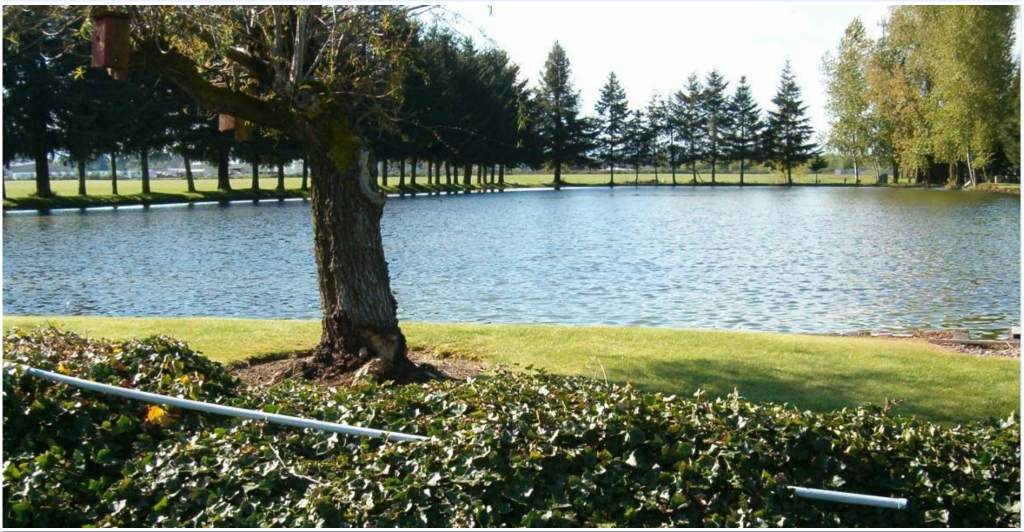
STORM WATER
Master Plan
for *City of Stayton*

April 6, 2009



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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 is listed as a Designated Management Agency (DMA) in the Willamette Basin TMDL and as such is required to prepare a TMDL Implementation Plan. The city of Stayton completed their TMDL Implementation Plan in 2008 which was subsequently approved by DEQ. The plan and approval letter can be found in Appendix H of this report.

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	Conceptual Level Opinion of Probable Cost*
Priority 1A Improvements	$3.6M
Priority 1B Improvements	$5.0M
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 Basins:* 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. The costs represented in this table are based on a conceptual level opinion of probable cost. 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	OPC*	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**

*Opinion of probable cost

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

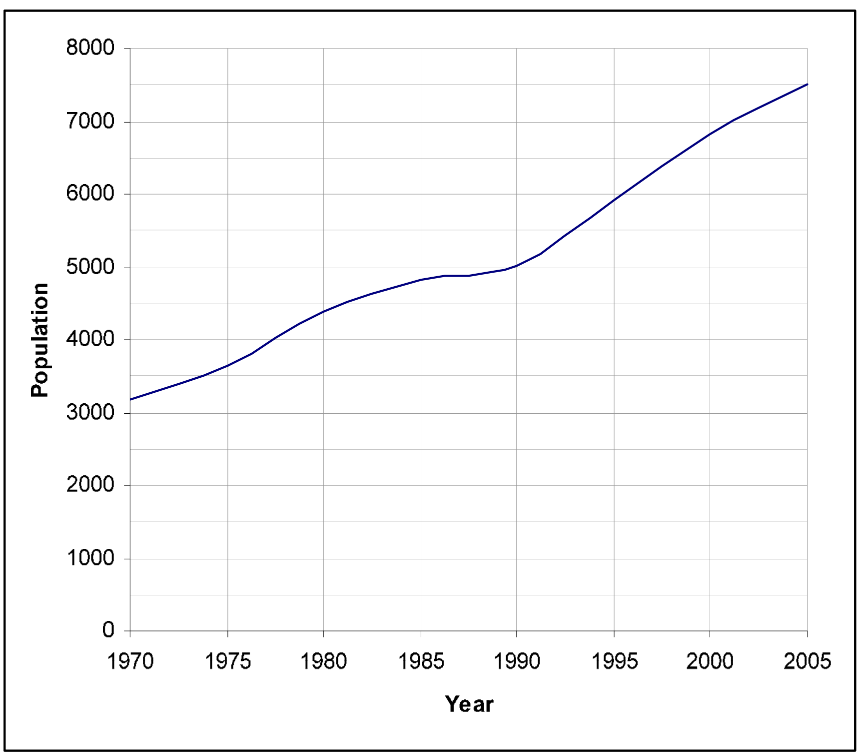
The estimated July 2006 population for the City of Stayton, as reported by the Portland State Population Research Center, was approximately 7,700. Historical population in the City of Stayton and in Marion County retrieved from census data is shown in Table 2.3.

