWNING & REARING - fish Minimum Elev.(m): Annual Observations
EO Data: SPRING RUN. ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE. ODFW SALMONID DISTRIBUTION DOCUMENTATION 1998: NORTH SANTIAM RIVER, LITTLE NORTH SANTIAM RIVER. 1997: NORTH SANTIAM RIVER. 1952: NORTH SANTIAM RIVER.
EO Comments:
Protection:
Management:
General: DOCUMENTATION INFORMATION USED IN THIS EOR WAS DERIVED FROM THE ODFW SALMONID DISTRIBUTION DOCUMENTATION DIGITAL DATABASE DISTRIBUTED IN 2001. DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFWS DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF CHINOOK IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus mykiss pop. 33***
Common Name: **Steelhead (Upper Willamette River ESU, winter run)**

Federal Status: LT	GRANK: G5T2Q	NHP List: 1	Category: Vertebrate Animal
State Status: SC	SRANK: S2	HP Track: Y	ELCODE: AFCHA02138
EO ID: 1134	First Obs:	Last Obs: 1999-PRE	Confirmed:

Directions: NORTH SANTIAM RIVER & TRIBUTARIES

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Linn		Data currently not available.
Marion		

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
			44122-F3	Lawhead Creek	17090005 - North Santiam
			44122-F4	Mill City South	
			44122-F8	Crabtree	
			44122-G2	Battle Ax	
			44122-G3	Elkhorn	
			44122-G4	Mill City North	
			44122-G5	Lyons	
			44122-G6	Stout Mountain	
			44122-G7	Stayton	
			44122-G8	Turner	
			44123-F1	Albany	

Owner Name/Type	Owner Comments	Managed Area Name

EO Type: SPAWNING & REARING - fish Minimum Elev.(m): Annual Observations
EO Data: WINTER RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFWS DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF STEELHEAD IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus mykiss pop. 33***
Common Name: **Steelhead (Upper Willamette River ESU, winter run)**

Federal Status: LT	GRANK: G5T2Q	NHP List: 1	Category: Vertebrate Animal
State Status: SC	SRANK: S2	HP Track: Y	ELCODE: AFCHA02138
EO ID: 4118	First Obs:	Last Obs: 1999-PRE	Confirmed:

Directions: ALDER CREEK

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Marion		Data currently not available.

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
			44122-G6	Stout Mountain	1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type | Owner Comments | Managed Area Name

EO Type: MIGRATION - fish | Minimum Elev.(m): | Annual Observations
EO Data: WINTER RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFWS DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF STEELHEAD IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus mykiss pop. 33***
Common Name: **Steelhead (Upper Willamette River ESU, winter run)**
Federal Status: LT | GRANK: G5T2Q | NHP List: 1 | Category: Vertebrate Animal
State Status: SC | SRANK: S2 | HP Track: Y | ELCODE: AFCHA02138
EO ID: 9461 | First Obs: | Last Obs: 1999-PRE | Confirmed:
Directions: ALDER CREEK

County Name | Ecoregion | Source Feature [Uncertainty Type (Distance)]
Marion | | Data currently not available.

Town-Range Sec Note | QuadCode QuadName | Watershed
| 44122-G6 Stout Mountain | 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type | Owner Comments | Managed Area Name

EO Type: REARING & MIGRATION - fish | Minimum Elev.(m): | Annual Observations
EO Data: WINTER RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFWS DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF STEELHEAD IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus mykiss pop. 33***
Common Name: **Steelhead (Upper Willamette River ESU, winter run)**
Federal Status: LT | GRANK: G5T2Q | NHP List: 1 | Category: Vertebrate Animal
State Status: SC | SRANK: S2 | HP Track: Y | ELCODE: AFCHA02138
EO ID: 16605 | First Obs: | Last Obs: 1999-PRE | Confirmed:
Directions: VALENTINE CREEK

County Name | Ecoregion | Source Feature [Uncertainty Type (Distance)]
Marion | | Data currently not available.

Town-Range Sec Note | QuadCode QuadName | Watershed
| 44122-G6 Stout Mountain | 1709000506 - NORTH SANTIAM RIVER, LOWER
| 44122-G7 Stayton |

Owner Name/Type | Owner Comments | Managed Area Name

EO Type: REARING & MIGRATION - fish | Minimum Elev.(m): | Annual Observations
EO Data: WINTER RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:

General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFWS DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF STEELHEAD IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus mykiss pop. 33***
Common Name: **Steelhead (Upper Willamette River ESU, winter run)**

Federal Status: LT | GRANK: G5T2Q | NHP List: 1 | Category: Vertebrate Animal
State Status: SC | SRANK: S2 | HP Track: Y | ELCODE: AFCHA02138
EO ID: 19279 | First Obs: | Last Obs: 1999-PRE | Confirmed:

Directions: MILL CREEK & TRIBUTARIES

County Name: Marion
Ecoregion:
Source Feature [Uncertainty Type (Distance)]: Data currently not available.

Town-Range Sec Note:

QuadCode	QuadName
44122-G7	Stayton
44122-G8	Turner
44122-H8	Salem East
44123-H1	Salem West

Watershed: 17090007 - Middle Willamette

Owner Name/Type:
Owner Comments:
Managed Area Name:

EO Type: SPAWNING & REARING - fish
Minimum Elev.(m):
Annual Observations:

EO Data: WINTER RUN; ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFWS DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF STEELHEAD IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oregonichthys crameri***
Common Name: **Oregon chub**

Federal Status: LE | GRANK: G2 | NHP List: 1 | Category: Vertebrate Animal
State Status: SC | SRANK: S2 | HP Track: Y | ELCODE: AFCJB56010
EO ID: 18585 | First Obs: 1996-05-20 | Last Obs: 2003-07-31 | Confirmed:

Directions: Sensitive Data - contact ORNHIC for more information

County Name: Marion
Ecoregion: WV
Source Feature [Uncertainty Type (Distance)]:
Point [Areal - Estimated (100 m)]
Point [Areal - Estimated (100 m)]
Polygon [Negligible (8 m)]

Town-Range	Sec	Note
009S001W	15	
009S001W	10	
009S001W	11	
009S001W	13	

QuadCode	QuadName
44122-G6	Stout Mountain
44122-G7	Stayton

Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type: CITY
Owner Comments: CITY OF SALEM OWNS MOST OF THE ISLAND ALTHOUGH A FEW PRIVATE INHOLDINGS EXIST.
Managed Area Name:

EO Type: YEAR-ROUND - fish
Minimum Elev.(m):
EO Data: See annual observations.

Annual Observations
- 2003 - 1845 chub captured/estimated
- 2002 - 747 chub captured/estimated
- 2001 - 782 chub captured/estimated
- 2000 - 359 chub captured/estimated
- 1999 - 894 chub captured/estimated
- 1998 - 1836 chub captured/estimated
- 1997 - 9737 chub captured/estimated
- 1996 - 12792 chub captured/estimated

EO Comments: Red-legged frog adults and eggs observed at site. Also tadpole, juvenile and adult bullfrogs and largemouth bass found.
Protection:
Management:
General: GEREN ISLAND IS THE SITE OF SALEM'S WATER SUPPLY AND FILTRATION PLANT. CHUBS WERE COLLECTED FROM A NUMBER OF SITES WITHIN A NETWORK OF CANALS, SLOUGHS AND PONDS CONNECTED WITH THE WATER TREATMENT PLANT. THE CITY HAS REQUESTED AN EXPANSION OF THE PLANT AND THE PROJECT IS CURRENTLY GOING THROUGH A BIOLOGICAL ASSESSMENT TO DETERMINE POTENTIAL IMPACTS TO CHUBS AND WETLANDS. PRELIMINARY DISCUSSIONS INDICATE THAT AN EASEMENT WILL BE GRANTED AND A RESERVE SET UP FOR THE LARGEST POND ON THE ISLAND (NORTH POND). Scheerer site #441, 442, 443, 444, 446, 447, 449, 574 and 612.

Scientific Name: ***Emys marmorata marmorata***
Common Name: **Northwestern pond turtle**
Federal Status: SOC | GRANK: G3G4T3T4 | NHP List: 2 | Category: Vertebrate Animal
State Status: SC | SRANK: S2 | HP Track: Y | ELCODE: ARAAD02031
EO ID: 2418 | First Obs: 1997-06-09 | Last Obs: 1999 | Confirmed:
Directions: PIONEER PARK SLOUGH; OFF OF THE NORTH SANTIAM RIVER SOUTH OF STAYTON, NEAR THE STAYTON PARK TRAIL.

County Name: Marion
Ecoregion: WV
Source Feature [Uncertainty Type (Distance)]: Polygon [Negligible (8 m)]

Town-Range	Sec	Note
009S001W	11	
009S001W	10	

QuadCode: 44122-G7 QuadName: Stayton
Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type
Owner Comments
Managed Area Name

EO Type:
Minimum Elev.(m): 140
Annual Observations
EO Data: 1999: 6 adults observed basking. 1997: 1 turtle.
EO Comments:
Protection:
Management:
General: REPORTED BY PAUL SCHEERER, ODFW.

Scientific Name: ***Emys marmorata marmorata***
Common Name: **Northwestern pond turtle**
Federal Status: SOC | GRANK: G3G4T3T4 | NHP List: 2 | Category: Vertebrate Animal
State Status: SC | SRANK: S2 | HP Track: Y | ELCODE: ARAAD02031
EO ID: 25544 | First Obs: | Last Obs: 1999 | Confirmed:
Directions: Valentine Cr. @ 16253 Old Mehama Road SE; E. of Stayton

County Name: Marion
Ecoregion: WV
Source Feature [Uncertainty Type (Distance)]: Point [Areal - Estimated (50 m)]

Town-Range	Sec	Note
009S001E	08	

QuadCode: 44122-G6 QuadName: Stout Mountain
Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type
Owner Comments
Managed Area Name

EO Type:
Minimum Elev.(m): 162
Annual Observations
EO Data: 1999: exact date not specified, 1 adult turtle observed basking.
EO Comments:
Protection:
Management:
General:

Scientific Name: ***Lomatium bradshawii***
Common Name: **Bradshaw's lomatium**
Federal Status: LE | GRANK: G2 | NHP List: 1 | Category: Vascular Plant
State Status: LE | SRANK: S2 | HP Track: Y | ELCODE: PDAPI1B030
EO ID: 22909 | First Obs: 1988 | Last Obs: 1988-07-26 | Confirmed:
Directions: BETWEEN KINGSTON & LYONS. TAKE KINGSTON-LYONS RD. TOWARDS LYONS, FOR 1.6 MI. TO SHARP RIGHT TURN. SIGHT IS STRAIGHT AHEAD. PLANTS ARE IN SEASONAL CREEK BED.

County Name: Linn
Ecoregion: WV
Source Feature [Uncertainty Type (Distance)]: Polygon [Areal - Delimited (8 m)]

Town-Range Sec Note: 009S001E 19
QuadCode QuadName: 44122-G6 Stout Mountain
Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type: PRIVATE
Owner Comments:
Managed Area Name: KINGSTON PRAIRIE PRESERVE

EO Type:
Minimum Elev.(m): 229
Annual Observations: * 1988 - 1000
EO Data: ABOUT 1000 PLANTS CONCENTRATED IN A 3-4 ACRE PATCH ALONG THE SEASONAL CREEK DRAINAGE. POPULATION FRUITING & FLOWERING WELL, IN SPITE OF VERY LIMITED HABITAT.
EO Comments: SHALLOW SOILED, BASALT CREEK BED & VERNAL POOLS. DOMINATED BY MIMGUT, DESCAE, ALOGEN, CAREX, JUNCUS & ELEOCHARIS, ALLIUM SP., POASCR & DANCAL. SURROUNDED BY FESRUB PRAIRIE.
Protection: NEEDS TNC PROTECTION ASAP!
Management:
General: GRAZING IS AN IMMEDIATE THREAT, AS IS FARMING. AREA WILL BE DEVELOPED SHORTLY (RECENTLY SUBDIVIDED)

Scientific Name: ***Erigeron decumbens var. decumbens***
Common Name: **Willamette Valley daisy**
Federal Status: LE | GRANK: G4T1 | NHP List: 1 | Category: Vascular Plant
State Status: LE | SRANK: S1 | HP Track: Y | ELCODE: PDAST3M133
EO ID: 11171 | First Obs: 1988 | Last Obs: 1988-07-26 | Confirmed:
Directions: BETWEEN KINGSTON & LYONS. TAKE KINGSTON-LYONS ROAD TOWARDS LYONS FOR 1.6 MILES TO SHARP RIGHT HAND TURN. SITE IS STRAIGHT AHEAD: PLANTS ARE ALSO ON E SIDE OF RD, 0.1 MI. FURTHER.

County Name: Linn
Ecoregion: WV
Source Feature [Uncertainty Type (Distance)]: Polygon [Areal - Delimited (8 m)]; Polygon [Areal - Delimited (8 m)]; Polygon [Areal - Delimited (8 m)]

Town-Range Sec Note: 009S001E 19; 009S001E 24
QuadCode QuadName: 44122-G6 Stout Mountain
Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type: PRIVATE
Owner Comments:
Managed Area Name: KINGSTON PRAIRIE PRESERVE

EO Type:
Minimum Elev.(m): 229
Annual Observations: * 1988 - 200 PLANTS
EO Data: ABOUT 200 PLANTS, 150 ON E. SIDE OF ROAD AND 50 ON W. SIDE OF RD. (AT THE SOUTH END OF SITE). PLANTS SCATTERED IN DRIER AREAS OF SITE. LARGE & ROBUST.
EO Comments: RED FESCUE PRAIRIE DOMINATED BY FESRUB, AGREXA, AGRTEN & PANCAL WITH AGRDAS, FESIDA, FESARU, ANTODA AND MANY NATIVE FORBS. ALLUVIAL SILTY SOIL, SHALLOW IN SPOTS.
Protection: NEEDS TNC ACQUISITION TO PREVENT DEVELOPMENT.
Management:
General: ALVERSON COLLECTION, OSC. 1988.

Scientific Name: ***Aster curtus***
Common Name: **White-topped aster**
Federal Status: SOC | GRANK: G3 | NHP List: 1 | Category: Vascular Plant
State Status: LT | SRANK: S2 | HP Track: Y | ELCODE: PDASTEF010
EO ID: 7265 | First Obs: 1990 | Last Obs: 1990-07-22 | Confirmed:
Directions: KINGSTON PRAIRIE, ALONG N. FENCELINE OF FRICHTL PROPERTY DUE EAST OF 90 DEGREE CURVE, 4 PATCHES SCATTERED AT EDGE OF PARCEL AND IN THE RIGHT-OF-WAY ACROSS THE FENCE

County Name: Linn
Ecoregion: WV
Source Feature [Uncertainty Type (Distance)]: Point [Areal - Estimated (50 m)]

Town-Range Sec Note: 009S001E 19
QuadCode QuadName: 44122-G6 Stout Mountain
Watershed: 1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type: PRIVATE
Owner Comments: RUBY FRICHTL
Managed Area Name: KINGSTON PRAIRIE PRESERVE

EO Type: Minimum Elev.(m): 229 Annual Observations

EO Data: AN ESTIMATED 75 RAMETS WERE OBSERVED IN 4 DIFFERENT PATCHES; ADDITIONAL COLONIES MAY OCCUR IN THE AREA. IN <1 ACRE

* 1990 - 75 RAMETS

EO Comments: REMNANT OF FESTUCA RUBRA/IDAHOENSIS PRAIRIE, WITH POTENTILLA GRACILIS, SIDALCEA CAMPESTRIS, ASTER HALLII, SOLIDAGO CANADENSIS. FENCE ROW AND R.O.W. MAY HAVE PROVIDED PROTECTION FROM GRAZING.

Protection:

Management: CYTISUS SCOPARIUS IS COLONIZING THE SITE

General:

Scientific Name: ***Lathyrus holochlorus***

Common Name: **Thin-leaved peavine**

Federal Status: SOC	GRANK: G2	NHP List: 1	Category: Vascular Plant
State Status:	SRANK: S2	HP Track: Y	ELCODE: PDFAB250B0
EO ID: 5269	First Obs: 1988-05-15	Last Obs: 1988-05-15	Confirmed:

Directions: WISNER CEMETERY. I MI S OF KINGSTON. POP ACROSS RD FROM CEMETARY.

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Linn	WV	Point [Areal - Estimated (50 m)]

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
009S001W	23		44122-G7	Stayton	1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type	Owner Comments	Managed Area Name

EO Type: Minimum Elev.(m): 177 Annual Observations

EO Data: [NO EODATA GIVEN]

EO Comments: NEKIA SILTY CLAY LOAM (CLASS III).

Protection:

Management:

General: 1990 REPORT FOR LOCATING NATIVE GRASSLAND REMNANTS IN THE MID-WILLAMETTE VALLEY BY EDWARD ALVERSON.

Scientific Name: ***Cimicifuga elata***

Common Name: **Tall bugbane**

Federal Status:	GRANK: G3	NHP List: 1	Category: Vascular Plant
State Status: C	SRANK: S3	HP Track: Y	ELCODE: PDRAN07030
EO ID: 2751	First Obs: 1998-06-30	Last Obs: 1998-06-30	Confirmed:

Directions: S OF BEAR BRANCH.

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Linn	WV	Point [Areal - Estimated (50 m)]

Town-Range	Sec	Note	QuadCode	QuadName	Watershed
009S001W	25		44122-G7	Stayton	1709000506 - NORTH SANTIAM RIVER, LOWER

Owner Name/Type	Owner Comments	Managed Area Name
COUNTY	LINN COUNTY RIGHT OF WAY	

EO Type: Minimum Elev.(m): 244 Annual Observations

EO Data: ONE PLANT; IN BUD.

* 1998 - 1 PLANT

EO Comments: PLANT GROWING IN A BRUSHY R/W AREA ALONG COUNTY RD, KINGSTON JORDAN RD; PSME OVERSTORY; MID SLOPE; FILTERED LIGHT; MOIST; ASSOC SPECIES: PSME, POMU.

Protection:

Management:

General: 1998 BLM PLANT SIGHTING REPORT; TERRY FENNELL REPORTER.

Scientific Name: ***Delphinium oreganum***

Common Name: **Willamette Valley larkspur**

Federal Status: SOC	GRANK: G1Q	NHP List: 1	Category: Vascular Plant
State Status: C	SRANK: S1	HP Track: Y	ELCODE: PDRAN0B220
EO ID: 16633	First Obs: 1989	Last Obs: 2000-06-28	Confirmed:

Directions: KINGSTON PRAIRIE. FROM STAYTON DRIVE S ON FIRST STREET WHICH CROSSES THE N SANTIAM RIVER AND BECOMES STAYTON-SCIO ROAD. ~1/4 MI AFTER CROSSING THE RIVER, TURN LEFT (E) ON KINGSTON-JORDAN DR. GO ~1 MI, JUST PAST A RAILROAD CROSSING, TURN LEFT ON LINGSTON-

County Name	Ecoregion	Source Feature [Uncertainty Type (Distance)]
Linn	WV	Polygon [Areal - Delimited (8 m)]
Town-Range Sec Note	QuadCode QuadName	Watershed
009S001E 19	44122-G6 Stout Mountain	1709000506 - NORTH SANTIAM RIVER, LOWER
Owner Name/Type	Owner Comments	Managed Area Name
PRIVATE	THE NATURE CONSERVANCY, OREGON FIELD OFFICE. THIS TRACT HAS BEEN IN TNC OWNERSHIP SINCE 1996.	KINGSTON PRAIRIE PRESERVE

EO Type: Minimum Elev.(m): 229 Annual Observations

EO Data: ~1280 FLOWERING PLANTS, IN 12 SEPARATE PATCHES OVER AN AREA OF ~20 ACRES.

EO Comments: MODERATE QUALITY UPLAND PRAIRIE THAT ALSO SUPPORTS A GOOD POP OF ERDED. ASSOC WITH: FESTUCA ROEMERI, FESTUCA RUBRA, AGROSTIS CAPILLARIS, FESTUCA ARUNDINACEA, ERIOPHYLLUM LANATUM, SIDALCEA CAMPESTRIS, BRODIAEA HYACINTHINA, ACHILLEA MILLEFOLIUM, ASTER HALLII, PRUNELLA VULGARIS VAR LANCEOLATA.

Protection: POP EXTENDS TO THE N OFF NATURE CONSERVANCY LAND ONTO THE ROW OF A PRIVATE DRIVE.

Management: SCOTS BROOM PATCHES WERE REMOVED IN 1997/1998 WITH ANNUAL FOLLOW-UP SINCE THEN.

General: 2000 PLANT SIGHTING REPORT, ED ALVERSON REPORTER. MAY BE ONE OF THE BEST PROTECTED SITES FOR THIS SPECIES. TENDS TO OCCUR IN AREAS OF DEEPER SOILS. NEED TO SURVEY OTHER TNC TRACTS FOR THIS SPECIES.

25 records total

Key to Oregon Natural Heritage Information Center Data

Field Name	Description
Scientific Name	The scientific name of the species.
Common Name	The common name of the species.
Category	Value that indicates the broad biological category for each species.
ELCODE	Unique Heritage Program code for identifying this element. 1st and 2nd byte (PD=Plant dict, PM=Plant monocot, PG=Plant gymnosperm, PP=Plant pteridophyte, AA=amphibian, AB=bird, AF=fish, AM=mammal, AR=reptile, I=invertebrate. 3rd-5th byte (family abbreviation). 6th-7th (genus code). 8th-9th (species). 10th (tie breaker).
Federal Status	US Fish and Wildlife Service or National Marine Fisheries Service status. **LE**=listed endangered, **LT**=listed threatened, **PE** or **PT**=proposed endangered or threatened, **C**=candidate for listing with enough information available for listing, **SOC**=species of concern, **-PD**=proposed delisting, **-NL**=not listed (in part of the range).
State Status	For animals, Oregon Department of Fish and Wildlife status; **LE**=listed endangered, **PE**=proposed endangered, **PT**=proposed threatened, **SC** or **C**=sensitive-critical, **SV** or **V**=sensitive-vulnerable, **SP** or **P**=sensitive-peripheral, **SU** or **U**=sensitive-undetermined status. For plants, Oregon Department of Agriculture status; **LE**=listed endangered, **LT**=listed threatened, **C**=candidate.
GRANK/SRANK	ORNHIC participates in an international system for ranking rare, threatened and endangered species throughout the world. The system was developed by The Nature Conservancy and is now maintained by NatureServe in cooperation with Heritage Programs or Conservation Data Centers (CDCs) in all 50 states, in 4 Canadian provinces, and in 13 Latin American countries. The ranking is a 1-5 scale, primarily based on the number of known occurrences, but also including threats, sensitivity, area occupied, and other biological factors. In this book, the ranks occupy two lines. The top line is the Global Rank and begins with a "G". If the taxon has a trinomial (a subspecies, variety or recognized race), this is followed by a "T" rank indicator. A "Q" at the end of this line indicates the taxon has taxonomic questions. The second line is the State Rank and begins with the letter "S". The ranks are summarized as follows: **1** = Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences; **2** = Imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction (extirpation), typically with 6-20 occurrences; **3** = Rare, uncommon or threatened, but not immediately imperiled, typically with 21-100 occurrences; **4** = Not rare and apparently secure, but with cause for long-term concern, usually with more than 100 occurrences; **5** = Demonstrably widespread, abundant, and secure; H = Historical Occurrence, formerly part of the native biota with the implied expectation that it may be rediscovered; **X** = Presumed extirpated or extinct; **U** = Unknown rank; **?** = Not yet ranked, or assigned rank is uncertain.
NHP list	All rare species in Oregon are assigned a list number of 1, 2, 3 or 4, where **1**=threatened or endangered throughout range, **2**=threatened or endangered in Oregon but more common elsewhere, **3**=Review List (more information is needed), **4**=Watch List (currently stable). A null value indicates the species is not currently on our rare species list.
HP Track	We currently obtain and computerize locational information for only those elements marked with **Y**(es). Those species marked with **N**(o) or **W**(atch) have incomplete data because we do not actively track them at this time.
EO ID	Unique identifier for the Element Occurrence (EO).
First_obs	First reported sighting date for this occurrence in the form YYYY-MM-DD.
Last_obs	Last reported sighting date, usually in the form YYYY-MM-DD.
Confirmed	Indication of whether taxonomic identification of the Element represented by this occurrence has been confirmed by a reliable individual. **Blank**=unknown, assumed to be correctly identified. **Y**=Yes, confident identification. **?**=identification questions.
Directions	Site name and/or directions to site.
County	County name(s) in which EO is mapped.
Ecoregion	Physiographic Province in which EO is mapped: **CR**=Coast Range, **WV**=Willamette Valley, **KM**=Klamath Mountains, **WC**=West slope and crest of the Cascades, **EC**=East slope of the Cascades, **BM**=Ochoco, Blue and Wallowa Mts., **BR**=Basin and Range, **CB**=Columbia Basin, **SP**=Snake River Plains.

Key to Oregon Natural Heritage Information Center Data

Field Name	Description
Source Feature	A Source Feature is the initial translation of a discrete unit of observation data as a spatial feature. Creation of a Source Feature requires an interpretive process. The likely location and extent of an observation is determined through consideration of the amount and direction of any variability between the recorded and actual locations of the observation data. In most cases, the Source Feature is delineated to encompass locational uncertainty. A Source Feature can be a point, line, or polygon. The type of Source Feature developed depends on both the preceding conceptual feature type and the locational uncertainty associated with the feature.
Uncertainty Type (Distance)	The recorded location of an observation of an Element may vary from its true location due to many factors, including the level of expertise of the data collector, differences in survey techniques and equipment used, and the amount and type of information obtained. This inaccuracy is characterized as locational uncertainty, and is assessed for Source Feature(s) based on the uncertainty associated with the underlying information on the location of the observation. Four categories of locational uncertainty have been identified, as follows: Negligible uncertainty is less than or equal to 6.25 meters in any dimension. Source Features with negligible uncertainty are based on a comprehensive field survey with high quality mapping and a high degree of certainty. Linear uncertainty is greater than 6.25 meters, and varies along an axis (e.g., a path, stream, ridgeline). The true location of an observation with linear uncertainty may be visualized as effectively sliding along a line that delineates the uncertainty. Areal delimited uncertainty is greater than 6.25 meters, and varies in more than one dimension. The true location of an observation can be visualized as floating within an area with a boundary that can be specifically delimited. Boundaries can be defined using roads, bodies of water, etc. Areal estimated uncertainty is greater than 6.25 meters, and varies in more than one dimension. A boundary cannot be specifically delimited based on the observation information, i.e., the actual extent is unknown. The true location of the observation can be visualized as floating within an area for which boundaries cannot be specifically delimited. Source Features with areal estimated uncertainty require that the user specify an estimated uncertainty distance to be used for buffering the feature to incorporate the locational uncertainty.
Town-Range, Sec, and Note	United States rectangular land survey (also known as the Public Land Survey System) legal township, range, and section descriptions that best define the location of the Element Occurrence. Township first (4 bytes), range second (4 bytes). For example: 004S029E = Township 4S, Range 29E. All locations are with reference to the Willamette Meridian. Fractional ranges or townships are indicated in the Note field.
Quadcode	USGS code for the USGS topographic quadrangle map(s) where the record is mapped.
Quadname	Name of the USGS topographic quadrangle map(s) where the record is mapped.
Watershed	Watershed(s), identified according to the U.S. Geological Survey (USGS) Hydrologic Unit Map 10-digit code, within which the Element Occurrence is located.
Owner Name/Type and Comments	Federal, State, Private, etc.
Managed Area Name	BLM District, USFS Forest, Private Preserve
EO Type	For animals, type of occurrence, eg. roost, nest, spawning, etc.
EO Data	Species and population biology - numbers, age, nesting success, vigor, phenology, disease, pollinators, etc.
EO Comments	Habitat information, e.g. aspect, slope, soils, associated species, community type, etc.
Minimum Elevation	Minimum elevation of the area covered by the range of the taxon, in meters. -339 or blank=not determined.
Annual Observation	Summary of yearly observation.
Protection	Comments on protectibility and threats.
Management	Comments on how the site is managed.
General	Miscellaneous comments.

Appendix B.5

Marion County Standards

FLOODPLAIN/GREENWAY APPLICATIONS

inside 100 yr - floodplain

PURPOSE OF THE FLOODPLAIN OVERLAY ZONE:

(a) Restrict or prohibit uses which are dangerous to health, safety and property due to water or erosion hazards or which result in damaging increases in erosion or in flood heights or velocities.

(b) Minimize expenditure of public money for flood control projects and rescue and relief efforts in areas subject to flooding.

(c) Minimize flood damage to new construction by elevating or flood proofing all structures.

(d) Control the alteration of natural floodplains, stream channels, and natural protective barriers which hold, accommodate, or channel flood waters.

(e) Control filling, grading, dredging, and other development which may be subject to, or increase, flood damage.

(f) Prevent or regulate the construction of flood barriers which may increase flood hazards in other areas.

(g) Comply with the requirements of the Federal Insurance Administration to qualify Marion County for participation in the National Flood Insurance Program.

(h) Minimize flood insurance premiums paid by the citizens of Marion County by reducing potential hazards due to flood damage.

(i) Implement the floodplain/greenway policies in the Marion County Comprehensive Plan.

GENERAL PROVISIONS: The following regulations apply to all lands in identified floodplains as shown graphically on the zoning maps. The floodplain is the area of special flood hazard identified by the Federal Insurance Administration in a scientific and engineering report entitled "The Flood Insurance Study for Marion County, Oregon, Unincorporated Areas", dated August 15, 1979, with accompanying Flood Insurance Rate Maps and amendments taking effect as of August 19, 1987. When base flood elevation data has not been provided, the Planning Division shall have the authority to determine the location of the boundaries of the floodplain where there appears to be a conflict between a mapped boundary and the actual field conditions, provided a record is maintained of any such determination.

(a) Duties of the Planning Division shall include, but not be limited to:

(1) Review all development permits to determine that the permit requirements of the Floodplain/Greenway Ordinances have been satisfied.

(2) Review all development permits to determine that all necessary permits have been obtained from those Federal, State, or local governmental agencies from which prior approval is required.

(3) Review development permits to determine if the proposed development is located in the floodway. If located in the floodway, assure that the encroachment provisions of Section 178.060 (j) are met.

In order to determine whether or not a particular Floodplain/Greenway Permit will be approved, the Planning Division will require evidence from the applicant which addresses the criteria for development in the Floodplain/Greenway. This information should be included in the "Applicant's Statement". <u>Failure to address the criteria may result in denial of your request or a delay in processing.</u> A copy of the entire Floodplain or Greenway Ordinance is available from the Planning Division.

<u>PROCEDURE:</u>

A. Once a complete application is received, the Planning Division will request comments from other County departments and affected agencies and special districts.

B. After receiving a response from these entities, the Planning Division will check the application for compliance with: a) the County Comprehensive Plan, b) the County Zoning Ordinance, c) the Oregon Statewide Planning Goals, and d) other applicable ordinances and regulations. The Planning Division will approve or conditionally approve the application if it clearly complies with all land use laws.

C. Notice of the decision, including findings, is sent to the applicant and, if approved, notice is also sent to property owners within the notification area. There is a 12 day appeal period. The appeal process and, if approved, any conditions attached are explained on the Notice of Decision.

<u>APPLICATION REQUIREMENTS:</u> A complete floodplain/greenway application consists of the following:

A. The attached application form filled out completely in ink.

B. Copy of the officially recorded title transfer instrument (deed, warranty deed, or contract) that shows the legal description for the parent parcel. Title reports are not acceptable. Available at the Clerk's Office, 1st floor of the County Courthouse, 100 High St. NE.

C. Plot Plan (see example) on a separate sheet of paper 8 1/2" X 11", drawn in <u>ink</u>, showing the location of the proposed use and its distance from other structures, property lines, roads and other features. The Plot Plan must be reviewed and initiated as approved by a Plans Examiner from the Building Inspection Division.

D. A written statement which explains how the proposal meets each applicable criteria contained in the County's Floodplain and/or Greenway Ordinances, whichever applies. Additional information may be submitted that can assist the Planning Division in determining whether the proposed new use meets the applicable criteria. Such information could include floodproofing and anchoring proposals, certification by a registered professional engineer or architect demonstrating that any proposed encroachments into the floodway will not result in any increase in flood levels during major floods, identification of unusual terrain features, and statements or drawings or photos of the proposed external appearance of the proposed activity as viewed from the river (if within the greenway).

E. Filing fee (make check payable to Marion County).

TO ENSURE YOU HAVE ALL NECESSARY ITEMS USE LIST ABOVE AS CHECK-OFF

NOTE: If all required information is not presented at the time you submit the application, it will be returned. Until a Planner has certified that the application is complete, no file will be set up and no processing will occur. If the application is withdrawn after the application has been certified complete and the file set up or fee deposited, the entire fee cannot be refunded. Partial refunds are at the discretion of the Planning Division based on the amount of staff work undertaken.

MARION COUNTY FLOODPLAIN/GREENWAY DEVELOPMENT APPLICATION

Effective 08/01/02

Applicant: Please check
one or both of the following:

FLOODPLAIN DEVELOPMENT PERMIT ( )
fee: $910.00

GREENWAY DEVELOPMENT PERMIT ( )
fee: $910.00

APPLICATIONS RETURNED BY MAIL WILL NOT BE ACCEPTED

If the Planning Division has questions about this application, who should be contacted?

____
Name

____
Address

____
Daytime phone (8:00 a.m.- 4:30 p.m.)

1. Property owners

____

____

Address and zip code

____

____

2. Contract and/or mortgage holders (if any)

____

Address and zip code

____

3. The owners of record of the subject property do hereby request permission to (describe the request and list each item separately):

____

FOR OFFICE USE ONLY

Section ______ Township______ Range______

Tax lot number(s) ________________________
Zone ________________________

Zone map number________________________
Name of watercourse and river mile location:

____

Type of case ________________________
urban or rural

Application elements submitted:

__(a) Title transfer instrument
__(b) Plot plan
__(c) Applicant's statement
__(d) Filing fee
__(e) GeoHazard Peer Review (if applicable)

____
Date app. determined complete

____
Application accepted by

4. Location of the property (street address, or if not addressed, state the nearest intersecting street or known landmark. Also, please give the name of the river mile location of the proposed floodplain and/or greenway development).

____

____

5. If the proposed use or development is within the floodplain as identified on the official zoning maps of Marion County, please fill in the following:

Zone AE: FEMA Base Flood Elevation from FIRM map or stream study ________________

Zone A, AO: Highest land elevation within 5 (five) feet of the development site ________ (USGS mean feet above sea level).

All Zones: The elevation above sea level of: 1) the lowest floor (including basements) of the proposed structure or development, 2) the lowest floor of any existing structures and other developments, and 3) the top of any proposed fill.

(1) ____
proposed use (USGS mean feet above sea level)

(2) ____
existing use(s) elevation

(3) ____
proposed fill or grade elevation and/or elevation of any altered topography

6. THE APPLICANT(S) SHALL CERTIFY THAT:

(a) If the application is granted, the applicant(s) will exercise the rights granted in accordance with the terms and subject to all the conditions and limitations of the approval.

(b) I/We hereby declare under penalties of false swearing (ORS 162.075 and 162.085) that all of the above information and statements and the statements in the plot plan, attachments and exhibits transmitted herewith are true; and the applicants so acknowledge that any permit issued on the basis of this application may be revoked if it is found that any such statements are false.

(c) The applicants have read the entire contents of the application, including the policies and criteria, and understand the requirements for approving or denying the application.

(d) I/We hereby grant permission for and consent to Marion County, its officers, agents, and employees coming upon the above-described property to gather information and inspect the property whenever it is reasonably necessary for the purpose of processing this application.

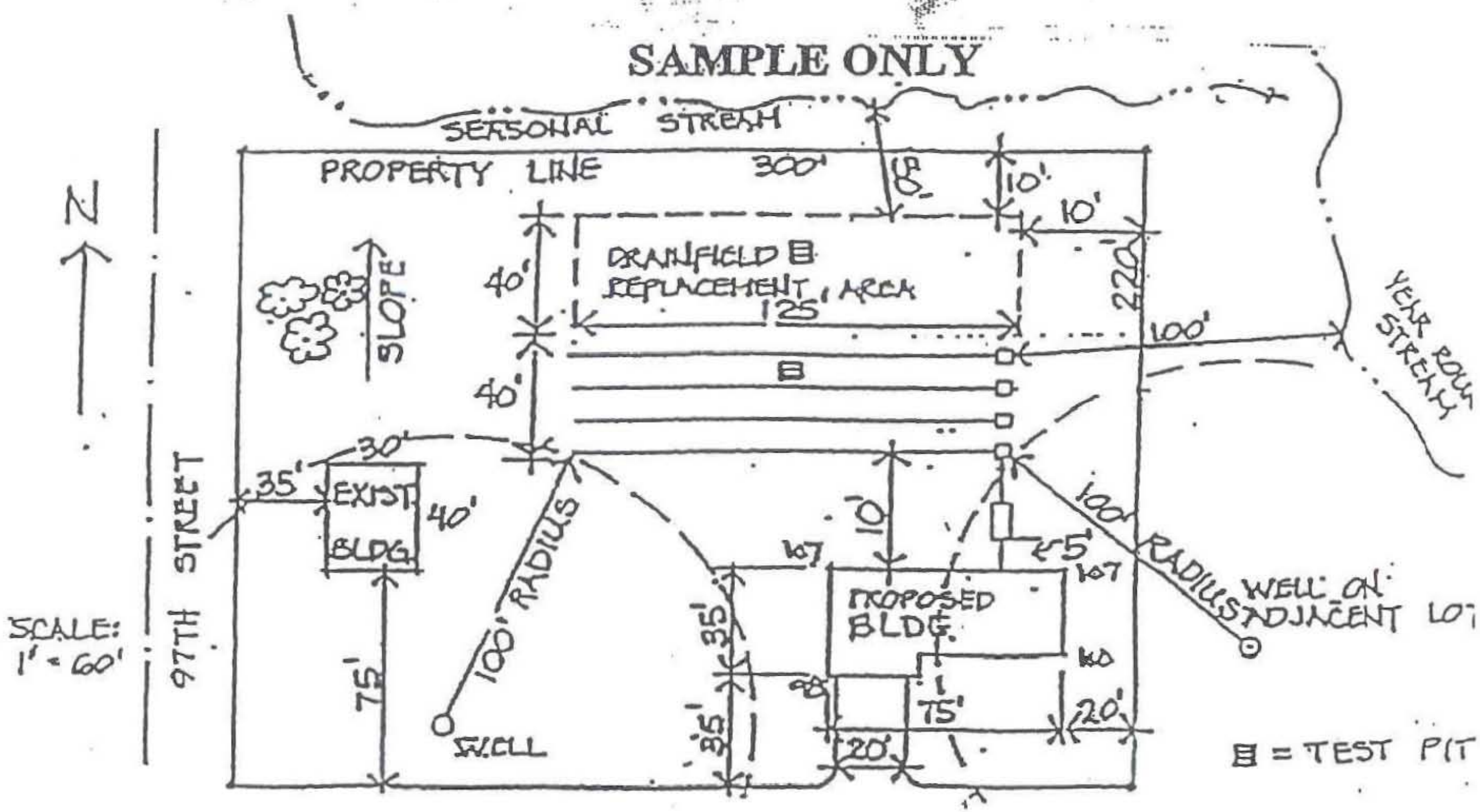
DATED this ________ day of ________________________ 20________

SIGNATURES of each owner of the subject property:

________________________________ ________________________________

________________________________ ________________________________

SAMPLE ONLY


SEASONAL STREAM
PROPERTY LINE
300'
10'
10'
220'
100'
YEAR ROUND STREAM
N
SLOPE
DRAINFIELD
REPLACEMENT AREA
125'
40'
40'
30'
35'
EXIST BLDG
40'
75'
100' RADIUS
WELL
97TH STREET
SCALE: 1' = 60'
10'
5'
100' RADIUS
WELL ON ADJACENT LOT
PROPOSED BLDG
35'
35'
20'
75'
20'
= TEST PIT

INSTRUCTIONS FOR PREPARING A RESIDENTIAL SITE PLAN

Site plan must be current, drawn to scale on 8 ½ x 11 paper, and show all property lines. If unable to draw to scale, property lines must still be shown noting actual dimensions or total acreage.

Failure to include all of the items listed below may delay the review necessary to obtain a permit

ITEMS THAT MUST BE SHOWN ON YOUR SITE PLAN:

1. **NORTH ARROW.**
2. **SCALE OF DRAWING.**
3. **STREET NAME** accessing the parcel.
4. **ALL PROPERTY LINES AND DIMENSIONS** – existing and proposed.
5. **DRIVEWAYS AND ROADS** – existing and proposed.
6. **EXISTING AND PROPOSED STRUCTURES** - label as *"Proposed"* and *"Existing"*. Include dimensions and distance to all property lines and other structures.
7. **UTILITY LINES AND EASEMENTS.**
8. **GEOGRAPHIC FEATURES** – ground slope and direction of slope, escarpments, streams, ponds, or other drainage ways.
9. **WELLS** – existing and proposed on this parcel and adjacent parcels within 100 feet.
10. **FENCES, RETAINING WALLS** – location of existing and/or proposed.
11. **PARTITIONING** (if applicable) – shown by dotted lines, with parcels labeled as *"Parcel 1", "Parcel 2"*, etc.
12. **SEPTIC SYSTEM and REPLACEMENT AREA** – existing and proposed. Show existing septic tank, drainfield lines and distance from structure(s).
13. **CUTS/FILLS** – show existing and proposed.
14. **ELEVATIONS** – at lot corners or construction area and at corners of building site.

If sanitary sewer service is not available, a septic system must be installed. Include the following additional items on the site plan:

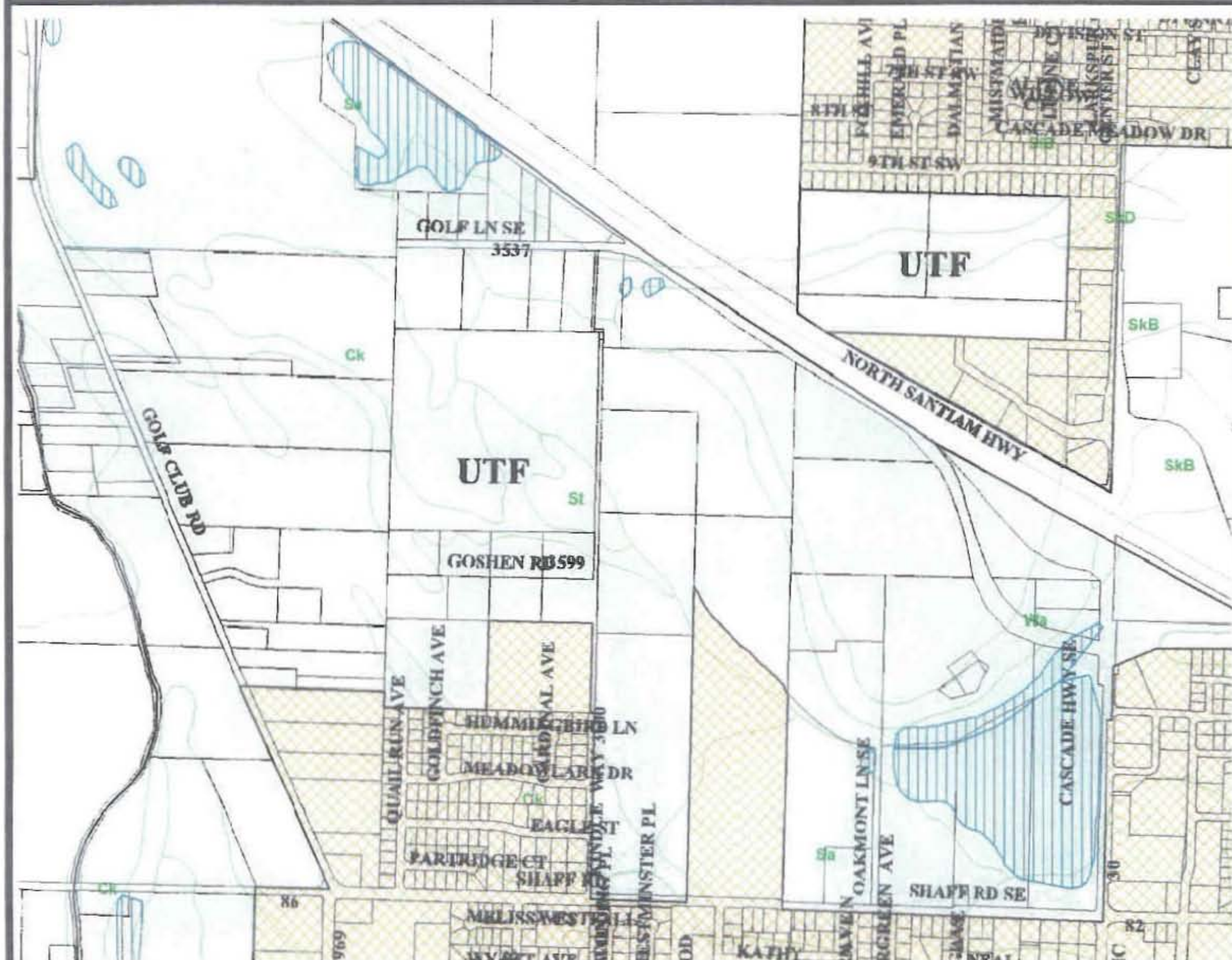
TEST HOLES – show distances between holes and property lines. One test hole should be located in the center of the initial system installation site, the other in the center of the replacement area. Accuracy of location is very important.

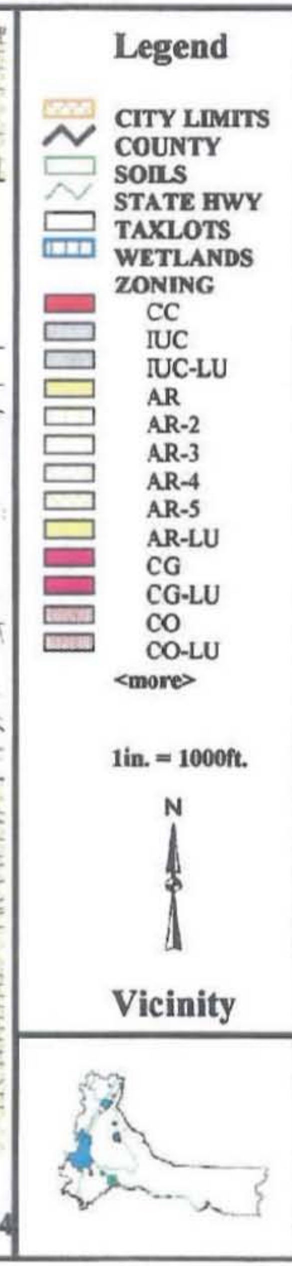
Additional information, such as patio slabs, walkways, roof overhangs, etc., may be required for the issuance of your permit.

USE THE REVERSE SIDE OF THIS FORM TO DRAW YOUR SITE PLAN

Marion County Map

Wetlands and Land Use

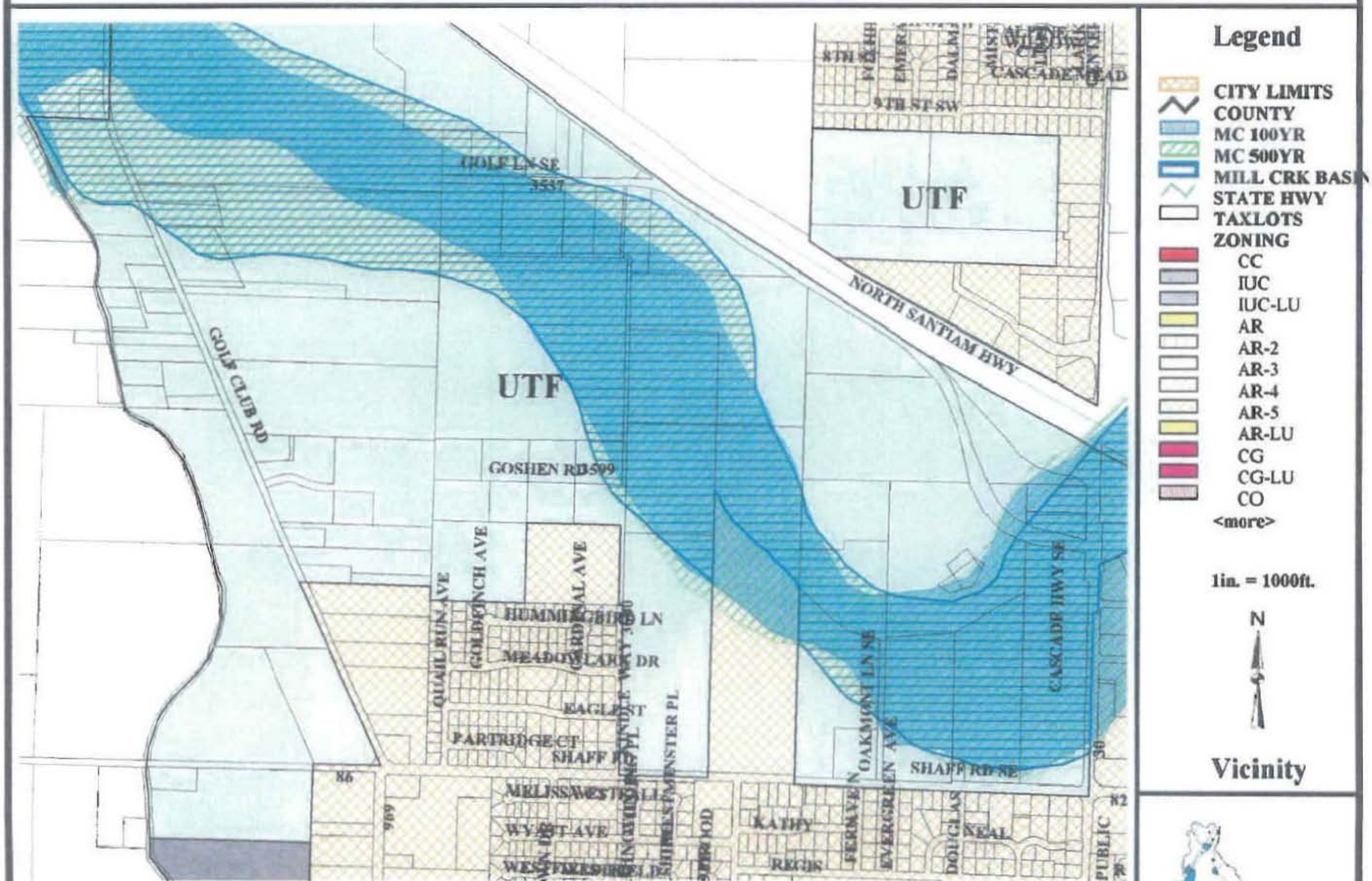




This map was produced using the Marion County GIS data. The GIS data is maintained by the county to support its governmental activities. The County is not reponsible for map errors, ommisions, misuse or misinterpretation.

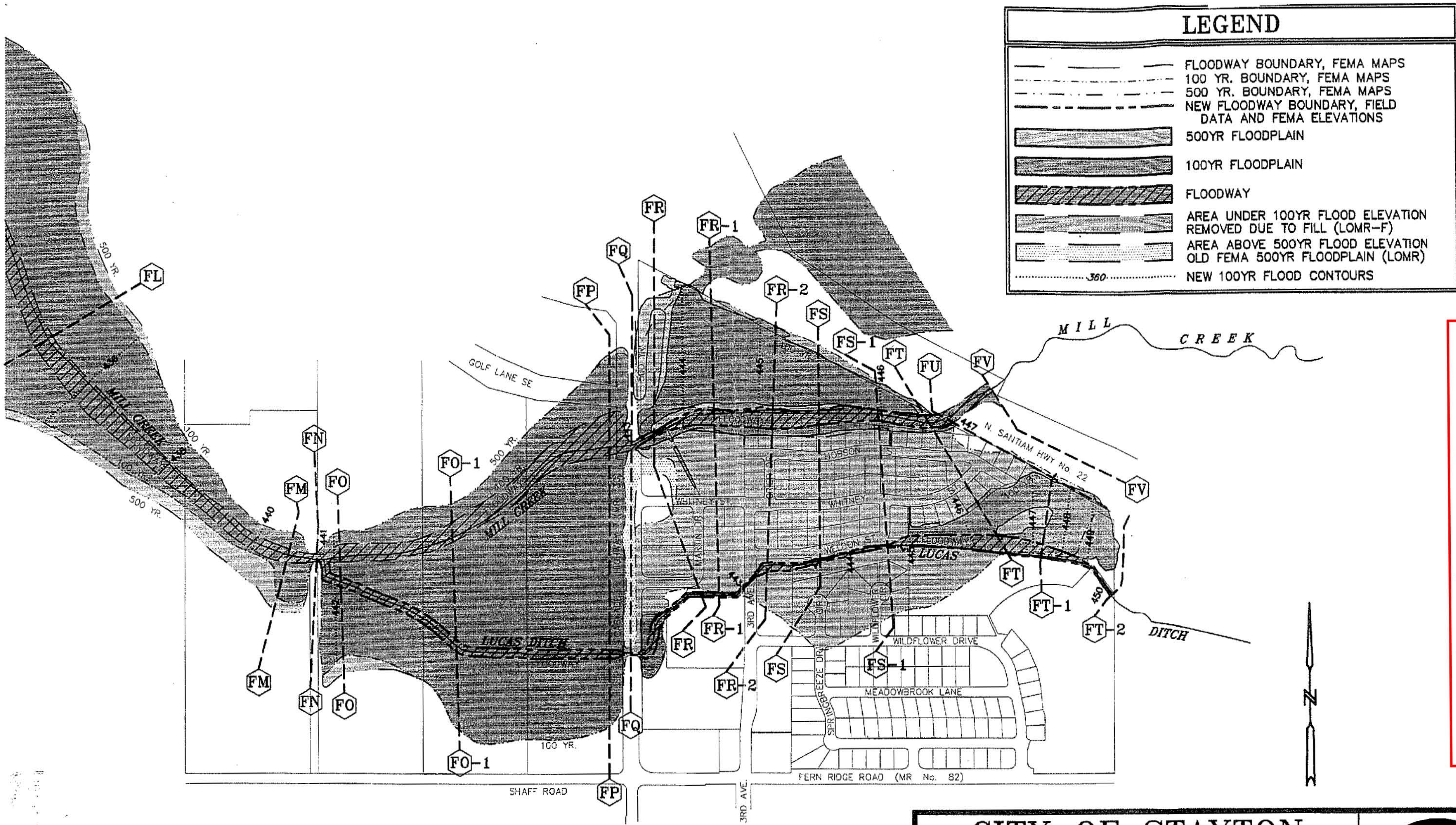
03/11/2004

Marion County Map



This map was produced using the Marion County GIS data. The GIS data is maintained by the county to support its governmental activities. The County is not reponsible for map errors, ommisions, misuse or misinterpretation.

03/11/2004



Letter of Map Revision (LOMR) Figure

CITY OF STAYTON		
LOMR-F APPLICATION MILL CREEK/LUCAS DITCH	MARION COUNTY, OREGON	
Scale: 1" = 500'	Date: FEB 25, 2004	Revised:
Design: ACS	Boatwright Engineering, Inc. 2613 12th Street SE, SALEM, OREGON 97302	Job No.
Drawn: ACS		Sheet 1 of 1
Chkd: CFB	TEL: (503) 363-9225 • FAX: (503) 363-1051	

\SYL-MDWS\STAYTON-SMALL.DWG

Appendix B.6

Threatened and Endangered Species Summary

Threatened and Endangered Species System (TESS)

Listings by State and Territory as of 03/09/2004

Oregon

Notes:
- *Displays one record per species or population.*
- *This list does not include experimental populations and similarity of appearance listings.*
- *The range of a listed population does not extend beyond the states in which that population is defined.*
- *This list does not include non-nesting sea turtles and whales in State/Territory coastal waters.*
- *Includes species or populations under the sole jurisdiction of the National Marine Fisheries Service.*

Go to the Threatened and Endangered Wildlife and Plants Page
Go to the TESS Home Page

View All Listed Species in State

Return to US Map

- *Click on the highlighted scientific names below to view a Species Profile for each listing.*

Oregon -- 50 listings

Animals -- 32

Status	Listing
E	Albatross, short-tailed (*Phoebastria (=Diomedea) albatrus*)
E	Butterfly, Fender's blue (*Icaricia icarioides fenderi*)
T	Butterfly, Oregon silverspot (*Speyeria zerene hippolyta*)
E	Chub, Borax Lake (*Gila boraxobius*)
T	Chub, Hutton tui (Hutton) (*Gila bicolor ssp.*)
E	Chub, Oregon (*Oregonichthys crameri*)
T	Dace, Foskett speckled (Foskett) (*Rhinichthys osculus ssp.*)
E	Deer, Columbian white-tailed Columbia River DPS (*Odocoileus virginianus leucurus*)
T	Eagle, bald (lower 48 States) (*Haliaeetus leucocephalus*)
T	Fairy shrimp, vernal pool (*Branchinecta lynchi*)
T	Murrelet, marbled (CA, OR, WA) (*Brachyramphus marmoratus marmoratus*)
T	Owl, northern spotted (*Strix occidentalis caurina*)
E	Pelican, brown (except U.S. Atlantic coast, FL, AL) (*Pelecanus occidentalis*)
T	Plover, western snowy (Pacific coastal pop.) (*Charadrius alexandrinus nivosus*)
T	Salmon, chinook (fall Snake R.) (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chinook (spring/summer Snake R.) (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chinook (lower Columbia R.) (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chinook (upper Willamette R.) (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chum (Columbia R.) (*Oncorhynchus (=Salmo) keta*)
T	Salmon, coho (OR, CA pop.) (*Oncorhynchus (=Salmo) kisutch*)
E	Salmon, sockeye U.S.A. (Snake River, ID stock wherever found.) (*Oncorhynchus (=Salmo) nerka*)
T	Sea turtle, green (except where endangered) (*Chelonia mydas*)
E	Sea turtle, leatherback (*Dermochelys coriacea*)
T	Sea turtle, loggerhead (*Caretta caretta*)
T	Sea-lion, Steller (eastern pop.) (*Eumetopias jubatus*)
T	Steelhead (Snake R. Basin) (*Oncorhynchus (=Salmo) mykiss*)
T	Steelhead (lower Columbia R.) (*Oncorhynchus (=Salmo) mykiss*)
T	Steelhead (middle Columbia R.) (*Oncorhynchus (=Salmo) mykiss*)
T	Steelhead (upper Willamette R.) (*Oncorhynchus (=Salmo) mykiss*)
E	Sucker, Lost River (*Deltistes luxatus*)
E	Sucker, shortnose (*Chasmistes brevirostris*)
T	Sucker, Warner (*Catostomus warnerensis*)
T	Trout, bull (U.S.A., conterminous, lower 48 states) (*Salvelinus confluentus*)

T	Trout, Lahontan cutthroat (*Oncorhynchus clarki henshawi*)
E	Whale, humpback (*Megaptera novaeangliae*)
T	Wolf, gray Western Distinct Population Segment (*Canis lupus*)

Plants -- 18

Status	*Listing*
E	Rock-cress, McDonald's (*Arabis mcdonaldiana*)
E	Sandwort, Marsh (*Arenaria paludicola*)
E	Milk-vetch, Applegate's (*Astragalus applegatei*)
T	Paintbrush, golden (*Castilleja levisecta*)
E	Daisy, Willamette (*Erigeron decumbens* var. *decumbens*)
E	Fritillary, Gentner's (*Fritillaria gentneri*)
T	Howellia, water (*Howellia aquatilis*)
E	Lily, Western (*Lilium occidentale*)
E	Meadowfoam, large-flowered wooly (*Limnanthes floccosa grandiflora*)
E	Desert-parsley, Bradshaw's (*Lomatium bradshawii*)
E	Lomatium, Cook's (*Lomatium cookii*)
T	Lupine, Kincaid's (*Lupinus sulphureus (=oreganus)* ssp. *kincaidii* (=var. *kincaidii*))
T	Four-o'clock, MacFarlane's (*Mirabilis macfarlanei*)
E	Popcornflower, rough (*Plagiobothrys hirtus*)
T	Checker-mallow, Nelson's (*Sidalcea nelsoniana*)
T	Catchfly, Spalding's (*Silene spaldingii*)
E	Wire-lettuce, Malheur (*Stephanomeria malheurensis*)
T	Thelypody, Howell's spectacular (*Thelypodium howellii spectabilis*)

Appendix B.7
Cultural Resources Review

KELLER associates

Oregon
Theodore R. Kulongoski, Governor

Parks and Recreation Department
State Historic Preservation Office
725 Summer St. NE, Suite C
Salem, OR 97301-1271
(503) 986-0707
FAX (503) 986-0793
www.hcd.state.or.us

March 22, 2004

Mr. Justin Walker
Keller Associates
131 SW 5th Ste A
Meridian, ID 83642

RE: SHPO Case No. 04-0498
Stayton Regional Wastewater Interceptor System
Construction of wastewater system
Keller Associates
8S 1W 33 and 9S 1W 3 and 4, Stayton, Marion County

Dear Mr. Walker:

Our office recently received a request to conduct a cultural resource review for the area of the project referenced above. In checking our statewide cultural resource database, I find that there have been no previous cultural surveys completed within your proposed project area but cultural sites are known to exist in the surrounding area. Your project area is located on a landform generally perceived to have a high probability for possessing archaeological sites and buried human remains.

While not having sufficient knowledge to pinpoint the exact location of cultural resources within your project area, two possibilities are open for determining the possibility of their presence. These possibilities include: 1) the completion of a cultural resource pedestrian survey of the area to identify any surface material, or 2) have an archaeological/tribal monitor on site for all surface disturbance activities. Due to the very high likelihood of significant sites being present, in this instance I suggest that your office contact an archaeologist to complete a cultural resource survey of the project area. A list of possible archaeological consultants can be found on our web page (www.hcd.state.or.us) by clicking on SHPO and highlighting the section marked Archaeological Permits.

ORS 358.905 and ORS 97.740 protect archaeological sites and objects and human remains on both state public and private lands in Oregon. I hope that by providing the above-suggested archaeological survey, damage to any archaeological sites in the area of your proposed project can be avoided.

If you have any questions about the above comments or would like additional information, please feel to contact me at your convenience.

Dennis Griffin

Dennis Griffin, Ph.D., RPA
SHPO Archaeologist
(503) 986-0674
dennis.griffin@state.or.us

MAR 24 2004

73410-0807

Index by State and City (Links) - NATIONAL REGISTER OF HISTORIC PLACES 03/15/2004 15:43:41

No filter Include filter in navigation

Row	STATE	COUNTY	RESOURCE NAME	ADDRESS	CITY	LISTED	MULTIPLE	WEB PAGE
1	OR	Linn	**Mt. Pleasant Presbyterian Church**	S of Stayton on Stayton-Jordan Rd.	Stayton	1974-01-24		NULL
2	OR	Marion	**Brown, Charles and Martha, House**	425 N. First Ave.	Stayton	2002-09-06		NULL
3	OR	Marion	**Paris Woolen Mill**	535 E. Florence St.	Stayton	1981-12-21		NULL

Page 1

First Page Next Page Refresh Export

Appendix C
Model Data

Appendix C.1

Model Data

Link Data

Name	Length ft	Roughness	Upstream Node Name	Downstream Node Name	Downstream Invert Elevation
Link46	39.500	0.014	Basin75	Node35	457.740
dummy2	1323.890	0.014	Basin75	Basin74	0.000
Link47	234.600	0.014	Node35	Basin76.1	456.920
Link48	279.370	0.014	Basin76.1	N104	456.280
Link326	472.830	0.014	Basin76.2	Node229	456.810
Link327	265.370	0.014	Node229	Node230	456.279
Link328	274.510	0.014	Node230	N104	455.730
Link40	242.830	0.014	N104	Basin70	454.880
Link41	276.760	0.014	Basin70	Node30	453.640
Link42	516.970	0.014	Node30	Basin69	451.750
Link43	43.620	0.014	Basin69	Node31	451.470
Link216	856.890	0.014	Basin71	Node192	441.750
dummy7	673.550	0.014	Basin71	Basin60	0.000
Link177	251.700	0.014	Basin73	Basin73.1	440.000
dummy34	32.010	0.014	Basin73	Basin72	0.000
Link177.1	251.710	0.014	Basin73.1	Node140	437.000
dummy33	1176.780	0.014	Node140	Node344	0.000
Link315	235.540	0.014	Basin66	Node342	436.460
Link79	351.910	0.014	Node342	Basin67	434.480
Link317	421.910	0.014	Basin67	Node344	431.960
dummy32	1341.430	0.014	Node344	Node347	0.000
Link19	443.480	0.014	Basin54	Node12	431.540
Link20	192.360	0.014	Node12	Node347	429.160
dummy31	327.750	0.014	Node347	Basin55	0.000
Link179	197.840	0.014	Basin55	N444	431.000
dummy30	1767.960	0.014	Basin55	N220	0.000
L202	644.960	0.014	Basin40	N220	429.770
dummy29	1635.390	0.014	N220	Node150	0.000
Link182	929.680	0.014	Basin32	Node150	430.000
dummy28	1099.690	0.014	Node150	Basin31C	0.000
Link184	322.880	0.014	Basin31C	Node152	426.370
Link222	237.040	0.014	Basin31D	Node152	426.370
Link227	572.270	0.014	Node152	Node197	425.350
Link394	248.650	0.014	Basin31B	Node418	426.600
dummy27	796.200	0.014	Basin31B	Node158	0.000
Link189	47.820	0.014	Basin38A	N103	433.460
Link219	229.500	0.014	N103	Node196	432.000
Link220	245.540	0.014	Node196	Node158	430.000
Link293	189.510	0.014	Basin38B	Node212	431.000
Link181	530.780	0.014	Basin39	Node148	430.000
Link221	797.490	0.014	Basin45	Node161	433.600
Link180	665.490	0.014	Basin46	Node146	434.000
Link59	719.450	0.014	Basin52	Basin54.1	437.750
Link60	209.380	0.014	Basin54.1	Node48	436.890
Link62	518.980	0.014	Node48	Node49	434.500
Link303	352.220	0.014	Basin62	Node326	442.440
Link308	522.160	0.014	Node334	N232	444.350
Link306	166.920	0.014	N232	Basin61	443.360
Link75	631.780	0.014	Basin59	Node61	444.810

Link Data

Name	Upstream Invert Elevation	Diameter (Height) ft
Link46	458.670	0.833
dummy2	0.050	0.050
Link47	457.740	0.833
Link48	456.720	0.833
Link326	457.755	0.667
Link327	456.810	0.667
Link328	456.279	0.667
Link40	455.780	0.833
Link41	454.780	0.833
Link42	453.190	1.000
Link43	451.600	1.250
Link216	454.700	1.000
dummy7	0.050	0.050
Link177	443.000	0.833
dummy34	0.050	0.050
Link177.1	440.000	0.833
dummy33	0.050	0.050
Link315	438.650	1.000
Link79	436.310	1.250
Link317	434.430	1.250
dummy32	0.050	0.050
Link19	433.430	0.833
Link20	431.290	1.000
dummy31	0.050	0.050
Link179	433.000	0.833
dummy30	0.050	0.050
L202	430.780	1.750
dummy29	0.050	0.050
Link182	434.000	1.000
dummy28	0.050	0.050
Link184	427.390	1.000
Link222	428.500	1.500
Link227	426.180	1.250
Link394	428.160	2.000
dummy27	0.050	0.050
Link189	433.480	0.833
Link219	433.460	0.833
Link220	432.000	1.000
Link293	432.000	0.667
Link181	430.500	0.833
Link221	435.280	0.833
Link180	434.013	0.667
Link59	439.600	1.250
Link60	437.650	1.250
Link62	436.590	1.500
Link303	443.390	0.833
Link308	447.650	0.833
Link306	444.200	1.250
Link75	447.780	1.000

Link Data

Name	Length ft	Roughness	Upstream Node Name	Downstream Node Name	Downstream Invert Elevation
Link76	120.000	0.014	Node61	Basin61	443.960
Link304	312.440	0.014	Basin61	Node331	443.230
Link77	362.850	0.014	Node331	Node326	442.540
Link300	240.610	0.014	Node326	Basin63	440.200
Link301	464.410	0.014	Basin63	Node323	440.260
Link78	157.050	0.014	Node323	Node322	439.140
Link214	331.680	0.014	Basin64	Node188	438.000
Link215	177.760	0.014	Basin65	Node190	442.160
dummy17	519.740	0.014	Node190	Node188	0.000
dummy18	23.370	0.014	Node188	Node322	0.000
dummy19	2660.690	0.014	Node322	Node49	0.000
dummy20	49.030	0.014	Node49	Node146	0.000
dummy21	898.990	0.014	Node146	Node161	0.000
dummy22	262.570	0.014	Node161	Node148	0.000
dummy40	100.540	0.014	Node148	Node212	0.000
dummy41	100.950	0.014	Node212	Node158	0.000
dummy24	1018.850	0.014	Node158	Node163	0.000
Link191	700.790	0.014	Basin37	Node163	430.000
dummy25	1088.850	0.014	Node163	Node115	0.000
Link362	249.270	0.014	Basin43.2	Basin43.2.1	434.120
Link307.1	177.740	0.014	Basin43.2.1	Node219	432.470
Link310	152.820	0.014	Node219	Node220	432.241
Link311	88.340	0.014	Node220	Node221	432.100
Link312	37.050	0.014	Node221	Node222	432.033
Link313	144.250	0.014	Node222	Node223	431.778
Link68	25.090	0.014	Basin43.1	Node54	432.120
Link314	367.940	0.014	Node54	Node223	431.778
Link316	284.530	0.014	Node223	Node57	431.513
Link73	25.030	0.014	Node57	Basin44	430.220
Link161	294.360	0.014	Basin44	Node127	428.950
Link162	379.400	0.014	Node127	Basin35	428.090
1383.1	301.950	0.014	Basin36.1	Basin35	428.240
1383.2	301.950	0.014	Basin36.1	Basin35	428.090
Link135	302.530	0.014	Basin35	Basin36.2	427.330
Link136	405.940	0.014	Basin36.2	Basin30	426.900
Link137	421.990	0.014	Basin30	Node114	425.400
Link138	278.980	0.014	Node114	Node115	425.000
Link139	174.960	0.014	Node115	Node59	424.500
dummy26	1629.250	0.014	Node59	Basin29	0.000
Link152	5.500	0.014	N423	Node271	426.290
Link155	218.540	0.014	N423	Node272	424.680
Link243	159.860	0.014	Node272	Basin13	423.850
Pump1	7.120	0.014	Node271	Node125	0.000
Pump2	10.000	0.014	Node271	Node125	0.000
QuailRun	7.120	0.014	Node271	Node125	0.000
Pump2	10.000	0.014	Node271	Node125	0.000
Link452	121.120	0.014	Node125	Basin14	429.590
Link244	144.500	0.014	Basin14	Node274	429.050
Link245	406.150	0.014	Node274	Node249	428.130

Link Data

Name	Upstream Invert Elevation	Diameter (Height) ft
Link76	444.760	1.000
Link304	443.260	1.250
Link77	443.130	1.250
Link300	442.240	1.250
Link301	440.200	1.500
Link78	440.010	1.500
Link214	441.000	0.833
Link215	443.000	0.833
dummy17	0.050	0.050
dummy18	0.050	0.050
dummy19	0.050	0.050
dummy20	0.050	0.050
dummy21	0.050	0.050
dummy22	0.050	0.050
dummy40	0.050	0.050
dummy41	0.050	0.050
dummy24	0.050	0.050
Link191	430.500	1.500
dummy25	0.050	0.050
Link362	435.770	1.000
Link307.1	434.120	1.000
Link310	432.471	1.000
Link311	432.241	1.250
Link312	432.100	1.250
Link313	432.033	1.500
Link68	432.330	1.500
Link314	432.120	1.500
Link316	431.778	1.500
Link73	431.513	1.500
Link161	429.920	1.500
Link162	428.950	1.500
1383.1	430.240	1.410
1383.2	430.240	1.000
Link135	428.090	1.500
Link136	427.330	1.500
Link137	426.900	3.750
Link138	425.400	3.750
Link139	425.000	2.000
dummy26	0.050	0.050
Link152	426.960	1.000
Link155	427.160	0.833
Link243	424.730	1.000
Pump1	0.050	0.050
Pump2	0.050	0.050
QuailRun	0.050	0.050
Pump2	0.050	0.050
Link452	427.000	0.500
Link244	429.290	1.000
Link245	429.100	1.000

Link Data

Name	Length ft	Roughness	Upstream Node Name	Downstream Node Name	Downstream Invert Elevation
Link255	82.210	0.014	Node249	Node288	425.790
Link378.1	234.740	0.014	N499	Node401	450.330
Link44	410.130	0.014	Node401	Node27	449.130
Link37	51.250	0.014	Node27	Basin68	448.740
Link366	420.270	0.014	Basin68	Basin57	448.700
Link365	1114.840	0.014	Basin57	Basin49	443.720
Link146	39.260	0.014	Basin58	N448	445.640
Link140	154.070	0.014	N448	Node117	445.430
Link141	140.260	0.014	Node117	Node118	444.800
Link147	155.840	0.014	Node118	Node120	444.160
Link148	468.090	0.014	Node120	Basin49	443.620
L92	308.270	0.014	Basin49	N94	442.360
L93	499.810	0.014	N94	N446	439.570
L93.1	424.700	0.014	N446	Basin48	437.310
Link52	278.660	0.014	Node40	Node39	444.530
Link53	358.840	0.014	Node40	Basin50	443.720
Link50	26.480	0.014	Node38	Basin51	444.380
Link51	152.560	0.014	Node38	Node39	444.030
Link337	1782.010	0.014	Node39	Node43	439.720
Link159	1126.890	0.014	Basin50	Node43	439.720
Link56	241.150	0.014	Node43	Node44	439.310
Link57	357.060	0.014	Node44	Node45	438.970
Link58	198.000	0.014	Node45	Basin48	437.560
L27	331.840	0.014	Basin48	Basin47	436.730
Link29	329.940	0.014	Basin47	Basin56	435.100
Link26	271.180	0.014	Basin56	Node20	434.980
Link27	132.900	0.014	Node20	Node261	433.220
Link49	441.290	0.014	Node261	Basin41	431.300
Link14	426.140	0.014	Basin41	Node10	430.390
Link15	103.970	0.014	Node10	Node262	429.020
Link234	415.900	0.014	Node262	Basin33	427.720
Link319	803.140	0.014	Basin42.2	Node225	434.560
Link320	116.840	0.014	Node225	Node226	434.063
Link322	101.450	0.014	Node226	Node227	433.830
Link324	144.240	0.014	Node227	Basin42.1	430.900
Link31	360.890	0.014	Basin42.1	N445	430.190
Link149	160.430	0.014	N445	Node121	426.740
Link296	128.200	0.014	Basin42.3	Node214	431.264
Link297	271.740	0.014	Node214	Node215	430.499
Link302	123.590	0.014	Basin42.4	Node215	430.499
Link299	253.490	0.014	Node215	Basin34	426.740
Link150	70.080	0.014	Basin34	Node121	426.830
Link151	565.650	0.014	Node121	Basin33	427.620
Link256	332.850	0.014	Basin33	Node288	425.790
Link156	532.040	0.014	Node288	Node264	422.850
Link247	25.270	0.014	Node264	N498	422.820
Link352	559.090	0.014	N498	Node248	422.810
Link353	331.840	0.014	Node248	Node250	421.240
Link358	39.470	0.014	Node248	Node245	423.807

Link Data

Name	Upstream Invert Elevation	Diameter (Height) ft
Link255	428.130	1.250
Link378.1	450.820	1.250
Link44	449.830	1.500
Link37	448.780	1.750
Link366	448.590	1.750
Link365	448.800	2.000
Link146	445.830	1.250
Link140	445.590	1.250
Link141	445.430	1.250
Link147	444.600	1.250
Link148	444.160	1.250
L92	443.520	2.000
L93	442.360	2.000
L93.1	439.320	2.000
Link52	444.830	1.000
Link53	444.830	1.000
Link50	444.440	1.000
Link51	444.340	1.000
Link337	444.030	0.833
Link159	443.320	1.500
Link56	439.720	1.500
Link57	439.210	1.500
Link58	438.870	1.500
L27	437.310	2.500
Link29	436.530	2.500
Link26	435.100	2.500
Link27	433.630	4.000
Link49	433.120	4.000
Link14	431.200	4.000
Link15	430.290	4.000
Link234	428.920	4.000
Link319	436.000	1.000
Link320	434.560	1.250
Link322	434.063	1.250
Link324	433.830	1.250
Link31	430.900	1.500
Link149	430.190	1.500
Link296	431.650	0.833
Link297	431.264	0.833
Link302	430.870	0.833
Link299	430.499	1.000
Link150	426.740	2.000
Link151	426.830	2.000
Link256	427.620	4.000
Link156	425.790	4.000
Link247	422.800	3.000
Link352	422.820	3.000
Link353	422.810	3.000
Link358	423.810	1.000

Link Data

Name	Length ft	Roughness	Upstream Node Name	Downstream Node Name	Downstream Invert Elevation
Link354	42.720	0.014	Node250	Node251	421.490
Link356	293.450	0.014	Node251	Node252	421.200
Link357	447.870	0.014	Node252	Basin29	419.540
Link228	123.530	0.014	Node418	Node197	425.800
Link224	36.800	0.014	Node197	Node420	425.310
Link185	588.120	0.014	Node420	Basin31A	424.120
Link229	918.570	0.014	Node420	Node155	423.790
Link186	704.210	0.014	Basin31A	Node155	423.000
Link187	205.860	0.014	Node155	Node156	423.160
Link230	102.960	0.014	Node156	Node199	422.530
Link178	583.720	0.014	Basin72	Node142	444.000
Link80	625.390	0.014	Basin80	Node63	444.260
Link173	223.000	0.013	Basin77.1	Basin77.2	451.050
Link175	291.540	0.013	Basin77.2	Basin77.3	449.910
Link344	277.760	0.013	Basin77.3	Basin77.4	448.700
Link343	412.280	0.013	Basin77.4	Basin77.5	445.840
Link82	237.560	0.013	Basin77.5	Node65	444.340
Link176	781.200	0.013	Basin81	Node138	446.000
Link85	229.280	0.014	Basin78	Node70	446.150
Link83	206.810	0.014	Basin82	Node67	446.280
Link84	18.370	0.014	Node67	Node68	445.800
Link86	553.730	0.014	Basin79	Node72	445.980
Link333	208.940	0.014	Basin86	Node235	463.166
Link336	1017.160	0.014	Node235	Node234	454.710
Link172	15.750	0.014	Node234	Basin88	454.910
Link166	118.240	0.014	Basin85	Basin94	461.510
Link167	60.110	0.014	Basin92	Basin94	461.510
Link350	52.180	0.014	Basin87.1	Basin87	463.070
Link345	9.450	0.014	Basin87	Node241	462.998
Link363	46.660	0.014	Basin87	Node254	464.170
Link349	22.070	0.014	Node243	Node241	466.910
Link346	169.740	0.014	Node241	Node242	461.700
Link351	114.470	0.014	Basin93	Node242	462.600
Link347	10.530	0.014	Node242	Basin94	461.710
Link92	388.750	0.014	Basin94	Basin95	459.130
Link325	568.240	0.014	Basin95	N123	451.560
dummy3	990.120	0.014	Basin95	Basin88	0.000
Link208	147.780	0.014	Basin97B	Node181	474.140
dummy5	931.280	0.014	Basin97B	Basin97A	0.000
Link213	218.880	0.014	Basin104	Node181	474.390
Link217	255.830	0.014	Basin102	Node181	474.190
Link209	682.490	0.014	Node181	Node182	473.000
Link231	726.470	0.014	Node182	Node184	471.000
Link212	142.610	0.014	Node184	Node185	469.000
Link94	803.270	0.014	Basin97A	N225	468.290
dummy4	955.580	0.014	Basin97A	Basin103	0.000
Link99	205.600	0.014	Basin103	Basin105	461.780
Link232	780.760	0.014	Basin105	N144	461.220
Link95	310.580	0.014	N225	Node78	466.800

Link Data

Name	Upstream Invert Elevation	Diameter (Height) ft
Link354	421.240	3.000
Link356	421.490	3.000
Link357	421.200	3.000
Link228	426.250	2.500
Link224	425.350	0.833
Link185	425.180	2.000
Link229	425.180	2.000
Link186	424.120	2.500
Link187	423.160	1.500
Link230	422.830	2.500
Link178	446.080	0.833
Link80	445.540	0.667
Link173	451.890	1.000
Link175	450.900	1.000
Link344	449.710	1.000
Link343	448.250	1.000
Link82	445.640	1.000
Link176	448.000	0.667
Link85	447.240	1.000
Link83	446.840	1.000
Link84	446.180	1.000
Link86	448.250	0.667
Link333	466.760	0.833
Link336	463.000	1.000
Link172	454.710	1.500
Link166	463.000	2.000
Link167	463.000	2.000
Link350	463.720	0.833
Link345	463.070	1.000
Link363	464.500	1.000
Link349	462.600	0.160
Link346	462.998	1.000
Link351	463.720	1.000
Link347	461.550	1.250
Link92	461.510	1.000
Link325	458.930	1.250
dummy3	0.050	0.050
Link208	475.000	1.500
dummy5	0.050	0.050
Link213	479.660	1.000
Link217	547.000	1.500
Link209	473.670	2.000
Link231	473.000	2.000
Link212	471.000	2.000
Link94	472.190	2.000
dummy4	0.050	0.050
Link99	461.730	3.000
Link232	461.730	3.000
Link95	468.190	2.000

Link Data

Name	Length ft	Roughness	Upstream Node Name	Downstream Node Name	Downstream Invert Elevation
Link164	554.700	0.014	Basin91	Node78	467.950
Link98	141.630	0.014	Node78	Basin99	465.850
Link143	437.410	0.014	Basin99	Node435	463.090
Link409	370.700	0.014	Node435	Basin101	460.340
L129	89.770	0.014	Basin101	N134	456.380
Link169	233.680	0.014	N134	Node133	458.000
Link170	226.580	0.014	Node133	N434	458.000
Link171	143.180	0.014	N434	Basin98	455.560
L121	155.620	0.014	Basin98	Basin100	454.020
L122	244.520	0.014	Basin100	Basin96	453.960
L122.1	397.770	0.014	Basin96	N123	451.560
Link323	381.360	0.014	N123	Node350	448.660
Link88	647.070	0.014	Basin88	N111	450.720
Link87	484.110	0.014	N111	N112	449.220
L111	300.630	0.014	N112	N113	447.630
dummy8	295.490	0.014	N113	Node72	0.000
dummy9	235.970	0.014	Node72	Node68	0.000
dummy10	60.550	0.014	Node68	Node70	0.000
dummy11	256.850	0.014	Node70	Node138	0.000
dummy12	266.100	0.014	Node138	Node65	0.000
dummy13	22.770	0.014	Node65	Node63	0.000
dummy14	285.420	0.014	Node63	Node142	0.000
dummy15	40.550	0.014	Node142	Node192	0.000
dummy16	829.710	0.014	Node142	Node190	0.000
Link309	353.960	0.014	Basin60	Node334	447.700
dummy6	647.680	0.014	Basin60	Node31	0.000
Link378	257.650	0.014	Node31	N499	450.970
L180	396.240	0.014	Basin74	N187	474.690
Link113	291.750	0.014	N187	Node92	468.650
Link114	435.950	0.014	Node92	Node93	463.790
Link115	48.240	0.014	Node93	Node385	462.260
Link355	140.840	0.014	Node385	N177	450.000
Link329	556.770	0.014	Basin23.2	Node232	446.060
Link364	203.220	0.014	Basin23.2	N177	450.000
Link330	188.900	0.014	Node232	Node233	445.200
Link332	289.480	0.014	Node233	Node200	445.000
L172	383.620	0.014	Basin23.1	N179	446.580
L173	176.540	0.014	N179	N180	446.080
Link238	133.940	0.014	N180	Node200	445.700
MHrim	10.000	0.014	Node200	Node256	0.000
orf1	10.000	0.014	Node200	Node256	0.000
1703.1	10.000	0.014	Node200	Node99	0.000
w1	10.000	0.014	Node200	Node99	0.000
Link368	83.500	0.014	Node256	Node99	444.000
Link361	346.640	0.014	Basin83	N183	462.680
Link107	388.830	0.014	Basin89	N447.1	477.640
Link106	14.670	0.014	N447.1	Basin90.1	477.320
Link108	262.270	0.014	Basin90.1	Basin90.2	473.000
Link109	29.040	0.014	Basin90.2	Node386	473.130

