City of Coos Bay

COOS COUNTY, OREGON

<u>STORMWATER MASTER PLAN</u>
<u>VOLUME A</u>

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1.0 Executive Summary

1.1 Introduction

The City of Coos Bay is located in Coos County on the Southern Oregon Coast. Coos Bay is the largest community on the Oregon Coast with a 2004 population of around 15,700 persons. Stormwater collected from within the City is typically piped in developed areas and discharged into the nearest natural water body (i.e. local streams, the bay or sloughs, Empire Lakes, etc.) In many cases, existing storm drains have been designed and constructed with the intent to serve only specific developing areas within the City. As storm drains have been constructed, little consideration has been given to the effects of future development in areas upstream of the subject development for which storm drain improvements have been constructed. Furthermore, many of the existing storm drains and culverts within the City are aged and nearing the end of their useful service lives.

In November 2003 the City of Coos Bay authorized the firm of The Dyer Partnership Engineers and Planners, Inc. to complete a Stormwater Master Plan for the downtown/central portion of the City. In 2004, the City of Coos Bay authorized the firm of HBH Consulting Engineers, Inc. to prepare a Stormwater Master Plan for the remaining areas of the City not covered in the previous study. This Stormwater Master Plan has been completed to provide an overview of the existing stormwater facilities within the study area, as well as identify any piping deficiencies due to sizing, age, or other factors.

In addition to providing the technical and engineering information needed to administer and manage the stormwater system, the master plans have been prepared to provide the backing and basis for the City to establish a system development charge (SDC) program to help offset the financial burden that new development has come to place on the storm drainage system. This effort is part of a multi-phased approach that is intended to establish SDC's for wastewater, stormwater, transportation, and eventually, the parks systems within the City of Coos Bay.

1.2 Existing System

The existing storm drain system owned and maintained by the City of Coos Bay includes approximately 48 miles of gravity piping in a range of sizes from 8-inches to 48-inches diameter and consisting of a variety of materials including concrete, corrugated steel and aluminum, polyvinyl chloride (PVC), high density polyethylene (HDPE), and others. Detailed information is provided in each stormwater master plan regarding the specific amounts of the various sizes of pipe in the various storm drainage basins.

For the purposes of this master plan, the study area has been divided into 21 separate drainage basins based on topography. Typically, basins include the watershed or collection area of a stream or major storm drain pipe. Some basins have been further divided into subbasins when multiple trunk storm drains exist within the basin. Mapping, including detail maps of one to two basins, is provided in Volume B of this study.

The City owns and operates 3 stormwater pumping stations within the community. Two of these stations are discussed in the Stormwater Master Plan prepared by The Dyer Partnership (2004). The other (Pump Station 23) is located on the south side of Grant Avenue between Wasson and Cammann Streets in the back yard of a residence. Pump Station 23 includes a grate topped wet well with a float controlled submersible pump which discharges water into a 10-inch storm drain pipe along Grant Avenue. Additional details are discussed in Section 4.4.3 of this study.

1.3 Identification of Deficiencies and Development of Improvement Alternatives

All of the existing storm drain system components were analyzed for deficiencies that exist presently. Facilities also have been evaluated for deficiencies that are expected to occur within the 20-year planning period. Deficiencies were identified related to the age and condition of facilities, anticipated development, and capacity.

As part of this planning effort, calculations were made to estimate the peak stormwater flows that could be expected from each basin under existing and future development conditions. Runoff calculations for the various storm drainage basins identified in this Master Plan were performed using a method developed by the Soil Conservation Service (SCS; now NRCS) for relating rainfall to runoff. The method is described in length in Technical Release 20 (TR-20) published by the SCS. The TR-20 method is based upon unit hydrograph theory and the runoff curve number method of calculating direct runoff from the rainfall occurring over specified areas. It considers an entire watershed with a variety of land uses and soil types. The TR-20 method also allows watershed areas (basins) to be divided into subbasins for analysis purposes, with drainage routes of one or more subbasins running through other subbasins downstream. This provides for the calculation of an overall peak discharge from a basin that may or may not equal the sum of the peak discharges from the individual subbasins.

Stormwater runoff calculations are further discussed in Chapter 5 of this Master Plan. Results of runoff calculations are presented in Appendix A.

1.4 Recommended Plan

In the final chapter of this Master Plan, a number of projects are identified which will address various deficiencies within the storm drainage system. Individual projects are grouped into three priority classifications. Each classification group is loosely defined as follows:

> **Group A:** These are the highest priority projects that should be undertaken as soon as adequate funding is available. It should be considered that these projects should be undertaken within the next 5 years with highest projects on the list to be addressed in the next year or two.
>
> **Group B:** These projects, while not of the highest priority, should be on the City's capital improvement planning window beyond the 5-year horizon. As Group A projects are completed, Group B projects should be moved to Group A status. System degradation or failures, project coordination, or other occurrence may require the movement of Group B projects to Group A status ahead of schedule. New projects that are developed that are not critical, should be grouped in Group B until funding is available.
>
> **Group C:** Group C projects are either of low priority or are dependent on development. If development in an area necessitates the implementation of a Group C improvement, the project should be moved to Group A status assuming that adequate funding is available to undertake it. Some projects may remain in Group C indefinitely if the need for the project or the development requiring it never arises.

Table 1.4.1 below summarizes the projects that have been developed for the City of Coos Bay storm drain system. A total of 20 projects have been developed totaling nearly 5-million dollars. High priority projects (Group A) for the storm drain system are in excess of 1-million dollars.

Table 1.4.1 – Storm Drain System Project Prioritization Summary

	Priority Rating	Project Number	Project Name (Description)	Total Project Cost
A	1	G1	Madison and Morrison Street Storm Drain Improvements	$280,882.80
	2	L1	Ocean Boulevard @ K-Mart Storm Drain Improvements	$125,755.20
	3	O4	Ocean Boulevard @ 19th Street Culvert Lining	$297,561.60
	4	O2	Ocean Boulevard @ 19th Street Storm Drain Lining	$158,374.80
	5	O1	Ocean Blvd. @ Woodland Dr. Storm Drain Improvements	$82,582.20
	6	S1	6th Avenue south of F Street Culvert Replacement	$56,678.40
B	7	K1	Schoneman Street Storm Drain Improvements	$556,821.00
	8	K2	Ocean Blvd. @ Newmark Storm Drain Improvements	$653,499.00
	9	K3	Ackerman Street Storm Drain Improvements	$167,230.80
	10	D1	Lakeshore Drive Storm Drain Improvements	$184,020.30
	11	D2	Seabreeze/Tideview Terrace Storm Drain Improvements	$432,910.80
	12	F1	Newmark Avenue Storm Drain Improvements	$458,150.40
	13	O3	Westgate Storm Drain Improvements	$287,082.00
	14	D3	Lakeshore Drive Culvert Replacement	$181,179.00
	15	B1	Margaretta Street Storm Drain Lining	$100,663.20
	16	C1	Norman Avenue Storm Drain Improvements	$80,589.60
	17	G2	Webster Avenue Storm Drain Improvements	$34,317.00
	18	A1	Fenwick Street Storm Drain Improvements	$90,405.00
C	19	L2	K-Mart Storm Drain Improvements	$457,855.20
	20	J1	LaClair Street Storm Drain Improvements	$195,643.80
			Total	**$4,882,202.10**

1.5 Plan Implementation

It is presumptuous to develop a strict schedule and order for the implementation of the projects developed in this Master Plan. Funding sources, development pressures, economic environment, and other variables will steer the implementation of the plan.

It is recommended that the City maintain the 3-Group approach discussed above. By working to complete the high priority projects and maintaining a living, working capital improvement plan (CIP), the City will systematically complete the projects necessary to maintain and improve their storm drainage system.

In order to make timely progress in completing the recommended improvements, the City should immediately begin developing a plan to finance the projects selected for completion.

1.6 Potential Financing Options

Based on the recommendations of this Master Plan, the City soon will be considering undertaking a number of storm drain system improvement projects. The overall cost of these projects will be millions of dollars. As discussed in Section 9.4, funding assistance is not typically available for storm drain system improvements since public health is not at stake. Non-grant funding includes bonds, loans, system development charges (SDC's), capital construction funds (sinking funds), local improvement districts, and others. It is understood that

It is expected that loans and bonds will be available to the City with interest rates on the order of 5 percent depending on the status of the federal prime rates, the term of the loans, the source of revenue used to payback the funds (user rates, general fund taxes, etc.), and other variables.

The City of Coos Bay does not presently have a specific user fee for storm drain system maintenance that is charged to rate payers. It has been assumed that a portion of the rates collected for sanitary sewer collection and treatment is diverted to cover storm drain system projects as necessary. In order to appropriately fund the storm drain system improvement projects identified in this Plan it is recommended that the City modify its rate structure to include a separate storm drain maintenance and improvement category. We understand that modifying the City's service rate structure is a difficult process and requires public approval in order to implement changes.

Appropriate user fees for storm drainage system maintenance and improvements could be determined by several different methods. It is recommended for simplicity that charges be determined on an Equivalent Dwelling Unit (EDU) basis as introduced in Sections 3.4.2 and 3.4.3. Under the described system, each single family dwelling would typically be charged an equal rate for one EDU. Commercial and industrial customers would be charged a rate for a number of EDU's calculated based on the amount of impermeable surface present on the site. In this way, customers having larger areas of impermeable surface, and which generate greater volumes of runoff, would be responsible for a greater portion of system maintenance and improvement fees.

Because the storm drain projects recommended herein will require significant capital for construction and repayment of loans or bonds, it is recommended that the City determine a basic rate structure sufficient to cover all existing maintenance costs prior to considering the improvement projects. Once baseline user fees have been determined, fee increases, to cover the cost of the recommended improvements may be applied.

1.7 Potential Impacts to Rate Payers

The impact to rate payers will depend on the projects that the City undertakes, the schedule that they follow, and the user rate structure that is established. The projects developed in this plan have been prioritized in three groups, as indicated in Table 1.4 and further discussed in Chapter 9. The City may choose to complete only the highest priority projects within the initial phase of planning.

A potential funding scenario is provided below to demonstrate the impact to rate payers:

> **Scenario 1:** It is assumed that the City will undertake all the projects in the Priority A group for a total project cost of $1,001,835.00. Because the projects will be primarily maintenance based, and in some cases capacity building to serve areas that are already developed, the projects will not be SDC eligible. Likewise, it is unlikely that local improvement districts would be approved for maintenance of existing systems. Based on these factors, the total cost impact to rate payers will be entirely based on a funding source that requires payback (loan, bond, etc.).
>
> Principal: $1,001,835.00
> Interest Rate: 5% per year
> Term: 20 years (240 months)
> Monthly Payment: $6,611.67
> EDU's: 4,352

Based on these terms, the rate increase per EDU required to pay back a loan of the indicated principal amount is approximately $1.52 per month.

The City owns and maintains a storm drain system which is constantly degrading. As portions of the system reach the end of their useful lives and development pressures increase the City must raise the necessary funds to maintain and expand the system as required. While establishment of new user fees and rate increases are not easy for any community, the City must weigh their available resources against what is needed to fund the necessary improvements to provide proper drainage in developed areas and protect property against damage.

2.0 Introduction, Purpose and Need

2.1 Background

The City of Coos Bay owns and maintains a public stormwater drainage system within the Coos Bay City Limits. The system includes numerous catch basins, area drains, ditch inlets, manholes and several miles of gravity pipe in a range of sizes. Additionally, three stormwater pump stations exist within the system. The two major stormwater pump stations lie outside of the study area of this Master Plan. The third, Pump Station 23, is described in Chapter 4.

The storm drainage system has been constructed over a number of years as development has occurred. The rate of growth within the City of Coos Bay has varied over the years. Recently, an increase in the rate of growth has been experienced within the community. New areas of development typically include storm drainage sized to serve only the newly developed area. Existing facilities downstream of the new developments may or may not be adequately sized for the increased flows generated by development.

In order to prepare for continued growth and ensure that the City's stormwater drainage system is adequately sized and maintained, the City has chosen to undertake this Stormwater Master Plan.

2.2 Previous Planning Efforts

In September 2004 the firm The Dyer Partnership Engineers and Planners, Inc. completed a Stormwater Master Plan which covered the southeastern portion of the City including downtown Coos Bay, Englewood, and the bay front area north of Telegraph Hill. In 1966 the firm R.H. Erichsen & Associates completed a Master Plan of Storm Sewers for the area including downtown Coos Bay, Englewood, Empire, and the area between Empire and downtown Coos Bay. The 1966 Master Plan addressed separation of what was then a combined system for sanitary sewer collection and storm drainage. To date, no comprehensive study has been performed covering the entire stormwater system.

2.3 Purpose and Need

The overall purpose of this Stormwater Master Plan is to supplement previous planning efforts and provide the City with the necessary planning information to form the technical, financial, and legal basis required for the establishment of stormwater SDC's. This Master Plan will serve as a guide for the management of the storm drain system through the upcoming planning period extending through the year 2026.

Specific objectives of this Master Plan include the following:

- Evaluate the existing storm drain system condition and capacity, and identify current deficiencies.
- Develop potential stormwater system improvements to serve existing and future development within the city limits.
- Provide cost estimates and phasing recommendations for the recommended improvements.

2.4 Scope of Engineering Services

The Stormwater Master Plan has been prepared to augment the stormwater planning that has recently been completed in the City of Coos Bay to provide a complete Master Plan for the storm drainage system. Tasks that have been completed in the preparation of this Master Plan include the following:

- Background and Data Gathering – Available information has been gathered on the existing drainage system in Coos Bay. Previous planning efforts, as-builts, and field reconaissance have been used in developing the plan.

- Mapping – Detailed storm drainage system maps have been developed utilizing the City's existing digital aerial contour maps. Drainage basins and watersheds have been overlaid on the maps. Existing storm drain piping has been identified using a color coded sizing system.

- Computer Modeling – Existing and future flows have been modeled using the 25-year and 50-year design storms. Deficient system components and likely flooding areas have been identified and shown on a drainage deficiency map.

- Alternatives and Recommendations - Alternatives have been developed to address deficiencies identified in the previous tasks. The alternatives include the construction of new piping and culvert sections, lining of existing pipes where applicable, and the installation of catch basins and manholes. Recommendations include improvements to existing deficiencies as well as proposed improvements for future drainage in areas of potential development. Cost estimates have been prepared for each recommended improvement project. Costs have been referenced to the ENR Index and include construction, engineering, contingency, legal, and other anticipated project costs.

- Capital Improvement Plan – Under this task, all the data, analysis, and information gathered for the study will be compiled within a final report. The final plan includes a Capital Improvement Plan (CIP) for the City's storm drainage system. The CIP includes an implementation schedule for the proposed improvements as well as financial projections of the anticipated project costs over the planning period. The CIP forms a portion of the basis for the methodology that will be developed for the Storm Drain SDC.

2.5 Authorization

The City of Coos Bay authorized the firm of HBH CONSULTING ENGINEERS, INC. to develop a Stormwater Master Plan by a contract dated January 25, 2005. Services are in accordance with this professional services contract and the HBH proposal for the project which was presented to the City in November 2004.

2.6 Acknowledgements

This plan is the result of contributions made by a number of individuals and agencies. In particular, the following persons should be acknowledged for the important roles they played in the preparation, review, and development of this plan:

Susanne Baker .... City of Coos Bay
Karen Turner .... City of Coos Bay
Steve Doty .... City of Coos Bay
Mike McDaniel.. OMI

In addition to these key personnel, we wish to thank the City of Coos Bay City Council and management staff for providing support and input on the project.

3.0 Study Area Characteristics

3.1 Study Area

The City of Coos Bay is located on the southern Oregon coast and lies approximately 100 miles north of the California border and approximately 200 miles south of the Columbia River. A map showing the location of Coos Bay within the State is presented in Figure 3-1.

The City of Coos Bay is situated on a hilly peninsula which is bounded on the west by the Coos Bay channel which leads to the Pacific Ocean and on the east by the interior portion of the bay and Isthmus Slough. The downtown portion of the City of Coos Bay lies on the mud flats located on the westerly side of Isthmus Slough. The remainder of the city lies on the rolling hills that form the described peninsula.

Coos Bay is a tourist destination during the summer and fall months and offers beaches, hotels, a casino, the nearby South Slough Estuarine Reserve, and numerous popular outdoor recreational opportunities. US Highway 101 passes through downtown Coos Bay and is the only major highway serving the city.

The study area for this Master Plan lies within the Coos Bay City Limits, but excludes Downtown Coos Bay, Englewood and the bay front area north of Telegraph Hill. A map of the study area is presented in Figure 3-2.

3.2 Physical Environment

The following subsection provides information about the physical environment in and around the City of Coos Bay as relates to wastewater and stormwater collections planning. Precipitation and groundwater characteristics are of particular interest as they can have a significant impact on sizing of wastewater collection facilities if not carefully monitored and prevented from entry into the system. Precipitation and groundwater conditions form the basis for sizing of storm drainage facilities.

3.2.1 Climate

The climate in Coos Bay is moist, marine and temperate. Average temperatures are 46º F in January and 60º F in August. The annual mean temperature is approximately 53º F. Extreme temperatures range from 14º F to 95º F. Wind rose plots published by the Oregon Climate Service from measurements at the North Bend Airport indicate that prevailing winds in the Coos Bay area are from the north northwest from May to September. Winds are generally from the southeast during the winter and early spring months. Average wind velocities range from about 9.4 mph in the winter to about 12.3 mph in the summer.