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.

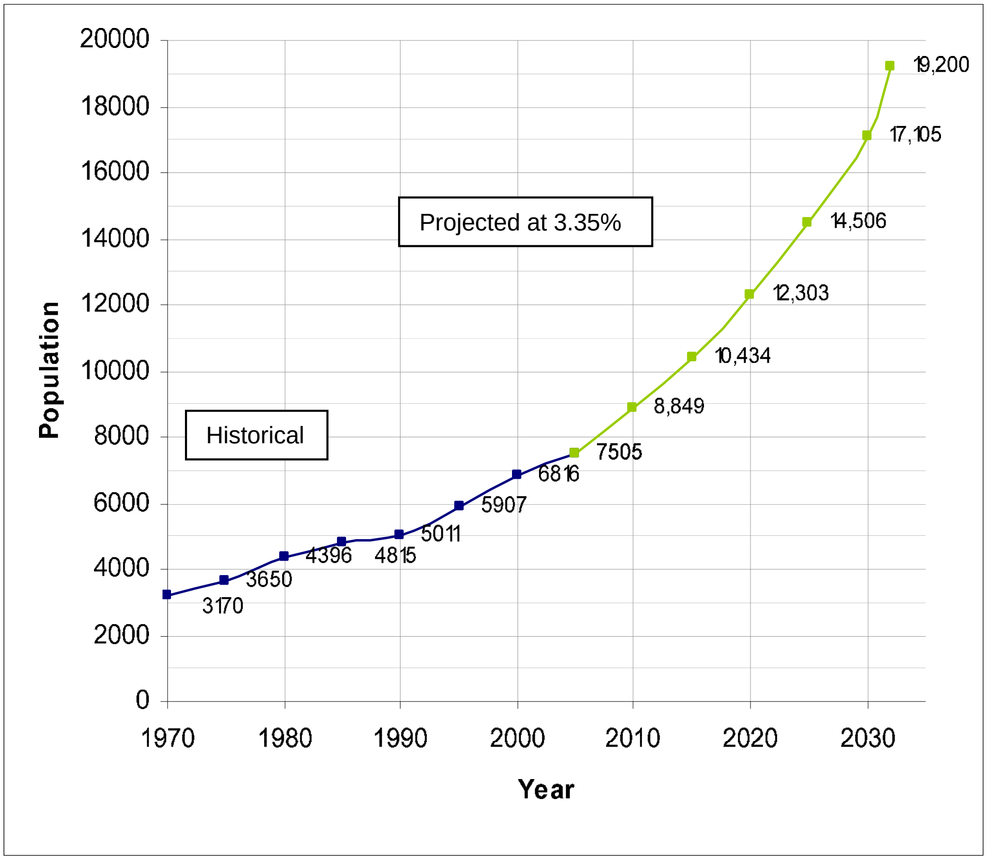
Chart 2.1
City of Stayton Historical Population



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)		
2^{nd} Max 1-hr	2^{nd} Max 8-hr	2^{nd} Max 1-hr	2^{nd} 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 draft changes were accepted by the TRC and included as part of this master plan. The details of the draft 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.