Link Data

Name	Upstream Invert Elevation	Diameter (Height) ft
Link164	549.000	0.667
Link98	466.650	2.000
Link143	465.700	2.000
Link409	462.890	2.000
L129	456.240	2.000
Link169	456.380	6.000
Link170	458.000	3.000
Link171	458.000	6.000
L121	453.780	1.500
L122	454.020	1.250
L122.1	453.760	1.000
Link323	449.960	2.500
Link88	454.910	1.500
Link87	450.620	1.500
L111	449.120	1.500
dummy8	0.050	0.050
dummy9	0.050	0.050
dummy10	0.050	0.050
dummy11	0.050	0.050
dummy12	0.050	0.050
dummy13	0.050	0.050
dummy14	0.050	0.050
dummy15	0.050	0.050
dummy16	0.050	0.050
Link309	450.160	0.833
dummy6	0.050	0.050
Link378	451.470	1.250
L180	492.000	1.000
Link113	474.690	1.000
Link114	468.550	1.500
Link115	463.690	1.500
Link355	462.650	1.500
Link329	453.690	1.000
Link364	453.690	1.500
Link330	445.960	1.000
Link332	445.200	1.000
L172	448.070	2.000
L173	446.480	2.000
Link238	445.980	2.500
MHrim	0.050	0.050
orf1	0.050	0.050
1703.1	0.050	0.050
w1	0.050	0.050
Link368	445.000	1.500
Link361	467.650	1.000
Link107	480.000	4.000
Link106	477.640	1.000
Link108	477.220	1.250
Link109	472.900	1.500

Link Data

Name	Length ft	Roughness	Upstream Node Name	Downstream Node Name	Downstream Invert Elevation
Link110	308.310	0.014	Node386	Basin84	467.970
Link111	308.360	0.014	Basin84	N183	461.680
Link360	51.750	0.014	N183	Node388	459.260
Link112	33.480	0.014	Node388	Basin24	458.840
Link116	254.100	0.014	Basin24	Node94	458.840
Link117	169.640	0.014	Node94	Node95	458.459
Link118	327.550	0.014	Node95	Node96	458.164
Link192	123.310	0.014	Basin28	Node165	510.000
Link193	197.250	0.014	Node165	Node166	507.600
Link194	414.670	0.014	Node166	Node167	503.860
1458.1	105.060	0.014	Node167	Node168	503.830
ditch	105.060	0.014	Node167	Node168	500.000
Link198	422.440	0.014	Node168	Node171	494.000
Link199	85.520	0.014	Node171	Node172	493.970
Link200	147.240	0.014	Node172	Basin27	491.860
Link201	106.360	0.014	Basin27	Node174	489.810
Link202	61.760	0.014	Node174	Node175	490.990
Link203	56.950	0.014	Node175	Basin26	483.510
Link204	858.170	0.014	Basin26	N477	474.000
Link205	130.850	0.014	N477	Basin25	478.510
Link207	992.390	0.014	Basin25	Node116	464.000
Link123	885.990	0.014	Node116	Node96	458.164
Link240	798.770	0.014	Node96	Node99	443.000
Link246	737.710	0.014	Node99	Basin21	441.000
Link248	466.200	0.014	Basin21	Basin22	440.000
Link249	296.570	0.014	Basin22	N404	439.500
dummy1	484.150	0.014	N404	Basin20	0.000
1544.1	157.920	0.014	N404	Node105	441.300
1544.2	157.920	0.014	N404	Node105	439.630
Link251	380.200	0.014	Basin20	Node206	443.000
Link129	418.280	0.014	Node105	Node205	437.000
Link130	190.460	0.014	Node205	Node107	436.000
Link131	134.180	0.014	Node107	Node108	436.280
Link237	389.930	0.014	N177	Basin23.1	448.070

Link Data

Name	Upstream Invert Elevation	Diameter (Height) ft
Link110	472.980	1.500
Link111	467.870	1.500
Link360	461.580	2.000
Link112	459.260	2.500
Link116	458.840	2.000
Link117	458.726	2.000
Link118	458.459	2.000
Link192	511.000	5.000
Link193	510.000	1.500
Link194	507.590	1.000
1458.1	503.870	0.667
ditch	502.890	3.000
Link198	500.000	5.000
Link199	494.030	2.000
Link200	493.970	5.000
Link201	491.860	2.000
Link202	489.810	5.000
Link203	490.990	3.000
Link204	475.000	10.000
Link205	479.480	3.000
Link207	478.000	3.000
Link123	464.000	3.000
Link240	458.164	3.000
Link246	443.000	4.000
Link248	441.000	4.000
Link249	440.000	4.000
dummy1	0.050	0.050
1544.1	439.450	3.000
1544.2	439.290	4.500
Link251	443.000	3.000
Link129	439.630	5.000
Link130	437.000	8.000
Link131	439.210	10.000
Link237	450.000	1.500

Junction Data

Name	Node Name	Ground Elevation (Spill Crest)	Maximum Crown Elevation	Invert Elevation ft
Basin75	Basin75	460.870	460.870	458.670
Node35	Node35	460.740	460.740	457.740
Basin76.1	Basin76.1	461.420	461.420	456.720
Basin76.2	Basin76.2	461.470	461.470	457.755
Node229	Node229	461.900	461.900	456.810
Node230	Node230	459.910	459.910	456.279
N104	N104	459.580	459.580	455.730
Basin70	Basin70	458.680	458.680	454.780
Node30	Node30	457.490	457.490	453.190
Basin69	Basin69	455.300	455.300	451.600
Basin71	Basin71	456.970	456.970	454.700
Basin73	Basin73	446.000	446.000	443.000
Basin73.1	Basin73.1	443.000	443.000	440.000
Node140	Node140	440.000	440.000	437.000
Basin66	Basin66	445.400	445.400	438.650
Node342	Node342	442.610	442.610	436.310
Basin67	Basin67	442.580	442.580	434.430
Node344	Node344	440.000	440.000	431.960
Basin54	Basin54	441.130	441.130	433.430
Node12	Node12	440.190	440.190	431.290
Node347	Node347	440.000	440.000	429.060
Basin55	Basin55	436.000	436.000	430.000
N444	N444	434.000	434.000	431.000
Basin40	Basin40	439.030	439.030	430.780
N220	N220	436.000	436.000	429.770
Basin32	Basin32	437.000	437.000	434.000
Node150	Node150	433.000	433.000	430.000
Basin31C	Basin31C	430.000	430.000	427.390
Basin31D	Basin31D	432.000	432.000	428.500
Node152	Node152	432.000	432.000	426.180
Basin31B	Basin31B	433.260	433.260	428.160
Basin38A	Basin38A	435.800	435.800	433.480
N103	N103	435.700	435.700	433.460
Node196	Node196	434.000	434.000	432.000
Basin38B	Basin38B	435.000	435.000	432.000
Basin39	Basin39	434.400	434.400	430.500
Basin45	Basin45	437.800	437.800	435.280
Basin46	Basin46	441.000	441.000	434.013
Basin52	Basin52	441.900	441.900	439.600
Basin54.1	Basin54.1	441.700	441.700	437.650
Node48	Node48	440.840	440.840	436.590
Basin62	Basin62	450.900	450.900	443.390
Node334	Node334	453.750	453.750	447.650
N232	N232	452.600	452.600	444.200
Basin59	Basin59	450.680	450.680	447.780
Node61	Node61	451.560	451.560	444.760
Basin61	Basin61	452.110	452.110	443.260
Node331	Node331	451.580	451.580	443.130
Node326	Node326	445.740	445.740	442.240

Junction Data

Name	Node Name	Ground Elevation (Spill Crest)	Maximum Crown Elevation	Invert Elevation ft
Basin63	Basin63	444.300	444.300	440.200
Node323	Node323	443.360	443.360	440.010
Basin64	Basin64	444.000	444.000	441.000
Basin65	Basin65	446.500	446.500	443.000
Node190	Node190	445.000	445.000	442.160
Node188	Node188	443.000	443.000	438.000
Node322	Node322	442.000	442.000	439.140
Node49	Node49	440.000	440.000	434.500
Node146	Node146	438.000	438.000	434.000
Node161	Node161	435.000	435.000	433.600
Node148	Node148	434.000	434.000	430.000
Node212	Node212	434.000	434.000	431.000
Node158	Node158	432.000	432.000	430.000
Basin37	Basin37	434.000	434.000	430.500
Node163	Node163	432.000	432.000	430.000
Basin43.2	Basin43.2	439.000	439.000	435.770
Basin43.2.1	Basin43.2.1	438.500	438.320	434.120
Node219	Node219	438.000	438.000	432.470
Node220	Node220	436.000	436.000	432.241
Node221	Node221	435.500	435.500	432.100
Node222	Node222	435.500	435.500	432.033
Basin43.1	Basin43.1	434.830	434.830	432.330
Node54	Node54	434.870	434.870	432.120
Node223	Node223	436.400	436.400	431.778
Node57	Node57	435.260	435.260	431.513
Basin44	Basin44	434.970	434.970	429.920
Node127	Node127	433.700	433.700	428.950
Basin36.1	Basin36.1	432.740	432.740	430.240
Basin35	Basin35	430.740	430.740	428.090
Basin36.2	Basin36.2	430.740	430.740	427.330
Basin30	Basin30	431.000	431.000	426.900
Node114	Node114	429.150	429.150	425.400
Node115	Node115	429.000	429.000	425.000
Node59	Node59	428.000	428.000	424.500
N423	N423	430.260	430.260	426.960
Node272	Node272	429.330	429.330	424.680
Basin13	Basin13	430.000	430.000	423.700
Node271	Node271	430.490	430.490	425.000
Node125	Node125	430.260	430.260	425.000
Basin14	Basin14	431.790	431.790	429.290
Node274	Node274	431.800	431.800	429.050
Node249	Node249	431.880	431.880	428.130
N499	N499	455.820	455.820	450.820
Node401	Node401	455.230	455.230	449.830
Node27	Node27	455.330	455.330	448.780
Basin68	Basin68	455.590	455.590	448.590
Basin57	Basin57	454.680	454.680	448.700
Basin58	Basin58	448.030	448.030	445.830
N448	N448	448.290	448.290	445.590

Junction Data

Name	Node Name	Ground Elevation (Spill Crest)	Maximum Crown Elevation	Invert Elevation ft
Node117	Node117	446.980	446.980	445.430
Node118	Node118	447.000	447.000	444.600
Node120	Node120	448.110	448.110	443.660
Basin49	Basin49	449.020	449.020	443.520
N94	N94	447.060	447.060	442.360
N446	N446	443.370	443.370	439.320
Node40	Node40	446.580	446.580	444.830
Node38	Node38	448.340	448.340	444.340
Basin51	Basin51	447.830	447.830	444.280
Node39	Node39	447.380	447.380	444.030
Basin50	Basin50	446.620	446.620	443.320
Node43	Node43	443.220	443.220	439.720
Node44	Node44	442.460	442.460	439.210
Node45	Node45	442.920	442.920	438.870
Basin48	Basin48	441.210	441.210	437.310
Basin47	Basin47	440.830	440.830	436.530
Basin56	Basin56	441.450	441.450	435.100
Node20	Node20	439.980	439.980	433.630
Node261	Node261	438.820	438.820	433.120
Basin41	Basin41	436.850	436.850	431.200
Node10	Node10	435.740	435.740	430.290
Node262	Node262	434.670	434.670	428.920
Basin42.2	Basin42.2	439.000	439.000	436.000
Node225	Node225	436.000	436.000	434.560
Node226	Node226	438.000	438.000	434.063
Node227	Node227	438.000	438.000	433.830
Basin42.1	Basin42.1	436.100	436.100	430.900
N445	N445	433.790	433.790	430.190
Basin42.3	Basin42.3	435.000	435.000	431.650
Node214	Node214	434.000	434.000	431.264
Basin42.4	Basin42.4	435.000	435.000	430.870
Node215	Node215	434.000	434.000	430.499
Basin34	Basin34	433.500	433.500	426.740
Node121	Node121	433.000	433.000	426.740
Basin33	Basin33	433.270	433.270	427.620
Node288	Node288	431.000	431.000	425.790
Node264	Node264	429.200	429.200	422.800
N498	N498	428.000	428.000	422.820
Node248	Node248	425.810	425.810	422.810
Node245	Node245	425.000	425.000	423.807
Node250	Node250	424.490	424.490	421.240
Node251	Node251	424.490	424.490	421.490
Node252	Node252	425.000	425.000	421.200
Basin29	Basin29	426.000	426.000	419.540
Node418	Node418	431.100	431.100	426.250
Node197	Node197	431.000	431.000	425.350
Node420	Node420	430.000	430.000	425.180
Basin31A	Basin31A	428.900	428.900	424.120
Node155	Node155	428.100	428.100	423.000

Junction Data

Name	Node Name	Ground Elevation (Spill Crest)	Maximum Crown Elevation	Invert Elevation ft
Node156	Node156	428.600	428.600	422.830
Node199	Node199	428.730	428.730	422.380
Basin72	Basin72	448.000	448.000	446.080
Basin80	Basin80	448.890	448.890	445.540
Basin77.1	Basin77.1	458.340	458.340	451.890
Basin77.2	Basin77.2	460.150	460.150	450.900
Basin77.3	Basin77.3	458.210	458.210	449.710
Basin77.4	Basin77.4	456.150	456.150	448.250
Basin77.5	Basin77.5	450.240	450.240	445.640
Basin81	Basin81	451.000	451.000	448.000
Basin78	Basin78	450.240	450.240	447.240
Basin82	Basin82	451.090	451.090	446.840
Node67	Node67	449.880	449.880	446.180
Basin79	Basin79	452.250	452.250	448.250
Basin86	Basin86	468.000	468.000	466.760
Node235	Node235	464.000	464.000	463.000
Node234	Node234	460.560	460.560	454.710
Basin85	Basin85	470.000	470.000	463.000
Basin92	Basin92	470.000	470.000	463.000
Basin87.1	Basin87.1	466.000	466.000	463.720
Basin87	Basin87	467.070	467.070	463.070
Node254	Node254	466.170	465.170	464.170
Node243	Node243	462.760	462.760	462.600
Node241	Node241	467.070	467.070	462.998
Basin93	Basin93	465.720	465.720	463.720
Node242	Node242	467.300	467.300	461.550
Basin94	Basin94	467.230	467.230	461.510
Basin95	Basin95	467.230	467.230	458.930
Basin97B	Basin97B	481.000	481.000	475.000
Basin104	Basin104	484.120	484.120	479.660
Basin102	Basin102	560.540	560.540	547.000
Node181	Node181	482.440	482.440	473.670
Node182	Node182	476.000	476.000	473.000
Node184	Node184	474.000	474.000	471.000
Node185	Node185	473.000	473.000	469.000
Basin97A	Basin97A	478.590	478.590	472.190
Basin103	Basin103	466.480	466.480	461.730
Basin105	Basin105	466.000	466.000	461.730
N144	N144	466.000	466.000	461.220
N225	N225	475.890	475.890	468.190
Basin91	Basin91	550.000	550.000	549.000
Node78	Node78	474.250	474.250	466.650
Basin99	Basin99	473.750	473.750	465.700
Node435	Node435	472.740	472.740	462.890
Basin101	Basin101	465.690	465.690	456.240
N134	N134	465.690	465.690	456.380
Node133	Node133	464.000	464.000	458.000
N434	N434	464.000	464.000	458.000
Basin98	Basin98	462.600	462.600	453.780

Junction Data

Name	Node Name	Ground Elevation (Spill Crest)	Maximum Crown Elevation	Invert Elevation ft
Basin100	Basin100	458.670	458.670	454.020
Basin96	Basin96	458.310	458.310	453.760
N123	N123	457.360	457.360	449.960
Node350	Node350	457.290	457.290	448.660
Basin88	Basin88	461.160	461.160	454.910
N111	N111	454.470	454.470	450.620
N112	N112	453.820	453.820	449.120
N113	N113	450.000	450.000	447.630
Node72	Node72	450.000	450.000	445.980
Node68	Node68	450.000	450.000	445.800
Node70	Node70	450.000	450.000	446.150
Node138	Node138	449.000	449.000	446.000
Node65	Node65	448.000	448.000	444.340
Node63	Node63	446.000	446.000	444.260
Node142	Node142	447.500	447.500	444.000
Node192	Node192	448.500	448.500	441.750
Basin60	Basin60	455.810	455.810	450.160
Node31	Node31	455.270	455.270	451.470
Basin74	Basin74	494.800	494.800	492.000
N187	N187	477.440	477.440	474.690
Node92	Node92	471.500	471.500	468.550
Node93	Node93	468.040	468.040	463.690
Node385	Node385	468.010	468.010	462.180
Basin23.2	Basin23.2	462.230	462.230	453.690
Node232	Node232	450.610	450.610	445.960
Node233	Node233	448.500	448.500	445.200
Basin23.1	Basin23.1	454.570	454.570	448.070
N179	N179	451.730	451.730	446.480
N180	N180	449.770	449.770	445.980
Node200	Node200	449.000	449.000	445.000
Node256	Node256	449.000	446.500	445.000
Basin83	Basin83	469.400	469.400	467.650
Basin89	Basin89	484.000	484.000	480.000
N447.1	N447.1	481.640	481.640	477.640
Basin90.1	Basin90.1	479.270	479.270	477.220
Basin90.2	Basin90.2	476.200	476.200	472.900
Node386	Node386	476.130	476.130	472.980
Basin84	Basin84	470.920	470.920	467.870
N183	N183	466.180	466.180	461.580
Node388	Node388	464.560	464.560	459.260
Basin24	Basin24	463.050	463.050	458.840
Node94	Node94	463.020	463.020	458.726
Node95	Node95	462.000	462.000	458.459
Basin28	Basin28	517.000	517.000	511.000
Node165	Node165	515.000	515.000	510.000
Node166	Node166	510.000	510.000	505.630
Node167	Node167	508.000	508.000	502.890
Node168	Node168	505.000	505.000	500.000
Node171	Node171	499.000	499.000	494.000

Junction Data

Name	Node Name	Ground Elevation (Spill Crest)	Maximum Crown Elevation	Invert Elevation ft
Node172	Node172	499.000	499.000	493.970
Basin27	Basin27	497.000	497.000	491.860
Node174	Node174	498.000	498.000	489.810
Node175	Node175	496.000	496.000	490.990
Basin26	Basin26	490.000	490.000	475.000
N477	N477	485.760	485.760	474.000
Basin25	Basin25	482.590	482.590	478.000
Node116	Node116	468.000	468.000	464.000
Node96	Node96	463.000	463.000	458.164
Node99	Node99	449.000	449.000	443.000
Basin21	Basin21	447.000	447.000	441.000
Basin22	Basin22	446.000	446.000	440.000
N404	N404	445.000	445.000	439.290
Basin20	Basin20	446.000	446.000	443.000
Node206	Node206	446.000	446.000	443.000
Node105	Node105	445.000	445.000	439.630
Node205	Node205	445.000	445.000	437.000
Node107	Node107	450.000	450.000	436.000
Node108	Node108	447.000	447.000	435.000
N177	N177	459.230	459.230	450.000

Appendix C.2

Model Calibration

Calibration Sites Map

STORM WATER MONITORING LOCATIONS

ID	SIZE	DESCRIPTION	TEST SEQUENCE*
1	24"	PLACE IN N. END OF VAULT (d/s)	1
2	30"	PLACE IN OUTFALL	2
3	18"	PLACE IN MANHOLE	1
4	12"	PLACE IN CB	3
5	18"	PLACE IN S. SIDE OF MANHOLE	2
6	18"	PLACE IN CB (LOCATED IN BLACKBERRY BUSHES)	3
7	48"	AT OUTFALL OR MANHOLE	4
8	24"	DOWNSTREAM SIDE OF MH	4
9	18"	PLACE IN DOWNSTREAM SIDE OF CB	5
10	24"?	ACCESS UNKNOWN	5

* ORDER OF TESTS (TWO FLOW METERS)

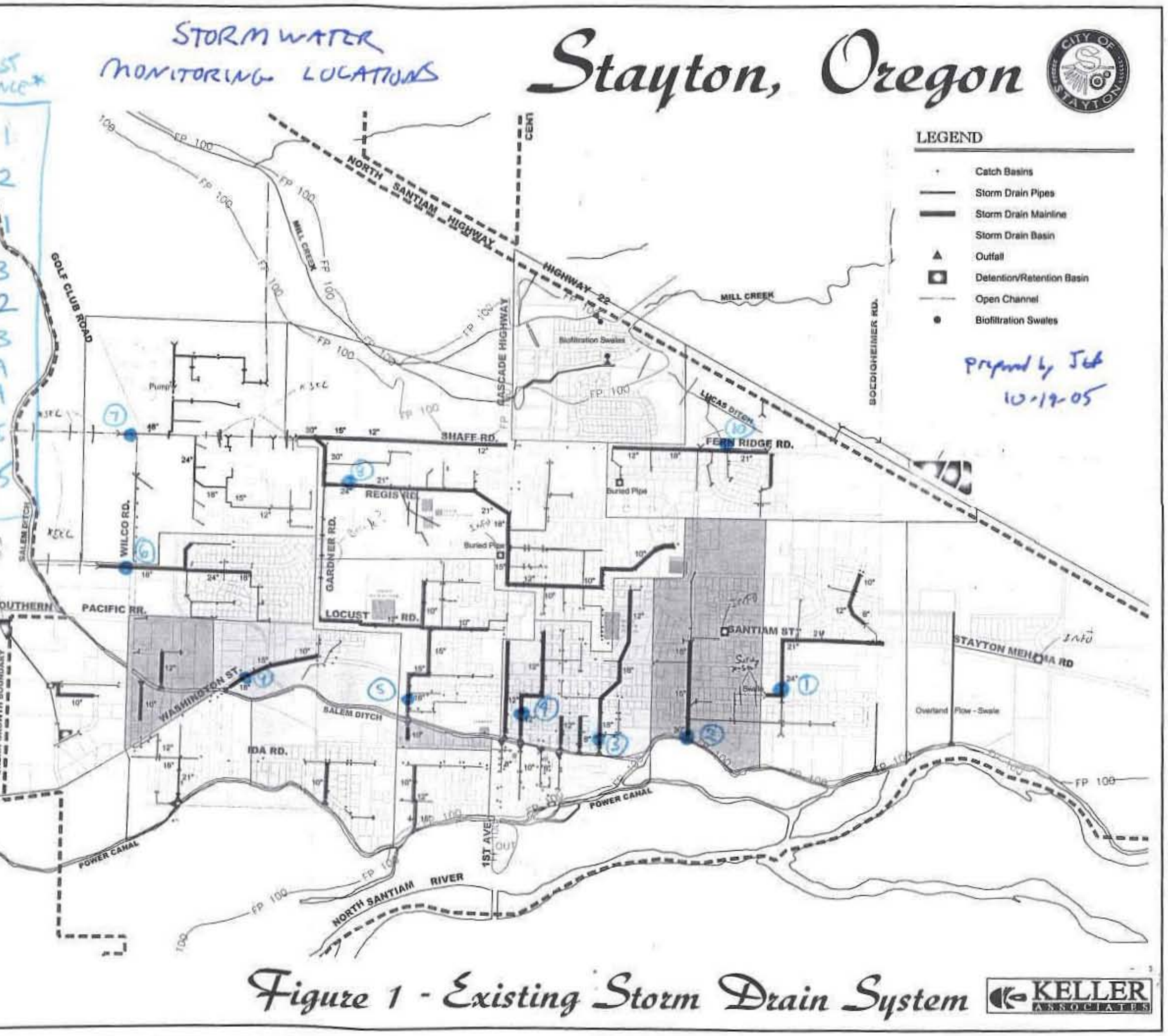
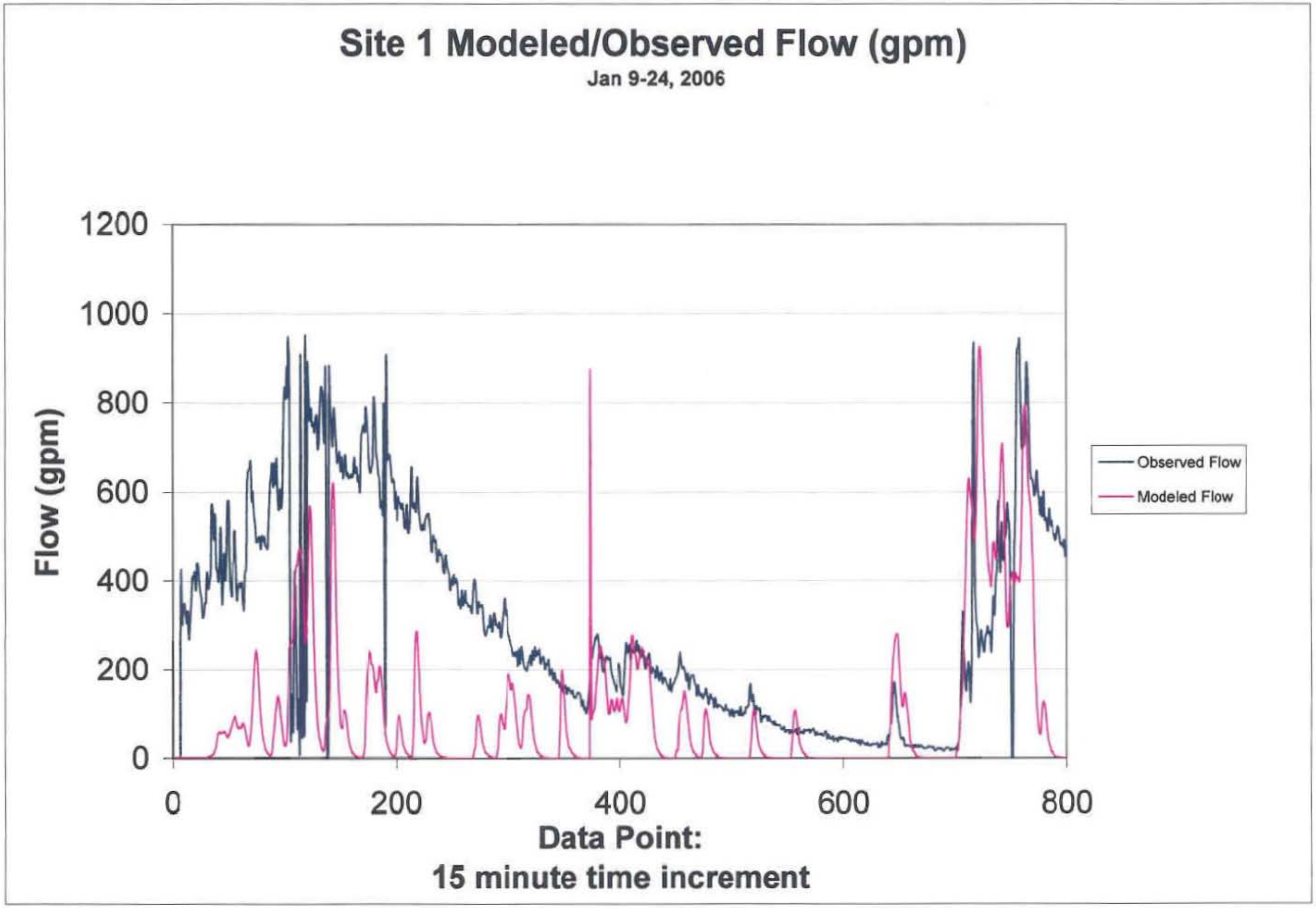
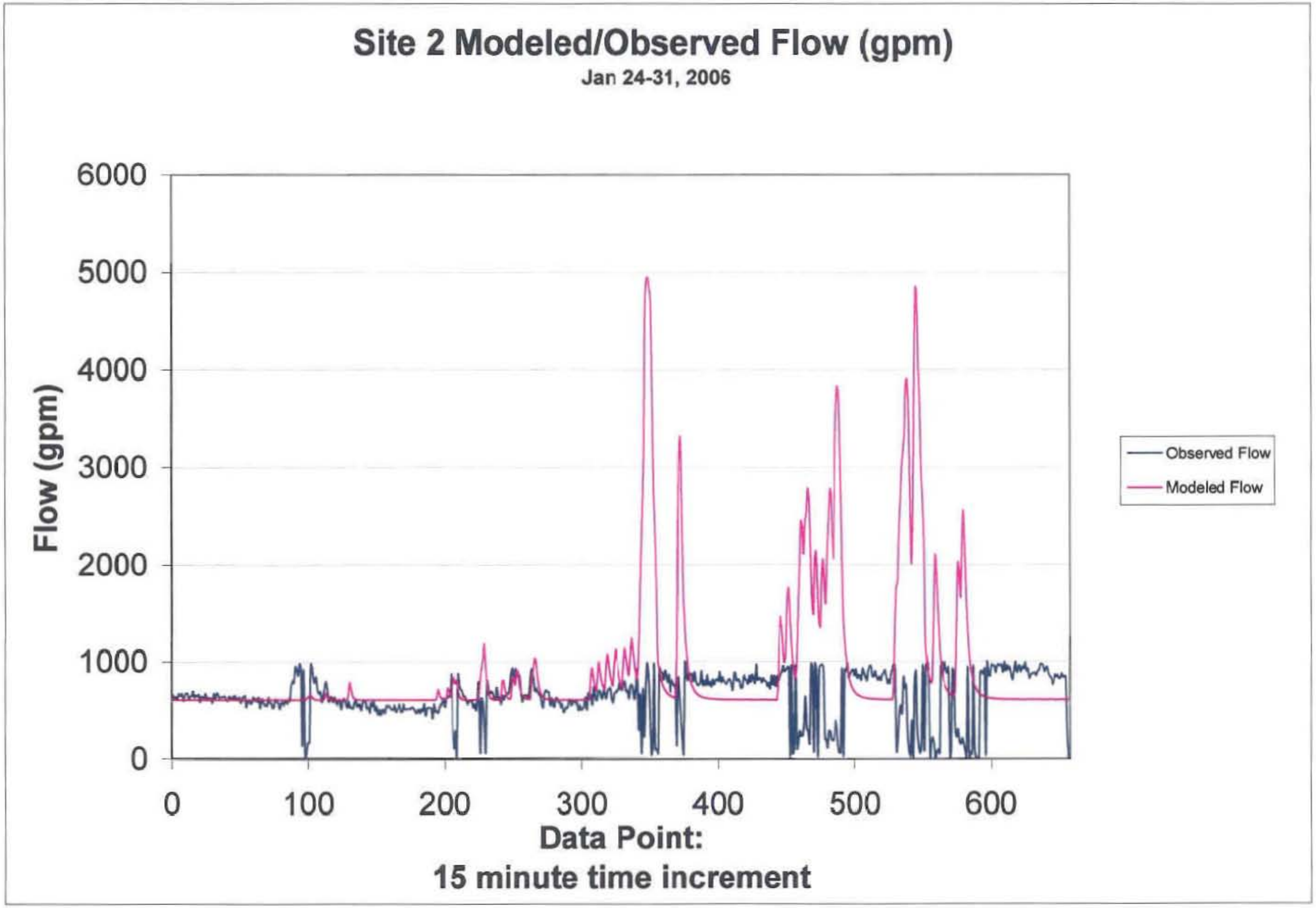


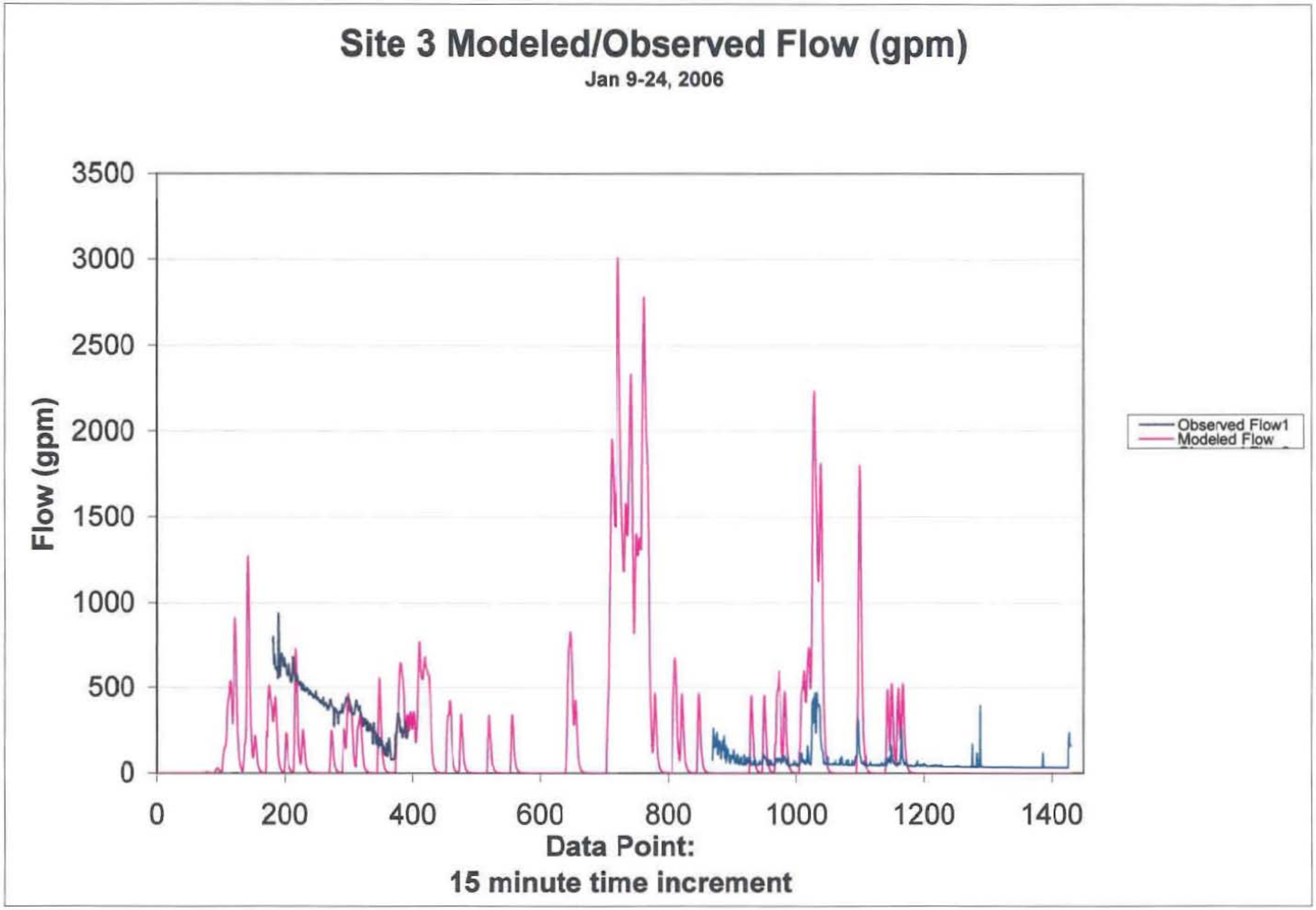
Figure 1 - Existing Storm Drain System

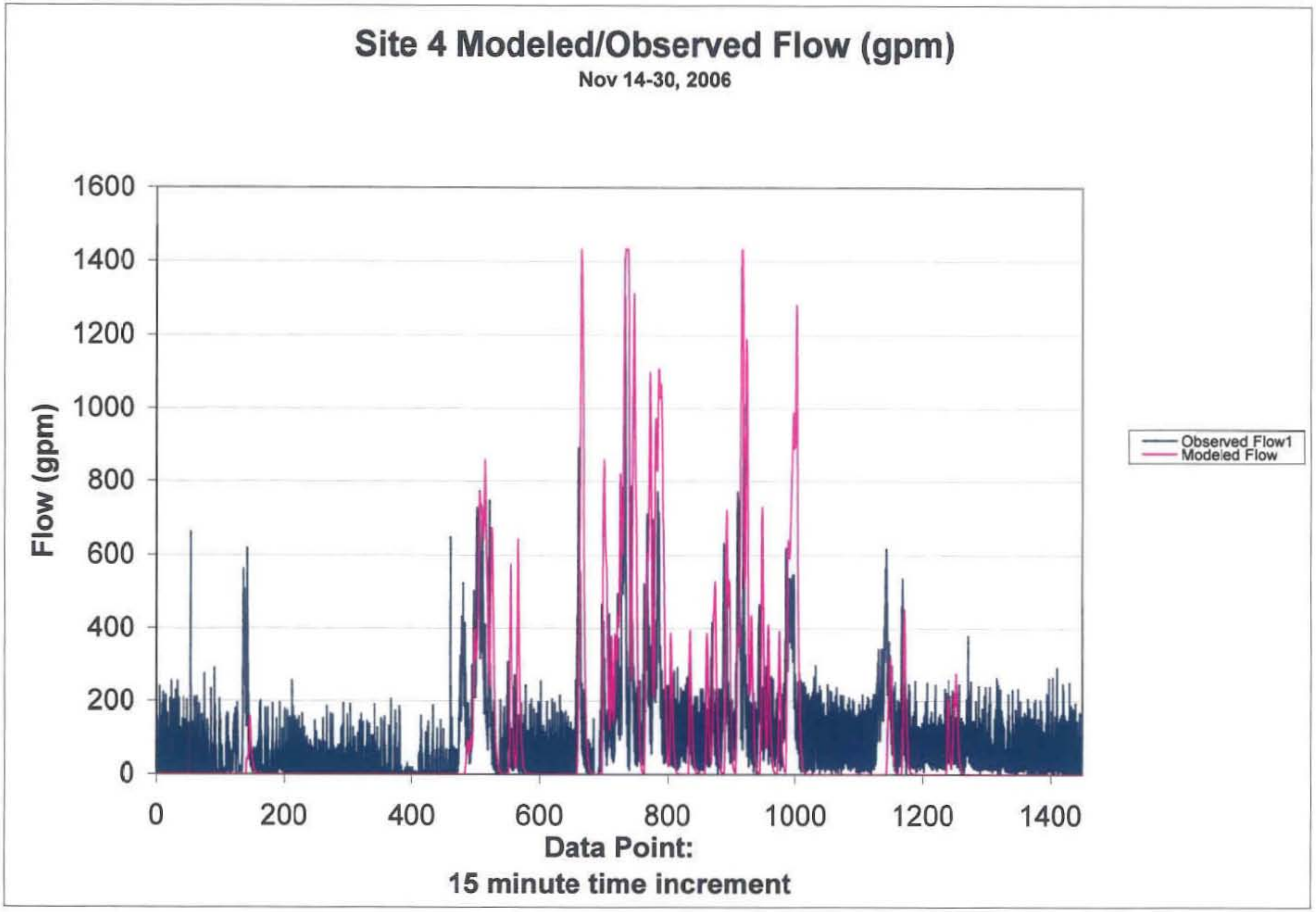
KELLER ASSOCIATES

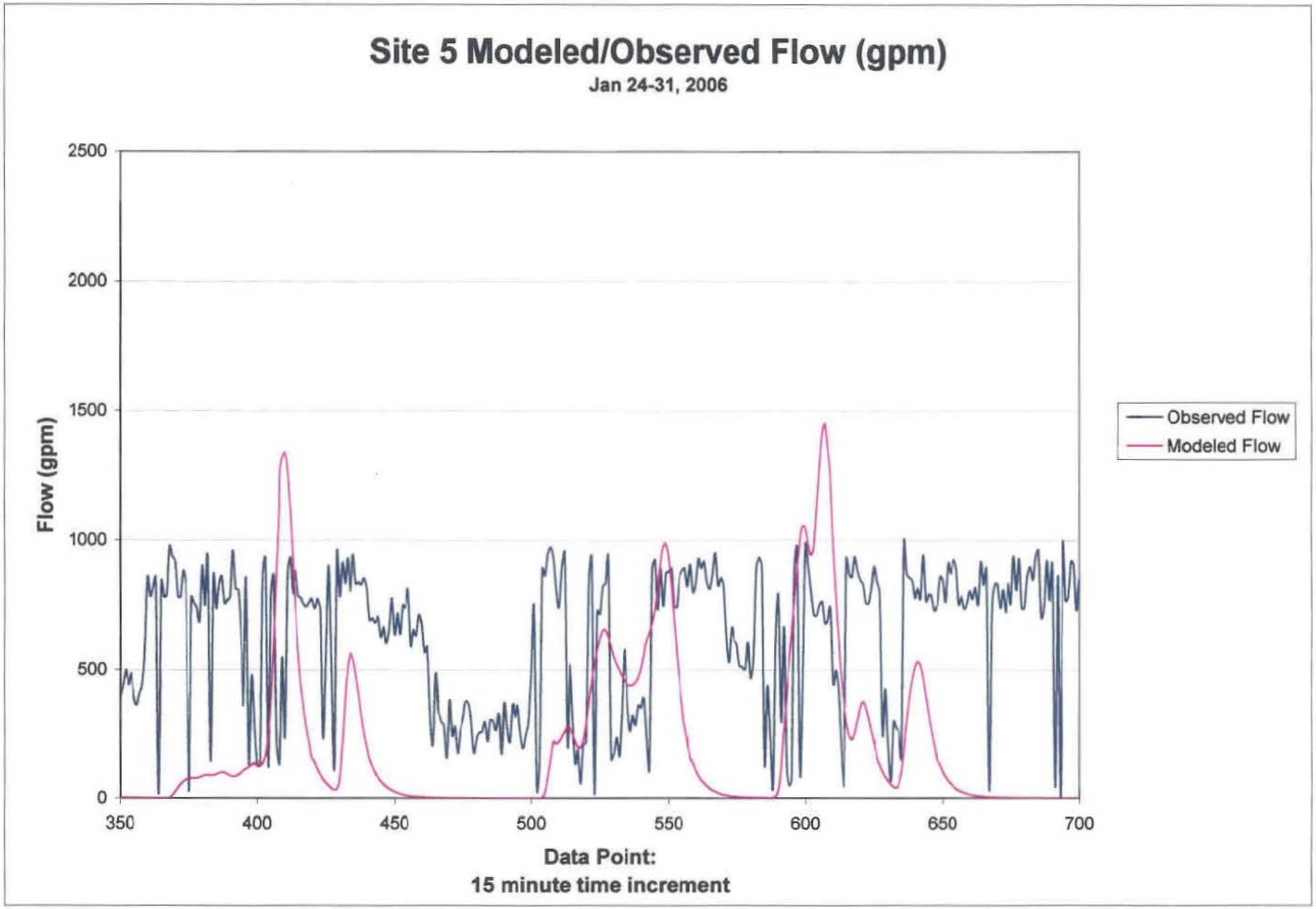

Site 1 Modeled/Observed Flow (gpm)
Jan 9-24, 2006
Flow (gpm)
1200
1000
800
600
400
200
0
0
200
400
600
800
Data Point:
15 minute time increment
Observed Flow
Modeled Flow

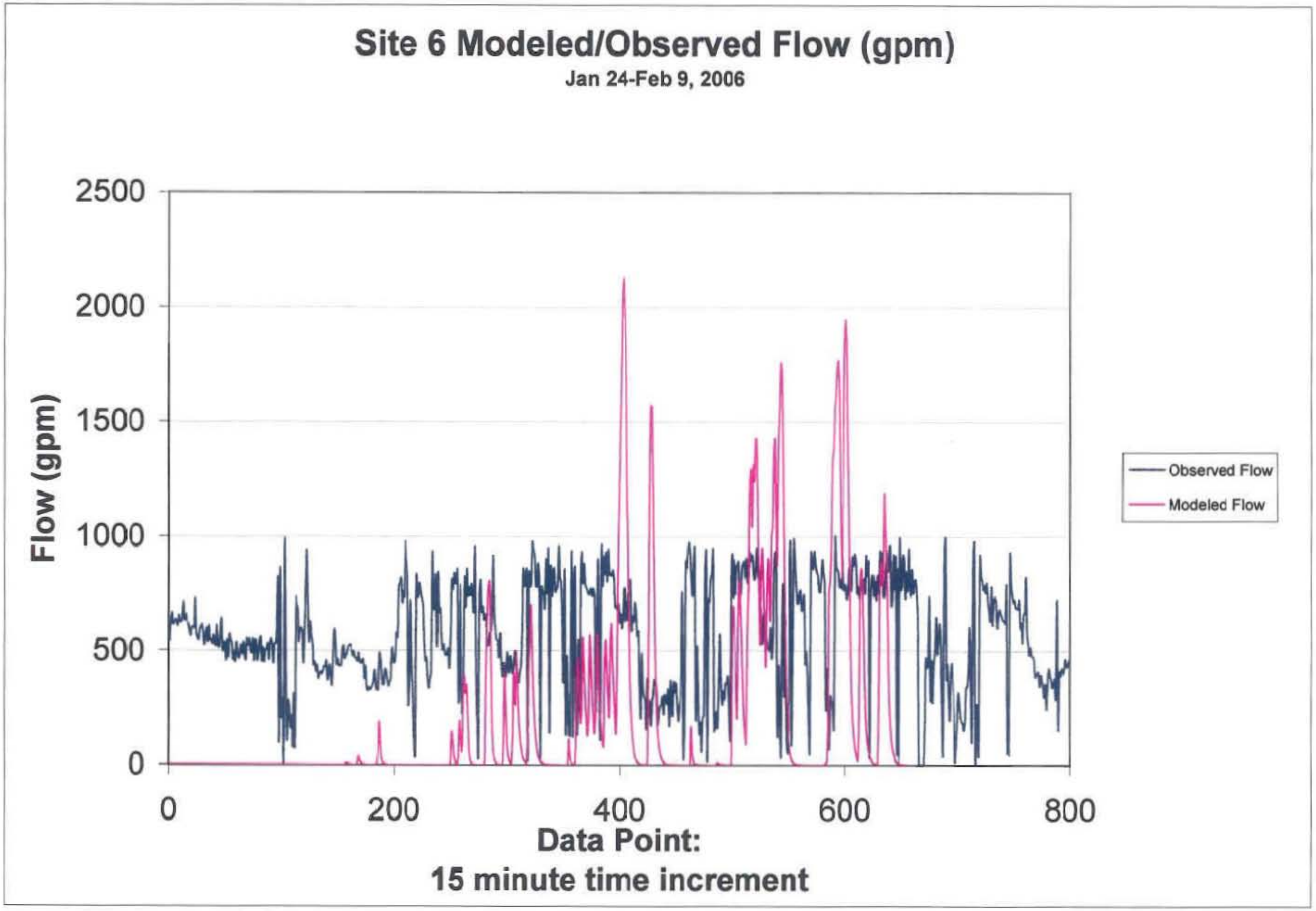


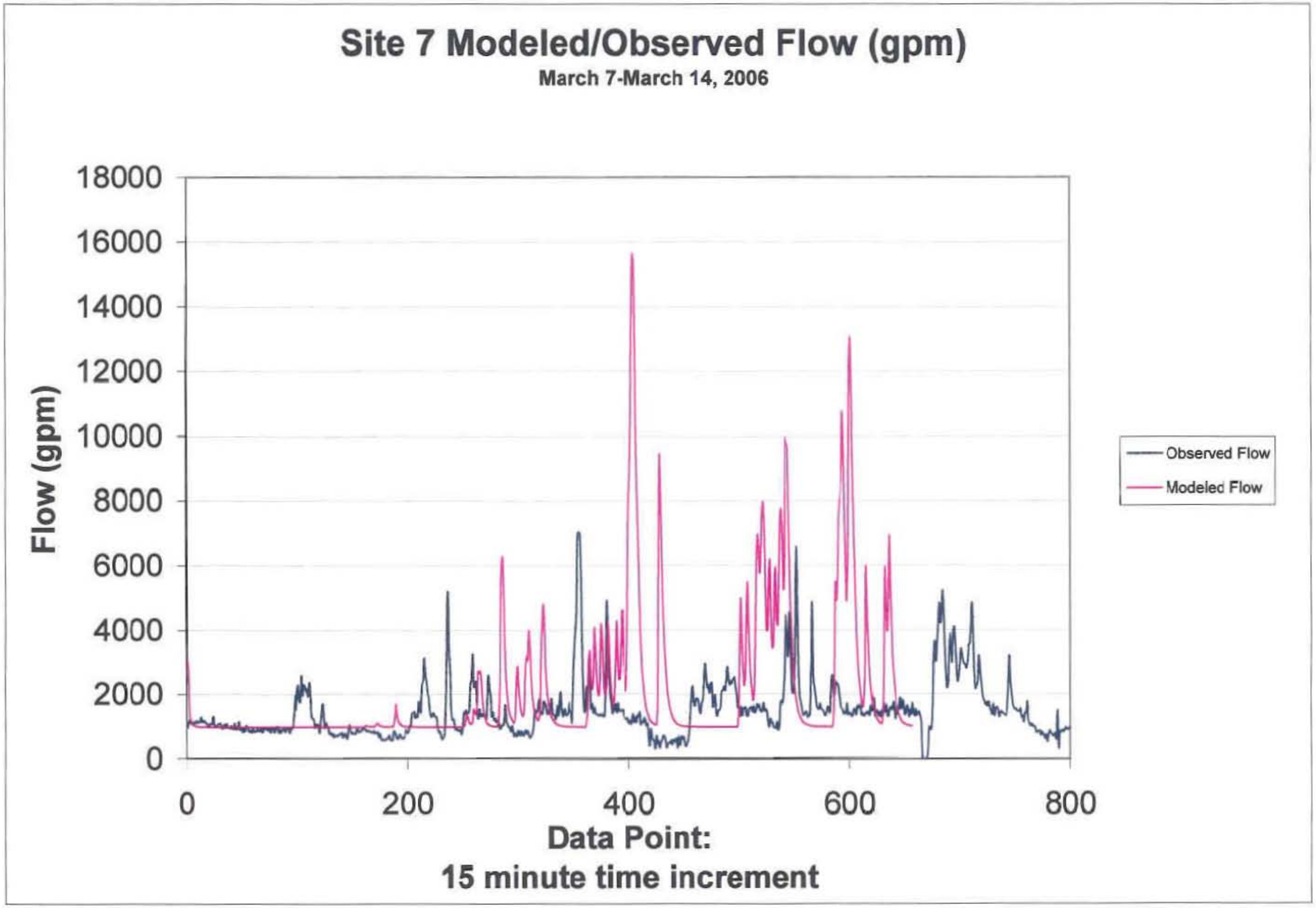
Site 2 Modeled/Observed Flow (gpm)
Jan 24-31, 2006
6000
5000
4000
3000
2000
1000
0
Flow (gpm)
0
100
200
300
400
500
600
Data Point:
15 minute time increment
Observed Flow
Modeled Flow


Site 3 Modeled/Observed Flow (gpm)
Jan 9-24, 2006
3500
3000
2500
2000
1500
1000
500
0
Flow (gpm)
0
200
400
600
800
1000
1200
1400
Data Point:
15 minute time increment
Observed Flow1
Modeled Flow

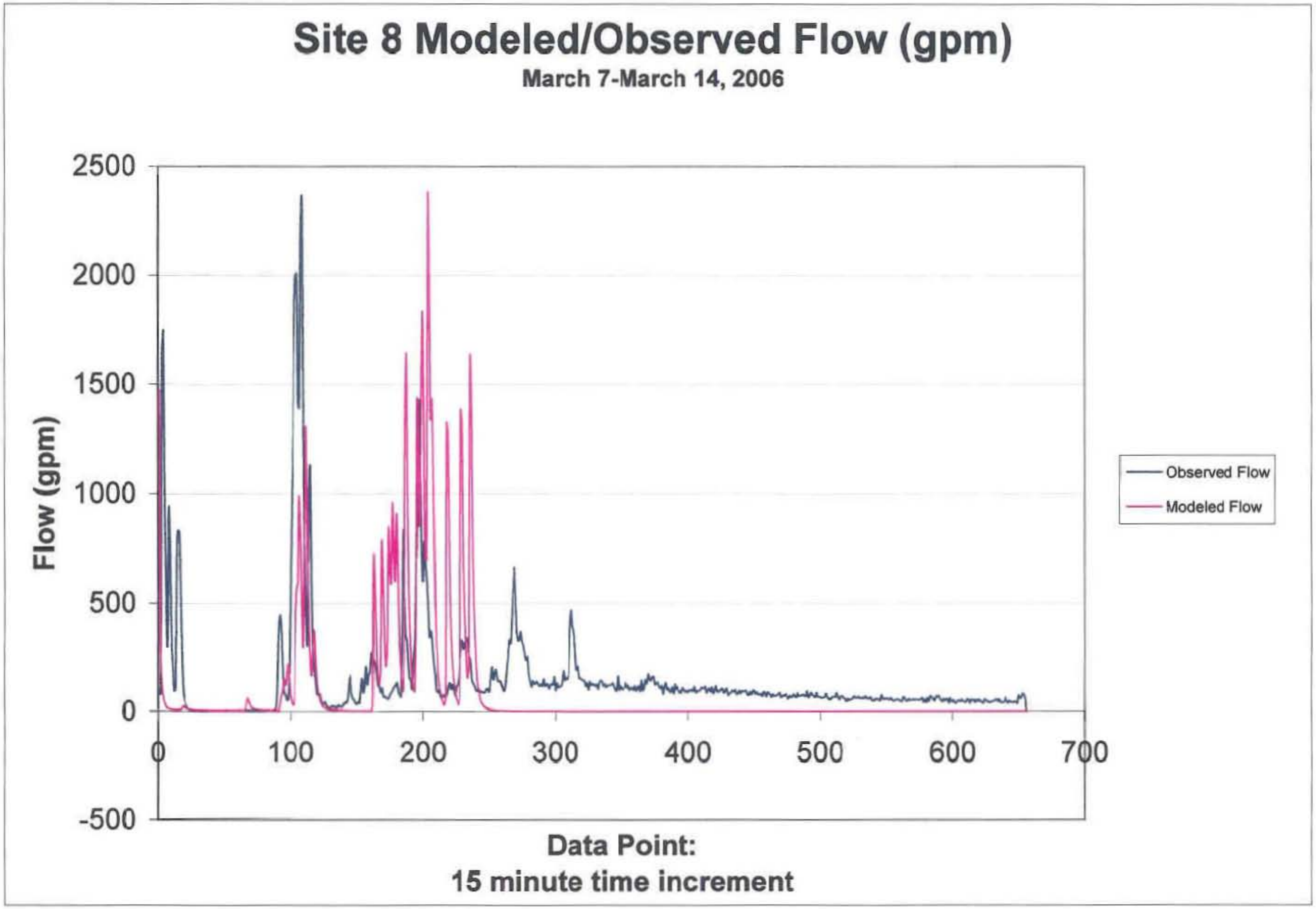

Site 4 Modeled/Observed Flow (gpm)
Nov 14-30, 2006
Flow (gpm)
1600
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
Data Point:
15 minute time increment
Observed Flow1
Modeled Flow

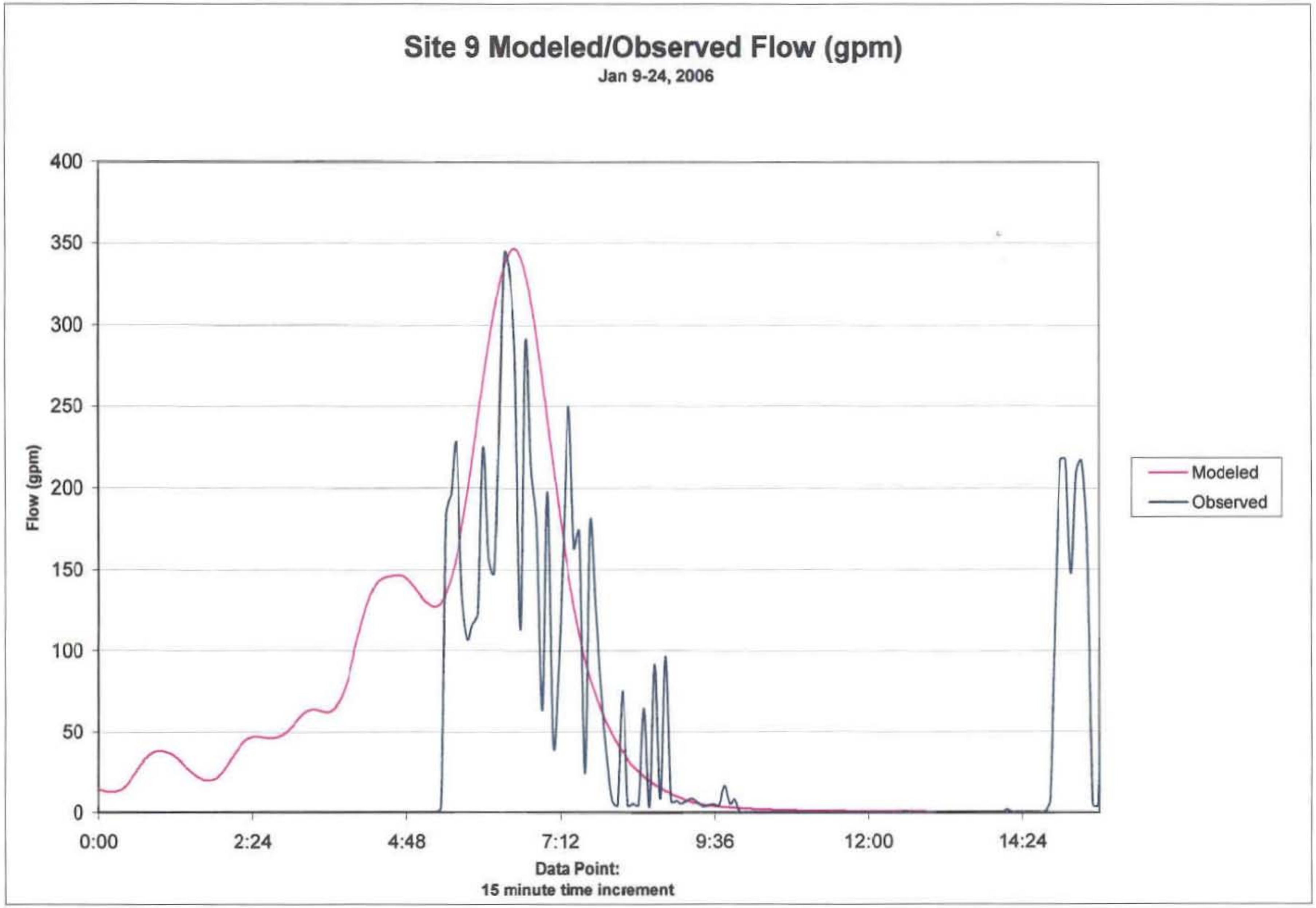

Site 5 Modeled/Observed Flow (gpm)
Jan 24-31, 2006
Flow (gpm)
2500
2000
1500
1000
500
0
350
400
450
500
550
600
650
700
Data Point:
15 minute time increment
Observed Flow
Modeled Flow

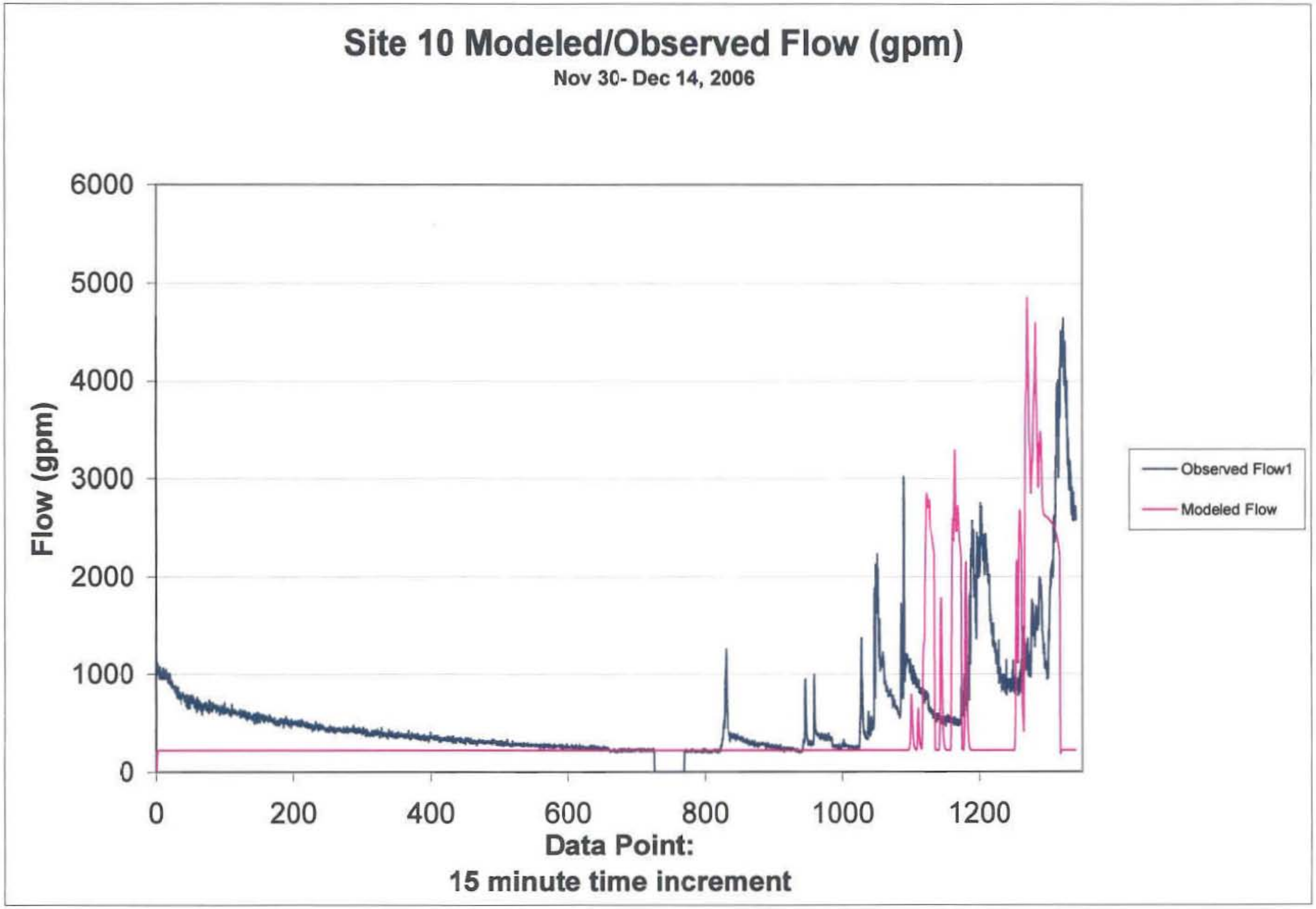

Site 6 Modeled/Observed Flow (gpm)
Jan 24-Feb 9, 2006
Flow (gpm)
2500
2000
1500
1000
500
0
0
200
400
600
800
Data Point:
15 minute time increment
Observed Flow
Modeled Flow



Site 7 Modeled/Observed Flow (gpm)
March 7-March 14, 2006
Flow (gpm)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
200
400
600
800
Data Point:
15 minute time increment
Observed Flow
Modeled Flow


Site 8 Modeled/Observed Flow (gpm)
March 7-March 14, 2006
Flow (gpm)
2500
2000
1500
1000
500
0
-500
0
100
200
300
400
500
600
700
Data Point:
15 minute time increment
Observed Flow
Modeled Flow


Site 9 Modeled/Observed Flow (gpm)
Jan 9-24, 2006
Flow (gpm)
400
350
300
250
200
150
100
50
0
0:00
2:24
4:48
7:12
9:36
12:00
14:24
Data Point:
15 minute time increment
Modeled
Observed



Site 10 Modeled/Observed Flow (gpm)
Nov 30- Dec 14, 2006
Flow (gpm)
6000
5000
4000
3000
2000
1000
0
0
200
400
600
800
1000
1200
Data Point:
15 minute time increment
Observed Flow1
Modeled Flow

Appendix C.3

Model Results

Subcatchment Results

2-year Storm Event: 2.5 inches

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin75	2.500	0.785	1.715	0.482	3.281
Node35	2.500	1.187	1.313	0.357	0.817
Basin76.1	2.500	1.187	1.313	0.357	0.817
Basin76.2	2.500	1.187	1.313	0.357	3.318
Basin70	2.500	1.182	1.318	0.357	3.182
Basin69	2.500	1.688	0.812	0.186	14.411
Basin71	2.500	1.598	0.902	0.213	3.043
Basin73	2.500	1.701	0.799	0.186	1.040
Basin73.1	2.500	1.701	0.799	0.186	1.040
Basin66	2.500	0.535	1.965	0.566	0.796
Basin67	2.500	0.528	1.972	0.566	0.809
Basin54	2.500	0.652	1.848	0.526	0.628
Node12	2.500	0.652	1.848	0.526	0.628
Basin55	2.500	0.531	1.969	0.566	0.118
Basin40	2.500	0.609	1.891	0.540	2.036
Basin32	2.500	1.713	0.787	0.186	2.164
Basin31C	2.500	1.467	1.033	0.265	2.108
Basin31D	2.500	1.003	1.497	0.415	2.204
Basin31B	2.500	1.513	0.987	0.265	5.197
Basin38A	2.500	1.744	0.756	0.186	1.272
N103	2.500	1.719	0.781	0.186	0.653
Basin38B	2.500	1.719	0.781	0.186	0.653
Basin39	2.500	1.762	0.738	0.186	1.340
Basin45	2.500	1.318	1.182	0.313	0.907
Basin46	2.500	0.525	1.975	0.566	0.387
Basin52	2.500	1.322	1.178	0.313	2.644
Basin54.1	2.500	1.322	1.178	0.313	1.321
Basin62	2.500	0.570	1.930	0.553	0.361
Basin59	2.500	0.575	1.925	0.553	0.745
Basin61	2.500	0.570	1.930	0.553	0.283
Basin63	2.500	0.197	2.303	0.602	0.369
Basin64	2.500	0.570	1.930	0.553	0.353
Basin65	2.500	0.743	1.757	0.497	0.339
Basin37	2.500	1.703	0.797	0.186	3.278
Basin43.2	2.500	1.314	1.186	0.313	7.802
Basin43.1	2.500	1.314	1.186	0.313	1.949
Basin44	2.500	0.652	1.848	0.526	0.766
Basin36.1	2.500	1.541	0.959	0.240	3.174
Basin35	2.500	1.541	0.959	0.240	1.315
Basin36.2	2.500	1.541	0.959	0.240	3.174
Basin30	2.500	1.774	0.726	0.158	5.105
Basin13	2.500	0.946	1.554	0.433	3.455
Basin14	2.500	1.002	1.498	0.415	3.588
Basin68	2.500	1.001	1.499	0.415	7.129
Basin57	2.500	0.699	1.801	0.512	1.468
Basin58	2.500	0.947	1.553	0.433	2.942
Basin49	2.500	1.249	1.251	0.335	3.027
Basin51	2.500	1.535	0.965	0.240	5.885
Basin50	2.500	0.791	1.709	0.482	2.715

Subcatchment Results

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin48	2.500	0.520	1.980	0.566	0.467
Basin47	2.500	1.184	1.316	0.357	3.466
Basin56	2.500	0.655	1.845	0.526	0.619
Basin41	2.500	1.003	1.497	0.415	1.459
Basin42.2	2.500	1.320	1.180	0.313	3.648
Basin42.1	2.500	0.653	1.847	0.526	2.196
Basin42.3	2.500	1.978	0.522	0.101	2.616
Basin42.4	2.500	1.542	0.958	0.240	0.693
Basin34	2.500	1.774	0.726	0.158	6.025
Basin33	2.500	1.535	0.965	0.240	4.057
Basin29	2.500	0.949	1.551	0.433	6.372
Basin31A	2.500	1.526	0.974	0.240	14.001
Basin72	2.500	1.729	0.771	0.186	1.719
Basin80	2.500	1.692	0.808	0.186	2.561
Basin77.1	2.500	1.698	0.802	0.186	2.103
Basin77.2	2.500	1.698	0.802	0.186	2.103
Basin77.3	2.500	1.698	0.802	0.186	2.103
Basin77.4	2.500	1.698	0.802	0.186	2.103
Basin77.5	2.500	1.698	0.802	0.186	2.103
Basin81	2.500	1.001	1.499	0.415	0.829
Basin78	2.500	1.377	1.123	0.290	1.585
Basin82	2.500	1.120	1.380	0.377	1.596
Basin79	2.500	0.295	2.205	0.602	0.102
Basin86	2.500	0.245	2.255	0.602	0.332
Node234	2.500	0.245	2.255	0.602	0.332
Basin85	2.500	0.668	1.832	0.526	0.846
Basin92	2.500	0.462	2.038	0.602	0.380
Basin87.1	2.500	1.700	0.800	0.186	1.571
Basin87	2.500	1.700	0.800	0.186	1.786
Basin93	2.500	0.467	2.033	0.602	0.398
Basin94	2.500	0.653	1.847	0.526	0.708
Basin95	2.500	0.610	1.890	0.540	0.424
Basin97B	2.500	0.528	1.972	0.566	0.340
Basin104	2.500	0.567	1.933	0.553	1.909
Basin102	2.500	0.463	2.037	0.590	0.356
Basin97A	2.500	0.456	2.044	0.590	0.813
Basin103	2.500	0.598	1.902	0.540	0.905
Basin105	2.500	0.659	1.841	0.526	1.254
Basin91	2.500	0.454	2.046	0.590	0.642
Basin99	2.500	0.457	2.043	0.590	0.362
Basin101	2.500	0.453	2.047	0.590	0.300
Basin98	2.500	0.567	1.933	0.553	0.536
Basin100	2.500	0.531	1.969	0.566	0.389
Basin96	2.500	0.531	1.969	0.566	0.600
Basin88	2.500	0.174	2.326	0.602	0.419
Basin60	2.500	0.571	1.929	0.553	0.711
Basin74	2.500	0.525	1.975	0.566	1.153
Basin23.2	2.500	1.059	1.441	0.397	1.990
Basin23.1	2.500	1.059	1.441	0.397	1.990

Subcatchment Results

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin83	2.500	0.886	1.614	0.450	4.627
Basin89	2.500	0.698	1.802	0.512	5.688
N447.1	2.500	0.948	1.552	0.433	2.216
Basin90.1	2.500	0.697	1.803	0.512	0.592
Basin90.2	2.500	0.570	1.930	0.553	0.387
Basin84	2.500	0.889	1.611	0.450	1.262
Basin24	2.500	1.035	1.465	0.397	1.580
Basin28	2.500	0.744	1.756	0.497	10.543
Basin27	2.500	0.699	1.801	0.512	4.586
Basin26	2.500	0.739	1.761	0.497	1.674
Basin25	2.500	1.552	0.948	0.240	3.991
Basin21	2.500	1.462	1.038	0.265	6.098
Basin22	2.500	0.962	1.538	0.433	6.188
Basin20	2.500	1.461	1.039	0.265	10.454

Subcatchment Results

10-year Storm Event: 3.5 inches

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin75	3.500	1.492	2.008	0.549	7.583
Basin76.1	3.500	2.031	1.469	0.378	1.521
Basin76.2	3.500	2.031	1.469	0.378	6.175
Basin70	3.500	2.022	1.478	0.378	5.865
Basin69	3.500	2.629	0.871	0.175	22.838
Basin71	3.500	2.522	0.978	0.205	4.950
Basin73	3.500	2.649	0.851	0.175	3.295
Basin66	3.500	1.134	2.366	0.670	2.719
Basin67	3.500	1.120	2.380	0.670	2.833
Basin54	3.500	1.305	2.195	0.612	5.386
Basin55	3.500	1.125	2.375	0.670	0.354
Basin40	3.500	1.241	2.259	0.632	5.673
Basin32	3.500	2.668	0.832	0.175	3.447
Basin31C	3.500	2.377	1.123	0.265	3.577
Basin31D	3.500	1.792	1.708	0.456	4.465
Basin31B	3.500	2.452	1.048	0.265	8.727
Basin38A	3.500	2.716	0.784	0.175	2.019
Basin38B	3.500	2.677	0.823	0.175	1.031
Basin39	3.500	2.743	0.757	0.175	2.122
Basin45	3.500	2.194	1.306	0.323	1.600
Basin46	3.500	1.113	2.387	0.670	1.355
Basin52	3.500	2.201	1.299	0.323	4.689
Basin62	3.500	1.184	2.316	0.651	0.983
Basin59	3.500	1.194	2.306	0.651	2.045
Basin61	3.500	1.184	2.316	0.651	0.785
Basin63	3.500	0.576	2.924	0.843	0.880
Basin64	3.500	1.186	2.314	0.651	1.119
Basin65	3.500	1.435	2.065	0.571	0.833
Basin37	3.500	2.653	0.847	0.175	5.195
Basin43.2	3.500	2.188	1.312	0.323	13.876
Basin43.1	3.500	2.188	1.312	0.323	3.465
Basin44	3.500	1.306	2.194	0.612	2.099
Basin36.1	3.500	2.464	1.036	0.235	5.261
Basin35	3.500	2.464	1.036	0.235	2.180
Basin36.2	3.500	2.464	1.036	0.235	5.261
Basin30	3.500	2.727	0.773	0.146	7.928
Basin13	3.500	1.716	1.784	0.480	7.215
Basin14	3.500	1.790	1.710	0.456	7.252
Basin68	3.500	1.788	1.712	0.456	14.272
Basin57	3.500	1.375	2.125	0.592	3.807
Basin58	3.500	1.717	1.783	0.480	6.152
Basin49	3.500	2.107	1.393	0.351	5.505
Basin51	3.500	2.455	1.045	0.235	9.706
Basin50	3.500	1.504	1.996	0.549	6.172
Basin48	3.500	1.102	2.398	0.670	1.608
Basin47	3.500	2.025	1.475	0.378	6.431
Basin56	3.500	1.311	2.189	0.612	1.706
Basin41	3.500	1.793	1.707	0.456	2.959
Basin42.2	3.500	2.198	1.302	0.323	6.460

Subcatchment Results

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin42.1	3.500	1.307	2.193	0.612	5.733
Basin42.3	3.500	2.961	0.539	0.108	3.911
Basin42.4	3.500	2.466	1.034	0.235	1.147
Basin34	3.500	2.727	0.773	0.146	9.347
Basin33	3.500	2.455	1.045	0.235	6.742
Basin29	3.500	1.721	1.779	0.480	13.105
Basin31A	3.500	2.441	1.059	0.235	23.136
Basin72	3.500	2.693	0.807	0.175	2.712
Basin80	3.500	2.634	0.866	0.175	4.056
Basin77.1	3.500	2.645	0.855	0.175	3.335
Basin77.2	3.500	2.645	0.855	0.175	3.335
Basin77.3	3.500	2.645	0.855	0.175	3.335
Basin77.4	3.500	2.645	0.855	0.175	3.335
Basin77.5	3.500	2.645	0.855	0.175	3.335
Basin81	3.500	1.788	1.712	0.456	1.659
Basin78	3.500	2.262	1.238	0.294	2.735
Basin82	3.500	1.944	1.556	0.405	3.055
Basin79	3.500	0.747	2.753	0.788	0.363
Basin86	3.500	0.663	2.837	0.819	0.786
Basin85	3.500	1.336	2.164	0.612	2.331
Basin92	3.500	1.063	2.437	0.734	1.083
Basin87.1	3.500	2.648	0.852	0.175	2.501
Basin87	3.500	2.648	0.852	0.175	2.843
Basin93	3.500	1.076	2.424	0.734	1.219
Basin94	3.500	1.307	2.193	0.612	1.931
Basin95	3.500	1.245	2.255	0.632	1.223
Basin97B	3.500	1.120	2.380	0.670	1.054
Basin104	3.500	1.178	2.322	0.651	6.112
Basin102	3.500	1.026	2.474	0.705	1.602
Basin97A	3.500	1.009	2.491	0.705	3.655
Basin103	3.500	1.219	2.281	0.632	2.666
Basin105	3.500	1.318	2.182	0.612	3.389
Basin91	3.500	1.006	2.494	0.705	2.517
Basin99	3.500	1.013	2.487	0.705	1.162
Basin101	3.500	1.004	2.496	0.705	0.832
Basin98	3.500	1.179	2.321	0.651	1.583
Basin100	3.500	1.126	2.374	0.670	1.276
Basin96	3.500	1.127	2.373	0.670	2.088
Basin88	3.500	0.532	2.968	0.844	1.027
Basin60	3.500	1.188	2.312	0.651	1.924
Basin74	3.500	1.113	2.387	0.670	4.035
Basin23.1	3.500	1.864	1.636	0.431	7.736
Basin23.2	3.500	1.864	1.636	0.431	7.736
Basin83	3.500	1.631	1.869	0.504	9.913
Basin89	3.500	1.372	2.128	0.592	13.864
Basin90.1	3.500	1.371	2.129	0.592	1.528
Basin90.2	3.500	1.184	2.316	0.651	1.194
Basin84	3.500	1.637	1.863	0.504	2.740
Basin24	3.500	1.822	1.678	0.431	3.115

Subcatchment Results

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin28	3.500	1.438	2.062	0.571	25.375
Basin27	3.500	1.374	2.126	0.592	11.900
Basin26	3.500	1.429	2.071	0.571	4.122
Basin25	3.500	2.481	1.019	0.235	6.627
Basin21	3.500	2.370	1.130	0.265	10.357
Basin22	3.500	1.745	1.755	0.480	12.476
Basin20	3.500	2.368	1.132	0.265	17.660

Subcatchment Results

25-year Storm Event: 4.0 inches

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin75	4.000	1.881	2.119	0.570	10.037
Basin76.1	4.000	2.476	1.524	0.381	1.894
Basin76.2	4.000	2.476	1.524	0.381	7.689
Basin70	4.000	2.465	1.535	0.381	7.282
Basin69	4.000	3.108	0.892	0.169	27.100
Basin71	4.000	2.995	1.005	0.199	5.917
Basin73	4.000	3.132	0.868	0.169	1.947
Basin73.1	4.000	3.132	0.868	0.169	1.947
Basin66	4.000	1.477	2.523	0.709	3.921
Basin67	4.000	1.458	2.542	0.709	4.085
Basin54	4.000	1.671	2.329	0.642	2.344
Node12	4.000	1.671	2.329	0.642	2.344
Basin55	4.000	1.466	2.534	0.709	0.504
Basin40	4.000	1.598	2.402	0.665	7.875
Basin32	4.000	3.154	0.846	0.169	4.092
Basin31C	4.000	2.847	1.153	0.261	4.333
Basin31D	4.000	2.215	1.785	0.466	5.697
Basin31B	4.000	2.937	1.063	0.261	10.543
Basin38A	4.000	3.211	0.789	0.169	2.395
Basin38B	4.000	3.166	0.834	0.169	1.222
Basin39	4.000	3.244	0.756	0.169	2.516
Basin45	4.000	2.651	1.349	0.321	1.960
Basin46	4.000	1.450	2.550	0.709	1.950
Basin52	4.000	2.659	1.341	0.321	5.766
Basin54.1	4.000	2.659	1.341	0.321	2.881
Basin62	4.000	1.534	2.466	0.687	1.370
Basin59	4.000	1.547	2.453	0.687	2.850
Basin61	4.000	1.534	2.466	0.687	1.096
Basin63	4.000	0.817	3.183	0.916	1.233
Basin64	4.000	1.535	2.465	0.687	1.586
Basin65	4.000	1.818	2.182	0.595	1.118
Basin37	4.000	3.137	0.863	0.169	6.158
Basin43.2	4.000	2.644	1.356	0.321	17.053
Basin43.1	4.000	2.644	1.356	0.321	4.259
Basin44	4.000	1.672	2.328	0.642	2.885
Basin36.1	4.000	2.938	1.062	0.230	6.325
Basin35	4.000	2.938	1.062	0.230	2.621
Basin36.2	4.000	2.938	1.062	0.230	6.325
Basin30	4.000	3.211	0.789	0.140	9.339
Basin13	4.000	2.131	1.869	0.493	9.277
Basin14	4.000	2.213	1.787	0.466	9.242
Basin68	4.000	2.209	1.791	0.466	18.141
Basin57	4.000	1.751	2.249	0.619	5.156
Basin58	4.000	2.133	1.867	0.493	7.920
Basin49	4.000	2.557	1.443	0.351	6.809
Basin51	4.000	2.928	1.072	0.230	11.659
Basin50	4.000	1.895	2.105	0.570	8.151
Basin48	4.000	1.436	2.564	0.709	2.316
Basin47	4.000	2.469	1.531	0.381	8.001

Subcatchment Results

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin56	4.000	1.678	2.322	0.642	2.337
Basin41	4.000	2.215	1.785	0.466	3.779
Basin42.2	4.000	2.656	1.344	0.321	7.925
Basin42.1	4.000	1.673	2.327	0.642	7.838
Basin42.3	4.000	3.457	0.543	0.120	4.554
Basin42.4	4.000	2.941	1.059	0.230	1.379
Basin34	4.000	3.211	0.789	0.140	11.007
Basin33	4.000	2.927	1.073	0.230	8.112
Basin29	4.000	2.137	1.863	0.493	16.839
Basin31A	4.000	2.911	1.089	0.230	27.785
Basin72	4.000	3.184	0.816	0.169	3.210
Basin80	4.000	3.115	0.885	0.169	4.806
Basin77.1	4.000	3.127	0.873	0.169	3.954
Basin77.2	4.000	3.127	0.873	0.169	3.954
Basin77.3	4.000	3.127	0.873	0.169	3.954
Basin77.4	4.000	3.127	0.873	0.169	3.954
Basin77.5	4.000	3.127	0.873	0.169	3.954
Basin81	4.000	2.209	1.791	0.466	2.109
Basin78	4.000	2.720	1.280	0.291	3.329
Basin82	4.000	2.381	1.619	0.410	3.843
Basin79	4.000	1.022	2.978	0.845	0.644
Basin86	4.000	0.923	3.077	0.882	1.316
Basin85	4.000	1.711	2.289	0.642	3.205
Basin92	4.000	1.410	2.590	0.764	1.674
Basin87.1	4.000	3.131	0.869	0.169	2.969
Basin87	4.000	3.131	0.869	0.169	3.375
Basin93	4.000	1.427	2.573	0.764	1.913
Basin94	4.000	1.674	2.326	0.642	2.654
Basin95	4.000	1.602	2.398	0.665	1.704
Basin97B	4.000	1.460	2.540	0.709	1.510
Basin104	4.000	1.526	2.474	0.687	8.657
Basin102	4.000	1.354	2.646	0.750	2.389
Basin97A	4.000	1.331	2.669	0.750	5.461
Basin103	4.000	1.570	2.430	0.665	3.719
Basin105	4.000	1.688	2.312	0.642	4.660
Basin91	4.000	1.327	2.673	0.750	3.780
Basin99	4.000	1.336	2.664	0.750	1.711
Basin101	4.000	1.325	2.675	0.750	1.209
Basin98	4.000	1.527	2.473	0.687	2.234
Basin100	4.000	1.467	2.533	0.709	1.836
Basin96	4.000	1.468	2.532	0.709	3.004
Basin88	4.000	0.763	3.237	0.933	1.433
Basin60	4.000	1.538	2.462	0.687	2.676
Basin74	4.000	1.450	2.550	0.709	5.806
Basin23.2	4.000	2.293	1.707	0.438	4.877
Basin23.1	4.000	2.293	1.707	0.438	4.877
Basin83	4.000	2.035	1.965	0.519	12.859
Basin89	4.000	1.747	2.253	0.619	18.649
Basin90.1	4.000	1.746	2.254	0.619	2.075