The average annual precipitation in Coos Bay is approximately 64 inches. Nearly all the precipitation occurs as rainfall, with the majority (approximately 72%) falling between the months of November and March. Records from the weather station at the North Bend airport indicated that for the period from 1971 to 2000 the average rainfall between November and January was over 30 inches. The wettest month is December with an average of approximately 10.4 inches of rainfall during the above stated period. Records from the stated period also indicate a maximum 24-hour rainfall occurrence of 6.67 inches in the month of November. The driest month is July with an average of about 0.5 inch of rainfall. Figure 3-3 provides a graphical representation of monthly average rainfall amounts for the area based on data from the North Bend airport during the 1971 to 2000 period.

Figure 3-1 – Project Location

Figure 3-2 – Study Area Map

Figure 3-3 – Monthly Mean Precipitation

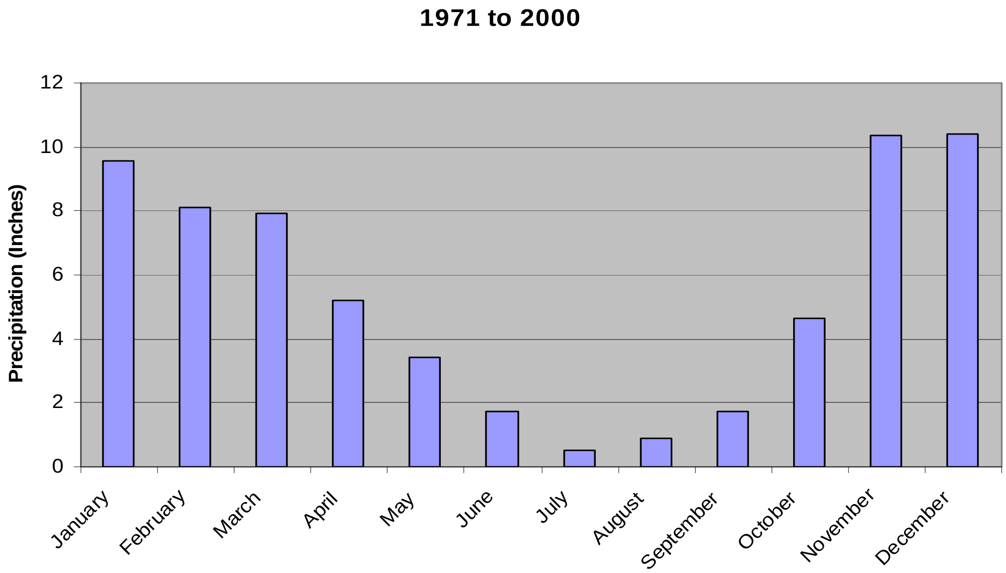
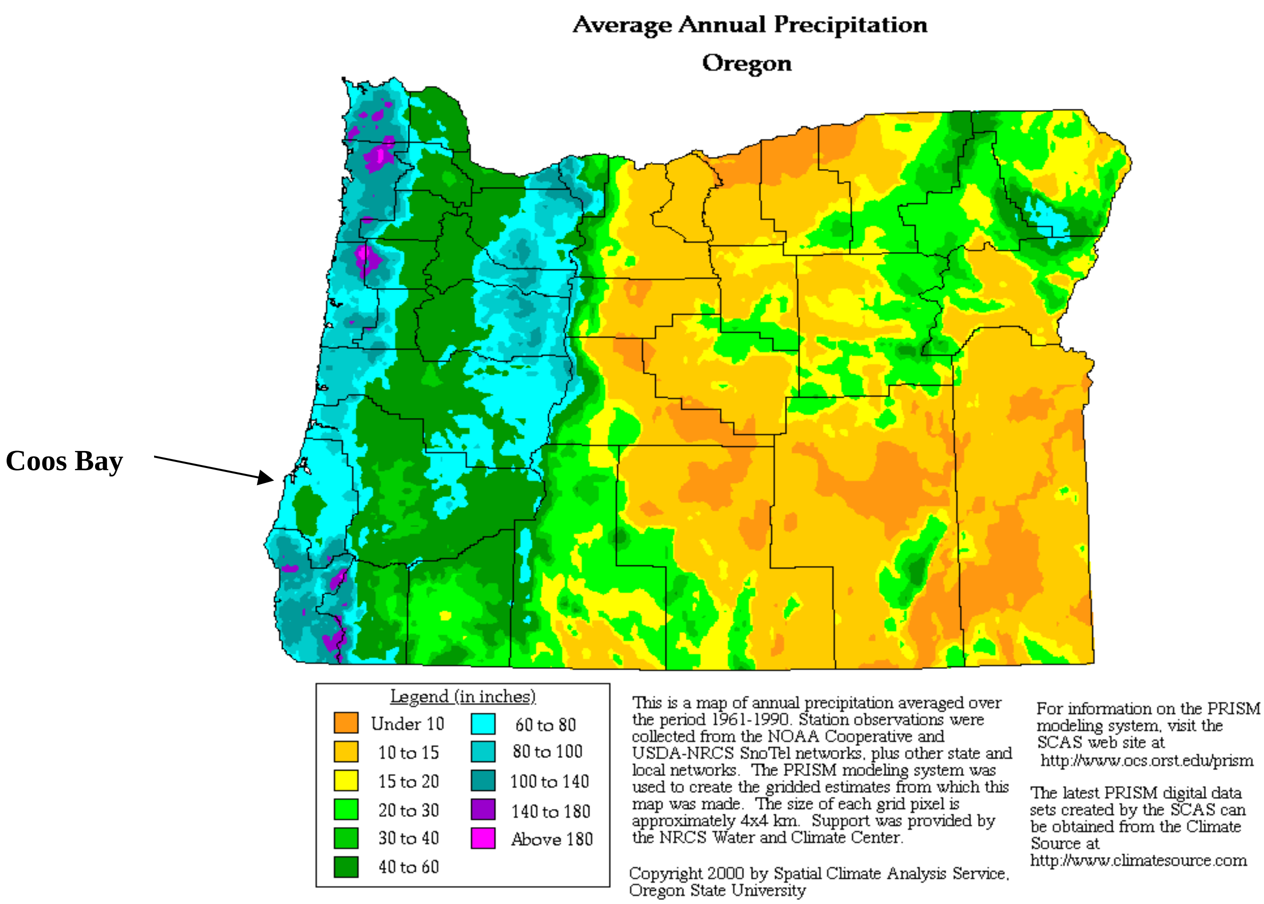


Figure 3-4 below indicates statewide average annual precipitation totals. Coos Bay is located in a zone identified as receiving an average of 60 to 80 inches annually.

Figure 3-4



3.2.2 Soils

Soils within the Coos Bay area are dominated by sandy loams and silt loams. The sandy loam soils that are present on the west facing slopes in the Empire area typically have a cemented layer beneath at depths varying from 1 to 4 feet below the surface. The cemented soils tend to have very slow permeability, but the underlying loams and sands typically have moderately rapid permeability. Silt loam soils that are present on the east facing slopes and in the Eastside area are non-cemented but tend to be clayey below the surface. Permeability of these soils ranges from moderately slow to moderate. Erosion potential of the area soils generally is slight to moderate except where surface slopes are 30% or more. A Soils Map is presented in Figure 3-5.

3.2.3 Geologic Hazards

Coos Bay is subject to a variety of geologic hazards including flooding, landslides, high groundwater, earthquakes and tsunamis. A discussion of each hazard and the areas it affects is presented below.

- **Flooding**

  Flooding in Coos Bay is related to two factors, rainfall and tides. Winter tides frequently include high tide levels that exceed those experienced the rest of the year. The most significant flooding occurs within downtown Coos Bay, Blossom Gulch, and the Englewood area when westerly storm winds and high tides coincide with heavy precipitation runoff. Portions of Eastside also are identified on the FEMA Flood Insurance Rate Maps as lying within the 100-year floodplain. Storm drains within these areas include numerous gravity culverts that discharge to the bay, many through tide gates. When tide levels are elevated runoff is unable to exit through the tide gates and water backs up onto streets through catch basins and manholes. Additionally, levees in portions of Englewood are not sufficiently high to prevent flooding during extreme high tides.

- **Landslides and High Groundwater**

  Landslides within the City of Coos Bay are a potential in locations where homes and/or roadways have been constructed on steep hillsides or cut banks and where high ground moisture makes slope stabilization difficult. One area of recurrent sliding is along the Coos River Highway in Eastside. High ground moisture coupled with clayey soils underlying the roadway have led to recurrent sliding at this location.

- **Earthquakes and Tsunamis**

  A number of faults of Late Quaternary to Holocene age exist within the Coos Bay area. All the faults are relatively short and are estimated to have slip rates of less than 1 mm per year. The most recent events are thought to have occurred on the South Slough syncline which runs north-south from about Beaver Hill to Charleston Harbor, and on the Coquille fault which runs northwest-southeast off shore beginning at the mouth of the Coquille River. The faults located in the immediate Coos Bay area are not considered to present any significant geologic hazard.

  A more significant geologic hazard is the Cascadia Subduction Zone located off the Oregon coast. The Cascadia Subduction Zone consists of a long sloping fault that stretches from mid-Vancouver Island to Northern California. The fault is located approximately 60 miles off the coast at Coos Bay. Very large earthquakes are known to occur periodically along this fault. It is estimated that an

Figure 3-5 – Soils Map

earthquake of magnitude 9.0 or greater could occur if rupture occurred along the entire fault. Large earthquakes along the Cascadia Subduction Zone are estimated to have a return period of 400 to 600 years with the last major earthquake occurring in January 1700. The Cascadia Subduction Zone presents a significant geologic hazard to the Coos Bay area both due to its potential to produce severe earth tremors and the likelihood to cause a tsunami following a major earthquake. Low lying areas of Coos Bay could experience significant damage from a tsunami. Ground acceleration resulting from a large earthquake could lead to major damage in areas where soft soils and/or high groundwater exist.

3.2.4 Water Resources

Water resources around the Coos Bay area include Coos River, Coos Bay and its associated sloughs, Empire Lakes, Pony Creek, and a number of other small streams. Each resource has significant impacts on the community in both physical and socioeconomic terms.

Numerous storm drains maintained by the City of Coos Bay enter the bay or the sloughs. Effluent from each of Coos Bay's wastewater treatment plants is discharged into the bay. The City holds NPDES permits for discharges from each of the outfalls.

The City of Coos Bay obtains domestic water from the Coos Bay-North Bend Water Board. Source water for the municipal supply comes from the upper and lower Pony Creek reservoirs located along the creek.

3.2.5 Flora and Fauna

The flora within the study area includes a variety of trees and shrubs suited to the temperate climate and wet winters. The NRCS Soil Survey for Coos County identifies trees and understory vegetation that occur within the various soils in the study area. In areas where sandy loam soils exist trees generally include Sitka Spruce, Western Hemlock, Red Alder, Western Red Cedar, Shore Pine, and Port Orford Cedar. The understory vegetation in these areas is mainly Salal, Evergreen Huckleberry, Western Brackenfern, Pacific Wax Myrtle, Pacific Rhododendron, Manzanita, and Slough Sedge. In areas where silty loam soils exist trees generally include Douglas Fir, Sitka Spruce, Western Hemlock, Western Red Cedar, Shore Pine, Red Alder, and Oregon Myrtle. The understory vegetation in these areas includes Evergreen Huckleberry, Creambush Oceanspray, Salal, Pacific Rhododendron, Cascara, Salmonberry, Rose, Trailing Blackberry, Hairy Brackenfern, Western Swordfern, Vine Maple, Thimbleberry, Northern Twinflower, and Pacific Trillium. Trees in low lying areas adjacent to streams include Pacific Willow, Red Alder, Black Cottonwood, and Sitka Spruce. The understory vegetation in these areas is mainly Slough Sedge, Soft Rush, Brown-headed Rush, and Skunk Cabbage. Vegetation along the bay shores is mainly Eelgrass, Seaside Arrowgrass, Pacific Bulrush, Tufted Hairgrass, and Baltic Rush.

Studies of local watersheds funded by the Bureau of Land Management have indicated a number of bird, reptile, amphibian and mammal species that occur or historically occurred in the general area. Because of development within the City of Coos Bay, many species that may have historically occurred within the study area would not be expected presently. Special status bird species known to inhabit the general area include American peregrine falcon, marbled murrelet, northern goshawk, bald eagle, mountain quail, northern spotted owl, and pileated woodpecker. Mammal species which inhabit the general area include Roosevelt elk, black bear, black-tailed deer, bobcat, mountain lion, mink, otter, raccoon, bats, coyote, fox, squirrels, chipmunks and beaver. Special status amphibian species that occur in the general area include southern torrent salamanders, Dunn's salamanders, Del Norte salamanders, tailed frogs, foothill yellow-legged frogs, northern red-legged frogs, western pond turtles, and northern alligator lizards.

3.2.6 Air Quality and Noise

Air quality in the Coos Bay area is generally very good due to the city's proximity to the Pacific Ocean. Summertime weather patterns include winds from the northwest which provide cool, fresh air from over the ocean. Air pollutants produced within the city are typically blown out before concentrations approach nuisance levels. Undeveloped areas around the city generally are forested or have established ground cover unless recently cleared. Despite summertime prevailing winds, dust is not typically a problem locally. During winter and spring months frequent rains keep dust and pollen levels to a minimum. Occasional brush or slash burning in the area can produce a smoke nuisance when winds direct smoke toward the city.

Major sources of noise within the city include ship horns, the railroad along Front Street and the bay, and traffic along Highway 101 and Ocean Boulevard. Generally noise levels are not significant away from the major traffic corridors. The rolling terrain of the area and the presence of numerous mature trees help diminish noise levels away from the sources.

3.2.7 Environmentally Sensitive Areas

Environmentally sensitive areas within the study area include the bay, the various sloughs, and marshes and tidelands surrounding these water bodies. Much of downtown Coos Bay is built on dredge fills where marshes once existed. Other environmentally sensitive areas include wetland areas adjacent to the various creeks.

3.3 Socio-Economic Environment

3.3.1 Economic Conditions and Trends

Economic conditions within Coos Bay have been varied since the inception of the city. The local economy has long relied on logging as its economic mainstay. Although logging and wood products do not currently meet production levels that they once did they remain a vital part of the economy. Other industries that have been integral to the local economy for many years include fishing and farming. Dairy farming, like logging, no longer meets the production levels that it once did in the local area. Dairies that used to occupy much of the land along the Coos River and Catching Slough have converted to beef farms or cease to operate at all. A significant portion of the local economy now centers around tourism and recreation. Major recreational attractions in the area include the Oregon Dunes, South Slough Estuarine Reserve, the Mill Casino, local beaches, fishing, and other outdoor opportunities.

3.3.2 Population

The 2004 Oregon Population Report published by the Population Research Center at Portland State University (PSU) estimated the population of the City of Coos Bay at 15,700 as of July 1, 2004. US Census data stated in the report showed the population of Coos Bay to be 15,372 as of April 1, 2000 and 15,076 as of April 1, 1990. Based on the census data, the average annual population growth rate between 1990 and 2000 was 0.20% per year. Based on population estimates by PSU, the average annual growth rate within the City of Coos Bay between 2000 and 2004 was 0.52% per year. Therefore, according to these estimates the average annual population growth rate over the past four years has more than doubled from the 10-year period between 1990 and 2000.

The average annual growth rate between 1990 and 2004 both in the City of Coos Bay and in Coos County was approximately 0.3% according to data presented in the 2004 Oregon Population Report by PSU. The Coos County Planning Department projects a growth rate of 0.4% for both the City of Coos Bay and Coos County.

The City of Coos Bay Transportation Master Plan utilized a growth rate of 0.7% for its population projections. The City officially recognized this growth rate and adopted it as the new Comprehensive Plan growth rate for Coos Bay.

For the purposes of this Master Plan a growth rate of 0.7% will be used in order to develop population projection estimates for the planning period (through the year 2030) and to be consistent with the City's comprehensive planning projections. The following table summarizes current and future population estimates for the study area based on a 0.7% growth rate.

Table 3.3.2 – Population Projections

	2003	2010	2020	2030
City of Coos Bay	15,650	16,433	17,620	18,893

It is worth mentioning that growth and development in Coos Bay has been steadily increasing over the past few years prior to the preparation of this plan. If this growth continues or increases, the population in Coos Bay will quickly outpace the projections in this plan and the City's Comprehensive Plan. Should this growth continue, the City should, within the next 5 to 10 years, readdress population growth in Coos Bay and how it affects infrastructure and land-use planning. This will require the City to adopt a new comprehensive plan growth rate and recalculate the projected populations.

3.4 Land Use

Land use in the City of Coos Bay is typical of urban areas with zones including high and low density residential, commercial, industrial, and public land. Most existing residential neighborhoods are zoned for low density residential. Newer neighborhoods and undeveloped areas within residential zones generally are planned for higher density development. The main commercial zones are located between Highway 101 and Fourth Street in downtown Coos Bay, and along Ocean Boulevard, Cape Arago Highway, and Newmark Avenue in the Empire area. Some commercial zoning also exists along Southwest Boulevard in the Englewood area and along the Coos River Highway in Eastside. Industrial and commercial-industrial zones are generally situated along water front areas around the City. The area surrounding Bay Area Hospital has been designated as a medical park zone. Schools, parks, cemeteries and the watershed areas surrounding the Pony Creek Reservoirs and Empire lakes are zoned public or semi-public. A Land Use Designation Map has been prepared from the City's current zoning map and is presented in Figure 3-6.