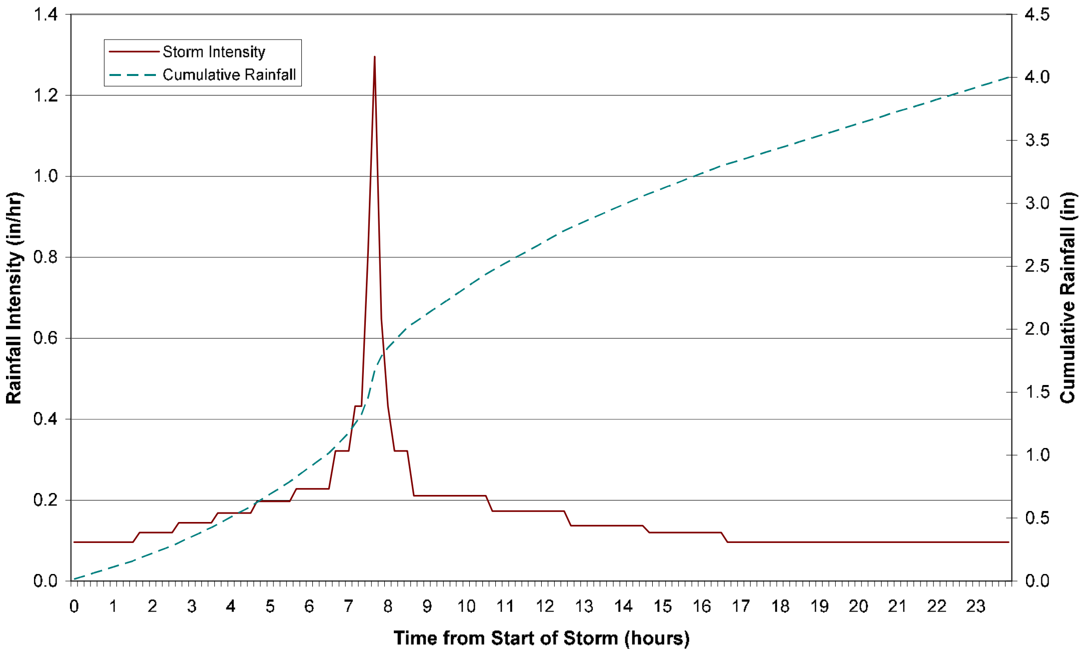
Table 3.1
24-Hour Storm Depths

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.

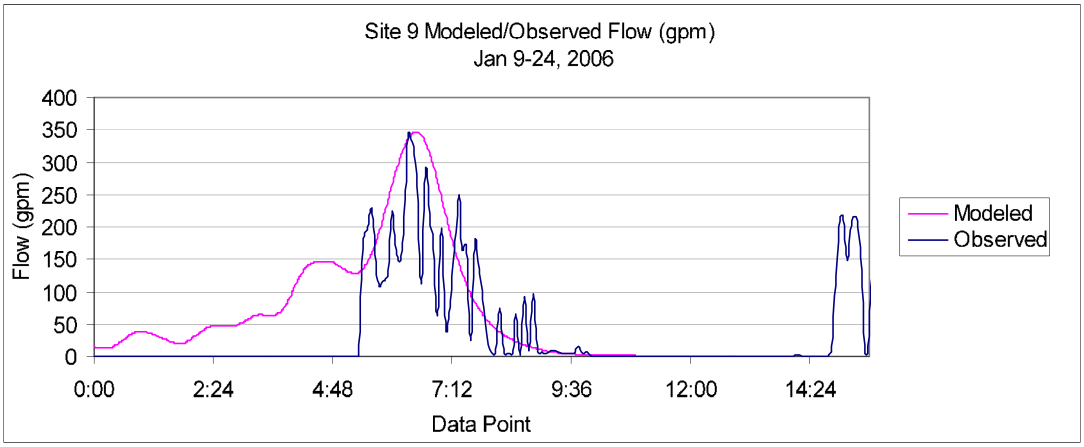
Thirdly, water and wastewater flows are much more regular and predictable. Storm drain flows are dependent on the weather which is much less predictable. Given these considerations, methods that would provide a reasonable assurance that the model accurately reflects field conditions were implemented.