Subcatchment Results

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin90.2	4.000	1.534	2.466	0.687	1.687
Basin84	4.000	2.042	1.958	0.519	3.566
Basin24	4.000	2.241	1.759	0.438	3.946
Basin28	4.000	1.821	2.179	0.595	33.976
Basin27	4.000	1.749	2.251	0.619	16.133
Basin26	4.000	1.810	2.190	0.595	5.518
Basin25	4.000	2.959	1.041	0.230	7.975
Basin21	4.000	2.838	1.162	0.261	12.547
Basin22	4.000	2.166	1.834	0.493	15.982
Basin20	4.000	2.836	1.164	0.261	21.384

Subcatchment Results

50-year Storm Event: 4.5 inches

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin75	4.500	2.285	2.215	0.586	12.617
Basin76.1	4.500	2.930	1.570	0.381	2.275
Basin76.2	4.500	2.930	1.570	0.381	9.235
Basin70	4.500	2.918	1.582	0.381	8.728
Basin69	4.500	3.591	0.909	0.163	31.359
Basin71	4.500	3.472	1.028	0.193	6.886
Basin73	4.500	3.619	0.881	0.163	2.250
Basin73.1	4.500	3.619	0.881	0.163	2.250
Basin66	4.500	1.842	2.658	0.740	5.222
Basin67	4.500	1.818	2.682	0.740	5.440
Basin54	4.500	2.055	2.445	0.665	3.031
Node12	4.500	2.055	2.445	0.665	3.031
Basin55	4.500	1.828	2.672	0.740	0.668
Basin40	4.500	1.974	2.526	0.691	10.260
Basin32	4.500	3.645	0.855	0.163	4.738
Basin31C	4.500	3.323	1.177	0.255	5.098
Basin31D	4.500	2.650	1.850	0.471	6.975
Basin31B	4.500	3.428	1.072	0.255	12.379
Basin38A	4.500	3.711	0.789	0.163	2.770
Basin38B	4.500	3.658	0.842	0.163	1.413
Basin39	4.500	3.748	0.752	0.163	2.909
Basin45	4.500	3.116	1.384	0.318	2.325
Basin46	4.500	1.808	2.692	0.740	2.602
Basin52	4.500	3.125	1.375	0.318	6.859
Basin54.1	4.500	3.125	1.375	0.318	3.427
Basin62	4.500	1.904	2.596	0.716	1.788
Basin59	4.500	1.920	2.580	0.716	3.723
Basin61	4.500	1.903	2.597	0.716	1.434
Basin63	4.500	1.085	3.415	0.976	1.845
Basin64	4.500	1.906	2.594	0.716	2.090
Basin65	4.500	2.218	2.282	0.613	1.419
Basin37	4.500	3.624	0.876	0.163	7.120
Basin43.2	4.500	3.107	1.393	0.318	20.279
Basin43.1	4.500	3.107	1.393	0.318	5.064
Basin44	4.500	2.057	2.443	0.665	3.728
Basin36.1	4.500	3.418	1.082	0.224	7.393
Basin35	4.500	3.418	1.082	0.224	3.063
Basin36.2	4.500	3.418	1.082	0.224	7.393
Basin30	4.500	3.697	0.803	0.144	10.745
Basin13	4.500	2.559	1.941	0.501	11.416
Basin14	4.500	2.648	1.852	0.471	11.300
Basin68	4.500	2.644	1.856	0.471	22.136
Basin57	4.500	2.145	2.355	0.639	6.600
Basin58	4.500	2.562	1.938	0.501	9.758
Basin49	4.500	3.016	1.484	0.349	8.146
Basin51	4.500	3.406	1.094	0.224	13.620
Basin50	4.500	2.303	2.197	0.586	10.247
Basin48	4.500	1.790	2.710	0.740	3.087
Basin47	4.500	2.922	1.578	0.381	9.605

Subcatchment Results

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin56	4.500	2.065	2.435	0.665	3.019
Basin41	4.500	2.651	1.849	0.471	4.629
Basin42.2	4.500	3.122	1.378	0.318	9.411
Basin42.1	4.500	2.058	2.442	0.665	10.099
Basin42.3	4.500	3.954	0.546	0.130	5.194
Basin42.4	4.500	3.421	1.079	0.224	1.611
Basin34	4.500	3.698	0.802	0.144	12.661
Basin33	4.500	3.405	1.095	0.224	9.489
Basin29	4.500	2.566	1.934	0.501	20.728
Basin31A	4.500	3.386	1.114	0.224	32.451
Basin72	4.500	3.678	0.822	0.163	3.707
Basin80	4.500	3.599	0.901	0.163	5.555
Basin77.1	4.500	3.613	0.887	0.163	4.572
Basin77.2	4.500	3.613	0.887	0.163	4.572
Basin77.3	4.500	3.613	0.887	0.163	4.572
Basin77.4	4.500	3.613	0.887	0.163	4.572
Basin77.5	4.500	3.613	0.887	0.163	4.572
Basin81	4.500	2.644	1.856	0.471	2.573
Basin78	4.500	3.186	1.314	0.287	3.928
Basin82	4.500	2.828	1.672	0.411	4.652
Basin79	4.500	1.322	3.178	0.896	0.967
Basin86	4.500	1.209	3.291	0.936	2.007
Basin85	4.500	2.105	2.395	0.665	4.136
Basin92	4.500	1.779	2.721	0.786	2.343
Basin87.1	4.500	3.618	0.882	0.163	3.436
Basin87	4.500	3.618	0.882	0.163	3.907
Basin93	4.500	1.801	2.699	0.786	2.698
Basin94	4.500	2.059	2.441	0.665	3.432
Basin95	4.500	1.980	2.520	0.691	2.220
Basin97B	4.500	1.820	2.680	0.740	2.006
Basin104	4.500	1.894	2.606	0.716	11.396
Basin102	4.500	1.704	2.796	0.787	3.261
Basin97A	4.500	1.676	2.824	0.787	7.432
Basin103	4.500	1.940	2.560	0.691	4.847
Basin105	4.500	2.076	2.424	0.665	6.016
Basin91	4.500	1.670	2.830	0.787	5.160
Basin99	4.500	1.682	2.818	0.787	2.324
Basin101	4.500	1.668	2.832	0.787	1.628
Basin98	4.500	1.895	2.605	0.716	2.937
Basin100	4.500	1.829	2.671	0.740	2.446
Basin96	4.500	1.831	2.669	0.740	4.008
Basin88	4.500	1.022	3.478	0.996	2.233
Basin60	4.500	1.909	2.591	0.716	3.492
Basin74	4.500	1.808	2.692	0.740	7.746
Basin23.2	4.500	2.733	1.767	0.442	5.914
Basin23.1	4.500	2.733	1.767	0.442	5.914
Basin83	4.500	2.454	2.046	0.530	15.929
Basin89	4.500	2.141	2.359	0.639	23.783
Basin90.1	4.500	2.139	2.361	0.639	2.659

Subcatchment Results

Name	Total Rainfall in	Total Runoff Depth in	Total Infiltration in	Max Infil. Rate in/hr	Max Flow cfs
Basin90.2	4.500	1.903	2.597	0.716	2.222
Basin84	4.500	2.462	2.038	0.530	4.428
Basin24	4.500	2.672	1.828	0.442	4.804
Basin28	4.500	2.222	2.278	0.613	43.067
Basin27	4.500	2.143	2.357	0.639	20.636
Basin26	4.500	2.208	2.292	0.613	7.011
Basin25	4.500	3.442	1.058	0.224	9.329
Basin21	4.500	3.313	1.187	0.255	14.755
Basin22	4.500	2.602	1.898	0.501	19.616
Basin20	4.500	3.310	1.190	0.255	25.136

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Link Name	Upstream Node Name	Upstream Invert Elevation ft	Downstream Node Name	Downstream Invert Elevation ft	Length ft	Conduit Slope ft/ft	Diameter ft	n value	Design Full Flow cfs	Max Flow cfs
1383.1	Basin36.1	430.24	Basin35	428.24	301.95	0.66	1.41	0.014	6.73	4.5
1383.2	Basin36.1	430.24	Basin35	428.09	301.95	0.71	1	0.014	2.79	1.81
1544.1	N404	439.45	Node105	441.3	157.92	-1.17	3	0.014	165.07	13.24
1544.2	N404	439.29	Node105	439.63	157.92	-0.22	4.5	0.014	157.23	29.37
ditch	Node167	502.89	Node168	500	105.06	2.75	3	0.014	169.45	4.9
L111	N112	449.12	N113	447.63	300.63	0.5	1.5	0.014	6.87	2.69
L121	Basin98	453.78	Basin100	454.02	155.62	-0.15	1.5	0.014	3.83	6.63
L122	Basin100	454.02	Basin96	453.96	244.52	0.02	1.25	0.014	0.94	4.48
L122.1	Basin96	453.76	N123	451.56	397.77	0.55	1	0.014	2.46	4.93
L129	Basin101	456.24	N134	456.38	89.77	-0.16	2	0.014	8.3	9.17
L172	Basin23.1	448.07	N179	446.58	383.62	0.39	2	0.014	13.09	11.61
L173	N179	446.48	N180	446.08	176.54	0.23	2	0.014	10	11.61
L180	Basin74	492	N187	474.69	396.24	4.37	1	0.014	6.91	5.8
L202	Basin40	430.78	N220	429.77	644.96	0.16	1.75	0.014	5.82	7.87
L27	Basin48	437.31	Basin47	436.73	331.84	0.17	2.5	0.014	15.92	23.91
L92	Basin49	443.52	N94	442.36	308.27	0.38	2	0.014	12.89	17.74
L93	N94	442.36	N446	439.57	499.81	0.56	2	0.014	15.69	17.27
L93.1	N446	439.32	Basin48	437.31	424.7	0.47	2	0.014	14.45	16.9
Link106	N447.1	477.64	Basin90.1	477.32	14.67	2.18	1	0.014	4.89	12.4
Link107	Basin89	480	N447.1	477.64	388.83	0.61	4	0.014	206.54	22.89
Link108	Basin90.1	477.22	Basin90.2	473	262.27	1.61	1.25	0.014	7.61	10.08
Link109	Basin90.2	472.9	Node386	473.13	29.04	-0.79	1.5	0.014	8.68	10.69
Link110	Node386	472.98	Basin84	467.97	308.31	1.62	1.5	0.014	12.43	10.69
Link111	Basin84	467.87	N183	461.68	308.36	2.01	1.5	0.014	13.82	12.49
Link112	Node388	459.26	Basin24	458.84	33.48	1.25	2.5	0.014	42.66	17.45
Link113	N187	474.69	Node92	468.65	291.75	2.07	1	0.014	4.76	5.65
Link114	Node92	468.55	Node93	463.79	435.95	1.09	1.5	0.014	10.19	5.65
Link115	Node93	463.69	Node385	462.26	48.24	2.96	1.5	0.014	16.79	5.65
Link116	Basin24	458.84	Node94	458.84	254.1	0	2	0.014	1.45	20.89
Link117	Node94	458.726	Node95	458.459	169.64	0.16	2	0.014	18.24	20.68
Link118	Node95	458.459	Node96	458.164	327.55	0.09	2	0.014	13.8	20.61
Link123	Node116	464	Node96	458.164	885.99	0.66	3	0.014	115.15	12.02
Link129	Node105	439.63	Node205	437	418.28	0.63	5	0.014	46.09	42.61
Link130	Node205	437	Node107	436	190.46	0.53	8	0.014	99.33	42.6
Link131	Node107	439.21	Node108	436.28	134.18	2.18	10	0.014	2572.56	148.2
Link135	Basin35	428.09	Basin36.2	427.33	302.53	0.25	1.5	0.014	4.89	10.5
Link136	Basin36.2	427.33	Basin30	426.9	405.94	0.11	1.5	0.014	13.32	15.66
Link137	Basin30	426.9	Node114	425.4	421.99	0.36	3.75	0.014	122.35	23.43
Link138	Node114	425.4	Node115	425	278.98	0.14	3.75	0.014	77.7	23.3
Link139	Node115	425	Node59	424.5	174.96	0.29	2	0.014	22.2	23.28
Link14	Basin41	431.2	Node10	430.39	426.14	0.19	4	0.014	58.15	35.3
Link140	N448	445.59	Node117	445.43	154.07	0.1	1.25	0.014	1.93	3.54
Link141	Node117	445.43	Node118	444.8	140.26	0.45	1.25	0.014	4.02	3.52
Link143	Basin99	465.7	Node435	463.09	437.41	0.6	2	0.014	16.23	9.01
Link146	Basin58	445.83	N448	445.64	39.26	0.48	1.25	0.014	4.17	5

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Link Name	Upstream Node Name	Upstream Invert Elevation ft	Downstream Node Name	Downstream Invert Elevation ft	Length ft	Conduit Slope ft/ft	Diameter ft	n value	Design Full Flow cfs	Max Flow cfs
Link147	Node118	444.6	Node120	444.16	155.84	0.28	1.25	0.014	3.19	4.28
Link148	Node120	444.16	Basin49	443.62	468.09	0.12	1.25	0.014	2.04	4.28
Link149	N445	430.19	Node121	426.74	160.43	2.15	1.5	0.014	14.3	8.97
Link15	Node10	430.29	Node262	429.02	103.97	1.22	4	0.014	147.42	35.3
Link150	Basin34	426.74	Node121	426.83	70.08	-0.13	2	0.014	7.53	12.76
Link151	Node121	426.83	Basin33	427.62	565.65	-0.14	2	0.014	7.85	16.34
Link152	N423	426.96	Node271	426.29	5.5	12.18	1	0.014	11.55	0.41
Link155	N423	427.16	Node272	424.68	218.54	1.13	0.833	0.014	2.16	-0.83
Link156	Node288	425.79	Node264	422.85	532.04	0.55	4	0.014	99.15	59.12
Link159	Basin50	443.32	Node43	439.72	1126.9	0.32	1.5	0.014	5.51	5.69
Link161	Basin44	429.92	Node127	428.95	294.36	0.33	1.5	0.014	5.6	6.75
Link162	Node127	428.95	Basin35	428.09	379.4	0.23	1.5	0.014	4.64	6.75
Link164	Basin91	549	Node78	467.95	554.7	14.61	0.667	0.014	4.29	3.77
Link166	Basin85	463	Basin94	461.51	118.24	1.26	2	0.014	23.58	3.2
Link167	Basin92	463	Basin94	461.51	60.11	2.48	2	0.014	33.07	1.67
Link169	N134	456.38	Node133	458	233.68	-0.69	6	0.014	626.58	8
Link170	Node133	458	N434	458	226.58	0	3	0.014	7.72	6.9
Link171	N434	458	Basin98	455.56	143.18	1.7	6	0.014	650.62	5.23
Link172	Node234	454.71	Basin88	454.91	15.75	-1.27	1.5	0.014	10.99	1.31
Link173	Basin77.1	451.89	Basin77.2	451.05	223	0.38	1	0.013	2.19	2.2
Link175	Basin77.2	450.9	Basin77.3	449.91	291.54	0.34	1	0.013	2.08	2.84
Link176	Basin81	448	Node138	446	781.2	0.26	0.667	0.013	0.61	0.87
Link177	Basin73	443	Basin73.1	440	251.7	1.19	0.833	0.014	2.22	1.95
Link177.	Basin73.1	440	Node140	437	251.71	1.19	0.833	0.014	2.22	3.1
Link178	Basin72	446.08	Node142	444	583.72	0.36	0.833	0.014	1.21	1.49
Link179	Basin55	433	N444	431	197.84	1.01	0.833	0.014	2.04	0.5
Link180	Basin46	434.013	Node146	434	665.49	0	0.667	0.014	0.05	1.13
Link181	Basin39	430.5	Node148	430	530.78	0.09	0.833	0.014	0.62	1.65
Link182	Basin32	434	Node150	430	929.68	0.43	1	0.014	2.17	2.15
Link184	Basin31C	427.39	Node152	426.37	322.88	0.32	1	0.014	1.86	3.15
Link185	Node420	425.18	Basin31A	424.12	588.12	0.18	2	0.014	8.92	-8.25
Link186	Basin31A	424.12	Node155	423	704.21	0.16	2.5	0.014	15.19	19.51
Link187	Node155	423.16	Node156	423.16	205.86	0	1.5	0.014	0.31	11.86
Link189	Basin38A	433.48	N103	433.46	47.82	0.04	0.833	0.014	0.42	1.74
Link19	Basin54	433.43	Node12	431.54	443.48	0.43	0.833	0.014	1.33	2.34
Link191	Basin37	430.5	Node163	430	700.79	0.07	1.5	0.014	2.61	5.61
Link192	Basin28	511	Node165	510	123.31	0.81	5	0.014	190.84	33.99
Link193	Node165	510	Node166	507.6	197.25	1.22	1.5	0.014	10.76	14.57
Link194	Node166	507.59	Node167	503.86	414.67	0.9	1	0.014	3.14	4.91
Link198	Node168	500	Node171	494	422.44	1.42	5	0.014	252.56	4.9
Link199	Node171	494.03	Node172	493.97	85.52	0.07	2	0.014	5.56	4.9
Link20	Node12	431.29	Node347	429.16	192.36	1.11	1	0.014	3.48	4.68
Link200	Node172	493.97	Basin27	491.86	147.24	1.43	5	0.014	289.5	4.9
Link201	Basin27	491.86	Node174	489.81	106.36	1.93	2	0.014	29.16	16.13
Link202	Node174	489.81	Node175	490.99	61.76	-1.91	5	0.014	292.92	16.13

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Link Name	Upstream Node Name	Upstream Invert Elevation ft	Downstream Node Name	Downstream Invert Elevation ft	Length ft	Conduit Slope ft/ft	Diameter ft	n value	Design Full Flow cfs	Max Flow cfs
Link203	Node175	490.99	Basin26	483.51	56.95	13.13	3	0.014	224.46	16.13
Link204	Basin26	475	N477	474	858.17	0.12	10	0.014	828.3	11.01
Link205	N477	479.48	Basin25	478.51	130.85	0.74	3	0.014	53.32	10.44
Link207	Basin25	478	Node116	464	992.39	1.41	3	0.014	121.35	12.24
Link208	Basin97B	475	Node181	474.14	147.78	0.58	1.5	0.014	7.44	1.51
Link209	Node181	473.67	Node182	473	682.49	0.1	2	0.014	6.58	11.1
Link212	Node184	471	Node185	469	142.61	1.4	2	0.014	24.88	10.64
Link213	Basin104	479.66	Node181	474.39	218.88	2.41	1	0.014	5.13	6.26
Link214	Basin64	441	Node188	438	331.68	0.9	0.833	0.014	1.93	1.58
Link215	Basin65	443	Node190	442.16	177.76	0.47	0.833	0.014	1.4	1.12
Link216	Basin71	454.7	Node192	441.75	856.89	1.51	1	0.014	4.07	4.51
Link217	Basin102	547	Node181	474.19	255.83	28.46	1.5	0.014	52.04	3.35
Link219	N103	433.46	Node196	432	229.5	0.64	0.833	0.014	1.62	1.68
Link220	Node196	432	Node158	430	245.54	0.81	1	0.014	1.34	1.15
Link221	Basin45	435.28	Node161	433.6	797.49	0.21	0.833	0.014	0.93	1.19
Link222	Basin31D	428.5	Node152	426.37	237.04	0.9	1.5	0.014	9.25	5.7
Link224	Node197	425.35	Node420	425.31	36.8	0.11	0.833	0.014	0.67	4.88
Link227	Node152	426.18	Node197	425.35	572.27	0.15	1.25	0.014	2.28	3.2
Link228	Node418	426.25	Node197	425.8	123.53	0.36	2.5	0.014	22.99	10.54
Link229	Node420	425.18	Node155	423.79	918.57	0.15	2	0.014	8.17	7.29
Link230	Node156	422.83	Node199	422.53	102.96	0.29	2.5	0.014	20.56	11.87
Link231	Node182	473	Node184	471	726.47	0.28	2	0.014	389.81	11.07
Link232	Basin105	461.73	N144	461.22	780.76	0.07	3	0.014	15.83	8.04
Link234	Node262	428.92	Basin33	427.72	415.9	0.29	4	0.014	71.65	35.3
Link237	N177	450	Basin23.1	448.07	389.93	0.49	1.5	0.014	6.86	7.6
Link238	N180	445.98	Node200	445.7	133.94	0.21	2.5	0.014	17.41	11.6
Link240	Node96	458.164	Node99	443	798.77	1.9	3	0.014	195.48	29.96
Link243	Node272	424.73	Basin13	423.85	159.86	0.55	1	0.014	2.45	-2.71
Link244	Basin14	429.29	Node274	429.05	144.5	0.17	1	0.014	1.35	2.78
Link245	Node274	429.1	Node249	428.13	406.15	0.24	1	0.014	1.62	2.26
Link246	Node99	443	Basin21	441	737.71	0.27	4	0.014	135.61	32.47
Link247	Node264	422.8	N498	422.82	25.27	-0.08	3	0.014	17.42	59.08
Link248	Basin21	441	Basin22	440	466.2	0.21	4	0.014	61.78	38.22
Link249	Basin22	440	N404	439.5	296.57	0.17	4	0.014	54.77	42.61
Link251	Basin20	443	Node206	443	380.2	0	3	0.014	3.23	21.31
Link255	Node249	428.13	Node288	425.79	82.21	2.85	1.25	0.014	10.12	2.38
Link256	Basin33	427.62	Node288	425.79	332.85	0.55	4	0.014	98.9	57.23
Link26	Basin56	435.1	Node20	434.98	271.18	0.04	2.5	0.014	8.01	30.32
Link27	Node20	433.63	Node261	433.22	132.9	0.31	4	0.014	74.08	32.52
Link29	Basin47	436.53	Basin56	435.1	329.94	0.43	2.5	0.014	25.07	28.09
Link293	Basin38B	432	Node212	431	189.51	0.53	0.667	0.014	0.82	1.22
Link296	Basin42.3	431.65	Node214	431.264	128.2	0.3	0.833	0.014	1.12	2.04
Link297	Node214	431.264	Node215	430.499	271.74	0.28	0.833	0.014	1.08	1.92
Link299	Node215	430.499	Basin34	426.74	253.49	1.48	1	0.014	4.03	2.42
Link300	Node326	442.24	Basin63	440.2	240.61	0.85	1.25	0.014	5.52	5.55

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Link Name	Upstream Node Name	Upstream Invert Elevation ft	Downstream Node Name	Downstream Invert Elevation ft	Length ft	Conduit Slope ft/ft	Diameter ft	n value	Design Full Flow cfs	Max Flow cfs
Link301	Basin63	440.2	Node323	440.26	464.41	-0.01	1.5	0.014	1.11	6.78
Link302	Basin42.4	430.87	Node215	430.499	123.59	0.3	0.833	0.014	1.11	1.44
Link303	Basin62	443.39	Node326	442.44	352.22	0.27	0.833	0.014	1.06	1.37
Link304	Basin61	443.26	Node331	443.23	312.44	0.01	1.25	0.014	0.59	4.48
Link306	N232	444.2	Basin61	443.36	166.92	0.5	1.25	0.014	4.26	1.91
Link307.	Basin43.2.	434.12	Node219	432.47	177.74	0.93	1	0.014	3.19	4.09
Link308	Node334	447.65	N232	444.35	522.16	0.63	0.833	0.014	1.62	1.9
Link309	Basin60	450.16	Node334	447.7	353.96	0.69	0.833	0.014	1.7	1.9
Link31	Basin42.1	430.9	N445	430.19	360.89	0.2	1.5	0.014	4.33	8.97
Link310	Node219	432.471	Node220	432.241	152.82	0.15	1	0.014	1.28	4.09
Link311	Node220	432.241	Node221	432.1	88.34	0.16	1.25	0.014	2.4	4.09
Link312	Node221	432.1	Node222	432.033	37.05	0.18	1.25	0.014	2.56	4.1
Link313	Node222	432.033	Node223	431.778	144.25	0.18	1.5	0.014	4.1	4.29
Link314	Node54	432.12	Node223	431.778	367.94	0.09	1.5	0.014	2.97	2.28
Link315	Basin66	438.65	Node342	436.46	235.54	0.93	1	0.014	3.19	3.93
Link316	Node223	431.778	Node57	431.513	284.53	0.09	1.5	0.014	2.98	5.79
Link317	Basin67	434.43	Node344	431.96	421.91	0.59	1.25	0.014	4.59	7.67
Link319	Basin42.2	436	Node225	434.56	803.14	0.18	1	0.014	1.4	2.65
Link320	Node225	434.56	Node226	434.063	116.84	0.43	1.25	0.014	3.91	3.5
Link322	Node226	434.063	Node227	433.83	101.45	0.23	1.25	0.014	2.88	3.51
Link323	N123	449.96	Node350	448.66	381.36	0.34	2.5	0.014	22.24	11.76
Link324	Node227	433.83	Basin42.1	430.9	144.24	2.03	1.25	0.014	8.55	3.51
Link325	Basin95	458.93	N123	451.56	568.24	1.3	1.25	0.014	6.83	7.35
Link326	Basin76.2	457.755	Node229	456.81	472.83	0.2	0.667	0.014	0.5	0.73
Link327	Node229	456.81	Node230	456.279	265.37	0.2	0.667	0.014	0.5	0.72
Link328	Node230	456.279	N104	455.73	274.51	0.2	0.667	0.014	0.5	0.62
Link329	Basin23.2	453.69	Node232	446.06	556.77	1.37	1	0.014	3.87	1.86
Link330	Node232	445.96	Node233	445.2	188.9	0.4	1	0.014	2.1	1.74
Link332	Node233	445.2	Node200	445	289.48	0.07	1	0.014	0.87	1.74
Link333	Basin86	466.76	Node235	463.166	208.94	1.72	0.833	0.014	2.67	1.32
Link336	Node235	463	Node234	454.71	1017.2	0.82	1	0.014	2.99	1.32
Link337	Node39	444.03	Node43	439.72	1782	0.24	0.833	0.014	1	1.17
Link343	Basin77.4	448.25	Basin77.5	445.84	412.28	0.58	1	0.013	2.72	4.44
Link344	Basin77.3	449.71	Basin77.4	448.7	277.76	0.36	1	0.013	2.15	3.55
Link345	Basin87	463.07	Node241	462.998	9.45	0.77	1	0.014	2.89	2.86
Link346	Node241	462.998	Node242	461.7	169.74	0.76	1	0.014	2.89	2.86
Link347	Node242	461.55	Basin94	461.71	10.53	-1.52	1.25	0.014	7.39	3.01
Link350	Basin87.1	463.72	Basin87	463.07	52.18	1.25	0.833	0.014	2.27	1.98
Link351	Basin93	463.72	Node242	462.6	114.47	0.98	1	0.014	3.27	2.38
Link352	N498	422.82	Node248	422.81	559.09	0	3	0.014	4.94	58.96
Link353	Node248	422.81	Node250	421.24	331.84	0.47	3	0.014	80.77	54.25
Link354	Node250	421.24	Node251	421.49	42.72	-0.59	3	0.014	47.38	53.69
Link355	Node385	462.65	N177	450	140.84	8.98	1.5	0.014	29.23	5.65
Link356	Node251	421.49	Node252	421.2	293.45	0.1	3	0.014	39.92	53.5
Link357	Node252	421.2	Basin29	419.54	447.87	0.37	3	0.014	69.85	53.48

Stayton, Or
Stormwater Model
Hydraulic Results

Link Name	Upstream Node Name	Upstream Invert Elevation ft	Downstream Node Name	Downstream Invert Elevation ft	Length ft	Conduit Slope ft/ft	Diameter ft	n value	Design Full Flow cfs	Max Flow cfs
Link358	Node248	423.81	Node245	423.807	39.47	0.01	1	0.014	0.29	4.45
Link360	N183	461.58	Node388	459.26	51.75	4.48	2	0.014	44.48	17.46
Link361	Basin83	467.65	N183	462.68	346.64	1.43	1	0.014	3.96	4.99
Link362	Basin43.2	435.77	Basin43.2.1	434.12	249.27	0.66	1	0.014	2.69	3.83
Link363	Basin87	464.5	Node254	464.17	46.66	0.71	1	0.014	2.78	4.82
Link364	Basin23.2	453.69	N177	450	203.22	1.82	1.5	0.014	13.14	3.01
Link365	Basin57	448.8	Basin49	443.72	1114.8	0.46	2	0.014	14.18	15.01
Link366	Basin68	448.59	Basin57	448.7	420.27	-0.03	1.75	0.014	2.38	14.2
Link368	Node256	445	Node99	444	83.5	1.2	1.5	0.014	10.67	4.09
Link37	Node27	448.78	Basin68	448.74	51.25	0.08	1.75	0.014	4.11	6.47
Link378	Node31	451.47	N499	450.97	257.65	0.19	1.25	0.014	2.64	6.19
Link378.	N499	450.82	Node401	450.33	234.74	0.21	1.25	0.014	2.74	6.19
Link394	Basin31B	428.16	Node418	426.6	248.65	0.63	2	0.014	16.64	10.54
Link40	N104	455.78	Basin70	454.88	242.83	0.37	0.833	0.014	1.24	2.09
Link409	Node435	462.89	Basin101	460.34	370.7	0.69	2	0.014	17.42	9
Link41	Basin70	454.78	Node30	453.64	276.76	0.41	0.833	0.014	1.31	2.7
Link42	Node30	453.19	Basin69	451.75	516.97	0.28	1	0.014	1.75	3.45
Link43	Basin69	451.6	Node31	451.47	43.62	0.3	1.25	0.014	3.27	8.83
Link44	Node401	449.83	Node27	449.13	410.13	0.17	1.5	0.014	4.03	6.19
Link452	Node125	427	Basin14	429.59	121.12	-2.14	0.5	0.014	0.76	0.78
Link46	Basin75	458.67	Node35	457.74	39.5	2.35	0.833	0.014	3.12	2.72
Link47	Node35	457.74	Basin76.1	456.92	234.6	0.35	0.833	0.014	1.2	1.08
Link48	Basin76.1	456.72	N104	456.28	279.37	0.16	0.833	0.014	0.81	1.46
Link49	Node261	433.12	Basin41	431.3	441.29	0.41	4	0.014	85.66	32.52
Link50	Node38	444.44	Basin51	444.38	26.48	0.23	1	0.014	1.57	-4.72
Link51	Node38	444.34	Node39	444.03	152.56	0.2	1	0.014	1.49	3.2
Link52	Node40	444.83	Node39	444.53	278.66	0.11	1	0.014	1.09	-2.17
Link53	Node40	444.83	Basin50	443.72	358.84	0.31	1	0.014	1.84	2.53
Link56	Node43	439.72	Node44	439.31	241.15	0.17	1.5	0.014	4.02	6.57
Link57	Node44	439.21	Node45	438.97	357.06	0.07	1.5	0.014	2.53	6.7
Link58	Node45	438.87	Basin48	437.56	198	0.66	1.5	0.014	7.93	6.7
Link59	Basin52	439.6	Basin54.1	437.75	719.45	0.26	1.25	0.014	3.04	3.93
Link60	Basin54.1	437.65	Node48	436.89	209.38	0.36	1.25	0.014	3.61	6.23
Link62	Node48	436.59	Node49	434.5	518.98	0.4	1.5	0.014	6.19	6.17
Link68	Basin43.1	432.33	Node54	432.12	25.09	0.84	1.5	0.014	8.92	-4.94
Link73	Node57	431.513	Basin44	430.22	25.03	5.17	1.5	0.014	22.17	5.75
Link75	Basin59	447.78	Node61	444.81	631.78	0.47	1	0.014	2.27	2.1
Link76	Node61	444.76	Basin61	443.96	120	0.67	1	0.014	2.7	2.1
Link77	Node331	443.13	Node326	442.54	362.85	0.16	1.25	0.014	2.42	4.48
Link78	Node323	440.01	Node322	439.14	157.05	0.55	1.5	0.014	7.26	6.78
Link79	Node342	436.31	Basin67	434.48	351.91	0.52	1.25	0.014	4.33	3.95
Link80	Basin80	445.54	Node63	444.26	625.39	0.2	0.667	0.014	0.51	0.99
Link82	Basin77.5	445.64	Node65	444.34	237.56	0.55	1	0.013	2.64	5.79
Link83	Basin82	446.84	Node67	446.28	206.81	0.27	1	0.014	1.72	3.84
Link84	Node67	446.18	Node68	445.8	18.37	2.07	1	0.014	4.76	3.84

Appendix D

Water Quality Related Data

D.1 - Storm Water Quality Lab Report
D.2 - Management Strategies
D.3 - NPDES Plan
D.4 - TMDL
D.5 - UIC

KELLER associates

Appendix D.1

Storm Water Quality Lab Report

TestAmerica
ANALYTICAL TESTING CORPORATION

PORTLAND, OR 9405 S.W. NIMBUS AVENUE
BEAVERTON, OR 97008-7132
ph: (503) 906.9200 fax: (503) 906.9210

March 19, 2007

Brenda Kuiken
City of Stayton
362 N Third Avenue
Stayton, OR 97383

RE: Stormwater Testing

Enclosed are the results of analyses for samples received by the laboratory on 03/01/07 14:56.
The following list is a summary of the Work Orders contained in this report, generated on 03/19/07 17:28.

If you have any questions concerning this report, please feel free to contact me.

Work Order	Project	ProjectNumber
PQC0032	Stormwater Testing	Stormwater Testing

Brian Cone, Industrial Services Manager

TestAmerica
ANALYTICAL TESTING CORPORATION

PORTLAND, OR 9405 S.W. NIMBUS AVENUE
BEAVERTON, OR 97008-7132
ph: (503) 906.9200 fax: (503) 906.9210

City of Stayton	Project Name:	**Stormwater Testing**	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
INLET	PQC0032-01	Water	03/01/07 10:20	03/01/07 14:56
6 AVE	PQC0032-02	Water	03/01/07 11:20	03/01/07 14:56
OUTLET	PQC0032-03	Water	03/01/07 12:00	03/01/07 14:56
CCH BSN	PQC0032-04	Water	03/01/07 12:50	03/01/07 14:56

Brian L Cone

Brian Cone, Industrial Services Manager

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ANALYTICAL TESTING CORPORATION

PORTLAND, OR 9405 S.W. NIMBUS AVENUE
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City of Stayton	Project Name:	Stormwater Testing	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Total Metals per EPA 200 Series Methods

TestAmerica - Portland, OR

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
PQC0032-01 (INLET)		**Water**			**Sampled: 03/01/07 10:20**					
Calcium	EPA 200.7	**3.57**	----	0.100	mg/l	1x	7030531	03/14/07 11:27	03/16/07 20:21	
Copper	EPA 200.8	ND	----	0.00200	"	"	7030485	03/13/07 14:22	03/15/07 01:05	
Lead	"	ND	----	0.00100	"	"	"	"	"	
Magnesium	EPA 200.7	**1.09**	----	0.100	"	"	7030531	03/14/07 11:27	03/16/07 20:21	
Zinc	EPA 200.8	ND	----	0.00500	"	"	7030485	03/13/07 14:22	03/15/07 01:05	
PQC0032-02 (6 AVE)		**Water**			**Sampled: 03/01/07 11:20**					
Calcium	EPA 200.7	**11.9**	----	0.100	mg/l	1x	7030531	03/14/07 11:27	03/16/07 20:40	
Copper	EPA 200.8	ND	----	0.00200	"	"	7030485	03/13/07 14:22	03/15/07 01:12	
Lead	"	ND	----	0.00100	"	"	"	"	"	
Magnesium	EPA 200.7	**2.60**	----	0.100	"	"	7030531	03/14/07 11:27	03/16/07 20:40	
Zinc	EPA 200.8	ND	----	0.00500	"	"	7030485	03/13/07 14:22	03/15/07 01:12	
PQC0032-03 (OUTLET)		**Water**			**Sampled: 03/01/07 12:00**					
Calcium	EPA 200.7	**4.24**	----	0.100	mg/l	1x	7030531	03/14/07 11:27	03/16/07 20:46	
Copper	EPA 200.8	ND	----	0.00200	"	"	7030485	03/13/07 14:22	03/15/07 01:20	
Lead	"	ND	----	0.00100	"	"	"	"	"	
Magnesium	EPA 200.7	**1.16**	----	0.100	"	"	7030531	03/14/07 11:27	03/16/07 20:46	
Zinc	EPA 200.8	ND	----	0.00500	"	"	7030485	03/13/07 14:22	03/15/07 01:20	
PQC0032-04 (CCH BSN)		**Water**			**Sampled: 03/01/07 12:50**					
Calcium	EPA 200.7	**10.5**	----	0.100	mg/l	1x	7030531	03/14/07 11:27	03/16/07 20:53	
Copper	EPA 200.8	ND	----	0.00200	"	"	7030485	03/13/07 14:22	03/15/07 01:27	
Lead	"	ND	----	0.00100	"	"	"	"	"	
Magnesium	EPA 200.7	**2.49**	----	0.100	"	"	7030531	03/14/07 11:27	03/16/07 20:53	
Zinc	EPA 200.8	**0.0202**	----	0.00500	"	"	7030485	03/13/07 14:22	03/15/07 01:27	

TestAmerica - Portland, OR

Brian L Cone

Brian Cone, Industrial Services Manager

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City of Stayton	Project Name:	**Stormwater Testing**	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Dissolved Metals per EPA 200 Series Methods

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Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
PQC0032-01 (INLET)		**Water**			**Sampled: 03/01/07 10:20**					
Copper	EPA 200.8	ND	----	0.00200	mg/l	1x	7030142	03/05/07 10:09	03/06/07 15:57	
PQC0032-02 (6 AVE)		**Water**			**Sampled: 03/01/07 11:20**					
Copper	EPA 200.8	ND	----	0.00200	mg/l	1x	7030142	03/05/07 10:09	03/06/07 16:01	
PQC0032-03 (OUTLET)		**Water**			**Sampled: 03/01/07 12:00**					
Copper	EPA 200.8	ND	----	0.00200	mg/l	1x	7030142	03/05/07 10:09	03/06/07 16:05	
PQC0032-04 (CCH BSN)		**Water**			**Sampled: 03/01/07 12:50**					
Copper	EPA 200.8	ND	----	0.00200	mg/l	1x	7030142	03/05/07 10:09	03/06/07 16:09	

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City of Stayton	Project Name:	**Stormwater Testing**	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Total Mercury per EPA Method 245.1

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Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
PQC0032-01 (INLET)		**Water**			**Sampled: 03/01/07 10:20**					
Mercury	EPA 245.1	ND	----	0.000200	mg/l	1x	7030245	03/07/07 12:11	03/07/07 17:59	
PQC0032-02 (6 AVE)		**Water**			**Sampled: 03/01/07 11:20**					
Mercury	EPA 245.1	ND	----	0.000200	mg/l	1x	7030245	03/07/07 12:11	03/07/07 18:01	
PQC0032-03 (OUTLET)		**Water**			**Sampled: 03/01/07 12:00**					
Mercury	EPA 245.1	ND	----	0.000200	mg/l	1x	7030245	03/07/07 12:11	03/07/07 18:03	
PQC0032-04 (CCH BSN)		**Water**			**Sampled: 03/01/07 12:50**					
Mercury	EPA 245.1	ND	----	0.000200	mg/l	1x	7030245	03/07/07 12:11	03/07/07 18:06	

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City of Stayton	Project Name:	**Stormwater Testing**	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Conventional Chemistry Parameters per APHA/EPA Methods

TestAmerica - Portland, OR

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
PQC0032-01 (INLET)		**Water**			**Sampled: 03/01/07 10:20**					
Biochemical Oxygen Demand	EPA 405.1	ND	----	4.00	mg/l	1x	7030064	03/02/07 08:59	03/07/07 18:47	
Chemical Oxygen Demand	EPA 410.4	**5.12**	----	5.00	"	"	7030506	03/14/07 08:51	03/14/07 14:50	
Orthophosphate-phosphorus	EPA 365.2	ND	----	0.0100	"	"	7030058	03/02/07 07:52	03/02/07 10:40	
Specific Conductivity	120.1/ 9050	**37.3**	----	10.0	uS/cm	"	7030149	03/05/07 11:05	03/05/07 12:19	
Total Solids	EPA 160.3	**62.0**	----	10.0	mg/l	"	7030316	03/08/07 14:40	03/08/07 16:57	
Total Suspended Solids	EPA 160.2/SM 2540D	**20.0**	----	10.0	"	"	7030241	03/07/07 10:43	03/07/07 15:47	
Turbidity	EPA 180.1	**3.22**	----	0.200	NTU	"	7030051	03/02/07 07:11	03/02/07 09:10	
Hardness	SM2340B	**13.4**	----	0.662	mg/l	"	[CALC]	03/14/07 11:27	03/16/07 20:21	
pH	EPA 150.1	**7.33**	----		pH Units	"	7030050	03/02/07 07:10	03/02/07 08:30	
Phosphorus	EPA 365.1	**0.0498**	----	0.0200	mg/l	"	7030280	03/08/07 09:45	03/09/07 15:00	
PQC0032-02 (6 AVE)		**Water**			**Sampled: 03/01/07 11:20**					
Biochemical Oxygen Demand	EPA 405.1	ND	----	4.00	mg/l	1x	7030064	03/02/07 08:59	03/07/07 18:47	
Chemical Oxygen Demand	EPA 410.4	ND	----	5.00	"	"	7030506	03/14/07 08:51	03/14/07 14:50	
Orthophosphate-phosphorus	EPA 365.2	ND	----	0.0100	"	"	7030058	03/02/07 07:52	03/02/07 10:40	
Specific Conductivity	120.1/ 9050	**116**	----	10.0	uS/cm	"	7030149	03/05/07 11:05	03/05/07 12:19	
Total Solids	EPA 160.3	**105**	----	10.0	mg/l	"	7030316	03/08/07 14:40	03/08/07 16:57	
Total Suspended Solids	EPA 160.2/SM 2540D	ND	----	10.0	"	"	7030241	03/07/07 10:43	03/07/07 15:47	
Turbidity	EPA 180.1	**2.57**	----	0.200	NTU	"	7030051	03/02/07 07:11	03/02/07 09:10	
Hardness	SM2340B	**40.4**	----	0.662	mg/l	"	[CALC]	03/14/07 11:27	03/16/07 20:40	
pH	EPA 150.1	**7.10**	----		pH Units	"	7030050	03/02/07 07:10	03/02/07 08:30	
Phosphorus	EPA 365.1	**0.0274**	----	0.0200	mg/l	"	7030280	03/08/07 09:45	03/09/07 15:00	
PQC0032-03 (OUTLET)		**Water**			**Sampled: 03/01/07 12:00**					
Biochemical Oxygen Demand	EPA 405.1	ND	----	4.00	mg/l	1x	7030064	03/02/07 08:59	03/07/07 18:47	
Chemical Oxygen Demand	EPA 410.4	ND	----	5.00	"	"	7030506	03/14/07 08:51	03/14/07 14:50	
Orthophosphate-phosphorus	EPA 365.2	ND	----	0.0100	"	"	7030058	03/02/07 07:52	03/02/07 10:40	
Specific Conductivity	120.1/ 9050	**44.0**	----	10.0	uS/cm	"	7030149	03/05/07 11:05	03/05/07 12:19	
Total Solids	EPA 160.3	**45.0**	----	10.0	mg/l	"	7030316	03/08/07 14:40	03/08/07 16:57	
Total Suspended Solids	EPA 160.2/SM 2540D	ND	----	10.0	"	"	7030241	03/07/07 10:43	03/07/07 15:47	
Turbidity	EPA 180.1	**2.13**	----	0.200	NTU	"	7030051	03/02/07 07:11	03/02/07 09:10	
Hardness	SM2340B	**15.4**	----	0.662	mg/l	"	[CALC]	03/14/07 11:27	03/16/07 20:46	
pH	EPA 150.1	**7.31**	----		pH Units	"	7030050	03/02/07 07:10	03/02/07 08:30	
Phosphorus	EPA 365.1	**0.0225**	----	0.0200	mg/l	"	7030280	03/08/07 09:45	03/09/07 15:00	

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City of Stayton	Project Name:	**Stormwater Testing**	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Conventional Chemistry Parameters per APHA/EPA Methods

TestAmerica - Portland, OR

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
PQC0032-04 (CCH BSN)		**Water**			**Sampled: 03/01/07 12:50**					
Biochemical Oxygen Demand	EPA 405.1	ND	----	4.00	mg/l	1x	7030064	03/02/07 08:59	03/07/07 18:47	
Chemical Oxygen Demand	EPA 410.4	**6.66**	----	5.00	"	"	7030506	03/14/07 08:51	03/14/07 14:50	
Orthophosphate-phosphorus	EPA 365.2	ND	----	0.0100	"	"	7030058	03/02/07 07:52	03/02/07 10:40	
Specific Conductivity	120.1/ 9050	**118**	----	10.0	uS/cm	"	7030149	03/05/07 11:05	03/05/07 12:19	
Total Solids	EPA 160.3	**96.0**	----	10.0	mg/l	"	7030316	03/08/07 14:40	03/08/07 16:57	
Total Suspended Solids	EPA 160.2/SM 2540D	ND	----	10.0	"	"	7030241	03/07/07 10:43	03/07/07 15:47	
Turbidity	EPA 180.1	**3.18**	----	0.200	NTU	"	7030051	03/02/07 07:11	03/02/07 09:10	
Hardness	SM2340B	**36.5**	----	0.662	mg/l	"	[CALC]	03/14/07 11:27	03/16/07 20:53	
pH	EPA 150.1	**6.95**	----		pH Units	"	7030050	03/02/07 07:10	03/02/07 08:30	
Phosphorus	EPA 365.1	**0.0204**	----	0.0200	mg/l	"	7030280	03/08/07 09:45	03/09/07 15:00	

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City of Stayton	Project Name:	**Stormwater Testing**	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Microbiological Parameters per APHA Standard Methods

TestAmerica - Portland, OR

Analyte	Method	Result	MDL*	MRL	Units	Dil	Batch	Prepared	Analyzed	Notes
PQC0032-01 (INLET)		**Water**			**Sampled: 03/01/07 10:20**					
E. Coli	SM 9223B	**6.30**	----	1.00	MPN/100 ml	1x	7030071	03/02/07 09:45	03/03/07 19:20	
PQC0032-02 (6 AVE)		**Water**			**Sampled: 03/01/07 11:20**					
E. Coli	SM 9223B	**7.20**	----	1.00	MPN/100 ml	1x	7030071	03/02/07 09:45	03/03/07 19:20	
PQC0032-03 (OUTLET)		**Water**			**Sampled: 03/01/07 12:00**					
E. Coli	SM 9223B	**14.8**	----	1.00	MPN/100 ml	1x	7030071	03/02/07 09:45	03/03/07 19:20	
PQC0032-04 (CCH BSN)		**Water**			**Sampled: 03/01/07 12:50**					
E. Coli	SM 9223B	**26.9**	----	1.00	MPN/100 ml	1x	7030071	03/02/07 09:45	03/03/07 19:20	

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City of Stayton	Project Name:	Stormwater Testing	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Total Metals per EPA 200 Series Methods - Laboratory Quality Control Results

TestAmerica - Portland, OR

QC Batch: 7030485 **Water Preparation Method: EPA 200/3005**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030485-BLK1)								Extracted: 03/13/07 14:22						
Copper	EPA 200.8	ND	---	0.00200	mg/l	1x	--	--	--	--	--	--	03/14/07 20:19	
Lead	"	ND	---	0.00100	"	"	--	--	--	--	--	--	"	
Zinc	"	ND	---	0.00500	"	"	--	--	--	--	--	--	03/15/07 13:37	
LCS (7030485-BS1)								Extracted: 03/13/07 14:22						
Copper	EPA 200.8	0.0861	---	0.00200	mg/l	1x	--	0.100	86.1%	(85-115)	--	--	03/14/07 20:26	
Lead	"	0.0896	---	0.00100	"	"	--	"	89.6%	"	--	--	"	
Zinc	"	0.0858	---	0.0100	"	2x	--	"	85.8%	"	--	--	03/15/07 13:44	
Duplicate (7030485-DUP1)				QC Source: PQB0979-01				Extracted: 03/13/07 14:22						
Copper	EPA 200.8	ND	---	0.00200	mg/l	1x	ND	--	--	--	3.71%	(20)	03/14/07 20:41	
Lead	"	ND	---	0.00100	"	"	ND	--	--	--	24.4%	"	"	R4
Zinc	"	0.0501	---	0.00500	"	"	0.0500	--	--	--	0.200%	"	03/15/07 13:59	
Matrix Spike (7030485-MS1)				QC Source: PQC0019-29				Extracted: 03/13/07 14:22						
Copper	EPA 200.8	0.115	---	0.00200	mg/l	1x	0.0350	0.100	80.0%	(75-125)	--	--	03/14/07 20:48	
Lead	"	0.0854	---	0.00100	"	"	0.000770	"	84.6%	"	--	--	"	
Zinc	"	0.180	---	0.00500	"	"	0.105	"	75.0%	(70-130)	--	--	03/15/07 14:06	
Matrix Spike (7030485-MS2)				QC Source: PQB0979-01				Extracted: 03/13/07 14:22						
Copper	EPA 200.8	0.0863	---	0.00200	mg/l	1x	0.00185	0.100	84.4%	(75-125)	--	--	03/14/07 21:10	
Lead	"	0.0882	---	0.00100	"	"	0.000230	"	88.0%	"	--	--	"	
Zinc	"	0.127	---	0.00500	"	"	0.0500	"	77.0%	(70-130)	--	--	03/15/07 14:21	

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City of Stayton	Project Name: **Stormwater Testing**	
362 N Third Avenue	Project Number: Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager: Brenda Kuiken	03/19/07 17:28

Total Metals per EPA 200 Series Methods - Laboratory Quality Control Results

TestAmerica - Portland, OR

QC Batch: 7030531 **Water Preparation Method: EPA 200/3005**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030531-BLK1)								**Extracted: 03/14/07 11:27**						
Calcium	EPA 200.7	ND	---	0.100	mg/l	1x	--	--	--	--	--	--	03/15/07 12:43	
Magnesium	"	ND	---	0.100	"	"	--	--	--	--	--	--	"	
LCS (7030531-BS1)								**Extracted: 03/14/07 11:27**						
Calcium	EPA 200.7	9.26	---	0.100	mg/l	1x	--	10.0	92.6%	(85-115)	--	--	03/15/07 12:49	
Magnesium	"	9.49	---	0.100	"	"	--	"	94.9%	"	--	--	"	
Duplicate (7030531-DUP1)				**QC Source: PQC0025-01**				**Extracted: 03/14/07 11:27**						
Calcium	EPA 200.7	12.4	---	0.100	mg/l	1x	12.0	--	--	--	3.28%	(20)	03/16/07 20:33	
Magnesium	"	1.63	---	0.100	"	"	1.57	--	--	--	3.75%	"	"	
Matrix Spike (7030531-MS1)				**QC Source: PQC0025-02**				**Extracted: 03/14/07 11:27**						
Calcium	EPA 200.7	19.1	---	0.100	mg/l	1x	10.2	10.0	89.0%	(75-125)	--	--	03/16/07 20:08	
Magnesium	"	4.25	---	0.100	"	"	1.55	"	27.0%	"	--	--	03/15/07 13:18	M2
Matrix Spike (7030531-MS2)				**QC Source: PQC0032-01**				**Extracted: 03/14/07 11:27**						
Calcium	EPA 200.7	21.6	---	0.100	mg/l	1x	3.57	10.0	180%	(75-125)	--	--	03/16/07 20:27	M2
Magnesium	"	2.55	---	0.100	"	"	1.09	"	14.6%	"	--	--	03/15/07 13:31	M2

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City of Stayton	Project Name:	Stormwater Testing	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Dissolved Metals per EPA 200 Series Methods - Laboratory Quality Control Results

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QC Batch: 7030142 **Water Preparation Method: EPA 200/3005 Diss**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030142-BLK1)								**Extracted: 03/05/07 10:09**						
Copper	EPA 200.8	ND	---	0.00200	mg/l	1x	--	--	--	--	--	--	03/06/07 15:17	
LCS (7030142-BS1)								**Extracted: 03/05/07 10:09**						
Copper	EPA 200.8	0.104	---	0.00200	mg/l	1x	--	0.100	104%	(85-115)	--	--	03/06/07 15:21	
Duplicate (7030142-DUP1)				**QC Source: PQB0510-01**				**Extracted: 03/05/07 10:09**						
Copper	EPA 200.8	ND	---	0.00200	mg/l	1x	ND	--	--	--	15.6%	(20)	03/06/07 15:29	
Matrix Spike (7030142-MS1)				**QC Source: PQB0860-17**				**Extracted: 03/05/07 10:09**						
Copper	EPA 200.8	0.124	---	0.00200	mg/l	1x	0.0176	0.100	106%	(70-130)	--	--	03/06/07 15:45	

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City of Stayton	Project Name: **Stormwater Testing**	
362 N Third Avenue	Project Number: Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager: Brenda Kuiken	03/19/07 17:28

Total Mercury per EPA Method 245.1 - Laboratory Quality Control Results

TestAmerica - Portland, OR

QC Batch: 7030245 **Water Preparation Method: EPA 245.1**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030245-BLK1)								**Extracted: 03/07/07 12:11**						
Mercury	EPA 245.1	ND	---	0.000200	mg/l	1x	--	--	--	--	--	--	03/07/07 17:22	
LCS (7030245-BS1)								**Extracted: 03/07/07 12:11**						
Mercury	EPA 245.1	0.00508	---	0.000200	mg/l	1x	--	0.00500	102%	(85-115)	--	--	03/07/07 17:24	
LCS Dup (7030245-BSD1)								**Extracted: 03/07/07 12:11**						
Mercury	EPA 245.1	0.00527	---	0.000200	mg/l	1x	--	0.00500	105%	(85-115)	3.67%	(20)	03/07/07 17:29	
Duplicate (7030245-DUP1)				**QC Source: PQB0975-01**				**Extracted: 03/07/07 12:11**						
Mercury	EPA 245.1	ND	---	0.000200	mg/l	1x	ND	--	--	--	NR	(20)	03/07/07 17:33	
Matrix Spike (7030245-MS1)				**QC Source: PQB0975-01**				**Extracted: 03/07/07 12:11**						
Mercury	EPA 245.1	0.00499	---	0.000200	mg/l	1x	ND	0.00500	99.8%	(75-125)	--	--	03/07/07 17:35	
Matrix Spike (7030245-MS2)				**QC Source: PQC0061-05**				**Extracted: 03/07/07 12:11**						
Mercury	EPA 245.1	0.00545	---	0.000200	mg/l	1x	0.000149	0.00500	106%	(75-125)	--	--	03/07/07 17:42	
Matrix Spike Dup (7030245-MSD1)				**QC Source: PQB0975-01**				**Extracted: 03/07/07 12:11**						
Mercury	EPA 245.1	0.00497	---	0.000200	mg/l	1x	ND	0.00500	99.4%	(75-125)	0.402%	(20)	03/07/07 17:39	
Matrix Spike Dup (7030245-MSD2)				**QC Source: PQC0061-05**				**Extracted: 03/07/07 12:11**						
Mercury	EPA 245.1	0.00535	---	0.000200	mg/l	1x	0.000149	0.00500	104%	(75-125)	1.85%	(20)	03/07/07 17:46	

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City of Stayton	Project Name:	Stormwater Testing	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Conventional Chemistry Parameters per APHA/EPA Methods - Laboratory Quality Control Results

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QC Batch: 7030050 Water Preparation Method: General Preparation

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Duplicate (7030050-DUP1)				QC Source: PQC0032-01				Extracted: 03/02/07 07:10						
pH	EPA 150.1	7.34	---		pH Units	1x	7.33	--	--	--	0.136%	(25)	03/02/07 08:30	

QC Batch: 7030051 Water Preparation Method: General Preparation

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030051-BLK1)								Extracted: 03/02/07 07:11						
Turbidity	EPA 180.1	ND	---	0.200	NTU	1x	--	--	--	--	--	--	03/02/07 09:10	
LCS (7030051-BS1)								Extracted: 03/02/07 07:11						
Turbidity	EPA 180.1	18.0	---	0.200	NTU	1x	--	20.0	90.0%	(85-115)	--	--	03/02/07 09:10	
Duplicate (7030051-DUP1)				QC Source: PQC0028-01				Extracted: 03/02/07 07:11						
Turbidity	EPA 180.1	ND	---	0.200	NTU	1x	ND	--	--	--	22.9%	(20)	03/02/07 09:10	R4

QC Batch: 7030058 Water Preparation Method: General Preparation

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030058-BLK1)								Extracted: 03/02/07 07:52						
Orthophosphate-phosphorus	EPA 365.2	ND	---	0.0100	mg/l	1x	--	--	--	--	--	--	03/02/07 10:40	
LCS (7030058-BS1)								Extracted: 03/02/07 07:52						
Orthophosphate-phosphorus	EPA 365.2	0.291	---	0.0100	mg/l	1x	--	0.300	97.0%	(85-115)	--	--	03/02/07 10:40	
Duplicate (7030058-DUP1)				QC Source: PQC0032-01				Extracted: 03/02/07 07:52						
Orthophosphate-phosphorus	EPA 365.2	ND	---	0.0100	mg/l	1x	ND	--	--	--	NR	(20)	03/02/07 10:40	
Matrix Spike (7030058-MS1)				QC Source: PQC0032-01				Extracted: 03/02/07 07:52						
Orthophosphate-phosphorus	EPA 365.2	0.0660	---	0.0100	mg/l	1x	ND	0.100	66.0%	(80-120)	--	--	03/02/07 10:40	M2

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City of Stayton	Project Name:	Stormwater Testing	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Conventional Chemistry Parameters per APHA/EPA Methods - Laboratory Quality Control Results

TestAmerica - Portland, OR

QC Batch: 7030064 Water Preparation Method: General Preparation

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030064-BLK1)										**Extracted: 03/02/07 08:59**				
Biochemical Oxygen Demand	EPA 405.1	ND	---	4.00	mg/l	1x	--	--	--	--	--	--	03/07/07 18:47	K3
LCS (7030064-BS1)										**Extracted: 03/02/07 08:59**				
Biochemical Oxygen Demand	EPA 405.1	179	---	4.00	mg/l	1x	--	198	90.4%	(85-115)	--	--	03/07/07 18:47	
Duplicate (7030064-DUP1)					**QC Source: PQB0956-02**					**Extracted: 03/02/07 08:59**				
Biochemical Oxygen Demand	EPA 405.1	ND	---	4.00	mg/l	1x	ND	--	--	--	NR	(40)	03/07/07 18:47	

QC Batch: 7030149 Water Preparation Method: General Preparation

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030149-BLK1)										**Extracted: 03/05/07 11:05**				
Specific Conductivity	120.1/ 9050	ND	---	10.0	uS/cm	1x	--	--	--	--	--	--	03/05/07 12:19	
LCS (7030149-BS1)										**Extracted: 03/05/07 11:05**				
Specific Conductivity	120.1/ 9050	1390	---	10.0	uS/cm	1x	--	1410	98.6%	(85-115)	--	--	03/05/07 12:19	
Duplicate (7030149-DUP1)					**QC Source: PQB0836-01**					**Extracted: 03/05/07 11:05**				
Specific Conductivity	120.1/ 9050	2780	---	10.0	uS/cm	1x	2830	--	--	--	1.78%	(20)	03/05/07 12:19	

QC Batch: 7030241 Water Preparation Method: General Preparation

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030241-BLK1)										**Extracted: 03/07/07 10:43**				
Total Suspended Solids	EPA 160.2/SM 2540D	ND	---	10.0	mg/l	1x	--	--	--	--	--	--	03/07/07 15:47	
LCS (7030241-BS1)										**Extracted: 03/07/07 10:43**				
Total Suspended Solids	EPA 160.2/SM 2540D	48.0	---	10.0	mg/l	1x	--	50.0	96.0%	(80-120)	--	--	03/07/07 15:47	
Duplicate (7030241-DUP1)					**QC Source: PQB0968-01**					**Extracted: 03/07/07 10:43**				
Total Suspended Solids	EPA 160.2/SM 2540D	ND	---	10.0	mg/l	1x	ND	--	--	--	NR	(20)	03/07/07 15:47	

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City of Stayton	Project Name:	Stormwater Testing	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Conventional Chemistry Parameters per APHA/EPA Methods - Laboratory Quality Control Results

TestAmerica - Portland, OR

QC Batch: 7030280 Water Preparation Method: Wet Chem

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030280-BLK1)								Extracted: 03/08/07 09:45						
Phosphorus	EPA 365.1	ND	---	0.0200	mg/l	1x	--	--	--	--	--	--	03/09/07 15:00	
LCS (7030280-BS1)								Extracted: 03/08/07 09:45						
Phosphorus	EPA 365.1	0.420	---	0.0200	mg/l	1x	--	0.400	105%	(90-110)	--	--	03/09/07 15:00	
Duplicate (7030280-DUP1)				QC Source: PQB0939-01				Extracted: 03/08/07 09:45						
Phosphorus	EPA 365.1	0.607	---	0.100	mg/l	5x	0.452	--	--	--	29.3%	(20)	03/09/07 15:00	R2
Matrix Spike (7030280-MS1)				QC Source: PQB0939-01				Extracted: 03/08/07 09:45						
Phosphorus	EPA 365.1	0.776	---	0.100	mg/l	5x	0.452	0.400	81.0%	(90-110)	--	--	03/09/07 15:00	M1

QC Batch: 7030316 Water Preparation Method: General Preparation

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030316-BLK1)								Extracted: 03/08/07 14:40						
Total Solids	EPA 160.3	ND	---	10.0	mg/l	1x	--	--	--	--	--	--	03/08/07 16:57	
Blank (7030316-BLK2)								Extracted: 03/08/07 14:40						
Total Solids	EPA 160.3	ND	---	10.0	mg/l	1x	--	--	--	--	--	--	03/08/07 16:57	
LCS (7030316-BS1)								Extracted: 03/08/07 14:40						
Total Solids	EPA 160.3	49.0	---	10.0	mg/l	1x	--	50.0	98.0%	(80-120)	--	--	03/08/07 16:57	
LCS (7030316-BS2)								Extracted: 03/08/07 14:40						
Total Solids	EPA 160.3	52.0	---	10.0	mg/l	1x	--	50.0	104%	(80-120)	--	--	03/08/07 16:57	
Duplicate (7030316-DUP1)				QC Source: PQC0032-03				Extracted: 03/08/07 14:40						
Total Solids	EPA 160.3	47.0	---	10.0	mg/l	1x	45.0	--	--	--	4.35%	(20)	03/08/07 16:57	
Duplicate (7030316-DUP2)				QC Source: PQC0032-04				Extracted: 03/08/07 14:40						
Total Solids	EPA 160.3	96.0	---	10.0	mg/l	1x	96.0	--	--	--	0.00%	(20)	03/08/07 16:57	

TestAmerica - Portland, OR

Brian L Cone

Brian Cone, Industrial Services Manager

PORTLAND, OR 9405 S.W. NIMBUS AVENUE
BEAVERTON, OR 97008-7132
ph: (503) 906.9200 fax: (503) 906.9210

City of Stayton	Project Name:	**Stormwater Testing**	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Conventional Chemistry Parameters per APHA/EPA Methods - Laboratory Quality Control Results

TestAmerica - Portland, OR

QC Batch: 7030506 **Water Preparation Method: General Preparation**

Analyte	Method	Result	MDL*	MRL	Units	Dil	Source Result	Spike Amt	% REC	(Limits)	% RPD	(Limits)	Analyzed	Notes
Blank (7030506-BLK1)										**Extracted: 03/14/07 08:51**				
Chemical Oxygen Demand	EPA 410.4	ND	---	5.00	mg/l	1x	--	--	--	--	--	--	03/14/07 14:50	
LCS (7030506-BS1)										**Extracted: 03/14/07 08:51**				
Chemical Oxygen Demand	EPA 410.4	50.9	---	5.00	mg/l	1x	--	50.0	102%	(90-110)	--	--	03/14/07 14:50	
Duplicate (7030506-DUP1)					**QC Source: PQC0032-01**					**Extracted: 03/14/07 08:51**				
Chemical Oxygen Demand	EPA 410.4	ND	---	5.00	mg/l	1x	5.12	--	--	--	--	(20)	03/14/07 14:50	

TestAmerica - Portland, OR

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report shall not be reproduced except in full, without the written approval of the laboratory.

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City of Stayton	Project Name:	**Stormwater Testing**	
362 N Third Avenue	Project Number:	Stormwater Testing	Report Created:
Stayton, OR 97383	Project Manager:	Brenda Kuiken	03/19/07 17:28

Notes and Definitions

Report Specific Notes:

K3	-	The dilution water D.O. depletion was > 0.2 mg/L.
M1	-	The MS and/or MSD were above the acceptance limits due to sample matrix interference. See Blank Spike (LCS).
M2	-	The MS and/or MSD were below the acceptance limits due to sample matrix interference. See Blank Spike (LCS).
R2	-	The RPD exceeded the acceptance limit.
R4	-	Due to the low levels of analyte in the sample, the duplicate RPD calculation does not provide useful information.

Laboratory Reporting Conventions:

DET	-	Analyte DETECTED at or above the Reporting Limit. Qualitative Analyses only.
ND	-	Analyte NOT DETECTED at or above the reporting limit (MDL or MRL, as appropriate).
NR/NA	-	Not Reported / Not Available
dry	-	Sample results reported on a Dry Weight Basis. Results and Reporting Limits have been corrected for Percent Dry Weight.
wet	-	Sample results and reporting limits reported on a Wet Weight Basis (as received). Results with neither 'wet' nor 'dry' are reported on a Wet Weight Basis.
RPD	-	RELATIVE PERCENT DIFFERENCE (RPDs calculated using Results, not Percent Recoveries).
MRL	-	METHOD REPORTING LIMIT. Reporting Level at, or above, the lowest level standard of the Calibration Table.
MDL*	-	METHOD DETECTION LIMIT. Reporting Level at, or above, the statistically derived limit based on 40CFR, Part 136, Appendix B. *MDLs are listed on the report only if the data has been evaluated below the MRL. Results between the MDL and MRL are reported as Estimated Results.
Dil	-	Dilutions are calculated based on deviations from the standard dilution performed for an analysis, and may not represent the dilution found on the analytical raw data.
Reporting Limits	-	Reporting limits (MDLs and MRLs) are adjusted based on variations in sample preparation amounts, analytical dilutions and percent solids, where applicable.
Electronic Signature	-	Electronic Signature added in accordance with TestAmerica's *Electronic Reporting and Electronic Signatures Policy.* Application of electronic signature indicates that the report has been reviewed and approved for release by the laboratory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

TestAmerica - Portland, OR

Brian L Cone

Brian Cone, Industrial Services Manager

008

TestAmerica
ANALYTICAL TESTING CORPORATION

11720 North Creek Pkwy N Suite 400, Bothell, WA 98011-8244 425-420-9200 FAX 420-9210
11922 E. First Ave, Spokane, WA 99206-5302 509-924-9200 FAX 924-9290
9405 SW Nimbus Ave, Beaverton, OR 97008-7145 503-906-9200 FAX 906-9210
2000 W International Airport Rd Ste A10, Anchorage, AK 99502-1119 907-563-9200 FAX 563-9210

CHAIN OF CUSTODY REPORT

Work Order #: PQC0032

CLIENT: CITY OF STAYTON

REPORT TO: BRENDA KUIKEN
ADDRESS: 362 N 3RD AVE
STAYTON, OREGON
PHONE: 503 769 2810 FAX:

INVOICE TO: CITY OF STAYTON
362 N 3rd AVE
STAYTON, OREGON 97383

P.O. NUMBER: WWTP

PROJECT NAME: STORMWATER TESTING
PROJECT NUMBER:
SAMPLED BY: John L Sullivan JR

TURNAROUND REQUEST in Business Days *
Organic & Inorganic Analyses: 10 (STD.) 7 5 4 3 2 1 <1
Petroleum Hydrocarbon Analyses: 5 (STD.) 4 3 2 1 <1
OTHER Specify:
* Turnaround Requests less than standard may incur Rush Charges.

PRESERVATIVE / REQUESTED ANALYSES

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	E.coli	Hg, Cu, Zn, Pb	Dis Cu	Hardness	COD O-phos	BOD	T phos	TS	TSS	TURB	PH	Conduct		MATRIX (W, S, O)	# OF CONT.	LOCATION / COMMENTS	TA WO ID
Preservative		—	HNO3	HNO3	HNO3	H2SO4												
1 INLET	3-1-07 1020	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		W	5		
2 GAVE	3-1-07 1120	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		W	5		
3 OUTLET	3-1-07 1200	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		W	5		
4 CCH BSN	3-1-07 1250	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		W	5		
5																		
6																		
7																		
8																		
9																		
10																		

RELEASED BY: DATE: 3-1-07
PRINT NAME: John L Sullivan JR FIRM: City of Stayton TIME:

RECEIVED BY: Camille Holladay DATE: 3/1/07
PRINT NAME: Camille Holladay FIRM: TAP TIME: 1456

RELEASED BY: DATE:
PRINT NAME: FIRM: TIME:

RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS:

TEMP: 4.3

PAGE OF

COC REV 05/2006

Note: By relinquishing samples to TestAmerica, client agrees to pay for the services requested on this chain of custody form and for any additional analyses performed on this project.
Payment for services is due within 30 days from the date of invoice unless otherwise contracted. Sample(s) will be disposed of after 30 days unless otherwise contracted.

TEST AMERICA SAMPLE RECEIPT CHECKLIST

Received By: (applies to temp at receipt)
Date: 3/1/07
Time: 1458
Initials: Ut

Logged-in By:
Date: 3/1/07
Initials: Ut

Unpacked/Labeled By:
Date: 3/1/07
Initials: Ut

Cooler ID: ____ (____ of ____)
Work Order No. PQL0032
Client: City of Staton
Project: Stormwater

Container Type:
✓ Cooler
____ Box
____ None/Other ______

COC Seals:
✓ Ship. Container
____ On Bottles
✓ Sign By
____ Date
____ None

Packing Material
____ Bubble Bags
____ Styrofoam
____ Foam Packs
✓ None/Other Other ______

Refrigerant:
✓ Gel Ice Pack ______
____ Loose Ice
____ None/Other ______
____ None

Received Via: Bill# ✓
____ Fed Ex
✓ Client
____ UPS
____ NCA Courier
____ DHL
____ Mid Valley
____ Senvoy
____ TDP
____ GS
____ Other ______

Cooler Temperature (IR): 4.3 °C Plastic Glass (circle one) (Frozen filters, Tedlars and aqueous Metals exempt)

Temperature Blank? ____ °C or NA

Trip Blank? Y or N or NA

Sample Containers:		ID			ID
Intact?	Y or N		Metals Preserved?	Y or N or NA	
Provided by NCA?	Y or N		Client QAPP Preserved?	Y or N or NA	
Correct Type?	Y or N		Adequate Volume? (for tests requested)	Y or N	
#Containers match COC?	Y or N		Water VOAs: Headspace?	Y or N or NA	
IDs/time/date match COC?	Y or N		Comments:		
Hold Times in hold?	Y or N				

PROJECT MANAGEMENT

Is the Chain of Custody complete? Y or N If N, circle the items that were incomplete

Comments, Problems ______

Total access set up? Y or N
Has client been contacted regarding non-conformances? Y or N If Y ____/____ Date Time

PM Initials: ______ Date: ______ Time: ______

Appendix D.2

Management Strategies

TETRA TECH/KCM
7080 SW Fir Loop
Portland, Oregon 97223-8022

Technical Memorandum

City of Stayton
STRATEGY FOR ADDRESSING STORMWATER MANAGEMENT

January 5, 2007

OVERVIEW

This technical memorandum presents a preliminary strategy for the City of Stayton to manage stormwater in a way that addresses existing and potential future regulatory requirements. The preliminary strategy is a starting point for developing a final long-term overall strategy. This memorandum describes current and potential future regulatory requirements, approaches to addressing the requirements, and how the approaches have worked for other communities. It describes how state and federal requirements can be met in a way that is most economical and beneficial to the citizens and environment of Stayton.

A stormwater management strategy must incorporate the goals of the community and input from City staff who will implement it. This memorandum was prepared to help elected officials, staff and citizens who must plan and implement programs to comply with regulations and protect local water quality.

The City of Stayton was not identified as a community included in the National Pollutant Discharge Elimination System (NPDES) Phase II program. However, the Oregon Department of Environmental Quality (DEQ) has developed the NPDES Phase II requirements into a program that could eventually merge with the requirements of the state's Total Maximum Daily Load (TMDL) Program, and Stayton is in the Willamette Basin, which adopted a TMDL on September 21, 2006. Therefore Stayton has the potential of being required to meet the same conditions as an NPDES Phase II community.

Benefits of Implementing a Stormwater Management Program

A comprehensive municipal stormwater management program can provide a wide array of benefits for local jurisdictions and for the environment. A successful program offers benefits related to water quality, municipal operations, preservation of green space, and other aspects of a community's quality of life. Ultimately, such benefits can translate into economic benefits through more efficient operating practices, increased property values, and increased revenues from recreation and tourism.

Poorly managed stormwater can contribute high levels of pollutants into receiving rivers, lakes, streams and groundwater. Stormwater management programs recognize the potential impacts of unchecked stormwater runoff: accelerated stream flows, destruction of aquatic habitat, modified natural hydrologic patterns, and elevated pollutant concentrations. A stormwater management program that promotes or requires advanced land use practices can minimize negative chemical, physical, and biological impacts and produce water quality improvements over time.

A stormwater management program that improves water quality can help to meet regulatory water quality standards, which are the yardstick for assessing the need for pollution controls such as TMDLs or other water cleanup plans. Avoiding the need for such additional pollution controls or for limits on development can translate into cost savings for communities. Stormwater management programs can also play an important role in reducing the number of impaired water bodies due to bacteria levels and reducing the need for additional expensive treatment technologies for drinking water supplies.

Stormwater management programs also can provide communities with a framework for efficient and cost-effective operational activities. Management practices that prevent pollutants from entering the storm sewer system reduce the need for costly system maintenance and repair activities. Through the reporting mechanisms required for stormwater management programs, communities establish the ability to track activities and expenditures related to stormwater management activities, thereby improving communication and coordination among responsible departments and with citizens.

Other benefits to consider include enhanced fishing and opportunities for recreation. Stormwater management helps to reduce pollutants that can harm important fish habitat and minimize the contaminants that make fish unsafe to eat—often the same pollutants that make swimming and boating unsafe. Stormwater quantity is often addressed through stormwater management techniques intended to improve water quality. Effective management techniques help to limit increases in impervious surface, thereby decreasing the quantity and velocity of stormwater runoff and minimizing flooding events. Stormwater management programs can help promote maintaining green spaces in the community, improve visual appearance of waterways, and promote cleaner, more attractive sites on land (e.g., better maintained parking lots, industrial sites, and municipal facilities).

REGULATORY FRAMEWORK

Background

The federal Clean Water Act is the primary federal law protecting water quality. The act requires that TMDLs be established when a water body does not meet water quality standards. The DEQ adopted a TMDL for the Willamette Basin in September 2006. The City of Stayton is within the Willamette Basin and has been identified as a “designated management agency” (DMA) in the Willamette River TMDL program. The TMDL includes limits for temperature, mercury, and bacteria.

The TMDL and Water Quality Management Plan (September 2006), states that DMAs are required to develop TMDL Implementation Plans to address TMDL allocations within their jurisdiction. TMDL Implementation Plans are due within 18 months from the date of the Notification Letters that ODEQ sends to DMAs, permitees, and other affected parties. The Notification Letters are to be sent out by ODEQ within 20 days of the TMDL being issued as an Order by ODEQ. The Implementation Plan due date is not dependent on USEPA’s approval of the TMDL.

The required elements for TMDL implementation plans are defined in OAR 340-042-0080(3). required to fulfill the following objectives:

- Develop and implement best management practices (BMPs) or other management strategies to achieve TMDL load allocations.
- Develop a timeline for implementation and a schedule for completing measurable milestones.
- Develop a monitoring plan to determine whether:
  - BMPs are being implemented
  - Individual BMPs are effective
  - TMDL load allocations are being met

  - Water quality criteria are being met.
- Evidence of compliance with applicable statewide land use requirements.

DMAs also will have to include a stormwater management component in their TMDL Implementation Plans. DMAs with a population between 10,000 and 50,000 will have to address the six minimum control measures identified in the NPDES Phase II program; DMAs with a population less than 10,000 are expected to give considerations to any of the measures that are relevant. Therefore, Stayton has the potential of being required to meet the same conditions of a Phase II community.

Endangered Species Act

The Federal Endangered Species Act (ESA) was enacted in 1973 to protect threatened and endangered species. In 1987 the State of Oregon enacted the Oregon Endangered Species Act (ESA). The Willamette River provides habitat for steelhead and chinook salmon that are listed under both the Oregon and federal ESA. As the City's stormwater projects and policies have impacts on the Willamette River, the City should protect itself from potential legal action by working to ensure that its stormwater does not adversely affect the river's water quality. The City is directly regulated by the ESA through the review and permitting of in-stream construction project.

NPDES Permit Program

The federal Clean Water Act includes the NPDES permit program. Point source discharges to waters of the U.S., including stormwater and wastewater discharges, are regulated through NPDES permits issued by the U.S. Environmental Protection Agency (EPA) or by delegated states. In Oregon, NPDES permits are issued and implemented by the DEQ. The Water Pollution Control Act (Oregon Revised Statue (ORS) 468B) is the primary Oregon State law protecting water quality.

DEQ combines the federal NPDES regulations with pertinent state regulations and issues combined permits that regulate discharges to waters of the U.S. and waters of the state. These permits are designed to meet NPDES permit requirements and state law under the Water Pollution Control Act. "Waters of the state" include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except private waters which do not combine with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.

The stormwater portion of the federal NPDES regulations has been implemented in two phases. Phase I addressed stormwater discharges by large and medium municipal separate storm sewer systems (MS4s) and certain industrial activities, including construction sites disturbing more than 5 acres. The term "separate" means that wastewater such as sewage is not combined with stormwater runoff. The Phase I stormwater regulations were published in 1990. Phase II addressed MS4s in smaller municipalities and construction sites disturbing between 1 and 5 acres; those regulations were adopted in 1999.

Phase I NPDES Permit Jurisdictions in Oregon

In Oregon, the DEQ has issued NPDES Phase I permits to regulate the discharges of stormwater from the MS4s operated by the following jurisdictions:

- Clean Water Services—Many jurisdictions in Washington County are covered by this permit
- City of Eugene

- City of Gresham—Including the City of Fairview and a portion of Multnomah County
- City of Portland—Including the Port of Portland and a portion of Multnomah County
- City of Salem
- Clackamas County SD No. 1—Including the following jurisdictions:
  - Clackamas County
  - City of Gladstone
  - City of Happy Valley
  - City of Johnson City
  - City of Lake Oswego
  - City of Milwaukie
  - City of Oregon City
  - City of River Grove
  - City of West Linn
  - City of Wilsonville
  - Oak Lodge Sanitary District

These Phase I jurisdictions were originally permitted in 1995, except for Salem, which was permitted in 1997. The Oregon Department of Transportation (ODOT) is also a Phase I municipal stormwater permittee for its stormwater discharges within the jurisdictions of the above cities and counties. Initially, ODOT was a co-permittee on all the Phase I permits, but DEQ issued ODOT a separate permit in 2000.

Phase II NPDES Permit

Affected Jurisdictions

Cities and counties in Oregon were required to apply for NPDES Phase II stormwater permit coverage if they meet all of the following conditions:

- Own and operate a municipal separate storm sewer system
- Discharge from the MS4 to surface waters
- Are within a census-defined urbanized area or are otherwise designated by DEQ.

The Phase II stormwater regulations apply only to discharges to surface waters. Communities that do not discharge to surface waters are not required to apply for NPDES stormwater permits.

The cities and counties listed below meet the three conditions above and are regulated under the NPDES Phase II program:

- City of Ashland
- City of Bend
- City of Central Point
- City of Philomath
- City of Phoenix
- City of Springfield
- City of Wood Village
- Benton County
- Jackson County

- City of Corvallis
- City of Keizer
- City of Medford
- City of Talent
- City of Troutdale
- City of Turner
- Lane County
- Marion County
- Polk County

General Requirements

The Phase II stormwater regulations address runoff from the urban areas of the cities and counties listed above. If runoff from agricultural land is discharging to a municipal storm drain system and contributing to a water quality problem, then the community should work to resolve those discharges.

DEQ requires Phase II municipalities to adopt ordinances and implement minimum measures and BMPs equivalent to those in the federal guidance and in DEQ's *Internal Management Directive—Phase II MS4 General Permit: Storm Water Management Program Plan Framework* (June 2003). Under the Phase II rules, municipalities may be subject not only to the requirements of MS4 owners and operators, but also to two other components of the federal NPDES stormwater program, also delegated to DEQ for implementation:

- The Industrial Stormwater General Permit as an operator of regulated industrial activity
- The Construction Stormwater General Permit as an operator of regulated construction activity disturbing more than 1 acre of land disturbed.

Each of the three components of the NPDES stormwater program (municipal, industrial and construction) has its own requirements and permits.

Industrial Stormwater General Permit (1200-Z; NPDES Permit for Stormwater Discharges Associated With Industrial Activities)

Businesses subject to the Industrial Stormwater General Permit have to prepare and implement a Stormwater Pollution Prevention Plan in accordance with the terms of that permit. The general permit (first issued in 1992, reissued in 1997 in the form of a 1200-Z permit, and again reissued in 2002) requires a description and implementation of operational source control BMPs and structural source control BMPs as applicable to their industrial activity. Erosion and sediment control (ESC) BMPs, flow control BMPs, and treatment BMPs are required if necessary to address an erosion, flow, or pollution problem.

Municipalities with industrial facilities and activities are also required to apply for the 1200-Z Industrial Permits. Under NPDES Phase II, a permitted small MS4 should probably apply for the 1200-Z permit, but its owner could designate those facilities to be covered under the "Municipal Operations" section of its plan with the DEQ's approval.

Construction Stormwater General Permit (1200-C; NPDES General Permit for Stormwater Discharges Associated With Construction Activity)

Operators of construction activities are required to seek coverage under the NPDES 1200-C general permit if the activity results in the disturbance (including clearing, grading, and excavation activities) of 1 acre or more, or if the activity is part of a "larger common plan of development or sale" with a planned disturbance of 1 acre or more and has a discharge of stormwater to a surface water and/or to a storm drain used to convey water to a stream, lake, or wetland. Construction projects that disturb 1 or more acres are subject to three major requirements:

- Submit an NPDES 1200-C permit application, along with a Land Use Compatibility Statement signed by the local land-use authority (county or city planning department) prior to the construction start.
- Develop, submit, and fully implement an erosion and sediment control plan that is approved by DEQ or DEQ agent prior to initiating any on-site activities. This plan specifies the measures that will be put in place to prevent and/or control erosion and sediment runoff.
- Submit a Notice of Termination when the following criteria have been met: final stabilization of the site has been achieved as defined in the permit, all temporary erosion and sediment controls have been removed, and no potential remains for construction-related sediment discharge to surface waters.

Jurisdictions can implement the state's 1200-C permit program locally, by Memorandum of Agreement, through coordination with the Oregon DEQ. DEQ completed a *Statewide Erosion Prevention and Sediment Control Manual* and related *Inspection Guidance Booklet* for use by the construction industry and state and local inspectors in April 2005.

Underground Injection Control Program

One of the provisions of the federal Safe Drinking Water Act is to protect underground sources of drinking water (USDW). The Underground Injection Control (UIC) Program was established to protect USDW by regulating the discharges of fluids into the subsurface by underground injection wells. The federal UIC program was enacted in 1974, and is administered under 40 Code of Federal Regulations (CFR) part 144. The DEQ was delegated by the EPA in 1984 to oversee this program in Oregon, and was re-authorized in 1991. The DEQ regulates this program under Oregon Administrative Rules (OAR) Chapter 340, Division 44. The intent of the UIC program is to protect groundwater aquifers, primarily used for drinking water, from contamination. All groundwater aquifers in Oregon are considered suitable as drinking water.