As a part of the Facilities Plan for Wastewater Treatment Plant No.2, West Yost & Associates determined the acreage of developed land by land use category within the City of Coos Bay as well as Charleston and Bunker Hill Sanitary Districts. They also determined the acreage of vacant developable land and that which is not developable within these areas. Table 3.4 lists acreage within the various land use categories from data presented in the referenced Facilities Plan.

Figure 3-6 – Land Use Designation Map

Table 3.4 – Land Use Designations

Land Use Category	Acreage			
	Within City Limits	**Bunker Hill**	**Charleston**	**Total**
Developed				
Residential	800	362	732	**1,894**
Commercial	320	--	14	**334**
Industrial	70	33	--	**103**
Public & Semi-public	540	--	4	**544**
Total Developed	**1,730**	**395**	**750**	**2,885**
Vacant and Open	2,160	--	474	**2,634**
Not Developable	3,010	155	892	**4,057**
Total Area	**6,900**	**550**	**2,116**	**9,576**

3.4.1 Development Density, Impervious Area, and Runoff

The City's aerial topographic and infrastructure maps have been used to layout storm drainage basins, determine development density, inventory facilities, and estimate impervious areas within each drainage basin. USGS Topographic maps have been used to determine drainage basins for portions of the study area not covered by the aerial mapping or extending outside the City Limits.

A total of 21 separate storm drainage basins have been identified within the study area. Some of the basins have been further divided into subbasins for modeling purposes. Mapping showing the basin delineations is presented in Volume B of this report. Table 3.4.1 below presents data by basin which is pertinent to stormwater planning, including overall basin area, number of homes, area of paved streets, and area of other impervious surfaces.

Table 3.4.1 – Drainage Basin Characteristics

Basin	Total Basin Area (acres)	Basin Area Within City (acres)	Street Area (s.f.)	Number of Homes	Impervious Area from Homes (s.f.)	Imperv. Area Commercial/ Other (s.f.)	No. of Mobile Homes	Imperv. Area from Mobile Homes (s.f.)	Total Impervious Area (s.f.)	% Imperv. Area
A	160	65.34	138,800	98	276,360	-	-	-	415,160	14.6%
B	100	74.34	224,400	185	521,700	-	-	-	746,100	23.0%
C	106	105.99	81,800	26	73,320	251,300	-	-	406,420	8.8%
D	157	156.58	612,000	259	730,380	22,573	-	-	1,364,953	20.0%
E	49	48.84	148,800	99	279,180	-	-	-	427,980	20.1%
F	145	144.57	978,200	180	507,600	634,726	-	-	2,120,526	33.7%
G	254	254.20	1,293,330	467	1,316,940	484,500	65	138,450	3,233,220	29.2%
H	420	111.50	204,000	63	177,660	78,354	22	46,860	506,874	10.4%
I	171	170.59	137,400	-	-	705,822	-	-	843,222	11.3%
J	79	79.46	177,900	55	155,100	1,423,000		-	1,756,000	50.7%
K	189	188.58	906,430	180	507,600	1,203,865	120	255,600	2,873,495	35.0%
L	264	263.77	360,400	71	200,220	1,097,648	209	445,170	2,103,438	18.3%
M	277	136.75	308,100	135	380,700	329,000	75	159,750	1,177,550	19.8%
N	2,520	1,734	-	-	-	-	-	-	-	0.0%
O	151	150.97	671,100	222	626,040	18,836	-	-	1,315,976	20.0%
P	155	154.54	67,900	33	93,060	15,825	-	-	176,785	2.6%
Q	127	126.78	70,536	38	107,160	17,700		-	195,396	3.5%
R	60	60.08	117,800	77	217,140	140,440	-	-	475,380	18.2%
S	146	145.52	636,664	230	648,600	352,900		-	1,638,164	25.8%
T	296	295.86	336,100	150	423,000	161,075	-	-	920,175	7.1%
U	56	56.23	70,700	10	28,200	-	-	-	98,900	4.0%
Totals	5,880	4,524.49	7,542,360	2,578	7,269,960	6,937,564	491	1,045,830	22,795,714	11.6%

3.4.2 Equivalent Dwelling Unit (EDU) Methodology

In order to evaluate the storm system capacity required by each individual property within a drainage area, it is necessary to establish a method for comparing properties based on their contribution to the total runoff. In essence, each property within a drainage area has a percentage of ownership of the storm drain infrastructure serving that area and therefore is responsible for a portion of the costs of maintaining those facilities. This section explains the rationale for assigning such responsibility to each property.

Storm drainage facilities are sized based on calculations of the runoff expected from the area served for a given design storm, for instance the 25-year design storm. Hydrologic analysis of the study area and design storm selection for runoff calculations are discussed in Chapter 5. Runoff occurs at differing rates depending on the type of ground cover, i.e. forest, lawn, paved roadways, roofs, etc. Under natural conditions, a portion of the rainfall is absorbed into the ground. In densely developed areas, much of the rainfall that occurs results in direct runoff due to the impervious nature of surfaces including, roadways, sidewalks, driveways, roofs, and patios. The amount of runoff from an area is, among other factors, a function of the amount of impervious surface within that area.

Table 3.4.1 above summarizes the impervious surface area and number of dwellings in each drainage basin defined in this Master Plan. As shown in the table, there are approximately 2,578 homes and 491 mobile homes within the study area. In most instances, duplexes have been counted as two homes when it appears they have nearly equivalent impervious area to that of two detached homes. Other multi-family dwellings, as well as schools, churches, most businesses, and any other buildings larger than a home or sites with paved parking areas, have been accounted for under the column for Commercial/Other. A detailed study of a five-block area north of Lakeshore Drive between Seagate and Sanford Streets, an area zoned Single Family/ Duplex Residential (R-2), has resulted in the conclusion that an average dwelling in the studied area includes a total of approximately 2,800 square feet (s.f.) of impervious area. In order to account for the additional impervious area occupied by the streets serving each residence, an additional

1,700 square feet has been added. Therefore, the total impervious area allotted to one average residence is 4,500 square feet.

For the purposes of this Master Plan and the System Development Charge (SDC) report that will follow, an Equivalent Dwelling Unit (EDU) will be used as the standard unit of measure for calculation of the cost sharing of storm drainage improvement projects. Each single family home, including manufactured homes, will be considered one EDU. Duplexes will be considered two EDU's. All other multiple residential, commercial, industrial and public buildings will have EDU's calculated by dividing the total impervious area on the property and adjacent street(s) fronting the property by 4,500 square feet. The following table summarizes the number of existing EDU's per basin:

Table 3.4.2 – Existing EDU's per Drainage Basin

Basin	EDU's Homes	EDU's Commercial/ Other	Total EDU's
A	98	-	98
B	185	-	185
C	26	56	82
D	259	5	264
E	99	-	99
F	180	141	321
G	467	138	605
H	63	28	91
I	-	157	157
J	55	316	371
K	180	324	504
L	71	343	414
M	135	109	244
N	-	-	-
O	222	4	226
P	33	4	37
Q	38	4	42
R	77	31	108
S	230	78	308
T	150	36	186
U	10	-	10
Totals	2,578	1,774	4,352

An example of a commercial EDU calculation is as follows. The K-Mart facility includes an estimated 374,300 square feet of impervious area between the building roof and pavement area. This equates to 83 EDU's based on 4,500 square feet of impervious area per EDU.

3.4.3 Future EDU's

Our analysis of existing and expected future land use within the City of Coos Bay has resulted in the determination of future storm drain system capacity requirements based on an increase in the number of EDU's anticipated within the study area. The following table provides a summary of the expected EDU increase by basin for the study area.

Table 3.4.3 – Future EDU's per Drainage Basin

Basin	Existing EDU's	Projected New EDU's	Total Future EDU's
A	98	43	141
B	185	71	256
C	82	30	112
D	264	35	299
E	99	-	99
F	321	-	321
G	605	115	720
H	91	415	506
I	157	77	234
J	371	110	481
K	504	38	542
L	414	664	1,078
M	244	36	280
N	-	177	177
O	226	54	280
P	37	503	540
Q	42	155	197
R	108	73	181
S	308	-	308
T	186	7	193
U	10	-	10
Totals	4,352	2,603	6,955

The above table summarizing future EDU's has been developed for use in the City's SDC Plan which will be prepared under a separate cover.

4.0 Existing Stormwater Facilities

4.1 General

This Section provides a brief description of the existing storm drain facilities within the City of Coos Bay. A system inventory was conducted using information contained on the City's aerial topographic maps. Additional storm drain facilities that have been constructed since the time of the aerial mapping have been included in order to provide a current inventory at the time of this Master Plan.

The study area has been divided into 21 storm drainage basins based on surface topography and drainage routes as delineated on the City's aerial topographic maps. An Overall Basin Map indicating the various drainage basins within the study area is presented in Figure 4-1. The central portion of Coos Bay including downtown and Englewood were subject to a previous study completed in September 2004 (The Dyer Partnership). The area previously studied is excluded from this Master Plan as indicated on the Overall Basin Map. A separate map volume (Volume B) also accompanies this Master Plan. The map volume also includes a copy of the Overall Basin Map as well as 12 detailed system maps each showing one to two individual drainage basins, storm drain pipes color coded by size, and general topography.

4.2 Information Gathering and Sources

The City of Coos Bay has relatively complete mapping of existing storm drainage facilities included on the described aerial maps. Much of the information used in developing the system inventory has been taken from the aerial maps. Additional information has been obtained from record drawings for developments that have occurred since the time of the aerial mapping. Field reconnaissance has included verification of size and condition of a number of storm drain outfalls and culverts within the system.

4.3 Storm Drainage System Overview

The City of Coos Bay is situated on rolling to hilly terrain with natural drainage features in various locations. Many of the residential and commercial developments within the City have been built around the streams and other water bodies and discharge storm drain runoff into them at various points. A general description of the various stormwater drainage basins and discharge points is presented below.

Stormwater collected from the area north of Lakeshore Drive discharges into two small unnamed creeks that run a short distance to the Bay. This area is identified as Basins A and B as shown on the mapping (Fig. 4-1). Portions of the drainage areas for Basins A and B extend outside the Coos Bay City Limits. Detailed mapping for these basins is incomplete since the mapping is based on the City's aerial topographic maps. The area roughly bounded by Lakeshore Drive on the north, Flanagan Avenue on the south, the Empire Lakes and Radar Road on the east, and Cammann Street on the west discharges stormwater into Chickses Creek at various points. This area is identified as Basins D and K on the mapping. The area westerly of Cammann Street and bounded by Taylor Avenue on the north and Montgomery Avenue on the south drains to the Bay via storm drains along Harris Avenue and Newmark Avenue. This area is identified as Basins E and F on the mapping. Stormwater from the developed area south of Flanagan Avenue and west of Radar Road is discharged into one of two unnamed creeks which are tributary to First Creek which discharges into the bay just north of Wastewater Plant No. 2. This area is identified on the mapping as Basin G. The area southwest of Radar Hill, which is primarily undeveloped, is drained by the main fork of First Creek. This area is identified as Basin H on the mapping. Portions of Basin H extend outside the City Limits and detailed mapping is incomplete.

Figure 4-1 Overall Basin Map

The area around the Empire Lakes and extending as far south as Ocean Boulevard generally is drained into the lakes. A storm drain along Norman Avenue collects surface runoff from the vicinity and discharges to a wetland area on the south shore of Lower Empire Lake. This area along with Lower Empire Lake itself is identified as Basin C on the mapping. The area around Upper Empire Lake and including the campus of Southwestern Oregon Community College is identified as Basin I on the mapping. Surface runoff within Basin I is collected in drainage ditches on and around the SWOCC campus. The area generally bounded by Newmark Avenue on the north, Ocean Boulevard on the south, Fir Street on the east, and a ridge between Norman Avenue and LaClair Street on the west is identified as Basin J on the mapping. Surface runoff from Basin J is collected by storm drains along LaClair and Newmark which join and discharge into Upper Empire Lake about 200 feet east of the intersection of LaClair and Newmark.

The area along Ocean Boulevard easterly of Radar Hill and west of Butler Road is drained by Pony Creek. This area is divided into five basins on the mapping, Basins L through O. Surface runoff either enters one of the forks of the creek directly or is conveyed by one of several storm drains terminating at Pony Creek or one of its tributaries. Basin L is generally bounded on the west by Radar Hill, on the east by a residential subdivision off of Ocean Boulevard at 28th Court, and on the north by Waite Street. The southerly limits of Basin L generally extend east from Radar Hill to the adjacent hilltop located approximately 750 feet south of K-Mart. A number of small storm drains are present within Basin L along Merrill Street, Vine Avenue, and 34th and 35th Streets north of Ocean Boulevard. Several culverts also cross Ocean Boulevard at various locations within Basin L. Basin M generally encompasses a low lying marsh area along Pony Creek and the slopes immediately surrounding the marsh. The basin is roughly bounded by Lake Merritt on the south, Newmark Avenue in North Bend on the north, Woodland Drive on the east and Fir Street on the west. Most of the surface runoff within Basin M runs directly into the described marsh. There are two separate storm drains within Ocean Boulevard that discharge into Pony Creek across the road from the water treatment plant, and one storm drain system along Fir Street and Lindberg and Walnut Avenues that discharges into a small creek on the west side of the marsh. Basin N encompasses the watershed areas around Lake Merritt and Upper Pony Creek Reservoir. Most of the watershed area around the reservoirs lies within the City Limits, however, detailed mapping has not been completed for this area since it is and will remain undeveloped. The area bounded by Cottonwood Avenue on the north, the Coos Bay-North Bend Water Board property on the west, Butler road on the east, and an east-west trending ridgeline approximately 2,000 feet south of Ocean Boulevard is identified as Basin O on the mapping. Surface runoff from Basin O is collected in four separate storm drain systems, one within Woodland Drive and 20th Street, and the second within 19th Street and Juniper Avenue. Both of these systems discharge into a 48-inch diameter culvert along the south side of Ocean Boulevard which subsequently discharges into a tributary to Pony Creek. The third storm drain system is located within the West Hills subdivision. This system discharges into an unnamed creek upstream of the described 48-inch culvert. The fourth system serves the area along Timberline and Evergreen Drives. This system includes a 24-inch outfall pipe adjacent to the described 48-inch culvert.

The six remaining storm drainage basins are located in Eastside. Basins P and Q generally encompass the area north of D Street and west of 9th Avenue. Basin P is primarily undeveloped but includes a number of residences northwesterly of the former Millicoma Jr. High School. Basin Q also is largely undeveloped with the exception of some residences north of D Street between 4th Avenue and 9th Avenue, and the former Eastside Wastewater Treatment Plant. Much of Basin Q is low lying land surrounded by a dike. Both Basins P and Q are drained entirely by surface features that discharge in to the Bay. The area west of 2nd Avenue and south of about Jackson Street is identified as Basin R on the mapping. This basin is drained by a 24-inch storm drain that discharges into Isthmus Slough just east of the Eastside Boat Ramp. A 12-inch storm drain located within D Street also ties into the 24-inch storm drain. Basin S encompasses the area generally bounded by 2nd Avenue and Isthmus Slough on the west, 14th Avenue on the east, D Street and the Eastside School on the north, and by a ridgeline south of I Street on the south. Much of the stormwater in Basin S runs off on the ground surface and through a series of ditches terminating at Isthmus Slough or an unnamed creek south of F Street. A storm drain system is present along F Street east of 9th Avenue and within 14th Avenue south of F Street. This storm drain discharges into the described creek at 9th Avenue south of F Street. Basin T is generally bounded by Catching Slough on the north and east, by 14th Avenue on the west, and by I Street on the south. The southerly portion of Basin T is bounded on the east by a ridgeline which extends from 18th Avenue down to Coos River Highway at the Catching Slough bridge. The southern portion of Basin T is situated on a relatively steep hillside and a number of residences are located in various areas where slopes are conducive to home site development. Stormwater from the southern portion of Basin T drains to the north via ditches and an unnamed stream that crosses the Coos River Highway just west of 16th Avenue. The northern portion of Basin T includes primarily undeveloped low lying flatlands that are drained by a series of channels tying into Catching Slough. The area between the ridgeline along 18th Avenue and Catching Slough south of Coos River Highway is identified as Basin U on the mapping. This basin is largely undeveloped and stormwater runs off via natural surface features extending down to Catching Slough.

4.4 Existing Storm Drain System Inventory

The existing storm drainage system owned by the City of Coos Bay includes approximately 17.4 miles of pipe ranging in size from 6-inches to 48-inches diameter, as well as numerous storm drain manholes and catch basins/area drains. Table 4-1 provides an inventory of existing manholes and catch basins within the study area. Table 4-2 provides an inventory of existing storm drain pipes. For the purposes of this inventory no effort has been made to distinguish between continuous storm drain pipes and culverts.