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

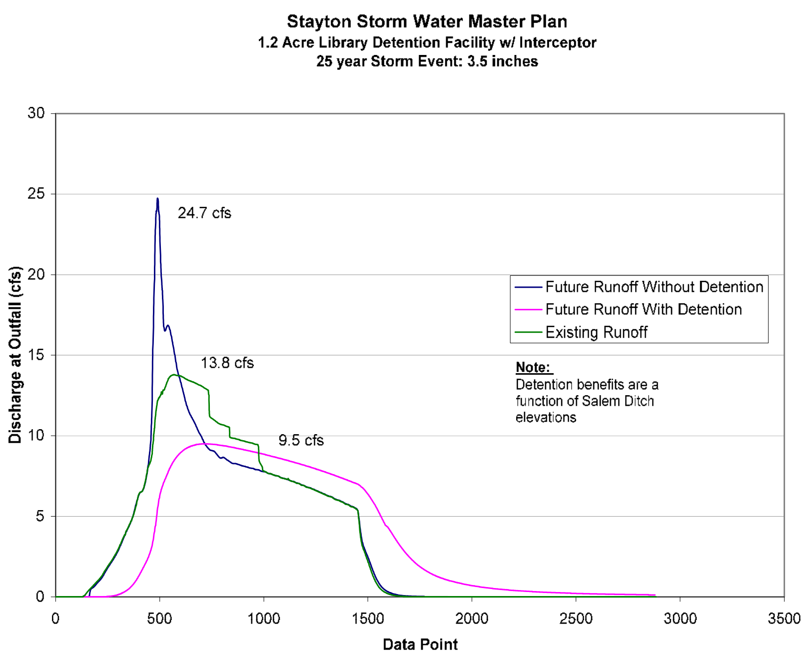
Problem areas or challenges discussed in Section 5 are summarized in Figure 10 in Appendix A. This section summarizes improvement alternatives and opinions of probable cost for the improvements. The improvement alternatives are organized by drainage basin.

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.

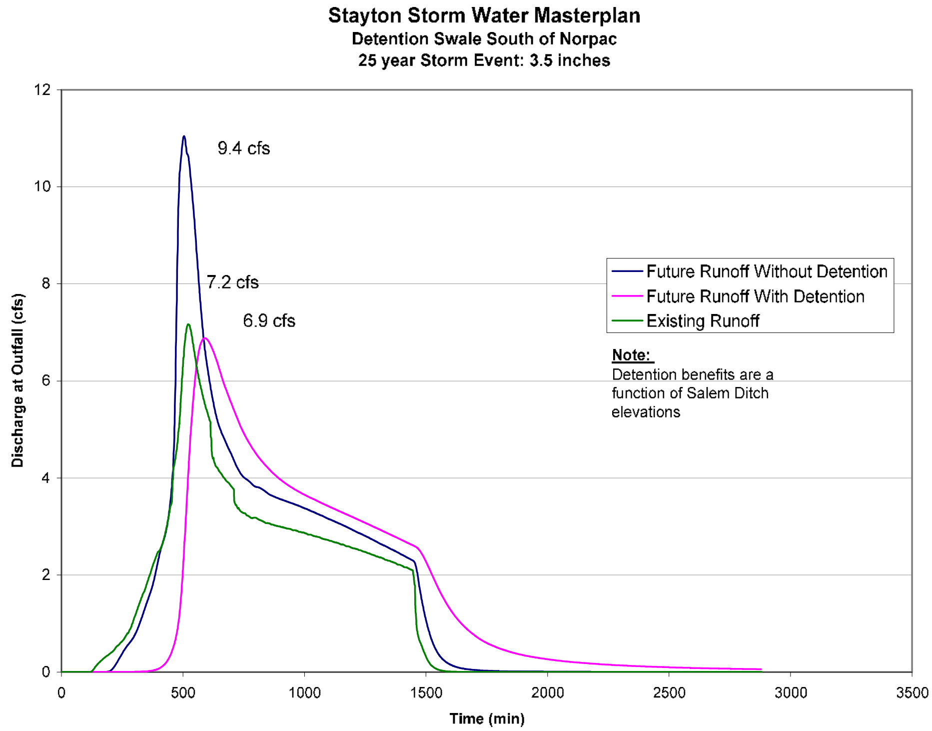
The **second alternative** is to construct a new storm water pipeline that would interceptor the storm water lines that have historically discharged into the Salem Ditch as shown on Figure 12. The new storm water pipeline would discharge into a new regional detention pond located on the Library property 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. An opinion of probable cost for this alternative is $2,115,000.

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. 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.