Subsurface infiltration systems, such as drywells, are classified as Class V injection wells in the EPA's federal UIC program. The two requirements of the UIC program are as follows:

- A non-endangerment performance standard must be met, prohibiting discharges that allow movement of fluids containing contaminants into potential underground sources of drinking water.
- All UIC facility owners/operators must provide inventory information by registering the facilities.

Under the federal UIC regulations, the definition of an underground injection well is a bored, drilled, or driven shaft whose depth is greater than the largest surface dimension; a dug hole whose depth is greater than the largest surface dimension; an improved sinkhole; or a subsurface fluid distribution system that includes an assemblage of perforated pipes, drain tiles, or other similar mechanisms intended to distribute fluids below the surface of the ground. Examples of a UIC well or a subsurface infiltration system are drywells, drain fields, pipe or French drains, and other similar devices that discharge to ground.

OTHER RELATED TOPICS FOR NPDES PHASE II

Common Terms

The following terms have specific definitions for use in discussions of NPDES Phase II permitting:

- A **Municipal Separate Storm Sewer System** (MS4) means a conveyance or system of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drain pipes, subsurface infiltration systems (drywells and infiltration trenches), detention systems, and stormwater quality facilities.
- An **operator** of an MS4 can be a town, city or county, the Oregon Department of Transportation, a tribe, or a special district (drainage improvement district, flood control district, etc.) and may include state-owned facilities (universities, prisons, hospitals, etc.).
- A **combined sewer** is a sewer system designed to convey commingled wastewater and stormwater runoff to a wastewater treatment plant. Where treatment plant or pipe capacity is inadequate during wet weather, the excess combined sewage discharges from the system at designated outfalls (termed combined sewer overflows).
- **Regulated small MS4s** are defined as all small MS4s located in “urbanized areas” as defined by the Bureau of the Census, and small MS4s located outside of a urbanized areas that are designated by NPDES permitting authorities. Only regulated small MS4s need to apply for a Phase II permit.

Urbanized Areas in Oregon and the Phase II NPDES Municipal Stormwater Permit

An urbanized area is a land area composed of one or more central places and the adjacent surrounding area (urban fringe) that together have a residential population of at least 50,000 and a density of at least 1,000 people per square mile. MS4s in other areas may be designated as needing a permit based on application of criteria to be developed by DEQ. The criteria must evaluate whether stormwater discharges result in or have the potential to result in exceedances of water quality standards, including impairment of designated uses, or other significant water quality impacts, including adverse habitat and biological impacts. In Oregon, there are six census-defined urbanized areas:

- Bend Urbanized Area
- Corvallis Urbanized Area
- Eugene Urbanized Area
- Medford Urbanized Area
- Portland Urbanized Area
- Salem Urbanized Area.

The federal Phase II stormwater regulations require the stormwater program to be implemented only within these urbanized areas. However, these urbanized areas do not generally follow city and county boundaries. Phase II communities, for ease of implementation, may want to implement the program jurisdiction-wide instead of only within the urbanized areas. For Phase II counties where only a small portion of the county is in the urbanized area, the county may want to implement the program within the urban growth boundary or other planning boundary or similar urban area. When identifying the area of implementation of their stormwater programs, communities may want to consider areas of significant development and industrial or commercial land uses that are outside of the urbanized area and discharge to their storm drain system.

DEQ, in coordination with local governments, considered the following when identifying the coverage area for the Phase II permit:

- **Where the urbanized area does not follow city/county boundaries**. The census defined urbanized area does not follow city and county boundaries.
- **Where the urbanized area includes a combined sewer area.** Some areas of Oregon contain combined sewer systems. Areas drained by combined sewers are not addressed in the Phase II regulations, but are instead addressed by the Combined Sewer Overflow Reduction Program. Cities and counties served by combined sewers should coordinate the development and implementation of these programs and practices jurisdiction-wide.
- **Where parts of the urbanized area discharge to ground through subsurface infiltration systems or do not drain to waters of the U.S.** NPDES municipal stormwater permits are not required in areas that do not drain to waters of the U.S. For cities or counties with numerous drywells and outfalls to surface waters, this could result in a patchwork program where Phase II requirements apply in some areas or to some stormwater discharges, but not others. The state's Water Pollution Control Act (ORS 468B) requires that discharges to all waters of the state be managed to protect water quality. The state's UIC rule will require cities and counties to manage stormwater discharges to UIC wells. Stormwater management programs are developed in compliance with the Phase II Municipal Stormwater Permit.
- **Where the urbanized area is only a small portion of a jurisdiction.** This especially applies to counties, where the urbanized areas are generally only a small portion of their jurisdictions.
- **Where the urban growth boundary is located with respect to the census-defined urbanized area.** DEQ is considering whether coverage under the Phase II municipal stormwater permit should be based on the Urban Growth Boundaries established by cities and counties under the state Growth Management Act. A coincident boundary may ease program implementation in the long run.
- **Where there are unincorporated islands within a city.** The Phase II stormwater regulations apply to all storm drain systems within urbanized areas. Where a city has an unincorporated island within the city boundary, this unincorporated island is subject to the permit, but responsibility for compliance falls to the county. These unincorporated islands present an excellent opportunity for city and county agencies to cooperate on developing a joint stormwater program.

Jurisdictions Not Covered by NPDES Phase II

In Oregon, 25 small MS4s within the census-defined urbanized areas designated by EPA in the 2000 Census were mandated to be evaluated for Phase II coverage. DEQ performed an analysis and designated 18 municipalities for coverage. From the initial list, DEQ determined that the following municipalities are exempt at this time:

- Adair Village
- Rainier

- Coburg
- Jacksonville
- Maywood Park
- Columbia County
- Deschutes County

Generally, these jurisdictions either have less than 1,000 people in the urbanized area served by MS4s, or they do not discharge to surface water.

The following jurisdictions outside of census-defined urbanized areas were considered for coverage by DEQ but were not designated at this time:

- Albany
- Canby
- Coos Bay
- Dallas
- Grants Pass
- Hermiston
- Klamath Falls
- La Grande
- Lebanon
- McMinnville
- Newberg
- Ontario
- Pendleton
- Redmond
- Roseburg
- St. Helens
- The Dalles
- Woodburn

Municipalities not subject to NPDES stormwater municipal permits are encouraged to adopt stormwater programs at least equivalent to the program components. Adoption of such a program is voluntary. Such municipalities would benefit by helping to protect local ground and surface water sources from stormwater pollution, reducing potential flooding concerns, and ensuring that their storm drain system is properly maintained. Such programs would include adoption of ordinances and implementation of minimum measures, including BMPs.

Any of the above listed jurisdictions can be designated by DEQ, should their status change. One of the most likely criteria for designation will result from a TMDL evaluation that indicates stormwater is a significant contributor to water quality pollution in a receiving water.

What Does Phase II Require

The Phase II stormwater regulations specify that an operator of an MS4 must implement a program of stormwater management activities to protect water quality. The program must at least address the following minimum requirements:

1. **Public education and outreach**—Develop and distribute educational materials and conduct public outreach aimed at informing citizens about the impacts of polluted stormwater as well as ways to minimize their contribution to pollution.
2. **Public involvement and participation**—Involve the public in stormwater management program development and implementation.
3. **Illicit discharge detection and elimination**—Develop and implement a program of detecting and eliminating illicit discharges to the storm drain system. This includes storm system mapping, dry weather sampling, and citizen information activities.
4. **Construction site stormwater runoff control**—Develop, implement, and enforce a program and standards to control or prevent erosion and sediment discharges from

construction sites that disturb 1 or more acres of land. This includes preparation of a construction site erosion and sediment control plan.

5. **Post-construction stormwater management**—Develop, implement, and enforce a program and standards to control or prevent discharge of polluted runoff from new development and redeveloped sites. This can include structural treatment and detention systems as well as resource protection measures (wetland protection, habitat protection, etc.) and pollution prevention planning.
6. **Pollution prevention, or "good housekeeping," for municipal operations**—Develop, implement, and enforce a program to control or prevent the discharge of polluted runoff from municipal operations (road maintenance, vegetation management, storm drain maintenance, etc.).
7. **Compliance with more stringent conditions**—Measures beyond the six above may be needed to achieve TMDLs or other cleanup plans to meet federal Clean Water Act requirements to restore beneficial uses of impaired water bodies.
8. **Evaluation and assessment**—Evaluate the program's compliance with permit conditions and the effectiveness and appropriateness of the identified BMPs. Keep records and report to DEQ any changes in activities resulting from program evaluation and assessment.

The federal regulations do not require Phase II jurisdictions to inspect industrial sites. DEQ is responsible for inspecting industrial sites to ensure compliance with the statewide Industrial Stormwater General Permits. Phase II communities will still be expected to investigate reports of illicit discharges to their storm drain systems at industrial sites, review erosion and sediment control plans for construction of new industrial sites, and implement other aspects of their stormwater management programs that are generally applicable jurisdiction-wide.

Development of a Phase II-compliant stormwater management program may necessitate additional staff, office space, equipment, and funding.

As a practical matter, implementing a stormwater management program to address the minimum requirements of a NPDES permit may require that operators of small MS4s do the following:

- Integrate a stormwater management program into their organizational structure.
- Hire additional staff to carry out the work (public involvement and education, plan review, inspection and enforcement, maintenance, planning, complaint response, management, etc.).
- Find additional office space for staff.
- Obtain additional office, field, and maintenance equipment.
- Develop and adopt ongoing funding methods.
- Develop and adopt various legal ordinances.
- Conduct ongoing stormwater and surface water planning efforts.

Appendix D.3

NPDES Plan

TETRA TECH/KCM
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Technical Memorandum

City of Stayton
STORMWATER NPDES
PHASE II PROGRAM PLAN

January 5, 2007

1.0 INTRODUCTION

This Stormwater NPDES Phase II Program Plan for the City of Stayton, Oregon, has been developed to address the Municipal Separate Storm Sewer System (MS4) permit requirements of the National Pollutant Discharge Elimination System (NPDES). The MS4 program for small jurisdictions is often called NPDES Phase II. The program described in this document is outlined for a 5-year period, since that is the standard length of a NPDES permit term. Although the City of Stayton is currently not required to meet NPDES Phase II requirements, the City is addressing several of these issues as part of the overall stormwater master plan effort. This program's approach will meet the requirements of the Willamette River TMDL program where the City is identified as a Designated Management Agency (DMA).

This Plan is arranged by the six minimum measures that were identified in the Federal Register. At the beginning of each section is a summary table listing each proposed activity (or BMP) associated with the measure addressed in that section. The five columns indicate which years (during the 5-year permit period) that the activity is anticipated to be performed by the City, working either jointly or independently, as applicable. The summary tables are followed by descriptions of schedules, measurable goals, responsible parties, and other implementation issues for each activity.

The measurable goals proposed for each activity were established through various means. Generally, they represent what seemed reasonable for each situation, based on past experience and common practices for stormwater management. Certain activities have precedent activities, so those are scheduled accordingly. From a practical sense, not all activities can be performed in Year 1, so a conscientious attempt was made to spread them out over a 5-year period.

A NPDES permit would require reporting of measurable goals and implementation schedule, which is also a requirement of the DMA's under the TMDL program.

2.0 STORMWATER PUBLIC EDUCATION PROGRAM

Stayton may wish to maximize the use of regional information and publications to the extent practical. This would include assisting with the circulation of literature developed by DEQ, EPA, the North Santiam Watershed Council, and others.

In addition to preparing the 5-year program, Stayton could implement a program to educate the public about possible regional coordination efforts and what the NPDES Phase II and the TMDL programs mean to the community. This work could include conducting open houses, preparing brochures, and making presentations to City Council. The following table describes efforts that could be undertaken and planned for the 5-year program.

TABLE 2-1
STORMWATER PUBLIC EDUCATION PROGRAM

BMP Activity / Description	Activity Year 1	2	3	4	5
Stormwater Education & Outreach Strategy	√	–	√	–	–
Stormwater Brochure for the General Public	–	–	√	–	–
Targeted Stormwater Brochures	–	√	–	√	–
Storm Drain Stenciling	√	√	√	√	√
Water Quality Education with Schools	–	√	–	√	–
Volunteer Groups on Stormwater Education	–	√	–	√	–
Stormwater Speakers Bureau	–	–	–	–	–
Stormwater Public Service Announcements	–	–	√	–	–
Stormwater Display	–	√	–	–	–
Stormwater Web Site	–	–	–	–	–

√	Activity scheduled for year	–	No activity scheduled for year

2.1 Develop a Stormwater Education and Outreach Strategy

Develop and implement a stormwater education and outreach strategy that examines target audiences. Include in the strategy information on the hazards associated with illicit discharges and improper disposal of waste.

Description: The stormwater outreach strategy is a required BMP under the NPDES Phase II permit. An effective education and outreach program begins with a comprehensive education and outreach strategy. The strategy focuses on identifying target audiences, including what they value and how they communicate. This information directly relates to determining the other education and outreach BMPs that are most appropriate for target audiences.

- Step 1. Characterize Target Audiences: Specific groups within the community may have the potential to contribute pollutants to stormwater. If so, document characteristics about these groups for use in developing and distributing educational materials.

- Step 2. Develop Education and Outreach Strategy: Using information about the storm drainage system and target audiences, develop an education and outreach strategy to help implement the overall program. The strategy identifies a variety of information, including the driving force (i.e., key problems caused by stormwater associated with the target audience); the key message(s); the objective (e.g., raise awareness, educate, or motivate action); the format for delivering the message; the distribution method; and the responsible parties and/or partners.

Potential Action Plan and Schedule: The Potential Action Plan for this activity is to meet with the North Santiam Watershed Council to discuss current public outreach activities and to identify potential audiences, methods to reach these audiences and a schedule to implement these activities.

Measurable Goal: Every six months City staff will meet with staff of the North Santiam Watershed Council to discuss Public Education and Outreach. This will determine the effectiveness of the existing programs and potential future endeavourers. If it is determined minor modifications to the program are required to reach a larger audience these will be outlined in the annual reporting.

2.2 Stormwater Brochure for the General Public

Develop and distribute a brochure or equivalent program to inform the general public about stormwater issues and of the hazards associated with illicit discharges and improper disposal of waste.

Description: Develop and distribute a general brochure on stormwater. The purpose of this brochure is to address how stormwater can impact water quality and the steps that people can take to reduce stormwater pollution (e.g., do not dump to storm drains). One element of the illicit discharge detection and elimination minimum measure is to “inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.” This BMP fulfills this element.

There are many opportunities to “piggyback” the distribution of educational materials onto the distribution of others such as newspapers, newsletters, and community events. Take advantage of these existing communication channels for distributing materials and messages in an effective and cost-efficient manner.

Exposing target audiences to a message on a regular basis can raise awareness. A combination of formats and distribution channels to reach each target audience is beneficial. A feedback mechanism can be developed for evaluating the effectiveness of the materials and the changes in target audiences’ level of awareness regarding stormwater.

Potential Action Plan and Schedule: The plan is to send out one general stormwater brochure in the third year of the program.

Measurable Goal: The measurable goal of this activity is the number or percentage of residents and business contacted with the brochure.

2.3 Targeted Stormwater Brochures

Develop and distribute stormwater brochures that address a variety of different target audiences.

Description: Brochures targeted and written specifically for the audience are often more effective than general brochures. The stormwater education and outreach strategy will provide direction on target audiences and issues to consider when developing targeted brochures.

Target audiences include residents, businesses, industries, and developers. Consider addressing topics such as pet waste management, pollution prevention tips for landscaping, proper disposal of household hazardous waste, pesticide use, do-it-yourself auto maintenance, car washing, and/or pavement deicing.

Potential Action Plan and Schedule: Within the second year Stayton will develop a targeted brochure for erosion control (see Section 5.6). The brochure will discuss the need for erosion control along within general prevention and where more information can be obtained. The brochure will be included in all building permit application packages.

Develop second brochure by the fourth year of the program. Other targeted brochures might include homeowners along creek corridors, or brochures describing new development requirements as part of this program. Targeted groups to be determined in year 1 as part of the Outreach Strategy.

Measurable Goal: Erosion Control targeted brochure included in all building permits by year 2.

2.4 Storm Drain Stenciling

Plan and conduct storm drain stenciling projects using “Do Not Dump – Drains to Stream” or an equivalent message on storm drain inlets draining to the system.

Description: Stenciling storm drains with messages such as “Do Not Dump – Drains to Stream” or “Do Not Dump – Drains to Ground Water” have proven very effective in many jurisdictions. Some residents still do not know that material placed in storm drains is not treated at a wastewater treatment plant before reaching a river or infiltrating into ground water. These permanent messages on storm drains serve as constant reminders and teaching tools for everyone who sees them.

There are several options to consider in terms of what type of stencils to use and how to get the job done. First is to consider enlisting the aid of volunteer organizations. Second is to decide on the method of applying the messages. To apply the “no dumping” messages, use either actual stencils that require paint or signs and emblems out of plastic and metal that permanently affix. Labor for stenciling can come from either municipal employees or volunteers. Set a goal to complete a certain amount of storm drain stenciling by the end of the first permit term. Using the storm sewer system map completed for the Illicit Discharge Detection and Elimination minimum measure (described in Section 4), prioritize storm drain inlets according to potential risk (e.g., inlets with a history of illegal dumping; inlets located near industries with outdoor, uncovered operations; and inlets located near areas with high rates of development) and begin stenciling projects in those areas.

Potential Action Plan and Schedule: The City may consider a program to stencil storm drains and catch basins which have not been stenciled. City Staff will investigate the wear of the stenciling in year 3 and 5 to determine if the storm drains will need repainting. All storm drains of new development and road improvement projects will be painted following project completion. This project could be listed as a service project available for community service organizations.

Measurable Goal: Measurable goal will be to monitor stencils for wear and to include storm drain stenciling in the City final inspection for new development.

2.5 Promote Water Quality Education with School Districts

Contact school districts to discuss opportunities to integrate water quality educational materials into the classroom and provide educational materials when requested by schools. This effort might already be preformed by the North Santiam Watershed Council and therefore should be discussed at the strategy meeting.

Description: For this BMP, contact all schools districts within the storm drain system and offer to distribute appropriate water quality educational materials. If feasible, offer staff from a department involved in stormwater management to teach some of the material or organize alternative educational efforts such as tours of wastewater treatment plants or stream restoration visits.

The Oregon Department of Environmental Quality lists Classroom Curriculum Guides (K-12) that could be distributed to local schools. See the web site http://www.deq.state.or.us/programs/education.htm for more information. DEQ also holds workshops for teachers on Project WET, Water Education for Teachers. Additional information can be found on DEQ’s web site.

Potential Action Plan and Schedule: The City of Stayton may wish to coordinate and promote stormwater Education. This effort could be lead by the Watershed Council or the City and include meetings with educators to determine how City Staff can provide educational instruction and material to local educators. The coordination will include working with local organizations and school districts to develop a water quality education program. Specific guidelines can be obtained from other resources throughout the region. Details of how the effort can assist educators will be determined based on the initial meetings with the educators. The effort will start approaching school districts and educators in year 2 of the program to determine the best methods to coordinate efforts.

Measurable Goal: Contact the school district within the storm drain system boundary by the end of permit year 2. Measurable goals for the detailed education will be based on the approach chosen to assist educators. The goals and achievements will be presented in the annual reporting.

2.6 Work with Volunteer Groups on Stormwater Education Projects

Contact volunteer organizations to discuss opportunities to integrate stormwater into existing education projects. This should include the Watershed Council and other groups within the area.

Description: Many volunteer organizations within the storm drainage system may already conduct water quality related educational programs. Where these organizations exist, they may be willing to incorporate stormwater issues into their programs and activities to help meet this minimum measure.

Begin by researching the various volunteer programs and organizations that focus on the boundaries of the storm drainage system and/or the watershed and identify ways to integrate stormwater issues into these existing volunteer opportunities.

Potential Action Plan and Schedule: Stayton may consider working with local volunteer organizations to discuss opportunities to integrate stormwater/water quality information into existing education projects.

Adopt a Street Program: This program allows businesses, service clubs, schools, and organizations to adopt an arterial or collector street. The groups is asked to adopt the street for at least 1 year and conduct litter clean ups at least every 3 months. Individual residents, neighborhoods, or families can also adopt streets in their neighborhood. They are asked to adopt the street for at least a 1 year period and clean it on an as needed basis.

Storm Drain Stenciling Program: The City might supply all equipment for the stenciling program for participants or other volunteers to stencil the words "Dump No Waste—Drains to Streams" on storm drains.

Measurable Goal: Assist any groups actively contacting the City. This could be an ongoing activity with groups that express interest. In years 2 and 4 actively contact at least 2 volunteer organizations per year to discuss and promote stormwater education.

2.7 Develop a Stormwater Speakers Bureau

Develop and promote a stormwater speakers bureau that gives presentations on stormwater issues throughout the community. The Watershed Council may already have qualified people to make these presentations.

Description: Recruiting a team of stormwater management advocates from target audiences is one way to educate stakeholders and to distribute stormwater educational messages at a low-cost. Speakers bureaus are an effective way to get out information on stormwater management and have the message come from a representative of each target audience. All that is needed to implement this BMP are presentation materials on stormwater management and a group of willing volunteers who like to speak in public.

Potential Action Plan and Schedule: This activity should be discussed with the Watershed Council to determine the best qualified residents or staff to go to meetings to discuss Stormwater Quality programs and activities.

Measurable Goal: Keep records of any stormwater presentations and the number of attendees or number of times the program was repeated.

2.8 Create Stormwater Public Service Announcements

Broadcast stormwater public service announcements (PSAs) through newspapers, television, or radio and run the announcements at appropriate frequent intervals to ensure target audiences are exposed to the message.

Description: Most people within communities receive their information from mass media sources such as newspapers, television, and radio. While these forms of outreach tend to be more expensive than printed materials, they can reach a wide audience and have a stronger, more lasting impact.

Design public service announcements (PSAs) for mass media sources such as newspaper, television, or radio. To have an impact, audiences need exposure to PSAs over a long-period of time and at regular intervals. Many communities have already designed and used PSAs related to stormwater and make these PSAs available to other communities to use either for free or at a minimal cost.

Potential Action Plan and Schedule: Working with the Watershed Council, DEQ or others a public announcement should be attempted in the third year of the program. This could be radio or news print and could use material developed by others.

Measurable Goal: The number of Public Service Announcements will be kept over the first five years.

2.9 Design a Stormwater Display

Display a stormwater exhibit at various community locations and events (e.g., county fairs, city events).

Description: Buildings and events that have regular traffic and/or attract a large number of people provide an opportunity for stormwater education. Free-standing educational displays are intended to communicate information in an easy-to-understand format using photographs, maps, and hands-on activities.

In order to design and develop an educational display on stormwater issues, include messages for members of each target audience, provide information on stormwater problems and solutions, and use a combination of images and text to convey information. In addition to developing the display, use the information contained in the education and outreach strategy (BMP 2A) to identify the most effective places and/or events to set-up the display.

Potential Action Plan and Schedule: A stormwater display will be developed by the second year of the program to be shown on community events.

Measurable Goal: Track the number of events and attendance the display is shown.

2.10 Create a Stormwater Web Site

Create a stormwater website that contains educational information for a variety of target audiences.

Description: Design and develop a stormwater website that contains educational information on stormwater and information on the jurisdiction's stormwater program. Include the website address on other forms of outreach, such as brochures and displays, to ensure that the community knows where to find additional information about stormwater.

Potential Action Plan and Schedule: Nothing is scheduled for this activity for the first 5 years of the program. This activity is listed as an alternate if others activities are not successful or not implemented.

Measurable Goal: A measurable goal for this activity would be the development of a web site or a section of the City's overall web site.

3.0 STORMWATER PUBLIC INVOLVEMENT AND PARTICIPATION PROGRAM

Stayton may wish to maximize the use of regional public involvement activities to the extent practical. This would include coordinating with activities performed by DEQ, EPA, the North Santiam Watershed Council, and others.

Stayton could implement a program to involve the public in local and regional coordination efforts. This work could include conducting public meetings, distributing news releases, and forming a stormwater group to advise staff and the City Council. The following table describes efforts that could be undertaken and planned for the 5-year program.

TABLE 3-1
STORMWATER PUBLIC INVOLVEMENT AND PARTICIPATION PROGRAM

BMP Activity / Description	Permit Year 1	2	3	4	5
Public Review/ Public Meetings	√	–	√	–	–
Distribute News Releases	√	–	–	–	–
Stormwater Advisory Group	√	√	√	√	√

√	Activity scheduled for year	–	No activity scheduled for year

3.1 Public Review/Public Meetings

Hold public meetings and solicit public review of the stormwater management plan.

Description: Follow all local and state public notice requirements to ensure that the public has an opportunity to participate in the program. Local public notice requirements vary, but will probably consist of public meetings and publishing notices in local newspapers.

Potential Action Plan and Schedule: The City of Stayton will investigate methods to encourage the involvement of the public in stormwater activities. This effort will continue throughout the 5-year program. The program will be developed to allow public comment on stormwater programs and projects.

Once the stormwater management plan is completed, Stayton will hold public meetings to solicit public review of the plan.

The effort for public review and public meetings will continue throughout the 5-year program however attempts should be made to have a public meeting in the first and third year of the program.

Measurable Goal: Hold at least two public meeting and publish at least two public notices during the 5-year program.

3.2 Distribute News Releases

Develop a news release for local newspapers in order to solicit interest to cover the new stormwater program as a feature story.

Description: To help encourage additional local coverage on the development of the stormwater program, create and distribute a new release for use by local papers. Include in the news release an overview of the new stormwater program, activities that will be conducted, and how the public can obtain more information.

Potential Action Plan and Schedule: The distribution of news releases will be provided when the local press is available and interested in stormwater topics. No schedule for this has been developed and opportunities will depend on the news agencies' interest in stormwater activities.

Measurable Goal: At least one news release story on the jurisdictions stormwater program over the first five year program.

3.3 Stakeholder Advisory Group

Hold meetings with a stakeholder advisory group for stormwater issues.

Description: An advisory group could be formed with representatives from several City departments and members of various organizations in the City and beyond. This group would address issues pertaining to the stormwater program and provide guidance for planning, engineering, construction and operation activities.

Potential Action Plan and Schedule: The group should set a schedule for meeting and every six months or every year.

Measurable Goal: Dates and attendance will be kept for each meeting. A summary of topics discussed and key decisions will be kept and submitted as part of the annual report.

4.0 ILLICIT DISCHARGE DETECTION AND ELIMINATION PROGRAM

In order to meet regulations under 40CFR122.34(b)(3), an Illicit Discharge Detection and Elimination Program will be developed for the City of Stayton. The following table describes efforts that could be undertaken and planned for the 5-year program.

TABLE 4-1
ILLICIT DISCHARGE DETECTION AND ELIMINATION PROGRAM

	Permit Year				
BMP Activity / Description	1	2	3	4	5
Storm Sewer System Map	√	–	–	–	–
Ordinance to Prohibit Non-Stormwater Discharges	√	√	–	–	–
Detect and Address Non-Stormwater Discharges	–	–	√	–	√
Conduct Field Inspections	–	√	√	√	√
Spill Response Plan (create new plans or review and update existing plans)	–	√	–	–	–
Plan for Enforcement Actions	–	√	–	–	–
Train Municipal Staff on Spill and Illicit Discharge BMPs	–	√	–	–	√

√	Activity scheduled for year	–	No activity scheduled for year

In addition to the following required best management practices (BMPs), brochures, including information about illicit discharges will be created for the general public as a part of the Public Education requirements.

4.1 Storm Sewer System Map

Create a storm sewer system map showing all known storm drain outfalls to receiving waters.

Description: If one does not already exist, a storm sewer system map showing, at a minimum, locations of all outfalls and the names and locations of all waters that receive a discharge from those outfalls is needed. The mapping of storm sewer pipe or storm drain inlet locations is not required, although it is probably desirable for most cities in the long-term to assist with maintenance

Potential Action Plan and Schedule: A storm sewer system map is being created as part of the Master Plan effort and therefore this effort is due to be completed in the first year of the plan.

The storm sewer system map will be updated as a part of the Illicit Discharge Detection and Elimination activities and the Post-Construction program activities. As new development is permitted the drainage system will be added to the base map.

Measurable Goal: The storm sewer system map will be updated annually.

4.2 Ordinance to Prohibit Non-Stormwater Discharges

Develop and enforce an ordinance prohibiting illicit discharges and illegal dumping, and authorizing enforcement actions, including on private property.

Description: First, assess whether the required legal authority to prohibit non-stormwater discharges to the storm drainage system currently exists. Look to existing ordinances or municipal codes to identify this legal authority. If adequate legal authority prohibiting illicit discharges does not exist, an ordinance can be drafted.

A model ordinance includes authority for all three of the ordinances required by EPA's Phase II regulations: ordinances to control illicit discharges, construction site runoff, and post-construction runoff. It may be easier to combine all three ordinances into a single ordinance if legal authority does not currently exist.

Potential Action Plan and Schedule: If it is not already in place, the city may consider enacting a policy or code making it unlawful to deposit substances in the public drainage system that could cause damage to that system..

Measurable Goal: The measurable goal is to have ordinances in place to make it (1) unlawful to discharge pollutants to the storm system, (2) allow the City to investigate private property for illegal discharges, (3) allow the City to force private properties to make changes if illegal discharges are detected, (4) make it illegal for new development to construct illegal discharge connections.

4.3 Detect and Address Non-Stormwater Discharges

Develop an illicit discharge detection plan that includes, at a minimum, the following components: (1) Identification of priority areas for assessment, (2) Field assessment activities, (3) Routine schedule for system inspection, (4) Characterization of any discharges found, (5) Procedures to trace an illicit discharge, and (6) Procedures to remove an illicit discharge.

Description: The primary component of this minimum measure is to develop an illicit discharge detection plan to find, identify, and eliminate unknown pollutant discharges to the storm drainage system. The purpose of this plan is to identify priority areas within the storm drainage system that are believed to be more susceptible to illicit discharges, describe field assessment activities, determine when a discharge is found whether it is illicit, and describe procedures to trace the discharge back to its source and eliminate the discharge.

Potential Action Plan and Schedule: An Illicit Discharge Plan will be prepared by year 3 of the program. This will include a procedure for the inspection and detection of illicit discharges. The following components will be included in the plan:

1. Identification of priority areas for assessment
2. Field assessment activities
3. Routine schedule for system inspection
4. Characterization of any discharges found
5. Procedures to trace an illicit discharge
6. Procedures to remove an illicit discharge

The new stormwater ordinance discussed under Section 4.2 will provide the City with regulations to remove illicit discharges if detected.

After the program has been implemented for a year the overall plan will be reevaluated in year 5 to make minor modifications.

Measurable Goal: Develop plan by year 3 and evaluate plan in year 5.

4.4 Conduct Field Inspections

Visually inspect for illicit discharges during dry weather at all known outfalls that discharge to surface waters (in conjunction with the storm sewer system map).

Description: Using the plan and City maps, the City field staff will inspect outfalls for any signs of illicit discharges. Field inspection activities consist of visiting outfall locations using the system map and recording visual observations at each outfall within a priority area. For accessible outfalls, mark the outfall once it is located and complete a field inspection form. If an outfall is not accessible, field crews must use the system map and identify the nearest point to access the system. Locate the storm sewer manhole closest to the outfall and remove the cover to identify signs of dry-weather flow, such as odor or residue. City Staff will inspect outfalls and the drainage system to determine if they are functioning as designed.

Potential Action Plan and Schedule: This activity is simply implementing the Illicit Discharge Plan developed under Section 4.3 of this section. The plan will develop a schedule and reporting procedures to be used when conducting these inspections. At a minimum, each outfall shall be inspected on a 3-year rotation. Appropriate actions will be taken to determine the source of any illicit discharges found during the inspections.

Measurable Goal: The measurable goals for this activity should be developed as part of the Illicit Discharge Plan. Methods for measurement might be inspection of a percentage of the system each year.

4.5 Spill Response Plan

Develop and implement a spill response plan.

Description: A written spill response plan is needed to identify appropriate actions when a spill occurs. Include in the plan, for different kinds of spills, who should be contacted and what the municipality will do in response. The plan also needs to include recordkeeping and reporting requirements so that each spill, the response, and its outcome are tracked.

Potential Action Plan and Schedule: A Spill Response Plan would be prepared in year 2 of the program.

Measurable Goal: Implement the program by the end of permit year 2.

4.6 Plan for Enforcement Actions

Develop and implement an enforcement plan to ensure compliance with local ordinances. This enforcement plan will be used for illicit discharges, construction site discharges, and post-construction discharges.

Description: The enforcement plan developed for this BMP addresses how to handle non-compliance with local ordinances and discharges from illicit sources, construction sites, and post-construction BMPs. Develop the plan so that it is specific enough to give inspectors guidance on the typical penalty for each situation.

Potential Action Plan and Schedule: After discovering an Illicit Discharge, the City of Stayton will first attempt to work with the responsible party to eliminate the problem or to route the flow to the sanitary sewer, if allowable. The City may consider establishing a municipal code providing the ability for the city to fine a party on a daily basis for an infraction. The City can also work with the DEQ to eliminate spills and illicit discharges when discovered.

Measurable Goal: No measurable goal for this activity.

4.7 Train Municipal Staff on Spill and Illicit Discharge BMPs

Provide training or coordinate with existing training efforts to educate relevant staff on proper BMPs for spills and illicit discharges.

Description: Provide training to relevant municipal staff, such as field maintenance crews, illicit discharge inspectors, and other first responders, on the proper BMPs to use for spills and illicit discharges. Include in the training who to call for different types of spills.

This training could be combined with other training of municipal staff conducted in Section 7.

Potential Action Plan and Schedule: Once the above items are completed, relevant municipal staff will be trained on the proper BMPs to use for spill response and illicit discharge detection and removal. The staff training will occur in combination with training for Pollution Prevention. “Refresher” training will update staff on changes to the procedures as needed.

The training of staff will begin in year 2 with refresher courses and courses for new staff conducted in year 5 of the program. Selected staff will go to regional or statewide training classes and develop a program to train all staff within the City crews.

Measurable Goal: The number of staff time spent in class along with class subjects will be documented and reported annually.

5.0 CONSTRUCTION SITE STORMWATER RUNOFF CONTROL PROGRAM

In order to meet regulations under 40 CFR 122.34(b)(4), the City of Stayton will need to develop, implement, and enforce a program to reduce pollutants in any stormwater runoff from construction activities. The regulations covering this activity will need to be part of the overall City stormwater ordinance. The size of the construction activity covered by the ordinance will be determined during the ordinance development. Meetings with City Council however, will cover, at a minimum, construction activity of 1-acre or larger. The following table describes efforts that could be undertaken and planned for the 5-year program.

TABLE 5-1
CONSTRUCTION SITE STORMWATER RUNOFF CONTROL PROGRAM

BMP Activity / Description	Permit Year 1	2	3	4	5
Modify Erosion and Sediment Control Ordinance	–	√	–	–	–
Develop Erosion Control Manual (or adopt state or other manual)	–	√	–	–	–
Train Plan Reviewers and Field Inspectors	–	√	–	–	–
Training for Contractors and Developers		√	–	–	–
Review Site Plans for Erosion and Sediment (E&S) Controls	–	–	√	√	√
Receive Information from the Public	–	–	√	√	√
Inspect Construction Sites	–	–	√	√	√
Information Brochures for Contractors	–	√	–	–	–
Provide Information on Training for Construction Operators	–	√	–	–	–

√	Activity scheduled for year	–	No activity scheduled for year

5.1 Modify Erosion and Sediment Control Ordinance

For permits or authorizations issued by the jurisdiction for construction operators disturbing at least 1 acre, require through an ordinance, erosion and sediment controls in compliance with an adopted stormwater management *Manual* or other guidance document. Jurisdictions may, at their discretion, require erosion and sediment controls for smaller sites based on local conditions and needs.

Description: The 1994 Storm Design Standards has a section describing erosion control requirements however this section is limited to areas within the banks of a waterway. This standard requires updating to include referencing the need for developing an ordinance to allow the collection of permit applications and the issuing of permits. This will allow the City to administer the DEQ program. This ordinance typically requires construction operators to follow a guidance manual. An effective ordinance also includes penalties to ensure compliance. At a minimum, this ordinance applies to all construction activity disturbing at least one (1) acre but can include single family construction. Incorporate these ordinance requirements into an existing grading permit process, requiring sites to submit erosion and sediment control plans and implement BMPs before a grading permit is issued.

Include in the local ordinance a requirement that construction sites comply with an adopted stormwater management *Manual*. Such a *Manual* could either be prepared locally, regionally, or statewide. Alternately, the Oregon DEQ has prepared a statewide *Erosion Prevention and Sediment Control Manual* for use by the construction industry and state and local inspectors. In any case, the details on the types of controls construction sites must implement should preferably be contained in the technical *Manual*, not in the ordinance. The State Building Code can also provide the legal authority, however, in most cases it is probably better to have the legal authority specified in the local municipal code.

Potential Action Plan and Schedule: Stayton will adopt a stormwater ordinance that will include illicit discharges, construction site runoff, and post construction runoff by year 2 of the program.

Stayton currently has design guidelines that include requirements for erosion and sediment control, however these guidelines are very brief (about one page of text). An expanded program should be developed to address new requirements of stormwater NPDES Phase II, or the state's manual, once available, could be used.

Measurable Goal: Adopt updated Ordinance and Design *Manual* by the end of program year 2.

5.2 Train Plan Reviewers and Field Inspectors

Provide training or coordinate with existing training efforts to educate plan reviewers and field inspectors in erosion and sediment control BMPs and requirements.

Description: Sections 5.3 and 5.5 describe the process to review site plans for erosion and sediment controls and inspect construction sites for proper BMP installation and maintenance. To help implement these activities, provide training to plan reviewers and field inspectors in developing and implementing an effective erosion and sediment control plan. This training can be developed in-house, or a variety of organizations offer training courses on construction site sediment and erosion control.

Potential Action Plan and Schedule: Once an ordinance is in place, Stayton will train city staff responsible for reviewing plans and inspecting construction sites to ensure that erosion and sediment control BMPs are properly installed and maintained. If possible, training will be coordinated with training on post-construction stormwater management. "Refresher" training will update staff on changes to the procedures as needed. Stayton may participate in a regional training program. This might include training programs by DEQ.

Train plan reviewers and field inspector by the end of program year 2.

Measurable Goal: The number of hours spent in class along with class subjects will be documented and reported annually.

5.3 Review Site Plans for Erosion and Sediment (E&S) Controls

Review stormwater site plans prior to construction to ensure that they include adequate E&S controls and post-construction controls. This review is conducted to determine compliance with local ordinances and the adopted stormwater management *Manual*. Federal rules require that all construction sites greater than one disturbed acre be subject to plan review. Jurisdictions may, at their discretion, require plan review for smaller sites based on local conditions and needs.

Description: To ensure that construction sites include the required stormwater controls, review pre-construction site plans to ensure that they include appropriate erosion and sediment controls and post-construction controls in compliance with the local ordinance and the adopted stormwater management *Manual*. Combine this pre-construction review of E&S controls with the review of post-construction controls to streamline the review time and conserve resources. EPA recommends that procedures for site plan review include the review of individual pre-construction site plans to ensure consistency with local sedimentation and erosion control requirements. At a minimum, include review of all plans for construction sites disturbing at least one acre in the site plan review process.

Potential Action Plan and Schedule: Once a stormwater ordinance is updated/adopted for Stayton, construction site plans will be reviewed to ensure they are in compliance with local ordinances and stormwater management manuals. Plans will also be reviewed for appropriate use of erosion and sediment BMPs as well as post-construction controls.

Start reviewing site plans for erosion control beginning in year 2. This will allow development of the stormwater ordinance and training of staff. Until that time the 1200-C permit process administered by DEQ will be used to review and control construction runoff in Stayton.

Measurable Goal: Once this effort has started, City staff will monitor the number of permit reviews, the number of on-site inspections, and the number of on-site revisions required. If enforcement is required this will also be recorded. All records will be reported annually.

5.4 Receive Information from Public

Publish a phone number, or equivalent system, to receive information from the public on construction site runoff issues. Set up a process to pass this information off to field inspectors.

Description: To meet this requirement, list a phone number for “construction-related complaints” in the local government pages, published in brochures and listed on the jurisdictions web site, if available. Direct this phone number to the appropriate staff person, such as an administrative assistant or a construction inspector.

Keep written logs of all complaints that include the date and time of the call, location of the construction site, and the nature of the complaint. Provide information on these complaints to the local construction inspectors by the end of the day; the goal is to have inspectors follow-up on each complaint within three days.

Potential Action Plan and Schedule: On brochures, permit applications, and other publications, the phone number of the City’s Stormwater Department will be given to allow the public to report complaints and/or comments from the general public regarding construction site runoff. These comments and follow-up activities will be monitored internally by City Staff. The City’s construction inspector will receive information on the complaint by the end of the day and will be responsible for following up on each complaint within 2 days.

Measurable Goal: Record the number of complaints received and handled, and submit with the annual report.

5.5 Inspect Construction Sites

Inspect all construction sites during the construction period that are regulated by the ordinance adopted in Section 5.1.

Description: Once site plans receive approval for E&S controls, it is extremely important to ensure that E&S controls are properly installed and maintained, and that the site plan reflects changes made on-site (e.g., different types of controls used and changed location of controls). Frequent and consistent inspections are the key to ensuring proper installation and maintenance of E&S controls. At a minimum, inspect all construction sites at least once during the project period.

Set inspection priorities based upon local goals, resources, and known problem areas. These priority sites can be based on particular areas or the priority sites can be based on specific operators with past problems or larger construction sites.

Potential Action Plan and Schedule: All construction sites which are required to submit site plans for erosion and sediment control will be inspected to ensure that the selected BMPs are installed and maintained correctly. Site plans must also reflect changes made on-site after the plans were reviewed. The frequency of inspection will be determined based on the complexity of the project. Each construction site shall be inspected at least once.

Inspection will start in year 3 of the program.

Measurable Goal: Records of the inspections and any follow-up work will be kept and submitted annually.

5.6 Provide Information on Training for Construction Operators

Provide information on local training available to construction operators on how to install and maintain effective erosion and sediment control and how to comply with the requirements in the adopted stormwater management *Manual*.

Description: Local jurisdictions do not need to conduct this training for local construction operators, but should direct construction operators to available training resources if requested. This could be provided as a single page handout during the pre-construction meeting or as requested.

The training described in Section 5.2 also applies to local construction operators. In fact, many classes will include a mix of both municipal construction plan reviewers and inspectors, along with local construction operators.

Potential Action Plan and Schedule: A brochure on construction site erosion control and post construction controls will be prepared and distributed (see Section 2.3). This will include brief descriptions of methods, sources of information for erosion control methods, including DEQ's manual and web sites. The brochure will also include information on training available for local construction operators. If contractors require further training following the classes provided by DEQ.

Develop Erosion Control brochure by year 2.

Measurable Goal: Document the distribution of the erosion control brochure and the scheduled classes along with attendance, and submit with the annual report.

6.0 POST-CONSTRUCTION STORMWATER MANAGEMENT PROGRAM

In order to meet regulations under 40 CFR 122.34(b)(5), the City of Stayton will develop a program for post construction stormwater management. The following table describes efforts that could be undertaken and planned for the 5-year program.

TABLE 6-1
POST-CONSTRUCTION STORMWATER MANAGEMENT PROGRAM

BMP Activity / Description	Permit Year				
	1	2	3	4	5
Ordinance Requiring Post-Construction Controls	√	√	–	–	–
Develop a Plan to Address Post-Construction Run-off	√	–	–	–	–
Training for Plan Reviewers and Field Inspectors	√	–	–	–	–
Training for Local Engineers and Developers	√	–	–	–	–
Site Plan Review for Post-Construction BMPs	√	√	√	√	√
Inspections of Structural Post-Construction BMPs	√	√	√	√	√

√	Activity scheduled for year	–	No activity scheduled for year

6.1 Ordinance Requiring Post-Construction Control

For permits or authorizations issued by the jurisdiction for construction of private developments, require through an ordinance, the installation and proper maintenance of post-construction runoff controls in compliance with an adopted stormwater management *Manual/Standards* or other guidance document. The size of the development requiring post development stormwater controls will be laid out the management manual and is at the discretion of the City.

This ordinance might already be in place but should be reviewed. The ordinance will not contain the detailed design requirements but will only reference the Stormwater Manual/ Design Standards being developed as part of the master plan effort and discussed below in Section 6.2.

Description: Combine the post-construction ordinance with the illicit discharge and construction ordinance, described in Sections 4 and 5 respectively, into a single stormwater ordinance. This ordinance largely requires local construction sites to comply with a local stormwater manual. After the ordinance is adopted, plan on evaluating the effectiveness of this ordinance during subsequent years of the permit.

EPA only requires the ordinance to "address post-construction runoff from new development and redevelopment projects" but does not say specifically what the ordinance must include. The ordinance could be as simple as requiring post-construction runoff to be no greater than pre-construction runoff.

Ensure that the ordinance addresses post-construction runoff from new developments and redevelopment projects that disturb more than one acre. The term "redevelopment" should refer to alterations of a property that change the "footprint" of a site or building and is not intended to include such activities as exterior remodeling, which would not be expected to cause adverse stormwater quality impacts and offer no new opportunity for stormwater controls.

Potential Action Plan and Schedule: Stayton will adopt a new stormwater ordinance that will include illicit discharges, construction site runoff, and post construction runoff. The stormwater ordinance is scheduled to be prepared and adopted in the first year of the 5-year program.

Measurable Goal: Adopt ordinance by the end of the first year of the program.

6.2 Develop a Plan to Address Post-Construction Runoff

Develop a plan to address post-construction stormwater runoff during the plan review, construction inspection, and post-construction maintenance inspection process.

Description: To develop a plan to address post-construction stormwater runoff, consider the key water quality and water quantity issues in the City and surrounding area. Incorporate findings from the stormwater master plan and existing flood management and stormwater planning strategies into the post-construction plan. Also, evaluate the existing plan review process to identify opportunities to integrate post-construction controls. For example, new developments under plan review provide an opportunity to reduce impervious surfaces or incorporate traditional or other BMPs.

Where water quality impairments have been identified by DEQ within the jurisdiction, include strategies or BMPs in the post-construction plan targeted to reducing those pollutants.

Potential Action Plan and Schedule: Stayton currently has stormwater design standards which predominantly specify the "nuts and bolts" of planning, designing, and constructing the physical drainage system and its components. As part of the master plan process the design requirements for stormwater detention facilities and water quality treatment facilities will be developed and incorporated into the new stormwater design standards. A formal post-construction runoff program designed to meet NPDES requirements would involve the development of much more detailed specifications for such treatment facilities (often referred to as Best Management Practices, or BMPs).

The Stormwater Design Manual/Standards should be developed in the first year of the program.

6.3 Training for Plan Reviewers and Field Inspectors

Provide training or coordinate with existing training efforts to educate construction plan reviewers and field inspectors on post-construction design standards, runoff control BMPs and maintenance standards.

Description: Coordinate post-construction training for plan reviewers and field inspectors with training identified in section 5.2, training for erosion and sediment control.

Potential Action Plan and Schedule: Once an ordinance is in place, Stayton will train City staff responsible for reviewing plans and inspecting construction sites to ensure that appropriate post-construction stormwater management is employed. If possible, training will be coordinated with training on erosion and sediment control BMPs. "Refresher" training will update staff on changes to the procedures as needed.

The training of staff will begin in the first year of the program.

Measurable Goal: The number of hours spent in training along with subjects will be documented and reported annually.

6.4 Site Plan Review for Post-Construction BMPs

In accordance with the plan developed in Section 6.2, review stormwater site plans prior to construction to ensure that they include post-construction controls in compliance with local ordinances and the adopted stormwater management *Manual*. Require submittal of information pertaining to the proper operation and maintenance of storm drain components and BMPs. This work should be coordinated with the review in Section 5.3.

Description: The site plan review process, for both erosion and sediment control practices and post-construction control practices, is described in Section 5.3. Conduct both of these reviews at the same time to ensure that plans include all the practices necessary to meet the requirements of the adopted stormwater management *Manual*.

Potential Action Plan and Schedule: Once the stormwater ordinance is adopted and design criteria or a design manual is developed, the City staff will start reviewing permit drawings for compliance with local ordinances and stormwater management manuals. Plans will also be reviewed for appropriate post-construction controls as well as erosion and sediment BMPs.

Reviewing site plans for post construction BMPs should start as soon as the ordinance is in place in the first year of the program.

Measurable Goal: Once this effort has started City staff will monitor the number of plan reviews, the number of on-site inspections, and the number of on-site revisions required. If enforcement is required this will also be recorded. All records will be reported annually.

6.5 Inspections of Structural Post-Construction BMPs

In accordance with the plan developed in Section 6.2, inspect priority structural post-construction BMPs for compliance with operation and maintenance (O&M) standards.

Description: Develop a program to ensure the long-term O&M of structural stormwater BMPs. This requirement only applies to new BMPs installed as part of new construction; existing BMPs installed prior to the effective date of the Phase II permit are not specifically addressed.

The post-construction O&M program includes the following components:

- Requirements for private property owners to maintain facilities
- Database of structural BMPs
- Inspection procedures, including a schedule for conducting inspections, and
- Inspection form

Potential Action Plan and Schedule: Stayton will develop an operations and maintenance program for public and private post-construction stormwater controls. The program will include requirements for private property owners to maintain facilities, a database of structural BMPs, inspection schedules and procedures, and an inspection form. This activity should start when the post-development BMP’s are required.

Measurable Goal: Once this effort has started, City staff will keep records of the number of BMPs installed, inspection schedules, and procedures. The City will also maintain copies of the inspection reports for each facility. If enforcement is required, this will also be recorded.

7.0 POLLUTION PREVENTION IN MUNICIPAL OPERATIONS PROGRAM

In order to meet regulations under 40 CFR 122.34(b)(6), the City of Stayton will develop a formal operations and maintenance plan. The following presents the requirements for the plan, how they are being achieved and the implementation schedule.

Basically most City operations already meet the requirements for NPDES Phase II. These requirements are generally "good housekeeping" measures when servicing vehicles and maintaining City facilities. The Operation and Maintenance (O&M) Plan will be a documentation of existing activities together with suggested modifications to reduce pollutants. The following table describes efforts that could be undertaken and planned for the 5-year program.

TABLE 7-1
POLLUTION PREVENTION IN MUNICIPAL OPERATIONS PROGRAM

BMP Activity / Description	Permit Year				
	1	2	3	4	5
Operations and Maintenance (O&M) Plan	√	–	–	–	–
Park and Open Space Maintenance	√	–	–	–	–
Vehicle & Equipment Maintenance & Washing	–	–	√	–	–
New Construction and Land Disturbance	–	√	√	√	√
Dust Control Practices	–	√	√	√	√
Stormwater System Maintenance	–	√	–	√	–
Open Channels and Structural Stormwater Controls	–	√	–	√	–
Roads, Highways, and Parking Lot Maintenance	√	√	√	√	√
Flood Management Project Evaluations	√	–	–	–	–
Employee Training on O&M Plan Implementation	√	–	–	–	–
Stormwater Plans for Municipal Facilities	√	–	–	–	–

√	Activity scheduled for year	–	No activity scheduled for year

7.1 Operation and Maintenance (O&M) Plan

Develop and implement a municipal O&M Plan that considers, where appropriate all the BMPs within Section 7 of this documents.

Description: An O&M plan is essential to ensure that all municipal activities and programs impacting stormwater are implemented efficiently and effectively. The O&M plan is intended to reduce the amount of pollutants carried by stormwater runoff into the storm drainage system. Comprised of a description of procedures and associated schedules, the O&M plan serves as a tool for all municipal employees that are directly involved in stormwater management or administer programs that impact stormwater. It also serves as the basis for the employee training program described in Section 7.10.

An O&M Plan contains the following information:

- Description of the required maintenance activities and procedures as it relates to existing municipal operations and programs
- List of responsible departments and personnel for each activity, and
- Schedule of activities, including maintenance, inspections and reporting

Potential Action Plan and Schedule: The City of Stayton will review existing municipal O&M activities and document the activities in an O&M Plan that will address municipal activities. The O&M Plan shall include the following:

- Descriptions of the required maintenance activities and procedures as it relates to existing municipal operations and programs
- A list of responsible department and personnel for each activity
- A schedule of activities, including maintenance, inspections & reports.
- Review the maintenance of Parks and open space.
- Review use of herbicides and pesticide and maintain records when applied.

The following sections discuss the particular maintenance activities to be addressed in further detail. The O&M Plan should be developed and implemented the first year of the program.

Measurable Goal: Plan preparation and records of all herbicide and pesticide use are the measurable goals for this activity.

7.2 Park and Open Space Maintenance

In accordance with the O&M plan developed, implement park and open space maintenance pollution prevention/good housekeeping practices.

Description: Municipal maintenance practices at parks and other open spaces (e.g., golf courses, picnic areas, recreational facilities, rights-of-way, landscaped areas in parking lots, plazas) can include fertilizer, herbicide, and pesticide application; vegetation maintenance and disposal; and trash management. To ensure these activities do not negatively impact stormwater runoff, incorporate these pollution prevention/good housekeeping procedures into existing municipal operations for maintaining parks and other open spaces.

Potential Action Plan and Schedule: Stayton will implement park and open space maintenance pollution prevention/good housekeeping practices as developed in the O&M Plan. These practices include fertilizer, herbicide and pesticide application; vegetation maintenance and disposal; and trash management. Currently, any herbicide or pesticide application is performed by a licensed applicator. Records of all herbicide and pesticide use are kept.

Measurable Goal: Same as Section 7.1 above.

7.3 Vehicle and Equipment Maintenance and Washing

In accordance with the O&M plan developed, implement publicly-owned vehicle and equipment washing pollution prevention/good housekeeping practices.

Description: Wash water from vehicle/equipment cleaning can contain oil and grease, suspended solids, heavy metals, organics, and other pollutants from detergents. Whenever possible, conduct vehicle/equipment cleaning in a self-contained, covered building. If the enclosed facilities are not available for vehicle/equipment cleaning, conduct this activity in a designated uncovered wash area that meets specific requirements.

Potential Action Plan and Schedule: If the City of Stayton already has a covered or self-contained location to wash and maintain vehicles the only action would be to require all vehicles to use the facility. If not the construction of such a facility is the action required. This involves a capital expenditure that should be work into the overall CIP program.

Measurable Goal: The measurable goals for this activity are the facility and the use of the facility.

7.4 New Construction and Land Disturbances

Description: This activity is simply requiring City construction projects following the same stormwater requirements as private developments.

Potential Action Plan and Schedule: Once new stormwater design standards for erosion control, post-development BMPs and other construction related activities have been established they will be incorporated into the City's CIP project. Public construction projects will be required to follow the same requirements and procedures as private development. Construction will be required to follow local ordinances, and design standards.

Measurable Goal: Records of the BMPs for public construction projects shall be kept; inspection reports and any follow-up work will be kept.

7.5 Dust Control Practices

In accordance with the O&M plan developed in Section 7.1, implement dust control practices where necessary on public projects.

Description: Follow appropriate BMPs to minimize and control dust from public construction projects. Dust control BMPs could be described in the adopted stormwater master plan, or other appropriate document.

Potential Action Plan and Schedule: Stayton will implement BMPs for dust control from public construction projects as developed in the O&M Plan. Public construction projects will be required to follow appropriate BMPs to minimize and control dust.

Measurable Goal: Implement dust control program upon completion of the O&M Plan.

7.6 Stormwater System Maintenance

In accordance with the O&M plan developed in Section 7.1, implement catch basin cleaning and stormwater system maintenance pollution prevention/good housekeeping practices.

Description: Several activities are suggested below; others can be added as needed.

- Catch Basin Inspections and Cleaning. Inspect catch basins and clean inlets at least once a year during the dry season. Based on inspection results, clean (i.e., remove debris from) catch basins as required to prevent water quality impacts. During or before the wet season, perform inspection, clearing, and cleaning in areas that generate large quantities of waste and debris during rainstorms and snowmelt events. Using adaptive management, optimize maintenance activities and frequencies.

- Proper Waste Disposal. Dewater wastes collected during storm drain cleaning and maintenance, if necessary, into the municipal sanitary sewer. Do not dewater near a storm drain or stream. Store solid waste and debris in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain. Dispose of sediment waste appropriately, depending on the level of contaminants.
- Record keeping. Document the following information for inspections and cleaning of catch basins: 1) date, 2) location of catch basin, 3) activity performed (e.g., inspection or cleaning), and 4) description of condition or overall amount of material removed (estimated in either volume or dry weight).

Potential Action Plan and Schedule: Stayton will implement stormwater system maintenance as developed in the O&M Plan. Catch basins and other stormwater facilities will be inspected and maintained regularly. Waste from the stormwater facilities will be disposed of properly, and records of cleaning and maintenance will be kept. Street sweeping will be conducted at a frequency established under Section 7.1.

Measurable Goal: Keep records of storm drain system cleaning and maintenance activities and submit in annual report. Waste disposal operations will be included in the records.

7.7 Open Channels and Structural Stormwater Controls

In accordance with the O&M plan developed in Section 7.1, implement structural stormwater control pollution prevention/good housekeeping practices.

Description: Several activities are suggested below; others can be added as needed.

- Open Channel and Structural Controls Inspections and Cleaning. Inspect open channels and structural controls (e.g., detention ponds, commercial stormwater technologies) for trash and debris, and clean, if necessary, at least once a year during dry season. Inspect and clean open channels and structural stormwater controls in areas that generate significant waste and debris during rainy season.
- Proper Waste Disposal. Dewater wastes collected during storm drain cleaning and maintenance, if necessary, into the municipal sanitary sewer. Do not dewater near a storm drain or stream. Store solid waste and debris in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain. Sediment may contain elevated levels of lead, hydrocarbons, and oil and grease. If sediment contains elevated levels of these pollutants, dispose of as hazardous waste.
- Record keeping. Document the following information for inspections and cleaning of open channels and structural controls, including catch basins: 1) date, 2) location, 3) activity performed (e.g., inspection or cleaning), 4) description of condition or overall amount of material removed (estimated in either volume or dry weight).

Potential Action Plan and Schedule: Stayton will implement open channel and structural stormwater control maintenance as developed in the O&M Plan. Open channel and structural stormwater controls will be inspected and maintained regularly. Waste from the stormwater controls will be disposed of properly, and records of cleaning and maintenance will be kept.

Measurable Goal: Maintain records of maintenance activities and submit in annual report.

7.8 Road, Highway, and Parking Lot Maintenance

In accordance with the O&M plan developed in Section 7.1, implement deicing and snow removal pollution prevention/good housekeeping practices for roads, highways, and parking lots.

Description: Maintaining roads, highways, and parking lots for public safety purposes can generate pollutants that will enter the storm drainage system. Include in the O&M plan pollution prevention procedures related to these maintenance activities. This could be adopting and following the ODOT "Routine Road Maintenance – Water Quality and Habitat Guide Best Management Practices" (ODOT, July 1999).

Potential Action Plan and Schedule: The City of Stayton should adopt existing guideline or develop a set of guidelines for maintenance of roads as part of the O&M Plan developed in Section 7.1.

Measurable Goal: Maintain records of maintenance activities.

7.9 Flood Management Project Evaluations

In accordance with the O&M plan developed in Section 7.1, implement flood management project evaluation and review procedures.

Description: Flood control has been the traditional focus of stormwater management in many communities. Traditional approaches to flood management often include projects such as widening channels, dredging riverbeds, or creating dikes, levees or embankments. By incorporating water quality considerations into project review criteria, negative impacts to water quality from new flood management projects can be decreased. In designing and/or evaluating flood management projects, attempt to employ more natural solutions and use controls that preserve the hydrology of a site (e.g., swales and natural channels, riparian buffers) as a first-line of flood control. Evaluate existing flood management projects to determine whether or not additional water quality protection devices should be added.

Potential Action Plan and Schedule: Stayton is in the process of developing and implementing a Stormwater Master Plan. This process will address increased runoff and flows, water quality and capital projects. All new flood management projects will include water quality considerations. Priority existing flood management projects will be identified and re-evaluated with water quality considerations.

This program will be developed in the first year of the program. Implementation will be scheduled based on priorities, funding and identifying opportunities to associate projects with other scheduled projects.

Measurable Goal: Track annual capital expenditures for stormwater improvements.

7.10 Employee Training on O&M Plan Implementation

Develop materials and conduct employee training on the procedures contained in the O&M plan developed in Section 7.1.

Description: At a minimum, employees in targeted positions (generally employees involved in stormwater management or municipal maintenance) should be trained on the requirements in the stormwater program by the end of permit term. Consider providing brief (1 hour) training to all municipal employees. More specific, specialized training can be developed for specific program areas. In addition to more intensive training, ensure that municipal employees have access to the public education materials produced under the public education minimum measure (Section 2).

Potential Action Plan and Schedule: Once the above items are completed, Stayton will train municipal city staff on operation and maintenance procedures as described in the O&M Manual. The staff training will occur in combination with training for Illicit Discharge and spill plan. Training will be general for all municipal employees and more specific training will be included for specific program areas. “Refresher” training will update staff on changes to the procedures as needed.

The training of staff will begin in year 2 of the program with refresher courses and courses for new staff conducted as the need requires.

Measurable Goal: The number of hours spent in training, along with subjects, will be documented.

7.11 Stormwater Plans for Municipal Facilities

Develop plans for all municipal facilities that would reasonably be expected to discharge contaminated runoff and are not covered under the NPDES Industrial Stormwater General Permit (1200-Z). Submit a permit application for all municipal facilities that are required to be covered under the 1200-Z General Permit.

Description: Some municipally owned or operated industrial facilities that discharge stormwater runoff to surface waters and/or storm drains are required to apply for coverage under DEQ’s Industrial Stormwater General Permit.

Municipal facilities that would reasonably be expected to discharge contaminated runoff and are not covered by the Industrial Stormwater General Permit should also have a stormwater plan developed. These facilities could include parking lots, fair grounds, storage facilities, maintenance facilities, airports, parks/sports fields, municipal buildings and any other municipally owned facilities.

Potential Action Plan and Schedule:

Industrial Stormwater General Permit (1200-Z)

Municipal facilities subject to this permit typically include:

- Landfills that receive or have received any industrial wastes (even closed landfills).
- Vehicle maintenance shops for local public transportation.
- Wastewater treatment plants with a design flow of 1.0 million gallons per day.
- Other municipal facilities could be required to apply for this permit. For more information and a full list of the types of facilities required to apply, see: http://www.deq.state.or.us/wq/wqpermit/StormWaterHome.htm.

Stormwater Plans

To implement this BMP, follow these steps:

1. Assess and Screen Municipal Facilities

Collect information on each municipally-owned or operated facility within your jurisdiction to assess the potential stormwater impact. If necessary, conduct site visits. Assess each facility to determine which of the following categories it falls into:

- Needs an Industrial Stormwater Permit. This facility falls within one of the SIC codes regulated by the permit and discharges to surface waters. Submit an industrial stormwater permit application.
- Some surface water pollution potential. Facilities that are not covered by the Industrial Stormwater Permit may still have the potential to impact surface waters. For facilities that have a potential to discharge contaminated runoff, a stormwater plan should be developed.
- Little/no surface water pollution potential. This facility either doesn't discharge to surface waters or has little or no potential to impact stormwater quality. No stormwater plan is required.

As you assess municipal facilities, consider factors such as distance to storm drains and surface waters, site activities, traffic flow, exposure to potential stormwater contaminants, facility size, existing stormwater BMPs already in place, and other relevant factors.

2. Prepare site-specific stormwater plans

The development of facility-specific pollution prevention plans should be based on guidance in the adopted stormwater management *Manual*. Consider including the following information in each stormwater plan:

- Description of storm drain system
- Materials storage, including exposure of potential pollutants
- Current O&M of storm drain system and structural BMPs
- Education/Training activities on stormwater
- Source Control activities
- New stormwater BMPs and pollutant control strategy
- Roles/responsibilities for stormwater
- Cost estimates

3. Prepare training materials and conduct training

Prepare training materials and conduct training at each facility on the practices described in the stormwater plan. This training should be coordinated with the general employee training as described in section 7.10.

4. Implement stormwater plans

Carry out implementation of the stormwater plan at each facility.

Measurable Goal: Submit permit application for municipal facilities that are required to be covered under the NPDES Industrial Stormwater General Permit (1200-Z). Identify municipal facilities that would reasonably be expected to discharge contaminated runoff and not covered under the 1200-Z General Permit, and develop pollution prevention plans for these facilities.

8.0 EVALUATION AND ASSESSMENT

Once again the City of Stayton is not required to obtain a NPDES Stormwater Permit and therefore nothing above is required under the NPDES stormwater program. Under the Willamette TMDL program it is expected that DMAs under 10,000 give consideration to the six minimum control measures identified in the NPDES Phase II program. Therefore the reporting of these activities to DEQ is unclear, however if the City's record keeping procedures on these activities are in place this will cover the City under stormwater quality requirements by DEQ, EPA and water quality surrounding ESA (Endangered Species Act). This will not cover the City under fish passage requirements.

If under an NPDES permit, and in preparation for the annual reporting requirements, the City of Stayton will document program implementation and progress. The Measurable Goals listed in this Program are initial goals. The City will work towards meeting those requirements for the Phase II permit that are not currently being implemented. The Measurable Goals in this Program reflect the implementation schedule of each of the BMPs. Once the BMP has been implemented, the City will revise the Measurable Goal for that requirement to track the progress of implementation, effectiveness, or environmental improvement as appropriate.

Appendix D.4

TMDL

TETRA TECH/KCM
7080 SW Fir Loop
Portland, Oregon 97223-8022

Technical Memorandum

City of Stayton
STRATEGIES FOR REDUCING POLLUTANTS IN SURFACE WATERS

January 5, 2007

The City of Stayton has been identified as a Designated Management Agency (DMA) in the Willamette River Total Maximum Daily Load (TMDL) program. Stayton is within two drainage basins—Mill Creek and North Santiam—both of which are in the Willamette River Basin. The Oregon Department of Environmental Quality (DEQ) adopted TMDL limits for the Willamette River Basin in September 2006.

This memorandum describes the pollutants of concern under the Willamette Basin TMDL program and presents the best management practices (BMPs) that are appropriate for reducing each of them.

POLLUTANTS OF CONCERN

The Willamette Basin TMDL set limits on bacteria, temperature and mercury for surface waters within the basin. Table 1 summarizes these water quality problems, their sources, and methods for addressing them.

STORMWATER BEST MANAGEMENT PRACTICES

Stormwater pollutant removal can be addressed with both nonstructural and structural BMPs. Nonstructural BMPs typically focus on pollution prevention; structural BMPs typically remove pollutants from stormwater before discharging into the receiving stream or stormwater system.

Nonstructural BMPs

Table 2 summarizes the benefits of nonstructural BMPs that are now or could easily be put in place to address potential causes of water quality problems. It also identifies minimum control requirements under Phase II of the National Pollutant Discharge Elimination System (NPDES) that each BMP helps satisfy. Table 3 translates the benefits of the nonstructural BMPs to the priority pollutants for the Willamette Basin. Pollution reduction as a result of these programs is not easily quantified but tends to occur gradually or incrementally. The nonstructural BMPs with the most easily quantifiable results relate to maintenance activities. Options for improved maintenance activities are described below, followed by descriptions of more general, long-term BMPs.

Storm Drain Maintenance

Improving storm drain maintenance provides immediately quantifiable results in improving stormwater quality. A well-defined stormwater maintenance program is a working tool for the benefit of City maintenance personnel. Such a program provides a general guide to help ensure that the work required to keep the stormwater system functioning properly is performed efficiently and in a timely way.

TABLE 1.
TMDL POLLUTANT SUMMARY

Typical Sources	Potential Solutions
Bacteria—*Bacteria in rivers and streams can pose a health risk.*	
Illicit Discharges	Adopt an illicit discharge program
Leaking Pipes	
Failing Septic Systems	Extend sewer lines and treatment for area-wide failing onsite septic systems
Pet Wastes	Educate public regarding pet waste pick up
	Provide pet waste pick up stations in parks
Agriculture Livestock	Ensure proper management of agriculture lands
Wildlife	Provide vegetated stream buffers
Temperature—*During the summer and early fall, water temperatures in the Willamette River and its tributaries are elevated to levels that are harmful to salmonids.*	
Lack of Shading	Restore riparian areas
Low Stream Flows	Consider temperature impacts when designing stormwater BMPs
Stormwater Runoff	
Mercury—*Mercury is a neurotoxin that can cause damage to the brain and nervous system. Consumption of fish or seafood containing elevated levels of mercury is the primary method of exposure for humans.*	
Soil Erosion	Erosion and sediment control for construction sites
	Stormwater maintenance
Dental Practices	Dental amalgam BMP
Household Products	Community collection events
Atmospheric Mercury Deposits	

The following elements can be included in a stormwater maintenance program:

- **Core maintenance activities**—The essential tasks to be performed to maintain the City's stormwater system such as street sweeping and catch basin cleaning.

  Street sweeping and catch basin cleaning have the benefit of flexibility, in that the equipment can be deployed at times and places as needed. Studies have shown significant improvement in the amount of solids removed from streets, and hence prevented from entering the storm drain system, with increased use of street sweeping and catch basin cleaning. A 1999 Port of Seattle study found that frequent street and catch basin cleaning can offer water quality benefits comparable to the use of a wet vault for stormwater treatment.

- **Guidelines for work in environmentally sensitive areas**—Provide guidelines for maintenance staff to address the specific considerations that must be taken into account when maintenance activities are performed in or near streams, wetlands and steep slopes.

- **Regulatory and permitting considerations**—Provide information to maintenance staff on regulations that may apply and permits that may be required when maintenance work is to be performed.

**TABLE 2.
GENERAL BENEFITS OF NONSTRUCTURAL BMPS**

	Benefit Area						
BMP	Lack of Cover	Low Flow	Erosion Dust	Waste	Stagnant Water	Illicit Discharge	NPDES[a]
Street Sweeping			◆				4, 5
Catch Basin Cleaning			◆	◆	◆	◆	4, 5
Development Standards	◆		◆	◆	◆	◆	5
Tree City Program	◆		◆				4
Pollution Prevention in City Operations				◆		◆	5
Pet Regulations				◆			5
Trash Container Protection, Separation				◆		◆	5
Illicit Discharge Inspection & Enforcement						◆	3, 5
System Mapping				◆	◆	◆	3, 5
Web Site	◆	◆	◆	◆	◆	◆	1
Bill Inserts	◆	◆	◆	◆	◆	◆	1
Talks, Articles	◆	◆	◆	◆	◆	◆	1
Public Reporting				◆		◆	2
Water Quality Monitoring	◆	◆	◆	◆	◆	◆	5
Farm Animal Management			◆	◆			5

a. Indicates the NPDES minimum control requirements that the BMP helps to satisfy: 1 = Public education; 2 = Public involvement/participation; 3 = Illicit discharge detection & elimination; 4 = Post-construction controls; 5 = Pollution prevention/good housekeeping.

- **Sediment and debris management**—Handling and disposing of the solids, organic debris, and trash that accumulate in facilities such as catch basins, vaults, and swales and should be disposed of appropriately.

Organic debris such as leaves should be composted. Tree limbs should be chipped for mulch or composting. Organic material is considered a valuable resource by many people, and many landfills now provide a separate holding or composting area for these materials.

TABLE 3.
BENEFITS OF NONSTRUCTURAL BMPS FOR PRIORITY POLLUTANTS

	Pollutant Reduction		
BMP	Temperature	Mercury	Bacteria
Street Sweeping		◆	◆
Catch Basin Cleaning		◆	◆
Development Standards	◆	◆	◆
Tree City Program	◆		
Pollution Prevention in City Operations		◆	◆
Pet Regulations		◆	◆
Trash Container Protection, Separation		◆	◆
Illicit Discharge Inspection & Enforcement		◆	◆
System Mapping		◆	◆
Website	◆	◆	◆
Bill Inserts	◆	◆	◆
Talks, Articles	◆	◆	◆
Public Reporting	◆	◆	◆
Water Quality Monitoring	◆	◆	◆
Farm Animal Management			◆

Sediment removed from detention facilities, biofilters, open channels or culverts may be temporarily stockpiled as long as runoff is positively prevented and the pile is covered between November 1 and March 31. Generally, bottom sediments removed from these facilities are not classified as hazardous waste and have heavy metal concentrations less than those of typical wastewater sludge. These sediments can be disposed of by land application, or as required by the City Waste Management Division.

Pollutant-contaminated sediments, waste oil, and debris from oil/water separators must be disposed of in accordance with OAR 340-093 (Solid Waste: General Provisions), and where appropriate OAR 340-093-0170 (Cleanup Materials Contaminated with Hazardous Substances) and OAR 093-0190 (Waste Requiring Special Management).

Oil/water separator waste is often too "dirty" to be recyclable; however, several vendors handle waste oil hauling and disposal. Any standing water removed during maintenance operations should be disposed of in a sanitary sewer.

- **Illicit discharge detection program**—Detection and removal of illicit pollutant discharges to the stormwater system.
- **Safety and training**—Provide training for city maintenance staff on stormwater maintenance and safety.
- **Tracking and recordkeeping**—Efficient ongoing maintenance requires an organized system for recording and tracking maintenance needs and completed activities.

There are many documents to assist communities with developing an overall maintenance program to reduce pollutants and sediment in stormwater. A good document for citywide activities is *Oregon Municipal Stormwater Toolbox for Maintenance Practices* (Oregon Association of Clean Water Agencies, June 1998). The City's road maintenance department should adopt *Routine Road Maintenance; Water Quality and Habitat Guide Best Management Practices* (Oregon Department of Transportation, July 1999).

Vector Control

Vector control is a common concern in stormwater facilities. Regular maintenance is critical to the control of vectors in stormwater facilities. Mosquitoes are of particular concern. Mosquitoes breed in shallow areas of standing water. Regular maintenance to ensure proper function of stormwater facilities prevents clogging, removes overgrown vegetation, mends broken pipes and removes sediment that may block outlets.

Facilities should be designed to minimize mosquito habitat, particularly avoiding standing water for more than 72 hours. For facilities that are designed to hold standing water, regular monitoring is required for the presence of mosquitoes.

A vector control agency can assist in design requirements for reduction of habitat.

Reducing Impervious Surface

Impervious surface area is the single largest cause of the degradation of streams in urban areas. Degradation of streams begins with even small quantities of impervious surface (10-20 percent; Center for Watershed Protection, 1995). The correlation between impervious surface and the quantity of runoff has been a cornerstone of urban drainage studies. The effects of impervious surface on water quality is not as well understood, and the correlation is not as intuitively obvious. Studies have shown that reducing the amount of impervious surface by 20 percent can reduce total suspended solids by up to 90 percent. Runoff volumes can be reduced by 20 to 60 percent with a corresponding reduction in impervious area. A 20- to 40-percent reduction in impervious surface can reduce nitrogen by 40 to 70 percent and phosphorous by 40 to 80 percent (Land Conservation and Development and DEQ, 2000).

In areas with suitable soils, reducing impervious surface allows more infiltration. The increase in infiltration not only removes pollutants but also increases groundwater flow and therefore increases the base flow in streams. Increase base flow generally reduces water temperatures in streams. The following are BMPs that can help to reduce impervious surface area:

- Use of porous pavement for streets or parking areas with low traffic volume, such as fire lanes, parking area turnarounds or sidewalks
- Encouraging narrow roads in rural areas

- Constructing streets without curbs to allow drainage to run into vegetation
- Encouraging common parking areas for multiple businesses or residents
- Encouraging road patterns that minimize impervious surface
- Requiring BMPs, such as vegetated swales, to be installed in parking lots
- Separating sidewalks and housing from the street with a vegetation strip
- Reducing the number and size of cul-de-sacs
- Using smaller parking stalls
- Establishing a maximum number of parking spaces a developer is allowed to install (such as 10 percent over the relevant parking demand ratio)
- Establishing a differential between primary and spillover parking; allow spillover parking to use alternative paving surfaces such as grid pavers, porous pavement, gravel or mowed grass.

The City of Stayton could review its current street design ordinances to allow for and encourage reductions in impervious surfaces.

Sediment and Erosion Control

Erosion can be a large source of sediment loading in stormwater runoff or streams. Erosion comes from a variety of places, including construction sites, unstable slopes, and other surfaces with bare soil. BMPs to control sediment and erosion include encouraging the use and retention of native vegetation, restricting development in areas with steep slopes, and properly installing BMPs at construction sites.

Native vegetation has the additional benefit of reducing the use of water, pesticides and fertilizer. Properly selected native riparian vegetation can provide for shade along stream corridors, which reduces water temperatures.

Many construction BMPs are available, but they must be installed and used correctly to prevent sediment and other pollutants from leaving the site.

The City's 1994 *Storm Design Standards* has a section describing erosion control requirements; however, this section is limited to areas within the banks of a waterway. It is recommended that the standards be revised to require an erosion and sediment control permit and the use of BMPs for all construction projects and earth disturbance projects with ground disturbance greater than 1,000 square feet in area in any 12-month period.

Stream and Wetland Buffers

Stream and wetland buffers provide a natural boundary between development and a stream or wetland. Vegetated stream buffers maintain bank stability, reduce sediment and nutrient loads from overland flow runoff, and allow infiltration to occur. Vegetated buffers reduce pollutant loading when runoff crosses the buffer as sheet flow, not when pipes transport stormwater directly to the creek or when channels are formed and runoff bypasses the vegetation. When a buffer is vegetated and no pesticides or herbicides are applied, total suspended solids can be reduced by 40 to 80 percent. When lawns are not located within a stream buffer, nitrogen reductions of 25 to 65 percent and phosphorous reductions of 30 to

70 percent can be achieved. (Land Conservation and Development and DEQ, 2000). Buffers can be combined with other BMPs to ensure pollutant reduction.

To be effective, stream buffers must be managed and protected during construction and for the ongoing period after construction. Residents can be educated to prevent dumping, trails, tree removal, erosion and lawns encroaching into the buffer. Education can include pamphlets, boundary markers, buffer walks, regular homeowner association meetings and individual maintenance agreements. Residents can also be encouraged to participate in stewardship of buffers and streams. Allowable and unallowable activities in stream buffers should be clearly defined.

Shading

Riparian vegetation performs many beneficial functions for stream ecosystems. One of these is to regulate water temperature through direct shading. Factors that determine the amount of solar radiation that reaches a stream channel include the width of the channel, the type and density of riparian vegetation, the orientation (east-west vs. north-south) of the channel, and the angle of the sun.

Because the sun is usually positioned to the south in the Pacific Northwest, areas with southern exposure receive more direct sunlight than those with northern exposures, resulting in higher water temperatures. Riparian vegetation can provide shade from both sides of the stream, but shading from the southern direction provides the most thermal regulation. On north-south oriented streams, vegetation must grow on both sides to provide a shade canopy over the stream.

Enhancement Methods

Riparian vegetation enhancement can be facilitated in the following ways:

- **Capital improvement projects**—Capital improvement projects to enhance riparian area vegetation
- **Development requirements**—Requirements for improvement and/or protection of riparian vegetation and shading along a stream corridor for development close to stream channels
- **Public involvement/education:**
  - Encourage school and volunteer groups to take on stewardship of stream reaches, including planting and maintaining riparian vegetation
  - Encourage private landowners through education about the benefits of riparian vegetation.

The following could be implemented to maintain and improve shading as part of projects in Stayton that include stream work:

- Maintain trees and plant trees on the south side, to shade creeks.
- Use native, riparian vegetation for landscaping along creeks.

Stream Shade Monitoring

Photo documentation is an easy and cost-effective method for monitoring stream shade and canopy cover (*Stream Shade and Canopy Cover Addendum to the Water Quality Technical Guide Book,* Oregon Watershed Enhancement Boards, July 1999). Procedures for preparing a photo documentation monitoring program, along with several other monitoring methods involving specific monitoring equipment, are described in the document. The addendum should be reviewed prior to development of a riparian shade monitoring program for the City of Stayton.

Farm Animal Management

Stayton is primarily an urban setting; however, there are some agricultural uses within the City. Farm animals contribute to erosion and increase nutrient loads in stormwater. Livestock should be kept out of riparian corridors and away from areas that drain directly to stormwater collection systems. Livestock BMPs include containment of contaminated runoff, proper storage of manure, installation of runoff treatment systems, reduction of livestock densities, and separation of livestock from sensitive water quality areas. The following are some guidelines for livestock from *Water Quality Model Code and Guidebook*:

- **Prohibited Areas**—Livestock shall not be kept within any of the following areas, as applicable, due to the higher intensity living environments of these areas or the potential impact on water quality:
  - Multi-family sub-district
  - Manufactured housing park sub-district
  - Neighborhood commercial sub-district
  - Within a riparian protection overlay.
- **Minimum Lot Size**—No livestock shall be kept on any lot less than 1 acre in area.
- **Density**—Limit the number of livestock over the age of 6 months that may be maintained per acre.
- **Farm Structures**—Establish a minimum distance from the property line for new barns, stables, and other buildings or structures used to house livestock.
- **Storage of fertilizer, pesticide herbicide, or animal waste**—Fertilizer, pesticides, herbicides and similar farm chemicals shall be covered and stored at an elevation 1 foot higher than the 100-year flood elevation. Animal waste that is collected shall also be stored at an elevation 1 foot higher than the 100-year flood elevation.

Structural BMPs

Numerous studies have been done on the effectiveness of structural BMPs. The pollution removal efficiency for structural BMPs vary based on the type of facility used, design, construction, and maintenance. Table 4 lists characteristics of various structural BMPs from *Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring* (Federal Highway Administration, May 2000), the Oregon Department of Land Conservation and Development and Department of Environmental Quality *Water Quality Model Code and Guidebook* (October 2000), and the Center for Watershed Protection's *Site Planning for Urban Stream Protection* (December 1995). As summarized in the table, these sources indicate the effectiveness of BMPs in removing a wide range of pollutants. Temperature and bacteria are directly indicated in the table; mercury is included in the listings for total suspended solids (TSS). The table also indicates the BMPs' effectiveness in addressing pollutants of concern other than those included in the Willamette Basin TMDL: biochemical oxygen demand (BOD); oil and grease; total phosphorus (TP); total nitrogen (TN); and metals.

More detail is provided in such references as the City of Portland's *Stormwater Management Manual*, the King County (Washington) *Surface Water Design Manual*, and the Washington Department of Ecology's *Stormwater Management Manual for Western Washington*.