Table 4.4A – Storm Drain Structure Inventory

	Manholes	Catch Basins
Basin A	10	20
Basin B	21	34
Basin C	8	18
Basin D	34	88
Basin E	8	17
Basin F	7	88
Basin G	52	149
Basin H	8	12
Basin I	0	4
Basin J	18	54
Basin K	34	147
Basin L	16	51
Basin M	14	81
Basin N	10	0
Basin O	48	71
Basin P	0	1
Basin Q	0	2
Basin R	3	11
Basin S	10	40
Basin T	0	7
Basin U	0	0
Study Area Total	**301**	**895**

Table 4.4B – Storm Drain Pipe Inventory

	10"	12"	15"	18"	21"	24"	27"	30"	36"	48"	Other	Total in Basin
Basin A	146	1,082	597	0	0	0	0	0	0	0	354	2,179
Basin B	0	2,062	1,556	255	256	113	354	0	0	0	945	5,541
Basin C	0	941	0	398	0	0	0	0	0	0	274	1,613
Basin D	744	4,282	782	1,272	0	0	0	0	0	62	1,822	8,964
Basin E	277	291	0	741	0	0	0	0	0	0	506	1,815
Basin F	132	2,609	0	70	0	163	0	0	0	0	2,576	5,550
Basin G	893	4,510	1,442	959	0	2,545	0	828	180	234	3,139	14,730
Basin H	0	1,017	0	145	0	110	0	0	0	0	965	2,237
Basin I	0	0	0	0	0	0	0	0	0	0	47	47
Basin J	1,365	267	1,506	68	0	2,672	0	0	247	81	695	6,901
Basin K	655	1,799	1,763	3,906	905	0	0	591	0	0	2,172	11,791
Basin L	0	3,451	22	353	0	0	0	0	141	0	1,243	5,210
Basin M	22	3,287	1,056	936	0	0	0	0	28	0	2,228	7,557
Basin N	0	0	0	0	0	0	0	0	0	0	0	0
Basin O	1,535	2,403	1,359	1,537	349	971	0	0	344	1,090	2,356	11,944
Basin P	0	0	0	0	0	0	0	0	0	0	0	0
Basin Q	0	0	0	0	0	0	0	0	0	0	10	10
Basin R	0	477	0	0	0	1,061	0	0	0	0	671	2,209
Basin S	541	1,281	1,051	31	0	0	0	0	0	0	1,524	4,428
Basin T	132	123	0	113	0	0	0	0	0	0	0	368
Basin U	0	0	0	0	0	0	0	0	0	0	0	0
Total in Study Area	6,442	29,882	11,134	10,784	1,510	7,635	354	1,419	940	1,467	21,527	**93,094**
% of Overall Total	6.9%	32.1%	12.0%	11.6%	1.6%	8.2%	0.4%	1.5%	1.0%	1.6%	23.1%	

All lengths are in feet

The storm drainage system inventory presented in the preceding tables was compiled from the City's digital aerial topographic maps. Some development has occurred since the aerial maps were produced and, therefore, it is possible that the inventory is not entirely complete. An effort has been made to include facilities resulting from new development in the inventory based on "as-built" plans obtained from the City.

4.4.1 Storm Drain Outfalls

As described previously Coos Bay's storm drainage system includes a variety of pipes, culverts, open drainage ditches, and natural streams for conveyance of runoff. Because of the mixture there are numerous outfalls where pipes discharge into streams, lakes or the bay. Coos Bay has a number of bay outfall pipes equipped with tide gates, although there are none within the study area. Most of the outfalls within the study area discharge into streams or above the normal high tide level within the bay where tide gates are not necessary. There is, however, one location where culvert pipes are equipped with tide gates (see Page 4-21). A complete inventory of outfalls has not been performed for this study, although an effort has been made to evaluate the condition of outfalls of the major storm drain pipes within the study area. A number of the outfalls are inaccessible due to terrain, vegetation, or location on or behind private property. Outfalls have been numbered using the letter of the basin in which they occur followed by a number. Table 4.4.1 provides a summary of the location, size and condition of the various storm drain outfalls within the study area. Outfalls are also located and numbered on the mapping in Volume B.

Outfall A1

Outfall A1 is a 15-inch pipe that discharges into a drainage ditch west of Fenwick Street at St. John Street. The location of the outfall was uncertain in the field because it appears that the upstream manhole has been overlaid with asphalt and the outfall is within a blackberry thicket. The condition of the outfall was not ascertained.

Outfall B1

Outfall B1 consists of a 27-inch corrugated metal pipe (CMP) and discharges into an unnamed creek at a point approximately 500 feet west of Seagate Street along the extension of the Margaretta Street right-of-way. The pipe appears to be in reasonably good condition with some corrosion at the invert.

Outfall C1

Outfall C1 consists of an 18-inch high density polyethylene (HDPE) pipe which discharges into a wetland area near the south shore of Lower Empire Lake just past the north end of Norman Avenue. The outfall daylights below the water surface in the photo below. The pipe was installed in 2003 and is in good condition.

Outfall D1

Outfall D1 consists of consists of a 15-inch HDPE pipe that discharges into Chickses Creek just west of the intersection of Chickses Drive and Tideview Terrace. The outfall is situated approximately 15-feet above the bottom of the gulley at this point. The outfall has recently been replaced and is in good condition.

Outfall D2

Outfall D2 is located on the north side of Lakeshore Drive west of Chickses Drive and consists of a 18-inch corrugated metal pipe. The outfall is situated on a steep embankment behind a private residence and beneath thick brush. The outfall was not accessible for inspection.

Outfall E1

Outfall E1 is located approximately 200 feet west of the intersection of Empire Boulevard and Harris Avenue and consists of a 30-inch diameter corrugated metal pipe. The outfall is situated on a relatively steep sand embankment and is set back approximately 300 feet from the Bay. The outfall appears to be in reasonably good condition.

Outfall F1

Outfall F1 consists of a 24-inch concrete pipe at the westerly end of Newmark Avenue. The pipe discharges into the Bay at the base of a wooden tide wall. The pipe appears to be in reasonably good condition and is not equipped with a tide gate.

Outfall G1

Outfall G1 consists of a 24-inch corrugated metal pipe and is located on the west side of Madison Street approximately 120 feet north of Garfield Avenue. The pipe discharges into an open grass lined ditch. The end of the pipe is slightly crushed and the invert appears to be partially filled with soil due to poor backwater conditions created by the ditch. It is recommended that the pipe be televised to determine if any other problems exist.

Outfall G2

Outfall G2 consists of an 18-inch corrugated metal pipe and is located on the south side of Webster Avenue approximately 150 feet west of Fillmore Street. The pipe was not located for evaluation.

Outfall G3

Outfall G3 consists of a 24-inch HDPE pipe and is located near the center of the Fulton Avenue right-of-way approximately 150-feet west of Madison Street. The pipe presently discharges into an open ditch. Future plans have been developed to tie into a new 24-inch HDPE storm drain that has been constructed along Fulton Avenue from about 150 feet east of the Fulton Avenue / Fillmore Street intersection to about 150 feet west of said intersection. The pipe appears to be in good condition.

Outfall G4

Outfall G4 consists of a 24-inch HDPE storm drain which daylights within the Fillmore Street right-of-way north of Kentucky Avenue. The pipe was installed in 2005 and is in good condition.

Outfall H1

Outfall H1 consists of an 18-inch concrete pipe which daylights into First Creek at the upstream end its crossing of the Cape Arago Highway, approximately 150 feet south of Fulton Avenue. The pipe appears to be in reasonably good condition.

Outfall J1

Outfall J1 consists of a 48-inch HDPE pipe which daylights into Upper Empire Lake on the north side of Newmark Avenue approximately 200 feet east of LaClair Street. The pipe was installed in 2003 during the reconstruction of Newmark Avenue and is in good condition.

Outfall K1

Outfall K1 is located approximately 200 feet west of Schoneman Street from a point approximately 300 feet north of the intersection of Schoneman and Newmark Avenue. According to mapping the outfall consists of a 30-inch pipe. Because the outfall is located behind a chain link fence and is buried in brush the condition of the pipe was not ascertained and the size and material were not verified.

Outfall K2

Outfall K2 consists of a 30-inch corrugated metal pipe that daylights into the easterly fork of Chickses Creek approximately 250 feet north of Newmark Avenue behind the Nancy Devereux Center. The pipe appears to be in reasonably good condition, but has some corrosion near the invert.

Outfall K3

Outfall K3 consists of a 30-inch corrugated metal pipe is located on the west side of Ackerman Street approximately 450 feet north of its intersection with Newmark Avenue. The pipe is located within a relatively steep sided gulley and is overgrown with brush. It appears to be in relatively good condition.

Outfall L1

Outfall L1 includes a 12-inch storm drain that daylights into a shallow drainage ditch along the south side of Ocean Boulevard east of Lindy Lane. The outfall pipe was unable to be located for inspection due to thick vegetation. It is also possible that the end of the pipe is buried. Inspection of a catch basin at the southwesterly corner of Ocean Boulevard and Lindy Lane indicated 12-inch concrete pipe in reasonably good condition.

Outfall L2

Outfall L2 includes an 18-inch storm drain that daylights into an unnamed creek extending south from Ocean Boulevard opposite Vine Avenue. This pipe was unable to be located due to brush and steep terrain. The pipe material and condition consequently were not determined.

Outfall L3

Outfall L3 includes an 18-inch asphalt coated CMP storm drain which daylights near the bottom of a steep embankment along the south side of Ocean Boulevard opposite 34th Street. The pipe appears to be in relatively good condition.

Outfall M1

Outfall M1 includes a 12-inch CMP storm drain which daylights into Pony Creek on the north side of Ocean Boulevard approximately 750 feet east of 26th Street, adjacent to a 96-inch sectional CMP culvert. The end of the 12-inch pipe is moderately corroded due to its location within the creek. The condition of the remainder of the pipe is uncertain. (Also pictured is Culvert M1-C).

Outfall M2

Outfall M2 consists of an 18-inch storm drain which daylights along the north side of Ocean Boulevard approximately 650 feet east of 26th Street. The pipe was not located for inspection due to brush and difficult terrain.

Outfall M3

Outfall M3 consists of a CMP storm drain located approximately 250 feet north of Ocean Boulevard and about 500 feet west of 28th Street. Mapping indicates the pipe to be 12-inches in diameter, but it appeared to be larger (15 or 18-inches) according to our field observation. The pipe appears to be in reasonably good condition with minor corrosion at the invert. No picture was obtained due to thick brush.

Outfall M4

Outfall M4 is identified on the mapping as an 18-inch storm drain located on the north side of Ocean Boulevard approximately 730 feet west of 28th Street. The pipe material and condition were not able to be determined due to thick vegetation around the end of the pipe.

Outfall M5

Outfall M5 is identified on the mapping as an 18-inch storm drain located approximately 350 feet southeast of the intersection of Walnut Avenue and Fir Street. The pipe is located on steep terrain and was not accessible for observation.

Outfall O1

Outfall O1 is a 24-inch corrugated metal pipe located along the south side of Ocean Boulevard approximately 800 feet west of 19th Street. The pipe discharges into an unnamed stream located between Ocean Boulevard and Timberline Drive. The pipe is estimated to be 30+ years old and appear to be in satisfactory condition with only moderate corrosion. It is recommended that the pipe be televised to verify its condition. (Also pictured is Culvert O2-C)

Outfall O2

Outfall O2 consists of an approximate 15-inch ductile iron pipe which daylights through a concrete wing wall and discharges into an unnamed creek approximately 120 feet northwest of the intersection of West Hills Boulevard and Ocean Terrace. The pipe was identified on mapping as being 12-inches in diameter. The pipe appears to be in reasonably good condition.

Outfall O3

Outfall O3 consists of a 24-inch asbestos cement pipe which discharges into an unnamed creek along the south side of Ocean Boulevard approximately 80 feet west of West Hills Boulevard. The outfall pipe is in reasonably good condition. According to mapping, the storm drain system at this location also includes 12 and 15 inch pipe (possibly CMP) along the south side of Ocean Boulevard and crossing Ocean to Butler Road.

Outfall R1

Outfall R1 consists of a 24-inch corrugated metal pipe which discharges on a slope above Isthmus Slough approximately 400 feet east of the Eastside Boat Ramp. The pipe appears to be in reasonably good condition.

Outfall R2

Outfall R2 consists of a 12-inch PVC pipe located at the south end of Whitty Street in Eastside. The pipe discharges into Isthmus Slough but is situated several feet above the mean high water mark. The storm drain pipe is in good condition but a corrugated metal flume pipe located at the end of the storm drain is deteriorated and should be replaced.

Outfall S1

Outfall S1 consists of a 15-inch HDPE pipe located on the west side of 9th Avenue approximately 250 feet south of F Street. The pipe discharges into an excavated drainage ditch and appears to be in relatively good condition.

Table 4.4.1 – Storm Drain Outfall Summary

Map #	Location	Size	Material	Condition
A1	Fenwick St @ St. John	15”	Uncertain	Uncertain – Inaccessible due to brush
B1	500’ W of Seagate St. @ Margaretta	27”	CMP	OK – Invert Corroded
C1	350’ N of Newmark @ Norman Ave.	18”	HDPE	Good
D1	Chickses Dr. @ Tideview Terrace	15”	HDPE	Good
D2	100’ W of Lakeshore @ Chickses Dr.	18”	CMP	Uncertain – Inaccessible due to brush/location
E1	200’ W of Empire Blvd. @ Harris Ave.	30”	CMP	OK
F1	West end of Newmark Ave.	24”	Concrete	OK
G1	120’ N of Madison St. @ Garfield Ave.	24”	CMP	Fair – Partially crushed, invert full of dirt
G2	150’ W of Fillmore St. @ Webser Ave.	18”	CMP	OK
G3	150’ W of Madison St. @ Fulton Ave.	24”	HDPE	Good
G4	100’ N of Kentucky Ave. @ Fillmore St.	24”	HDPE	Good
H1	Cape Arago Hwy. 150’ S of Fulton Ave.	18”	Concrete	OK
J1	Newmark Ave. 200’ E of La Clair St.	48”	HDPE	Good
K1	360’ NE of Newmark Ave. @ Schoneman	30”	Uncertain	Uncertain – Inaccessible due to brush/location
K2	250’ N of Newmark Ave. @ Ocean Blvd.	30”	CMP	OK – Invert Corroded
K3	Ackerman St. 450’ N of Newmark Ave.	30”	CMP	OK
L1	S side of Ocean Blvd. 30’ E of Lindy Lane	12”	Concrete	Uncertain – Inaccessible due to brush/buried
L2	S side Ocean Blvd. opposite Vine Ave.	18”	Uncertain	Uncertain – Inaccessible due to brush/location
L3	S side Ocean Blvd. opposite 34th Street	18”	CMP	OK
M1	N side Ocean Blvd. 750’ E of 26th St.	12”	CMP	OK – Corroded
M2	N side Ocean Blvd. 650’ E of 26th St.	18”	Uncertain	Not located to assess condition
M3	N side Ocean Blvd. 500’ W of 28th St.	15”?	CMP	OK – Invert Corroded
M4	N side Ocean Blvd. 730’ W of 28th St.	18”	Uncertain	Uncertain – Inaccessible due to vegetation
M5	350’ SE of Fir St. @ Walnut Ave.	18”	Uncertain	Uncertain – Inaccessible due to brush/location
O1	S side Ocean Blvd. 800’ W of 19th Ave.	24”	CMP	OK – Invert Corroded
O2	120’ W of West Hills Blvd. @ Ocean Terr.	15”	Duct. Iron	OK
O3	S side of Ocean Blvd. 80’ W of West Hills	24”	A.C.	OK
R1	400’ E of Eastside Boat Ramp	24”	CMP	OK
R2	S End of Whitty Street	12”	PVC	Pipe OK, CMP Flume poor condition
S1	9th Ave. 250’ S of F Street	15”	HDPE	Good

4.4.2 Culverts

There are numerous culverts within the study area at points where roadways cross streams and open drainage channels. This subsection presents an overview of the location and condition of the major culverts within the study area. The culverts are numbered by basin in the following format: A3-C, where A is the basin designation, 3 is the culvert number, and C is included to differentiate culverts from storm drain outfalls. Descriptions of the location and apparent condition of the culverts are presented on the following pages. A summary of the culverts is presented in Table 4.4.2.

Culvert D1-C

Culvert D1-C includes a single 60-inch corrugated metal pipe located at the crossing of Lakeshore Drive and Chickses Creek. The pipe appears to be in reasonably good shape. At the time of our observation flows in Chickses Creek were moderately high and the pipe was flowing approximately two-thirds full.

Culvert D2-C

Culvert D2-C consists of an estimated 48-inch concrete pipe and is located at the crossing of Taylor Avenue and Chickses Creek. At the time of our observation the inlet of the culvert was submerged and some ponding was occurring on the upstream side. Flows in the creek were elevated at the time of observation, but not extreme.

Culvert D3-C

Culvert D3-C consists of a single 24-inch concrete pipe and is located at the crossing of Harris Avenue and westerly fork of Chickses Creek. The pipe appeared to be in reasonably good condition and was adequately handling the elevated stream flows occurring at the time of observation.

Culvert D4-C

Culvert D4-C consists of a single 48-inch CMP located at the crossing of Morrison Street and the easterly fork of Chickses Creek, just north of wastewater Pump Station No. 7. The pipe appears to be in relatively good condition and was flowing approximately two-thirds full at the time of observation. Pipe capacity appears to be reasonable based on the water level of observed during elevated stream flow conditions.

Culvert F1-C

Culvert F1-C consists of a 12-inch PVC pipe located along Empire Boulevard approximately 200 feet north of Schetter Avenue at the crossing of an unnamed creek. The inlet side of the pipe was not located for observation due to brush and its location in a wetland area. Flows observed at the outlet suggest that either the pipe is situated at such a level as to create and maintain the wetland, or the pipe is partially plugged somewhere toward the upstream end.