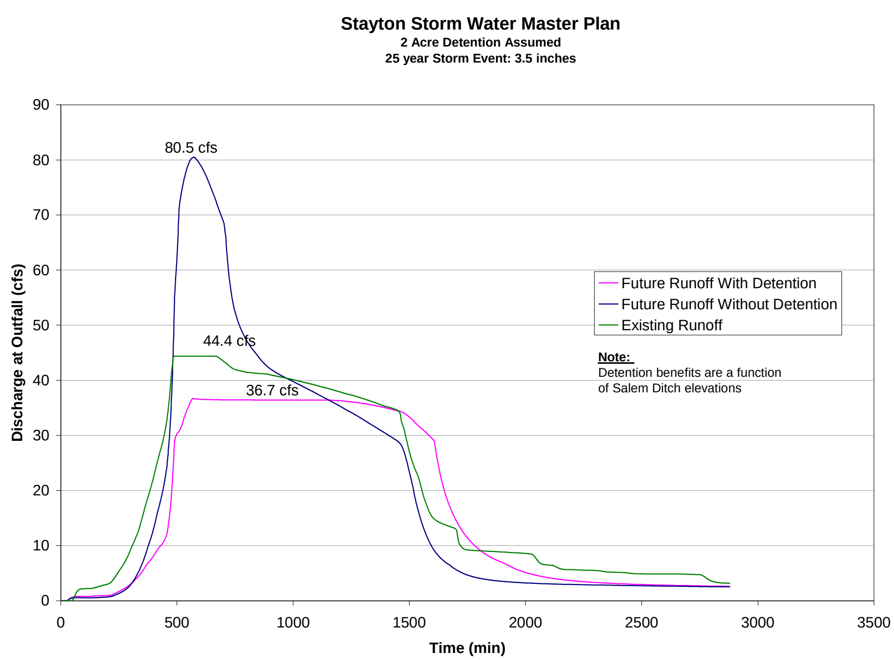
The **second alternative** is to construct a new storm water pipeline that would interceptor the storm water lines that have historically discharged into the Salem Ditch as shown on Figure 13. The new storm water pipeline would discharge into a new regional detention pond that contains approximately 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. An opinion of probable 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. An opinion of probable 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. Stayton submitted their TMDL Implementation Plan in 2008, and it was subsequently approved by DEQ. The Implementation Plan and DEQ approval letter is in Appendix H.

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 Opinions of probable cost 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 OPC*
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**

*Opinion of Probable Cost

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 opinion of probable 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 6^{th} and 1^{st}, 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 OPC*
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**

*Opinion of probable cost

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 **2.0 PTE**	**Total until 2011**
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 **2.0 PTE**	**Total after 2011**

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	OPC***	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).

***Opinion of probable cost

SECTION 9 – CAPITAL IMPROVEMENT PLAN

9.0 GENERAL

This section summarizes the recommended capital improvements and an associated opinion of probable cost. Recommended improvements are illustrated in Figure 12 in Appendix A.

9.1 CAPITAL IMPROVEMENT PLAN

The opinions of probable coast for the capital improvement plan are 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. *Opinions of probable cost are in 2007 dollars for improvements necessary to correct flooding for the 25-year storm event have been summarized below.* Details of the opinions of probable cost 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 opinion of probable cost for all 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>Opinion of Probable 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. Opinion of Probable Cost = $1,011,000

- Construct a regional detention facility in the existing City Park area off Marion Street and a local detention facility on the property on the northwest corner of 10th Avenue and East Santiam Street. These detention facilities 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 structures. These facilities 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. If feasible, the detention facilities could be designed to double as recreation areas during dry periods. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable Cost = $572,600

- 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. Opinion of Probable 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. Opinion of Probable 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 the opinion of probable cost for these improvements totals $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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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. Opinion of Probable 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

Priority Improvements							
Item (2007 Opinion of Probabe 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	$1,011,000						15%
PRIORITY 1A SUBTOTAL	$3,557,700						
1B							
Industrial Detention Site Improvements	$95,000						25%
Shaff Road Basin Pipeline Improvements	$3,575,500						5%
10th Avenue Pipeline Improvements	$572,600						15%
Norpac NE Detention Site	$620,800						0%
5 Additional Manhole Monitoring Equipement	$96,700						0%
PRIORITY 1B SUBTOTAL	$4,960,600						
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.

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. Opinions of probable cost for 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