TABLE 4.
STRUCTURAL BMP SELECTION CHARACTERISTICS

BMP Types	Ultra-Urban	Area Served (acres)	BMP Area	Min. Head Req'd (feet)	Summer Temp Increase[a]	Contaminant Removal Percentage: TSS	Bacteria[c]	BOD	Oil & Grease	TP	TN	Metals	Capital Costs	Maintenance	O&M Costs	Effective Life (years)
Ext. Detention Wet Pond	no	2 (min)	10-20%	3-6	Yes	46-98	NA	25-45[d]	NA	20-94	28-50	24-89	Mod	Annual Inspection	Low	20-50
Underground Det. Tanks	yes	1-2	0.5-1%	5-8	No	NA	NA	10-20[d]	NA	NA	NA	NA	Mod to High	Frequent cleanout	High	50-100
Infiltration Trench	yes	2-4	2-4%	3-8	No	75-99	60-100	70-90	NA	50-75	45-70	75-99	Mod to High	Sediment and debris removal	Mod	10-15
Infiltration Basin	no	2-20	2-4%	3-4	No	75-99	60-100	70-90	NA	50-70	45-70	50-90	Mod	Mowing	Mod	5-10
Bioretention	yes	1-50	4-10%	2-3	No	75	NA		NA	50	50	75-80	Mod	Mowing / plant replacement	Low	5-20
Catch Basins and Inlets	yes	<1	none		No	20-40	NA	10-20[d]	NA	10-20[d]	10-20[d]	10-20[d]	Low	Frequent Cleanout	Low	?
Catch Basin Inserts	yes	<1	none	1-2	No	NA	NA		up to 90	NA	NA	NA	Low	Frequent Cleanout	Mod to High	10-20
Control Structures/Flow Restrictors	yes				No	20-40	NA	10-20[d]	NA	10-25[d]	10-20[d]	10-25[d]	Low	Frequent Cleanout	Low to Mod	
Manufactured Systems	yes	1-10	none	4	No	NA	NA		up to 96	NA	NA	NA	Mod	Periodic cleanout	Mod	50-100
Premanufactured Vaults[b]																
Storm Vault	yes	no limits	0.5-1%	low	No	86	NA		high	48	NA	36	Mod to High	Periodic cleanout and inspection	Mod	50-100
Vortech	yes		0.5-1%	low	No	80	NA		high	67	54	NA	Mod to High	Frequent cleanout	Mod	50-100
Multi-Chambered Treatment Train	yes	0.2-2.5	0.5-1.5%	4-6	No	83	NA		NA	NA	NA	95	High	Sand filter cleaning and replacement of oil absorbent material	High	5-20
Oil-Grit Separators (Coalescent Plate)	yes	1-2	<1%	3-6	No	20-40	NA	10-20[d]	50-80	<10	<10	<10	Mod	Frequent Cleanout	High	50-100
Ditches (with vegetation)	yes				Yes	0-50	NA	0-25[d]	0-25[d]	0-25[d]	0-25[d]	0-25[d]	Low	Frequent Cleanout	Low to Mod	
Vegetated Swales	yes	2-4	10-20%	2-6	Yes	30-90	NA	50-80	NA	20-85	0-50	0-90	Low to Mod	Mowing	Low	5-20
Vegetated Filter Strips	no	NA	25%	Neg	Yes	27-70	NA	50-80	NA	20-40	20-40	2-80	Low	Mowing	Low	20-50
Constructed Wetlands	no	1 (min)	10%	1-8	Yes	65	NA	40-80	NA	25	20	35-65	Mod to High	Annual Inspection / Plant replacement	Mod	20-50
Natural Streams/Wetlands	no				Yes	50-95	50-98	40-80	40-90	20-85	20-85	40-90	Low	Regular inspection / debris removal / erosion control	Low to Mod	
Vegetated Rock Filters	yes	2-5	3-5%	2-4	No	95	78		NA	82	75	21-80	High	Regular inspection and cleanout	High	5-20
Underground Sand Filters	yes	2-5	2-3%	1-8	No	70-90	NA		NA	43-70	30-50	22-91	High	Annual Media Removal	High	5-20
Surface Sand Filters	no	2-5	2-3%	5-8	No	75-92	NA		NA	27-80	27-71	33-91	Mod	Biannual media removal	Mod	5-20
Organic Media Filters	yes	2-5	2-3%	5-8	No	90-95	90		NA	49	55	48-90	High	Annual media removal	High	5-20
Porous Pavements	no	2-4	NA	NA	No	82-95	NA		NA	60-71	80-85	33-99	Low	Semi annual vacuum cleaning	Mod	15-20

General Source: *FHWA-EP-00-002 Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring*, February 2000.

NA means Not Applicable or Not Available

a. Open systems exposed to solar radiation that do not infiltrate assumed to increase water temperature in summer.
b. Per manufacturer's monitoring reports.
c. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs* (Thomas R. Schueler, July 1987), bacteria removal data for infiltration noted bacteria as fecal coliform, pp. 1-6, 2-13. Data for other BMPs is from FHWA; data falls within the 60%-100% removal range, and is presumed to apply to fecal coliform bacteria.
d. Estimated based on 50% particulate fraction

Appendix D.5

UIC

Oregon DEQ UIC Program Information

Web Address: http://www.deq.state.or.us/wq/uic/uic.htm
Phone: (503) 229-5945

There is no grandfather clause for existing UIC systems. All systems must go through the registration process and either be permitted or rule authorized. Each UIC is evaluated on a case by case basis, and registration through the DEQ can take up 90 days.

Existing unregistered UICs that are to be decommissioned must be brought to the attention of the DEQ and follow DEQ's decommissioning process.

Subsurface infiltration systems, such as drywells, are classified as Class V injection wells in the EPA's federal UIC program. The two requirements of the UIC program are as follows:

- A non-endangerment performance standard must be met, prohibiting discharges that allow movement of fluids containing contaminants into potential underground sources of drinking water.
- All UIC facility owners/operators must provide inventory information by registering the facilities.

Under the federal UIC regulations, the definition of an underground injection well is a bored, drilled, or driven shaft whose depth is greater than the largest surface dimension; a dug hole whose depth is greater than the largest surface dimension; an improved sinkhole; or a subsurface fluid distribution system that includes an assemblage of perforated pipes, drain tiles, or other similar mechanisms intended to distribute fluids below the surface of the ground.

Examples of a UIC well or a subsurface infiltration system are drywells, drain fields, pipe or French drains, and other similar devices that discharge to ground. In addition to the non-endangerment standard, storm water injection systems will qualify as "rule authorized" only if no other disposal option is appropriate. Oregon Administrative Rules (OAR) 340-044-0030 specifically prohibits injection wells with depths greater than their largest surface dimension, if any other treatment or disposal method which "affords better protection of public health or water resources is reasonably available or possible."

All "rule authorized" systems must meet the *General Requirements* in RA 1101. Further provisions in *Basic Requirements* must be met by all injection systems except roof drains. Additional specific *Category Requirements* (per RA 1101) apply to the following categories:

- Municipal systems with 50 or more injection wells

- Municipal systems with less than 50 injection wells
- Industrial/commercial facilities with hazardous substances
- Industrial/commercial facilities without hazardous substances
- Large parking lots
- Small parking lots
- Residential systems included in the UIC Program (e.g. garage floor and driveway drains)

Owners of any category of “rule authorized” storm water injection systems (except residential) must prepare and implement a storm water management plan. The required elements of the plan vary depending on the size of the system. Certain elements – system assessment; Best Management Practices (BMPs) for source control and treatment; spill prevention and response; maintenance plan; employee and public education; and evaluation of plan effectiveness – are required for any size system. For municipal systems with 50 or more injection systems, storm water management plans must also have monitoring and record-keeping plans.

Department of Environmental Quality (DEQ) has developed recommendations for source control measures, spill response, storm water maintenance standards, education outreach, and monitoring. These are documented in “DEQ Underground Injection Control (UIC) Class V BMPs for Groundwater.”

If an injection system does not qualify as “rule authorized”, the Owner may be required to either: 1) modify the system so it meets the criteria for rule authorized; 2) close the injection system; 3) discharge to a municipal storm sewer, if available; or 4) apply for a Water Pollution Control Facility (WPCF) Permit. DEQ will be developing a general WPCF storm water permit for Class V systems which fail to meet Rule Authorization requirements.

Municipalities with over 50 injection systems need to develop a Decommissioning Plan for injection systems that do not meet the *Basic Requirements* (Oregon Administrative Rules (OAR) 340-044-0018). DEQ documents (Ref. 5 and 6) outline evaluation steps needed, and suggest closure standards for storm water injection systems. DEQ Storm water Management Guidelines outline different methods to remove pollutants from storm water prior to groundwater discharge, including alternatives to injection wells.

Municipalities also have the option to negotiate an area-wide permit or memorandum of agreement with DEQ for systems that fail to meet Rule Authorization requirements. (As of March 2002, no area-wide UIC Class V agreements had yet been negotiated.) An area-wide permit would need to include the following elements:

- Quarterly inventory reporting of new injection systems
- Use of DEQ database spread sheet

- GPS location data
- Monitoring and maintenance plans
- Maintenance schedule
- Storm water management
- Screening for hazardous areas
- Spill plans
- Closure and remediation requirements
- Inspection and enforcement options
- Information on existing land uses and any available data on unsuitable areas (soils)

In summary, any owner or operator of a Class V storm water system is required to:

- Register system prior to use, and provide inventory data to Department of Environmental Quality (DEQ).

- Meet “non-endangerment” performance standard to prevent contamination of groundwater by storm water.

- Submit a closure plan to DEQ, and then properly decommission a banned system or any system when it is no longer in use.

- Comply with other local, state and federal regulations (including requirements of the State Groundwater Act and the Safe Drinking Water Act Standards).

Appendix E
Cost Estimates

Stayton, OR
Storm Water Master Plan CIP

Priority Improvements							
Item (2007 Project Costs*)	Priority 1	Priority 2	Priority 3	Priority 4	Future	Total	% Benefiting Growth
Priority 1 (2008)							
1A							
Wetland Preservation	$792,000						60%
Shaff Road Detention Basin and piping	$1,754,700						10%
10th Ave Detention Basin and piping	$765,100						15%
PRIORITY 1A SUBTOTAL	$3,311,800						
1B							
Industrial Detention Site Improvements	$95,000						25%
Shaff Road Basin Pipeline Improvements	$3,575,500						5%
10th Avenue Pipeline Improvements	$818,500						15%
Norpac NE Detention Site	$620,800						0%
5 Additional Manhole Monitoring Equipement	$96,700						0%
PRIORITY 1B SUBTOTAL	$5,206,500						
Total Priority 1	***$8,518,300***						
Priority 2 (2010)							
Fir to Regis through Regis HS Parking Lot		$358,800					5%
Evergreen Ave to Norpac Dtn Site		$575,600					5%
3rd and Jefferson to Library Dtn Site		$2,115,000					5%
Millstream Woods to Norpac SW Dtn Site		$1,975,400					10%
Total Priority 2		***$5,024,800***					
Priority 3 (2015)							
Sylvan Meadows Subdivision			$72,100				0%
Gardner Road-Regis High School			$637,800				5%
Wedgewood Place			$736,600				0%
Western Avenue			$732,400				0%
Total Priority 3			***$2,178,900***				
Priority 4 (2020)							
Library Improvements				$49,500			0%
1st Avenue				$122,300			0%
Washington Street Area				$216,600			42%
North Peach Street				$82,500			50%
Total Priority 4				***$470,900***			
Future*							
Pacific Court					$349,600		
Fern Ridge Street Area					$1,701,400		34%
Dozler Property Area					$740,800		48%
Phillips Property Area					$1,991,900		87%
Larch Avenue					$130,200		0%
Detention Facilities					$3,402,000		98%
Pipeline Upsize Costs (over 18")					$1,430,800		0%
Total Future					***$9,746,700***		
TOTAL (rounded)	**$8,518,300**	**$5,024,800**	**$2,178,900**	**$470,900**	**$9,746,700**	**$25,939,600**	

* All costs in 2007 Dollars. Costs include engineering and contingencies.
** Timing depends on when growth occurs. Development participation anticipated.

Stayton Storm Water Master Plan
Priority 1 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)	
Industrial Detention Site Improvements				**1A**	**1B**
Rebuild Berm on east edge of dtn pond	CY	$15	540		$8,100
Divert farm flow to ditch to north	CY	$15	4500		$67,500
Mobilization	%	5%			$405
Total Construction Costs					$76,005
Contingency	%	10%			$7,601
Engineering & Legal	%	15%			$11,401
Detention Outlet Control Subtotal					***$95,000***
Wetland Preservation					
Land Acquisition	AC	$20,000	35	$700,000	
Legal and Permitting	EA	$20,000	1	$20,000	
Total Costs				$720,000	
Contingency	%	10%		$72,000	
Wetland Subtotal				***$792,000***	
Additional Monitoring Manholes					
Manholes	EA	$3,500	5		$17,500
Manhole Monitoring Equipment	EA	$9,200	5		$46,000
Sum					$63,500
Mobilization	%	5%			*$3,200*
Total Construction Costs					$66,700
Contingency	%	30%			$20,010
Engineering	%	15%			$10,005
Fir to Regis Subtotal					***$96,700***
Shaff Road Basin Improvements				**1A**	**1B**
Fir to Hollister on 6th Ave					
Parallel 30" Storm Water Line	LF	$180	250		$45,000
Manholes	EA	$3,500	2		$7,000
Manhole interties	EA	$4,500	2		$9,000
Additional/Replacement Catch Basins	EA	$1,800	6		$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180		$8,820
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	250		$7,500
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	250		$1,500
Traffic Control	LF	$2	250		$500
6th Ave to 5th Ave on Hollister					
Parallel 36" Storm Water Line	LF	$200	300		$60,000
Manholes	EA	$3,500	1		$3,500
Manhole interties	EA	$4,500	1		$4,500
Additional/Replacement Catch Basins	EA	$1,800	3		$5,400
Additional 10" pipe to tie in catch basins	LF	$49	90		$4,410
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	300		$9,000
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	300		$1,800
Traffic Control	LF	$2	300		$600
Santiam to Robidoux on 6th Ave					
Single 24" Storm Water Line	LF	$115	530		$60,950
Manholes	EA	$3,500	3		$10,500
Manhole interties	EA	$4,500	3		$13,500
Additional/Replacement Catch Basins	EA	$1,800	6		$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180		$8,820
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	530		$15,900
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	530		$3,180
Traffic Control	LF	$2	530		$1,060
6th Ave to 5th Ave on Robidoux					
Single 24" Storm Water Line	LF	$115	320		$36,800
Manholes	EA	$3,500	1		$3,500
Manhole interties	EA	$4,500	1		$4,500
Additional/Replacement Catch Basins	EA	$1,800	5		$9,000
Additional 10" pipe to tie in catch basins	LF	$49	150		$7,350
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	320		$9,600
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	320		$1,920
Traffic Control	LF	$2	320		$640

Stayton Storm Water Master Plan
Priority 1 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)	
Robidoux to Hollister on 5th Ave					
Single 24" Storm Water Line	LF	$115	300		$34,500
Manholes	EA	$3,500	0		$0
Manhole interties	EA	$4,500	0		$0
Additional/Replacement Catch Basins	EA	$1,800	5		$9,000
Additional 10" pipe to tie in catch basins	LF	$49	150		$7,350
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	300		$9,000
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	300		$1,800
Traffic Control	LF	$2	300		$600
5th Ave to 1st Ave on Hollister					
Parallel 36" Storm Water Line	LF	$200	941		$188,200
Manholes	EA	$3,500	4		$14,000
Manhole interties	EA	$4,500	5		$22,500
Additional/Replacement Catch Basins	EA	$1,800	15		$27,000
Additional 10" pipe to tie in catch basins	LF	$49	450		$22,050
Additional cost for Control Density Backfill	LF	$40	941		$37,640
Pavement Repair- 1/2 lane	LF	$30	0		$0
Pavement Repair- Full Lane	LF	$52	941		$48,932
Utilities	LF	$6	941		$5,646
Traffic Control	LF	$2	941		$1,882
Hollister to Cedar on 1st Ave					
Parallel 42" Storm Water Line	LF	$218	800		$174,400
Manholes	EA	$3,500	4		$14,000
Manhole interties	EA	$4,500	4		$18,000
Additional/Replacement Catch Basins	EA	$1,800	15		$27,000
Additional 10" pipe to tie in catch basins	LF	$49	450		$22,050
Additional cost for Control Density Backfill	LF	$40	800		$32,000
Pavement Repair- 1/2 lane	LF	$30	0		$0
Pavement Repair- Full Lane	LF	$52	800		$41,600
Utilities	LF	$6	800		$4,800
Traffic Control	LF	$2	800		$1,600
Cedar to Regis on 1st Ave					
Parallel 36" Storm Water Line	LF	$200	647		$129,400
Manholes	EA	$3,500	3		$10,500
Manhole interties	EA	$4,500	3		$13,500
Additional/Replacement Catch Basins	EA	$1,800	6		$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180		$8,820
Additional cost for Control Density Backfill	LF	$40	647		$25,880
Pavement Repair- 1/2 lane	LF	$30	0		$0
Pavement Repair- Full Lane	LF	$52	647		$33,644
Utilities	LF	$6	647		$3,882
Traffic Control	LF	$2	647		$1,294
1st Ave to Kathy on Regis					
Parallel 36" Storm Water Line	LF	$200	883		$176,600
Manholes	EA	$3,500	3		$10,500
Manhole interties	EA	$4,500	3		$13,500
Additional/Replacement Catch Basins	EA	$1,800	5		$9,000
Additional 10" pipe to tie in catch basins	LF	$49	150		$7,350
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	883		$26,490
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	883		$5,298
Traffic Control	LF	$2	883		$1,766
Kathy to Gardner on Regis					
Parallel 36" Storm Water Line	LF	$200	1,460		$292,000
Manholes	EA	$3,500	3		$10,500
Manhole interties	EA	$4,500	3		$13,500
Additional/Replacement Catch Basins	EA	$1,800	9		$16,200
Additional 10" pipe to tie in catch basins	LF	$49	270		$13,230
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	1,460		$43,800
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	1,460		$8,760
Traffic Control	LF	$2	1,460		$2,920
Regis to Shaff on Gardner					
Parallel 42" Storm Water Line	LF	$218	1,100		$239,800
Manholes	EA	$3,500	5		$17,500
Manhole interties	EA	$4,500	5		$22,500
Additional/Replacement Catch Basins	EA	$1,800	9		$16,200
Additional 10" pipe to tie in catch basins	LF	$49	270		$13,230

Stayton Storm Water Master Plan
Priority 1 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)	
Additional cost for Control Density Backfill	LF	$40	100		$4,000
Pavement Repair- 1/2 lane	LF	$30	0		$0
Pavement Repair- Full Lane	LF	$52	1,100		$57,200
Utilities	LF	$6	1,100		$6,600
Traffic Control	LF	$2	1,100		$2,200
Eagle Street to Shaff Road on Quail Run Ave					
Parallel15" Storm Water Line	LF	$63	634		$39,942
Manholes	EA	$3,500	3		$10,500
Manhole interties	EA	$4,500	3		$13,500
Additional/Replacement Catch Basins	EA	$1,800	2		$3,600
Additional 10" pipe to tie in catch basins	LF	$49	60		$2,940
Additional cost for Control Density Backfill	LF	$40	65		$2,600
Pavement Repair- 1/2 lane	LF	$30	0		$0
Pavement Repair- Full Lane	LF	$52	634		$32,968
Utilities	LF	$6	634		$3,804
Traffic Control	LF	$2	634		$1,268
Shaff Road Detention Facility					
Land Acquisition	AC	$20,000	4	$80,000	
Single 48" Storm Water Line	LF	$225	900	$202,500	
Bore under Shaff Road to North side	LF	$900	60	$54,000	
Manholes	EA	$3,500	4	$14,000	
Manhole interties	EA	$4,500	0	$0	
Manhole Monitoring Equipment	EA	$9,200	1	$9,200	
Additional/Replacement Catch Basins	EA	$1,800	4	$7,200	
Additional 10" pipe to tie in catch basins	LF	$49	120	$5,880	
Additional cost for Control Density Backfill	LF	$40	900	$36,000	
Pavement Repair- 1/2 lane	LF	$30	900	$27,000	
Pavement Repair- Full Lane	LF	$52	0	$0	
Utilities	LF	$6	900	$5,400	
Traffic Control	LF	$2	900	$1,800	
Excavation	CY	$15	17,333	$259,995	
Inlet structure	EA	$6,000	1	$6,000	
Outlet control structure	EA	$7,500	1	$7,500	
Outfall Piping - 30"	LF	$180	1,747	$314,460	
Landscaping	SF	$0.95	217,800	$206,910	
Sum				$1,237,845	$2,522,386
Mobilization	*%*	*5%*		*$61,900*	*$126,100*
Total Construction Costs				$1,299,745	$2,648,486
Contingency	%	20%		$259,949	$529,697
Engineering & Legal	%	15%		$194,962	$397,273
Shaff Basin Subtotal				***$1,754,700***	***$3,575,500***
10th Avenue Improvements				**1A**	**1B**
Hospital Discharge to County Housing on 10th Ave					
Parallel 15" Storm Water Line	LF	$63	900		$56,700
Manholes	EA	$3,500	2		$7,000
Manhole interties	EA	$4,500	0		$0
Additional/Replacement Catch Basins	EA	$1,800	6		$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180		$8,820
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	500		$15,000
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	900		$5,400
Traffic Control	LF	$2	500		$1,000
County Housing to Santiam on 10th Ave					
Parallel 18" Storm Water Line	LF	$70	486		$34,020
Manholes	EA	$3,500	2		$7,000
Manhole interties	EA	$4,500	2		$9,000
Additional/Replacement Catch Basins	EA	$1,800	6		$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180		$8,820
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	486		$14,580
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	486		$2,916
Traffic Control	LF	$2	486		$972
Santiam to Virginia on 10th Ave					
Parallel 18" Storm Water Line	LF	$70	890		$62,300
Manholes	EA	$3,500	2		$7,000
Manhole interties	EA	$4,500	2		$9,000
Additional/Replacement Catch Basins	EA	$1,800	7		$12,600
Additional 10" pipe to tie in catch basins	LF	$49	210		$10,290

Stayton Storm Water Master Plan
Priority 1 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)	
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	890		$26,700
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	890		$5,340
Traffic Control	LF	$2	890		$1,780
12th Ave to 10th Ave on Virginia					
Parallel 18" Storm Water Line	LF	$12	650		$7,800
Manholes	EA	$3,500	3		$10,500
Manhole interties	EA	$4,500	3		$13,500
Additional/Replacement Catch Basins	EA	$1,800	6		$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180		$8,820
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	650		$19,500
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	650		$3,900
Traffic Control	LF	$2	650		$1,300
Virginia and 10th to Park Detention Facility					
Single 30" Storm Water Line	LF	$180	600		$108,000
Manholes	EA	$3,500	4		$14,000
Manhole interties	EA	$4,500	2		$9,000
Additional/Replacement Catch Basins	EA	$1,800	6		$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180		$8,820
Additional cost for Control Density Backfill	LF	$40	0		$0
Pavement Repair- 1/2 lane	LF	$30	600		$18,000
Pavement Repair- Full Lane	LF	$52	0		$0
Utilities	LF	$6	600		$3,600
Traffic Control	LF	$2	600		$1,200
Park Detention Facility					
Land Acquisition	AC	$20,000	2	$40,000	
Excavation	CY	$15	12,900	$193,500	
Inlet structure	EA	$6,000	1	$6,000	
Manholes	EA	$3,500	1	$3,500	
Manhole Monitoring Equipment	EA	$9,200	1	$9,200	
Outlet control structure	EA	$7,500	1	$7,500	
Outfall Piping - 18"	LF	$70	1,747	$122,290	
Landscaping	SF	$1	87,120	$82,764	
Subsurface Drainage	AC	$75,000	1	$75,000	
Sum				$539,754	$577,378
Mobilization	%	5%		*$27,000*	*$28,900*
Total Construction Costs				$566,754	$606,278
Contingency	%	20%		$113,351	$121,256
Engineering & Legal	%	15%		$85,013	$90,942
10th Ave Subtotal				***$765,100***	***$818,500***
Norpac Northeast Facility				**1A**	**1B**
Land Acquisition	AC	$20,000	1.5		$30,000
Excavation	CY	$15	12,907		$193,605
Manholes	EA	$3,500	1		$3,500
Manhole Monitoring Equipment	EA	$9,200	1		$9,200
Inlet structure	EA	$6,000	1		$6,000
Outlet control structure	EA	$7,500	1		$7,500
Outfall Piping - 18"	LF	$70	1,747		$122,290
Landscaping	SF	$1	87,120		$82,764
Sum					$454,859
Mobilization	%	5%			*$22,700*
Total Construction Costs					$477,559
Contingency	%	15%			$71,634
Engineering & Legal	%	15%			$71,634
Norpac Northeast Detention Facility Subtotal					***$620,800***
Total Priority 1 Costs				**$3,311,800**	**$5,206,500**

Stayton Storm Water Master Plan
Priority 2 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Fir to Regis Through Regis High Parking Lot				
Parallel 36" Storm Water Line	LF	$200	880	$176,000
Manholes	EA	$3,500	3	$10,500
Manhole interties	EA	$4,500	3	$13,500
Additional/Replacement Catch Basins	EA	$1,800	6	$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180	$8,820
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	880	$26,400
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	880	$5,280
Traffic Control	LF	$2	880	$1,760
Sum				$253,060
Mobilization	%	5%		*$12,700*
Total Construction Costs				$265,760
Contingency	%	20%		$53,152
Engineering	%	15%		$39,864
Fir to Regis Subtotal				***$358,800***
Evergreen Ave to NE Norpac Dtn Site				
Hollister to Locust on Evergreen Ave				
Parallel 12" Storm Water Line	LF	$56	667	$37,352
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	2	$9,000
Additional/Replacement Catch Basins	EA	$1,800	7	$12,600
Additional 10" pipe to tie in catch basins	LF	$49	210	$10,290
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	667	$20,010
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	667	$4,002
Traffic Control	LF	$2	667	$1,334
1st Ave to Douglas on Locust				
Parallel 12" Storm Water Line	LF	$56	1,100	$61,600
Manholes	EA	$3,500	3	$10,500
Manhole interties	EA	$4,500	3	$13,500
Additional/Replacement Catch Basins	EA	$1,800	10	$18,000
Additional 10" pipe to tie in catch basins	LF	$49	300	$14,700
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	1,100	$33,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	1,100	$6,600
Traffic Control	LF	$2	1,100	$2,200
Locust to Washington on Douglas				
Parallel 12" Storm Water Line	LF	$56	700	$39,200
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	2	$9,000
Additional/Replacement Catch Basins	EA	$1,800	5	$9,000
Additional 10" pipe to tie in catch basins	LF	$49	150	$7,350
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	700	$21,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	700	$4,200
Traffic Control	LF	$2	700	$1,400
Douglas to Norpak NE Detention on Washington				
Parallel 12" Storm Water Line	LF	$56	300	$16,800
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional 10" pipe to tie in catch basins	LF	$49	60	$2,940
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	300	$9,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	300	$1,800
Traffic Control	LF	$2	300	$600
Sum				$406,078
Mobilization	%	5%		*$20,300*
Total Construction Costs				$426,378
Contingency	%	20%		$85,276
Engineering	%	15%		$63,957
Evergreen to Norpac Subtotal				***$575,600***

Stayton Storm Water Master Plan
Priority 2 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
3rd and Jefferson to Library Detention				
Jefferson to Virginia on 3rd Ave				
Parllel 18" Storm Water Pipe	LF	$70	550	$38,500
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	2	$9,000
Additional/Replacement Catch Basins	EA	$1,800	12	$21,600
Additional 10" pipe to tie in catch basins	LF	$49	360	$17,640
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	550	$16,500
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	550	$3,300
Traffic Control	LF	$2	550	$1,100
3rd Ave to 2nd Ave on Virginia				
Parllel 18" Storm Water Pipe	LF	$70	275	$19,250
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	4	$7,200
Additional 10" pipe to tie in catch basins	LF	$49	120	$5,880
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	275	$8,250
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	275	$1,650
Traffic Control	LF	$2	275	$550
Virginia to Marion Ave on 2nd Ave				
Parallel 18" Storm Water Pipe	LF	$70	525	$36,750
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	4	$7,200
Additional 10" pipe to tie in catch basins	LF	$49	120	$5,880
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	525	$15,750
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	525	$3,150
Traffic Control	LF	$2	525	$1,050
6th to 2nd on Marion Ave				
Single 18" Storm Water Pipe	LF	$70	1,155	$80,850
Manholes	EA	$3,500	5	$17,500
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	16	$28,800
Additional 10" pipe to tie in catch basins	LF	$49	480	$23,520
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	1,155	$34,650
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	1,155	$6,930
Traffic Control	LF	$2	1,155	$2,310
Salem Ditch to Marion on 6th				
Regrade Gutters	LF	$12	266	$3,192
Gutter grates	LF	$30	266	$7,980
Abandon Existing Stormlines	LF	$10	266	$2,660
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	266	$7,980
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	266	$1,596
Traffic Control	LF	$2	266	$532
Salem Ditch to Marion on 5th				
Regrade Gutters	LF	$12	263	$3,156
Gutter grates	LF	$30	263	$7,890
Abandon Existing Stormlines	LF	$10	263	$2,630
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	263	$7,890
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	263	$1,578
Traffic Control	LF	$2	263	$526
Salem Ditch to Marion on 4th				
Regrade Gutters	LF	$12	250	$3,000
Gutter grates	LF	$30	250	$7,500
Abandon Existing Stormlines	LF	$10	250	$2,500
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600

Stayton Storm Water Master Plan
Priority 2 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	250	$7,500
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	250	$1,500
Traffic Control	LF	$2	250	$500
Salem Ditch to Marion on 3rd				
Regrade Gutters	LF	$12	200	$2,400
Gutter grates	LF	$30	200	$6,000
Abandon Existing Stormlines	LF	$10	200	$2,000
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	200	$6,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	200	$1,200
Traffic Control	LF	$2	200	$400
Salem Ditch to Marion on 2nd				
Regrade Gutters	LF	$12	160	$1,920
Gutter grates	LF	$30	160	$4,800
Abandon Existing Stormlines	LF	$10	160	$1,600
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	160	$4,800
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	160	$960
Traffic Control	LF	$2	160	$320
Salem Ditch to Marion on 1st				
Regrade Gutters	LF	$12	60	$720
Gutter grates	LF	$30	60	$1,800
Abandon Existing Stormlines	LF	$10	60	$600
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional cost for Control Density Backfill	LF	$40	60	$2,400
Pavement Repair- 1/2 lane	LF	$30	60	$1,800
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	60	$360
Traffic Control	LF	$2	60	$120
Virginia to Marion Ave on 2nd Ave				
Parallel 18" Storm Water Pipe	LF	$70	525	$36,750
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	4	$7,200
Additional 10" pipe to tie in catch basins	LF	$49	120	$5,880
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	525	$15,750
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	525	$3,150
Traffic Control	LF	$2	525	$1,050
Stayton Christian School to Marion on 1st Ave				
Parallel 12" Storm Water Pipe	LF	$56	1,110	$62,160
Manholes	EA	$3,500	5	$17,500
Manhole interties	EA	$4,500	5	$22,500
Additional/Replacement Catch Basins	EA	$1,800	16	$28,800
Additional 10" pipe to tie in catch basins	LF	$49	480	$23,520
Additional cost for Control Density Backfill	LF	$40	1,110	$44,400
Pavement Repair- 1/2 lane	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	1,110	$57,720
Utilities	LF	$6	1,110	$6,660
Traffic Control	LF	$2	1,110	$2,220
2nd Ave to Library Detention on Marion				
Parallel 18" Storm Water Line	LF	$70	600	$42,000
Parallel 24" Storm Water Line	LF	$115	600	$69,000
Bore under 1st Ave	LF	$500	60	$30,000
Manholes	EA	$3,500	8	$28,000
Manhole interties	EA	$4,500	5	$22,500
Additional/Replacement Catch Basins	EA	$1,800	8	$14,400
Additional 10" pipe to tie in catch basins	LF	$49	240	$11,760
Additional cost for Control Density Backfill	LF	$40	60	$2,400
Pavement Repair- 1/2 lane	LF	$30	600	$18,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	600	$3,600
Traffic Control	LF	$2	600	$1,200
Library Detention Facility				

Stayton Storm Water Master Plan
Priority 2 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Land Acquisition	AC	$20,000	0	$0
Manholes	EA	$3,500	3	$10,500
Manhole Monitoring Equipment	EA	$9,200	1	$9,200
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional 10" pipe to tie in catch basins	LF	$49	60	$2,940
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	20	$120
Traffic Control	LF	$2	0	$0
Excavation	CY	$15	5,808	$87,120
Inlet structure	EA	$6,000	1	$6,000
Outlet control structure	EA	$7,500	1	$7,500
Outfall Piping - 15"	LF	$63	80	$5,040
Landscaping	SF	$1	87,120	$82,764
Subsurface Drainage	AC	$75,000	1.5	$112,500
Sum				$1,492,074
Mobilization	*%*	*5%*		*$74,600*
Total Construction Costs				$1,566,674
Contingency	%	20%		$313,335
Engineering & Legal	%	15%		$235,001
3rd and Jefferson to Library Subtotal				***$2,115,000***
Mill Stream Woods to Norpac SW Detention Site on Ida				
Mill Stream Woods to Norpac SW Detention Site on Ida				
Single 24" Line	LF	$115	4,076	$468,740
Manholes	EA	$3,500	15	$52,500
Manhole interties	EA	$4,500	11	$49,500
Additional/Replacement Catch Basins	EA	$1,800	46	$82,800
Additional 10" pipe to tie in catch basins	LF	$49	1,380	$67,620
Additional cost for Control Density Backfill	LF	$40	60	$2,400
Pavement Repair- 1/2 lane	LF	$30	4,076	$122,280
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	4,076	$24,456
Traffic Control	LF	$2	4,076	$8,152
Bore under 1st Ave	LF	$500	60	$30,000
Salem Ditch to Ida on 4th Ave				
Regrade Gutters	LF	$12	200	$2,400
Gutter grates	LF	$30	200	$6,000
Abandon Existing Stormlines	LF	$10	200	$2,000
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	200	$6,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	200	$1,200
Traffic Control	LF	$2	200	$400
3rd and High to 3rd and Ida				
Regrade Gutters	LF	$12	241	$2,892
Gutter grates	LF	$30	241	$7,230
Abandon Existing Stormlines	LF	$10	241	$2,410
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	241	$7,230
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	241	$1,446
Traffic Control	LF	$2	241	$482
2nd and High to 2nd and Ida				
Regrade Gutters	LF	$12	270	$3,240
Gutter grates	LF	$30	270	$8,100
Abandon Existing Stormlines	LF	$10	270	$2,700
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	270	$8,100
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	270	$1,620
Traffic Control	LF	$2	270	$540
1st and High to 1st and Ida				
Regrade Gutters	LF	$12	330	$3,960
Gutter grates	LF	$30	330	$9,900

Stayton Storm Water Master Plan
Priority 2 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Abandon Existing Stormlines	LF	$10	330	$3,300
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	330	$9,900
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	330	$1,980
Traffic Control	LF	$2	330	$660
3rd and Water to 3rd and Ida				
Single 15" Line	LF	$63	518	$32,634
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	0	$0
Additional/Replacement Catch Basins	EA	$1,800	8	$14,400
Additional 10" pipe to tie in catch basins	LF	$49	240	$11,760
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	518	$15,540
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	518	$3,108
Traffic Control	LF	$2	518	$1,036
2nd and Water to 2nd and Ida				
Single 15" Line	LF	$63	350	$22,050
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	0	$0
Additional/Replacement Catch Basins	EA	$1,800	7	$12,600
Additional 10" pipe to tie in catch basins	LF	$49	210	$10,290
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	350	$10,500
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	350	$2,100
Traffic Control	LF	$2	350	$700
1st and Florence to 1st and Ida				
Single 15" Line	LF	$63	250	$15,750
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	0	$0
Additional/Replacement Catch Basins	EA	$1,800	6	$10,800
Additional 10" pipe to tie in catch basins	LF	$49	180	$8,820
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	250	$7,500
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	250	$1,500
Traffic Control	LF	$2	250	$500
Norpac SW Detention Site				
Land Acquisition	AC	$20,000	1	$20,000
Manholes	EA	$3,500	2	$7,000
Manhole Monitoring Equipment	EA	$9,200	1	$9,200
Manhole interties	EA	$4,500	0	$0
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional 10" pipe to tie in catch basins	LF	$49	60	$2,940
Additional cost for Control Density Backfill	LF	$40	0	$0
Utilities	LF	$6	20	$120
Traffic Control	LF	$2	0	$0
Excavation	CY	$15	3,230	$48,450
Inlet structure	EA	$6,000	1	$6,000
Outlet control structure	EA	$7,500	1	$7,500
Outfall Piping - 15"	LF	$63	20	$1,260
Landscaping	SF	$1	87,120	$82,764
Sum				$1,393,560
Mobilization	*%*	*5%*		*$69,700*
Total Construction Costs				$1,463,260
Contingency	%	20%		$292,652
Engineering	%	15%		$219,489
Mill Stream Woods to Norpac SW Dtn Site Subtotal				***$1,975,400***
Total Priority 2 Costs				**$5,024,800**

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Stayton Storm Water Master Plan
Priority 3 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Sylvan Meadows Subdivision Improvements				
From MH in Walking Path to Detn. Pond				
Parallel 12" Storm Water Line	LF	$56	250	$14,000
Manholes	EA	$3,500	3	$10,500
Manhole Monitoring Equipment	EA	$9,200	1	$9,200
Manhole interties	EA	$4,500	2	$9,000
Surveying	EA	$2,000	1	$2,000
Detention Area and Elevation Work	CY	$15	300	$4,500
Utilities	LF	$6	250	$1,500
Landscaping	SF	$1	250	$238
Sum				$50,938
Mobilization	*%*	*5%*		*$2,500*
Total Construction Costs				$53,438
Contingency	%	20%		$10,688
Engineering	%	15%		$8,016
Sylvan Meadows Subdivision Subtotal				***$72,100***
Gardner Road-Regis High School Improvements				
Locust Street to Gardner				
Single 15" Storm Water Line	LF	$63	800	$50,400
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	7	$12,600
Additional 10" pipe to tie in catch basins	LF	$49	210	$10,290
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	800	$24,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	800	$4,800
Traffic Control	LF	$2	800	$1,600
Gardner to Western Place				
Parallel 18" Storm Water Line	LF	$70	1,600	$112,000
Manholes	EA	$3,500	5	$18,667
Manhole interties	EA	$4,500	5	$22,500
Additional/Replacement Catch Basins	EA	$1,800	16	$28,800
Additional 10" pipe to tie in catch basins	LF	$49	480	$23,520
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	1,600	$48,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	1,600	$9,600
Traffic Control	LF	$2	1,600	$3,200
Western Place to Regis				
Prallel 24" Storm Water Line	LF	$115	300	$34,500
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	2	$9,000
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional 10" pipe to tie in catch basins	LF	$49	60	$2,940
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	300	$9,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	300	$1,800
Traffic Control	LF	$2	300	$600
Sum				*$449,917*
Mobilization	*%*	*5%*		$22,500
Total Construction Costs				$472,417
Contingency	%	20%		$94,483
Engineering	%	15%		$70,863
Gardner Road-Regis High School Subtotal				***$637,800***
Wedgewood Place Improvements				
Wilshire Drive				
Parallel 24" Storm Water Line	LF	$115	1,050	$120,750
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	2	$9,000
Additional/Replacement Catch Basins	EA	$1,800	3	$5,400
Additional 10" pipe to tie in catch basins	LF	$49	0	$0

Stayton Storm Water Master Plan
Priority 3 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Additional cost for Control Density Backfill	LF	$40	750	$30,000
Pavement Repair- 1/2 lane	LF	$30	750	$22,500
Pavement Repair- Full Lane	LF	$52	0	$0
Landscaping	SF	$1	300	$285
Utilities	LF	$6	1,050	$6,300
Traffic Control	LF	$2	750	$1,500
Wedgewood Place-Wilco Road				
Parallel 30" Storm Water Line	LF	$180	1,350	$243,000
Manholes	EA	$3,500	4	$14,000
Manhole interties	EA	$4,500	3	$13,500
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional 10" pipe to tie in catch basins	LF	$49	0	$0
Crossing of Wilco Road	LF	$200	100	$20,000
Pavement Repair- commercial area	LF	$30	600	$18,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	1,350	$8,100
Landscaping	SF	$1	300	$285
Traffic Control	LF	$2	0	$0
Sum				$519,620
Mobilization	%	5%		*$26,000*
Total Construction Costs				$545,620
Contingency	%	20%		$109,124
Engineering	%	15%		$81,843
Wedgewood Place Improvements Subtotal				***$736,600***
Western Avenue Improvements				
Western Avenue-Westfield Pl				
Parallel 15" Storm Water Line	LF	$63	2,000	$126,000
Manholes	EA	$3,500	6	$21,000
Manhole interties	EA	$4,500	3	$13,500
Additional/Replacement Catch Basins	EA	$1,800	4	$7,200
Additional 10" pipe to tie in catch basins	LF	$49	50	$2,450
Additional cost for Control Density Backfill	LF	$40	1,700	$68,000
Pavement Repair- 1/2 lane	LF	$30	1,700	$51,000
Pavement Repair- Full Lane	LF	$52	0	$0
Landscaping	SF	$1	300	$285
Utilities	LF	$6	2,000	$12,000
Traffic Control	LF	$2	1,700	$3,400
Western Place-Shaff Road				
Parallel 30" Storm Water Line	LF	$180	700	$126,000
Parallel 12" Storm Water Line	LF	$56	650	$36,400
Manholes	EA	$3,500	5	$17,500
Manhole interties	EA	$4,500	2	$9,000
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional 10" pipe to tie in catch basins	LF	$49	0	$0
Pavement Repair- commercial area	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	1,350	$8,100
Landscaping	SF	$1	1,350	$1,283
Traffic Control	LS	$10,000	1	$10,000
Sum				$516,718
Mobilization	%	5%		*$25,800*
Total Construction Costs				$542,518
Contingency	%	20%		$108,504
Engineering	%	15%		$81,378
Western Avenue Improvements Subtotal				***$732,400***
Total Priority 3 Costs				**$2,178,900**

Stayton Storm Water Master Plan
Priority 4 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Library Improvements				
Librabry Improvements				
Singe 15" Storm Water Line	LF	$63	350	$22,050
Manholes	EA	$3,500	2	$7,000
Manhole interties	EA	$4,500	0	$0
Utilities	LF	$6	350	$2,100
Abandon Existing Storm Line	LF	$10	350	$3,500
Landscaping	SF	$1	350	$333
Sum				$34,983
Mobilization	%	5%		*$1,700*
Total Construction Costs				$36,683
Contingency	%	20%		$7,337
Engineering	%	15%		$5,502
Library Subtotal				***$49,500***
1st Avenue Improvements				
1st Avenue Improvements				
Single 15" Storm Water Line	LF	$63	425	$26,775
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	2	$9,000
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional 10" pipe to tie in catch basins	LF	$49	5	$245
Additional cost for Control Density Backfill	LF	$40	425	$17,000
Pavement Repair- 1/2 lane	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	425	$22,100
Utilities	LF	$6	425	$2,550
Abandon Existing Storm Line	LF	$10	425	$4,250
Traffic Control	LF	$2	425	$850
Sum				$86,270
Mobilization	%	5%		*$4,300*
Total Construction Costs				$90,570
Contingency	%	20%		$18,114
Engineering	%	15%		$13,586
1st Avenue Subtotal				***$122,300***
Washington Street Improvements				
Washington Street Detention Facility				
Land Acquisition	AC	$20,000	2	$30,000
Manholes	EA	$3,500	3	$10,500
Manhole Monitoring Equipment	EA	$9,200	1	$9,200
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional 10" pipe to tie in catch basins	LF	$49	0	$0
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LS	$2,500	1	$2,500

Stayton Storm Water Master Plan
Priority 4 Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Traffic Control	LS	$1,500	1	$1,500
Excavation	CY	$15	2,420	$36,300
Inlet structure	EA	$6,000	1	$6,000
Outlet control structure	EA	$7,500	1	$7,500
Outfall Piping - 12"	LF	$63	80	$5,040
Landscaping	SF	$1	21,780	$20,691
End of Pipe Water Quality Treatment	LS	$25,000	1	$25,000
Sum				$158,731
Mobilization	*%*	*5%*		*$7,900*
Total Construction Costs				$166,631
Contingency	*%*	15%		$24,995
Engineering	*%*	15%		$24,995
Washington Street Improvements Subtotal				***$216,600***
N. Peach Avenue Improvements				
N. Peach Avenue Improvements				
Single 18" Storm Water Line	LF	$70	525	$36,750
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional 10" pipe to tie in catch basins	LF	$49	20	$980
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	0	$0
Landscaping	SF	$1	525	$499
Utilities	LF	$6	525	$3,150
Abandon Existing Storm Line	LF	$10	525	$5,250
Traffic Control	LF	$2	0	$0
Sum				$58,229
Mobilization	*%*	*5%*		*$2,900*
Total Construction Costs				$61,129
Contingency	*%*	20%		$12,226
Engineering	*%*	15%		$9,169
Peach Avenue Improvements Subtotal				***$82,500***
Total Priority 4 Costs				**$470,900**

Stayton Storm Water Master Plan
Future Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Pacific Court Improvements				
Pacific Court Improvements				
Single 24" Storm Water Line	LF	$115	1,000	$115,000
Manholes	EA	$3	1	$3
Manhole interties	EA	$4,500	0	$0
Additional/Replacement Catch Basins	EA	$1,800	3	$5,400
Additional 10" pipe to tie in catch basins	LF	$49	60	$2,940
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	1,000	$30,000
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	1,000	$6,000
Traffic Control	LF	$2	1,000	$2,000
Landscaping	SF	$1	300	$285
Abandon Existing Storm Line	LF	$10	1,000	$10,000
Underground Detention Facility	EA	$75,000	1	$75,000
Sum				$246,628
Mobilization	%	5%		*$12,300*
Total Construction Costs				$258,928
Contingency	%	20%		$51,786
Engineering	%	15%		$38,839
Pacific Court Subtotal				***$349,600***
Fern Ridge Street Area Improvements				
Fern Ridge Street				
Parallel 15" Storm Water Line	LF	$63	400	$25,200
Parallel 18" Storm Water Line	LF	$70	950	$66,500
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	3	$13,500
Additional/Replacement Catch Basins	EA	$1,800	5	$9,000
Additional 10" pipe to tie in catch basins	LF	$49	100	$4,900
Additional cost for Control Density Backfill	LF	$40	1,350	$54,000
Pavement Repair- 1/2 lane	LF	$30	1,350	$40,500
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	1,350	$8,100
Traffic Control	LF	$2	1,350	$2,700
Pipelines North of Fern Ridge				
Parallel 15" Storm Water Line	LF	$525	400	$210,000
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional 10" pipe to tie in catch basins	LF	$49	0	$0
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	400	$2,400
Traffic Control	LF	$2	400	$800
Pipelines South of Fern Ridge				
Storm Water Line	LF	$115	4,500	$517,500
Manholes	EA	$3,500	11	$39,375
Fern Ridge Detention Facility				
Land Acquisition	AC	$20,000	2	$30,000
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	0	$0
Manhole Monitoring Equipment	EA	$9,200	1	$9,200
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional 10" pipe to tie in catch basins	LF	$49	0	$0
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LS	$2,500	0	$0
Traffic Control	LS	$1,500	0	$0
Excavation	CY	$15	6,450	$96,750
Inlet structure	EA	$6,000	1	$6,000
Outlet control structure	EA	$7,500	1	$7,500
Outfall Piping - 12"	LF	$63	0	$0
Landscaping	SF	$1	43,560	$41,382
Sum				$1,200,307
Mobilization	%	5%		*$60,000*
Total Construction Costs				$1,260,307
Contingency	%	20%		$252,061
Engineering	%	15%		$189,046
Fern Ridge Street Area Subtotal				***$1,701,400***
Dozler Property Improvements				
Pipelines				
Storm Water Line	LF	$115	2,300	$264,500
Manholes	EA	$3,500	6	$20,125
Dozler Detention Facility				
Land Acquisition	AC	$20,000	3	$50,000
Excavation	CY	$15	8,070	$121,050
Manholes	EA	$3,500	1	$3,500
Manhole Monitoring Equipment	EA	$9,200	1	$9,200
Inlet structure	EA	$6,000	2	$12,000

Stayton Storm Water Master Plan
Future Improvements

Item	Unit	Unit Price	Estimated Quantity	Cost (Rounded)
Outlet control structure	EA	$7,500	1	$7,500
Outfall Piping - 12"	LF	$63	100	$6,300
Landscaping	SF	$1	30,000	$28,500
Sum				$522,675
Mobilization	%	5%		*$26,100*
Total Construction Costs				$548,775
Contingency	%	20%		$109,755
Engineering	%	15%		$82,316
Dozler Property Area Subtotal				***$740,800***
Phillips Property Area Improvements				
Detention Swale				
Detention Swale	LF	$150	2,500	$375,000
Landscaping	LF	$100	2,500	$250,000
Easements	LF	$50	2,500	$125,000
Pipelines				
Parallel 42" Storm Water Line	LF	$218	350	$76,300
Parallel 36" Storm Water Line	LF	$200	350	$70,000
Single 30" Storm Water Line	LF	$180	2,600	$468,000
Manholes	EA	$3,500	11	$38,500
Manhole interties	EA	$4,500	0	$0
Additional/Replacement Catch Basins	EA	$1,800	0	$0
Additional 10" pipe to tie in catch basins	LF	$49	0	$0
Additional cost for Control Density Backfill	LF	$40	0	$0
Pavement Repair- 1/2 lane	LF	$30	0	$0
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	400	$2,400
Traffic Control	LF	$2	0	$0
Sum				$1,405,200
Mobilization	%	5%		*$70,300*
Total Construction Costs				$1,475,500
Contingency	%	20%		$295,100
Engineering	%	15%		$221,325
Phillips Property Area Subtotal				***$1,991,900***
Detention Facilities				
Potential Regional Detention Facility	EA	$600,000	4	$2,400,000
Sum				$2,400,000
Mobilization	%	5%		*$120,000*
Total Construction Costs				$2,520,000
Contingency	%	20%		$504,000
Engineering	%	15%		$378,000
Future Detention Facilities Subtotal				***$3,402,000***
Upsize Pipelines				
Future Pipelines				
Storm Water Line upsize ("30 over 18")	LF	$110	8,500	$935,000
Manholes	EA	$3,500	21	$74,375
Sum				$1,009,375
Mobilization	%	5%		*$50,500*
Total Construction Costs				$1,059,875
Contingency	%	20%		$211,975
Engineering	%	15%		$158,981
Future Pipeline Subtotal				***$1,430,800***
Larch Avenue Improvements				
Larch Avenue Improvements				
Single 15" Storm Water Line	LF	$63	525	$33,075
Manholes	EA	$3,500	1	$3,500
Manhole interties	EA	$4,500	1	$4,500
Additional/Replacement Catch Basins	EA	$1,800	2	$3,600
Additional 10" pipe to tie in catch basins	LF	$49	20	$980
Additional cost for Control Density Backfill	LF	$40	525	$21,000
Pavement Repair- 1/2 lane	LF	$30	525	$15,750
Pavement Repair- Full Lane	LF	$52	0	$0
Utilities	LF	$6	525	$3,150
Abandon Existing Storm Line	LF	$10	525	$5,250
Traffic Control	LF	$2	525	$1,050
Sum				$91,855
Mobilization	%	5%		*$4,600*
Total Construction Costs				$96,455
Contingency	%	20%		$19,291
Engineering	%	15%		$14,468
Larch Avenue Improvements Subtotal				***$130,200***
Total Future Costs				**$9,746,700**

Appendix F
Revised Stormwater Standards

F.1 - Draft Design Standards
F.2 - Catch Basin Recommendations

KELLER associates

Appendix F.1

Draft Design Standards

KELLER associates

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CITY OF STAYTON

DEPARTMENT OF PUBLIC WORKS

DRAFT STORM DRAINAGE

DESIGN STANDARDS

2007

Latest Revision Date: October 10, 2007

Latest Revision Date: October 10, 2007

Appendices

A. Storm Drainage Report and Construction Plan Requirements

B. Hydrology Calculation Requirements

C. Water Quality and Quantity Facility Design

D. Water Quality and Quantity Facility Operations and Maintenance Guidelines

E. City of Stayton Standard Details (To be reviewed and provide by the City of Stayton)

1.0 PURPOSE

The purpose of these Storm Drainage Design Standards is to provide a consistent policy under which certain physical aspects of stormwater management will be implemented. Most of the elements contained in this document are Public Works oriented and most are related to the development or platting process; however, it is intended that they apply to both public and private work designated herein.

These Standards cannot provide for all situations. They are intended to assist but not to substitute for competent work by design professionals. It is expected that engineers will bring to each project the best skills from their respective disciplines.

The Standards are also not intended to limit unreasonably any innovative or creative effort which could result in better quality, cost savings, or both. Any proposed departure from the Standards will be judged, however, on the likelihood that such variance will produce a compensating or comparable result, in every way adequate for the user and City resident.

Following from the above purpose, the standards have the objective of developing a stormwater management system which will:

a. be consistent with the Stayton Code and adopted Sector Plans;

b. be of adequate design to safely manage all volumes of water generated upstream and on the site to an approved point of discharge;

c. provide points of discharge for stormwater generated by future development upstream;

d. prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining pubic or private property;

e. prevent the capacity of downstream channels and storm drainage facilities from being exceeded;

f. have sufficient structural strength to resist erosion and all external loads which may be imposed;

g. maintain the runoff characteristics of the original undeveloped drainage basin;

h. protect Stayton's natural drainage system of streams and wetlands;

i. maintain Stayton's existing high level of overall water quality;

j. be designed in a manner to allow economical future maintenance; and

k. be designed using materials to insure a minimum practical design life as specified herein.

1.1 SHORTENED DESIGNATION

These City of Stayton's Storm Drainage Design Standards shall be cited routinely in the text as the "Standards."

1.2 APPLICABILITY

These Standards shall govern all construction and upgrading of all public and private drainage facilities in the City of Stayton and applicable work within its service areas.

1.3 REFERENCES

The Standards are intended to be consistent with the most currently adopted provisions of:

a. Stayton Code.

b. Stayton Area Comprehensive Plan.

c. City of Stayton Urban Growth Management Plan.

d. Stayton Area Stormwater Management Plan.

e. Stayton Area Water Quality Plan

f. Oregon Statewide Planning Goals and Guidelines

g. Oregon Department of Environmental Quality's Erosion and Sediment Control Manual

1.4 STANDARD SPECIFICATIONS

Except where the standards provide otherwise, design detail, workmanship and materials shall be in accordance with the City of Stayton's current edition of the "Standard Construction Specifications."

1.5 DEFINITIONS AND TERMS

Building Storm Drain—A building storm drain is that part of the piping of a stormwater drainage system which begins at the connection to the building drain at a point five (5) feet outside the established line of the building or structure and conveys stormwater to the approved point of discharge.

City Engineer — the Engineer employed or designated by the City as responsible for technical review of plans, drawings, specifications and making any engineering decisions directly or indirectly related to storm drainage issues.

Creek—Any and all surface water routes generally consisting of a channel having a bed, banks, and/or sides in which surface waters flow in draining from higher to lower land, both perennial and intermittent; the channel, banks, and intervening artificial components, excluding flows which do not persist for more than 24 hours after cessation of one-half (1/2) inch of rainfall in a 24-hour period from October through March.

Cut Sheets—means sheets of tabulated data, indicating stationings, structures, fittings, angle points, beginning of curve, points on curve, end of curves, storm drain slope, staking offset, various elevations, offset cuts, and storm drain depths.

Definition of Words—Wherever in these standards the words directed, required, permitted, ordered, designated, or words of like importance are used, they shall be understood to mean the direction, requirement, permission, or order of designation of the Director. Similarly, the words approved, acceptable, satisfactory, shall mean approved by, acceptable to, or satisfactory to the Director.

Design Engineer—The developer's design or consulting engineer, licensed by the State of Oregon as a Civil Engineer under whose direction plans, profiles, and details for the work are prepared and submitted to the City for review and approval.

Detention—The holding of runoff for a short period of time and then releasing it to the natural water course where it returns to the hydrologic cycle.

Developer — Anyone planning or implementing improvements to any property within the jurisdiction of the City of Stayton that meets one of the type descriptions included in Section 1.8.

Director—The person employed or designated by the City as responsible for implementing policy and administrative issues related to stormwater issues. The Public Works Director will coordinate with and rely upon the City Engineer with regard to issues involving technical and engineering aspects or decisions.

Drainage Facilities—Pipes, ditches, detention basins, creeks, culvert bridges, etc., used singularly or in combination with each other for the purpose of conveying, storing, or providing water quality treatment of runoff.

Drainage Master Plan—A document prepared by Keller & Associates that describes Stayton’s existing planned trunk drainage system.

Easement—Easements are areas along the line of all public storm drains which are outside of dedicated storm drain or road easements or rights-of-way, and shall be prepared on City forms granting rights along the line of the storm drain to the City.

French Drain or Leach Line—means a covered underground excavated trench filled with washed gravel that surrounds a perforated delivery pipe used to receive stormwater, wherein ‘the sides and bottom of the trench are porous, permitting the stormwater to seep into the ground.

Impervious Areas—Impervious Surfaces. Those hard surface areas located upon real property which either prevent or retard saturation of water into the land surface, as existed under natural conditions pre-existent to development, and cause water to run off the land surface in greater quantities or at an increased rate of flow from that present under natural conditions pre-existent to development. Common impervious surfaces include, but are not limited to rooftops, concrete or asphalt sidewalks, walkways, patio areas, driveways, parking lots or storage areas and graveled, oiled, macadam or other surfaces which similarly impact the natural saturation or runoff patterns which existed prior to development.

Natural Location—The location of those channels, swales, and other nonman-made conveyance systems as defined by the first documented topographic contours existing for the subject property either from maps or photographs.

On-Site Detention—The storage of excess runoff on the development site prior to its entry into a public storm drain system and gradual release of the stored runoff after the peak of the runoff has passed.

Owner—Any individual, partnership, firm, or corporation by whom the project engineer has been retained or who, as a property owner, is making arrangements with the City.

Peak Discharge—The maximum water runoff rate (cfs) determined for the design storm.

Plans—Construction plans, including system site plans, storm drain plans and profiles, cross sections, detailed drawings, etc., or reproductions thereof, approved or to be approved by the City Engineer, which show the location, character, dimensions, and details for the work to be done, in which constitute a supplement to these standards.

Pre-Development—a site with natural vegetation on native soils.

Private Storm Drain—means a storm drain located on private property serving more than one structure on the same premises or parking lot catchbasins.

Project Engineer—see “Design Engineer”.

Public Storm Drain—means any storm drain in public right-of-way or easement operated and maintained by the City.

Receiving Bodies of Water—Creeks, streams, lakes, and other bodies of water into which waters are artificially or naturally directed.

Release Rate—The controlled rate of release of drainage, storm, and runoff water from property, storage pond, runoff detention pond, or other facility during and following a storm event.

Right-of-Way—All land or interest therein which by deed, conveyance, agreement, easement, dedication, usage, or process of law is reserved for or dedicated to the use of the general public, within which the City shall have the right to install and maintain storm drains.

Retention Facilities—Facilities designed to or which do hold water for a considerable length of time and then consume it by evaporation, plant transpiration, or infiltration into the soil. Any point discharge to a drainage channel or receiving body of water must be addressed in the Storm Drainage Report.

Sedimentation—Disposition of erosional debris-soil sediment displaced by erosion and transported by water from a high elevation to an area of lower gradient where sediments are deposited as a result of slack water.

Silt—Fine textured soil particles including clay and sand as differentiated from coarse particles of sand and gravel.

Siltation—Deposition of (silt) waterborne sediments—fine textured sedimentation—terms used to describe the smoothing or cementing effect of a blanket of silt deposited over sand and gravel areas used by migratory fish for spawning (including colloidal material when the transporting water evaporates).

Standard Plans—The drawings of structures or devices commonly used on City work and referred to on the plans (see standard construction specifications).

Storm Drainage Report—An Engineering Report, prepared by the Developer or a designated agent, that is required by the City of Stayton. The report must provide a hydrologic evaluation of the pre-development and developed site conditions associated with the proposed improvements. The report must demonstrate how the proposed stormwater management and water quality facilities will comply with these standards. The report must be signed and stamped by a professional engineer registered in Oregon.

Streets or Roads—Any public highway, road, street, avenue, alley, way, easement, or right-of-way used or to be used for vehicle movement.

Structures—Those structures designated on the standard plans as catchbasins, manholes, etc. Detailed drawings of structures or devices commonly used in ‘ City work and mentioned in these Standards are included in the standard construction specifications.

Subdivision—means to divide an area or tract of land into four or more lots within a calendar year when such area or tract of land existed as a unit or contiguous units of land under a single ownership at the beginning of such year.

Terrace—A relatively level step constructed in the face of a grade surface for drainage, erosion control, and maintenance purposes.

Trunk Drainage System—The trunk drainage system is that portion of the drainage system of the City which receives waters from an adjacent land area in excess of 20 acres. The trunk drainage system may consist of watercourses or man-made facilities such. as pipes, ditches, and culverts.

Wetlands—Those lands adjacent to watercourses or isolated therefrom which may normally or periodically be inundated by the waters from the watercourse or the drainage waters from the drainage basin in which it is located. These include swamps, bogs, sinks, marshes, and lakes, all of which are considered to be part of the watercourse and drainage system of the City and shall include the headwater areas where the watercourse first surfaces. They may be, but are not necessarily, characterized by special soils such as peat, muck, and mud.

1.6 ENGINEERING POLICY

The engineering policy of the City of Stayton requires strict compliance with Oregon Revised Statute 672 for professional engineers.

All engineering plans, reports, or documents shall be prepared by a registered professional Civil Engineer, or by a subordinate employee under his/her direction, and shall be signed by the engineer and stamped with his/her seal to indicate his/her responsibility for them. It shall be the project engineer’s responsibility to review any proposed storm drain system, extension, and/or existing system change with the City, prior to engineering or proposed design work, to determine any special requirements or whether the proposal is permissible. A “Preliminary Review” and/or a “Plans Approval for Construction” stamp of the City, on the plans, and etc., for any job, does not in any way relieve the project engineer of his/her responsibility to meet ail requirements of the City or obligation to protect the life, health, and property of the public. The Plan for any job shall be revised or supplemented at any time it is determined that the full requirements of the City have not been met.

1.7 APPROVAL OF ALTERNATE MATERIALS OR METHODS

Any alternate material or method not explicitly approved herein will be considered for approval on the basis of the objectives set forth in 1.00 PURPOSE. Persons seeking such approvals shall make application in writing. Approval of any major deviation from these Standards will (normally) be in written form. Approval of minor matters will be made in writing if requested.

Any alternate must meet or exceed the minimum requirements set in these Standards.

The written application is to include, but is not limited to, the manufacturer’s specifications and testing results, design drawings, calculations, and other pertinent information.

Any deviations or special problems shall be reviewed on a case-by-case basis and approved by the City Engineer. When requested by the City, full design calculations shall be submitted for review with the request for approval.

1.8 GENERAL APPLICABILITY

Permanent drainage facilities shall be provided on all property improvements within the City of Stayton per these Standards for the following types of development:

a. All major or minor partitions and subdivisions.

b. All commercial, industrial, single-family, and multifamily developments creating new impervious surfaces of greater than one thousand square feet in area within any twelve-month period. Individual single family residences maybe reviewed by the City Engineer on a case by case basis. These standards are intended to fulfill the requirements of Section 1406, “Special Storm Sewers,” of the Uniform Plumbing Code for private storm drains.

c. Developments entailing construction which would change the point of discharge of surface waters, the quantity of discharge, or discharge surface waters at a higher velocity than that of the preconstruction discharge rate, or add to pollution of surface waters.

d. Construction or reconstruction of public roadways and temporary detours.

e. Developments entailing construction in or adjacent to any existing stream or surface watercourse including intermittent streams.

f. Developments requiring construction in or adjacent to the 100 year floodplain of any stream.

2.0 GENERAL DESIGN CONSIDERATIONS

Storm drainage design within a development area must include provisions to adequately control runoff and provide water quality treatment from all public and private streets and the roof, footing, and area drains of residential, multifamily, commercial, or industrial buildings sufficient to meet the City's current TMDL requirements for compliance. The Design shall also include provisions to the drainage system in conformance with the adopted Stormwater Drainage Master Plan. These provisions are:

a. Surface or subsurface drainage, caused or affected by the changing of the natural grade of the existing ground or removal of natural ground cover or placement of impervious surfaces, shall not be allowed to flow over adjacent public or private property in a volume or location materially different from that which existed before development occurred, but shall be collected and conveyed in an approved manner to an approved point of discharge.

b. Surface water entering the subject property shall be received at the naturally occurring locations and surface water exiting the subject property shall be discharged at the natural locations with adequate energy dissipaters within the subject property to minimize downstream damage and with no diversion at any of these points.

c. The approved point of discharge for all stormwater may be a storm drain, existing open channel, creek, detention, or retention pond approved by the City Engineer. Acceptance of suggested systems will depend upon the prevailing site conditions, capacity of existing downstream facilities, and feasibility of the alternate design.

d. When private property must be crossed in order to reach an approved point of discharge, it shall be the developer's responsibility to acquire a recorded drainage easement (of dimensions in accordance with those included in Section 4.1.4 from the private property owner meeting the approval of the City Engineer. The drainage facility installed must be a closed conduit system. Temporary drainage ditch facilities, when approved, must be engineered to contain the stormwater without causing erosion or other adverse effects to the private property.

e. The design storm peak discharge from the subject property may not be increased from conditions existing prior to the proposed development.

f. Water Quality: All runoff from impervious areas and developed areas shall be treated for water quality and pollution reduction. The developer and project engineer are encouraged to incorporate "green" or low impact, environmentally friendly controls similar to those included in Appendix C in their designs. Water quality measures must address the Willamette Basin TMDL target pollutants of mercury, bacteria, and temperature.

g. The developer shall include sufficient flow control facilities (i.e. detention ponds, lakes, retention areas, infiltration devices, etc.) in the project design to ensure that the releases from the developed condition does not exceed the natural occurring releases from the pre-developed condition. It will be the responsibility of the developer/project engineer to provide hydrologic and design calculations for both the pre-developed and developed conditions (in accordance with Appendix B) and to demonstrate compliance for the 2, 5, 10, 25, 50 and 100 year storm events. Flow control facilities shall be designed in accordance with Appendix C.

h. Minimum width of an access easement from an existing public road to a drainage facility shall be fifteen (15) feet.

i. Temporary and permanent erosion control measures shall be provided in accordance with Section 6.0 of these standards.

g. Stormwater quality facilities shall be provided as required in Section 5.0.

h. A Drainage Report and Drainage Plans shall be submitted in accordance with the guidelines presented in Appendix A.

2.1 DESIGN CRITERIA

2.1.1 Design Storm Recurrence

The intensity-duration design frequency is based on the type area through which the facility (pipe or ditch) passes and the size of the drainage facility. The adopted criteria are listed in Table 2-1.

TABLE 2-1.
DESIGN STORM RECURRENCE

Area	Conveyance: Peak Flow/Recurrence
Residential Areas	25-year storm
Commercial and High Value Districts	25-year storm
Trunk Lines (24” pipe and larger)	25-year storm
Minor Creeks and Drainage Ways (not shown as a flood plain on the Flood Insurance Rate Map (FIRM) (Culverts and Channels)	50-year storm
Major Creeks (shown as a flood plain on the FIRM) (Culverts, Bridges, etc)	100-year storm

2.1.2 Water Quality

All runoff from impervious areas and developed areas shall be treated for water quality and pollution reduction. Facilities shall be sized to treat flow from the Water Quality Storm, calculated from the total precipitation of 0.36 inches falling in 4 hours with a storm return period of 96 hours, as shown in Appendix B.

2.1.3 Flow Control Releases

Stormwater quantity on-site detention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the pre-development runoff rates from the site, based on a 2 through 50-year, 24-hour return storm. Specifically, the 2, 10, 25, and 50-year post development runoff rates will not exceed their respective 2, 10, 25 and 50-year pre-development runoff rates from each discharge location. Facilities shall be designed with an emergency spillway sized to pass 100-year storm event or an approved hydraulic equivalent.

2.2 SUBMITTAL REQUIREMENTS

2.2.1 Storm Drainage Report

A Storm Drainage Report must be submitted in accordance with Appendix A: Storm Drainage Report and Construction Plan Requirements.

Calculations

Design calculations shall be submitted for all drainage facilities and provided in a Drainage Report as outline in Appendix B.

2.2.2 Storm Drainage Construction Plans

Storm Drainage Construction Plans must be submitted in accordance with Appendix A: Storm Drainage Report and Construction Plan Requirements.

2.2.3 Plan Submittal

Construction plans shall be submitted in duplicate to Public Works/Engineering through the Permit Application Center (PAC) for checking to ensure compliance with these Standards, City of Stayton Ordinances, and good engineering practice. Submitted plans shall include specifications, test data, a materials list, drainage calculations, a soils report and design recommendations, easement and right-of-way descriptions, tie to City of Stayton Bench Mark and Monument System, and other material as requested by the City Engineer. A plan check fee will be levied at the time plans are submitted to PAC.

Once the plans are approved and the construction permit issued, the consulting engineer shall be responsible for providing all surveying services necessary to stake the project and prepare the as-built drawings when the project is complete.

3.0 COLLECTION

The following section contains the physical design requirements for the stormwater collection for public storm drains in the city. These design requirements may be used for private systems when plumbing code requirements cannot be met, provided the system is designed by a professional civil engineer.

3.1 SURFACE

In general, storm drains shall be designed to have access for cleaning no further than 400 feet apart with junctions made at manholes, cleanouts, or catchbasins.

3.1.1 Roof Drains

Roof drains shall run through a vegetative filtration such as a planter box, rain garden, or lawn.

3.1.2 Curb and Gutter

Types and Application, see Standards Plan No. 303

In general, curb and gutter shall be installed on all new street construction or reconstruction to control drainage from sheet flowing across the street, to preserve curb exposure during subsequent overlays, and to eliminate cracking new curbs during the street paving operation.

a. Type “A” curb and gutter shall be utilized for all street with slope less than 0.5 ft. per 100 feet.

   The minimum gutter grade permitted shall be 0.25 feet per 100 feet (0.25 percent grade).

b. Rolled Curb may be used in urban developments on private streets only.

c. Type “C” curb may be used with slopes down to a minimum 0.50 feet per 100 feet (.50% grade).

3.1.3 Catchbasin and Connector Pipes

This portion of drainage system is comprised of the curbed gutters of streets, the catchbasin inlets that collect the surface runoff, and ten-inch diameter connector and/or outlet pipes.

The inlet systems are to be designed in accordance with the following criteria:

(a) ODOT Hydraulics Manual.

(b) Hydraulic Engineering Circular No. 22 (FHWA-TS-84-202) Drainage of Highway Pavements.

Cleanouts and Catchbasin Design Requirements

a. Catchbasins and cleanouts may be used for the junction of pipes fifteen (15) inches-or less in diameter, and where the depth from rim to invert is less than four (4.0) feet. Pipe lines eighteen (18) inches in diameter may be connected to the larger dimension of the structure (catchbasin/cleanout) when the structure is formed and poured around the pipe during new construction.

   Variance from the four (4) foot maximum depth will be reviewed on a case by case basis for approval on fifteen (15) and eighteen (18) inch diameter pipes.

b. The maximum length of curb and gutter which may be drained by a catchbasin is five hundred (500) feet. Catchbasins shall be installed where the improvement ends on all streets terminating on a descending grade, and piped to an approved point of discharge.

c. On new main line and lateral construction, catchbasin laterals of thirty (30) feet or less and ten (10) inches in diameter may tie into the main line with a shop fabricated 90º ‘T’, provided said connection is located not more than one hundred (100) feet from a manhole or cleanout on said main line being fifteen (15) inches or larger in diameter.

d. The width of gutter flow on residential street shall not go past the shoulder and one travel lane or top the curb for a twenty (25) year design storm at any point along the street.

e. Catchbasins shall be designed to completely intercept the ten (10) year design storm gutter flow.

f. Type 1 catchbasins, Standard Drawings No. 203, shall be used at all locations where other construction (e.g., driveways, pedestrian ramps, etc.) or facilities do not prohibit. Exceptions will be considered on a case-by-case basis.

g. Type “A” grates shall be used in street sags; Type “B” grates shall be used on construction grades.

3.1.4 Manholes

a. Manholes shall be installed at all pipe junctions where the depth from rim to invert exceeds four (4) feet or where the pipe is eighteen (18) inches in diameter or greater except as provided for in Section 3.1.3 (a). Exceptions will be reviewed on a case by case basis for approval.

b. Manholes for pipes twenty-four (24) inches or greater in diameter shall conform to Standard Plan No. 104.

c. Where the pipe size decreases upstream through the manhole, the upstream invert must be set above the downstream invert a distance equal to the difference in the two diameters (the crowns kept at the same elevation).

3.1.5 Slope Intercept Drainage

Slope intercept drains shall be provided at the following locations and shall be designed with the requirements of Section 6.0 of these Standards with respect to erosion control:

a. along the upper boundaries of a development where the natural ground slope exceeds ten (10) percent to intercept drainage from the tributary area above the site.

b. along the lower boundary of a development where the natural ground slope exceeds ten (10) percent to prevent drainage onto a lower tributary area other than by means of an approved point of discharge.

c. along the top of all cuts which exceed four (4) feet with cut slopes which exceed 2:l where the tributary drainage area above the cut slopes towards the hinge point of the cut and has a drainage path greater than forty (40) feet measured horizontally.

3.2 SUBSURFACE DRAINAGE

Subsurface drains (underdrains) shall be provided at the following locations:

a. on all cut and fill slopes in excess of four (4) feet for stability except when a soils report submitted by a registered professional engineer experienced in soils certifies they are not required.

b. for all existing springs or springs intercepted during construction activity for other facilities, i.e., sewer, water mains, or street excavations.

c. where high ground water exists or when it is necessary to reduce the piezometric surface to an acceptable level to prevent land slippage or underfloor flooding of buildings.

The drainage line installed shall begin at a cleanout and terminate at an approved point of discharge. Open jointed storm drain lines will not be considered as an acceptable solution.

4.0 CONVEYANCE

The following section contains the physical design requirements for the stormwater conveyance for public storm drains in the city. These design requirements may be used for private systems when plumbing code requirements cannot be met, provided the system is designed by a professional civil engineer.

4.1 PIPED SYSTEMS

4.1.1 Laterals

This portion of the drainage system begins with a 12 inch or larger diameter pipe at the discharge point of the “CATCHBASIN, GUTTERS, AND CONNECTOR PIPE SYSTEM.” This portion of the system is designed to convey the twenty-five year frequency flow of the entire contributing area in its fully developed land use condition. This system terminates at the subsequent downstream point at which it is no longer capable of conveying the flow in an unsurcharged state in an 18 inch diameter pipe, at which point the system becomes a “TRUNKLINE.”

4.1.2 Trunk Lines

This portion of the drainage system can be a pipe or an open channel. The trunk line system begins with an equivalent 21 inch diameter or larger pipe at the discharge point of the “LATERAL SYSTEM.” The trunk system is designed to convey the twenty-five year frequency storm flow of the entire contributing area in its fully developed land use condition. This assumes on site and/or regional detention is incorporated in the design. This system terminates at the subsequent downstream point at which it is no longer capable of conveying the flow in an unchanged state in a pipe diameter less than 36 inches.

4.1.3 Culvert Design

Culverts provide for passage of water under or through obstructions placed across streams and drainageways. Culverts shall be designed to pass the required flows without compromising public safety or causing new or additional flooding. For pipe systems or culverts that convey flows from or through sensitive areas, a local representative of Oregon Department of Fish and Wildlife (ODFW) or other applicable state or federal agency should be contacted to determine if fish passage is required and to identify site specific design criteria. Additionally, ODFW may require fish passage accommodations on any stream that has a history or the potential for fish production.

4.1.4 Design Criteria

Pipe Materials

Pipe materials for public storm drains shall be PVC pipe, but concrete pipe should be considered for diameters greater than 18 inches.

Acceptable abbreviations for existing and proposed types of pipe are as follows:

PVC—Polyvinyl Chloride

CP—Concrete Pipe

Private storm drain pipe materials shall conform to Section 1403 of the Uniform Plumbing Code.

Pipe load analysis calculations must be submitted when requested by the City Engineer. Instances for such a request will include shallow cover (less than the minimum specified below), excessive cover and for the most economical pipe class.

Concrete pipe lines twenty-one (21) inches or greater in diameter which are laid transversed to traffic in the street section and which are subject to wheel loads shall be reinforced concrete rubber ringed Class III C-76.

Approval of alternate materials will be reviewed on a case-by-case basis for approval which shall include cast in-place pipe methods.

Pipe Size

Main line and lateral storm drains shall not be less than twelve (12) inches diameter and shall begin at a structure and shall terminate at an approved point of discharge.

Proposed exceptions to the above will be reviewed and considered for approval on a case-by-case basis by the City Engineer.

When two (2) parallel pipes are installed in lieu of a box culvert, the minimum separation between the pipes shall be one (1) foot or one-third the diameter, whichever is greater. This requirement may be waived if the void between the pipes below the spring line is filled by grouting or other approved method/substance.

Minimum Grade

All storm drains shall be laid on a grade which will produce a mean velocity (when flowing full) of at least two and one-half (2-1/2) feet per second, based upon Manning's pipe friction formula using a roughness coefficient valued at not less than 0.013, or the pipe manufacturer's recommendations, whichever is greater. The minimum acceptable grade for various pipe sizes with an "n" value of 0.013 are listed below:

TABLE 2-5.
MINIMUM PIPE GRADE

Inside Pipe Diameter (inches)	2.5 ft/sec Grade (feet per 100 feet)	2.0 ft/sec Grade (feet per 100 feet)
4	1.31	0.84
6	0.77	0.49
8	0.52	0.33
10	0.39	0.25
12	0.3	0.19
15	0.23	0.14
18	0.18	0.11
21	0.14	0.09
24	0.12	0.08
27	0.1	0.07
30 (or larger)	0.09	0.06

The minimum grade may be reduced from the above table to produce an absolute minimum velocity of 2.0 fps upon approval of the City Engineer. Cases requiring a flatter grade than permitted above shall also be reviewed on a case-by-case basis for approval by the City Engineer.

In theory, new PVC pipe has a manufacturer's "n" value of 0.009; however, sand and grit as well as slime build-up on the pipe walls render a true "n" value with time of 0.013; hence, an "n" value of less than 0.013 will not be considered for approval.

The use of corrugated aluminum pipe will require approximately one larger pipe size for any given flow, due to a Manning "n" value of 0.24 +/- depending upon corrugation patterns, use of coatings, etc. All use of corrugated aluminum pipe shall be supported by size calculations in accordance with the manufacturer's recommendations.

Alignment

Generally, storm drains shall be laid on a straight alignment between catch basins and between manholes; however, lines 12 inch diameter and smaller may be laid on horizontal curves conforming to the street curvature, but not less than a radius of 200 feet. PVC and aluminum pipe shall be laid on straight alignment only.

Variance for horizontal curves on larger size pipes shall be reviewed on a case by case basis for approval by the City Engineer.

Anchor Walls

Storm drains laid on slopes of twenty (20) percent or greater shall be secured by anchor walls in accordance with Standard Plan No. 113.

Where velocities greater than fifteen (15) per second are attained, special provision shall be made to protect structures against erosion and displacement by shock.

If either of these conditions occur the installation must be approved by the City Engineer.

Cover Requirements

All storm drains shall be laid at a depth sufficient to protect against damage by traffic and to drain building footings where practical. Sufficient depth shall mean the minimum cover from the top of the pipe to finish grade at the storm drain alignment.

Under normal conditions minimum cover shall be twenty-four (24) inches above the top of the pipe in paved areas and thirty (30) inches at all other locations. For PVC pipe, minimum cover shall be thirty-six (36) inches.

In areas of relatively flat terrain, the design engineer must show that sufficient depth is provided at the boundary of the development to properly drain the remainder of the upstream basin area tributary to the site.

Location

Where storm drains are being designed for installation parallel to other utility pipe or conduit lines, the vertical location shall be in such a manner that will permit future side connections of main or lateral storm drains and avoid conflicts with parallel utilities without abrupt changes in vertical grade of main or lateral storm drains.

Storm Drains in Streets or Easements

a. Under normal conditions, storm drains shall be located in the street right-of-way within two (2) feet of the curbline and preferably on the low side of the street, except when catch basin location warrants otherwise. All exceptions shall be reviewed on a case-by-case basis for approval.

b. When it is necessary to locate storm drains in easements, the storm drain shall be centered in the easement. Exception: When the storm drain is 12 inches in diameter and the easement is centered on a property line, the storm drain shall be offset eighteen (18) inches from property line (distances being measured property line to center line of pipe). All storm drain easements shall be exclusive and shall not be used for any purpose which would interfere with the unrestricted use of the storm drain line. Exception to this requirement will be reviewed on a case by case basis, such as a utility corridor in a new subdivision.

c. Easements for storm drain lines fifteen (15) inches or less in diameter shall have a minimum width of ten (10) feet. Pipe line eighteen (18) to thirty-six (36) inches in diameter shall have a minimum width of fifteen (15) feet. All pipe lines greater than thirty-six (36) inches in diameter, shall have a minimum width of twenty (20) feet.

d. Open channels shall have easements sufficient in width to convey the 100-year Floodplain Line when a 100-year design storm is required or fifteen (15) feet from the waterway centerline or ten (10) feet from the top of the recognized bank, whichever is greater. A fifteen (15) foot wide access easement shall be provided on both sides of the channel for channel widths greater than fourteen (14) feet at the top of the recognized bank.

e. Easement locations for public storm drains serving a PUD, apartment complex, or commercial/industrial development shall be in parking lots, private drives, or similar open areas which will permit an unobstructed vehicle access for maintenance by City forces.

f. All easements must be furnished to the City for review and approval prior to recording.

Relation to Creeks and Drainage Channels

Storm drain lines shall enter a creek or drainage channel at 90º or less to the direction of flow. The outlet shall have a head wall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of pipe or channel being entered will govern which protective measures are required. All protective measures must conform to the requirements of Section 6.0 of these Standards with respect to erosion control.

4.2 SURFACE DRAINAGE

4.2.1 Channel Protection

Open channels shall be designed to prevent scouring of the channel. Where rip rap protection is specified, rip rap protection shall be placed over a filter fabric base or a minimum 6” thick gravel base. The following provides additional design guidance in assisting the design Engineer, however, the design Engineer shall be responsible for the final design.

PROTECTION FOR NEW CHANNEL CONSTRUCTION
Velocity at Design Flow (fps)

Greater than	Less than or equal to	Required Protection	Thickness	Minimum Height above Design Water Surface
0	3	Vegetation Lining	N/A	0.5 ft
3	5	Vegetation Lining and Check Dams	N/A	0.5 ft
5	8	Bioengineered lining* or	N/A	1 ft
		ODOT Class 50** Riprap	1.5 ft	
8	12	ODOT Class 200** Riprap	2.5 ft	2 ft
12	20	Slope Mattress, etc.***	varies	2 ft

* Bioengineered lining allowed for greater than 5 fps.

** ODOT Riprap Class in English Units

*** For high velocity channels, engineering calculations are to be submitted to the City for review

4.2.2 Outfall Protection

Outfalls will be designed to prevent scouring at the outfall discharge and provide velocity reduction prior to discharge to the receiving channel. Where rip rap protection is specified, rip rap protection shall be placed over a filter fabric base or a minimum 6” thick gravel base. The following provides additional design guidance in assisting the design Engineer, however, the design Engineer shall be responsible for the final design.

ROCK PROTECTION AT OUTFALLS					
	Required Protection Minimum Dimensions				
Velocity at Design Flow (fps)	Type	Thickness	Width	Length	Height
0 to 5	ODOT Class 50** Riprap	1.5 ft	Dia. + 6 ft	8 ft or 4x dia, whichever is great	crown + 1 ft
5 to 10	ODOT Class 200** Riprap	2.5 ft	Dia. + 6 ft or 3 x dia, whichever is greater	12 ft or 4x dia, whichever is great	crown + 1 ft
10 to 20	Designed System*	As required	As required	As required	crown + 1 ft
Greater than 20	Energy Dissipater Required				

* For high velocity outfalls, engineering calculation are to be submitted to the City for review.

** ODOT Riprap Class in English Units

*** For high velocity channels, engineering calculations are to be submitted to the City for review

4.2.3 Creeks or Drainage Ways Not Shown with a Floodplain on the Federal Insurance Rate Maps (FIRM) as Published by the Federal Emergency Management Agency (FEMA)

This portion of the drainage system can be a covered facility (pipe, etc.) or an open channel. This portion of the drainage system begins with an equivalent 36 inch diameter or larger pipe at the discharge point of the “trunk system.” This system is designed to convey the 25 year frequency storm flow of the entire contributing area in its fully developed state. This system terminates at the subsequent downstream point of discharge at which the system is clearly a creek whose floodplain is first designated on the FIRM or is determined to be an interim flood hazard area by the City Engineer.