Culvert F2-C

Culvert F2-C consists of an 18-inch pipe which crosses Marple Street approximately 200 feet north of Schetter Avenue at the crossing of an unnamed creek. The upstream end of this culvert is concrete in fair condition and the outlet is HDPE pipe in good condition. Based on some distortion in the paved surface, it is possible that some of the joints on the concrete pipe leak and have allowed some settlement.

Culvert G1-C

Culvert G1-C consists of a 36-inch HDPE pipe located along Cape Arago Highway approximately 300 feet north of Fulton Avenue at the crossing of the north fork of First Creek. The culvert is relatively new and in good shape.

Culvert G2-C

Culvert G2-C consists of 48-inch CMP and is located approximately 450 feet north of the intersection of Marple Street and Fulton Avenue at the crossing of the north fork of First Creek. The pipe appears to be in fair condition with some corrosion near the invert.

Culvert G3-C

Culvert G3-C consists of 48-inch concrete pipe located just south of the intersection of Wall Street and Webster Avenue at the crossing of the north fork of First Creek. The pipe appears to be in reasonably good condition, however, it is approximately half full of silt.

Culvert G4-C

Culvert G4-C consists of 48-inch concrete pipe whose outlet is located near the southwest corner of the intersection of Wasson Street and Webster Avenue. The described 48-inch pipe is outlet for two separate 30-inch pipes which join at this point. The piping extending north at the fork appears to lie on private property. The piping to the east includes 30-inch concrete which continues across Wasson Street at the Webster Avenue right-of-way. The 30-inch concrete pipe inlet within the Webster Avenue right-of-way is pictured below.

Culvert G5-C

Culvert G5-C is a 30-inch CMP culvert located in the front yards of the residences addressed 505 and 515 S. Wasson Street. The pipe appears to be reasonably good condition. Because of its location on private property, it is assumed that this culvert is not the City's responsibility to maintain.

Culvert G6-C

Culvert G6-C consists of 30-inch concrete pipe along the south side of Pacific Avenue from the west side of Cammann Street to South Main Street. The pipe was only observed from within a manhole located on the southwest corner of Pacific Avenue and Cammann Street, but appears to be in relatively good shape.

Culvert G7-C

Culvert G7-C includes a 24-inch pipe across Cammann Street approximately 200 feet south of Webster Avenue. It appears that the pipe was originally concrete, but has had a new HDPE outfall installed relatively recently. The pipe appears to be in reasonably good condition.

Culvert H1-C

Culvert H1-C includes two 36-inch corrugated metal pipes at the point where First Creek crosses the access road to Wastewater Plant No. 2. The pipes appear to be in fair condition. Both pipes are equipped with tide gates which have relatively new brass hinge bolts. The gates appear to be working properly.

Culvert H2-C

Culvert H2-C includes a single CMP, estimated to be 48-inched in diameter, on the north side of Cape Arago Highway and southerly of the access road to Wastewater Plant No.2. The pipe appears to be in relatively good condition.

Culvert H3-C

Culvert H3-C includes two 36-inch concrete pipes beneath Cape Arago Highway at First Creek, approximately 150 feet south of Fulton Avenue. The pipes appear to be in relatively good shape.

Culvert L1-C

Culvert L1-C consists of a 42-inch corrugated metal pipe located along the north side of Ocean Boulevard across from K-Mart (behind Sanitary Sewer Pump Station No. 12). The pipe is in fair condition. Existing problems include several inches of sediment in the pipe invert and some corrosion near the water surface. The pictures below include the upstream end of the pipe on the left and the outfall on the right.

Culvert L2-C

Culvert L2-C includes an 18-inch pipe across Ocean Boulevard approximately 60 feet east of Lindy Lane. We were unable to locate the pipe for inspection due to thick vegetation. It is also possible that the end of the culvert is buried.

Culvert M1-C

Culvert M1-C includes a 96-inch sectional CMP culvert across Ocean Boulevard approximately 200 feet west of the Coos Bay-North Bend Water Board facility entrance. The culvert likely is 30+ years old it appears to be in fair condition with moderate corrosion near the invert. It is recommended that the condition of the culvert be monitored carefully as replacement or rehabilitation will involve significant expense.

Culvert O1-C

Culvert O1-C includes a 48-inch CMP culvert which crosses beneath Ocean Boulevard approximately 550 feet west of Woodland Drive. The pipe appears to be in reasonably good condition with some corrosion and sediment in the invert. As with other pipes installed during the widening of Ocean Boulevard, Culvert O1-C is likely 30+ years old. Due to its age, it is recommended that the condition of the culvert be monitored carefully.

Culvert O2-C

Culvert O2-C includes a 48-inch CMP culvert along the south side of Ocean Boulevard from about 100 feet east of 19th Street to approximately 800 feet west of 19th Street. It appears to be in fair condition with moderate corrosion at the invert. As with other pipes installed during the widening of Ocean Boulevard, the pipe is 30+ years old. Due to its age, the condition of the culvert should be monitored carefully. It is recommended that the pipe be televised to determine if any current problems exist. (In picture: Culvert O2-C, left; Outfall O1, right).

Culvert S1-C

Culvert S1-C includes an approximate 48-inch wide, 18-inch tall box culvert across 6th Avenue approximately 300 feet south of F Street in Eastside. The culvert is in relatively poor condition and should be replaced soon. Because it crosses a State highway, it is uncertain whether this culvert falls within the jurisdiction of the City of Coos Bay or ODOT.

Culvert S2-C

Culvert S2-C includes a pipe of uncertain size and material across the 9th Avenue approximately 300 feet south of F Street in Eastside. The culvert has been extended on the upstream end to the back side of a private residence. The culvert was not accessible for observation.

Culvert T1-C

Culvert T1-C includes a 12-inch concrete pipe which crosses the Coos River Highway approximately 70 feet west of 16th Avenue in Eastside. A ditch inlet with a bar grate is present on the upstream end of the pipe, and the downstream end of the pipe was submerged at the time of our observation. The area around the outlet should be cleaned to promote better flow away from the pipe. The pipe also should be carefully inspected to determine its condition at a time when flows allow such.

Culvert T2-C

Culvert T2-C includes an 18-inch CMP culvert across the Coos River Highway approximately 100 feet west of D Street in Eastside. This culvert is considered minor was not located to evaluate its condition.

Culvert T3-C

Culvert T3-C includes an 18-inch pipe across the Coos River Highway approximately 350 feet west of D Street in Eastside. This culvert is considered minor was not located to evaluate its condition.

Table 4.4.2 – Culvert Summary

Map #	Location	Size	Material	Condition
D1-C	Chickses Creek @ Lakeshore Drive	60”	CMP	OK
D2-C	Chickses Creek @ Taylor Ave.	48”	Concrete	Possible blockage at inlet
D3-C	Chickses Creek (west fork) @ Harris Ave.	24”	Concrete	OK
D4-C	Chickses Creek (east fork) @ Morrison St.	48”	CMP	OK
F1-C	Empire Blvd. 200’ north of Schetter Ave.	12”	PVC	OK – Possible upstream blockage
F2-C	Marple Street 200’ north of Schetter Ave.	18”	Con/HDPE	Fair/Good – Possible joint problems in concrete
G1-C	Cape Arago Hwy. 300’ north of Fulton Ave.	36”	HDPE	Good
G2-C	Marple Street 450’ north of Fulton Ave.	48”	CMP	Fair – Some corrosion near invert
G3-C	Wall Street south of Webster Ave.	48”	Concrete	OK – Approximately half full of silt
G4-C	Wasson Street south of Webster Ave.	48”/30”	Concrete	OK
G5-C	505/515 S. Wasson Street	30”	CMP	OK – Private
G6-C	Pacific Ave. between Cammann and Main	30”	Concrete	OK
G7-C	Cammann St. 200’ south of Webster Ave.	24”	Con/HDPE	OK
H1-C	First Creek @ WWTP 2 access road	2 @ 36”	CMP	Pipes Fair – Tide gates have been rebuilt
H2-C	N. side of Cape Arago Hwy. near WWTP 2	48”	CMP	OK
H3-C	Cape Arago Hwy. 150’ south of Fulton Ave.	2 @ 36”	Concrete	OK
L1-C	N side of Ocean Blvd. across from K-Mart	42”	CMP	Fair – Invert filled w/ sediment, some corrosion
L2-C	Ocean Blvd. 60’ east of Lindy Lane	18”	Uncertain	Uncertain – Buried/Inaccessible
M1-C	Ocean Blvd. 200’ west of H2O Board	96”	CMP	Fair – Some corrosion at invert
O1-C	Ocean Blvd. 550’ west of Woodland Drive	48”	CMP	OK – Some corrosion and sediment in invert
O2-C	S. side of Ocean Blvd. near 19th Street	48”	CMP	Fair – Some corrosion at invert
S1-C	6th Ave. 300’ south of F Street (Eastside)	48 x 18	Uncertain	Poor
S2-C	9th Ave. 300’ south of F Street	Uncertain	Uncertain	Uncertain – Inaccessible
T1-C	Coos River Hwy. 70’ west of 16th Ave.	12”	Concrete	Should clean around outlet to optimize flow
T2-C	Coos River Hwy. 100’ west of D Street	18”	CMP	Uncertain – Not observed
T3-C	Coos River Hwy. 350’ west of D Street	18”	Uncertain	Uncertain – Not observed

4.4.3 Pump Stations

The City of Coos Bay owns and operates three stormwater pump stations. The two major stormwater pump stations are located in the downtown area and are covered in a previous study completed in September 2004 (The Dyer Partnership). The other stormwater pump station, Pump Station 23, is located on Grant Avenue midway between Wasson and Cammann Streets and serves to drain a locally low lying area between the residences addressed 495 Wasson Street and 494 Cammann Street. Pump Station 23 includes a submersible pump in a concrete wet well with a slotted grate on top. Pump control is achieved using a float system. A pole mounted meter base and breaker panel are located adjacent to the wet well. Water is pumped out to a 10-inch storm drain pipe which runs along Grant Avenue. The stormwater is ultimately discharged onto the ground surface on the easterly side of Cammann Street.

5.0 Hydrologic Analysis

This chapter presents the basis of the hydrologic analysis used in evaluating the City's existing storm drainage facilities within this master plan. There are several classifications of hydrologic models used for stormwater runoff analysis, each with a specific application to which it is best suited. The classifications include calibrated and uncalibrated peak discharge models, single event hydrograph models, watershed multiple event models, and joint probability models. Each of these types of models and their specific applications is discussed in depth in the textbook, "Hydrologic Analysis and Design," by Richard H. McCuen, Prentice-Hall, Inc., 1989. For the purposes of this master plan an uncalibrated peak discharge model has been used. A calibrated model would require peak discharge data obtained from flood frequency analyses at gauged sites. No studies have been performed within the City of Coos Bay to provide such data.

The peak discharge is a primary variable for the design of stormwater runoff pipe systems, storm inlets, culverts, and small open channels. It also can be used for hydrologic planning such as small detention facilities. Peak discharge modeling is considered an acceptable method for designs where the time variation of storage is not a primary factor in the runoff process. Storm drainage basins identified in the preparation of this master plan range in area from about 10 acres to 60 acres. For basins of this range of sizes and accounting for the fairly steep slopes that are common along primary drainage routes within the study area, significant storage is not expected to occur. Therefore, peak discharge modeling is considered appropriate for design of storm drainage facilities within the City of Coos Bay. Even in basins where some storage is likely to occur, peak discharge modeling is acceptable as it would tend to result in facilities being conservatively oversized rather than undersized.

5.1 Rational Method

McCuen notes that several peak discharge hydrologic models exist for various applications based on land use, terrain, and characteristics of the primary drainage route. The Rational Method is the most widely used equation. Mathematically, the Rational Method relates the peak discharge (q_p, ft^3/sec) to the drainage area (A, acres), the rainfall intensity (i, in/hr), and the runoff coefficient (C) by the following formula:

$$q_p = CiA$$

The rainfall intensity is obtained from an intensity-duration-frequency (IDF) curve using the return period and a duration equal to the time of concentration (T_c) as input. The value of the runoff coefficient is a function of the land use, cover condition, soil group, and surface slope.

A primary use of the Rational Method has been for design of storm drainage systems for small urban areas (less than 200 acres) which are characterized by small drainage areas, short times of concentration and relatively uniform land use. For such designs, short duration storms are critical, which is why the time of concentration is used as the input duration for obtaining i from the IDF curves.

5.2 SCS Rainfall Runoff Relationship

The Soil Conservation Service (SCS; now NRCS) has developed a method for relating rainfall to runoff which considers an entire watershed with a variety of land uses and soil types. The method, described in length in Technical Release 20 (TR-20) published by the SCS, is based upon unit hydrograph theory and the runoff curve number method of calculating direct runoff from the rainfall occurring over specified areas. The TR-20 method also allows watershed areas (basins) to be divided into subbasins for analysis purposes, with drainage routes of one or more subbasins running through other subbasins downstream. This provides for the calculation of an overall peak discharge from a basin that may or may not equal the sum of the peak discharges from the individual subbasins. The TR-20 method is considered much more versatile for modeling complex areas where the Rational Method is limited.

The volume of storm runoff depends on a number of factors, including but not limited to, rainfall volume. For very large watersheds, the volume of runoff from one storm event may depend on rainfall that occurred during previous storm events. However, for smaller watersheds such as those identified within this master plan, hydrologists usually assume that runoff from a given storm event is independent of rainfall which occurred in previous events. This assumption of storm independence is common and has been applied herein.

5.2.1 Factors Affecting Runoff Volume

In addition to rainfall, other factors affecting the volume of runoff include land cover, land use, soil type, and antecedent soil moisture conditions. In hydrologic modeling, the amount of rainfall available for runoff is typically separated into three parts: direct runoff, initial abstraction, and losses. Land cover and use, soil type and antecedent soil moisture conditions affect the split between losses and runoff. Many factors affect the separation of rainfall into direct runoff and losses, and therefore hydrologic modeling requires that a number of assumptions be made in order to simplify the process.

5.2.2 SCS Rainfall – Runoff Equation

Development of the SCS rainfall – runoff relationship included dividing the total rainfall (P) into the following components: direct runoff (Q), actual retention (F), and the initial abstraction (I_a). The initial abstraction is the amount of rainfall at the beginning of a storm that is not available for runoff. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. The actual retention is the difference between the amount of rainfall available for runoff and the actual runoff. It is quantified according to the following relationship:

$$F = (P - I_a) - Q$$

The potential maximum retention (S) is assumed to have the following relationship to the other components:

$$F / S = Q / (P - I_a)$$

By substituting the first equation above into the second and by rearranging to isolate Q, the following relationship is derived:

$$Q = (P - I_a)^2 / [(P - I_a) + S]$$

The preceding equation contains one known value, P, and two unknown variables, I_a and S which must be estimated in order to calculate the runoff volume. According to the NRCS Technical Release 55 (TR-55) I_a is highly variable but generally is correlated with soil and cover parameters. It is further noted in TR-55 that through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S$$

By substituting the above equation for I_a in the previous runoff equation, the following equation, having only a single unknown, S, is derived after simplifying:

$$Q = (P - 0.2S)^2 / (P + 0.8S)$$

The preceding equation is identified as the basic equation for computing the runoff depth, Q, for a given rainfall depth, P. In this expression Q and P have units of depth (inches) but are commonly referred to as volumes as it is assumed for design that rainfall occurs at a uniform depth over the entire watershed.

5.2.3 Runoff Curve Numbers

In order to compute the runoff for a given depth of precipitation within a watershed one must be able to estimate the retention, S. The SCS runoff curve number (CN) was developed for this purpose. The curve number is an index that represents the combination of a hydrologic soil group and a land use and treatment class. Curve numbers are indicated to be functions of the three factors, soil group, cover complex, and antecedent moisture conditions. The CN has a range of 0 to 100 and is related to S according to the following equation:

$$S = (1000/\mathrm{CN}) - 10$$

Soil Group Classification

The SCS method includes dividing soils into four groups represented by the letters A, B, C, and D. Group A soils are identified as deep sand, deep loess, and aggregated silts and are defined as having a minimum infiltration rate of 0.30 to 0.45 inch/hour. Group B soils include shallow loess and sandy loam with infiltration rates ranging from 0.15 to 0.30 inch/hour. Group C soils are those low in organic content and usually high in clay, including clay loams and shallow sandy loams with an infiltration rate in the range of 0.05 to 0.15 inch/hour. Group D soils are those that swell significantly when wet including fat (highly plastic) clays and certain saline soils and are identified as having an infiltration rate less than 0.05 inch/hour.

The NRCS Soil Survey for Coos County identifies a variety of soils within the study area. Figure 4-1 shows the soils within the study area and gives a brief description of each soil type, including a rate of permeability ranging from very rapid to very slow. For modeling purposes, soil types identified by the Soil Survey as having very rapid to rapid permeability were classified as Group A soils; soil types identified as having moderately rapid to moderate permeability were classified as Group B soils; and soil types identified as having slow to very slow permeability were classified as Group C soils. No fat clay soils were identified within the study area and consequently no Group D soils were considered in the stormwater modeling performed for this master plan.

Cover Complex Classification

The cover complex classification developed by SCS consists of three factors: land use, treatment or practice, and hydrologic condition. There are approximately 21 different land uses identified in the tables for estimating curve numbers. In reviewing cover complex within watershed areas for analysis of specific storm drains, land uses were generally found to be of one of the following classifications: open space (lawns, parks, etc.), paved streets with curbs, paved streets with open ditches, gravel roads, residential districts with 1/8 acre to 1/2 acre average lot sizes, commercial/business districts, industrial, and undeveloped forest or brush areas.