4.2.4 Waterways with Floodplains Shown on the FIRM

These reaches of the drainage system are located on the FIRM, or as otherwise located by the City Engineer, and are always designed for the 100 year frequency storm flow of the entire contributing area in its fully developed land use condition.

4.2.5 Artificial Water Source Requirements

a. Artificial watercourses shall be designed with a “natural” curved alignment with a variable side slope not to exceed four to one, except that in tight spots created by existing natural features (e.g., boulders, large trees, etc.) where the slope can be three to one until the natural feature is bypassed or where steeper slopes are needed and do not impair the hydraulic efficiency of the waterway. The watercourse shall include a low flow channel as described in “e.” below and will be reviewed on a case-by-case basis for approval.

   The bank shall be designed with one (1) foot of free board above the design storm with a minimum top of bank width of six (6) feet. A larger width shall be provided when required by the City Engineer for maintenance purposes. The backslope of the bank shall not exceed two (2) horizontal to one (1) vertical. The existing ground adjacent to the toe of the bank backslope shall be graded to slope away at 2 percent to prevent water ponding at the backslope toe.

b. Design shall be curvilinear with a 100 foot minimum radius. Tighter curves may be used if the City Engineer determines that sufficient erosion control has been incorporated into the design lo maintain stable conditions following development.

c. A low flow channel shall be designed to carry a two year design storm or the normal low water flow of a year-round creek, whichever is greater. Low flow channel slopes shall not exceed two to one and shall be stabilized to the satisfaction of the City Engineer. In general, bank stabilization will be required in any channel with a design flow velocity in excess of three feet per second. The invert shall be paved with concrete if the velocity is less than three (3) feet per second and to prevent local ponding for mosquito abatement purposes.

d. New roadside ditch construction adjacent to public streets by new developments will not be permitted. Exception to this requirement will be reviewed on a case-by-case basis.

e. Capacity of channels shall be determined by the Manning Formula. The value for “n” shall be 0.033 for maintained grass-lines “swales. The value for “n” shall be 0.35 for channels with rock-lined bottoms.

f. Existing ditches approved for the point of discharge for storm drains and culverts shall be provided with rock-lined bottoms and side slopes at the discharge point of storm drain or culvert as specified in Section 4.2.2. These requirements are in addition to those required by Section 4.1.4 “Relation to Creeks and Drainage Channels.”

g. All channel sides and bottoms shall be seeded, sodded, or rock-lined immediately following construction. Bank stabilization measures shall be consistent with the erosion control requirements in Section 6.0 of these Standards unless the City Engineer determines other proposed methods provide equal or greater erosion control.

h. Points of discharge from culverts and storm drains into ditches and swales 15 percent or greater in grade shall be rock-lined with boulders with one face a minimum of 24” in dimension. Said rock lining shall extend for a distance of ten feet minimum from the point of culvert or storm drain discharge and shall have a width three feet in excess of the diameter of the culvert or storm drain. Special energy dissipaters may be substituted for boulders at the discretion of the City Engineer.

4.2.6 Natural Creeks

a. Creek Classification—Creeks in Stayton shall be classified as salmon-producing creeks or other creeks. No in-stream work will be allowed in salmon producing creeks during the months of September or October. The intent is to minimize sediment production in these creeks during critical salmon spawning season. The following creeks shall be included in the salmon-producing classification:

- Mill Creek
- Salem Ditch

A permit must be obtained from the Division of State Lands and the Department of Fish and Wildlife for all work between the creek banks.

4.2.7 Salmon-Producing Creek Requirements

The following requirements must be met in salmon-producing creeks. These are not in replacement of the requirements in 2.24 for natural creeks, but in addition to them.

a. Creek bed alterations shall provide diversified habitats for a variety of creek organisms and a pleasing appearance. Creek bed alternations may be approved by the City Engineer on a case-by-case basis with approval to consider provision of:

   1) Sufficient water depth to support fish and other aquatic life during low flows.

   2) Diversity of water velocities through the use of pools and riffles.

   3) A meandering channel to facilitate a. and b. above.

   4) Sufficient creek bed gradient to provide adequate flow velocities.

b. Creek bed gravel shall be well rounded rock in the following gradations (with larger rock in sufficient quantity to provide adequate riffling) or as approved by the City Engineer:

   Mill Creek Approx. 15% 6”-3”

c. Creek banks and sides shall be designed and constructed so as to provide stability, adequate shading, and cover for fish and other aquatic life, to the approval of the City Engineer. Shading shall be provided by plantings of appropriate types and sufficient quantities per Section 6.0 of these Standards. Creek bank designs and vegetation restoration plans may be approved by the City Engineer on a case-by-case basis.

   Vertical creek banks (walls) should be avoided whenever possible as such a creek channel configuration decreases the creek carrying capacity and increases in-creek velocities during high flows.

d. All creek work and channel design shall include a construction sequence list designed primarily to control erosion (per Section 6.0 of these Standards) and also to facilitate the planned construction. The construction sequence may be modified by the City Engineer during the construction as field conditions warrant. Such modifications may include more or less erosion control and construction shut down.

e. Vegetation disturbance shall be minimized, creek banks shall be revegetated with appropriate native vegetation to provide shading for the creek.

4.2.8 Other Natural Creek Requirements

a. Natural creeks shall be preserved and all work in and adjacent to creeks shall incorporate both temporary and permanent erosion control measures in accordance with Section 6.0 of these Standards. No alteration will be permitted that reduces the overall creek capacity.

c. Creek construction, relocation, and/or reconstruction may be approved if the City Engineer determines that such a proposal will result in an overall benefit to or maintenance of a surface water system of equal quality in terms of water quantity and quality control.

d. Any and all stream work shall be consistent with the floodplain management policies and regulations.

e. Any and all stream work shall be consistent with the City’s Stormwater Management Plan.

5.0 STORMWATER QUALITY AND QUANTITY FACILITIES

City of Stayton requires stormwater facilities for development creating new impervious surfaces of greater than one thousand square feet in area within any twelve-month period. These stormwater facility standards are intended to provide guidance toward flow control and reduction in stormwater pollutants. The guidelines are not intended to be a comprehensive list of all stormwater facilities, but provides a general overview of those commonly used.

Stormwater facilities are installed to reduce flow and pollutants from a site prior to entering the cities storm drainage system or natural drainage course. Stormwater plans submitted to the city must address water quality measures taken to meet the Willamette Basin TMDL targets for mercury, bacteria, and temperature.

In selecting the appropriate stormwater facility for a site the designer must consider the site characteristics, anticipated land uses, runoff characteristics, and treatment objectives.

Stormwater facilities shall also be construction in accordance with the following requirement and Appendix C: Water Quality and Quantity Facility Design. Numerous resources are available which provide additional detail and design requirement for stormwater facilities, including City of Portland Stormwater Management Manual, Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management, the King County Surface Water Design Manual, and the Washington Department of Ecology's (DOE) Stormwater Management Manual for Western Washington.

5.1 WATER QUALITY FACILITIES

Owners of new development and other activities which create new impervious surfaces or increase the amount of stormwater runoff or pollution leaving the site are required to construct or fund permanent water quality facilities to reduce contaminants entering the storm and surface water system.

5.1.1 Criteria for Requiring Construction of a Water Quality Facility

a. A water quality facility shall be constructed on-site unless, in the judgment of the City, any of the following conditions exist:

    1) The site topography or soils makes it impractical, or ineffective to construct an on-site facility;

    2) The site is small, and the loss of area for the on-site facility would preclude the effective development.

    3) There is a more efficient and effective regional site within the subbasin that was designed to incorporate the development or is in the near vicinity with the capacity to treat the site.

    4) The development is for the construction of one or two family (duplex) dwellings on an existing lot of record.

b. If construction of an on-site facility is not required, the owner of the development shall pay a System Development Charge in accordance with City Rules and Regulations. The System Development Charge shall be calculated on an equivalent basis of constructing the minimum Standard Water Quality Swale.

5.1.2 Water Quality Facility Design Standards

a. The stormwater quality facilities shall be designed to remove 80 percent of the total suspended solids from the runoff from 100 percent of the newly constructed impervious surfaces.

b. The total suspended solids removal efficiency specifies only the design requirements and is not intended as a basis for performance evaluation or compliance determination of the stormwater quality control facility installed or constructed pursuant to this document.

c. If an onsite water quality facility cannot be constructed to treat the runoff from the development's impervious surface, then with City approval, an on- or off-site water quality facility may be designed to treat runoff from an equivalent area of adjacent untreated impervious surfaces.

d. Facilities shall be designed such that flow from the development is treated off-line from the storm conveyance system and reconnected to upstream flows following treatment. If an off-line facility is not feasible, additional capacity may be required for upstream flow.

e. Discharges to sensitive areas shall maintain the hydroperiod and flows of pre-development site conditions to the extent necessary to protect the characteristic functions of the sensitive area.

f. The stormwater quality facilities shall be designed for a dry weather storm event totaling 0.36 inches of precipitation falling in 4 hours with an average storm return period of 96 hours.

g. Water quality facilities shall be constructed as part of the subdivision public improvements.

h. Other design options for meeting this section may be considered by the City for approval.

i. All water quality facilities shall be designed in accordance with Appendix C: Water Quality and Quantity Facility Design.

j. Water quality facilities shall be designed to address the Willamette Basin TMDL pollutants of mercury, temperature, and bacteria.

5.1.3 Impervious Area Used In Design

a. For single family and duplex residential subdivisions, stormwater quality facilities shall be sized for all impervious area created by the subdivision and for all existing impervious area proposed to remain on site.

b. For all developments other than single family and duplex, including rowhouses and condominiums, the sizing of stormwater quality facilities shall be based on the impervious area created by the development and for all existing impervious area proposed to remain on site, including structures and all roads and impervious areas. Impervious surfaces shall be determined based upon building permits, construction plans, or other appropriate methods of measurement deemed reliable by City.

c. The City encourages design initiatives that reduce effective impervious area. In developments other than single family and duplex, a decrease in the size of the water quality facility may be possible.

5.2 WATER QUANTITY/FLOW CONTROL FACILITIES

Each new development including, but not limited to new subdivisions, all commercial and industrial development and all parking lots with a total developed area of 1000 square feet or more and all other developments where the City engineer determines control is needed to prevent flooding or damage downstream. must incorporate techniques for mitigating its impacts on the public stormwater system. The City shall determine which of the following techniques may be used to satisfy this mitigation requirement.

a. Construction of permanent on-site stormwater quantity detention facilities designed in accordance with Appendix C: Water Quality & Quantity Facility Design; or

b. Enlargement or improvement of the downstream conveyance system in accordance with Appendix C: Water Quality & Quantity Facility Design; or

c. Payment of a Storm and Surface Water Management System Development Charge (SWM SDC) which includes a water quantity component to meet these requirements.

5.2.1 Criteria for Requiring On-Site Detention

a. If the on-site facility is required to be constructed, the development shall be eligible for a credit against SWM SDC fees. On-site facilities shall be constructed when any of the following conditions exist:

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

   2) There is an identified regional detention site within the boundary of the development.

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

   4) Water quantity facilities as required by City adopted watershed management plans or adopted subbasin master plans.

5.2.2 Water Quantity Facility Design Criteria

a. All water quantity facilities shall be designed in accordance with City guidance documents and be consistent with Appendix C: Water Quality and Quantity Facility Design.

b. When required, stormwater quantity on-site detention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the pre-development runoff rates from the site, based on a 2 through 25-year, 24-hour return storm. Specifically, the 2, 10, and 25-year post development runoff rates will not exceed their respective 2, 10, and 25-year pre-development runoff rates; unless other criteria are identified in an adopted watershed management plan or subbasin master plan.

c. When required because of an identified downstream deficiency, stormwater quantity on-site detention facilities shall be designed such that the peak runoff rates will not exceed pre-development rates for the specific range of storms which cause the downstream deficiency.

d. Construction of on-site detention shall not be allowed as an option if such a detention facility would have an adverse effect upon receiving waters in the basin or subbasin in the event of flooding, or would increase the likelihood or severity of flooding problems downstream of the site.

e. Channel Protection shall be provide as required in Section 4.2.1.

f. A downstream analysis shall be preformed as described in Section 5.2.4.

5.2.3 Water Quantity Facility Design Standards

All water quantity facilities shall be designed in accordance with Appendix C: Water Quality and Quantity Facility Design.

5.2.4 Downstream System Analysis

a. The design engineer for each development constructing new impervious surface of more than 1,000 square feet shall submit documentation, for review by the City, of the downstream capacity of any existing storm facilities impacted by the proposed development. The design engineer must perform an analysis of the drainage system downstream of the development to a point in the drainage system where the proposed development site constitutes ten percent or less of the total tributary drainage volume, but in no event less that 1/4 mile.

b. If the capacity of any downstream public storm conveyance system or culvert is surpassed, due directly to the development, the developer shall correct (mitigate) the capacity problem or construct an on-site detention facility unless approved otherwise by the City.

c. If the projected increase in surface water runoff which will leave a proposed development will cause or contribute to damage from flooding to existing buildings or dwellings, the downstream stormwater system shall be enlarged to relieve the identified flooding condition prior to development, or the developer must construct an on-site detention facility.

d. Any increase in downstream flow shall be reviewed for erosion potential, defined as downstream channels, ravines, or slopes with evidence of erosion/incision sufficient to pose a sedimentation hazard to downstream conveyance systems or pose a landslide hazard by undercutting adjacent steep slopes.

6.0 EROSION AND SEDIMENT CONTROL

The applicability of this section shall be for all construction projects and earth disturbance projects with ground disturbance greater than one thousand (1000) square feet in area within any twelve-month period.

Prior to approval of construction an Erosion/Sedimentation Control Plan shall be developed in accordance with the following criteria and the Oregon DEQ guidelines set forth in the *Erosion and Sediment Control Manual*

a. Proposed measures for controlling runoff during all three phases of construction:

    1) Prior to excavation or construction.

    2) During excavation and construction.

    3) After construction until the site is stabilized.

b. For subdivision plats this shall include temporary erosion control measures to be utilized by the applicant during installation of plant improvement and by subsequent builders during construction of dwellings and other lot improvements.

c. Prior to the initial clearing and grading of any land development, provisions shall be made for the interception of all potential silt-laden runoff that could result from said clearing and grading. Said interception shall preclude any silt-laden runoff from discharging from the proposed land development to downstream properties unless previously approved by the City Engineer. Said interception shall cause all silt-laden runoff to be conveyed by open ditch or other means to whatever temporary facility is necessary to remove silt prior to discharge to downstream properties.

d. Prior to initial clearing and grading of construction site, an evaluation of the following factors must be performed:

    1) Soil Erodibility—Soil erodibility should be identified using Soil Conservation Service erodibility ratings. Erosion control techniques shall be designed accordingly.

    2) Slope and Runoff—All cleared areas will require protection from erosion.

    3) Cover—Erosion protection will be required for all disturbed areas.

e. Temporary/permanent hydroseeding or acceptable seeding and mulching must be provided whenever perennial cover cannot be established on sites which will be exposed for 180 days or more.

f. Construction projects and earth disturbance projects with ground disturbance greater than one acre shall obtain a National Pollutant Discharge Elimination System Stormwater Construction General Permit No. 1200-C as required by the Oregon DEQ.

APPENDIX A

STORM DRAINAGE REPORT AND

CONSTRUCTION PLAN REQUIREMENTS

STORM DRAINAGE REPORT

a. The Drainage Report shall be on 8-1/2” x 11” paper and maps shall be folded to 8-1/2” x 11” size unless another format is approved prior to submittal.

b. The Drainage Report shall be prepared by and bear the seal and original signature of a Professional Engineer registered in the State of Oregon and shall contain the following information:

1) Cover Sheet, including the project name, land use authority case file number, proponent’s name, address and telephone number, Design Engineer, and date of submittal.

2) Table of Contents, with the page numbers for each section of the report, including exhibits, appendices, and attachments.

3) Vicinity Map.

4) Project Description: Describe the type of permit(s) for which the proponent is applying, the size and location of the project site, address or parcel number and legal description of the property, property zoning. Also describe other permits required (e.g. Corps of Engineers 404 Fill Permit, DEQ Erosion Control Permits, etc). Describe the project, including proposed land use, proposed site improvements, proposed construction of impervious surfaces, proposed landscaping, and special circumstances.

5) Existing Conditions:

   a) Describe existing site conditions and relevant hydrological conditions including but not limited to:

   - Project site topography;
   - Land cover and land use;
   - Abutting property land cover and land use;
   - Offsite drainage to the property;
   - Natural and constructed channels;
   - Sensitive areas, wetlands, creeks, ravines, gullies, steep slopes, springs and other environmentally sensitive areas on or adjacent to the project site.
   - Seasonal groundwater levels for subsurface system components (i.e., lines, detention ponds, underground storage, etc.)

   b) General soils conditions present within the project site, using SCS soil designations.

   c) Points of discharge for existing drainage from the project site.

   d) Include references to relevant reports such as basin plans, flood studies, groundwater studies, wetland designation, watershed plans, subbasin master plans, sensitive area designation, environmental impact statements, water quality reports, or other relevant documents. Where such reports impose additional conditions on the Proponent, those conditions shall be included in the report.

   e) Soils Report(s), where applicable.

f) Hydrologic Analysis

g) Basin Map(s), showing boundaries of project, any offsite contributing drainage basins, onsite drainage basins, approximate locations of all major drainage structures within the basins, and depicting the course of stormwater originating from the subject property and extending all the way to the closest receiving body of water. Reference the source of the topographic base map (e.g. USGS), the scale of the map, and include a north arrow.

h) Drainage Basin Description: Describe the drainage basin(s) to which the project site contributes runoff, and identify the receiving waters for each of these drainage basins.

i) Developed Site Drainage Conditions: Describe the land cover resulting from the proposed project; describe the potential stormwater quantity and quality impacts resulting from the proposed project; describe the proposal for the collection and conveyance of site runoff from the project site, for the control of any increase in stormwater quantity resulting from the project, and for the control of stormwater quality.

j) Description of upstream basins, identifying any sources of runoff to the project site. This should be based on field investigation. Any existing drainage or erosion issues upstream that may have an impact on the proposed development should be noted.

k) Downstream analysis, include a summary table comparing the pre-developed and developed hydraulic analysis for all discharge points.

l) Hydraulic Design Computations, supporting the design of all proposed stormwater conveyance, quantity and quality control facilities, and verifying the capacity of existing and proposed drainage facilities. These computations may include capacity and backwater analysis required either as part of the proposed drainage design or as part of the downstream drainage investigation, and flood routing computations required for the design of detention/retention storage facilities, for wetland impact analysis, or for floodplain analysis. A description on how the stormwater system will function during the water quality storm, 2-year storm, 25-year storm and the 100-year storm shall also be included.

m) Maintenance and Operation Manual: Required for privately owned and maintained stormwater quantity and quality control facilities. This manual will be an attachment to the maintenance covenant.

n) Appendices: Shall include technical information as necessary.

STORM DRAINAGE CONSTRUCTION PLANS

General

Complete plans and specifications for all proposed drainage improvements including any necessary dedications and easements shall be submitted for approval and must receive the required approval prior to construction permit issuance and beginning of construction.

Plan Preparation

Construction plans and specifications shall be prepared by a professional civil engineer licensed in the State of Oregon. It is the responsibility of the Design Engineer to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of the design guidelines contained in this document.

a. Dimensions—Construction plans shall be clearly and legibly drawn on paper 22 by 34 inches with a 1-112 inch clear margin on the left edge and one inch margins on all other edges.

Plans from consultants for construction permit projects shall be blueline or photocopied drawings meeting the above size (24 by 36 inch blueline prints are acceptable.)

b. Scale—Horizontal scale shall be 1” = 50’; vertical scale shall be 1” = 5’ or as approved by the City Engineer.

c. Form—Title Sheet, Plan and Profiles, Storm Drain Appurtenances, and Site Drainage Plan.

The Drainage Plan shall contain the following:

Title Sheet

a. Plan view (Site Plan) of the entire project, showing street right-of-way and/or subdivision layout to a scale of 1” = 100’. A smaller scale may be used on large projects upon approval of the City Engineer. A project is too large when a minimum dimension of two (2) inches cannot be maintained between the title, system site plan, and vicinity map. A scale of 1” = 200’ may be used in this case. The site plan shall be a composite plan showing all complete properties to be served by the storm drain improvements and properties adjacent to and within 250 feet of those served, existing and proposed natural or artificial streams, swales, and storm drains, line sizes, designations, structures and their numbers, tract names and numbers, lot numbers or property owners’ names, street names, and total acreage including streets directly served.

b. Index of Sheets.

c. Complete legend of symbols used.

d. Vicinity Map to a scale of not less than 1” = 800’ showing the project location and drainage basin used to size the system.

e. Title Block—located in lower right hand comer or right edge of paper with scale, north point, date, drawing number, the Design Engineer’s name, address and official stamp, and where applicable, the owner/developer’s name and address.

f. Temporary and permanent bench marks including their descriptions.

g. General and special notes relating to construction methods. Note: For projects showing five (5) lots or less, the title sheet and plan and profile sheet may be one and the same if approved by the City Engineer.

Project Site

At least one sheet will contain a plan view of the entire project site. In the event the project site is sufficiently large that detailed drainage plans on any given sheet do not encompass the entire project site, then a sheet containing the plan view of the entire site must serve as an index to subsequent detailed plan sheets.

Existing Conditions

A topographical contour map clearly defining existing conditions:

a. Existing contours of the land at two (2) foot intervals or as approved by the City Engineer with the location of existing buildings, structures on the property. Location of any existing building or structure on adjacent property which is within fifteen (15) feet of a proposed public drainage facility;

b. Adjacent streets, including street names.

c. Existing public and private utilities, including franchised utilities located above or below ground and drainage facilities that transport surface water onto, across, or from the project site. Existing drainage pipes, culverts, and channels shall include the invert or flowline elevations.

d. All areas, within 250 feet of the site, improved or unimproved, lying upstream and draining to or through the proposed development;

e. Location of existing drainage facilities which transport surface water onto, across, or from the site, including natural watercourses, artificial channels, drain pipes, or culverts.

f. Locations of springs or other subsurface water outlets;

g. Existing environmentally sensitive areas (e.g. ravines, swales, steep slopes, springs, wetlands, creeks, lakes, etc.). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year flood plain boundary (if applicable).

h. Arrows indicating drainage direction in all public and private property and for all hydraulic conveyance systems.

Proposed Drainage Improvements Plan

A topographic contour plan clearly defining proposed conditions:

a. Proposed contours of the land after completion of the project at two (2)" foot intervals or as approved by the City Engineer. This shall include elevations, dimensions and location, extent, and slopes of all grading work proposed to be done.

b. Identify cut and fill areas, desilting facilities, interceptor ditches (channels), velocity check dams, soils, topography, vegetation, and areas of proposed reseeding.

c. Proposed structures including roads and road improvements, parking surfaces, building footprints, walkways, landscape areas, etc.

d. Proposed utilities, showing exact line and grade of all proposed utilities at crossings with the proposed drainage system.

e. Setbacks from environmentally sensitive areas.

f. Proposed drainage structures, including pipes, open channels, culverts, ponds, vaults, biofiltration swales, infiltration facilities, outfalls, riprap treatment, energy dissipaters, etc.

g. Plan and profile of drainage conveyance facilities will include the following information: pipe sizes, pipe types and materials, lengths, slopes, type of structure (e.g. Type 2 CB), location of structures, invert elevations in/out of structures, and top elevations of structures. Notes shall be included referencing details, cross-sections, profiles, etc.

h. Indicate any proposed phasing of construction.

i. Boundaries of all areas that will be paved or otherwise altered in a manner that will increase surface water runoff and boundaries of all areas to remain in an existing or natural condition.

Stormwater Quality and Quantity Facility Plan(s)

A detailed grading plan will be provided for all open stormwater quantity control and/or quality control facilities. This plan shall include the following:

a. Existing ground contours (screened) and proposed ground contours at a minimum of a 2-foot contour interval. Slopes steeper that 6 horizontal to 1 vertical shall be identified.

b. Location of top and toe of slope.

c. Limits of embankment designed to impound water.

d. Location of all drainage structures as well as any other piped utilities in vicinity.

e. Flow route of the secondary/emergency overflow system.

f. Maintenance access, as applicable.

Landscape Plan

A detailed landscape plan will be provided for open stormwater quantity control and/or quality control facilities. This plan shall include the Following:

a. Final ground contours at a minimum of a 2-foot contour interval.

b. Location of top and toe of slope.

c. Maximum water surface elevation.

d. Location of all drainage structures as well as any other piped utilities in vicinity (screened).

e. Limits of areas to receive amended topsoil.

Cross Sections

Cross sections shall be provided for at least the following:

a. Detention/retention ponds (including parking lot ponds and other multi-use facilities), wet ponds and sediment ponds. This cross section(s) shall graphically illustrate:

(1) The design maximum water surface for the 2-year and 25-year design storms.

(2) The proposed dead storage water surface (as applicable).

(3) Pavement section or amended soil section as applicable.

b. Proposed ditches and swales, including vegetated swales.

Storm Drain System Plan and Profiles

Plan

Plan view of storm drain lines shall be to a scale of 1” = 50’ and shall contain the following information in addition to the above:

a. Adjacent street curbs and property lines, right-of-way and utility easements referenced to property comers, street intersections, or section lines. Adequate two (2) foot contour lines or property corner and curb elevations to help determine the points of disposal for building storm drains.

b. The location of each manhole and catchbasin shall be numbered and stationed to facilitate checking I the plans with the profiles. The stationing shall be tied to existing property corners and/or street monuments with the relationship of each manhole and catch basin shown to the property corners (minimum two directions). Each line with a separate designation shall be stationed continuously up grade from Station 0+00 at its point of connection to another line.

c. Location of water courses, railroad crossings, culverts, and sanitary sewers that cross the alignment within 250 feet of the proposed extension. All water course channels must show the 100 year flood plain and floodway channel for the design storm as specified by Sections 2.01 and 2.29 of these Standards.

d. Location of water mains, valves, pump stations, blow-offs, services, gas mains, underground power, and other utilities that either cross the alignment within 250 feet of the terminus of the proposed extension or are adjacent to the proposed extension within the public right-of-way or within ten (10) feet of the easement line. The intent is to prevent grade conflicts of all future extensions.

e. The location and elevation of the bench mark used as the basis of vertical control in the design shall be shown on the plans and referenced to property corners and/or street monuments.

Profiles

Profiles for the individual storm drain lines and open channels shall be to the same horizontal scale on the same sheet and drawn immediately below the corresponding plan view to a vertical scale of 1” = 5’ reading from 0+00 left to right (where conditions warrant, right to left may be approved as well as a smaller vertical scale), and shall contain at least the following information in addition to the above:

a. Location of catchbasins, manholes, and other appurtenances with each manhole and catchbasin numbered and stationed as in item 2 of Plan above.

b. Profile of the existing and proposed ground/or pavement surface, storm drain invert, and backwater curve for the design storm.

c. Size, slope, length, and type of material of the line between consecutive catchbasins or manholes (type of pipe may be designated by abbreviations listed under Section 2.13), type of pipe bedding and backfill material.

d. Elevation of original ground, finished grade, proposed rim elevation, and storm drain inverts at each catchbasin or manhole (Mean Sea Level Datum, U.S.G.S.).

e. Railroad crossings, ditch, or creek channels with elevations of the ditch or creek bed and the 100-year flood elevation profile. See Section 2.20 for additional plan requirements.

f. Utility crossings that conflict with the proposed storm drain installation.

g. All existing facilities upon which work is to be performed, i.e., installation, repair, or removal.

   SPECIAL NOTE: The Design Engineer shall field locate and verify the alignment, depth, and inverts of all existing facilities shown on the plans that will be crossed by proposed facilities and shall certify them with a note on the plans. City as-builts are only to be used as an aid to the Design Engineer when field verifying the exiting facilities.

Storm Drain Appurtenances

Detailed drawings shall be included for all storm drain appurtenances including manholes, catchbasins, culverts, head walls, orifice controls, detention diversion structures, etc. Appropriate references to City of Stayton Standard Drawings may be used in lieu of details actually shown on the plans.

Surface Drainage

a. Plan requirements for surface drainage courses shall include the requirements previously specified above and the following supporting data:

   1. Plan drawn to a scale of not less than 1” = 100’ with north arrow and vicinity map. Topography with two (2) foot contours. If in a floodplain shown on the F.I.R.M. show the 100-year floodway contour.

   2. Profile of the channel showing the existing flowline and top of bank, proposed flowline and top of bank and design stormwater surface profile (backwater curve).

   3. A minimum of three (3) cross sections of the existing channel adjoining or crossing the property taken at the upstream, midsection, and downstream boundaries of the property. More section may be required depending on the length of the reach and existing channel alignment.

APPENDIX B
HYDROLOGY CALCULATION REQUIREMENTS

1.0 HYDROLOGIC ANALYSIS

This section presents acceptable methodology for estimating the quantity and characteristics of surface water runoff, as well as the assumptions and data required as input to the methods. These methods should be used to analyze existing and design proposed drainage systems and related facilities.

1.1 Rational Method

The rational method for analyzing small drainage basins is allowed with the following limitations:

a. Only for use in predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements.

b. Drainage subbasin area cannot exceed 25 acres for a single calculation without approval from the City.

c. The time of concentration shall be five minutes when computed to be less than five minutes.

d. Rainfall intensities shall be from the rainfall intensity-duration curve for City of Stayton as shown on Figure 1.

Runoff Coefficients

The recommended coefficients of runoff (C) are listed in Table 1.

TABLE 1.
RUNOFF COEFFICIENTS, C

Soil Cover	Flat Terrain s<2%	Rolling Terrain 2%<s<40%	Steep Terrain s>l0%
Relatively high permeability (lawns, pasture, woods)	0.20	0.25	0.3
Moderate impermeability			
1) Single-family residential in urban areas, except corner lots with duplex potential	0.40	0.45	0.50
2) Gravel parking lots	0.50	0.55	0.60
3) Mobile home parks	0.60	0.65	—
4) Multi-family residential, zero-lot-line single-family residential and potential duplex lots in single-Family residential	0.70	0.75	0.80
High impermeability (roofs and paved areas)	0.90	0.90	0.90

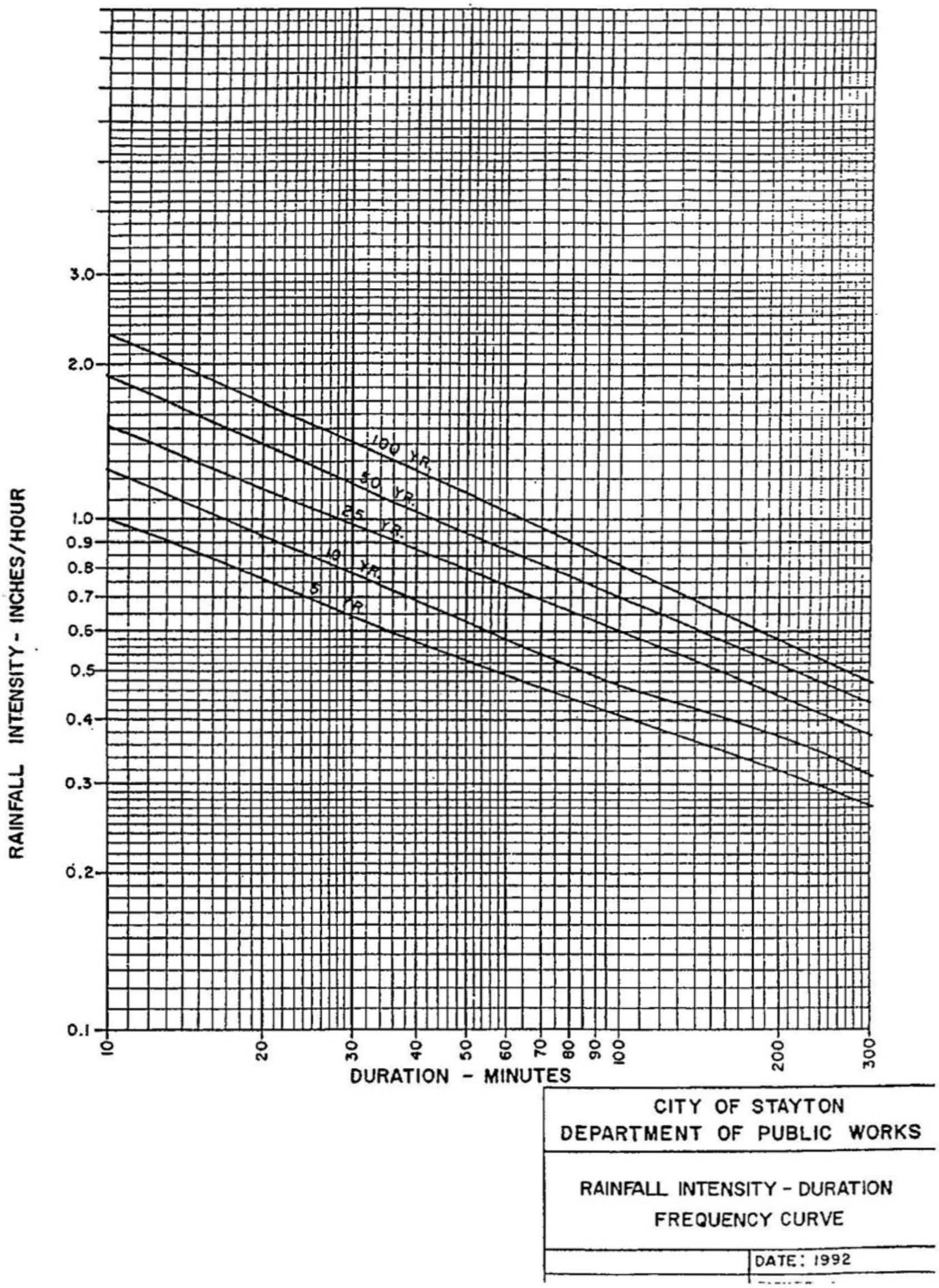


Figure 1. City of Stayton Rainfall Intensity-Duration Frequency Curve

1.2 Unit Hydrograph Methods

a. To obtain a realistic and consistent hydrologic analysis for each development site, all developments shall use the hydrograph analysis method for drainage planning and design unless otherwise approved in advance by the City. The physical characteristics of the site and the design storm shall be used to determine the magnitude, volume and duration of the runoff hydrograph. The Santa Barbara Urban Hydrograph (SBUH) will be the primary acceptable unit hydrograph method.

b. The Design Storm

1. Return frequency and duration specify the design storm event. The design storms shall be based on two parameters:
    - Total rainfall (depth in inches).
    - Rainfall distribution (dimensionless).

c. Design Storm Distribution

1. The rainfall distribution to be used within the City is the design storm of 24-hour duration based on the standard NRCS Type 1A rainfall distribution using the chart on the following page. The total depth of rainfall for storms of 24-hour duration and 2, 5, 10, 25, 50 and 100 year recurrence are 2.7, 3.2, 3.5, 4.0, 4.4, 4.7 inches respectively. As reported in the City of Salem, Stormwater Master Plan, September 2000.
2. The Table 2 contains the NRCS Type 1A precipitation distribution.

TABLE 2. TYPE IA DESIGN STORM DISTRIBUTION CHART								
	Percent Rainfall		**Rainfall Depth (inches)**					
Hour	Incremental	Cumulative	2yr	5 yr	10 yr	25 yr	50 yr	100 yr
			2.7	3.2	3.5	4.0	4.4	4.7
1	2.40	2.40	0.06	0.08	0.08	0.10	0.11	0.11
2	2.60	5.00	0.07	0.08	0.09	0.10	0.11	0.12
3	3.20	8.20	0.09	0.10	0.11	0.13	0.14	0.15
4	3.80	12.00	0.10	0.12	0.13	0.15	0.17	0.18
5	4.44	16.44	0.12	0.14	0.16	0.18	0.20	0.21
6	5.18	21.62	0.14	0.17	0.18	0.21	0.23	0.24
7	6.48	28.10	0.17	0.21	0.23	0.26	0.29	0.30
8	16.44	44.54	0.44	0.53	0.58	0.66	0.72	0.77
9	7.58	52.12	0.20	0.24	0.27	0.30	0.33	0.36
10	5.28	57.40	0.14	0.17	0.18	0.21	0.23	0.25
11	4.96	62.36	0.13	0.16	0.17	0.20	0.22	0.23
12	4.32	66.68	0.12	0.14	0.15	0.17	0.19	0.20
13	4.02	70.70	0.11	0.13	0.14	0.16	0.18	0.19
14	3.42	74.12	0.09	0.11	0.12	0.14	0.15	0.16
15	3.28	77.40	0.09	0.10	0.11	0.13	0.14	0.15
16	3.00	80.40	0.08	0.10	0.11	0.12	0.13	0.14
17	2.80	83.20	0.08	0.09	0.10	0.11	0.12	0.13
18	2.40	85.60	0.06	0.08	0.08	0.10	0.11	0.11
19	2.40	88.00	0.06	0.08	0.08	0.10	0.11	0.11
20	2.40	90.40	0.06	0.08	0.08	0.10	0.11	0.11
21	2.40	92.80	0.06	0.08	0.08	0.10	0.11	0.11
22	2.40	95.20	0.06	0.08	0.08	0.10	0.11	0.11
23	2.40	97.60	0.06	0.08	0.08	0.10	0.11	0.11
24	2.40	100.00	0.06	0.08	0.08	0.10	0.11	0.11

d. Runoff Parameters

The physical drainage basin characteristics listed below shall be used to develop the runoff hydrograph.

1) Area

2) Curve Number

3) Time of Concentration

a) Selection of Area:

To obtain the highest degree of accuracy in hydrograph analysis requires the proper selection of homogeneous basin areas. Significant differences in land use within a given basin must be addressed by dividing the basin area into subbasin areas of similar land use and/or runoff characteristics. Hydrographs should be computed for each subbasin area and superimposed to form the total runoff hydrograph for the basin.

All pervious and impervious areas within a given basin or subbasin shall be analyzed separately. This may be done by either computing separate hydrographs or computing the precipitation excess. The total precipitation excess is then used to develop the runoff hydrograph. By analyzing pervious and impervious areas separately the cumulative errors associated with averaging these areas are avoided and the true shape of the runoff hydrograph is better approximated.

b) Selection of Curve Number:

The Natural Resources Conservation Service (NRCS) (formerly referred to as the Soil Conservation Service (SCS)) has developed "curve number" (CN) values based on soil type and land use. The combination of these two factors is called the "soil-cover complex." The soil-cover complexes have been assigned to one of four hydrologic soil groups, according to their runoff characteristics. Soil Hydrologic Groups may be found in Table 4, Soil Survey of Marion County, Oregon (SCS September 1972).

The following are important criteria/considerations for selection of CN values:

(1) Many factors may affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lower infiltration rate and greater runoff potential.
(2) CN values can be area weighted when they apply to pervious areas of similar CN (within 20 CN points). However, high CN areas should not be combined with low CN areas (unless the low CN areas are less than 15 percent of the subbasin).
(3) Antecedent soil moisture values should be considered. Soil should be considered to be moist prior to the start of the precipitation event.

c) SCS Curve Number Equations:

The rainfall-runoff equations of the NRCS curve number method relate a land area's runoff depth (precipitation excess) to the precipitation it receives and to its natural storage capacity, as follows:

$Q_d = (P_R - 0.2S)2 / (P_R + 0.8S)$ for $P_R > 0.2S$; and
$Q_d = 0$ for $P_R < 0.2S$

Where
Qd = runoff depth in inches over the area,
PR = precipitation depth in inches over the area,
S = potential maximum natural detention, in inches over the area, due to infiltration, storage, etc.

The area's potential maximum detention, S, is related to its curve number, CN:
$S = (1000/CN) - 10$

The computed runoff represents inches over the tributary area. Therefore, the total volume of runoff is found by multiplying Q_d by the area (with necessary conversions):

Total Runoff Volume (cubic-feet) = Q_d (in) x A (ac) x 3,630 (cubic-feet/(ac-in))

When developing the runoff hydrograph, the above equation for Qd is used to compute the incremental runoff depth for each time interval from the incremental precipitation depth given by the design storm hyetograph. This time distribution runoff depth is often referred to as the precipitation excess and provides the basis for synthesizing the runoff hydrograph.

d) Time of Concentration:

Time of concentration (T_c) is the time for runoff to travel from the hydraulically most distant point of the watershed to the point where the hydrograph is to be calculated. Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c). T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system. T_c influences the shape and peak of the runoff hydrograph.

(1) Sheet Flow
Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. For sheet flow up to 300 feet, use the kinematics solution below to directly compute T_t:

Sheet Flow: T_t = (0.93L0.6 x n0.3) / (I0.4 x S0.3)

Where
T_t = travel time (min)
n = Manning's effective roughness coefficient for sheet flow
L = flow length (ft)
I = rainfall intensity in inches per hour
S = slope of hydraulic grade line (ft/ft)
Sheet flow shall not be used for distances exceeding 300-feet.

(2) Shallow Concentrated Flow
For slopes less than 0.005 ft/ft the following equations can be used:

a) For Unpaved Surfaces: V = 16.1345 $(S)_{0.5}$
b) For Paved Surfaces: V = 20.3282 $(S)_{0.5}$

Where:
V = velocity in feet per second
S = Slope in ft/ft

(3) Channel Flow
A commonly used method of computing average velocity of flow, once it has measurable depth, is the following equation:

V = (1.486/n) x R0.6 x S0.5
Where:
V = velocity (ft/s)

n = Manning's roughness coefficient
S = slope of flow path (ft/ft)
R = area/perimeter

1.3 Water Quality Hydrology

Water Quality

The Water Quality Storm as described below has been derived from the Clean Water Services Water Quality Storm.

The water quality storm is the storm required by regulations to be treated. The storm defines both the volume and rate of runoff.

a. Water Quality Storm: Total precipitation of 0.36 inches falling in 4 hours with a storm return period of 96 hours.

Water quality volume (WQV) is the volume of water that is produced by the water quality storm.

b. Water Quality Volume (WQV): 0.36-inches over 100-percent of the new impervious area.

Water Quality Volume (cf) = 0.36(in) x Area (sf) 12 (in/ft)

c. Water Quality Flow (WQF): The average design flow anticipated from the water quality storm.

Water Quality Flow (cfs) = Water Quality Volume (cf)/14,4000 Sec

or

Water Quality Flow (cfs) = 0.36(in) x Area (sf)/12(in/ft)(4 hr)(60 min/hr)(60 sec/min)

APPENDIX C

WATER QUALITY AND QUANTITY FACILITY DESIGN

1.0 GENERAL REQUIREMENTS FOR WATER QUALITY AND QUANTITY FACILITIES

- Facilities shall be designed to minimize mosquito habitat. Facilities should be designed such that water is not allowed to pond for greater than 72 hours. In facilities that are designed to hold standing water, regular monitoring is required for the presence of mosquitoes.
- An Operations and Maintenance Plan must be developed.
- A geotechnical report may be required to evaluate the suitability of the proposed facility location.

1.1 Erosion Protection

a. Inlets to water quality and quantity facilities shall be protected from erosive flows through the use of an energy dissipater or rip rap stilling basin of appropriate size based on flow velocities. Flow shall be evenly distributed across the treatment area.

b. All exposed areas of water quality and quantity facilities shall be protected using coconut or jute matting. Coconut matting or high density jute matting (Geojute Plus or approved equal) shall be used in the treatment area of swales and below the WQV levels of ponds. Low density jute matting (Econojute or approved equal) may be used on all other zones.

1.2 Vegetation

a. Vegetation shall meet requirements in either the Clean Water Service Design and Construction Standards for Sanitary Sewer and Stormwater Management or City of Portland Stormwater Management Manual.

b. No invasive species shall be planted or permitted to remain within the facility which may affect its function, including, but not limited to the following:

1. Himalayan blackberry (Rubus discolor)
2. Reed canarygrass (Phalaris arundinacea)
3. Teasel (Dipsacus fullonum)
4. English Ivy (Hedra helix)
5. Nightshade (Solanum sp.)
6. Clematis (Clematis ligusticifolia and C. vitabla)
7. Cattail (Typhus latifolia)
8. Thistle (Cirsium arvense and C. vulgare)
9. Scotch Broom (Cytisus scoparius)

1.3 Safety

Fencing or other measures limiting access may be required on a site specific basis, as required by the City Engineer.

1.4 Access

General Access Requirement

Access roads shall be provided for maintenance of all water quality and quantity facilities. The following criteria are considered to be the minimum required for facilities maintained by the City. If the Design Engineer anticipates that any of the requirements will not be met due to the configuration of the proposed development, the Design Engineer is advised to meet with City staff to gain approval for the deviation prior to submittal.

Standard Road Design

1. The road section shall be three (3) inches of class “C” asphaltic concrete; over two (2) inches of ¾”-0” compacted crushed rock; over six (6) inches of 1½”-0” compacted crushed rock; over subgrade compacted to 95-percent AASHTO T-99; or, the Design Engineer may submit an alternate design certified as capable of supporting a 30-ton maintenance vehicle in all weather conditions.
2. Strengthened sidewalk sections shall be used where maintenance vehicles will cross.
3. Maximum grade shall be 10-percent with a maximum 3-percent cross-slope.
4. Minimum width shall be 12 feet on straight runs and 15 feet on curves.
5. Curves shall have a minimum 40-foot interior radius.
6. Access shall extend to within 10-feet of the center of all structures unless otherwise approved by the City.
7. A curb or other delineator shall be provided at the edge of the road unless otherwise approved.
8. The minimum side slope for road embankments shall be 2:1.
9. A vehicle turnaround shall be provided when the access road exceed 40’ in length.

Alternate Access Road

An alternate access road design meeting the requirements of this section may be approved by the City for facilities in which access is required for general maintenance and long term care of the facility, but where there is no structure, as determined by the City, requiring regular maintenance.

1. The road section shall meet the requirements of 1.4.b.1) or an alternate section certified as capable of supporting AASHTO HS- 20 loading.
2. As an alternative to the requirements of 1.4.c.1), a concrete grid paver surface may be constructed by removing all unsuitable material, laying a geotextile fabric over the native soil, placing pavers, filling the honeycombs/grids with soil, and planting appropriate grasses.
3. Strengthened sidewalk sections shall be required.
4. Maximum grade shall be 20-percent with a maximum 3-percent cross-slope.
5. Minimum finished width shall be 12 feet.
6. A curb or other delineator shall be provided at the edge of the road unless otherwise approved.
7. The minimum side slope for road embankments shall be 2:1.

8. A vehicle turnaround shall be provided when the access road exceed 40’ in length.

2.0 WATER QUALITY FACILITY DESIGN

This section presents methodology for designing water quality facilities.

2.1 Water Quality Volumes and Flows

Water Quality Volume and Flows shall be calculated as required in Appendix B.

3.0 WATER QUALITY TREATMENT FACILITIES

The design criteria are not intended to be a comprehensive list of all stormwater facilities, but provides a general overview of those commonly used.

Biofiltration

Biofiltration removes pollutants primarily by the filtering action of vegetation trapping particulates. Other pollutant removal mechanisms include sediment deposition in low-velocity areas, infiltration into the subsoil, and surface adhesion of pollutants to vegetation, biological assimilation, and soil adsorption. Biofiltration BMPs include grass swales, vegetated swales and vegetated filter strips.

Well-designed and -maintained biofilters have been known to remove the majority of suspended sediments and particulate pollutants in stormwater. Biofilters generally do not remove dissolved pollutants effectively. Swales appear to be more effective at removing metals than nutrients; however, accumulations of trace metals in biofilter sediments may occur. Resuspension or remobilization of nutrients may occur, particularly if maintenance is not performed regularly.

Vegetated Swales

Biofiltration swales are long, gently sloped conveyance ditches with flattened sideslopes, designed to remove pollutants by filtering stormwater through vegetation. Grass is the most common vegetation, but other vegetation types, such as emergent wetland species, are often used, depending on site conditions. Swales are designed to distribute flow evenly across the entire width of the densely vegetated bottom, and may employ check dams and wide depressions to increase runoff storage and promote greater settling of pollutants. Often providing both treatment and conveyance of peak design flows, swales can reduce development costs by eliminating the need for separate conveyance systems. Biofiltration swales are best applied on a relatively small scale (generally less than 5 acres of impervious surface).

Swales which are incorporated in the streets are known as Green Streets. Green Streets incorporate curb extensions with biofiltration swales.

Applicable Locations:

Along roadways, driveways, and parking lots.

Hydraulic Design Criteria:

Design Flow: Water Quality Flow

Minimum Hydraulic Residence Time: 9 minutes

Maximum Water Design Depth: 0.5-feet

Minimum Freeboard: 1.0-foot (for facilities not protected from high flows)

Manning “n” Value: 0.24

Maximum Velocity: 2.0-fps based on 25-year flow

Design Criteria:

- Provide an energy dissipater at the entrance to swale, with a minimum length of 4-feet. It will be designed to reduce velocities and spread the flow across the treatment cross section.
- The use of intermediate flow spreaders maybe required.
- Minimum Length: 100-feet
- Minimum Slope: 0.5-percent
- Minimum Bottom Width: 2-foot
- Maximum Treatment Depth (measured from top of gravel): 0.5-feet
- Maximum Side Slope:
- In Treatment Area: 4H:1V
- Above Treatment Area: 2.5H:1V
- The treatment area shall have 2”-¾” river run rock placed 2.5 to 3 inches deep on high density jute or coconut matting over 12 inches of topsoil or base stabilization method as approved by the City. Extend river rock, topsoil, and high density jute or coconut matting to top of treatment area (or WQV level). Extend topsoil and low density jute matting to the edge of water quality tract or easement area.
- Provide an approved outlet structure for all flows.
- Where swales wrap 180-degrees forming parallel channels, freeboard must be provided between each of the parallel channels. A 1-foot (above ground surface) wall may be used above the treatment area to provide freeboard while enabling a narrower system. As an alternative, a soil-based berm may be used. The berm shall have a minimum top width of 1 foot and 2.5:1 side slopes.
- Where swales are designed with ditch inlets and outlet structures and design of maintenance access to such structures may be difficult due to swale location, swales may be designed as flowthrough facilities with unsumped structures. Maintenance access to one end of the facility will still be required.
- Check dams shall be constructed of durable, non-toxic materials such as rock, brick, or concrete, or soil by integrating them into the grading of the swale. Check dams shall be 12 inches in length, by the width of the swale, by 3 to 6 inches in height.
- Swale areas should be clearly marked before site work begins to avoid soil disturbance and compaction during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of swale areas.
- Swales are appropriate for all soil types. Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended to support plant growth.
- Required setback from centerline of swale to property lines is 5 feet, and 10 feet from building foundations unless lined with impermeable fabric.
- Wildflowers, native grasses, and ground covers used for maintained facilities maintained by the city shall be designed not to require mowing. Where mowing

cannot be avoided, facilities shall be designed to require mowing no more than once annually. Turf and lawn areas are not allowed for city-maintained facilities.

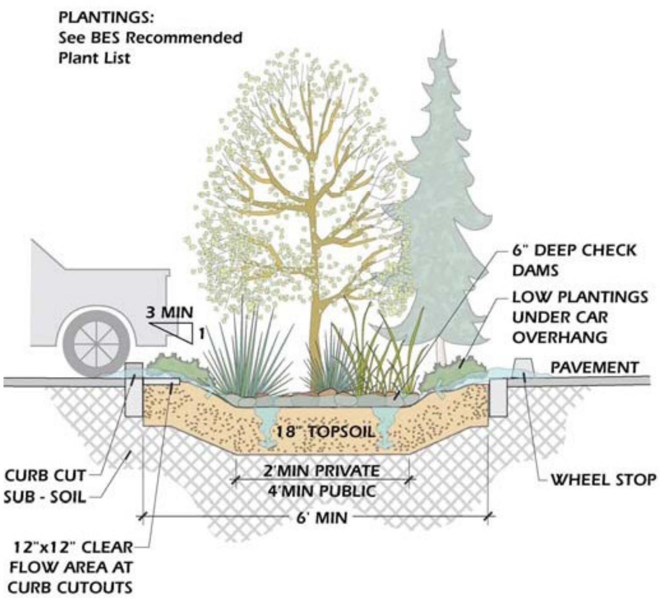


Figure 7. Vegetated Swale (Source City of Portland Stormwater Management Manual, 2004)

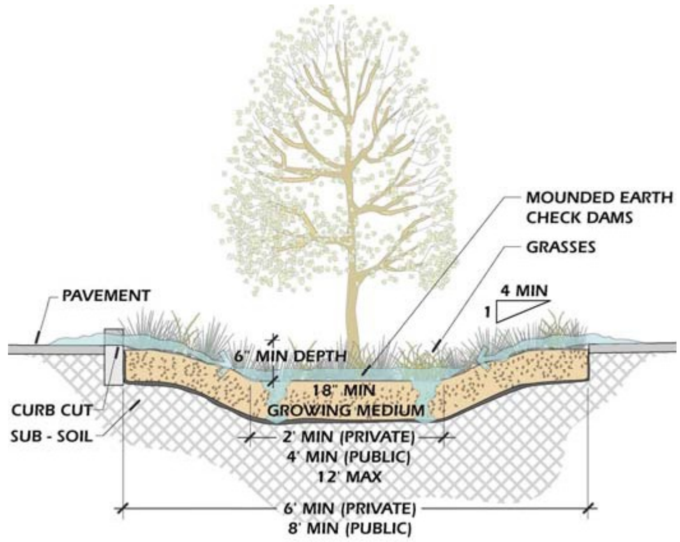


Figure 8. Grassy Swale (Source City of Portland Stormwater Management Manual, 2004)

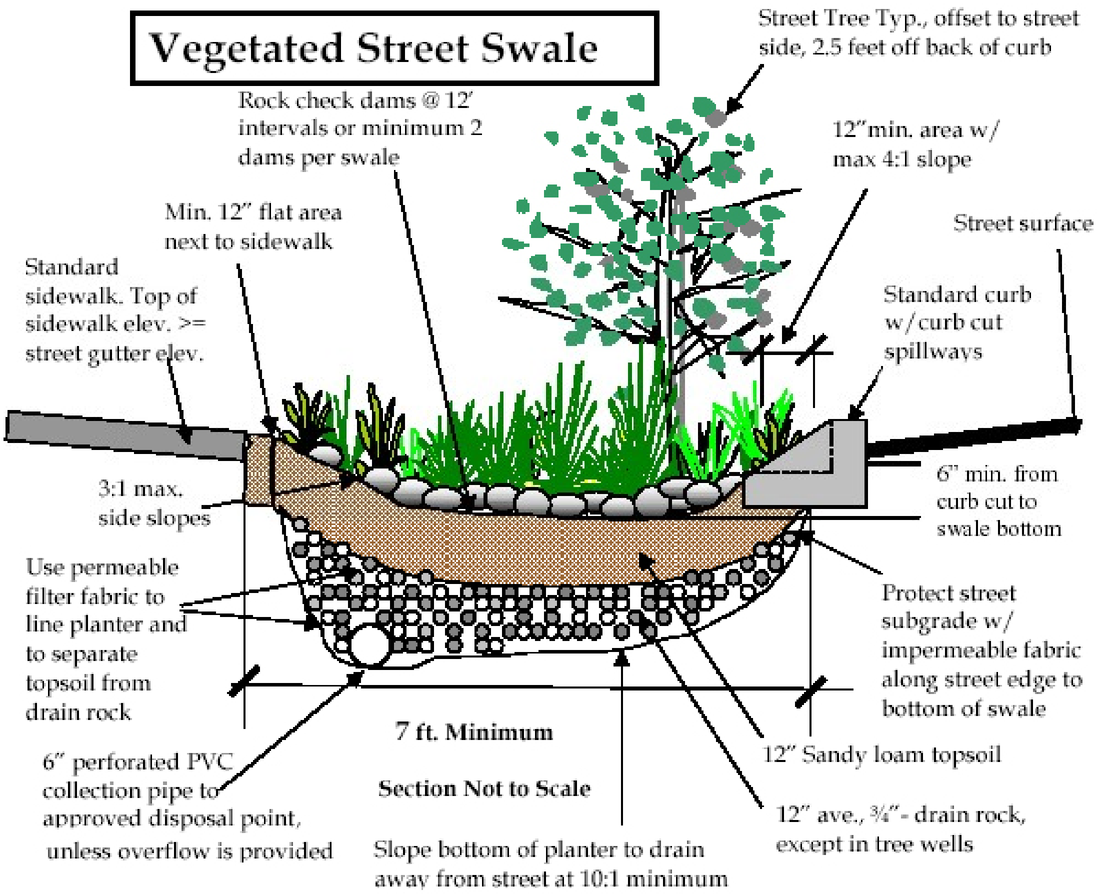


Figure 9. Vegetated Street Swale (Stormwater Management Manual, City of Portland, 2004)

Vegetated Filter Strips

Filter strips are vegetated sections of land designed to accept runoff as overland sheet flow from upstream development. They may adopt any naturally vegetated form, from grassy meadow to emergent wetland to small forest. The dense vegetative cover facilitates pollutant removal. Filter strips differ from swales in that swales are concave conveyance systems, while filter strips are located parallel to the contributing area, have fairly level surfaces, and provide treatment of sheet flow.

Applicable Locations:

Parking lots, residential or small business streets. Treat stormwater from small drainage areas.

Design Considerations:

- When designing vegetated filters, slopes should be kept as flat as possible to prevent erosion. Spreading the flow evenly across the filter is also important in ensuring that the facility functions correctly and avoids flow channeling.
- Vegetated filter areas should be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of filter areas. Flow spreaders must be constructed perfectly level to distribute flows evenly across the filter.

- Vegetated filters are appropriate for all soil types. Unless existing vegetated areas are used for the filter, topsoil shall be used within the building foundations unless lined with impermeable fabric.
- Maximum allowable vegetated filter slopes are 10%. Terraces may be used to decrease ground slopes. Minimum slopes are 0.5%.
- Required setback from property lines is 5 feet, and 10 feet from building foundations unless lined with impermeable fabric.
- Unless used for very long, narrow projects such as pathways and trails, vegetated filters cannot be used to manage flow from more than 2,000 square-feet of impervious area. Filters shall be a minimum of 10 feet wide x 10 feet long. A simplified approach sizing factor of 0.2 may be used to receive credit for pollution reduction and flow control. A high-flow by-pass mechanism will not be required in these cases, but a high-flow overflow must be provided at the downstream end of the filter to an approved disposal point.
- Check dams shall be constructed of durable, non-toxic materials such as rock, brick, or concrete, or graded into the native soils. Check dams shall be 12 inches in length, by the width of the filter, by 3 to 5 inches in height.

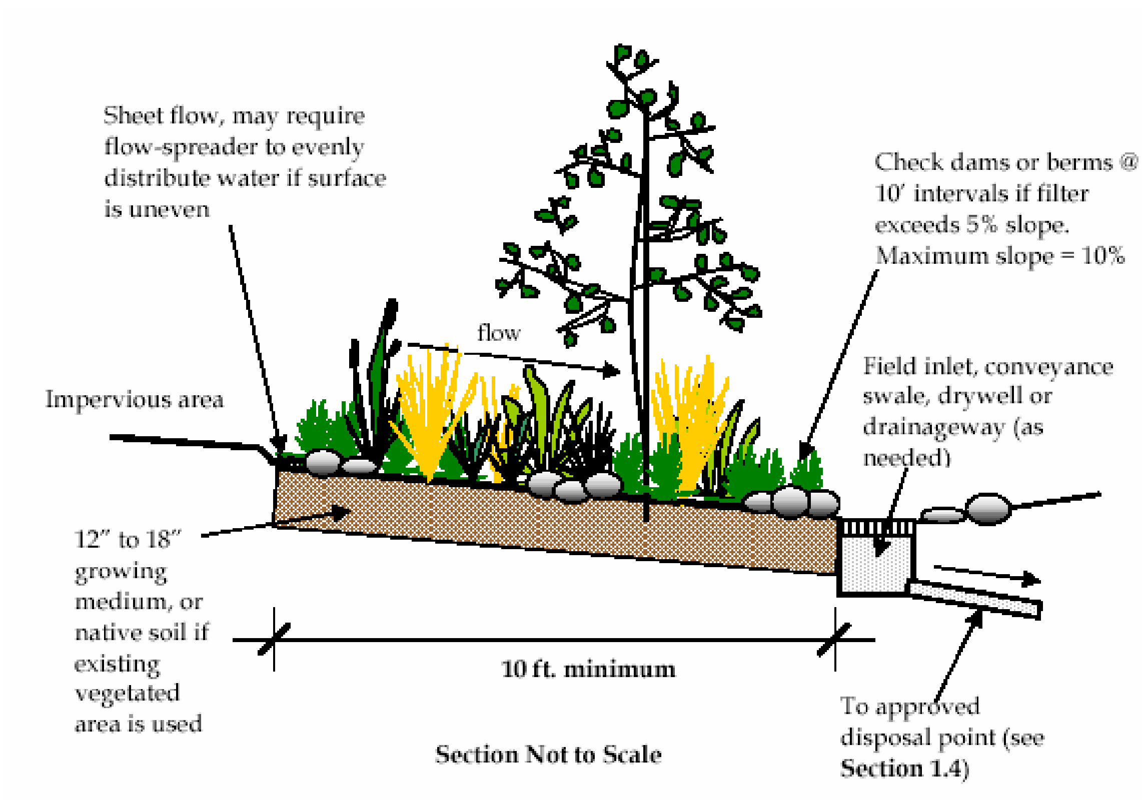


Figure 11. Vegetated Filter Strip (Stormwater Management Manual, City of Portland, 2004)

Extended Dry Basin

Dry detention ponds are vegetated basins designed to fill during storm events and slowly release the water over a number of hours. Dry detention ponds are designed primarily for flow control. Additional water quality facilities are required to meet pollutant reduction requirement unless the bottom of the flow path of the pond should be designed as a vegetated or grass swale in order to meet pollution reduction requirements.

Dry Detention ponds have the opportunity for use as multi-purpose detention facilities. Such facilities include: parking lots, rooftops, sports fields, and recessed plazas.

Applicable Locations:

High density areas, where land availability is limited.

Hydraulic Design Criteria:

- Permanent Pool Depth: 0.4-feet
- Permanent pool is to cover the entire bottom of the basin.
- Water Quality Detention Volume: Water Quality Volume (WQV) + Required Storage
- Water Quality Drawdown Time: 48 hours

  Orifice Size: USE: *D = 24 * [(Q/ (C[2gH]0.5) / π] 0.5*

  Where: *D (in) = diameter of orifice*

  *Q(cfs) = WQV(cf) /(48*60*60)*

  C = 0.62

  H(ft) = 2/3 x temporary detention height to centerline of orifice.

- Maximum Depth of Water Quality Pool (not including Permanent Pool): 4-feet.
- Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. Emergency spillway to be located in existing soils when feasible and armored with riprap or other approved erosion protection extending to the toe of the embankment.

Design Criteria:

- Minimum of 2 cells, with the first cell (forebay) at least 10% of surface area. The forebay shall also constitute 20% of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
- Inlet and outlet structures shall be designed to avoid direct flow between structures without receiving treatment (i.e. short circuiting of flow). The minimum length-to-width ratio is 3:1, at the maximum water surface elevation. If area constraints make this ratio unworkable, baffles, islands, or peninsulas may be installed, with City approval, to increase the flow path and prevent short-circuiting.
- Minimum Bottom Width: 4-feet
- Maximum Side Slopes in Basin Treatment Area: 3H:1V
- Minimum Freeboard: 1-foot from 25-year design water surface elevation.

- The treatment area shall have high density jute or coconut matting over 12 inches of topsoil or base stabilization method as approved by the City. If required by the City, 2”-¾” river run rock shall be placed 2.5 to 3 inches deep in areas where sustained flow is anticipated to occur. Extend river rock (if required), topsoil, and high density jute or coconut matting to top of treatment area (or WQV level). Extend topsoil and low density jute matting to the edge of water quality tract or easement area
- Provide an approved outlet structure for all flows.
- The Design Engineer shall certify that the pond storm sewer design is in compliance with all requirement in this document and that at normal design water surface that the upstream storm sewer will not be in a surcharged condition for longer than 24 hours
- Adequate grading and drainage must be provided to allow full use of facilities primary purposes following a storm event.
- Facility must be designed to minimize potential safety risks, potential property damage and inconvenience to the facility’s primary purpose.
- Detention Basins designed to function as multi-use/recreational facilities, shall be located in a separate tract, defined easement, or designated open space.
- Minimum distance from the edge of the pond maximum pond water surface to property lines and structures: 20 feet, unless an easement with adjacent property owner is provided.
- Distance from the toe of the pond berm embankment to the nearest property line: one-half of the berm height (minimum distance of 5 feet).
- Minimum distance from the edge of the maximum pond water surface to septic tank, distribution box, or septic tank drain field: 50 feet.
- Surrounding slopes shall not exceed 10%. Minimum distance from the edge of the maximum pond water surface to the top of a slope greater than 15 percent: 200 feet, unless a geotechnical report is submitted and approved by the City.
- Minimum distance from the edge of the maximum pond water surface to a well: 100 feet.
- Access routes to the pond for maintenance purposes must be shown on the plans.

Constructed Water Quality Wetland

A constructed wetland is a shallow, sometimes intermittent, pool constructed to provide suitable conditions for the growth of wetland plants for the purposes of stormwater management. Constructed wetlands often consist of a combination of shallow trenches, marshes, and ponded sections, with a wide variety of vegetation types. Stormwater wetlands are designed to maximize pollutant removal through uptake by plants, retention, and settling.

Created wetlands, are distinct from constructed wetlands, are considered mitigation for an activity, and are *not* used for stormwater management. They are treated as natural wetlands, and are subject to the same protections.

Wetlands can be sources of wildlife habitat, enhancing the aesthetic value of an area and providing opportunities for passive recreation and public education.

Constructed wetlands remove pollutants through gravitational settling, wetland plant uptake, adsorption, filtration, and microbial decomposition. Deep water areas such as wet ponds improve the sedimentation, photosynthetic, biological, and chemical removal of pollutants.

The actual pollutant removal efficiency of constructed wetlands depends on many variables. Numerous field studies indicate these systems are able to remove the majority of the settleable solids and particulate pollutants in stormwater. These detention facilities can also prevent increases in water temperature with a well established vegetated canopy.

Applicable Locations:

Larger Commercial or residential projects where land is available to treat a large drainage area.

Hydraulic Design Criteria:

- Permanent Pool Volume: 0.55 x Water Quality Volume (WQV)
- Water Quality Detention Volume: Water Quality Volume (WQV) + Storage Volume
- Water Quality Drawdown Time: 48 hours

  Orifice Size: USE: D = 24 * [(Q/ (C[2gH]0.5) / π] 0.5

  Where: *D (in) = diameter of orifice*

  *Q(cfs) = WQV(cf) /(48*60*60)*

  C = 0.62

  H(ft) = 2/3 x temporary detention height to centerline of orifice.
- Maximum Depth of Permanent Pool: 2.5-feet or as limited by issuing jurisdiction
- Maximum velocity through the wetland should average less than 0.01-fps for the water quality flow. Design should distribute flows uniformly across the wetland.
- Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. Emergency spillway to be located in existing soils when feasible and armored with riprap or other approved erosion protection extending to the toe of the embankment.
- Provide for a basin de-watering system with a 24-hour maximum drawdown time.

Design Criteria:

- Minimum of 2 cells, with the first cell (forebay) at least 10% of surface area. The forebay shall also constitute 20-percent of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
- Permanent pool depth to be spatially varied throughout wetland.
- Provide a perimeter zone 10 to 20-feet wide, which is inundated during storm events.
- Maximum Side Slopes for Wetland Planting: 5H:1V
- Maximum Side Slopes for Non-Wetland Planting: 3H:1V
- Overexcavate by a minimum of 20-percent to allow for sediment deposition.

- Minimum Freeboard: 1-foot from 25-year design water surface elevation.
- Provide an approved outlet structure for all flows. A detailed hydraulic analysis must be performed by a Professional Engineer, showing compliance with flow control standards
- All ponds shall have an emergency overflow spillway or structure designed to convey the 100- year, 24-hour design storm for post-development site conditions, assuming the pond is full to the overflow spillway or structure crest. The overflow shall be designed to convey these extreme event peak flows around the berm structure for discharge into the downstream conveyance system. The overflow shall be designed and sited to protect the structural integrity of the berm. This will assure that catastrophic failure of the berm is avoided, property damage is avoided, and water quality of downstream receiving water bodies is protected.

Sand Filters

Stormwater filtering systems have been used successfully in ultra-urban areas due to their relatively small footprint and moderate physical and head drop requirements. A number of filtering systems have been developed for use in heavily urbanized areas. Filters typically contain the same basic components: a sedimentation area to retain the largest particles; and a chamber containing the filter medium that captures soluble pollutants.

A typical sand filter consists of a flow spreader, sand bed, and an underdrain. Pretreatment is required for removal of larger particulates and reduce velocities. Sand filters can be used in residential, commercial and industrial area, where debris, large particulates, and oil & grease will not clog the filter. Sand filters can be located either above or below ground.

Applicable Locations:

Small Commercial and industrial areas projects. Small footprint allows for installation in areas where land availability is limited.

Design Requirements:

- Sand filters must be lined with an impermeable liner.
- Facility storage depth must be at least 12 inches, unless a larger-than-required planter square-footage is used. Minimum sand filter width is 18 inches. Filter slopes shall be less than 0.5%.
- Required setback from property lines is 5 feet, unless the sand filter height is less than 30 inches. Required setback from building structures is 10 feet, unless the sand filter is properly lined. Special attention needs to be paid to the filter waterproofing if constructed adjacent to building structures.
- Sand filter walls shall be made of stone, concrete, brick, or wood. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater shall not be used.
- Sand filters sized with the simplified approach shall be designed to receive less than 15,000 square-feet of impervious area runoff. For these projects, a simplified approach sizing factor of 0.06 may be used to receive credit for pollution reduction and flow control. For projects with more than 15,000 square feet of impervious surface, additional facilities may be required to meet flow control requirements. A high-flow overflow must be provided to an approved

disposal point. Sand filters shall be designed to pond water for less than 4 hours after each storm event.

- Plantings are optional in sand filters. For aesthetic purposes, potted plants may be submerged in the sand filter.
- The sand filter inlet structure shall spread the flow of incoming water uniformly across the surface of the filter medium during all anticipated flow conditions. This flow shall be spread in a manner that prevents roiling or otherwise disturbing the filter medium.
- The length-to-width ratio of the filter shall be 2:1 or greater.
- Sand used as filter medium shall be certified by a testing laboratory as meeting or exceeding the specifications presented below:
- The filter bed medium shall consist of clean medium to fine sand with no organic material, or other deleterious materials and meeting the following gradation:

•

Sieve Size	Percent Passing
3/8”	100
#4	95-100
#8	80-100
#16	45-85
#30	15-60
#50	3-15
#100	<4

- The underdrain piping system shall consist of appropriately sized (minimum 4-inch diameter) collector manifold with perforated lateral branch lines. The pipe used in this conveyance system shall be schedule 40 polyvinyl chloride (PVC) material or an approved equal. Lateral spacing shall not exceed 10 feet. The underdrain laterals shall be placed with positive gravity drainage to the collector manifold. The collector manifold shall have a minimum 1 percent grade toward the discharge point. All laterals and collector manifolds shall have cleanouts installed, accessible from the surface without removing or disturbing filter media.
- The sand bed configuration may be either of the two configurations shown in Figure 12. All depths shown are final depths. The effects of consolidation and/or compaction must be taken into account when placing medium materials. The surface of the filter medium shall be level.

Sand Bed with Gravel Filter (Figure 12:A)

- The top layer shall be a minimum of 18 inches of approved sand.
- The sand shall be placed over an acceptable geofabric material covering a layer of ½- to 2-inch washed drain rock. The finished depth of this drain rock shall be sufficient to provide a minimum of 2 inches of cover over the underdrain piping system.
- No gravel is required below the underdrain piping system.
- The piping shall be underlain with an impermeable liner.

Sand Bed Using Trench Design (Figure 12:B)

- The top layer shall be a minimum of 12 inches of approved sand.
- The sand shall be placed over an acceptable geotextile fabric material covering a layer of ½ to 2-inch washed drain rock. The finished depth of this drain rock shall be sufficient to provide a minimum of 2 inches of cover over the underdrain piping system.
- The piping and gravel shall be underlain with an impermeable liner.

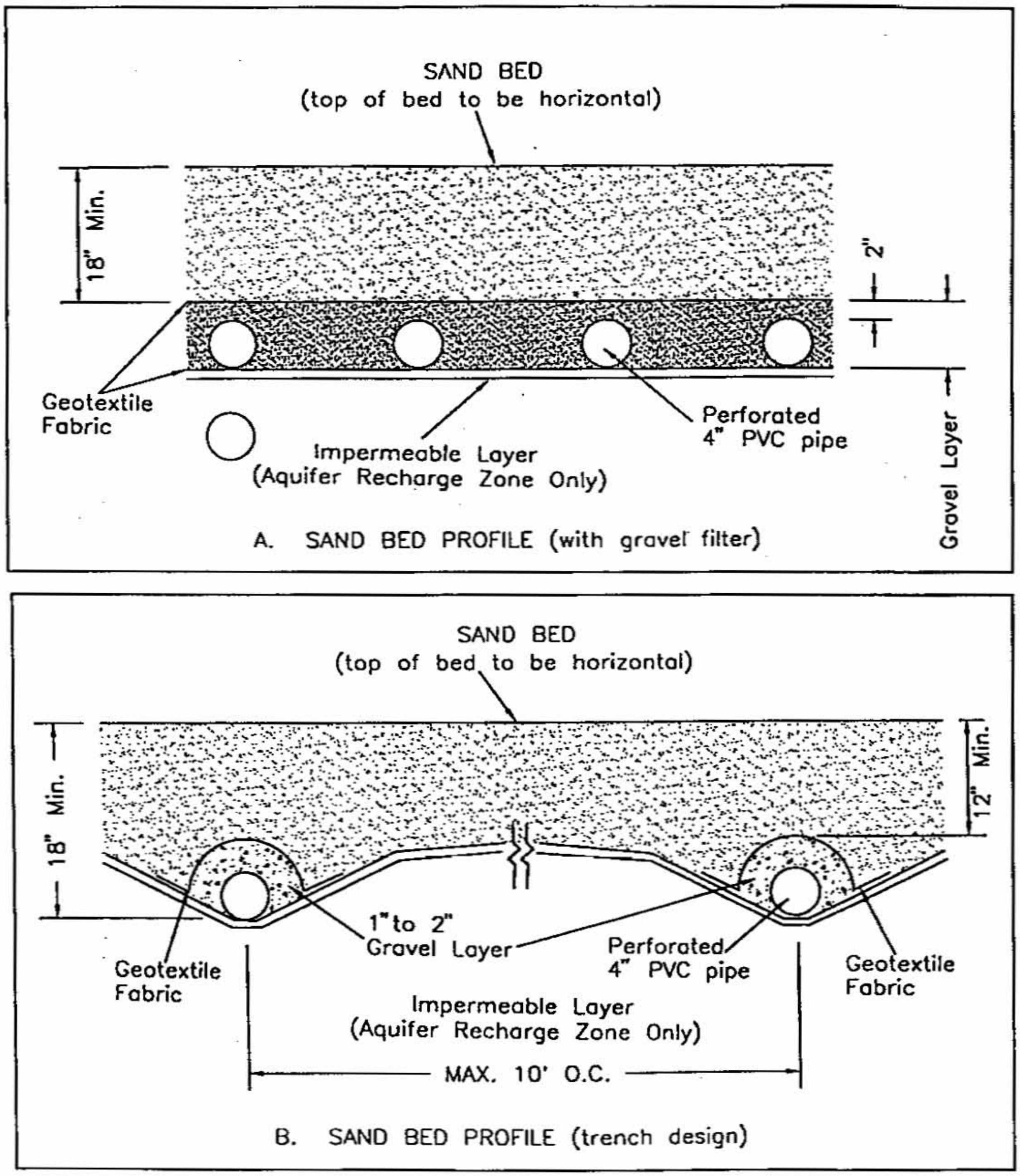


Figure 12. Sandfilters (Source City of Portland Stormwater Management Manual, 2004)

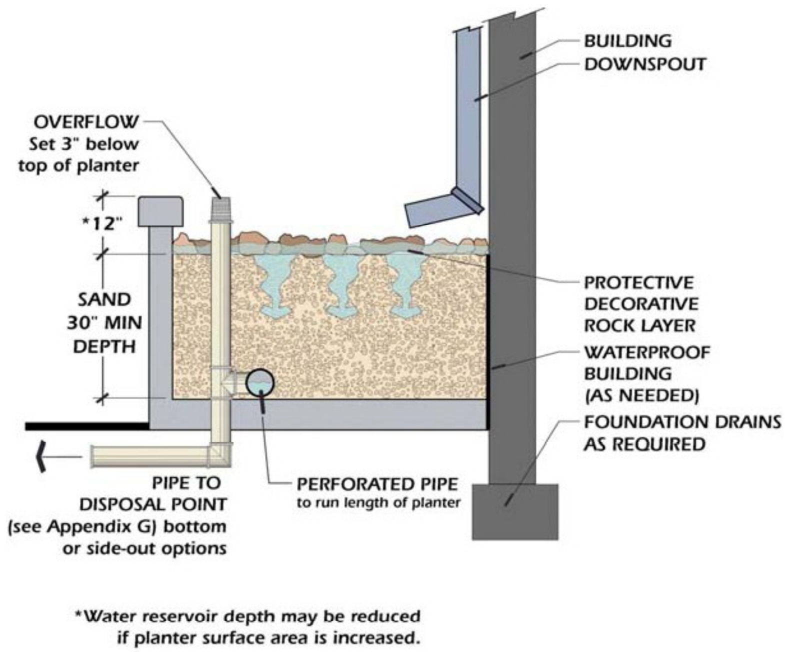


Figure 13. Downspout Sandfilter (Source City of Portland Stormwater Management Manual, 2004)

3.4 Other Water Quality Treatment Facilities

The use of other forms of water quality treatment is allowed with the approval of the City. However, the applicant must provide evidence of the ability of the facility to meet the City's performance criteria and long term maintenance requirements.

4.0 WATER QUANTITY FACILITY DESIGN

4.1 Hydraulic Design Criteria:

a. Detention design shall be assessed by dynamic flow routing through the basin. Documentation of the proposed design shall be included in the drainage report.

Acceptable analysis programs include:

1. HYD;
2. HEC-1;
3. HEC-HMS;
4. SWMM;
5. HYDRA;
6. HYDROCAD
7. Others as approved.

b. Stormwater quantity on-site detention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the pre-development runoff rates from the site, based on a 2 through 25-year, 24-hour return storm. Specifically, the 2, 10, and 25-year post development runoff rates will not exceed their respective 2, 10, and 25-year pre-development runoff rates; unless other criteria are identified in an adopted watershed management plan or subbasin master plan.

c. A pond overflow system shall provide for discharge of the design storm event without overtopping the pond embankment or exceeding the capacity of the emergency spillway. Vortex valve discharge control should be considered to optimize effective pond volume.

d. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. Emergency spillway to be located in existing soils when feasible and armored with riprap or other approved erosion protection extending to the toe of the embankment.

4.2 Design Criteria:

a. The facility can be a combined water quality and quantity facility provided it meets all relevant criteria. If a water quality component in not incorporated into the detention facility additional water quality treatment must be provided.

b. Interior side slopes up to the Maximum Water Surface: 3H:1V

c. If interior slopes need to be mowed – maximum side slope: 4H:1V

d. Maximum Exterior Side Slopes: 2H:1V, unless analyzed for stability by a geotechnical engineer.

e. Over excavate by a minimum of 20-percent to allow for sediment deposition.

f. Minimum Freeboard: 1-foot from 25-year design water surface elevation.

g. Provide an approved outlet structure for all flows.

h. Detention facilities shall be designed to protect public and private property.

i. Facilities shall be designed to minimize mosquito habitat. Facilities should be designed such that water is not allowed to pond for greater than 72 hours. In facilities that are designed to hold standing water, regular monitoring is required for the presence of mosquitoes.

j. An Operations and Maintenance Plan must be developed.

k. A geotechnical report may be required to evaluate the suitability of the proposed facility location.

4.3 Walls in Water Quantity Facilities

a. Retaining walls may serve as pond walls if the design is prepared and stamped by a registered professional engineer and a fence is provided along the top of the wall. At least 25% of the pond perimeter will be vegetated to a maximum side slope of 3:1.

b. Walls that are 4 feet or higher must meet all of the following criteria:

1. Be approved by a licensed structural or geotechnical engineer;
2. The City shall not have maintenance responsibility for the wall. The party responsible for maintenance of the walls within the water quantity tract or easement shall be clearly documented on the plat or in alternate form as approved by the City.

STRUCTURAL BMP SELECTION CHARACTERISTICS

BMP Types	Ultra-Urban	Area Served (acres)	BMP Area	Min. Head Req'd (feet)	Summer Temp Increase[a]	Contaminant Removal Percentage: TSS	Bacteria[c]	BOD	Oil & Grease	TP	TN	Metals	Capital Costs	Maintenance	O&M Costs	Effective Life (years)
Ext. Detention Wet Pond*	no	2 (min)	10-20%	3-6	Yes	46-98	NA	25-45[d]	NA	20-94	28-50	24-89	Mod	Annual Inspection	Low	20-50
Underground Det. Tanks	yes	1-2	0.5-1%	5-8	No	NA	NA	10-20[d]	NA	NA	NA	NA	Mod to High	Frequent cleanout	High	50-100
Infiltration Trench*	yes	2-4	2-4%	3-8	No	75-99	60-100	70-90	NA	50-75	45-70	75-99	Mod to High	Sediment and debris removal	Mod	10-15
Infiltration Basin*	no	2-20	2-4%	3-4	No	75-99	60-100	70-90	NA	50-70	45-70	50-90	Mod	Mowing	Mod	5-10
Bioretention*	yes	1-50	4-10%	2-3	No	75	NA		NA	50	50	75-80	Mod	Mowing / plant replacement	Low	5-20
Catch Basins and Inlets	yes	<1	none		No	20-40	NA	10-20[d]	NA	10-20[d]	10-20[d]	10-20[d]	Low	Frequent Cleanout	Low	?
Catch Basin Inserts	yes	<1	none	1-2	No	NA	NA		up to 90	NA	NA	NA	Low	Frequent Cleanout	Mod to High	10-20
Control Structures/Flow Restrictors	yes				No	20-40	NA	10-20[d]	NA	10-25[d]	10-20[d]	10-25[d]	Low	Frequent Cleanout	Low to Mod	
Manufactured Systems	yes	1-10	none	4	No	NA	NA		up to 96	NA	NA	NA	Mod	Periodic cleanout	Mod	50-100
Premanufactured																
Vaults[b]	yes	no	0.5-1%	low	No	86	NA		high	48	NA	36	Mod to High	Periodic cleanout and inspection	Mod	50-100
Storm Vault	yes	limits	0.5-1%	low	No	80	NA		high	67	54	NA	Mod to High	Frequent cleanout	Mod	50-100
Vortech																
Multi-Chambered Treatment Train	yes	0.2-2.5	0.5-1.5%	4-6	No	83	NA		NA	NA	NA	95	High	Sand filter cleaning and replacement of oil absorbent material	High	5-20
Oil-Grit Separators (Coalescent Plate)	yes	1-2	<1%	3-6	No	20-40	NA	10-20[d]	50-80	<10	<10	<10	Mod	Frequent Cleanout	High	50-100
Ditches (with vegetation)	yes				Yes	0-50	NA	0-25[d]	0-25[d]	0-25[d]	0-25[d]	0-25[d]	Low	Frequent Cleanout	Low to Mod	
Vegetated Swales	yes	2-4	10-20%	2-6	Yes	30-90	NA	50-80	NA	20-85	0-50	0-90	Low to Mod	Mowing	Low	5-20
Vegetated Filter Strips	no	NA	25%	Neg	Yes	27-70	NA	50-80	NA	20-40	20-40	2-80	Low	Mowing	Low	20-50
Constructed Wetlands	no	1 (min)	10%	1-8	Yes	65	NA	40-80	NA	25	20	35-65	Mod to High	Annual Inspection / Plant replacement	Mod	20-50

STRUCTURAL BMP SELECTION CHARACTERISTICS

BMP Types	Ultra-Urban	Area Served (acres)	BMP Area	Min. Head Req'd (feet)	Summer Temp Increase[a]	Contaminant Removal Percentage: TSS	Bacteria[c]	BOD	Oil & Grease	TP	TN	Metals	Capital Costs	Maintenance	O&M Costs	Effective Life (years)
Natural Streams/Wetlands	no				Yes	50-95	50-98	40-80	40-90	20-85	20-85	40-90	Low	Regular inspection / debris removal / erosion control	Low to Mod	
Vegetated Rock Filters	yes	2-5	3-5%	2-4	No	95	78		NA	82	75	21-80	High	Regular inspection and cleanout	High	5-20
Underground Sand Filters	yes	2-5	2-3%	1-8	No	70-90	NA		NA	43-70	30-50	22-91	High	Annual Media Removal	High	5-20
Surface Sand Filters	no	2-5	2-3%	5-8	No	75-92	NA		NA	27-80	27-71	33-91	Mod	Biannual media removal	Mod	5-20
Organic Media Filters	yes	2-5	2-3%	5-8	No	90-95	90		NA	49	55	48-90	High	Annual media removal	High	5-20
Porous Pavements	no	2-4	NA	NA	No	82-95	NA		NA	60-71	80-85	33-99	Low	Semi annual vacuum cleaning	Mod	15-20

General Source: *FHWA-EP-00-002 Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring*, February 2000.

NA means Not Applicable or Not Available

a. Open systems exposed to solar radiation that do not infiltrate assumed to increase water temperature in summer.

b. Per manufacturer's monitoring reports.

c. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs* (Thomas R. Schueler, July 1987), bacteria removal data for infiltration noted bacteria as fecal coliform, pp. 1-6, 2-13. Data for other BMPs is from FHWA; data falls within the 60%-100% removal range, and is presumed to apply to fecal coliform bacteria.

d. Estimated based on 50% particulate fraction

* Structural BMPs designed to percolate to groundwater must be approved by the City and are generally approved only if all other disposal options are infeasible.

APPENDIX D

STORMWATER FACILITY

OPERATION AND MAINTENANCE REQUIREMENTS

DRY DETENTION PONDS

Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Inlet pipe shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Determine if pipe is in good condition:
    - If more than 1 inch of settlement, add fill material and compact soils.
    - If alignment is faulty, correct alignment.
    - If cracks or openings exist indicated by evidence of erosion at leaks, repair or replace pipe as needed.
- Embankment, Dikes, Berms & Side Slopes retain water in the pond.
  - Slopes shall be stabilized using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
  - Structural deficiencies shall be corrected upon discovery:
    - If cracks exist, repair or replace structure.
    - If erosion channels deeper than 2 inches exist, stabilize surface. Sources of erosion damage shall be identified and controlled.
- Control Devices (e.g., weirs, baffles, etc.) shall direct and reduce flow velocity. Structural deficiencies shall be corrected upon discovery:
  - If cracks exist, repair or replace structure.
- Overflow Structure conveys flow exceeding reservoir capacity to an approved stormwater receiving system.
  - Overflow structure shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Sources of erosion damage shall be identified and controlled when native soil is exposed at the top of overflow structure or erosion channels are forming.
- Remove Debris and sediment from ponding area. Debris and sediment shall be tested and disposed of in accordance with federal and state regulations.
- Vegetation shall be healthy and dense enough to protect underlying soils from erosion.
  - Grass (where applicable) shall be mowed to 4”-9” high and grass clippings shall be removed.
  - Fallen leaves and debris from deciduous plant foliage shall be raked and removed.

  - Nuisance or prohibited vegetation (such as blackberries or English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.

- Spill Prevention measures shall be exercised when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

- Training and/or written guidance information for operating and maintaining ponds shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

- Access to the facility shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
  - Obstacles preventing maintenance personnel and/or equipment access to the wet pond shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

- Insects & Rodents shall not be harbored in the pond. Pest control measures shall be taken when insects/rodents are found to be present.
  - If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
  - Holes in the ground located in and around the pond shall be filled.

If used at this site, the following will be applicable:

- Signage shall clearly convey information.
  - Broken or defaced signs shall be replaced or repaired.
- Fences shall be maintained to preserve their functionality and appearance.
  - Collapsed fences shall be restored to an upright position.
  - Jagged edges and damaged fences and shall be repaired or replaced.

BIOFILTRATION

Swales

Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Swale Inlet (such as curb cuts or pipes) shall maintain a calm flow of water entering the swale.
  - Source of erosion shall be identified and controlled when native soil is exposed or erosion channels are forming.
  - Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4" thick or so thick as to damage or kill vegetation.
  - Inlet shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Rock splash pads shall be replenished to prevent erosion.
- Side Slopes shall be maintained to prevent erosion that introduces sediment into the swale.
  - Slopes shall be stabilized and planted using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Swale Media shall allow stormwater to percolate uniformly through the landscape swale. If the swale does not drain within 48 hours, it shall be tilled and replanted according to design specifications.
  - Annual or semi-annual tilling shall be implemented if compaction or clogging continues.
  - Debris in quantities that inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery.
- Swale Outlet shall maintain sheet flow of water exiting swale unless a collection drain is used. Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.
  - Outlets such as drains and overland flow paths shall be cleared when 50% of the conveyance capacity is plugged.
  - Sources of sediment and debris shall be identified and corrected.
- Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.
  - Mulch shall be replenished as needed to ensure survival of vegetation.
  - Vegetation, large shrubs or trees that interfere with landscape swale operation shall be pruned.

- Fallen leaves and debris from deciduous plant foliage shall be removed.
- Grassy swales shall be mowed to keep grass 4” to 9” in height.
- Nuisance and prohibited vegetation (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation and woody material shall be removed to maintain less than 10% of area coverage or when swale function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.

- Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- Training and/or written guidance information for operating and maintaining swales shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
- Access to the swale shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
  - Obstacles preventing maintenance personnel and/or equipment access to the swale shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- Insects & Rodents shall not be harbored in the swale. Pest control measures shall be taken when insects/rodents are found to be present.
  - If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
  - Holes in the ground located in and around the swale shall be filled.
- If Check Dams are used in the facility they shall control and distribute flow.
  - Causes for altered water flow shall be identified, and obstructions cleared upon discovery.
  - Causes for channelization shall be identified and repaired.

Vegetated Filter Strips

Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)

All facility components and vegetation shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Flow Spreader shall allow runoff to enter the vegetative filter as predominantly sheet flow.
    - Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.
- Sediment build-up near or exceeding 2” in depth shall be removed.
- Filter Inlet shall assure unrestricted stormwater flow to the vegetative filter.
    - Sources of erosion shall be identified and controlled when native soil is exposed or erosion channels are present.
    - Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4 inches thick or so thick as to damage or kill vegetation.
    - Inlet shall be cleared when conveyance capacity is plugged.
    - Rock splash pads shall be replenished to prevent erosion.
- Filter Media shall allow stormwater to percolate uniformly through the vegetative filter.
    - If the vegetative filter does not drain within 48 hours, it shall be regraded and replanted according to design specifications. Established trees shall not be removed or harmed in this process.
    - Debris in quantities more than 2” deep or sufficient to inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery.
- Check Dams shall direct and control flow.
    - Causes for altered water flow and channelization shall be identified, and obstructions cleared upon discovery.
    - Cracks, rot, and structural damage shall be repaired.
- Filter Outlet shall allow water to exit the vegetative filter as sheet flow, unless a collection drainpipe is used.
    - Sources of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are deeper than 2 inches.
    - Outlet shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
- Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.

- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Nuisance and prohibited vegetation (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when vegetative filter function is impaired. Vegetation shall be replaced immediately to control erosion where soils are exposed and within 3 months to maintain cover density.

- Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- Training and/or written guidance information for operating and maintaining vegetated filters shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
- Access to the vegetative filter shall be safe and efficient. Egress and ingress routes shall be maintained to design standards.
  - Obstacles preventing maintenance personnel and/or equipment access to the facility shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- Insects & Rodents shall not be harbored in the vegetated filter. Pest control measures shall be taken when insects/rodents are found to be present.
  - If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
  - Holes in the ground located in and around the vegetated filter shall be filled.

CONSTRUCTION WETLAND

Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Inlet shall assure unrestricted stormwater flow to the wetland.
  - Inlet pipe shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Determine if pipe is in good condition:
    - If more than 1 inch of settlement, add fill material and compact soils.
    - If alignment is faulty, correct alignment.
    - If cracks or openings exist indicated by evidence of erosion at leaks, repair or replace pipe as needed.
- Fore bay traps coarse sediments, reduces incoming velocity, and distributes runoff evenly over the wetland. A minimum 1-foot freeboard shall be maintained.
  - Sediment buildup exceeding 50% of the facility capacity shall be removed every 2-5 years, or sooner if performance is being affected.
- Embankment, Dikes, Berms & Side Slopes retain water in the wetland.
  - Slopes shall be stabilized using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
  - Structural deficiencies shall be corrected upon discovery:
    - If cracks exist, repair or replace structure.
    - If erosion channels deeper than 2 inches exist, stabilize surface. Sources of erosion damage shall be identified and controlled.
- Control Devices (e.g., weirs, baffles, etc.) shall direct and reduce flow velocity.
  - Structural deficiencies shall be corrected upon discovery:
  - If cracks exist, repair or replace structure.
- Overflow Structure conveys flow exceeding reservoir capacity to an approved stormwater receiving system.
  - Overflow structure shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Sources of erosion damage shall be identified and controlled when native soil is exposed at the top of overflow structure or erosion channels are forming.
  - Rocks or other armament shall be replaced when only one layer of rock exists above native soil.
- Sediment & Debris Management shall prevent loss of wetland volume caused by sedimentation.
  - Wetlands shall be dredged when 1 foot of sediment accumulates.

- Gauges located at the opposite ends of the wetland shall be maintained to monitor sedimentation. Gauges shall be checked 2 times per year.
- Sources of restricted sediment or debris, such as discarded lawn clippings, shall be identified and prevented.
- Debris in quantities sufficient to inhibit operation shall be removed routinely, e.g. no less than quarterly, or upon discovery.

- Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion and minimizing solar exposure of open water areas.
  - Mulch shall be replenished when needed.
  - Vegetation, large shrubs or trees that limit access or interfere with wetland operation shall be pruned.
  - Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
  - Nuisance or prohibited vegetation (such as blackberries or English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
  - Dead vegetation shall be removed to maintain less than 10% of area coverage or when wetland function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.
  - Vegetation producing foul odors shall be eliminated.
- Spill Prevention measures shall be exercised when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- Training and/or written guidance information for operating and maintaining treatment wetlands shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
- Access to the wetland shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
  - Obstacles preventing maintenance personnel and/or equipment access to the wetland shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- Insects & Rodents shall not be harbored in the constructed treatment wetland. Pest control measures shall be taken when insects/rodents are found to be present.
  - If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
  - Holes in the ground located in and around the constructed treatment wetland shall be filled.

If used at this site, the following will be applicable:

- Signage shall clearly convey information.

    - Broken or defaced signs shall be replaced or repaired.

- Fences shall be maintained to preserve their functionality and appearance.
    - Collapsed fences shall be restored to an upright position.
    - Jagged edges and damaged fences and shall be repaired or replaced.

SAND FILTERS

Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Filter Inlet shall allow water to uniformly enter the sand filter as calm flow, in a manner that prevents erosion.
    - Inlet shall be cleared of sediment and debris when 40% of the conveyance capacity is plugged.
    - Source of erosion shall be identified and controlled when native soil is exposed or erosion channels are forming.
    - Sediment accumulation shall be hand-removed if it is more than 4 inches thick.
    - Rock splash pads shall be replenished to prevent erosion.
- Reservoir receives and detains stormwater prior to infiltration. If water does not drain within 2-3 hours of storm event, sources of clogging shall be identified and correction action taken.
    - Debris in quantities more than 1 cu ft or sufficient to inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery.
    - Structural deficiencies in the sand filter box including rot, cracks, and failure shall be repaired upon discovery.
- Filter Media shall allow to stormwater to percolate uniformly through the sand filter. If water remains 36-48 hours after storm, sources of possible clogging shall be identified and corrected.
    - Sand filter shall be raked and if necessary, the sand/gravel shall be excavated, and cleaned or replaced.
    - Sources of restricted sediment or debris (such as discarded lawn clippings) shall be identified and prevented.
    - Debris in quantities sufficient to inhibit operation shall be removed no less than quarterly, or upon discovery.
    - Holes that are not consistent with the design structure and allow water to flow directly through the sand filter to the ground shall be filled.
- Underdrain Piping (where applicable) shall provide drainage from the sand filter, and Cleanouts (where applicable) located on laterals and manifolds shall be free of obstruction, and accessible from the surface.
    - Underdrain piping shall be cleared of sediment and debris when conveyance capacity is plugged. Cleanouts may have been constructed for this purpose.
    - Obstructions shall be removed from cleanouts without disturbing the filter media.
- Overflow or Emergency Spillway conveys flow exceeding reservoir capacity to an approved stormwater receiving system.

- Overflow spillway shall be cleared of sediment and debris when 50% of the conveyance capacity is plugged.
- Source of erosion damage shall be identified and controlled when erosion channels are forming.
- Rocks or other armament shall be replaced when sand is exposed and eroding from wind or rain.

Appendix F.2

Catch Basin Recommendations

Technical Memorandum

TO: Mike Faught, City of Stayton Public Works Director

FROM: James Bledsoe, P.E. and Roland Rocha, E.I.T.

DATE: October 11, 2007

SUBJECT: **Storm Water Catch Basin Recommendations**

Keller Associates has prepared this summary of storm water catch basin considerations in response to your request for a standard storm water catch basin recommendation. The question regarding a standard catch basin implies three main considerations: Hydraulics (is it going to capture the flow?), Maintenance (can it be easily accessed and cleaned?), and Water Quality capabilities.

Hydraulics

In the draft standards submitted by Tetra-Tech, the ODOT hydraulics manual and Hydraulic Engineering Circular No. 22 (HEC 22) were referenced. The ODOT manual generally follows HEC 22 which is the more detailed of the two. These manuals recommend site specific calculations to determine the best catch basin for the area. The calculations consider the slope, anticipated sediment loads, flow rates, street width, and other factors. Therefore, as far as hydraulics are concerned, there is not a "one size fits all" catch basin.

Maintenance

We've contacted the city's current contractor, C-More Pipe, and inquired about catch basin needs from a maintenance point of view. Apparently, the vacuum hoses used to clean out the debris are not a concern, but the cameras used for TV inspection and the root cutting tools are. The contractor's camera is about 3ft in length, and the root cutters range from 16" to 25" in length. Therefore, the ideal catch basin for maintenance access would be 3'X3'.

Water Quality

Water quality catch basins will typically have a grit chamber and an oil/water separator feature. There are generally two types of oil/water separators available, namely gravity and coalescing separators. Information and figures on the gravity separators are included in Attachment 1 and information and figures on the coalescing separators are included in Attachment 2.

The basic difference between the two types is that the gravity separators are simple, they remove some oil, and cost less, while the coalescing separators are complex, remove more oil, and cost quite a bit more.

The city of Portland and the city of Salem recommend oil/water separator catch basins only in high-risk areas. The type of separator depends on the application. Salem's stormwater manual specifically recommends their use in the following areas:

- Petroleum Storage Yards
- Vehicle Maintenance Facilities
- Manufacturing areas
- Transportation facilities
- Fueling stations
- High-use commercial parking lots
- Commercial truck operations
- Auto parts stores

Another consideration with oil/water separators is the need for more frequent cleaning, and the added difficulty and cost associated with disposing of the accumulated pollutants. Stayton's current contractor, C-More Pipe, has never dealt with disposal of this kind and does not know what types of regulations are in place. An EPA publication (Attachment 2) suggests the waste trapped in oil/water separators typically contains polyaromatic hydrocarbons, trace metals, phthalates, phenol toluene, and methlylene chloride. With these pollutants, the waste may not be suitable for traditional landfill disposal.

Recommendations

Hydraulic sizing and spacing of catch basins should follow the ODOT and HEC 22 standards as recommended in the draft standards included in the storm water master plan. These standards should dictate the catch basin size and type, unless maintenance access requires a larger size.

Where maintenance access to the storm water lines relies on the catch basin, the catch basin opening should be a minimum of 3 ft in the direction of lines to be accessed. In some cases this will require a minimum of a 3ft square catch basin.

Given the higher capital and operational costs associated with water quality catch basins, Keller Associates recommends the city consider an approach similar to the cities of Portland and Salem as they reevaluate and adopt new storm water standards.

Attachment No. 1
Gravity Oil Water Separators

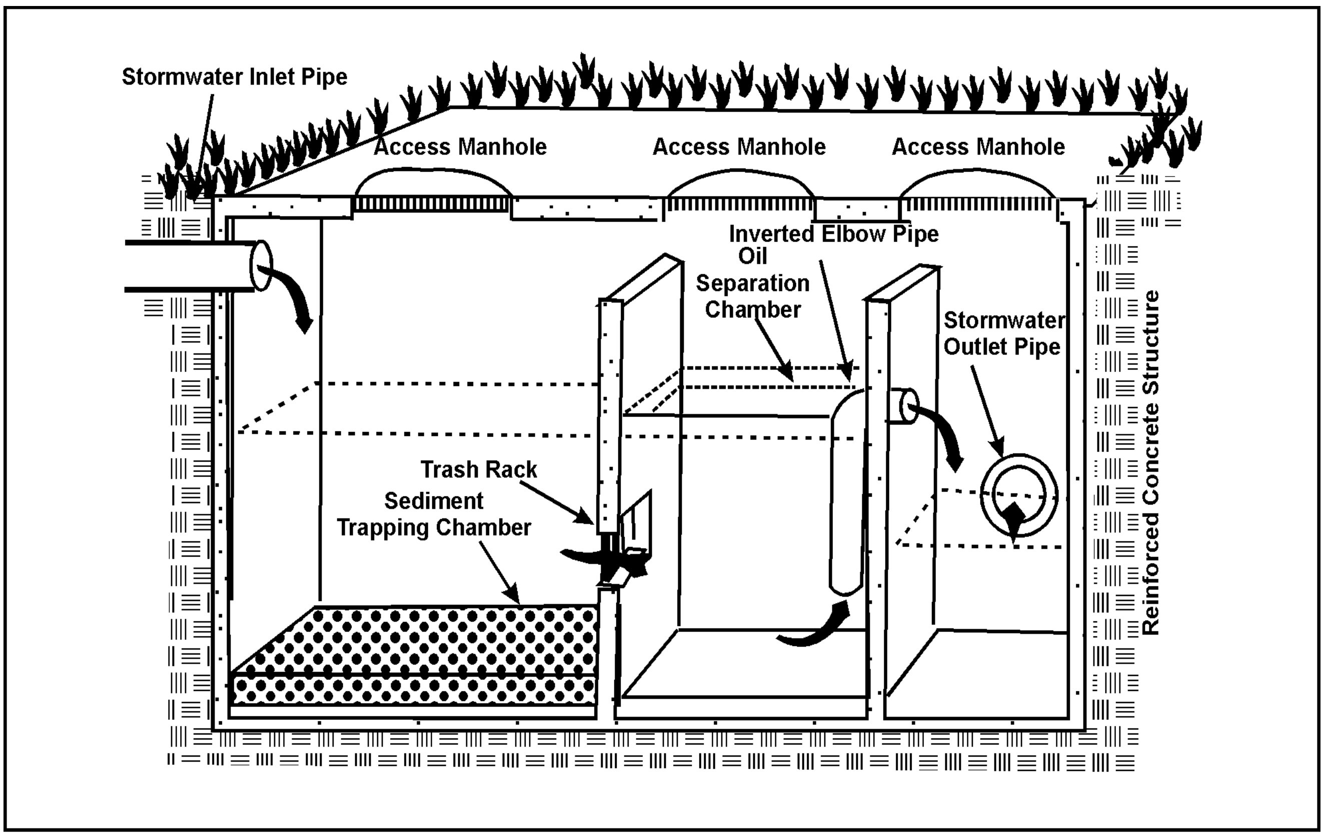
United States Environmental Protection Agency | Office of Water Washington, D.C. | EPA 832-F-99-029 September 1999

Storm Water Technology Fact Sheet
Water Quality Inlets

DESCRIPTION

Water quality inlets (WQIs), also commonly called oil/grit separators or oil/water separators, consist of a series of chambers that promote sedimentation of coarse materials and separation of free oil (as opposed to emulsified or dissolved oil) from storm water. Most WQIs also contain screens to help retain larger or floating debris, and many of the newer designs also include a coalescing unit that helps to promote oil/water separation. WQIs typically capture only the first portion of runoff for treatment and are generally used for pretreatment before discharging to other best management practices (BMPs).

A typical WQI, as shown in Figure 1, consists of a sedimentation chamber, an oil separation chamber, and a discharge chamber. The basic WQI design is often modified to improve performance. Possible



Source: Berg, 1991.

FIGURE 1 PROFILE OF A TYPICAL WATER QUALITY INLET

modifications include: an additional orifice and chamber that replace the inverted pipe elbow; the extension of the second chamber wall up to the top of the structure; or the addition of a diffusion device at the inlet. The diffusion device is intended to dissipate the velocity head and turbulence and distribute the flow more evenly over the entire cross-sectional area of the sedimentation chamber (API, 1990).

The addition of a coalescing unit to the WQI can dramatically increase its effectiveness in oil/water separation while also greatly reducing the size of the required unit. Coalescing units are made from oil-attracting materials, such as polypropylene or other materials. These units attract small oil droplets, which begin to concentrate until they are large enough to float to the surface and separate from the storm water. Without these units, the oil and grease particles must concentrate and separate naturally. This requires a much larger surface area; and therefore, units that do not use the coalescing process must be larger than units utilizing a coalescing unit.

WQIs can be purchased as pre-manufactured units (primarily oil/water separator tanks) or constructed on site. Suppliers of pre-manufactured units (e.g., Highland Tank and Manufacturing, Jay R. Smith Manufacturing, etc.) can also provide modifications of the typical design for special conditions.

APPLICABILITY

WQIs are widely used in the U.S. and can be adapted to all regions of the country. They are often used where land requirements and cost prohibit the use of larger BMP devices, such as ponds or wetlands. WQIs are also used to treat runoff prior to discharge to other BMPs.

Because of their ability to remove hydrocarbons, WQIs are typically located at sites with automotive-related contamination or at other sites that generate high hydrocarbon concentrations (MWCOG, 1993). For example, WQIs may be ideal for small, highly impervious areas, such as gas stations, loading areas, or parking areas (Schueler, 1992). Many WQIs, particularly those installed at industrial sites, serve the dual purpose of treating storm water runoff from contaminated areas, and serving as collection and treatment units for washdown processes or petroleum spills.

Higher residual hydrocarbon concentrations in trapped sediments cause maintenance and residual disposal costs associated with WQIs to be higher than those of other BMPs. Therefore, planners should carefully evaluate maintenance and residual disposal issues for the site before selecting a WQI. Possible alternatives to the WQI include sand filters, oil absorbent materials, and other innovative BMPs (e.g., Stormceptor System).

ADVANTAGES AND DISADVANTAGES

WQIs can effectively trap trash, debris, oil and grease, and other floatables that would otherwise be discharged to surface waters (Schueler, 1992). In addition, a properly designed and maintained WQI can serve as an effective BMP for reducing hydrocarbon contamination in receiving water sediments. While WQIs are effective in removing heavy sediments and floating oil and grease, they have demonstrated limited ability to separate dissolved or emulsified oil from runoff. WQIs are also not very effective at removing pollutants such as nutrients or metals, except where the metals removal is directly related to sediment removal.

Several major constraints can limit the effectiveness of WQIs. The first is the size of the drainage area. WQIs are generally recommended for drainage areas of 0.4 hectares (1 acre) or less (Berg, 1991, NVPDC, 1992). Construction costs often become prohibitive for larger drainage areas. However, because WQIs are primarily designed for specific industrial sites that have the potential for petroleum-contaminated process washdown, spills, and storm water runoff, sizing considerations are not usually a problem.

Sediment can also cause problems for WQIs. There are several reasons for this. First, high sediment loads can interfere with the ability of the WQI to effectively separate oil and grease from the runoff. Second, during periods of high flow, sediment residuals may be resuspended and released from the WQI to surface waters. A 1993 Metropolitan Washington Council of Governments (MWCOG) long-term study evaluating the performance and effectiveness of more than 100 WQIs found that pollutants in the WQI sediments were similar to those pollutants found in downstream receiving water sediments (the tidal Anacostia River). This information suggests that downstream sediment contamination is linked to contaminated runoff and pass-through from WQIs (MWCOG, 1993). Third, WQI residuals accumulate quickly and require frequent removal. There is also some concern that because the collected residuals contain hydrocarbon by-products, the residuals may be considered too toxic for conventional landfill disposal. The 1993 MWCOG study found that the residuals from WQIs typically contain many priority pollutants, including polyaromatic hydrocarbons, trace metals, phthalates, phenol, toluene, and possibly methylene chloride (MWCOG, 1993). Based on these considerations, WQIs should not be implemented at sites that generate large amounts of sediment in the runoff unless the runoff has been pretreated to reduce the sediment loads to manageable levels.

WQIs are also limited by maintenance requirements. Maintenance of underground WQIs can be easily neglected because the WQI is often "out of sight and out of mind." Regular maintenance is essential to ensuring effective pollutant removal. As discussed above, lack of maintenance will often result in resuspension of settled pollutants.

Finally, WQIs generally provide limited hydraulic and residuals storage. Due to the limited storage, WQIs do not provide adequate storm water quantity control.

DESIGN CRITERIA

Prior to WQI design, the site should be evaluated to determine if another BMP would be more cost-effective in removing the pollutants of concern. WQIs should be used when no other BMP is feasible. The WQI should be constructed near a storm drain network so that flow can be easily diverted to the WQI for treatment (NVPDC, 1992). Any construction activities within the drainage area should be completed before installation of the WQI, and the drainage area should be revegetated so that the sediment loading to the WQI is minimized. Upstream sediment control measures should be implemented to decrease sediment loading.

WQIs are most effective for small drainage areas. Drainage areas of 0.4 hectares (1 acre) or less are often recommended. WQIs are typically used in an off-line configuration (i.e., portions of runoff are diverted to the WQI), but they can be used as on-line units (i.e., receive all runoff). Generally, off-line units are designed to handle the first 1.3 centimeters (0.5 inches) of runoff from the drainage areas. Upstream isolation/diversion structures can be used to divert the water to the off-line structure (Schueler, 1992). On-line units receive higher flows that will likely cause increased turbulence and resuspension of settled material, thereby reducing WQI performance.

As discussed above, oil/water separation tank units are often utilized in specific industrial areas, such as airport aprons, equipment washdown areas, or vehicle storage areas. In these instances, runoff from the area of concern will usually be diverted directly into the unit, while all other runoff is sent to the storm drain downstream from the oil/water separator. Oil/water separation tanks are often fitted with diffusion baffles at the inlets to prevent turbulent flow from entering the unit and resuspending settled pollutants.

WQIs are available as pre-manufactured units or can be cast in place. Reinforced concrete should be used to construct below-grade WQIs. The WQIs should be water tight to prevent possible ground water contamination.

Chamber Design

Structural loadings should be considered in the WQI design (Berg, 1991), particularly with respect to the sizing of the chambers. When the combined length of the first two chambers exceeds 4 meters (12 feet), the chambers are typically designed with the length of the first and second chamber being two-thirds and one-third of the combined length of the unit, respectively. Each of the chambers should have a separate manhole to provide access for cleaning and inspection.

The State of Maryland design standards indicate that the combined volume of the first and second chambers should be determined based on 1.1 cubic meters (40 cubic feet) per 0.04 hectares (0.10 acres) draining to the WQI. In Maryland, this is equivalent to capturing the first 0.33 centimeters (0.133 inches) of runoff from the contributing drainage area.

Permanent pools within the chambers help prevent the possibility of sediment resuspension. The first and second chambers should have permanent pools with depths of 1.2 meters (4 feet). If possible, the third chamber should also contain a permanent pool (NVPDC, 1992).

The first and second chambers are generally connected by an opening covered by a trash rack, a PVC pipe, or other suitable material pipe (Berg, 1991). If a pipe is used, it should also be covered by a trash rack or screen. The opening or pipe between the first and second chambers should be designed to pass the design storm without surcharging the first chamber (Berg, 1991). The design storm will vary depending on geographical location and is generally defined by local regulations.

In the standard WQI, an inverted elbow is installed between the second and third chamber. The elbow should extend a minimum of 1 meter (3 feet) into the second chamber's permanent pool. Because oil will naturally separate from, and float on top of, the water, water will be forced through the submerged elbow and into the third chamber while oil will be retained in the second chamber (NVPDC, 1992). The depth of the elbow into the permanent pool should should be. The size of the elbow or the number of elbows can be adjusted to accommodate the design flow and prevent discharge of accumulated oil(Berg, 1991).

Pre-manufactured oil/water separation tanks do not usually follow the separated-chamber design; instead, these units often rely on baffle units to separate the different removal process. Particulates are thus retained near the inlet to the tank, while oil/water separation takes place closer to the tank outlet.

PERFORMANCE

WQIs are primarily utilized to remove sediments from storm water runoff. Grit and sediments are partially removed by gravity settling within the first two chambers. A WQI with a detention time of 1 hour may expect to have 20 to 40 percent removal of sediments. Hydrocarbons associated with the accumulated sediments are also often removed from the runoff through this process. The WQI achieves slight, if any, removal of nutrients, metals and organic pollutants other than free petroleum products (Schueler, 1992).

The 1993 MWCOG study discussed above found that an average of less than 5 centimeters (2 inches) of sediments (mostly coarse-grained grit and organic matter) were trapped in the WQIs. Hydrocarbon and total organic carbon (TOC) concentrations of the sediments averaged 8,150 and 53,900 milligrams per kilogram, respectively. The mean hydrocarbon concentration in the WQI water column was 10 milligrams per liter. The study also indicated that sediment accumulation did not increase over time, suggesting that the sediments become re-suspended during storm events. The authors concluded that although the WQI effectively separates oil and grease from water, re-suspension of the settled matter appears to limit removal efficiencies. Actual removal only occurs when the residuals are removed from the WQI (Schueler 1992).

A 1990 report by API found that the efficiency of oil and water separation in a WQI is inversely proportional to the ratio of the discharge rate to the unit's surface area. Due to the small capacity of the WQI, the discharge rate is typically very high and the detention time is very short. For example, the MWCOG study found that the average detention time in a WQI is less than 0.5 hour. This can result in minimal pollutant settling (API, 1990). However, the addition of coalescing units in many current WQI units may increase oil/water separation efficiency. Most coalescing units are designed to achieve a specific outlet concentration of oil and grease (for example, 10-15 parts per million oil and grease).

OPERATION AND MAINTENANCE

The key to the performance of WQIs is maintenance. When properly maintained, WQIs should experience very few separation, clogging, or structural problems.

Basic maintenance should consist of regularly checking and cleaning out the sediment that has accumulated in the WQI. A lack of regular clean-outs can lead to the resuspension of collected sediments; therefore, WQIs should be inspected after every storm event to determine if maintenance is required. At a minimum, each WQI should be cleaned at the beginning of each season (Berg, 1991). The required maintenance will be site-specific due to variations in sediment and hydrocarbon loading. Maintenance should include clean out, disposal of the sediments, and removal of trash and debris. The clean out and disposal techniques should be environmentally acceptable and in accordance with local regulations. Since WQI residuals contain hydrocarbon by-products, they may require disposal as hazardous waste. Many WQI owners coordinate with waste haulers to collect and dispose of these residuals. Since WQIs can be relatively deep, they may be designated as confined spaces. Caution should be exercised to comply with confined space entry safety regulations if it is required.

Oil/water separator tank units can be fitted with sensing units that will indicate when the units need to be cleaned. Because most of oil/water separator tank units are designed for specific industrial applications, their maintenance schedule should be closely tied to the industrial process schedule. However, these units should also be inspected after rain events.

COSTS

The construction costs for WQIs will vary greatly depending on their size and depth. The construction costs (in 1993 dollars) for cast-in-place WQIs range from $5,000 to $16,000, with the average WQI costing around $8,500 (Schueler, 1992). For the basic design and construction of WQIs, the pre-manufactured units are generally less expensive than those that are cast in place (Berg, 1991).

Maintenance costs will also vary greatly depending on the size of the drainage area, the amount of the residuals collected, and the clean out and disposal methods available (Schueler, 1992). The cost of residuals removal, analysis, and disposal can be a major maintenance expense, particularly if the residuals are toxic and are not suitable for disposal in a conventional landfill.

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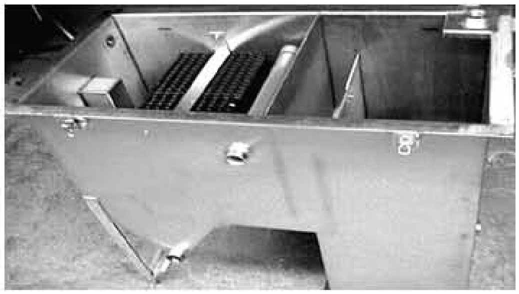
MUNICIPAL TECHNOLOGY BRANCH

Attachment No. 2
Coalescing Oil Water Separators

Oil/Water Separators



Oil/water separators are devices used to remove free and dispersed oil and other petroleum products from ground water recovery, industrial wastewater and/or storm water systems. Oil/water separators use several techniques, depending on the type and application or intended use of the separation system. Onion Enterprises has typically used a coalescing separation system instead of conventional gravity. The performance of these systems is based primarily on the relatively low solubility of petroleum products in water and the difference between the specific gravity of water and the specific gravities of petroleum compounds.

Oil/water separator are not designed to separate other products such as solvents, detergents, or metals. The illustration below represents a very simple example of the separation phases in an oil/water diameter oil droplet will rise about 6 inches in water in ten minutes. A 20 micron diameter oil droplet will take over two hours to rise the same distance. In a typical gravity type oil/water separator an oil droplet must rise approximately 48 inches to reach the surface of the water and be removed from the flow. Because of this, many of the smaller droplets pass through convention type oil/water separators unaffected. Addition of inclined coalescing plates will allow the droplet to separate after rising only 3/4 inch before hitting the upper plate and being removed from the water flow.

Description of operation: There are two basic types of separators: conventional and coalescing. Often, gravity type oil/water separators do not remove enough oil to meet regulatory requirements. In these cases, coalescing oil/water separators are needed to enhance separation. Oily wastewater influent is introduced to the inlet of the separator.

Coalescing (binding together) the smaller oil droplets makes them larger and more buoyant, causing them to rise faster. Many coalescing oil/water separators use inclined plates to reduce the distance the oil droplets have to rise to be removed from the flow; thereby, increasing the separation efficiency of a typical gravity type separator.

Coalescence type separators are a highly efficient solution. These oil/water separators have been designed to accelerate the process which oil and water do naturally - separate. This separation is accomplished with no moving parts and is based on principles as consistent as gravity and buoyancy. The operation of the coalescence type separator is based on the use of relatively close tolerance 1/2' to 1.25' or larger spacing) surface areas which reduce the distance an oil droplet must travel before it reaches a collection surface. The coalescence plates are constructed of materials which are hydrophobic (water repelling) and oleophilic (oil attracting). When the oil droplet comes in contact with the plate it reaches a zone of zero velocity and adheres to the surface. The coalescence surfaces multiply the effectiveness of the natural action of oil and water to separate.

As the media plate becomes coated with continuously agglomerating oil, the oil begins to form droplets. These droplets then coalesce or migrate upward. The media plates are set at 45-60 degree angles with respect to horizontal. This creates a condition which accelerates the vertical movement of the oil on them. The oil coating the media surface accumulates at the top edge of the media where it detaches as a droplet and floats to the surface of the separation chamber. Once it breaks away from the media, the oil then resides on the surface of the water. There are now two zones of liquid in the separator - oil and water. The oil which has separated overflows a fixed weir into a collection chamber for subsequent removal. The clear water underflows the oil and is discharged from the system on a continuous basis.

Separation Process: The water/solids mixture enters the clarifier and is spread out horizontally, distributed through an energy and turbulence diffusing device. The mixture enters an influent chamber that begins the settling process by equalizing the flow into a non-turbulent, homogenized, downward flow path. When the flow exits this chamber it is redirected into a horizontal and then vertical flow path. Once it begins the vertical path the flow encounters the slant plates where the solids come into contact with the plates, effectively separating from the flow. The solids slide down the plates and are deposited in the sludge hopper located under the slant plate pack.

Onion Enterprises
630 West Street
Naples FL 34109
USA

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clarifier, coal, industrial wastewater, oil water separator, oil/water separator, petroleum, separation system, separator, sludge, solvent, wastewater, weir

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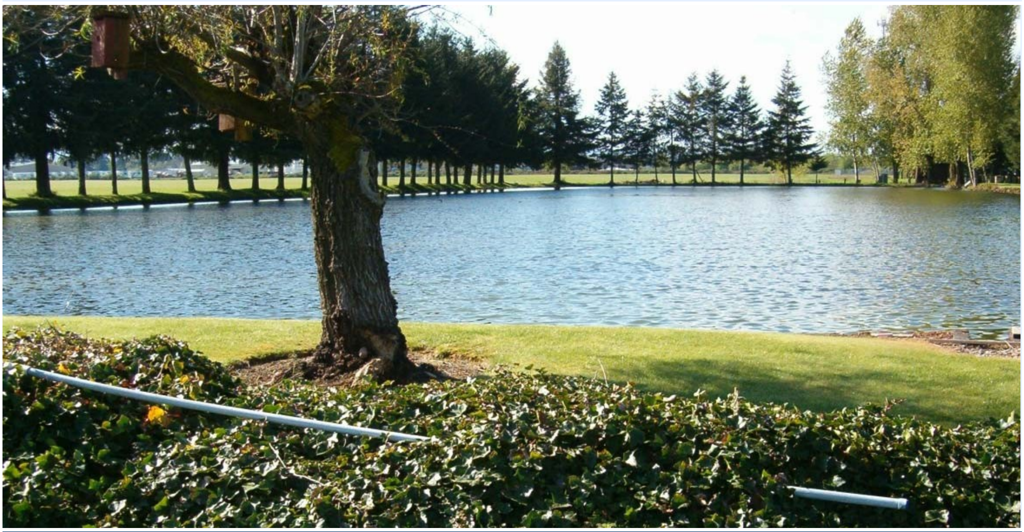

Appendix G

Storm Water System User Fee

G.1 - Funding Report
G.2 - Stormwater Grants

KELLER associates

Appendix G.1

Funding Report

KELLER associates

CITY OF STAYTON

DRAFT STORMWATER RATE ANALYSIS

DRAFT STORMWATER RATE ANALYSIS

November 5, 2007

prepared by:

ECONOMIC & FINANCIAL ANALYSIS

1409 Franklin Street • Suite 201 • Vancouver, WA 98660
360.823.1700 • 503.228.3225 • Fax: 360.695.1804 • rjbefa@aol.com

Memorandum:

TO: Mike Faught

FROM: Raymond J. Bartlett

DATE: April 24, 2008

RE: Storm Water Rates

We finished compiling the billable amount of impervious surfaces in Stayton and came up short of my original estimate of approximately 17.6 million square feet. It came out to 13.3 million square feet. Table 1 summarizes the square feet by broad categories.

Table 1 Square Feet of Billable Impervious Surfaces in Stayton

	No of Accounts	Impervious Area	% of total	Average Sq. Ft.
Single Family Residential	2,232	5,580,000	42%	2,500
Multiplexes (2 to 4 units)	140	486,383	4%	3,474
Commercial (Incl. Apartments & Industrial)	409	7,185,065	54%	17,567
Totals	2,781	13,251,448	100%	

The plan was to charge a flat $5.00 rate per single-family house and allocate the multiplexes and commercials on a cost per square foot. Table 2 does that based on total annual revenues of $400,000. The rate is $2.90 per 1,000 square feet of impervious surface. Commercial excludes Norpac since they have their own discharge permit.

Table 2 Storm Water Rates and Projected Revenues and Monthly Bills

	Rate per		Annual Revenue		Average Monthly Bill	Maximum Monthly Bill
Single Family Residential	$5.00	House	$133,920	33%	$5.00	$5.00
Multiplexes	$2.90	1,000 sq ft	16,926	4%	$10.08	$27.20
Commercial	$2.90	1,000 sq ft	250,040	62%	$50.95	$1,410.13
Totals			$400,886			

At this rate, the monthly bill for the largest commercial customers will exceed $1,000. Table 3 shows a frequency distribution of all commercial properties. The largest 10 to 14 properties likely will have

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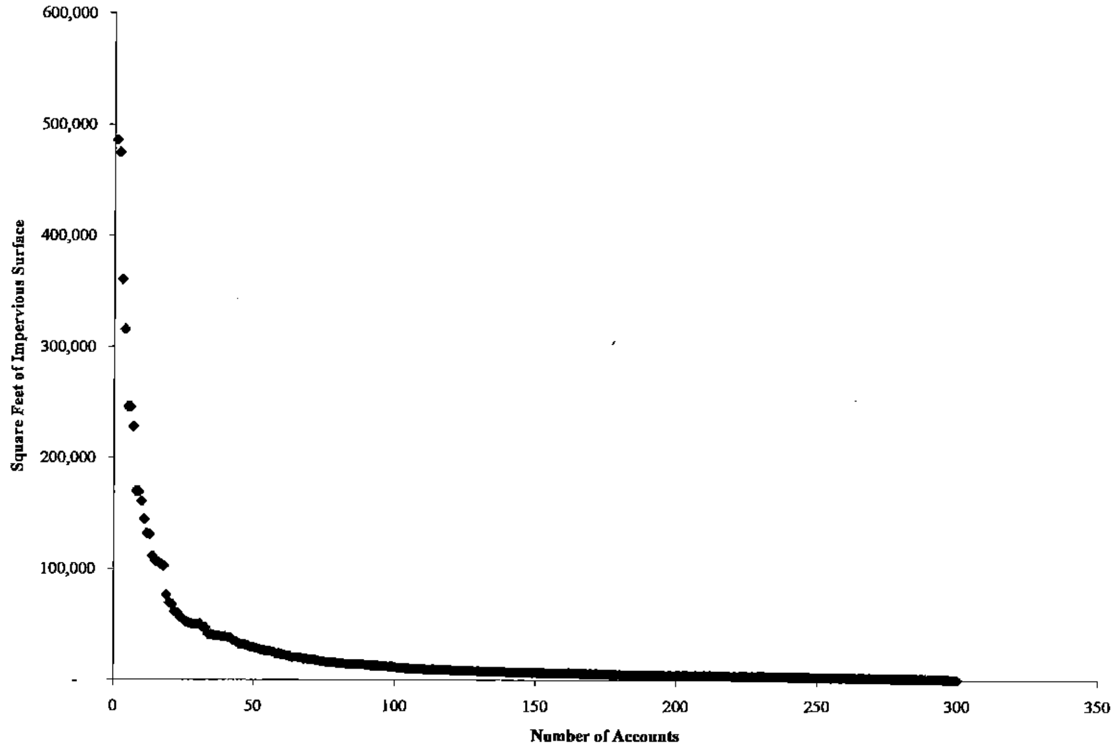
a problem with the rate as is. Figure 1 shows a scatter graph of all of the commercial properties. Notice that only 16 accounts are over 100,000 square feet. Of course it is more equitable to charge based on actual square feet for all uses, but we could consider either capping the monthly charge at some level, or reducing the rate and settling for less total revenue per year.

I'm out of town most of today and all day Friday, but I would like to discuss this issue with you on Monday or Tuesday next week and come to a resolution before finalizing the storm water rate analysis.

Table 3 Frequency of Commercial Accounts by Range of Impervious Surfaces

Range in Sq Ft			Monthly Bills		
Bottom	Top	Frequency	Bottom	Mid Point	Top
0	1,000	113		$1.45	$2.90
1,001	5,000	111	$2.90	$8.70	$14.50
5,001	9,000	63	$14.50	$20.30	$26.10
9,001	13,000	29	$26.10	$31.90	$37.70
13,001	17,000	20	$37.70	$43.50	$49.30
17,001	21,000	10	$49.30	$55.10	$60.90
21,001	25,000	6	$60.90	$66.70	$72.50
25,001	29,000	7	$72.50	$78.30	$84.10
29,001	33,000	6	$84.10	$89.90	$95.70
33,001	37,000	2	$95.70	$101.50	$107.30
37,001	41,000	8	$107.30	$113.10	$118.90
41,001	45,000	1	$118.90	$124.70	$130.50
45,001	49,000	2	$130.50	$136.30	$142.10
49,001	53,000	6	$142.10	$147.90	$153.70
53,001	57,000	2	$153.70	$159.50	$165.30
57,001	61,000	1	$165.30	$171.10	$176.90
61,001	65,000	1	$176.90	$182.70	$188.50
65,001	69,000	1	$188.50	$194.30	$200.10
69,001	73,000	1	$200.10	$205.90	$211.70
73,001	77,000	1	$211.70	$217.50	$223.30
77,001	81,000	0	$223.30	$229.10	$234.90
81,001	85,000	0	$234.90	$240.70	$246.50
85,001	89,000	0	$246.50	$252.30	$258.10
89,001	93,000	0	$258.10	$263.90	$269.70
93,001	97,000	0	$269.70	$275.50	$281.30
97,001	101,000	0	$281.30	$287.10	$292.90
101,001	110,000	4	$292.90	$305.95	$319.00
110,001	210,000	7	$319.00	$464.00	$609.00
210,001	310,000	3	$609.00	$754.00	$899.00
310,001	410,000	2	$899.00	$1,044.00	$1,189.00
410,001	510,000	2	$1,189.00	$1,334.00	$1,479.00

Figure 1 Scatter Graph of Commercial Accounts by Square Feet of Impervious Surface



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SUMMARY

The City of Stayton currently pays for stormwater operations and maintenance from its public works department. This department receives revenues from the sanitary sewer, water, and general funds. It has paid for capital improvements with contributed capital from private developers and as part of other public works projects such as roadway and sewer line construction. Financially, the stormwater utility is split among these funds.

To more effectively manage the stormwater utility, the City needs to create the stormwater utility as a separate enterprise fund and eventually establish a schedule of rates and charges to pay for it.

The analysis shows that a beginning storm water rate of $5.00 per single family house ($0.002 per square foot for all other land uses) will produce sufficient revenue to pay for operating costs, debt service, and to build a capital reserve to periodically pay for capital improvements.

CURRENT STORMWATER FINANCING

In this section, we estimate the City's current operation and maintenance expenses for stormwater, and estimate what the City should be spending to maintain the current stormwater system. Since the City has not kept track of stormwater as a separate utility, we compiled the financial information available and acknowledge that it provides an incomplete financial picture of the utility.

Table 1 shows the cash flow history and identifies missing information. For operating activities, the City transfers money from the General Fund, which is usually from the state-shared gas-tax revenues, for operating expenses. Notice that the utility does not have operating receipts of its own, such as water rates for the water utility. It also does not specifically identify personal services (labor expenses). These expenses are borne by the Public Works Department who's revenues come from sewer and water rates, and general fund revenues such as the gas tax.

For capital and capital related activities, the City undertakes storm drainage projects as cash is made available from other funds, often gas tax revenues. The City completed some storm drain repairs to its existing storm drainage lines and catch basins, installation of new facilities in Shaff Road in 2005-06 ($8,522, and in 2006-07 ($184,000). It also paid for a stormwater master plan, ($69,300 in 2006-07).

Since the stormwater utility does not exist as a financial entity, it does not accumulate cash savings or earn interest on investments. The utility existed in the General Fund until fiscal year 2006-07, when it was transferred to the sewer fund, as part of the sanitary sewer utility. The City has not been keeping accounting records on the actual cost of labor to operate the system, and repairs and maintenance of the system has had to compete with other capital projects, such as street repairs, for money to make capital improvements.

Table 1 Cash Flow History, Stormwater Utility

	Audit		Estimate	Budget
	2004 2005	2005 2006	2006 2007	2007 2008
CASH FLOWS FROM OPERATING ACTIVITIES				
Operating Receipts				
Transfers from the Street Fund	2,319	11,781	25,860	18,025
Total Operating Receipts	2,319	11,781	25,860	18,025
Operating Expenditures				
Personal services				
Materials and services	2,319	11,781	25,860	18,025
Total Operating Expenditures	2,319	11,781	25,860	18,025
Net Cash Provided by Operating Activities	-		-	-
CASH FLOWS FROM CAPITAL AND RELATED FINANCING ACTIVITIES				
System development charges				
Capital expenditures	(7,413)	(28,127)	(253,300)	(30,000)
Bond/Loan Proceeds				
Grants				
Bond/Loan Closing Expense				
Transfers from other City funds	7,413	28,127	253,300	30,000
Net Cash Provided by (Used in) Capital and Related Financing Activities	-	-	-	-
CASH FLOWS FROM INVESTING ACTIVITIES:				
Interest income on investments				
Net Increase (Decrease) in Cash & Cash Equivalents	-	-	-	-
CASH AND CASH EQUIVALENTS - July 1	-	-	-	-
CASH AND CASH EQUIVALENTS - June 30	-	-	-	-

Source: City of Stayton, annual financial reports and budgets.

PROPOSED STORMWATER FINANCING

Keller Associates, Inc. evaluated the labor requirements and capital improvements needed by the existing stormwater system, and estimate the following annual costs of operation. The existing system is composed of approximately 13 miles of storm drain lines with 650 catch basins.

To maintain this system, Keller Associates estimates labor requirements of 1.2 full time equivalents (FTE) public works staff. The total annual cost of wages, benefits, and taxes is $70,000 per year per FTE. The total annual cost in 2007 dollars is $84,000 for staff. Keller Associates also estimate annual costs of materials and services for cleaning and routine maintenance is $15,000 per year in 2007 dollars.

Keller Associates estimates a remaining useful life of 40 years during which time much of the system will need to be replaced or substantially reconstructed. In 2007 dollars, each catch basin costs on average $1,100 and the drainage lines cost $85 per lineal foot to replace. The total replacement value of the system is $6.55 million. To properly repair the system, all of it will have to be replaced over the next 40 years at a cost in 2007 dollars of $164,000 per year.

Keller Associates estimates that the current system has an average 40-year life cycle and at the current size and replacement cost, the City will have to spend about $192,000 per year in 2007 dollars perpetually repair and replace the existing stormwater system.

In addition, Keller Associates estimates that recurring operating costs should amount to about $166,000 per year in 2007 dollars: $87,500 for 1.25 full-time equivalent public works staff, $12,000 for water quality laboratory fees, $36,500 for storm-water line cleaning and TV inspection of the lines, and $30,000 for seasonal maintenance.

In addition to these recurring annual costs, Keller Associates identified capital improvement projects needed to alleviate current stormwater problems and to provide for future capacity as population and employment grow. Table 2 shows the list of capital improvements that amount to $25.9 million 2007 dollars.

Table 2 Complete List of Capital Improvements, 2007 Dollars

Item (2007 Project Costs*)	% Benefit Growth	Growth (SDC)	Current (Rates)	Total
PRIORITY 1 (2008)				
Priority 1A				
Wetland Preservation	60%	429,000	286,000	715,000
Shaff Road Detention Basin and Piping	10%	175,470	1,579,230	1,754,700
10th Ave Detention Basin and Piping	15%	114,765	650,335	765,100
Subtotal Priority 1A		719,235	2,515,565	3,234,800
Priority 1B				
Industrial Detention Site Improvements	25%	23,750	71,250	95,000
Shaff Road Basin Pipeline Improvements	5%	178,775	3,396,725	3,575,500
10th Avenue Pipeline Improvements	15%	122,775	695,725	818,500
Norpac NE Detention Site	0%	0	620,800	620,800
5 Additional Manhole Monitoring Equipment	0%	0	96,700	96,700
Subtotal Priority 1B		325,300	4,881,200	5,206,500
Total Priority 1		1,044,535	7,396,765	8,441,300
PRIORITY 2 (2010)				
Fir to Regis through Regis HS Parking Lot	5%	17,940	340,860	358,800
Evergreen Ave to Norpac Dtn Site	5%	28,780	546,820	575,600
3rd and Jefferson to Library Dtn Site	5%	105,750	2,009,250	2,115,000
Millstream Woods to Norpac SW Dtn Site	10%	197,540	1,777,860	1,975,400
Total Priority 2		350,010	4,674,790	5,024,800
PRIORITY 3 (2015)				
Sylvan Meadows Subdivision	0%		72,100	72,100
Gardner Road-Regis High School	5%		637,800	637,800
Wedgewood Place	0%		736,600	736,600
Western Avenue	0%		732,400	732,400
Total Priority 3		0	2,178,900	2,178,900
PRIORITY 4 (2020)				
Library Improvements	0%		49,500	49,500
1st Avenue	0%		122,300	122,300
Washington Street Area	42%	90,972	125,628	216,600
North Peach Street	50%	41,250	41,250	82,500
Pacific Court			349,600	349,600
Fern Ridge Street Area	34%	578,476	1,122,924	1,701,400
Dozler Property Area	48%	355,584	385,216	740,800
Phillips Property Area	87%	1,732,953	258,947	1,991,900
Larch Avenue	0%	0	130,200	130,200
Detention Facilities	98%	3,333,960	68,040	3,402,000

Item (2007 Project Costs*)	% Benefit Growth	Growth (SDC)	Current (Rates)	Total
Pipeline Upsize Costs (over 18")	0%		1,430,800	1,430,800
Total Priority 4		6,133,195	4,084,405	10,217,600
TOTAL (rounded)		7,527,740	18,334,860	25,862,600

As Table 3 shows, about $7.5 million of these projects will benefit and be paid by future development and likely will be funded from a system development charge. Each future development will pay its proportionate share of the cost of these projects. The majority of the projects and their costs, approximately $18 million, will have to be paid by all of the City's residents and businesses.

The City currently has no specific rates or charges to pay for either operating costs or capital improvements. The City also may qualify for and apply to one of the many federal and state grant and loan programs described in the Appendix. In this forecast, we assume that the City does not receive any federal or state grants. Projects are scheduled to meet cash flow and assuming one large project, Shaff Road Detention Basin and pipeline, is financed with revenue bonds (approximately $4.1 million) or as a loan from a state of Oregon agency such as DEQ or the OECDD.

Also, we limit the projects to be funded from 2010 through 2020 and to Priority 1 projects only. The lower the priority the less urgent they are needed, in part because they benefit future development; and, are more likely to be funded from SDC revenues.

We assume the revenue bond will be issued in fiscal year 2011-12 to pay for the Shaff Raod regional detention facility. This project is important because it will accommodate 10.4 acre feet of storage volume collected from the largest drainage basin, reducing peak stormwater runoff into the Salem Ditch. It will be designed to provide water quality treatment, and could double as a recreation area during dry periods. Since this detention pond will serve most of the already developed portions of the City, only 10 percent is allocated to future development. By that time, the stormwater user fee will have to be sufficient to pay all operating costs and interest and principal payments on the bonds. Since the stormwater utility will not have a sufficient financial history to issue the bonds without support from the sewer or water funds. Likely, the City will have to pledge net revenues from the sewer fund to help secure the stormwater revenue bonds. The City may also be able to apply to the State of Oregon for direct state loans that would not require a secondary pledge of sewer or water revenues.

The other projects in Priority 1 will be funded from cash reserves, net cash flows from operating activities, and accumulated SDC revenues. None of the Priority 2, 3, or 4 projects are scheduled to be completed until after 2020.

How these projects are to be paid for is shown in Tables 4 and 5. Table 4 is a list of forecast assumptions including the forecast of storm water rates. Table 5 is the cash flow forecast. Missing from the forecast is any grant funding that may become available from one or more of the sources listed in the Appendix.

Table 3 Priority 1 & 2 Capital Improvements, 2007 Dollars

	Total Cost 2007 $'s	2009 2010	2010 2011	2011 2012	2012 2013	2013 2014	2014 2015	2015 2016	2016 2017	2017 2018	2018 2019	2019 2020
PRIORITY 1 (2008)												
Priority 1A												
Wetland Preservation	715,000		312,000						203,000			232,000
Shaff Road Detention Basin and piping	1,754,700		240,000	250,000	262,000							
10th Ave Detention Basin and piping	765,100											248,000
Subtotal Priority 1A	3,234,800		552,000	250,000	802,000				203,000			480,000
Priority 1B												
Industrial Detention Site Improvements	95,000											
Shaff Road Basin Pipeline Improvements	3,575,500			4,080,000								
10th Avenue Pipeline Improvements	818,500											
Norpac NE Detention Site	620,800											
5 Additional Manhole Monitoring Equipement	96,700											
Subtotal Priority 1B	5,206,500			4,080,000								
Total Priority 1	8,441,300		552,000	4,330,000	802,000				203,000			480,000
PRIORITY 2 (2010)												
Fir to Regis through Regis HS Parking Lot	358,800											
Evergreen Ave to Norpac Dtn Site	575,600											
3rd and Jefferson to Library Dtn Site	2,115,000											
Millstream Woods to Norpac SW Dtn Site	1,975,400											
Total Priority 2	5,024,800											
TOTAL (rounded)	13,466,100	0	552,000	4,330,000	802,000	0	0	0	203,000	0	0	480,000

Table 4 Cost of Annual Repair & Replacement

	2009 2010	2010 2011	2011 2012	2012 2013	2013 2014	2014 2015	2015 2016	2016 2017	2017 2018	2018 2019	2019 2020
Growth Rate	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Square feet of billable impervious surface	17,600,000	17,950,000	18,310,000	18,680,000	19,050,000	19,430,000	19,820,000	20,220,000	20,620,000	21,030,000	21,450,000
Rate Changes	5.00%	10.0%	9.1%	8.3%	3.8%	0.0%	0.0%	3.7%	3.6%	3.4%	3.3%
Rate/Month, Avg. SF Residential (2,500 sq ft)	$5.00	$5.50	$6.00	$6.50	$6.75	$6.75	$6.75	$7.00	$7.25	$7.50	$7.75
Rate, $/1,000 sq ft/month	$2.00	$2.20	$2.40	$2.60	$2.70	$2.70	$2.70	$2.80	$2.90	$3.00	$3.10
System Development Charge	$2,000	$2,090	$2,180	$2,280	$2,380	$2,490	$2,600	$2,720	$2,840	$2,970	$3,100
SDC/sq ft	$0.73	$0.76	$0.79	$0.83	$0.87	$0.91	$0.95	$0.99	$1.03	$1.08	$1.13
Inflation											
Labor	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%	7.50%
Materials & Services	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
Construction Cost Index	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
Annual Repair & Replacement	192,000	201,000	210,000	219,000	229,000	239,000	250,000	261,000	273,000	285,000	298,000

Table 5 Cash Flow Forecast, Stormwater Utility

	2009 2010	2010 2011	2011 2012	2012 2013	2013 2014	2014 2015	2015 2016	2016 2017	2017 2018	2018 2019	2019 2020
CASH FLOWS FROM OPERATING ACTIVITIES											
Receipts from customers											
Customer Service Charges	422,400	473,880	527,328	582,816	617,220	629,532	642,168	679,392	717,576	757,080	797,940
Total receipts	422,400	473,880	527,328	582,816	617,220	629,532	642,168	679,392	717,576	757,080	797,940
Payments to suppliers & contractors	48,000	52,000	56,000	60,000	65,000	70,000	75,000	81,000	87,000	94,000	101,000
Payments to employees	87,000	94,000	101,000	109,000	117,000	126,000	135,000	145,000	156,000	168,000	181,000
Seasonal maintenance employees	30,000	32,000	34,000	37,000	40,000	43,000	46,000	49,000	53,000	57,000	61,000
Total expenses	135,000	146,000	157,000	169,000	182,000	196,000	210,000	226,000	243,000	262,000	282,000
Net cash from operating activities	287,400	327,880	370,328	413,816	435,220	433,532	432,168	453,392	474,576	495,080	515,940
CASH FLOWS FROM CAPITAL AND RELATED FINANCING ACTIVITIES											
Acquisition of property & plant	-	(552,000)	(4,330,000)	(262,000)	-	-	-	(203,000)	-	-	(480,000)
Annual capital replacement	(192,000)	(201,000)	(210,000)	(219,000)	(229,000)	(239,000)	(250,000)	(261,000)	(273,000)	(285,000)	(298,000)
SDC Revenues	213,000	213,000	228,000	246,000	258,000	277,000	296,000	317,000	330,000	354,000	380,000
Loan and Bond Proceeds			4,418,000								
Cost of issuance			(88,000)								
Principal paid on long-term obligations			-	(130,120)	(136,951)	(144,141)	(151,709)	(159,674)	(168,056)	(176,879)	(186,166)
Interest paid on long-term obligations			(115,973)	(231,945)	(225,114)	(217,924)	(210,356)	(202,392)	(194,009)	(185,186)	(175,900)
Net cash from capital and related financing activities	21,000	(540,000)	(97,973)	(597,065)	(333,065)	(324,065)	(316,065)	(509,065)	(305,065)	(293,065)	(760,065)
CASH FLOWS FROM INVESTING ACTIVITIES											
Interest on investments		1,500	5,600	2,900	4,500	6,300	8,100	7,400	10,100	13,300	9,800
NET INCREASE (DECREASE) IN CASH	308,400	(210,620)	277,956	(180,349)	106,655	115,767	124,203	(48,273)	179,611	215,315	(234,325)
CASH, BEGINNING OF YEAR	-	308,400	97,780	375,736	195,386	302,041	417,808	542,011	493,738	673,348	888,663
CASH, END OF YEAR	308,400	97,780	375,736	195,386	302,041	417,808	542,011	493,738	673,348	888,663	654,338

Rather than speculate on grants in the forecast, any grant funding can be applied to projects in Priority 1 or 2 that are not scheduled for funding in Table 3.

The forecast assumptions assume a 2.5 percent per year growth in the amount of impervious surfaces that are billable. The amount of square footage that is billable is explained in the next section of the report. Also, explained below is the discussion of how we arrived at the forecast of storm water rates. They begin at $5.00 per month per single-family house and $0.002 per square foot for all multiple family and non-residential uses, excluding City properties (city hall, parks, and public works).

The system development charge is developed in a separate report and begins at $2,000 single-family house and $0.73 per square foot of impervious surface for multiple family and all non-residential developments excluding City properties.

Operating costs are forecast to increase at the same rates as those for the City's other utilities—sewer and water. The cost of capital improvements increases at 4.5 percent per year. And the City expects to send $192,000 per year beginning in 2010 to repair and replace existing storm water infrastructure.

The cash flow forecast shows the financial consequences of the planned capital improvements schedule, operating costs, receipts from customers, SDC revenues, and of one financing. The financing is for $4.418 million in fiscal year 2011-12 at 5.25 percent interest and a term of 20 years. It also includes an amount equal to 2 percent of the bond amount for bond issuance costs. The annual debt service is approximately $362,000. The City may obtain better terms than this forecast by extending the term to 25 years, or by applying to the State of Oregon for a direct loan.

These cash flows result in a growing cash balance at the end of each year through about fiscal year 2014-15. After that time the City alternatives between accruing cash reserves and making capital improvements. The cash balance is kept above $500,000 in anticipation of some projects on the CIP that may be needed before 2020.

PROPOSED STORMWATER RATES

In general, the monthly storm water rate equals a potion of total annual cost of owning and operating the storm sewer system divided by the total amount of billable square feet of impervious surface divided by 12 months. Total annual costs are adjusted to account for system development charges and proceeds from new debts issued to make capital improvements. This adjusted amount is the amount of revenue required to be collected from the storm water rate applied to all storm water customers.

Equation 1

$$\textit{Monthly Storm Water Rate} = \text{Revenue Requirement} \Big/ \textit{Total Square Feet of Billable Impervious Surface} \Big/ \textit{12 Months}$$

In this equation, the Total Annual Cost equals total expenses, plus annual debt service on outstanding debts, plus an amount for Annual Capital Replacement, plus an amount for cash acquisition of capital improvements not covered by the system development charge. Table shows the forecast of annual revenue requirements. Notice that the last item in the revenue requirements is positive or negative depending on whether the net income is positive or negative. A positive number means that cash is being saved for future capital improvements and a negative number indicates that money is being spent on CIP projects. The future storm water rates are based on the monthly average total revenue requirements. This forecast of costs to recovered from storm water rates is divided by the total number of users' impervious surface to calculate the storm water rate.

For this initial analysis of storm water rates, we have to estimate the billable impervious surface. Impervious surface is all area covered by the footprint of the building, driveways, hard-surfaces parking lots and turning areas, private hard-surface walkways (excluding the sidewalks in public rights of way), and bare earth covered by a permanent roof. Impervious surface is land that no longer absorbs precipitation naturally.

The storm water master plan measured all of the impervious surfaces—public and private. The City currently has approximately 53.5 million square feet of impervious surface, however, only the impervious surface on private property is billable. To determine this amount, EFA surveyed a number of cities in Oregon that have established storm water user rates and extrapolated that data to Stayton based primarily on population. On average, a city in our survey has about 3,629 square feet of private impervious surface per single family housing unit. That multiplied by the number of single family houses in Stayton, 2,841, results in an estimate of 16.6 million square feet of private impervious surface. In the forecast, EFA uses the 16.6 million square feet as the Total Square Feet of Billable Impervious Surface in Equation 1, above.

To implement the rate, the City will have to "measure" the amount of impervious surface per customer. In the forecast, EFA assumes the City will use an average square footage per single family housing unit, and review tax assessment records to determine the square footage for multiple family and non-residential users. After these measurements have been made, the City will adjust the initial storm water rate presented in this report to produce the amount of revenue required to fund the utility. The estimates presented here are adequate for planning purposes and are likely to require only minor adjustment.

In the forecast, EFA assumes the private impervious surface will increase at the same rate as the population growth, 2.5 percent per year. For the initial rate the City has chosen to peg the rate for a single family residence at $5.00 per month and assumes a house has impervious surfaces of 2,500 square feet.

This area is an average of the footprint of the buildings, plus the driveway(s), and impervious patio areas on site. The rate per square foot for multiple family and all non-residential uses is $0.002 per square foot ($5.00 / 2,500 square feet) or $2.00 per 1,000 square feet of impervious surface.

This rate is approximately at the bottom of the top quartile of cities surveyed. After the first year, the forecast assumes the rate will increase $0.50 per single family house ($0.0002 per square foot) each year for the following 2 years, then by $0.25 per single family house ($0.0001) until it reaches $6.75 per single family house ($0.0027 / sq. ft.) in fiscal year 2013-14.

Table 6 Total Annual Revenue Requirements

	2009 2010	2010 2011	2011 2012	2012 2013	2013 2014	2014 2015	2015 2016	2016 2017	2017 2018	2018 2019	2019 2020
Total Annual Revenue Requirements	422,400	473,880	527,328	582,816	617,220	629,532	642,168	679,392	717,576	731,844	772,200
Operating Costs	121,900	131,000	141,000	152,000	163,000	175,000	188,000	202,000	217,000	234,000	252,000
Annual capital replacement	192,000	201,000	210,000	219,000	229,000	239,000	250,000	261,000	273,000	285,000	298,000
Debt Service	-	-	115,973	362,065	362,065	362,065	362,065	362,065	362,065	362,065	362,065
Savings for (Acquisition of) CIP	108,500	141,880	60,355	(150,249)	(136,845)	(146,533)	(157,897)	(145,673)	(134,489)	(149,221)	(139,865)
Total Annual Revenue Requirements	422,400	473,880	527,328	582,816	617,220	629,532	642,168	679,392	717,576	731,844	772,200
	-	-	-	-	-		-	-	-	-	-

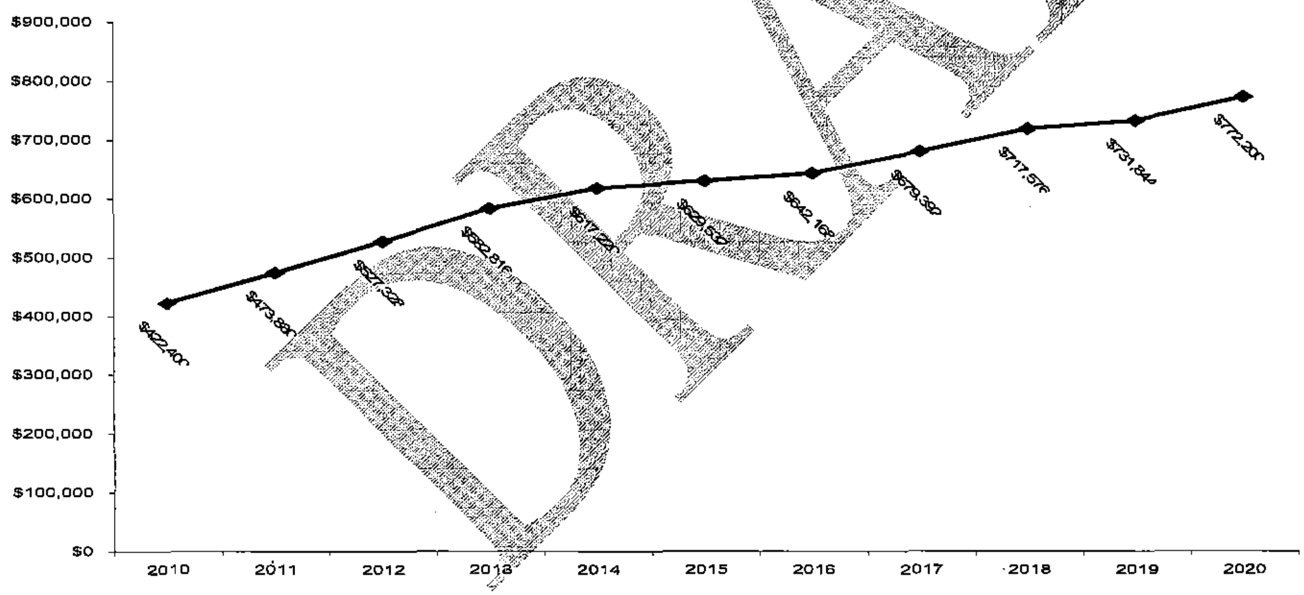


Table 7 Stormwater Rate Comparison, Oregon Cities

City / Agency	Monthly Storm Water Fee Single-family house	**Rank**
Gresham	$7.65	**1**
Fairview	$7.43	**2**
Independence	$5.35	**3**
Stayton - proposed	$5.00	**4**
Corvallis	$4.98	**5**
Clean Water Services (Urban Washington County)	$4.00	**6**
Oregon City	$4.00	**6**
West Linn	$3.94	**8**
Wilsonville	$3.72	**9**
Roseburg	$3.35	**10**
Newberg	$3.29	**11**
Troutdale	$3.24	**12**
Keizer	$2.70	**13**
Lafayette	$2.62	**14**
Salem	$2.56	**15**
Molalla	$2.00	**16**
Average	$4.11	

APPENDIX A

Program Name	Overview	Potential Application to Statyon's Stormwater Master Plan
Access & Habitat Program, Oregon Department of Fish & Wildlife	To qualify for A&H funding, a project must improve wildlife habitat and/or increase public hunting access to private land. A&H activities are designed to be grassroots in nature and encourage cooperative working relationships....	This funding could be used for the wetland preservation or riparian creation along detention swales if it can be shown to improve wildlife habitat
Bonneville Environmental Foundation Watershed Program	BEF supports only long-term (10-year) and monitoring-intensive Model Watershed restoration programs. In selected Model Watersheds, BEF provides 10-year funding to support monitoring and assessment activities, long-term oversight, and the services of an i...	Can be used to fund TMDL Implementation Plan water quality monitoring and BMP implementation because it is part of the Willamette Basin restoration.
Bullitt Foundation - Aquatic Ecosystems Program	The mission of The Bullitt Foundation is to protect, restore, and maintain the natural physical environment of the Pacific Northwest for present and future generations. The Foundation invites proposals from nonprofit organizations that serve Washington, O...	Can be used for water quality measures or possibly for wetland. Cannot be used for land acquisition.
Bullitt Foundation - Training, Communications, and Unique Opportunities	The mission of The Bullitt Foundation is to protect, restore, and maintain the natural physical environment of the Pacific Northwest for present and future generations. The Foundation invites proposals from nonprofit organizations that serve Washington, O...	Could be used for the purchase of water quality monitoring samplers or other technology needs related to the master plan implementation.
Clean Water State Revolving Fund Loan Program - Oregon	The Clean Water State Revolving Fund (CWSRF) Loan Program provides low-cost loans for the planning, design and construction of water pollution control facilities and activities. Oregon's DEQ is committed to working with Oregon communities to attain or mai...	Can be used to fund non-point source pollution reduction strategies in the implementation plan.
Drinking Water Protection Loan Fund (DWPLF) - Oregon	The Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund (DWSRF) to make funds available to drinking water systems to finance infrastructure improvements. The program also emphasizes providing funds to small and...	This loan might be applicable to stormwater activities that reduce pollutant loading to surface or ground water used for drinking water.
Environmental Monitoring for Public Access and Community Tracking (EMPACT) Grants, EPA	The goal of EMPACT is to provide public access to clearly communicated, time-relevant, useful, and accurate environmental monitoring data in an ongoing and sustainable manner in 86 of the largest U.S. metropolitan areas. Projects may address clean air, cl...	Could be used for the purchase of water quality monitoring samplers.
Environmental Systems Research Institute (ESRI) Conservation Program	ESRI provides donations and discounts of Geographic Information Systems (GIS) software, data, books, and training to	Could get training and software for GIS system expansion for continued

Program Name	Overview	Potential Application to Statyon's Stormwater Master Plan
	non-profits, governments, and other eligible groups....	stormwater mapping.
FishAmerica Foundation	The Fish America Foundation's mission is to provide funding for local, hands on-projects to enhance fish populations, restore fisheries habitat, improve water quality, and advance fisheries research in North America to increase the opportunity for sports...	Could be used for portions of the master plan shown to improve the water quality to fish habitats such as the Mill Creek or the North Santiam.
Flood Mitigation Assistance Program, FEMA	FMA provides funding to assist States and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program (NFIP). Th...	Can be used for general capital improvement funding that mitigates flooding risks.
General Purpose Grants - M.J. Murdock Charitable Trust	The Trust's mission is to enrich the quality of life in the Pacific Northwest by providing grants to organizations that seek to strengthen the region's educational and cultural base in creative and sustainable ways. Although major emphases are education...	Projects shown to enhance the quality of life - especially for youth. This could aid in funding a youth internship for water quality monitoring or restoration projects. This would fill public education requirements of the NPDES phase II program.
Hatfield Restoration Program, Oregon	Former U.S. Senator Mark O. Hatfield established the Upper Klamath Basin Working Group (UKBWG) to address ecosystem restoration and water quality, economic stability, and drought impacts. Funding is available for projects which address watershed restoration...	Applicable to watershed restoration projects.
Jubitz Family Foundation	AREAS OF INTEREST: • Early childhood development and youth education, with an emphasis on children at-risk. • Environmental stewardship, with an emphasis on rivers and their watershed ecosystems. • Peacemaking activities, with an emphasis on teaching p...	River and watershed ecosystem projects such as the wetlands, erosion prevention, riparian management etc.
Land and Water Conservation Fund - Oregon	Land & Water Conservation Fund grant funds may be used for the acquisition and development of state and local facilities that provide recreational opportunities. Recreation enhancement may be accomplished through the preservation of open space, forests, ...	Could be used for detention facilities that double as recreational facilities.
Lawrence Foundation, The	The Lawrence Foundation makes contributions and grants to organizations that are working to solve pressing educational, environmental, and health issues....	General applicability to stormwater improvements funding
Nonpoint Source Implementation Grant (319) Program - Oregon	Section 319 of the 1987 Clean Water Act authorizes grants for implementation of nonpoint source pollution control programs	Non-point source bmp funding

Program Name	Overview	Potential Application to Statyon's Stormwater Master Plan
	and projects to help protect or improve water quality. The Department of Environmental Quality, the state agency authorized to carry...	
Oregon Wildlife Heritage Foundation	The mission of the Oregon Wildlife Heritage Foundation is to initiate, organize, and support projects through public and private partnerships that benefit Oregon's Fish and Wildlife....	Projects shown to enhance fish and wildlife habitats
Pacific Grassroots Salmon Initiative, National Fish and Wildlife Foundation	The PGSI seeks to catalyze and support salmon-friendly activities at the local, grassroots level in west-coast states of California, Oregon, and Alaska. The initiative will benefit native anadromous fishes and their aquatic and riparian habitats through p...	If salmon are in either the Mill Creek or N. Santiam, projects improving the quality of those rivers may qualify for funding.
Partnership Planning Grants for Economic Development Districts, Indian Tribes, & Other Eligible Area	Planning grants provide support for the formulation and implementation of local economic development programs as well as strategies designed to create and retain permanent jobs and income, and provides new employment opportunities in economically distress...	Implementation of some of the stormwater improvements both enhance the city and provide permanent jobs.
Pedestrian & Bicycle Facility Improvement Grant Program	Oregon's Bicycle and Pedestrian Program provides funding for bicycle and pedestrian improvements. ...	This could be used in conjuction with regional detention facilities that double as parks, walking paths, and recreation sites.
PGE Foundation	The Foundation's giving interests include art and humanities, civic and public affairs, education, the environment, health and social services. The Foundation seeks to preserve and enhance environmental quality throughout Oregon. We support a variety of ...	General applicablity to stormwater improvements funding
Plum Creek Foundation	The Plum Creek Foundation is the major channel of philanthropy for Plum Creek Timber Company, Inc. and its subsidiaries. The Plum Creek Foundation has been established to provide a philanthropic contribution program to support and improve the general welf...	Applies to community development, parks and recreation facilities, and public education portions of the master plan or TMDL implementation plan.
Recreational Trail Program (RTP) Grants - Oregon	The RTP is a Federal-aid assistance program to help States provide and maintain recreational trails for both motorized and non-motorized trail use. The program provides funds for all kinds of recreational trail use, such as pedestrian use, which includes	Applies to trails as related to parks and detention facilities
Renewable Energy Program, Bonneville Environmental Foundation	The Bonneville Environmental Foundation (BEF) was founded in 1998 to support watershed restoration programs and develop	Applies to watershed restoration facets of stormwater master plan or TMDL IP

Program Name	Overview	Potential Application to Statyon's Stormwater Master Plan
	new sources of renewable energy. Funding for these efforts has been provided in a way that would be called unusual for most foundations...	
Watershed Restoration Grant Program, OWEB	OWEB focuses on projects that approach natural resources management from a whole-watershed perspective. OWEB encourages projects that foster interagency cooperation, include other sources of funding, provide for local stakeholder involvement, include yout...	Applies generally to the stormwater master plan

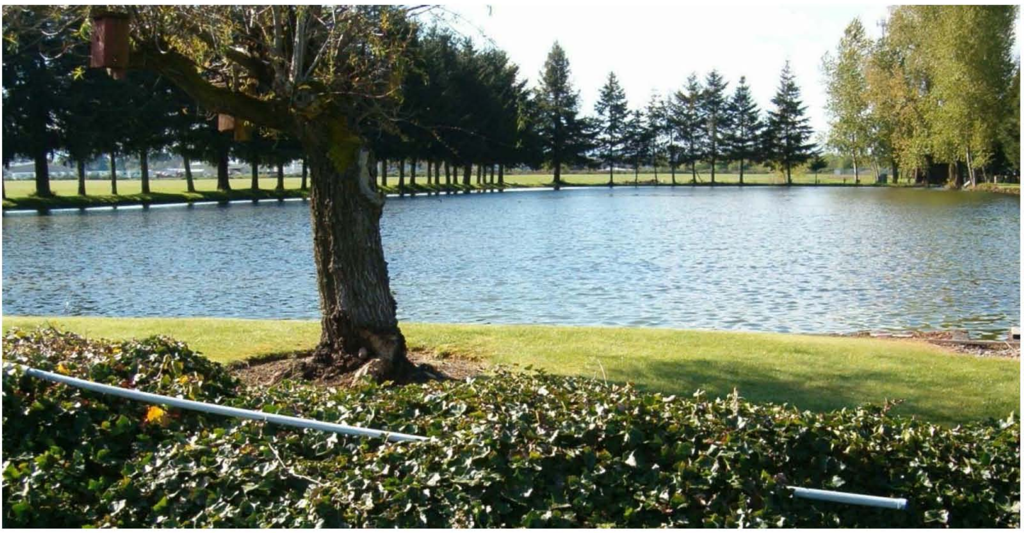
Appendix G.2

Storm Water Grants

KELLER associates

Program Name	Overview	Potential Application to Statyon's Storm Water Master Plan
Access & Habitat Program, Oregon Department of Fish & Wildlife	To qualify for A&H funding, a project must improve wildlife habitat and/or increase public hunting access to private land. A&H activities are designed to be grassroots in nature and encourage cooperative working relationships....	This funding could be used for the wetland preservation or riparian creation along detention swales if it can be shown to improve wildlife habitat
Bonneville Environmental Foundation Watershed Program	BEF supports only long-term (10-year) and monitoring-intenisve Model Watershed restoration programs. In selected Model Watersheds, BEF provides 10-year funding to support monitoring and assessment activities, long-term oversight, and the services of an i...	Can be used to fund TMDL Implementation Plan water quality monitoring and BMP implementation because it is part of the Willamette Basin restoration.
Bullitt Foundation - Aquatic Ecosystems Program	The mission of The Bullitt Foundation is to protect, restore, and maintain the natural physical environment of the Pacific Northwest for present and future generations. The Foundation invites proposals from nonprofit organizations that serve Washington, O...	Can be used for water quality measures or possibly for wetland. Cannot be used for land acquistion.
Bullitt Foundation - Training, Communications, and Unique Opportunities	The mission of The Bullitt Foundation is to protect, restore, and maintain the natural physical environment of the Pacific Northwest for present and future generations. The Foundation invites proposals from nonprofit organizations that serve Washington, O...	Could be used for the purchase of water quality monitoring samplers or other technology needs related to the master plan implementation.
Clean Water State Revolving Fund Loan Program - Oregon	The Clean Water State Revolving Fund (CWSRF) Loan Program provides low-cost loans for the planning, design and construction of water pollution control facilities and activities. Oregon's DEQ is committed to working with Oregon communities to attain or mai...	Can be used to fund non-point source pollution reduction strategies in the implementation plan.
Drinking Water Protection Loan Fund (DWPLF) - Oregon	The Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund (DWSRF) to make funds available to drinking water systems to finance infrastructure improvements. The program also emphasizes providing funds to small and...	This loan might be applicable to storm water activities that reduce pollutant loading to surface or ground water used for drinking water.
Environmental Monitoring for Public Access and Community Tracking (EMPACT) Grants, EPA	The goal of EMPACT is to provide public access to clearly communicated, time-relevant, useful, and accurate environmental monitoring data in an ongoing and sustainable manner in 86 of the largest U.S. metropolitan areas. Projects may address clean air, cl...	Could be used for the purchase of water quality monitoring samplers.
Environmental Systems Research Institute (ESRI) Conservation Program	ESRI provides donations and discounts of Geographic Information Systems (GIS) software, data, books, and training to non-profits, governments, and other eligible groups....	Could get training and software for GIS system expansion for continued storm water mapping.
FishAmerica Foundation	The FishAmerica Foundation's mission is to provide funding for local, hands on-projects to enhance fish populations, restore fisheries habitat, improve water quality, and advance fisheries research in North America to increase the opportunity for sportfis...	Could be used for portions of the master plan shown to improve the water quality to fish habitats such as the Mill Creek or the North Santiam.
Flood Mitigation Assistance Program, FEMA	FMA provides funding to assist States and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program (NFIP). Th...	Can be used for general capital improvement funding that mitigates flooding risks.
General Purpose Grants - M.J. Murdock Charitable Trust	The Trust's mission is to enrich the quality of life in the Pacific Northwest by providing grants to organizations that seek to strengthen the region's educational and cultural base in creative and sustainable ways. Although major emphases are education...	Projects shown to enhance the quality of life - especially for youth. This could aid in funding a youth internship for water quality monitoring or restoration projects. This would fill public education requirements of the NPDES phase II program.
Hatfield Restoration Program, Oregon	Former U.S. Senator Mark O. Hatfield established the Upper Klamath Basin Working Group (UKBWG) to address ecosystem restoration and water quality, economic stability, and drought impacts. Funding is available for projects which address watershed restorati...	Applicable to watershed restoration projects.