Curve Number Selection

Curve numbers used in the stormwater modeling performed for this study were determined from the runoff curve number table (Table 2-2) contained within TR-55 as published by the NRCS. A copy of the table is contained within Appendix A. The CN for each distinct area identified within the watersheds was selected based on a combination of the cover complex and hydrologic soil group of the specific location as explained above. The land area applying to each CN identified was determined from the City's aerial topographic mapping and the Soil Map (Figure 4-1). An overall weighted CN was calculated for each watershed area based on the individual CN's and their corresponding land areas. Peak runoff was calculated using the weighted CN for each watershed area analyzed. The following table presents curve numbers that were selected representing a variety of land uses identified within the study area.

Table 5.2.3 – SCS Curve Numbers for Identified Land Uses

	Hydrologic Soil Group		
Cover Type and Hydrologic Condition	**A**	**B**	**C**
Open Space (lawns, parks, cemeteries, etc.) – fair condition	49	69	79
Paved Streets w/ curbs and storm drains	98	98	98
Paved Streets w/ open ditches	83	89	92
Commercial and business districts	89	92	94
Industrial areas	81	88	91
Residential with 1/8 acre or smaller lots, town houses	77	85	90
Residential with 1/4 acre lots	61	75	83
Residential with 1/3 acre lots	57	72	81
Woods (Forestland) – Grass combination – fair condition	43	65	76
Woods (Forestland) – Grass combination – good condition	32	58	72
Brush – brush-weed-grass mixture – poor condition	48	67	77
Brush – brush-weed-grass mixture – fair condition	35	56	70

5.2.4 Time of Concentration

The time of concentration (T_c) is an important input parameter used in runoff calculations. There are two commonly accepted definitions of the time of concentration. In the first, T_c is defined as the length of time for a particle of water to travel from the most distant point in a watershed to the point of design (i.e. outlet). The second definition is based on a rainfall hyetograph and the resulting runoff hydrograph. A hyetograph is the curve obtained when rainfall depth is plotted against time for a measured storm event. A hydrograph is a plot of runoff versus time for a watershed area. In the second definition of time of concentration, T_c is the time between the center of mass of rainfall excess and the inflection point on the recession of the direct runoff hydrograph. Both the rainfall excess and direct runoff are computed from the actual hyetograph and hydrograph. No direct rainfall or runoff data exist for the storm drainage basins identified herein and therefore attempting to compute the rainfall excess and direct runoff from any given basin is impractical.

Times of concentration for each basin have been calculated using velocity methods to determine the time for runoff to travel from the most distant point of the basin to the outlet. According to common practice, T_c has been computed as the sum of the individual travel times for each component of the drainage conveyance system. Runoff velocity for each component is determined based on surface roughness, channel shape, and slope. Runoff moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The travel time (T_t) for an individual segment of the drainage system is equal to the length (L) of the segment divided by the velocity (V) of runoff within that segment, as shown below:

$$T_t = L/V$$

The velocity of overland flow has been estimated using the following relationship between velocity (ft/sec) and slope (percent):

$$V = kS^{0.5}$$

The value of *k* from the above equation is a function of land cover and has been determined according to the following table:

Table 5.2.4A – Land Cover Coefficients

K	Land Use / Flow Regime
0.25	Forest with heavy ground litter; hay meadow (overland flow)
0.50	Trash fallow or minimum tillage cultivation; contour or strip cropped; woodland (overland flow)
0.70	Short grass pasture (overland flow)
0.90	Cultivated straight row (overland flow)
1.00	Nearly bare and untilled (overland flow); alluvial fans in western mountain regions
1.50	Grassed waterway
2.00	Paved area (sheet flow); small upland gullies

Flow velocities within pipes and open channels have been computed using Manning's equation:

$$V = (1.49/n)R_h^{2/3}S^{0.5}$$

where V is the velocity (ft/sec), n is the roughness coefficient, R_h is the hydraulic radius (feet), and S is the slope (ft/ft). The hydraulic radius R_h is defined as the area of the flow cross section divided by its wetted perimeter. For simplicity sake, velocities in pipes have been calculated based on full flow conditions. For full or half-full pipes, the formula for hydraulic radius R_h is simplified as follows:

$$R_h = d_0/4$$

where d_0 is the inside diameter of the pipe. For pipe flow conditions other than full or half-full, the formula for determining hydraulic radius is more complex.

The roughness coefficient n used in Manning's equation is a function of the channel or pipe material and condition. Studies have determined Manning's n for a number of different channel/pipe materials. The following table provides some typical values. The tabulated values are excerpted from Table 5, Chapter 10 of the textbook "Elementary Fluid Mechanics"; Seventh Edition; Robert L. Street, Gary Z. Watters, and John K. Vennard; Copyright 1996; John Wiley & Sons, Inc.

Table 5.2.4B – Manning's *n* for Partially Full Pipes and Open Channels

Type of Conduit	Minimum *n*	Normal *n*	Maximum *n*
Welded Steel	0.010	0.012	0.014
Coated Cast Iron	0.010	0.013	0.014
Corrugated Metal	0.021	0.024	0.030
Cement Mortar Lined (neat)	0.010	0.011	0.013
Concrete Culvert (finished)	0.011	0.012	0.014
Concrete pipe (steel form)	0.012	0.013	0.014
Vitrified Clay	0.011	0.014	0.017
Earth Channel, straight and uniform, clean	0.016	0.018	0.020
Earth Channel, straight and uniform, short vegetation	0.022	0.027	0.033
Earth Channel, winding, clean	0.023	0.025	0.030
Earth Channel, winding, short vegetation	0.025	0.030	0.033
Natural Channel, straight, no riffles or pools	0.025	0.030	0.033
Natural Channel, winding, some pools and shoals	0.033	0.040	0.045

5.2.5 Rainfall

Rainfall is the driving force of hydrologic design. Problems result when rainfall occurs at extreme volumes or rates. High rates of rainfall on small urban watersheds cause flooding of streets and parking lots because the drainage facilities were not designed to drain all the water generated by high rainfall rates. Some hydrologic planning and design requires only a volume of rainfall. For the purposes of hydrologic analysis and design, however, the distribution of rainfall with respect to time is usually required. The time distribution of rainfall is called a hyetograph. A hyetograph is a graph of the rainfall intensity or volume as a function of time.

Storm events can be separated into two groups, actual storms and design storms. Rainfall analysis is based on actual storms. Hydrologic designs are typically based on what is called the design storm approach. A design storm is a rainfall hyetograph with predefined characteristics, not an actual measured storm event. In fact, a real storm identical to the design storm most likely has not occurred and will not ever occur. Design storms have characteristics that are the average of the characteristics of storms that occurred in the past and therefore represent the average characteristics of storm events that are expected to occur in the future.

The three most important storm characteristics in hydrologic analysis and design are duration, volume, and frequency. The volume of a storm is often reported as a depth (i.e. inches). The depth is assumed to occur uniformly over an entire watershed. Therefore, the volume is actually the product of the depth times the area of the watershed. Another closely related characteristic is the intensity which is equal to the volume divided by the duration. A specified volume of rainfall may result from many different combinations of intensities and durations. The intensity and duration of a storm will have a significant effect on the resulting rate and volume of runoff.

Just as intensity, duration and volume are important in storm drainage system design, frequency also is a necessary determinant. Frequency can be discussed as either the exceedence probability or the return period. The exceedence probability is the probability that a storm of specified volume and duration will be exceeded in any one year. The return period is the average length of time between events of a specified volume and duration. The exceedence probability is inversely proportional to the return period. For example, if a storm of a specified duration and volume has a 1% chance of occurring in any one year, it has an exceedence probability of 0.01 and a return period of 100 years.

The relationship between volume (or intensity), duration and frequency is location dependent. That is, a storm with a given volume and duration will occur at a different frequency in one location than another. Because of the importance of the relationship between volume (or intensity), duration and frequency in hydrologic design, studies have been performed to develop rainfall volume – duration – frequency (VDF) curves and intensity-duration-frequency (IDF) curves for most localities. Coos Bay is identified as lying within Oregon's IDF Zone 3.

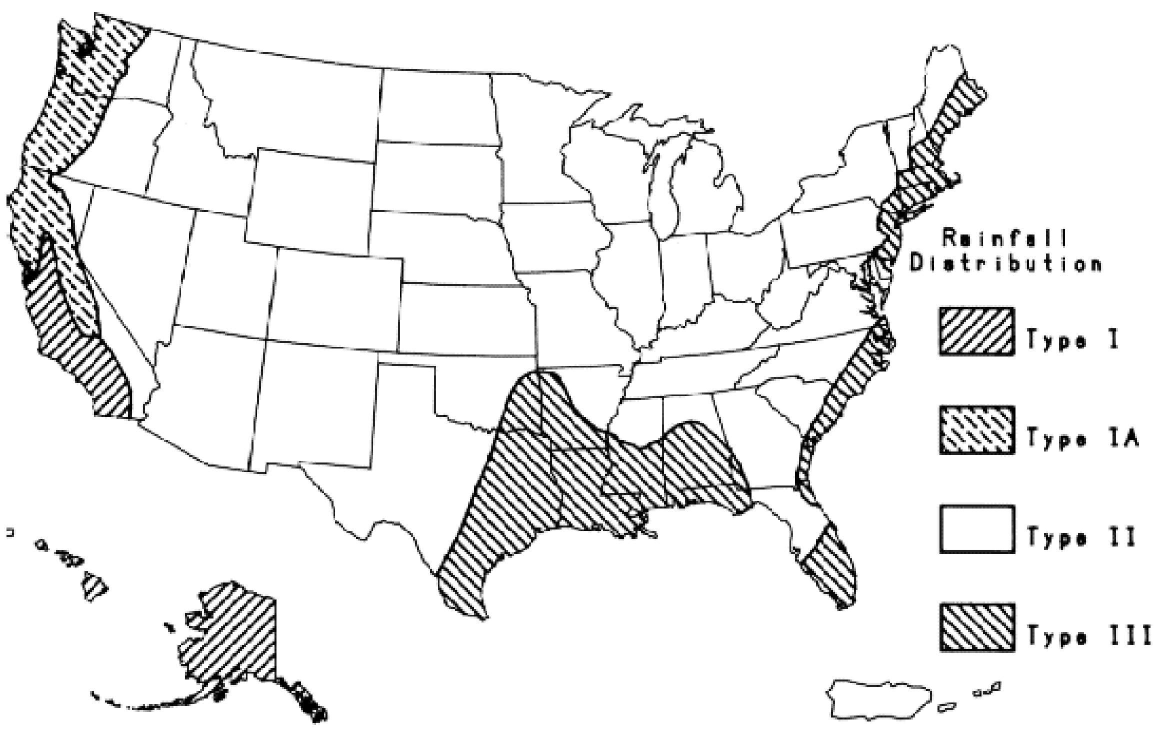
Constant Intensity Storm

Frequently hydrologic designs on very small urban watersheds are designed based on constant intensity storms. The critical cause of flooding is often short-duration, high-intensity rainfall. Therefore, it is assumed that for the critical storm duration, the rainfall intensity will be constant. It is intuitive that the largest peak runoff rate occurs when the entire drainage area is contributing, and so it is common to assume that the duration of the design storm equals the time of concentration of the watershed. The intensity of the storm is obtained from an IDF curve for the location, often using the time of concentration as the duration and the frequency specified by the design standards (i.e. 10-year, 25-year, etc.) For a constant intensity storm, the rainfall volume is equal to the intensity multiplied by the duration.

SCS 24-Hour Storm Distributions

The SCS developed four dimensionless rainfall distributions using the Weather Bureau's Rainfall Frequency Atlases. The rainfall frequency data for areas less than 400 mi^2, for durations to 24 hours and for frequencies from 1 to 100 years were used. Analysis indicated four major regions, and the resulting rainfall distributions were labeled type I, IA, II, and III. The locations where these design storms should be used are shown in Figure 5-1. As indicated, Type IA design storms should be used for Coos Bay.

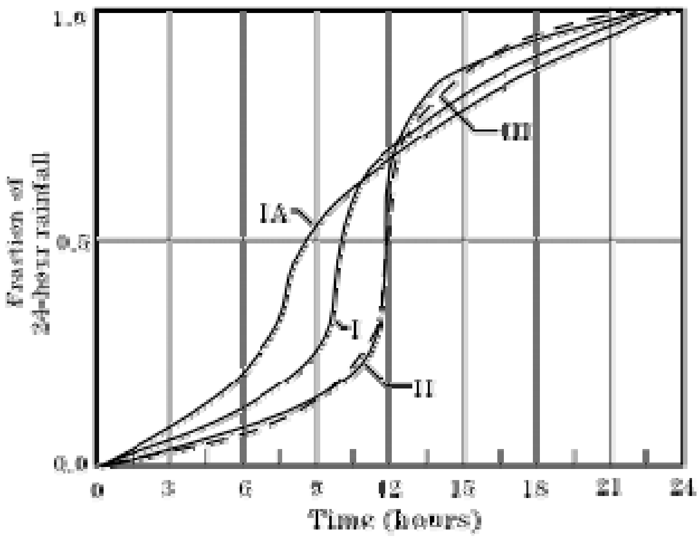
Figure 5-1 – Geographic Areas for SCS Rainfall Distributions



Rainfall Distribution

The SCS rainfall distributions are based on generalized rainfall volume-duration-frequency relationships obtained from Weather Bureau technical publications. Rainfall depths for various durations were used to derive the storm distributions. Incremental rainfall depths were determined using 6-minute increments. The time of the peak rainfall was found from the analysis of measured storm events to be location dependent. For the regions with type I and IA storms, the peak intensity was found to occur about 8 hours after the beginning of the storm, while for the regions with type II and III storms, the peak was found to occur at the center of the storm, about 12 hours. The SCS 24-hour rainfall distributions are graphically presented in Figure 5-2 below.

Figure 5-2 – SCS 24-Hour Rainfall Distributions



It is assumed for type II and III storms that the greatest 6-minute depth occurs at the middle of the 24-hour period, the second largest 6-minute incremental depth in the next 6 minutes, the third largest in the 6-minute interval preceding the maximum intensity, and so on, with each incremental rainfall depth to be of decreasing order of magnitude. The smallest increments fall at the beginning and end of the 24-hour storm. This procedure results in the maximum 6-minute depth is contained within the maximum 1-hour depth, the maximum 1-hour depth is contained within the maximum 6-hour depth, and so on. For type I and IA storms, the maximum incremental rainfall depth occurs at about 8-hours, with successively lower incremental depths following and preceding the maximum, and so on. Because all the critical storm depths are contained within the storm distributions, the distributions are appropriate for designs on both small and large watersheds. Type IA design storms have been used for each basin defined herein.

Rainfall Intensity

The IDF curves for an area can be used to obtain the rainfall intensities for storm durations of 5 minutes to 6 hours. A design storm can be formed using incremental data obtained from the IDF curves. This process can be somewhat cumbersome. Alternatively, isopluvial maps can be used to determine the total rainfall depth for a specific geographic area based on rainfall depth contours for storms of specific durations and return periods. For Oregon, maps are available for storms of 6-hour and 24-hour durations and 2, 5, 10, 25, 50, and 100-year return periods. Isopluvial maps for the Coos Bay vicinity are presented in Appendix C for the 25, 50, and 100-year 24-hour duration storms. The total rainfall depths presented in Table 5-4 were obtained from the isopluvial maps.

Table 5.2.5 – Design Storm Rainfall Totals for Coos Bay

Design Storm Return Period	24-Hour Rainfall Total
25-year	5.5 inches
50-year	6.0 inches
100-year	6.5 inches

The Oregon Department of Transportation Hydraulics Manual recommends that storm drainage designs for city streets utilize a 25-year design storm, designs for state highways be based on a 50-year design storm, and other cases where roadway overtopping is likely a 100-year design storm be used. For the purposes of this master plan the 25 and 50 year design storms have been considered.

5.2.6 Hydrographs and Discharge

As defined previously, a hydrograph is a plot of the runoff from a watershed over time. The variation in flows represented on a hydrograph for a watershed area is expected to correlate to the variation in the rainfall hyetograph. For this study, runoff hydrographs were calculated for each storm drainage basin based on the 25 and 50-year Type IA design storms using the SCS TR-20 method. Calculations were performed using HydroCAD Version 5.11 modeling software which includes the SCS TR-20 method as one of the methods to calculate runoff. Results of the modeling are presented in Appendix A.

6.0 Storm Drain Model

The existing storm drainage systems within the study area have been modeled in order to determine the existing capacity of various system components and the existing and future stormwater discharges that are likely to occur from each basin and subbasin modeled. A number of factors affect the analysis including but not limited to land use, soil type, and both surface condition and vegetation in undeveloped areas. Each storm drain identified in this section has been modeled based on the estimated area drained as determined from the City's aerial topographic mapping. Ground surface slopes, existing development, and the presence of drainage facilities also is based on the aerial mapping. Potential future discharges have been calculated using information from the zoning and land use maps from the City of Coos Bay 2000 Comprehensive Plan to identify areas of probable future development.

As explained in the previous Chapter, we have used the SCS (TR-20) Method to calculate stormwater discharge volumes from the identified basins and subbasins. The SCS Method utilizes curve numbers to rate the runoff potential of an area based on the land use, cover condition and soil type. The table below presents curve numbers for various land use classifications that were identified within the study area. Areas identified for future development were assigned curve numbers representative of the development expected to occur.