Program Name	Overview	Potential Application to Statyon's Storm Water Master Plan
Jubitz Family Foundation	AREAS OF INTEREST: • Early childhood development and youth education, with an emphasis on children at-risk. • Environmental stewardship, with an emphasis on rivers and their watershed ecosystems. • Peacemaking activities, with an emphasis on teaching p...	River and watershed ecosystem projects such as the wetlands, erosion prevention, riparian management etc.
Land and Water Conservation Fund - Oregon	Land & Water Conservation Fund grant funds may be used for the acquisition and development of state and local facilities that provide recreational opportunities. Recreation enhancement may be accomplished throught the preservation of open space, forests, ...	Could be used for detention facilities that double as recreational facilites.
Lawrence Foundation, The	The Lawrence Foundation makes contributions and grants to organizations that are working to solve pressing educational, environmental, and health issues....	General applicablity to storm water improvements funding
Nonpoint Source Implementation Grant (319) Program - Oregon	Section 319 of the 1987 Clean Water Act authorizes grants for implementation of nonpoint source pollution control programs and projects to help protect or improve water quality. The Department of Environmental Quality, the state agency authorized to carry...	Non-point source bmp funding
Oregon Wildlife Heritage Foundation	The mission of the Oregon Wildlife Heritage Foundation is to initiate, organize, and support projects through public and private partnerships that benefit Oregon's Fish and Wildlife....	Projects shown to enhance fish and wildlife habitats
Pacific Grassroots Salmon Initiative, National Fish and Wildlife Foundation	The PGSI seeks to catalyze and support salmon-friendly activities at the local, grassroots level in west-coast states of California, Oregon, and Alaska. The initiative will benefit native anadromous fishes and their aquatic and riparian habitats through p...	If salmon are in either the Mill Creek or N. Santiam, projects improving the quality of those rivers may qualify for funding.
Partnership Planning Grants for Economic Development Districts, Indian Tribes, & Other Eligible Area	Planning grants provide support for the formulation and implementation of local economic development programs as well as strategies designed to create and retain permanent jobs and income, and provide new employment opportunities in economically distress...	Implementation of some of the storm water improvements both enhance the city and provides permanent jobs.
Pedestrian & Bicycle Facility Improvement Grant Program	Oregon's Bicycle and Pedestrian Program provides funding for bicycle and pedestrian improvements. ...	This could be used in conjuction with regional detention facilities that double as parks, walking paths, and recreation sites.
PGE Foundation	The Foundation's giving interests include art and humanities, civic and public affairs, education, the environment, health and social services. The Foundation seeks to preserve and enhance environmental quality throughout Oregon. We support a variety of ...	General applicablity to storm water improvements funding
Plum Creek Foundation	The Plum Creek Foundation is the major channel of philanthropy for Plum Creek Timber Company, Inc. and its subsidiaries. The Plum Creek Foundation has been established to provide a philanthropic contribution program to support and improve the general welf...	Applies to community development, parks and recreation facilities, and public education portions of the master plan or TMDL implementation plan.
Recreational Trail Program (RTP) Grants - Oregon	The RTP is a Federal-aid assistance program to help States provide and maintain recreational trails for both motorized and non-motorized trail use. The program provides funds for all kinds of recreational trail use, such as pedestrian use, which includes ...	Applies to trails as related to parks and detention facilities
Renewable Energy Program, Bonneville Environmental Foundation	The Bonneville Environmental Foundation (BEF) was founded in 1998 to support watershed restoration programs and develop new sources of renewable energy. Funding for these efforts has been provided in a way that would be called unusual for most foundations...	Applies to watershed restoration facets of storm water master plan or TMDL IP
Watershed Restoration Grant Program, OWEB	OWEB focuses on projects that approach natural resources management from a whole-watershed perspective. OWEB encourages projects that foster interagency cooperation, include other sources of funding, provide for local stakeholder involvement, include yout...	Applies generally to the storm water master plan

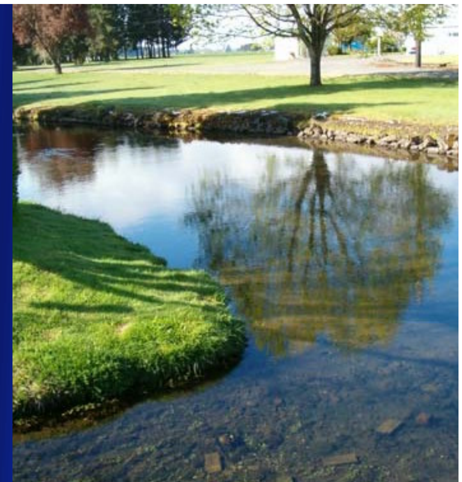


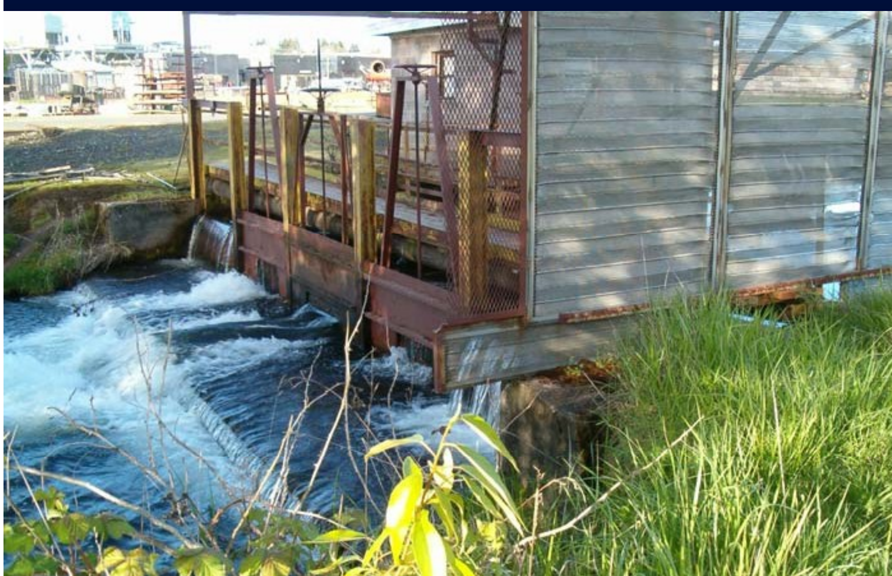
Appendix H
TMDL Implementation Plan

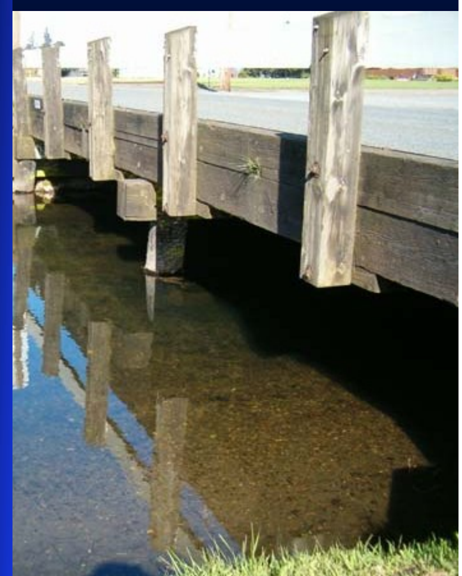
KELLER associates

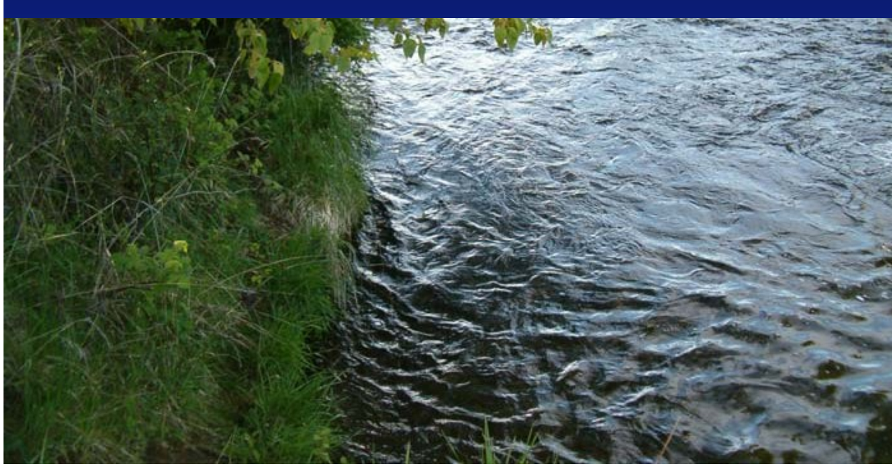
Stayton, Oregon
Willamette Basin TMDL
Implementation Plan

February 2009









KELLER
associates

Oregon
Theodore R. Kulongoski, Governor

Department of Environmental Quality
Western Region - Salem Office
750 Front St. NE, Ste. 120
Salem, OR 97301-1039
(503) 378-8240
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January 28, 2009

JAN 30

Dave Kinney
Public Works Director
City of Stayton
362 N. Third Avenue
Stayton, OR 97383

Re: Willamette River Basin TMDL Implementation Plan

Dear Mr. Kinney:

The Oregon Department of Environmental Quality (DEQ) has reviewed the November 2008 ***Stayton, Oregon Willamette Basin Total Maximum Daily Load (TMDL) Implementation Plan*** prepared by Keller Associates. The DEQ appreciates the amount of work that went into this plan by the City of Stayton with the assistance of Keller Associates. The plan meets the intent and requirements for the development of TMDL implementation plans as specified in Oregon Administrative Rule 340-042-0080 (3) and we would like to approve the plan for implementation at this time. We do have some comments, however, that we would like to convey to the City of Stayton to be considered as part of an adaptive management framework.

As Stayton proceeds with implementation, we think it would be helpful to expand upon the stormwater controls measures and evaluate existing riparian conditions. Some measures related to the above that would support the TMDL reductions for Stayton to consider include:

1. Assessment and analysis of current riparian conditions to confirm existing conditions within the first year and identify sites for restoration [ex., riparian setbacks in place being adhered to; areas that don't meet the setback requirement; areas where new development is proposed; establish when 50 feet is sufficient based on the quality and quantity of vegetation; establish list of priority projects and areas along the riparian corridors that would benefit from shade canopy (temperature) and native understudy (erosion and temperature)].
2. Implement additional best management practices supportive of pollution prevention in municipal operations for roads, parks, and city maintenance shops. For example, reduce sediment reaching Mill Creek and North Santiam through overland flow.

3. Assess planning and building ordinances for barriers to post construction development and redevelopment supportive of TMDL reductions. As Stayton proceeds with developing and implementing Post Construction Stormwater Management, in addition to riparian preservation section 3 requirements, consider such things as, low impact development, stormwater treatment, "green building," and maintenance of hydrology as key structural and source control strategies.
4. Provide a link for the City of Stayton website and include water quality topics on the website.

For clarification purposes, DEQ would also like to submit the following comments pertaining to the plan at this time:

Page 5-1 and 5-2: 5.3 NPDES Phase II Six Minimum Control Measures
10,000 should be 50,000.

We would like to check in with you on an annual basis to assess the TMDL implementation process and the status of the measures contained in your BMP tracking matrix. The matrix is designed with the annual reporting requirement in mind and we believe that it is well-suited for tracking progress overtime. We feel that the annual review process will facilitate adaptive management and the five year reviews.

Stayton's first annual report will be due the last week of September 2009, and should cover February 2009 through August 2009. Stayton's first fifth year report will be due the last week in September 2013, and should assess implementation efforts from February 2009 through August 2013.

Please feel free to contact me at 503-378-5073 or via e-mail at gramlich.nancy@deq.state.or.us should you have any questions related to TMDL Implementation. Thank you for your effort on the development of Stayton's TMDL Implementation Plan. We look forward to your continued involvement in TMDL Implementation efforts in the Middle Willamette and North Santiam Subbasins, and to your ongoing commitment to improving water quality conditions.

Sincerely,

Nancy Gramlich

Nancy Gramlich
Willamette Basin Coordinator

cc:
Roland Rocha, Keller Associates
Don Eubank, City of Stayton

City of Stayton, Oregon

Willamette Basin TMDL Implementation Plan – Agency Review

February, 2009

Table of Contents

Chapter 1 INTRODUCTION

1.0 General

As part of a watershed approach to water quality problems, the State of Oregon is in the process of developing a Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP) for each water body that does not meet specific water quality standards. The Willamette River is among these water quality impaired bodies of water for parameters of temperature, mercury, and bacteria.

The United States EPA approved the Willamette River Basin TMDL (WB-TMDL) On September 29, 2006. In the WB-TMDL, the City of Stayton is listed as a Designate Management Agency (DMA) because it is bordered by Mill Creek and North Santiam River which are Willamette River tributaries. As a DMA, Stayton is responsible for water quality within its jurisdiction and is required to submit a TMDL Implementation Plan to the Oregon Department of Environmental Quality under Oregon Administrative Rule 340-042-0080(3).

This report provides a comprehensive description of Stayton's ongoing and planned efforts to reduce targeted pollutant loadings in accordance with the WB-TMDL.

1.1 TMDL Implementation Plan Objective

The objective of Stayton's implementation plan is to fulfill all requirements designated in the Oregon State TMDL Rule 340-042-0080(3). To meet these requirements, the implementation plan must:

- Identify the management strategies which will be used to achieve load allocation and reduce pollutant loading
- Provide a timeline for implementing the management strategies
- Provide target completion dates for benchmarks in implementing the management strategies
- Provide for performance monitoring with a plan for periodic review and revision
- Provide evidence of compliance with applicable statewide land use requirements
- Provide any other elements as specified in the WQMP

The following chapters in this report specify how the City of Stayton plans to meet these requirements. The final chapter provides a general summary of the implementation plan including a progress tracking matrix for annual reporting and review.

1.2 Related Documents

Through prior efforts, the city has recently completed a Storm Water Master Plan. The Storm Water Master Plan addresses water quality issues, and contains preliminary plans anticipating both the TMDL implementation and the NPDES phase II program. This implementation plan is consistent with these master plan elements, and the master plan provides much of the background and supporting data for the implementation plan.

1.3 Acknowledgements

Key to the present and ongoing success of water quality efforts in Stayton are the citizens of Stayton, the employees of the Stayton City Public Works Department; Michael Faught, Public Works Director; Members of the Stayton City Council, and the Oregon Department of Environmental Quality.

Chapter 2 EXISTING CONDITIONS

2.0 General

The City of Stayton is proactive in its efforts to improve water quality. The city has recently completed a Storm Water Master Plan outlining significant capital improvement projects, and is currently working toward establishing a storm water program aimed at positioning the city to meet future state and federal requirements. This chapter summarizes the city's current status with regard to the applicable Statewide Land Use Goals, and current storm water quality conditions.

2.1 Oregon Statewide Land Use Goals

In 1973 the Oregon State Legislature established statewide standards to be used by local government agencies in land use planning. The intent of the standards was to protect Oregon's natural resources and promote economic development. The Department of Land Conservation and Development (DLCD) was created at that time to be the administrative agency to manage these standards.

Over time, these standards have evolved into a set of 19 Land Use and Planning goals covering everything from Citizen Involvement to the preservation of Ocean Resources. As not all of these goals directly apply to the WB-TMDL, DEQ has shown interest in the position of Stayton in relation to Statewide Landuse and Planning Goals 5 and 6 because these are the pertinent sections with regard to the Implementation Plan.

Statewide Planning Goal 5 is to protect natural resources, and conserve scenic and historic areas, and open spaces. In correlation with this goal, local governments are to adopt programs that will achieve this goal. Part of this is to inventory riparian corridors and establish policies to protect them.

Statewide planning Goal 6 is similar to Goal 5 in that the objective is to maintain and improve the quality of the air, water and land resources of the state. All waste and process discharges cannot exceed the carrying capacity of the water resources nor degrade nor threaten them.

The city's comprehensive plan was revised in April 2006, and addresses all of statewide land use goals. The comprehensive plan has been acknowledged by the Department of Land Conservation and Development to be compliant with the state wide goals. The city's ongoing land use practices, permitting practices, and development code are consistent with the land use goals and the proposed management strategies in the implementation plan. A letter from the Stayton City Planner has been included in Appendix B, which states the city is in compliance with Statewide Land Use Goals (Goals 5&6 in particular). Furthermore, the proposed TMDL Implementation Plan is consistent with the city's comprehensive plan to the extent required by law.

2.2 Existing Water Quality

Stayton's TMDL efforts focus on the waters within the city's jurisdiction which includes the Salem Ditch (also known as the Stayton Ditch), the North Santiam River, Mill Creek, and the Power Canal.

The majority of the city's urban impact is on the Salem Ditch, which travels east to west along the south border of the city, then turns north and runs along the city's west border ultimately discharging to Mill Creek in the northwest corner of the city limits. Figure 1 in Appendix A identifies the ultimate discharge locations for the various portions of the city's storm system.

Because the majority of the stormwater discharges to the Salem Ditch, the ditch provides an opportunity to test the net impact of the stormwater discharge on water quality.

In March of 2007, four storm water samples were collected from two points in the Salem Ditch upstream of Stayton, and two points downstream of Stayton. The samples were taken during a rain event and were tested for Biochemical Oxygen Demand, Chemical Oxygen Demand (COD), Orthophosphate-phosphorus, Specific Conductivity, Total Solids, Total Suspended Solids (TSS), Turbidity, Hardness, pH, Phosphorus, and E coli.

The water quality test results specific to the WB-TMDL target pollutants have been summarized in Table 2.1. The TMDL targets are basin-wide targets and are not specific to Stayton, but they serve as comparison basis for the city.

No data was collected on the temperature, but mercury and bacteria were tested. No mercury was detected, and bacteria increased by 8.5 mpn/100 ml. More testing over an extended period would be necessary before any firm conclusions can be drawn on the storm water quality, but initial testing appears to indicate the city's overall impact in relation to the WB-TMDL is relatively light.

Table 2.1 TMDL Targets vs. Existing Conditions

Water Quality Parameter	WB-TMDL Target	City Inlet	City Outlet
Temperature	Mill Creek: 18°C* North Santiam: 18°C*	No Data	No Data
Mercury	27% Reduction	None Detected	None Detected
Bacteria	80% Reduction	6.3 mpn/100 ml	14.8 mpn/100 ml

*Target temperatures for summer months

Chapter 3 MANAGEMENT STRATEGIES

3.0 General

This chapter discusses the general strategies the city will implement to reduce pollutant loads. The methods for assessing the effectiveness of these strategies are discussed in Chapter 4. Fundamentally, these strategies are designed to focus efforts on activities that will result in the maximum reduction of pollutants given the city's limited resources.

3.1 Management Strategies

The following sub-sections describe Stayton's management strategies for reducing temperature, mercury, and bacteria. Some of the strategies are already in place, and have been identified in their scheduled implementation as 'ongoing'. Strategies that have been selected as part of this plan to fill the gaps have specific implementation dates as chosen by the city according the resources available. The strategies, along with the benchmarks and schedules are summarized in the Tracking Matrix in Appendix A.

3.1.1 Temperature

The WB-TMDL has established a temperature TMDL to create a healthier environment for salmon and trout species found in the Willamette Basin. There is not one target temperature for the entire basin, because the optimum temperatures vary by location according to the fish habitat designation for the area. DEQ would like to see efforts from Stayton to address temperature concerns through protection, restoration, or creation of riparian vegetation. The Oregon State DEQ does not recognize storm water as a source of temperature loading for the purposes of the temperature TMDL.

Because storm water runoff from the city is not recognized by DEQ as a source of temperature loading in the rivers, direct solar radiation on the water bodies within Stayton's jurisdiction is the primary source for temperature loading. The effects of temperature loading can be minimized if the water in the river is deep and well shaded.

The depth of the water is affected by two factors, namely, flow volume and the channel shape. During the summer months, when solar radiation is at a peak, the flow in the river and the runoff volume from the city is typically low. Under this scenario, any flow added to the river from the city's storm water system will help lower the stream temperatures because it will provide additional volume to the river and it will typically be cooler because it is piped underground prior to discharging to the river.

The second factor affecting the depth of the water in the river channel is the shape of the channel. The channel shape can be negatively affected through erosion. Erosion is more likely to occur where the channel banks are bare and unstable. As banks erode, the shape of the channel tends to be wide and flat, therefore reducing the water depth and increasing the impact of solar radiation. Riverbank vegetation or structural stabilization measures prevent channel erosion and promote a deeper channel resulting in cooler water temperatures. Bank vegetation not only prevents erosion, but can provide shading if the vegetation consists of trees.

In an effort to improve water quality in the North Santiam River, the City of Stayton recently completed a stream bank tree planting project. In September of 2007, the city planted 3,200 Willow Tree cuttings. The project improved approximately 18,000 square feet of the river's north bank south of Stayton.

The city's land use development code also contains provisions that require 50 foot riparian setbacks as a measure of protecting the riverbanks and promoting stream health. This code will continue to promote cooler water temperatures as the city develops beyond its current limits. The city's goal is to continue the practice of enforcing the existing land use code through the development review and approval process.

In addition to setback requirements, Sections 17.16.090 and 17.20.80 specifically protects trees and other vegetation in riparian corridors.

The city has also formed an active partnership with North Santiam Watershed Council, and the Oregon Association of Clean Water Agencies (ACWA). This relationship will provide the city opportunities to take part in a watershed approach to water quality, and to partner with these agencies on future water quality projects similar to the recent riparian development project completed in September 2007. The city's goal is to stay involved with these groups by attending six meetings each year as a management strategy to address the temperature TMDL.

3.1.2 Mercury

Mercury is pollutant of concern because of its toxicity and its tendency to bioaccumulate. Bioaccumulation is the process by which a substance builds up in concentration in living organisms as they take in contaminated air, water, or food because the substances can only be metabolized very slowly. The toxic effects of mercury poisoning range from debilitation to death.

Mercury is a natural soil component common throughout the Willamette Basin, and soil erosion accounts for nearly half of all the mercury found in the Willamette River and its tributaries. Automobile emissions, Dental fillings, light bulbs, and thermometers are a few of the common non-natural sources of mercury.

The City of Stayton has identified sediment in sediment laden storm water and air pollution as two primary sources of mercury loading in the surrounding waters. To address sediment carried by stormwater, the city will focus on reducing runoff from construction sites, and reducing sediment loads in stormwater through improved maintenance practices.

The city currently provides reminders to developers during preconstruction meetings to obtain 1200-C permits as required by the state. The city also reviews erosion control plans as part of the plan review process. The city's goal is to continue these practices to aid in the prevention of excessive sediment in stormwater runoff from construction sites.

1200-C permits address construction sites that are an acre or larger in area. There are not currently any regulations for sites less than an acre and the city recognizes such sites as a potential source for sediment erosion. As such, the city will consider adding language to existing codes and/or design standards.

To reduce sediment loading from stormwater, the city currently sweeps the streets on a regular basis. Downtown corridors are swept weekly, collectors are swept twice a month, and residential streets are swept monthly. The city's plan is to continue street sweeping and begin tracking completion of the street sweeping.

In addition to street sweeping, the city currently cleans all of their estimated 650 storm water catch basins annually. Cleaning the catch basins not only prevents trapped sediment from reentering the system, but also enables the basins to function properly and remove more sediment from the system. The city's goal is to continue cleaning all of the catch basins annually and track the number of basins cleaned.

As part of the stormwater master plan, the city has established a plan to begin pressure cleaning the storm water lines. There are approximately 15 miles of stormwater lines in the city. The plan is to clean the lines once every five years. This will prevent buildup, allow for proper function of the system, and remove excess sediment.

In addition to mercury carried in storm water sediment, the city realizes air pollution can contribute to mercury levels in surface waters. For this and many other benefits, the city supports a county commuter ride program. A large park-and-ride lot is located in the northeast end of the city. Commuter ride program information is also available at the public works office. The goal in relation to this management strategy is to continue to support the commuter ride program.

An implementation schedule and measurable benchmarks are identified for each of these strategies in the Tracking Matrix in Appendix A.

3.1.3 Bacteria

Bacteria concentrations in water are typically measured by an indicator group of bacteria such as E. coli in units of Most Probable Number (MPN) per unit volume. Potential sources of bacteria include failing septic systems, leaking sewer lines, substandard wastewater effluent discharges, pet waste, livestock waste, duck feeding areas, and cross-connections.

Stayton has reviewed the potential sources of bacterial contamination and has determined that pet waste, poorly maintained sewer lines, and cross connections are the areas on which they will focus their management efforts.

The city has installed pet waste stations in local parks to encourage owners to clean up after their pets. The city plans to inventory theses stations to determine quantities, locations, installation years and other data necessary to assess additional needs. The city will continue to stock and maintain the stations, as well as inventory the existing stations and assess additional needs.

The city currently cleans and inspects the sewer system periodically. The goal is to continue this practice and commit to a schedule of cleaning and inspecting every line once every five years. The anticipated outcome of this effort is well maintained lines that will prevent sewage leaking or overflowing and reaching the natural waters surrounding the city.

In reviewing the city codes and ordinances, it was discovered that there is nothing prohibiting storm drain and sanitary sewer cross-connections. As a result, a goal has been established to propose ordinance language prohibiting cross-connections.

The specific implementation schedules and benchmarks for each of these strategies are listed in the Tracking Matrix in Appendix A.

Chapter 4 PLAN REVIEW AND REPORTING

General

Tracking and reporting on the progress of the implementation plan is essential to its success because it provides the feedback necessary to make necessary adjustments. Adjustments are necessary over time due to changing needs or variances in field conditions.

As such, tracking and reporting have been included as part of the implementation plan to serve as tools to help the city achieve the plan objectives. This chapter presents the city's plan for tracking and reporting their progress on the implementation plan activities.

4.1 Implementation Tracking

Implementation tracking refers to keeping track of which of the planned activities have been implemented within their chosen timeline and which ones have not. It should be noted that the timelines for implementation are not regulatory, but rather City of Stayton will track and report on the progress of the planned TMDL Implementation Plan Activities – including interim steps necessary for the various benchmarks. The City will keep an internal inventory of progress towards completion of each of the activities listed on the tracking matrix throughout the year.

4.2 Effectiveness Tracking and Evaluation

Effectiveness tracking will focus on how beneficial the strategies are in relation to the time and effort required to implement them. The evaluation of this effectiveness in reducing pollutant loads will rely on city personnel performing adequate and timely data collection and analysis.

A record of the time and resources spent will be kept on each of the activities and will be compared to the measurable benchmark for the activity. For example, catch basin cleaning may cost an average of $17 per catch basin, and result in an average of 2 lbs of sediment being removed from the system. This would allow the city to compare this activity with other activities for effectiveness resources required.

The effectiveness of activities such as public education are difficult to quantify, however activities themselves can be tracked as indicated in the tracking matrix. However, the intent in tracking the meetings is to measure the level of effort compared to a sense of its effectiveness which should be determined by those participating in the activities.

Central to the effectiveness evaluation will be the questions: "How well is this activity helping us reach our goal of pollutant reduction?", "Can this activity be modified to be more effective?", "Are there other activities that could be more beneficial?" Once the appropriate data is collected, the results will be evaluated on the basis of these questions.

The city will review the results of all effectiveness evaluations on an annual basis and consider possible alterations to the implementation plan if some activities prove to be ineffective. This internal review will be completed prior to the annual DEQ reporting. The city will also review and track interim steps being taken towards their benchmarks in the annual and five-year reviews.

4.3 Reporting

Oregon DEQ requires the city to report implementation progress annually. This reporting will be facilitated through the use of the tracking matrix presented in the previous chapter. The annual reporting will consist of filling out the status column with an appropriate indicator and submitting the matrix to DEQ. The annual and 5-year reports will also discuss interim steps being taken towards the various benchmarks. Any necessary minor adjustments may also be made at this time. In an effort to coordinate TMDL reporting with other reporting required of the city, they will report in September of each year after an internal review held in August starting in 2009.

4.4 Adaptive Management

As circumstances change, the needs and strategies related to this implementation plan will change. This may be due to changes within the city, state and federal regulations, or in the Willamette Basin itself. The City of Stayton will specifically revisit this implementation plan every five years. The city will also consider potential revisions or redirections that may be necessary as a result of DEQ's revisions to the WB-TMDL. The first of these revisits will be in 2013. The reevaluation will include a review of existing tracking data and other information to evaluate the effectiveness of the plan relative to the pollution reduction goals.

Chapter 5 ADDITIONAL ELEMENTS

5.0 General

The WB-TMDL requires additional elements from the WQMP to be addressed by various communities according to their population designation. Because Stayton is considered by DEQ to be non-MS4 DMA, the additional requirements are not as extensive as those required of MS4 DMAs. This chapter addresses the additional elements required for the City of Stayton.

5.1 Public Involvement Plan

Stayton is required to include a public involvement element as part of the TMDL Implementation Plan. The city will implement the plan upon acceptance from DEQ, however, the city's plan is to involve the public through a public open house where the implementation plan will be presented to the public and City Council in within 60 days of DEQ's approval of the Implementation Plan.

As revisions to ordinances and standards are proposed during city council meetings which are open to the public, the public will have an opportunity to be further involved.

5.2 Fiscal Analysis

A fiscal analysis is required in order to identify the resources necessary to develop, implement, and maintain the plan components identified in this report. Given the absence of resources available for additional programs and practices, many of the plan elements have been selected on the basis of their minimal financial impact. Items such as policy implementation will cause an insignificant financial impact and will be absorbed into the regular operations budgets.

The more resource intensive components of the plan are to be integrated as part of the storm water master plan or other existing programs, and the funding will come from the utility or program budgets. For example, the storm water master plan components will likely be funded by a System Development Charge for new developments, and a utility for existing users which has been detailed in the Storm Water Master Plan.

5.3 NPDES Phase II Six Minimum Control Measures

Because Stayton is not currently a Municipal Separate Storm Sewer System (MS4) community, the city is not required to implement the Six Minimum Control Measures for mercury and bacteria reductions tied to the NPDES Phase II requirements. An MS4 designation is typically triggered by a population of

50,000, other urbanization indicators, or at DEQ's discretion. Stayton's population is currently estimated at 7,700.

However, as part of this implementation plan, DEQ has asked the city to consider these elements and determine which measures could feasibly be accomplished as part of the implementation plan. The Six Minimum Control Measures identified in Chapter 14 of the Willamette Basin Water Quality Management Plan are:

1) Pollution prevention in municipal operations
2) Public education and outreach on storm water impacts
3) Public involvement and participation
4) Illicit discharge detection and elimination
5) Construction site storm water runoff control
6) Post-construction storm water management in new development and redevelopment.

Each of these measures and the extent to which the city plans to address them is covered in the Tracking Matrix in Appendix A.

Chapter 6 IMPLEMENTATION SUMMARY

6.0 General

This chapter presents a summarized list of implementation actions in chronological order. This will serve as a quick planning and tracking reference for city personnel. However, this list is not intended to be comprehensive so the report and the Tracking Matrix should be consulted for more detail on the Implementation Plan and its elements.

6.1 Summary of TMDL IP Actions

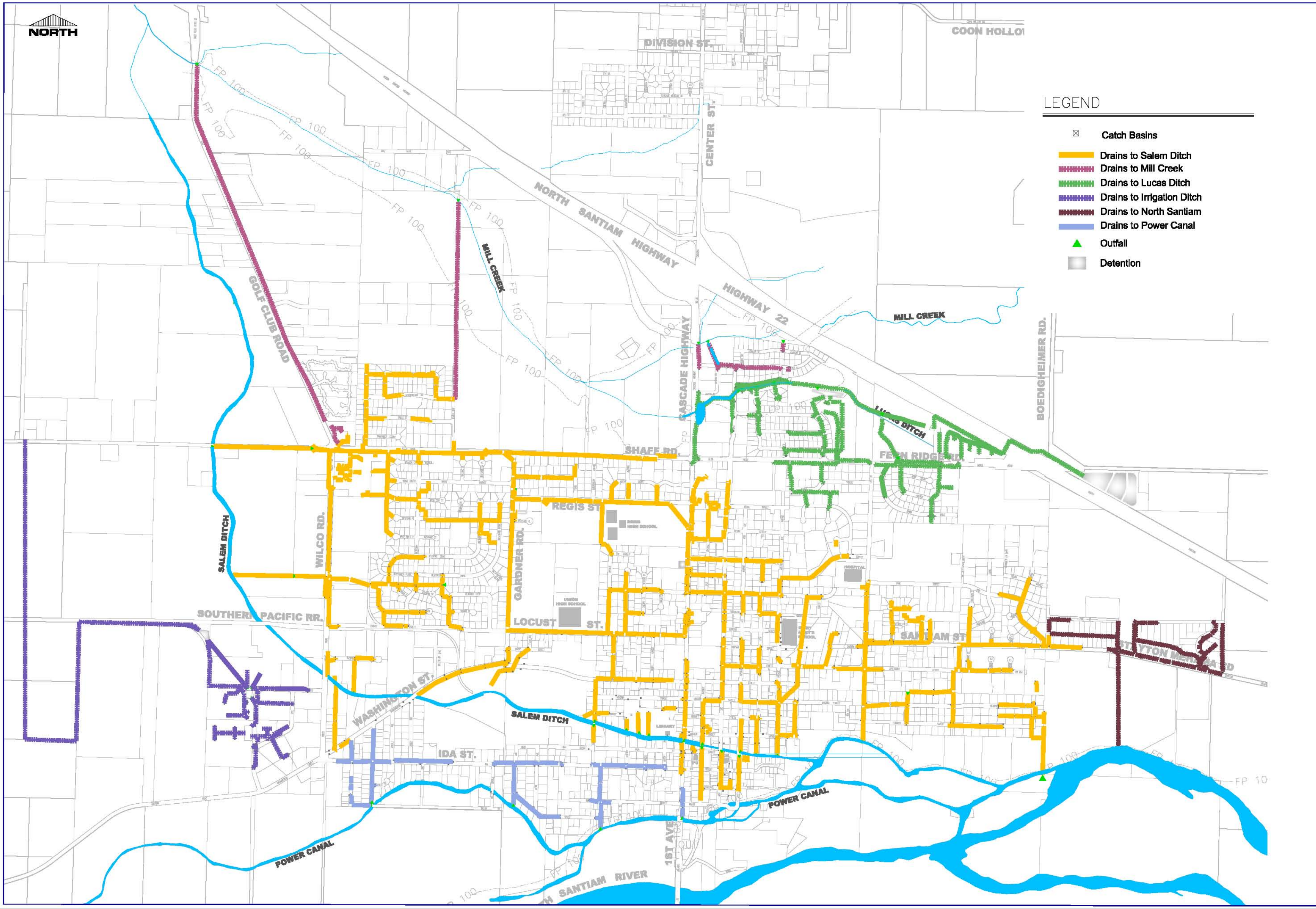
Table 6.1 - Implementation Plan Actions

Year	Action	Targeted Outcome
2008	Present TMDL IP to Council and Public	Involve the public
(& Ongoing)	Review Sediment Erosion Control Plans	Reduce mercury loadings
	Remind developers to obtain 1200C permits	Reduce mercury loadings
	Maintain riparian setbacks	Reduce temperature and mercury loadings
	Support commuter ride program	Reduced mercury loadings
	Continue Watershed Council and ACWA Involvement	Remain current with local storm water issues, potential temperature reduction through riparian preservation or restoration projects.
	Street sweeping	Reduce mercury loadings
	Clean catch basins	Reduce mercury loadings
	Inspect 20% annually and repair damaged Sanitary Sewer lines as resources permit	Reduce bacteria loadings
	Visit riparian project site annually	Reduce mercury loadings
	Hold internal plan review	Maintain or adjust goals as necessary
	Fill out Tracking Matrix, send to DEQ annually	Keep DEQ informed on progress
2010	Clean storm water lines, Track % cleaned	Reduce mercury loadings
2012	Inventory and assess Pet Waste Stations	Reduce bacteria loadings
	Propose code/standard language for erosion control on construction sites < 1 acre	Reduce Mercury loadings
2013	Track Volunteer Coordination and Support	Improve existing benefits of volunteer efforts
	Propose Cross-Connection Control Language for new ordinance	Reduce bacteria loadings
	Complete 1st 5-year TMDL IP review and coordinate with DEQ	Adapt management strategies changing conditions

Appendix A: Tracking Matrix and Figure

Implementation Plan Tracking Matrix

POLLUTANT	SOURCE	STRATEGY What is being done, or what will be done to reduce or control pollution from this source	HOW THIS WILL BE DONE	MEASURE How implementation or completion will be measured	TIMELINE When this strategy will be implemented or completed	BENCHMARK The goal to be met within the indicated timeline	STATUS
Temperature	Solar Radiation	Protect and promote healthy riparian areas	Sustain land use code which requires riparian setbacks	Track the number of development and redevelopment plans reviewed for conformance with riparian policy	Ongoing	100% of development and redevelopment plans	
			Review progress of riaprian project along N. Santiam River	Are the trees growing?	Ongoing	Check the site annually	
		Work with other agencies on watershed solutions	Maintain contact with ACWA and continue to participate with North Santiam Watershed Council	Track number of coordination meetings attended annually	Ongoing	Attend 6 meetings annually	
Mercury	Sediment	Reduce sediment reaching Mill Creek and North Santiam through storm water	Ensure sediment erosion control plans are provided for development and redevelopment plans	Track % of sediment erosion control plan checks performed as part of plan review process	Ongoing	100% of development and redevelopment plans	
			Remind developers of 1200-C permit requirements in preconstruction meetings	Track % of meetings wherein a 1200-C permit reminder was provided	Ongoing	100% of preconstruction meetings involved a 1200-C permit reminder	
			Consider adding language to existing city codes and/or design standards for erosion control on construction sites <1ac	Public works or Planning and Zoning to propose language to be considered for inclusion in existing codes and standards.	2012	Propose Language for revised code	
			Perform regular street sweeping	Track % of streets swept monthly	2008	Downtown 4/mo, Collectors 2/mo, Residential 1/mo	
			Clean catch basins annually	Track % of catch basins cleaned annually	Ongoing	100% of catch basins cleaned annually	
			Clean storm lines once every 3 yrs	Track % of lines cleaned annually	2010	20% of storm lines cleaned annually	
	Air deposition	Reduce air pollution	Support commuter ride program by providing information at Public Works Building	Brochures provided? Y/N	Ongoing	Brochures provided? Y/N	
Bacteria	Pet Waste	Reduce pet waste reaching streams through storm water runoff	Continue support and use of pet waste stations at city parks. Inventory existing stations, and assess need for additional stations	Provide inventory and assessment results in a report	2012	Report presented? Y/N	
	Municipal Sewage	Reduce municipal sewage reaching streams through surface water and groundwater pathways	Detect and repair leaking city sewer lines as resources allow	Track % of lines cleaned and inspected	Ongoing	20% of lines cleaned annually	
			Propose language in city code which prohibits storm system and sanitary sewer cross-connections	Language proposed? Y/N	2010	Language Proposed? Y/N	
Additional Elements Required from the WB-WQMP	Six Control Measures for Mercury and Bacteria from NPDES Phase II Program	Pollution Prevention in Municipal Operations	See: Mercury>Sediment>Street Sweeping, Catch Basin Cleaning, Storm Line Cleaning				
		Public Education and Outreach	See: Mercury>Air>Reduce Pollution>Commuter Ride information				
			Coordinate with Volunteer Groups	Begin tracking and report number of volunteer projects performed annually	2008	100% of City Coordinated Volunteer projects reported	
		Public Participation	Present TMDL IP to City Council for Approval	Presented? Y/N	2008	Presented? Y/N	
		Illicit Discharge Detection and Elimination	See: Bacteria>Sewage>Reduce>Cross-Connections				
			Map storm lines and outfalls	Completed in 2007			
		Construction Site Runoff Control	See: Mercury>Sediment>Stormwater Reduction>1200C, Erosion Control Plans				
		Post Construction Storm Water Management	See: Riparian preservation requirements in section 3 of implementation plan.				



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KELLER ASSOCIATES

TMDL Implementation Plan
Stayton, OR

Existing Drainage Areas

FIGURE
1

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Appendix B: Land Use Compatibility

City of Stayton

Planning Department

Mailing address: 362 N. Third Avenue · Stayton, OR 97383
Office location: 311 N. Third Avenue
Phone: (503) 769-2998 · FAX: (503) 767-2134
Email: dfleishman@ci.stayton.or.us

TO: Michael R. Faught, Public Works Director

FROM: Dan Fleishman, City Planner

SUBJECT: Compliance with Statewide Goals 5 and 6

DATE: December 6, 2007

You have asked for a memorandum regarding the City's compliance with Statewide Planning Goals 5 and 6. Oregon state law requires all municipal comprehensive plans and land use regulations to comply with 14 statewide planning goals. Compliance is assured by submittal of local plans and regulations to the Department of Land Conservation and Development for review and "acknowledgement." These two statewide planning goals address natural resource issues and can be summarized as the following.

Goal 5: To protect natural resources and conserve scenic and historic areas and open spaces.

> Local governments shall adopt programs that will protect natural resources and conserve scenic, historic, and open space resources for present and future generations. These resources promote a healthy environment and natural landscape that contributes to Oregon's livability.

Goal 6: To maintain and improve the quality of the air, water and land resources of the state.

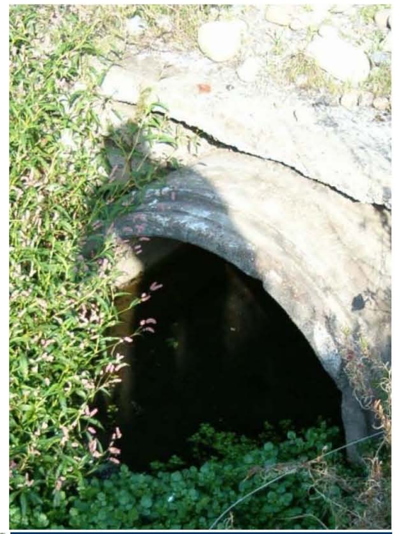
> All waste and process discharges from future development, when combined with such discharges from existing developments shall not threaten to violate, or violate applicable state or federal environmental quality statutes, rules and standards. With respect to the air, water and land resources of the applicable air sheds and river basins described or included in state environmental quality statutes, rules, standards and implementation plans, such discharges shall not (1) exceed the carrying capacity of such resources, considering long range needs; (2) degrade such resources; or (3) threaten the availability of such resources.

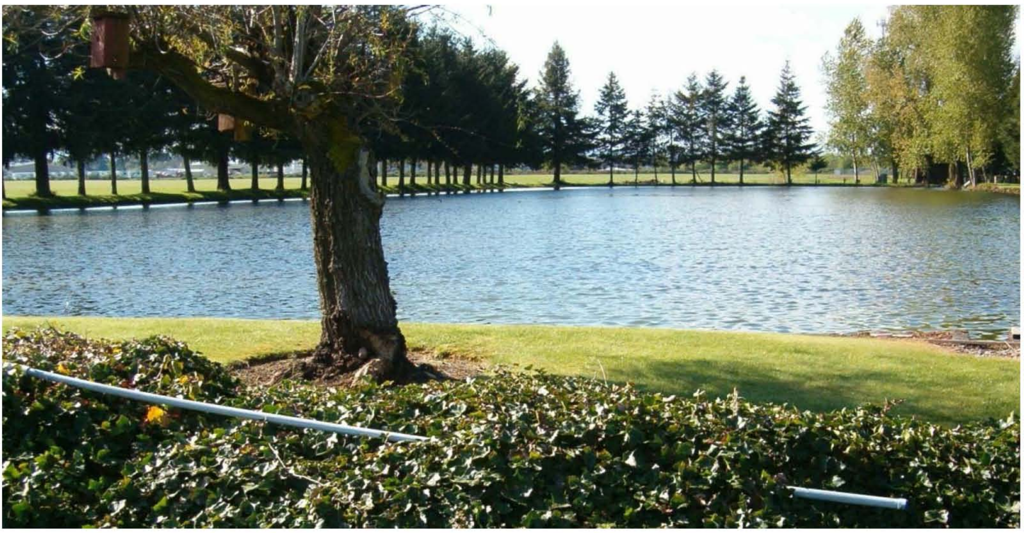
Generally, Stayton's Comprehensive Plan and Land Use and Development Code were initially drafted in the late 1970s. They were acknowledged by DLCD at that time as being compliant with the goals. Subsequent updates and amendments have also been acknowledged as compliant.

More specifically, Stayton's Comprehensive Plan inventories the significant natural, historic and cultural resources within the urban growth boundary and contains policies for their protection. The City has purchased tens of acres of open space for parks. The City's Land Use and Development Code contains provisions that require riparian setbacks and protection of wetlands. There are also two historic preservation districts and particular protection to buildings and sites identified in the comprehensive plan as historically significant.

The City has adopted a Parks and Recreation Master Plan that calls for the development of more park land to assure protect natural resources and provide open space. The City has recently updated its water and wastewater master plans to assure that it can both provide adequate service for the projected growth and meet its obligations to maintain the quality and quantity of water resources within and adjacent to the City.

Let me know if you need additional information.



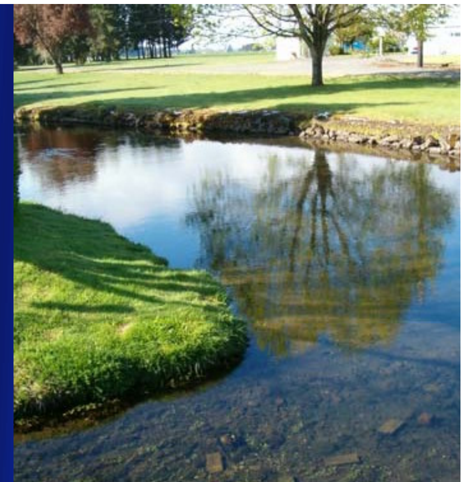


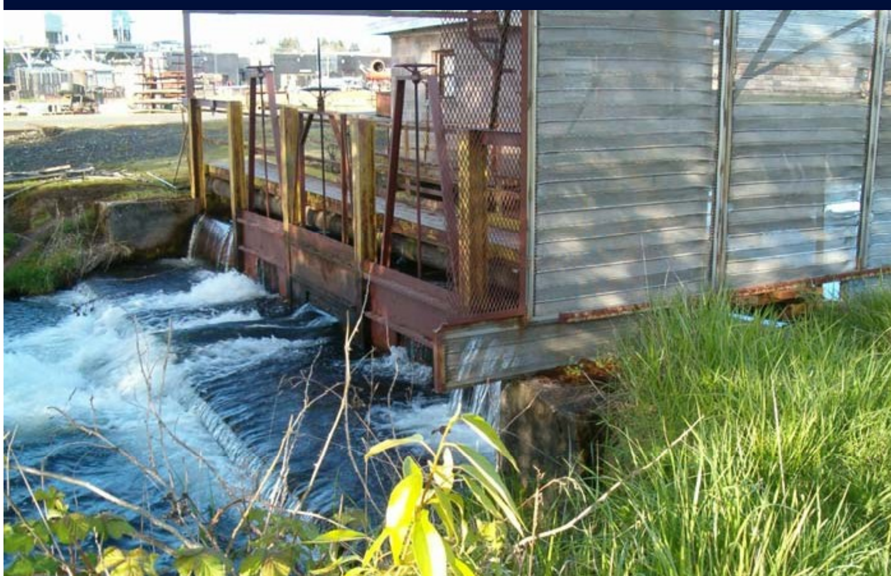
Appendix H
TMDL Implementation Plan

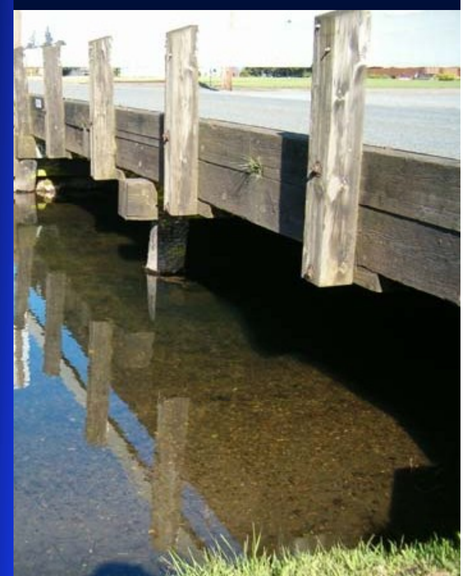
KELLER associates

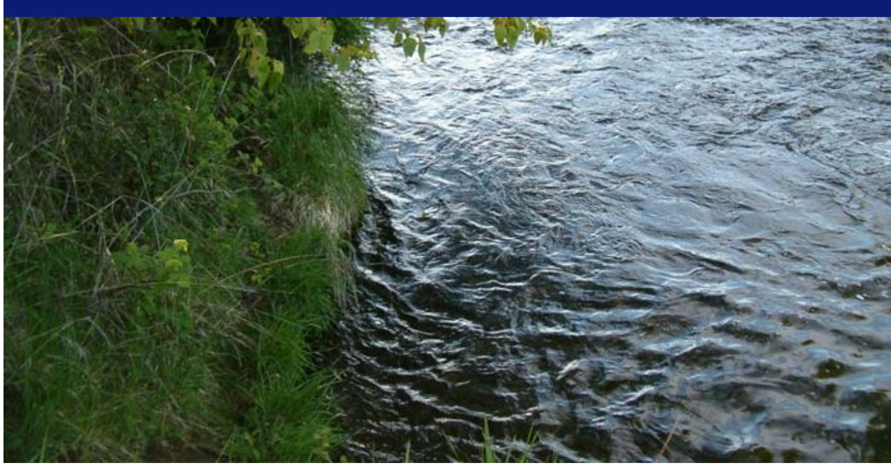
Stayton, Oregon
Willamette Basin TMDL Implementation Plan

February 2009









KELLER
associates

Oregon
Theodore R. Kulongoski, Governor

Department of Environmental Quality
Western Region - Salem Office
750 Front St. NE, Ste. 120
Salem, OR 97301-1039
(503) 378-8240
(503) 378-3684 TTY

January 28, 2009

JAN 3 0

Dave Kinney
Public Works Director
City of Stayton
362 N. Third Avenue
Stayton, OR 97383

Re: Willamette River Basin TMDL Implementation Plan

Dear Mr. Kinney:

The Oregon Department of Environmental Quality (DEQ) has reviewed the November 2008 ***Stayton, Oregon Willamette Basin Total Maximum Daily Load (TMDL) Implementation Plan*** prepared by Keller Associates. The DEQ appreciates the amount of work that went into this plan by the City of Stayton with the assistance of Keller Associates. The plan meets the intent and requirements for the development of TMDL implementation plans as specified in Oregon Administrative Rule 340-042-0080 (3) and we would like to approve the plan for implementation at this time. We do have some comments, however, that we would like to convey to the City of Stayton to be considered as part of an adaptive management framework.

As Stayton proceeds with implementation, we think it would be helpful to expand upon the stormwater controls measures and evaluate existing riparian conditions. Some measures related to the above that would support the TMDL reductions for Stayton to consider include:

1. Assessment and analysis of current riparian conditions to confirm existing conditions within the first year and identify sites for restoration [ex., riparian setbacks in place being adhered to; areas that don't meet the setback requirement; areas where new development is proposed; establish when 50 feet is sufficient based on the quality and quantity of vegetation; establish list of priority projects and areas along the riparian corridors that would benefit from shade canopy (temperature) and native understudy (erosion and temperature)].
2. Implement additional best management practices supportive of pollution prevention in municipal operations for roads, parks, and city maintenance shops. For example, reduce sediment reaching Mill Creek and North Santiam through overland flow.

3. Assess planning and building ordinances for barriers to post construction development and redevelopment supportive of TMDL reductions. As Stayton proceeds with developing and implementing Post Construction Stormwater Management, in addition to riparian preservation section 3 requirements, consider such things as, low impact development, stormwater treatment, "green building," and maintenance of hydrology as key structural and source control strategies.
4. Provide a link for the City of Stayton website and include water quality topics on the website.

For clarification purposes, DEQ would also like to submit the following comments pertaining to the plan at this time:

Page 5-1 and 5-2: 5.3 NPDES Phase II Six Minimum Control Measures
10,000 should be 50,000.

We would like to check in with you on an annual basis to assess the TMDL implementation process and the status of the measures contained in your BMP tracking matrix. The matrix is designed with the annual reporting requirement in mind and we believe that it is well-suited for tracking progress overtime. We feel that the annual review process will facilitate adaptive management and the five year reviews.

Stayton's first annual report will be due the last week of September 2009, and should cover February 2009 through August 2009. Stayton's first fifth year report will be due the last week in September 2013, and should assess implementation efforts from February 2009 through August 2013.

Please feel free to contact me at 503-378-5073 or via e-mail at gramlich.nancy@deq.state.or.us should you have any questions related to TMDL Implementation. Thank you for your effort on the development of Stayton's TMDL Implementation Plan. We look forward to your continued involvement in TMDL Implementation efforts in the Middle Willamette and North Santiam Subbasins, and to your ongoing commitment to improving water quality conditions.

Sincerely,

Nancy Gramlich

Nancy Gramlich
Willamette Basin Coordinator

cc:
Roland Rocha, Keller Associates
Don Eubank, City of Stayton

City of Stayton, Oregon

Willamette Basin TMDL Implementation Plan – Agency Review

February, 2009

Table of Contents

Chapter 1 INTRODUCTION

1.0 General

As part of a watershed approach to water quality problems, the State of Oregon is in the process of developing a Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP) for each water body that does not meet specific water quality standards. The Willamette River is among these water quality impaired bodies of water for parameters of temperature, mercury, and bacteria.

The United States EPA approved the Willamette River Basin TMDL (WB-TMDL) On September 29, 2006. In the WB-TMDL, the City of Stayton is listed as a Designate Management Agency (DMA) because it is bordered by Mill Creek and North Santiam River which are Willamette River tributaries. As a DMA, Stayton is responsible for water quality within its jurisdiction and is required to submit a TMDL Implementation Plan to the Oregon Department of Environmental Quality under Oregon Administrative Rule 340-042-0080(3).

This report provides a comprehensive description of Stayton's ongoing and planned efforts to reduce targeted pollutant loadings in accordance with the WB-TMDL.

1.1 TMDL Implementation Plan Objective

The objective of Stayton's implementation plan is to fulfill all requirements designated in the Oregon State TMDL Rule 340-042-0080(3). To meet these requirements, the implementation plan must:

- Identify the management strategies which will be used to achieve load allocation and reduce pollutant loading
- Provide a timeline for implementing the management strategies
- Provide target completion dates for benchmarks in implementing the management strategies
- Provide for performance monitoring with a plan for periodic review and revision
- Provide evidence of compliance with applicable statewide land use requirements
- Provide any other elements as specified in the WQMP

The following chapters in this report specify how the City of Stayton plans to meet these requirements. The final chapter provides a general summary of the implementation plan including a progress tracking matrix for annual reporting and review.

1.2 Related Documents

Through prior efforts, the city has recently completed a Storm Water Master Plan. The Storm Water Master Plan addresses water quality issues, and contains preliminary plans anticipating both the TMDL implementation and the NPDES phase II program. This implementation plan is consistent with these master plan elements, and the master plan provides much of the background and supporting data for the implementation plan.

1.3 Acknowledgements

Key to the present and ongoing success of water quality efforts in Stayton are the citizens of Stayton, the employees of the Stayton City Public Works Department; Michael Faught, Public Works Director; Members of the Stayton City Council, and the Oregon Department of Environmental Quality.

Chapter 2 EXISTING CONDITIONS

2.0 General

The City of Stayton is proactive in its efforts to improve water quality. The city has recently completed a Storm Water Master Plan outlining significant capital improvement projects, and is currently working toward establishing a storm water program aimed at positioning the city to meet future state and federal requirements. This chapter summarizes the city's current status with regard to the applicable Statewide Land Use Goals, and current storm water quality conditions.

2.1 Oregon Statewide Land Use Goals

In 1973 the Oregon State Legislature established statewide standards to be used by local government agencies in land use planning. The intent of the standards was to protect Oregon's natural resources and promote economic development. The Department of Land Conservation and Development (DLCD) was created at that time to be the administrative agency to manage these standards.

Over time, these standards have evolved into a set of 19 Land Use and Planning goals covering everything from Citizen Involvement to the preservation of Ocean Resources. As not all of these goals directly apply to the WB-TMDL, DEQ has shown interest in the position of Stayton in relation to Statewide Landuse and Planning Goals 5 and 6 because these are the pertinent sections with regard to the Implementation Plan.

Statewide Planning Goal 5 is to protect natural resources, and conserve scenic and historic areas, and open spaces. In correlation with this goal, local governments are to adopt programs that will achieve this goal. Part of this is to inventory riparian corridors and establish policies to protect them.

Statewide planning Goal 6 is similar to Goal 5 in that the objective is to maintain and improve the quality of the air, water and land resources of the state. All waste and process discharges cannot exceed the carrying capacity of the water resources nor degrade nor threaten them.

The city's comprehensive plan was revised in April 2006, and addresses all of statewide land use goals. The comprehensive plan has been acknowledged by the Department of Land Conservation and Development to be compliant with the state wide goals. The city's ongoing land use practices, permitting practices, and development code are consistent with the land use goals and the proposed management strategies in the implementation plan. A letter from the Stayton City Planner has been included in Appendix B, which states the city is in compliance with Statewide Land Use Goals (Goals 5&6 in particular). Furthermore, the proposed TMDL Implementation Plan is consistent with the city's comprehensive plan to the extent required by law.

2.2 Existing Water Quality

Stayton's TMDL efforts focus on the waters within the city's jurisdiction which includes the Salem Ditch (also known as the Stayton Ditch), the North Santiam River, Mill Creek, and the Power Canal.

The majority of the city's urban impact is on the Salem Ditch, which travels east to west along the south border of the city, then turns north and runs along the city's west border ultimately discharging to Mill Creek in the northwest corner of the city limits. Figure 1 in Appendix A identifies the ultimate discharge locations for the various portions of the city's storm system.

Because the majority of the stormwater discharges to the Salem Ditch, the ditch provides an opportunity to test the net impact of the stormwater discharge on water quality.

In March of 2007, four storm water samples were collected from two points in the Salem Ditch upstream of Stayton, and two points downstream of Stayton. The samples were taken during a rain event and were tested for Biochemical Oxygen Demand, Chemical Oxygen Demand (COD), Orthophosphate-phosphorus, Specific Conductivity, Total Solids, Total Suspended Solids (TSS), Turbidity, Hardness, pH, Phosphorus, and E coli.

The water quality test results specific to the WB-TMDL target pollutants have been summarized in Table 2.1. The TMDL targets are basin-wide targets and are not specific to Stayton, but they serve as comparison basis for the city.

No data was collected on the temperature, but mercury and bacteria were tested. No mercury was detected, and bacteria increased by 8.5 mpn/100 ml. More testing over an extended period would be necessary before any firm conclusions can be drawn on the storm water quality, but initial testing appears to indicate the city's overall impact in relation to the WB-TMDL is relatively light.

Table 2.1 TMDL Targets vs. Existing Conditions

Water Quality Parameter	WB-TMDL Target	City Inlet	City Outlet
Temperature	Mill Creek: 18°C* North Santiam: 18°C*	No Data	No Data
Mercury	27% Reduction	None Detected	None Detected
Bacteria	80% Reduction	6.3 mpn/100 ml	14.8 mpn/100 ml

*Target temperatures for summer months

Chapter 3 MANAGEMENT STRATEGIES

3.0 General

This chapter discusses the general strategies the city will implement to reduce pollutant loads. The methods for assessing the effectiveness of these strategies are discussed in Chapter 4. Fundamentally, these strategies are designed to focus efforts on activities that will result in the maximum reduction of pollutants given the city's limited resources.

3.1 Management Strategies

The following sub-sections describe Stayton's management strategies for reducing temperature, mercury, and bacteria. Some of the strategies are already in place, and have been identified in their scheduled implementation as 'ongoing'. Strategies that have been selected as part of this plan to fill the gaps have specific implementation dates as chosen by the city according the resources available. The strategies, along with the benchmarks and schedules are summarized in the Tracking Matrix in Appendix A.

3.1.1 Temperature

The WB-TMDL has established a temperature TMDL to create a healthier environment for salmon and trout species found in the Willamette Basin. There is not one target temperature for the entire basin, because the optimum temperatures vary by location according to the fish habitat designation for the area. DEQ would like to see efforts from Stayton to address temperature concerns through protection, restoration, or creation of riparian vegetation. The Oregon State DEQ does not recognize storm water as a source of temperature loading for the purposes of the temperature TMDL.

Because storm water runoff from the city is not recognized by DEQ as a source of temperature loading in the rivers, direct solar radiation on the water bodies within Stayton's jurisdiction is the primary source for temperature loading. The effects of temperature loading can be minimized if the water in the river is deep and well shaded.

The depth of the water is affected by two factors, namely, flow volume and the channel shape. During the summer months, when solar radiation is at a peak, the flow in the river and the runoff volume from the city is typically low. Under this scenario, any flow added to the river from the city's storm water system will help lower the stream temperatures because it will provide additional volume to the river and it will typically be cooler because it is piped underground prior to discharging to the river.

The second factor affecting the depth of the water in the river channel is the shape of the channel. The channel shape can be negatively affected through erosion. Erosion is more likely to occur where the channel banks are bare and unstable. As banks erode, the shape of the channel tends to be wide and flat, therefore reducing the water depth and increasing the impact of solar radiation. Riverbank vegetation or structural stabilization measures prevent channel erosion and promote a deeper channel resulting in cooler water temperatures. Bank vegetation not only prevents erosion, but can provide shading if the vegetation consists of trees.

In an effort to improve water quality in the North Santiam River, the City of Stayton recently completed a stream bank tree planting project. In September of 2007, the city planted 3,200 Willow Tree cuttings. The project improved approximately 18,000 square feet of the river's north bank south of Stayton.

The city's land use development code also contains provisions that require 50 foot riparian setbacks as a measure of protecting the riverbanks and promoting stream health. This code will continue to promote cooler water temperatures as the city develops beyond its current limits. The city's goal is to continue the practice of enforcing the existing land use code through the development review and approval process.

In addition to setback requirements, Sections 17.16.090 and 17.20.80 specifically protects trees and other vegetation in riparian corridors.

The city has also formed an active partnership with North Santiam Watershed Council, and the Oregon Association of Clean Water Agencies (ACWA). This relationship will provide the city opportunities to take part in a watershed approach to water quality, and to partner with these agencies on future water quality projects similar to the recent riparian development project completed in September 2007. The city's goal is to stay involved with these groups by attending six meetings each year as a management strategy to address the temperature TMDL.

3.1.2 Mercury

Mercury is pollutant of concern because of its toxicity and its tendency to bioaccumulate. Bioaccumulation is the process by which a substance builds up in concentration in living organisms as they take in contaminated air, water, or food because the substances can only be metabolized very slowly. The toxic effects of mercury poisoning range from debilitation to death.

Mercury is a natural soil component common throughout the Willamette Basin, and soil erosion accounts for nearly half of all the mercury found in the Willamette River and its tributaries. Automobile emissions, Dental fillings, light bulbs, and thermometers are a few of the common non-natural sources of mercury.

The City of Stayton has identified sediment in sediment laden storm water and air pollution as two primary sources of mercury loading in the surrounding waters. To address sediment carried by stormwater, the city will focus on reducing runoff from construction sites, and reducing sediment loads in stormwater through improved maintenance practices.

The city currently provides reminders to developers during preconstruction meetings to obtain 1200-C permits as required by the state. The city also reviews erosion control plans as part of the plan review process. The city's goal is to continue these practices to aid in the prevention of excessive sediment in stormwater runoff from construction sites.

1200-C permits address construction sites that are an acre or larger in area. There are not currently any regulations for sites less than an acre and the city recognizes such sites as a potential source for sediment erosion. As such, the city will consider adding language to existing codes and/or design standards.

To reduce sediment loading from stormwater, the city currently sweeps the streets on a regular basis. Downtown corridors are swept weekly, collectors are swept twice a month, and residential streets are swept monthly. The city's plan is to continue street sweeping and begin tracking completion of the street sweeping.

In addition to street sweeping, the city currently cleans all of their estimated 650 storm water catch basins annually. Cleaning the catch basins not only prevents trapped sediment from reentering the system, but also enables the basins to function properly and remove more sediment from the system. The city's goal is to continue cleaning all of the catch basins annually and track the number of basins cleaned.

As part of the stormwater master plan, the city has established a plan to begin pressure cleaning the storm water lines. There are approximately 15 miles of stormwater lines in the city. The plan is to clean the lines once every five years. This will prevent buildup, allow for proper function of the system, and remove excess sediment.

In addition to mercury carried in storm water sediment, the city realizes air pollution can contribute to mercury levels in surface waters. For this and many other benefits, the city supports a county commuter ride program. A large park-and-ride lot is located in the northeast end of the city. Commuter ride program information is also available at the public works office. The goal in relation to this management strategy is to continue to support the commuter ride program.

An implementation schedule and measurable benchmarks are identified for each of these strategies in the Tracking Matrix in Appendix A.

3.1.3 Bacteria

Bacteria concentrations in water are typically measured by an indicator group of bacteria such as E. coli in units of Most Probable Number (MPN) per unit volume. Potential sources of bacteria include failing septic systems, leaking sewer lines, substandard wastewater effluent discharges, pet waste, livestock waste, duck feeding areas, and cross-connections.

Stayton has reviewed the potential sources of bacterial contamination and has determined that pet waste, poorly maintained sewer lines, and cross connections are the areas on which they will focus their management efforts.

The city has installed pet waste stations in local parks to encourage owners to clean up after their pets. The city plans to inventory theses stations to determine quantities, locations, installation years and other data necessary to assess additional needs. The city will continue to stock and maintain the stations, as well as inventory the existing stations and assess additional needs.

The city currently cleans and inspects the sewer system periodically. The goal is to continue this practice and commit to a schedule of cleaning and inspecting every line once every five years. The anticipated outcome of this effort is well maintained lines that will prevent sewage leaking or overflowing and reaching the natural waters surrounding the city.

In reviewing the city codes and ordinances, it was discovered that there is nothing prohibiting storm drain and sanitary sewer cross-connections. As a result, a goal has been established to propose ordinance language prohibiting cross-connections.

The specific implementation schedules and benchmarks for each of these strategies are listed in the Tracking Matrix in Appendix A.

Chapter 4 PLAN REVIEW AND REPORTING

General

Tracking and reporting on the progress of the implementation plan is essential to its success because it provides the feedback necessary to make necessary adjustments. Adjustments are necessary over time due to changing needs or variances in field conditions.

As such, tracking and reporting have been included as part of the implementation plan to serve as tools to help the city achieve the plan objectives. This chapter presents the city's plan for tracking and reporting their progress on the implementation plan activities.

4.1 Implementation Tracking

Implementation tracking refers to keeping track of which of the planned activities have been implemented within their chosen timeline and which ones have not. It should be noted that the timelines for implementation are not regulatory, but rather City of Stayton will track and report on the progress of the planned TMDL Implementation Plan Activities – including interim steps necessary for the various benchmarks. The City will keep an internal inventory of progress towards completion of each of the activities listed on the tracking matrix throughout the year.

4.2 Effectiveness Tracking and Evaluation

Effectiveness tracking will focus on how beneficial the strategies are in relation to the time and effort required to implement them. The evaluation of this effectiveness in reducing pollutant loads will rely on city personnel performing adequate and timely data collection and analysis.

A record of the time and resources spent will be kept on each of the activities and will be compared to the measurable benchmark for the activity. For example, catch basin cleaning may cost an average of $17 per catch basin, and result in an average of 2 lbs of sediment being removed from the system. This would allow the city to compare this activity with other activities for effectiveness resources required.

The effectiveness of activities such as public education are difficult to quantify, however activities themselves can be tracked as indicated in the tracking matrix. However, the intent in tracking the meetings is to measure the level of effort compared to a sense of its effectiveness which should be determined by those participating in the activities.

Central to the effectiveness evaluation will be the questions: “How well is this activity helping us reach our goal of pollutant reduction?”, “Can this activity be modified to be more effective?”, “Are there other activities that could be more beneficial?” Once the appropriate data is collected, the results will be evaluated on the basis of these questions.

The city will review the results of all effectiveness evaluations on an annual basis and consider possible alterations to the implementation plan if some activities prove to be ineffective. This internal review will be completed prior to the annual DEQ reporting. The city will also review and track interim steps being taken towards their benchmarks in the annual and five-year reviews.

4.3 Reporting

Oregon DEQ requires the city to report implementation progress annually. This reporting will be facilitated through the use of the tracking matrix presented in the previous chapter. The annual reporting will consist of filling out the status column with an appropriate indicator and submitting the matrix to DEQ. The annual and 5-year reports will also discuss interim steps being taken towards the various benchmarks. Any necessary minor adjustments may also be made at this time. In an effort to coordinate TMDL reporting with other reporting required of the city, they will report in September of each year after an internal review held in August starting in 2009.

4.4 Adaptive Management

As circumstances change, the needs and strategies related to this implementation plan will change. This may be due to changes within the city, state and federal regulations, or in the Willamette Basin itself. The City of Stayton will specifically revisit this implementation plan every five years. The city will also consider potential revisions or redirections that may be necessary as a result of DEQ’s revisions to the WB-TMDL. The first of these revisits will be in 2013. The reevaluation will include a review of existing tracking data and other information to evaluate the effectiveness of the plan relative to the pollution reduction goals.

Chapter 5 ADDITIONAL ELEMENTS

5.0 General

The WB-TMDL requires additional elements from the WQMP to be addressed by various communities according to their population designation. Because Stayton is considered by DEQ to be non-MS4 DMA, the additional requirements are not as extensive as those required of MS4 DMAs. This chapter addresses the additional elements required for the City of Stayton.

5.1 Public Involvement Plan

Stayton is required to include a public involvement element as part of the TMDL Implementation Plan. The city will implement the plan upon acceptance from DEQ, however, the city's plan is to involve the public through a public open house where the implementation plan will be presented to the public and City Council in within 60 days of DEQ's approval of the Implementation Plan.

As revisions to ordinances and standards are proposed during city council meetings which are open to the public, the public will have an opportunity to be further involved.

5.2 Fiscal Analysis

A fiscal analysis is required in order to identify the resources necessary to develop, implement, and maintain the plan components identified in this report. Given the absence of resources available for additional programs and practices, many of the plan elements have been selected on the basis of their minimal financial impact. Items such as policy implementation will cause an insignificant financial impact and will be absorbed into the regular operations budgets.

The more resource intensive components of the plan are to be integrated as part of the storm water master plan or other existing programs, and the funding will come from the utility or program budgets. For example, the storm water master plan components will likely be funded by a System Development Charge for new developments, and a utility for existing users which has been detailed in the Storm Water Master Plan.

5.3 NPDES Phase II Six Minimum Control Measures

Because Stayton is not currently a Municipal Separate Storm Sewer System (MS4) community, the city is not required to implement the Six Minimum Control Measures for mercury and bacteria reductions tied to the NPDES Phase II requirements. An MS4 designation is typically triggered by a population of

50,000, other urbanization indicators, or at DEQ's discretion. Stayton's population is currently estimated at 7,700.

However, as part of this implementation plan, DEQ has asked the city to consider these elements and determine which measures could feasibly be accomplished as part of the implementation plan. The Six Minimum Control Measures identified in Chapter 14 of the Willamette Basin Water Quality Management Plan are:

1) Pollution prevention in municipal operations
2) Public education and outreach on storm water impacts
3) Public involvement and participation
4) Illicit discharge detection and elimination
5) Construction site storm water runoff control
6) Post-construction storm water management in new development and redevelopment.

Each of these measures and the extent to which the city plans to address them is covered in the Tracking Matrix in Appendix A.

Chapter 6 IMPLEMENTATION SUMMARY

6.0 General

This chapter presents a summarized list of implementation actions in chronological order. This will serve as a quick planning and tracking reference for city personnel. However, this list is not intended to be comprehensive so the report and the Tracking Matrix should be consulted for more detail on the Implementation Plan and its elements.

6.1 Summary of TMDL IP Actions

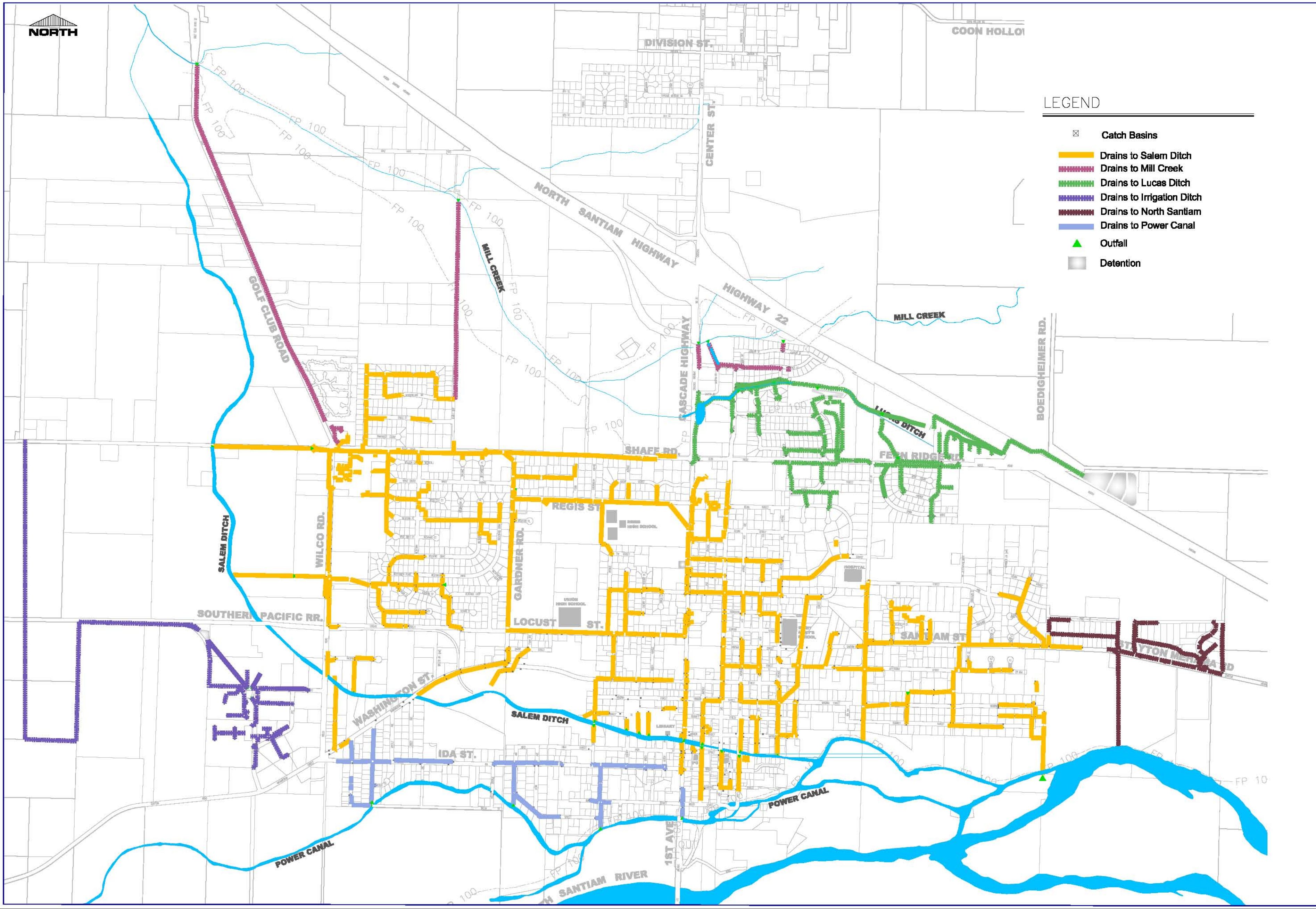
Table 6.1 - Implementation Plan Actions

Year	Action	Targeted Outcome
2008	Present TMDL IP to Council and Public	Involve the public
(& Ongoing)	Review Sediment Erosion Control Plans	Reduce mercury loadings
	Remind developers to obtain 1200C permits	Reduce mercury loadings
	Maintain riparian setbacks	Reduce temperature and mercury loadings
	Support commuter ride program	Reduced mercury loadings
	Continue Watershed Council and ACWA Involvement	Remain current with local storm water issues, potential temperature reduction through riparian preservation or restoration projects.
	Street sweeping	Reduce mercury loadings
	Clean catch basins	Reduce mercury loadings
	Inspect 20% annually and repair damaged Sanitary Sewer lines as resources permit	Reduce bacteria loadings
	Visit riparian project site annually	Reduce mercury loadings
	Hold internal plan review	Maintain or adjust goals as necessary
	Fill out Tracking Matrix, send to DEQ annually	Keep DEQ informed on progress
2010	Clean storm water lines, Track % cleaned	Reduce mercury loadings
2012	Inventory and assess Pet Waste Stations	Reduce bacteria loadings
	Propose code/standard language for erosion control on construction sites < 1 acre	Reduce Mercury loadings
2013	Track Volunteer Coordination and Support	Improve existing benefits of volunteer efforts
	Propose Cross-Connection Control Language for new ordinance	Reduce bacteria loadings
	Complete 1st 5-year TMDL IP review and coordinate with DEQ	Adapt management strategies changing conditions

Appendix A: Tracking Matrix and Figure

Implementation Plan Tracking Matrix

POLLUTANT	SOURCE	STRATEGY What is being done, or what will be done to reduce or control pollution from this source	HOW THIS WILL BE DONE	MEASURE How implementation or completion will be measured	TIMELINE When this strategy will be implemented or completed	BENCHMARK The goal to be met within the indicated timeline	STATUS
Temperature	Solar Radiation	Protect and promote healthy riparian areas	Sustain land use code which requires riparian setbacks	Track the number of development and redevelopment plans reviewed for conformance with riparian policy	Ongoing	100% of development and redevelopment plans	
			Review progress of riaprian project along N. Santiam River	Are the trees growing?	Ongoing	Check the site annually	
		Work with other agencies on watershed solutions	Maintain contact with ACWA and continue to participate with North Santiam Watershed Council	Track number of coordination meetings attended annually	Ongoing	Attend 6 meetings annually	
Mercury	Sediment	Reduce sediment reaching Mill Creek and North Santiam through storm water	Ensure sediment erosion control plans are provided for development and redevelopment plans	Track % of sediment erosion control plan checks performed as part of plan review process	Ongoing	100% of development and redevelopment plans	
			Remind developers of 1200-C permit requirements in preconstruction meetings	Track % of meetings wherein a 1200-C permit reminder was provided	Ongoing	100% of preconstruction meetings involved a 1200-C permit reminder	
			Consider adding language to existing city codes and/or design standards for erosion control on construction sites <1ac	Public works or Planning and Zoning to propose language to be considered for inclusion in existing codes and standards.	2012	Propose Language for revised code	
			Perform regular street sweeping	Track % of streets swept monthly	2008	Downtown 4/mo, Collectors 2/mo, Residential 1/mo	
			Clean catch basins annually	Track % of catch basins cleaned annually	Ongoing	100% of catch basins cleaned annually	
			Clean storm lines once every 3 yrs	Track % of lines cleaned annually	2010	20% of storm lines cleaned annually	
	Air deposition	Reduce air pollution	Support commuter ride program by providing information at Public Works Building	Brochures provided? Y/N	Ongoing	Brochures provided? Y/N	
Bacteria	Pet Waste	Reduce pet waste reaching streams through storm water runoff	Continue support and use of pet waste stations at city parks. Inventory existing stations, and assess need for additional stations	Provide inventory and assessment results in a report	2012	Report presented? Y/N	
	Municipal Sewage	Reduce municipal sewage reaching streams through surface water and groundwater pathways	Detect and repair leaking city sewer lines as resources allow	Track % of lines cleaned and inspected	Ongoing	20% of lines cleaned annually	
			Propose language in city code which prohibits storm system and sanitary sewer cross-connections	Language proposed? Y/N	2010	Language Proposed? Y/N	
Additional Elements Required from the WB-WQMP	Six Control Measures for Mercury and Bacteria from NPDES Phase II Program	Pollution Prevention in Municipal Operations	See: Mercury>Sediment>Street Sweeping, Catch Basin Cleaning, Storm Line Cleaning				
		Public Education and Outreach	See: Mercury>Air>Reduce Pollution>Commuter Ride information				
			Coordinate with Volunteer Groups	Begin tracking and report number of volunteer projects performed annually	2008	100% of City Coordinated Volunteer projects reported	
		Public Participation	Present TMDL IP to City Council for Approval	Presented? Y/N	2008	Presented? Y/N	
		Illicit Discharge Detection and Elimination	See: Bacteria>Sewage>Reduce>Cross-Connections				
			Map storm lines and outfalls	Completed in 2007			
		Construction Site Runoff Control	See: Mercury>Sediment>Stormwater Reduction>1200C, Erosion Control Plans				
		Post Construction Storm Water Management	See: Riparian preservation requirements in section 3 of implementation plan.				



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KELLER ASSOCIATES

CITY OF STAYTON

TMDL Implementation Plan
Stayton, OR

Existing Drainage Areas

FIGURE
1

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Appendix B: Land Use Compatibility

City of Stayton

Planning Department

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TO: Michael R. Faught, Public Works Director

FROM: Dan Fleishman, City Planner DF

SUBJECT: Compliance with Statewide Goals 5 and 6

DATE: December 6, 2007

You have asked for a memorandum regarding the City's compliance with Statewide Planning Goals 5 and 6. Oregon state law requires all municipal comprehensive plans and land use regulations to comply with 14 statewide planning goals. Compliance is assured by submittal of local plans and regulations to the Department of Land Conservation and Development for review and "acknowledgement." These two statewide planning goals address natural resource issues and can be summarized as the following.

Goal 5: To protect natural resources and conserve scenic and historic areas and open spaces.

Local governments shall adopt programs that will protect natural resources and conserve scenic, historic, and open space resources for present and future generations. These resources promote a healthy environment and natural landscape that contributes to Oregon's livability.

Goal 6: To maintain and improve the quality of the air, water and land resources of the state.

All waste and process discharges from future development, when combined with such discharges from existing developments shall not threaten to violate, or violate applicable state or federal environmental quality statutes, rules and standards. With respect to the air, water and land resources of the applicable air sheds and river basins described or included in state environmental quality statutes, rules, standards and implementation plans, such discharges shall not (1) exceed the carrying capacity of such resources, considering long range needs; (2) degrade such resources; or (3) threaten the availability of such resources.

Generally, Stayton's Comprehensive Plan and Land Use and Development Code were initially drafted in the late 1970s. They were acknowledged by DLCD at that time as being compliant with the goals. Subsequent updates and amendments have also been acknowledged as compliant.

More specifically, Stayton's Comprehensive Plan inventories the significant natural, historic and cultural resources within the urban growth boundary and contains policies for their protection. The City has purchased tens of acres of open space for parks. The City's Land Use and Development Code contains provisions that require riparian setbacks and protection of wetlands. There are also two historic preservation districts and particular protection to buildings and sites identified in the comprehensive plan as historically significant.

The City has adopted a Parks and Recreation Master Plan that calls for the development of more park land to assure protect natural resources and provide open space. The City has recently updated its water and wastewater master plans to assure that it can both provide adequate service for the projected growth and meet its obligations to maintain the quality and quantity of water resources within and adjacent to the City.

Let me know if you need additional information.