Table 6.0 – SCS Curve Numbers for Identified Land Uses

	Hydrologic Soil Group		
Cover Type and Hydrologic Condition	**A**	**B**	**C**
Open Space (lawns, parks, cemeteries, etc.) – fair condition	49	69	79
Paved Streets w/ curbs and storm drains	98	98	98
Paved Streets w/ open ditches	83	89	92
Commercial and business districts	89	92	94
Industrial areas	81	88	91
Residential with 1/8 acre or smaller lots, town houses	77	85	90
Residential with 1/4 acre lots	61	75	83
Residential with 1/3 acre lots	57	72	81
Woods (Forestland) – Grass combination – fair condition	43	65	76
Woods (Forestland) – Grass combination – good condition	32	58	72
Brush – brush-weed-grass mixture – poor condition	48	67	77
Brush – brush-weed-grass mixture – fair condition	35	56	70

6.1 Basin Descriptions

The following basin descriptions include summaries of current and future land use, soil type, range of ground surface slope based on the identified soil types, calculated peak runoff for existing and future development conditions, and existing storm drainage facilities. Some basins are largely undeveloped at this time. Estimates have been made regarding development that is likely to occur in order to calculate peak runoff for future conditions in these areas. Problems with existing storm drainage facilities as identified in this Section are rated and developed into projects in Chapter 8.

6.1.1 Basin A

Basin A includes a total of about 160 acres, 65 within the Coos Bay City Limits, and lies northerly of Lakeshore Drive. It is generally bounded on the south by a rise in the terrain approximately mid-block between Howard Avenue and St. John Street, on the northwest by the Bay, and on the east by a north-south trending ridgeline within the City of North Bend. A small storm drainage system is present within Fenwick and Sanford Streets and Virginia Avenue. The system discharges into an unnamed creek on the west side of the intersection of Fenwick and St. John Streets.

Soil Type
Heceta Fine Sand (Map Unit 28)
Netarts Loamy Fine Sand (Map Unit 43D)
Waldport Fine Sand (Map Unit 59D)

Slope
0-30%

Current Land Use
32.25 Acres – Single Family/Duplex Residential (R-2)
21.29 Acres – Restricted Waterfront Residential (R-W)
3.75 Acres – Conservation Shoreland (53-CS)

Peak Runoff

25-Year Storm (Exist.)	7.51 cfs
50-Year Storm (Exist.)	8.79 cfs
25-Year Storm (Future)	11.83 cfs
50-Year Storm (Future)	13.81 cfs

Existing Storm Drain System
A storm drainage system including 12-inch and 15-inch pipe is present within Fenwick and Sanford Streets and Virginia Avenue. A 15-inch pipe discharges into an unnamed creek on the west side of the intersection of Fenwick and St. John Streets. Flows then proceed overland to the Bay or are absorbed into the ground. The 15-inch outfall pipe is estimated to lie at a slope of about 1% or less and its material is uncertain. The full-flow capacity of a 15-inch corrugated metal pipe at 1% slope is 3.51 cfs. The full flow capacity of a 15-inch concrete pipe at 1% slope would be about 6.48 cfs.

Present Problems
The existing storm drain outfall appears to be undersized to handle peak flows generated by the 25-year and 50-year design storms under open channel flow conditions. It is recommended that the outfall pipe be replaced with a minimum 15-inch diameter HDPE pipe in order to handle the calculated 25-year peak runoff.

Future System
Undeveloped land includes approximately 5.2 acres zoned R-2 along with about 3.7 acres zoned R-W. The R-2 zoned land could be developed in such a way as to have storm drainage tied into an extension of the existing storm drain system. If this occurs, the new storm drain mainline and outfall should consist of minimum 18-inch HDPE pipe in order to handle the calculated peak flows. If developed, the R-W zoned land most likely will not tie into the existing storm drain system. It is estimated that 30 new EDU’s could be added in the R-2 zoned area and 13 new EDU’s in the R-W zoned area, for a total of 43 new EDU’s.

6.1.2 Basin B

Basin B occupies a total of about 100 acres, 74 acres within the Coos Bay City Limits, and is bounded on the south by Lakeshore Drive, on the north by a rise in the terrain approximately mid-block between Howard Avenue and St. John Street, on the west by the Bay, and on the east by a north-south trending ridgeline within the City of North Bend. Storm drainage within Basin B includes a trunk storm drain along Margaretta Street with pipes extending north and south at most cross streets from Augustine Street to Stillwater Avenue. Runoff is discharged into an unnamed creek about 500 feet west of Seagate Street.

Soil Type
Netarts Loamy Fine Sand (Map Unit 43D)
Waldport Fine Sand (Map Unit 59D)

Slope
0-30%

Current Land Use
47.57 Acres – Single Family/Duplex Residential (R-2)
11.83 Acres – Restricted Waterfront Residential (R-W)
1.44 Acres – Conservation Shoreland (53-CS)

Peak Runoff

25-Year Storm (Exist.)	31.86 cfs
50-Year Storm (Exist.)	36.52 cfs
25-Year Storm (Future)	39.28 cfs
50-Year Storm (Future)	45.51 cfs

Existing Storm Drain System
The existing storm drain system within Basin B includes mainly 12 and 15-inch pipes tied to catch basins within Augustine, Fenwick, Sanford, and Crocker Streets, and Stillwater Avenue. The main trunk storm drain pipe is within Margaretta Street and consists of 15-inch pipe from Stillwater Avenue to Fenwick Street, 18-inch pipe from Fenwick to Augustine, 21-inch pipe from Augustine to Seagate, 24-inch pipe from Seagate to a manhole located approximately 100-feet west of Seagate, and 27-inch CMP the remaining distance of about 400 feet to the outfall. Based on the ground slope in the area west of Seagate Street, it is estimated that the 27-inch CMP is laid at a slope of 2.2% or less. If the pipe is at 2.2% the full-flow capacity would be about 24.95 cfs.

Present Problems
The existing 27-inch CMP outfall appears to be slightly undersized to handle peak flows generated by the 25-year and 50-year design storms under open channel flow conditions. Because the calculated runoff is only slightly greater than the full-flow capacity of the outfall pipe capacity, it is likely that the system may surcharge at times without actually flooding streets.

Future System
County Assessor maps indicate there are about 21 vacant platted residential parcels (2.41 acres) within the R-2 zone in Basin B, along with 0.69 acres of undeveloped public right-of-way. There also is an undeveloped parcel zoned R-W which includes 11.83 acres within Basin B. It is estimated that 40 to 50 new home sites could be provided within Basin B on the subject parcel. Storm drainage could be tied into the existing system. The existing 27-inch CMP storm drain would have to be replaced or lined in order to handle any additional runoff. Lining the existing pipe with 24 or 26-inch O.D. smooth wall HDPE pipe is recommended. It is estimated that a total of 71 new EDU's may be added in Basin B.

6.1.3 Basin C

Basin C includes approximately 106 acres around Lower Empire Lake and extending south to Ocean Boulevard along Norman Avenue. A storm drain along Norman Avenue collects surface runoff from the vicinity and discharges to a wetland area on the south shore of Lower Empire Lake.

Soil Type
Bandon Sandy Loam (Map Units 1B and 1C)
Blacklock Fine Sandy Loam (Map Unit 5B)

Slope
0-12%

Current Land Use
14.08 Acres – Multiple Residential (R-3)
5.37 Acres – General Commercial (C-2)
81.09 Acres – Park/Cemetery (QP-1)

Peak Runoff

25-Year Storm (Exist.)	16.83 cfs
50-Year Storm (Exist.)	18.98 cfs
25-Year Storm (Future)	21.90 cfs
50-Year Storm (Future)	24.62 cfs

Existing Storm Drain System
The existing storm drain system in Basin C includes 12-inch concrete pipe (installed about 1977) along Norman Avenue from Lund Avenue to Newmark, and 18-inch HDPE pipe (installed in 2003) from Newmark north to the point of discharge in the wetlands on the southerly side of Lower Empire Lake. Surface inlets include catch basins along Norman Avenue as well as area drains within parking lots at some of the adjacent developments.

Present Problems
According to our hydraulic calculations the first segment of existing 12-inch concrete piping within Norman Avenue south of Newmark Avenue is undersized for the peak runoff generated by the 25 and 50-year design storms. As-built drawings indicate that the pipe is laid at a slope of 0.53%. This section of 12-inch concrete pipe should be replaced with minimum 18-inch HDPE pipe. The recently installed 18-inch outfall pipe also is slightly undersized due to its slope of 1.2%.

Future System
Approximately 4.15 acres of undeveloped land zoned R-3 is present within Basin C in areas served by the Norman Avenue storm drain. There also is a vacant 0.34 acre parcel zoned C-2 at the southwest corner of Norman and Newmark Avenues. If all this land is developed the peak runoff would be increased as indicated above. In order to handle the peak runoff generated by the 25-year design storm a 21-inch HDPE outfall pipe is recommended. It is estimated that 28 new EDU’s may be added in the R-3 zoned area if developed and approximately 2 new EDU’s may be added on the parcel zoned C-2, for a total of 30 new EDU’s within Basin C.

6.1.4 Basin D

Basin D is about 157 acres in area and is roughly bounded by Lakeshore Drive on the north, Harris Avenue on the south, Lower Empire Lake on the east, and Wall Street on the west. Runoff from Basin D discharges into Chickses Creek at various points. Several small storm drain systems are present within Basin D serving one or two streets. These small systems have not been modeled. The main storm drain system within Basin D is along Lakeshore Drive east of Chickses Creek.

Soil Type
Bandon Sandy Loam (Map Unit 1B)
Blacklock Fine Sandy Loam (Map Unit 5B)
Netarts Loamy Fine Sand (Map Unit 43D)
Waldport Fine Sand (Map Unit 59D)
Waldport-Heceta Fine Sand (Map Unit 61D)

Slope
0-30%

Current Land Use
105.73 Acres – Single Family/Duplex Residential (R-2)
15.14 Acres – Restricted Waterfront Residential (R-W)
21.90 Acres – Park/Cemetery (QP-1)
0.53 Acre – Indian Trust Land (ITL)
2.35 Acres – Conservation Shoreland (53-CS)

Peak Runoff

25-Year Storm (Exist.)	35.16 cfs
50-Year Storm (Exist.)	40.17 cfs
25-Year Storm (Future)	35.16 cfs
50-Year Storm (Future)	40.17 cfs

Existing Storm Drain System
An existing storm drain system is present along Lakeshore Drive from Chickses Creek east to Stillwater Avenue. The piping includes 18-inch diameter CMP west of Seagate Street and 12-inch pipe to the east. A 12-inch storm drain also extends south along Seagate Street to Edwards Avenue, and then east to Fenwick Street. Storm drain pipes extending south at Seabreeze Terrace and Morrison Street also tie into the 18-inch storm drain along Lakeshore Drive. Another drainage system is present along Tideview Terrace and Seabreeze Terrace with an outfall pipe daylighting just west of the intersection of Chickses Drive and Tideveiw Terrace. Storm drain piping within this system includes 12 and 15-inch CMP. The outfall at Chickses Drive and Tideview Terrace has recently been replaced with 15-inch HDPE pipe.

Present Problems
The 18-inch CMP storm drain piping and outfall within Lakeshore Drive are undersized for the runoff generated by the 25 and 50-year design storms. It is recommended that the 18-inch piping from the outfall to Morrison Street be replaced with minimum 24-inch HDPE pipe.

Future System
Most of the undeveloped land within Basin D is located in areas that would require the construction of new storm drainage facilities rather than tying into existing facilities. Construction on remaining vacant residential lots in the area between Lakeshore Drive and Lower Empire Lake will not significantly affect runoff from this area. It is estimated that a total of 35 new EDU’s may be added within Basin D.

6.1.5 Basin E

Basin E is approximately 49 acres in area and extends just past Taylor Avenue on the north, nearly to Jackson Avenue on the south, to Cammann Street on the east, and to the Bay on the west. Storm drainage within Basin E includes a system within Harris Avenue from about 200 feet west of Empire Boulevard to Wasson Street.

Soil Type
Bandon Sandy Loam (Map Units 1B and 1C)
Netarts Loamy Fine Sand (Map Unit 43D)
Waldport Fine Sand (Map Units 59D and 59E)

Slope
0-70%

Current Land Use
16.13 Acres – Single Family/Duplex Residential (R-2)
14.55 Acres – Restricted Waterfront Residential (R-W)
1.78 Acres – Conservation Shoreland (53-CS)
7.72 Acres – Urban Water Dependent (54-UW)

Peak Runoff

25-Year Storm (Exist.)	25.56 cfs
50-Year Storm (Exist.)	29.39 cfs
25-Year Storm (Future)	25.56 cfs
50-Year Storm (Future)	29.39 cfs

Existing Storm Drain System
The existing storm drain system in Basin E runs along Harris Avenue and includes a 30-inch CMP outfall pipe which daylights approximately 200 feet west of Empire Boulevard. Piping from Empire Boulevard to Wall Street includes 18-inch piping, and a 10-inch pipe continues one additional block east to Wasson Street. The 30-inch CMP outfall is estimated to have a slope of about 1.5%. The resulting full-flow capacity is therefore approximately 27.28 cfs.

Present Problems
No existing problems have been identified within Basin E. The existing storm drain piping appears to be reasonably sized to handle runoff from the 25-year design storm. This is considered adequate in this location.

Future System
No additional development is anticipated within Basin E. Although some redevelopment would be expected within the basin, no significant impact on stormwater runoff volumes is anticipated. The existing storm drain system adequately meets capacity requirements through the planning period.

6.1.6 Basin F

Basin F occupies approximately 147 acres abutting the bay and is generally bounded by Jackson Avenue on the north, Montgomery Avenue on the south, and Cammann and Main Streets on the east. Most of the stormwater runoff in Basin F occurs on the ground surface before entering a 12-inch storm drain present along Newmark Avenue.

Soil Type
Bandon Sandy Loam (Map Unit 1B and 1C)
Udorthents (Map Unit 57)

Slope
0-12%

Current Land Use
15.76 Acres – Single Family/Duplex Residential (R-2)
24.33 Acres – Multiple Residential (R-3)
2.80 Acres – Residential Professional (R-4P)
48.27 Acres – General Commercial (C-2)
6.41 Acres – Industrial-Commercial (I-C)
31.88 Acres – Waterfront Industrial (W-I)
7.15 Acres – Natural Aquatic (55B-NA)
7.80 Acres – Development Aquatic (54-DA)
2.66 Acres – Urban Development (55-UD)

Peak Runoff

25-Year Storm (Exist.)	15.81 cfs
50-Year Storm (Exist.)	17.57 cfs
25-Year Storm (Future)	15.81 cfs
50-Year Storm (Future)	17.57 cfs

Existing Storm Drain System
A 12-inch concrete storm drain with an apparent minimum slope of about 1.5% is present along the north side of Newmark Avenue from about Mill Street east to Main Street. Water is discharged into an open ditch on the south side of Newmark west of Mill Street and then passes through a 24-inch concrete culvert that daylights through a tide wall at the west end of Newmark Avenue.

Present Problems
The existing 12-inch concrete storm drain piping along Newmark Avenue is undersized for the peak runoff generated by the 25 and 50-year design storms. Because Newmark Avenue and S. Empire Boulevard is a State Highway, it is recommended that the 50-year design storm be utilized for sizing of drainage facilities. The 12-inch concrete pipe should be replaced with minimum 18-inch HDPE pipe between Empire Boulevard and Cammann Street.

Future System
Basin F is substantially built-out. With the exception of the potential for redevelopment, no changes are anticipated that would significantly affect the peak runoff from this basin.

6.1.7 Basin G

Basin G includes approximately 254 acres which is the watershed area for the unnamed creek that crosses Cape Arago Highway approximately 300 feet northerly of Fulton Avenue. Basin G extends as far north as Michigan Avenue, south just past Kentucky Avenue, east to Radar Road, and west to the Bay. Four separate storm drainage systems are present within Basin G along with numerous culverts along the described stream. Each storm drainage system has been modeled separately as an individual subbasin.

Soil Type
Bandon Sandy Loam (Map Unit 1B and 1C)
Bullards Sandy Loam (Map Units 8B and 8C)
Templeton Silt Loam (Map Unit 54D)

Slope
0-30%

Current Zoning
176.64 Acres – Single Family/Duplex Residential (R-2)
2.77 Acres – Multiple Residential (R-3)
13.19 Acres – Residential Certified Factory-Built Home Park (R-5)
22.57 Acres – General Commercial (C-2)
1.24 Acres – General Industrial (G-I)
22.49 Acres – Park/Cemetery (QP-1)
3.60 Acres – Indian Trust Land (ITL)
3.83 Acres – Urban Development (55-UD)
7.82 Acres – Natural Aquatic (55B-NA)

Peak Runoff

	Subbasin 1	Subbasin 2	Subbasin 3	Subbasin 4
25-Year Storm (Exist.)	61.13 cfs	12.64 cfs	17.20 cfs	25.52 cfs
50-Year Storm (Exist.)	68.12 cfs	14.02 cfs	19.78 cfs	29.25 cfs
25-Year Storm (Future)	61.13 cfs	12.64 cfs	20.51 cfs	31.23 cfs
50-Year Storm (Future)	68.12 cfs	14.02 cfs	23.20 cfs	35.11 cfs

Existing Storm Drain System
Subbasin 1 – The first system includes a 24-inch CMP storm drain outfall located on the west side of Madison Street one-half block north of Garfield Avenue. The storm drain extends east to Morrison and the piping transitions to concrete someplace mid-block. At Morrison Street, an 18-inch concrete pipe then extends south to Garfield Avenue where a 10-inch concrete pipe continues south and a 15-inch concrete pipe ties in from the east. The 10-inch pipe extends one block south to Pacific Avenue, transitions to 12-inch concrete, and continues two more blocks to Webster Avenue. The 15-inch pipe extends one block east to Schoneman Street and then a 12-inch pipe extends south from there two blocks to the east end of Arago Avenue.

Subbasin 2 – The second system includes an 18-inch CMP storm drain along Webster Avenue from a point approximately 120 feet west of Fillmore Street to Madison Street. At Madison Street 12-inch pipes extend to the north and south one block each way.

Subbasin 3 – The third system includes a 24-inch HDPE storm drain that daylights within the Fulton Avenue right-of-way approximately 150 feet west of Madison Street. At Madison Street the piping transitions to 15-inch and extends east about 800 feet and then transitions again to 12-inch and continues east to Prefontaine Drive. A 15-inch pipe also ties in from the north at Morrison Street. It extends one block to Blanco Avenue where 12-inch pipe continues east along Blanco approximately 500 feet.

Subbasin 4 – The fourth storm drain system includes 24-inch HDPE piping along Kentucky Avenue from Fillmore Street to the Schoneman Street right-of-way. From there 12-inch pipe continues east to Prefontaine Drive where 12-inch pipes extend north and south about 250 feet and 150 feet, respectively. The outfall for this system is a 24-inch HDPE pipe within the Fillmore Street right-of-way about 100 feet north of Kentucky Avenue.

Present Problems

The primary problems with the existing piping in Basin G are in Subbasin 1. The 24-inch storm drain located at Madison Street one-half block north of Garfield Avenue is undersized to handle the calculated peak runoff generated by the 25 and 50-year design storms. The pipe is estimated to be laid at a slope of 1%, or slightly less. Based on this slope, the CMP portion of the pipe has a capacity of about 12.29 cfs, while concrete portion of the pipe has a capacity of about 22.68 cfs. Based on the calculated peak runoff rate and the apparent pipe capacity it is expected that a storm equal to the 25-year storm would cause significant street flooding in this area as well as flooding on private property. City personnel have confirmed that this storm drain system has overflowed in the past.

The 18-inch and 10-inch concrete pipes which extend south along Morrison Street upstream of the 24-inch pipe also are undersized for the calculated peak runoff at the respective points in the system. According to our analysis using the 25-year design storm the peak runoff at the respective points in the storm drain system predicts flows of approximately twice the capacity of the 18-inch pipe and about three times the capacity of the 10-inch pipe. Based on these deficiencies the following storm drain piping improvements are recommended. The existing 24-inch pipe from the outfall to the manhole located midway between Madison and Morrison Streets should be replaced with minimum 30-inch HDPE piping, the existing 24-inch pipe from the described manhole to Morrison Street should be replaced with minimum 27-inch HDPE piping, the existing 18-inch pipe should be replaced with minimum 24-inch HDPE piping, and the 10-inch pipe should be replaced with minimum 12-inch HDPE piping.

A minor capacity problem exists in Subbasin 2 of Basin G. The 18-inch CMP outfall pipe along Webster Avenue west of Fillmore Street is slightly undersized for the calculated peak runoff from the 25-year design storm. Based on ground contours, it is estimated that the pipe is laid at approximately 2.3% slope. Therefore, the calculated full flow capacity of the 18-inch CMP storm drain is 8.65 cfs, approximately two-thirds the peak runoff rate predicted using the 25-year design storm. In order to increase capacity, it is suggested that the CMP outfall pipe be replaced with 18-inch HDPE piping west of Fillmore Street.

Future System

Basin G is essentially built out in Subbasins 1 and 2, which encompasses the area north of Blanco Avenue. The area south of Blanco Avenue, identified as subbasins 3 and 4, is currently experiencing significant growth. It is expected that if the current trend continues build-out may occur within three to five years in these subbasins. Subbasin 3 is estimated to have approximately 6.43 acres of vacant land in the R-2 zone, with 4.89 acres in an area of Group B soil, and 1.54 acres in Group C soil. Subbasin 4 includes 9.70 acres of undeveloped land zoned R-2 and located within Group B soil, as well as 4.17 acres of developing land zoned R-2 and located within a Group C soil area. Based on the amount of undeveloped land yet existing within Basin G, a total of 101 new EDU's is estimated.

6.1.8 Basin H

Basin H is the watershed area of First Creek which encompasses approximately 420 acres total area. About 386 acres of Basin H lies east of the Cape Arago Highway and about 112 acres is within the Coos Bay City Limits. Basin H is largely undeveloped and drainage occurs primarily through the natural creek channel. First Creek crosses Cape Arago Highway about 150 feet south of Fulton Avenue.

Soil Type
Bandon Sandy Loam (Map Unit 1B and 1C)
Bullards Sandy Loam (Map Units 8B, 8C, and 8E)
Templeton Silt Loam (Map Unit 54D)

Slope
0-50%

Current Zoning
109.92 Acres – Single Family/Duplex Residential (R-2)
13.86 Acres – General Commercial (C-2)
5.11 Acres – General Industrial (G-I)
58.83 Acres – Watershed (QP-2)
99.06 Acres – Indian Trust Land (ITL)
15.59 Acres – Natural Aquatic (55B-NA)

Peak Runoff

25-Year Storm (Exist.)	173.1 cfs
50-Year Storm (Exist.)	202.9 cfs
25-Year Storm (Future)	205.7 cfs
50-Year Storm (Future)	237.1 cfs

Existing Storm Drain System
Basin H is primarily drained by overland flow which eventually becomes channeled within First Creek. Two 36-inch concrete culverts are present where Cape Arago Highway crosses the creek. An 18-inch storm drain pipe also is present along the east side of the highway from First Creek to Fulton Avenue, as well as a 12-inch pipe along the north side of Fulton Avenue from the highway to Wasson Street.

Present Problems
The two 36-inch concrete culverts at the highway crossing of First Creek appear to be adequately sized for the peak runoff generated by the 25 and 50-year design storms provided they are laid at a slope of 2% or more. The 12 and 18-inch storm drain described above serves a very small area and is considered adequately sized for the area served.

Future System
Some development is occurring at the present time within Basin H on the southwesterly slopes of Radar Hill. There is a total of about 90 acres of previously undeveloped land zoned R-2 with access from the south end of Prefontaine Drive. Presently, approximately 8.1 acres is under development within the described R-2 zoned area. Lots in the new development range in size from about 1/8 acre to about 1/5 acre. For the purposes of this study it is assumed that the remaining 82 acres will be similarly developed. Additional development is occuring along Kentucky Avenue west of Fillmore Street. A subdivision including approximately 3.9 acres within Basin H is presently under construction in this area. An additional 3.6 acres of undeveloped land zoned R-2 also is present in this area. Based on the above summary of vacant land, it is estimated that a maximum of 358 new EDU’s may be added in Basin H.

6.1.9 Basin I

Basin I encompasses approximately 170 acres around Middle/Upper Empire Lake and the campus of Southwestern Oregon Community College (SWOCC). Basin I is generally bounded on the south by Newmark Avenue, on the north by Lakeshore Drive, on the east by SWOCC East Drive, and on the west by Lower Empire Lake.

Soil Type
Bandon Sandy Loam (Map Unit 1B and 1C)
Bullards Sandy Loam (Map Units 8B)
Netarts Loamy Fine Sand (Map Unit 43D)

Slope
0-30%

Current Zoning
6.59 Acres – Single Family/Duplex Residential (R-2)
1.53 Acres – Multiple Residential (R-3)
2.70 Acres – General Commercial (C-2)
20.79 Acres – Park/Cemetery (QP-1)
136.67 Acres – Public Educational Facility (QP-3)

Peak Runoff

25-Year Storm (Exist.)	97.38 cfs
50-Year Storm (Exist.)	111.2 cfs
25-Year Storm (Future)	104.4 cfs
50-Year Storm (Future)	118.4 cfs

Existing Storm Drain System
No existing storm drain piping is identified on the mapping within Basin I. The SWOCC campus is generally drained to Middle/Upper Empire Lake using open ditches, although culverts undoubtedly exist at walkway and roadway crossings.

Present Problems
Due to the lack of existing storm drainage facilities identified in Basin I, no present problems have been determined.

Future System
Future development within Basin I likely will include continued expansion of the SWOCC campus. There is currently approximately 36 undeveloped acres north of the existing campus zoned QP-3 that could be developed in the future. For the purposes of this study it is assumed that an additional 20 acres north of the current campus will be developed and that it will include approximately 40% impervious surfaces. This equates to approximately 77 new EDU’s within Basin I.

6.1.10 Basin J

Basin J occupies approximately 80 acres including the area around Wal Mart and is generally bounded by Newmark Avenue on the north, Ocean Boulevard on the south, Fir Street on the east, and by a rise in the terrain about midway between LaClair Street and Norman Avenue on the west.

Soil Type
Bandon Sandy Loam (Map Unit 1B)
Blacklock Fine Sandy Loam (Map Unit 5B)
Bullards Sandy Loam (Map Unit 8C)

Slope
0-12%

Current Zoning
8.02 Acres – Single Family/Duplex Residential (R-2)
8.82 Acres – Multiple Residential (R-3)
0.35 Acre – Residential Certified Factory-Built Home Park (R-5)
57.23 Acres – General Commercial (C-2)
0.26 Acre – Park/Cemetery (QP-1)
2.75 Acres – Public Education Facility (QP-3)

Peak Runoff

	Subbasin 1	Overall
25-Year Storm (Exist.)	22.83 cfs	90.05 cfs
50-Year Storm (Exist.)	25.82 cfs	100.1 cfs
25-Year Storm (Future)	28.48 cfs	96.44 cfs
50-Year Storm (Future)	31.48 cfs	106.4 cfs

Existing Storm Drain System
The storm drain system in Basin J discharges to Middle Empire Lake through a new 48-inch diameter HDPE pipe that crosses Newmark Avenue approximately 200 feet east of LaClair Street. Storm drainage piping splits on the south side of Newmark Avenue and includes a 24-inch pipe that extends easterly along Newmark and turns south into the Wal Mart property. A 36-inch pipe extends south through a vacant lot, then a 24-inch pipe turns west to LaClair Street, and then 15 and 10-inch piping continues south along LaClair Street.

Present Problems
The existing 15 and 10-inch piping along LaClair Street south of Milligan Avenue are undersized for the peak runoff generated by the 25 and 50-year design storms. The existing piping should be replaced with minimum 21-inch HDPE storm drain piping from Milligan Avenue to Thomas Street, and 12-inch HDPE piping thereafter.

Future System
An undeveloped 10.41 acre parcel zoned C-2 is present on the southeast corner of LaClair and Thomas Streets. Four undeveloped parcels zoned C-2, totaling 2.83 acres, are located on the southeast corner of Newmark and LaClair. Additionally, a 0.96 acre parcel zoned R-3 is present on the south side of Newmark Avenue approximately 100 feet west of LaClair Street. If these properties are fully developed in the future a significant increase in runoff would be expected from Basin J. Specific storm drainage studies should accompany development of each parcel. It is estimated that a maximum of 110 new EDU’s may be added within Basin J on the described properties.

6.1.11 Basin K

Basin K encompasses approximately 189 acres in the Empire area. It extends approximately 1,200 feet north of Newmark Avenue between Schoneman and Ackerman Streets, as far south as Fulton Avenue at Radar Road, west to Madison Street, and east just past LaClair Street at Ocean Boulevard. Storm drain piping within Basin K consists of three separate systems which discharge into two forks of Chickses Creek north of Newmark Avenue. The systems are identified as Subbasins 1, 2, and 3 in the modeling.

Soil Type
Bandon Sandy Loam (Map Units 1B and 1C)
Blacklock Fine Sandy Loam (Map Units 5A and 5B)
Bullards Sandy Loam (Map Units 8B and 8C)
Templeton Silt Loam (Map Unit 54D)
Waldport-Heceta Fine Sand (Map Unit 61D)

Slope
0-30%

Current Zoning
46.35 Acres – Single Family/Duplex Residential (R-2)
36.20 Acres – Multiple Residential (R-3)
30.08 Acres – Residential Certified Factory-Built Home Park (R-5)
48.41 Acres – General Commercial (C-2)
8.03 Acres – Industrial-Commercial (I-C)
3.91 Acres – Indian Trust Land (ITL)
16.23 Acres – Park/Cemetery (QP-1)

Peak Runoff

	Subbasin 1	Subbasin 2	Subbasin 3
25-Year Storm (Exist.)	59.25 cfs	70.99 cfs	20.89 cfs
50-Year Storm (Exist.)	66.41 cfs	80.06 cfs	23.48 cfs
25-Year Storm (Future)	65.34 cfs	78.37 cfs	20.89 cfs
50-Year Storm (Future)	72.80 cfs	88.11 cfs	23.48 cfs

Existing Storm Drain System
<u>Subbasin 1</u> – Piping within Subbasin 1 includes a 30-inch CMP outfall located approximately 250 feet north of Newmark Avenue and about 170 feet west of Schoneman Street. The 30-inch pipe extends south to the intersection of Newmark and Schoneman and then 18-inch piping continues south along Schoneman to Flanagan Avenue. Two pipes tie into the storm drain at Salmon Avenue, a 10-inch pipe from the west, and a 15-inch pipe from the east.

<u>Subbasin 2</u> – Piping within Subbasin 2 includes a 30-inch CMP outfall located approximately 250 feet north of Newmark Avenue next to the Nancy Devereux Center (1200 Newmark Avenue). The 30-inch pipe extends south to Newmark Avenue, and then ties into storm drain piping along the south edge of Ocean Boulevard which extends to LaClair Street. The piping configuration at the intersection of Ocean Boulevard and Newmark Avenue is uncertain due to incomplete records in this area. Piping along Ocean Boulevard includes about 150 feet of 21-inch piping, 1,120 feet of 18-inch pipe, 920 feet of 15-inch pipe, and 600 feet of 12-inch pipe. Storm drains also tie in from the south at Wallace Street and Radar Road.

Subbasin 3 – Piping within Subbasin 3 includes a 21-inch CMP outfall located on the west side of Ackerman Street approximately 450 feet north of Newmark Avenue. The 21-inch pipe extends about 150 feet south along Ackerman Street, transitions to 18-inch pipe and continues south to Newmark Avenue, turns east along the south side of Newmark and extends to Wallace Street, and then extends about 400 feet south along Wallace Street.

Present Problems

The existing 21 and 30-inch diameter CMP outfalls within Basin K are undersized for the peak runoff generated by the 25 and 50-year design storms under gravity flow conditions. In each case, the pipes are situated relatively deep and several feet of surcharge could occur before water would begin to pond on the ground surface. Because each of the pipes crosses Newmark Avenue and the Subbasin 2 pipe also crosses Ocean Boulevard, it is recommended that they be sized using the 50-year design storm.

Future System

There is an approximate 7.6 acre area of undeveloped land zoned R-3 at the south end of Woolridge Street extending to Flanagan Avenue. Basin K is otherwise fully developed at this time. The undeveloped area appears to drain naturally to both Subbasins 1 and 2. If the area is developed it is possible that storm drainage could be routed to either of the systems. The future flows given on the previous page include the increase from the 7.6 acres developed to the maximum density in both Subbasins 1 and 2 since it is uncertain which way flows would be routed. It is estimated that a total of 30 new EDU's may be added within Basin K in the described area.

6.1.12 Basin L

Basin L occupies about 263 acres of land primarily on the south side of Ocean Boulevard between Radar Hill and 28th Court. The basin crosses Ocean Boulevard to the north between Brule Street and Pacific Loop and extends as far north as Waite Street. The southern boundary of Basin L lies along an east-west trending ridgeline between Radar Hill and the adjacent hilltop to the east.

Soil Type
Bandon Sandy Loam (Map Units 1B and 1C)
Blacklock Fine Sandy Loam (Map Unit 5B)
Bullards Sandy Loam (Map Units 8B, 8C and 8D)
Netarts Loamy Fine Sand (Map Unit 43D)

Slope
0-30%

Current Zoning
47.41 Acres – Single Family/Duplex Residential (R-2)
25.05 Acres – Multiple Residential (R-3)
94.71 Acres – Residential Certified Factory-Built Home Park (R-5)
52.51 Acres – General Commercial (C-2)
19.79 Acres – Industrial-Commercial (I-C)
1.12 Acres – Park/Cemetery (QP-1)
2.99 Acres – Public Education Facility (QP-3)
0.65 Acre – Indian Trust Land (ITL)

Peak Runoff

	Subbasin 1	Overall
25-Year Storm (Exist.)	6.75 cfs	149.2 cfs
50-Year Storm (Exist.)	7.51 cfs	174.1 cfs
25-Year Storm (Future)	6.75 cfs	211.1 cfs
50-Year Storm (Future)	7.51 cfs	238.4 cfs

Existing Storm Drain System
Several separate storm drain systems are present within Basin L. Most serve relatively small areas. The primary drainage from the basin occurs via a tributary stream to Pony Creek. The stream passes through an approximate 1,190-foot long 42-inch CMP culvert which has its inlet west of the existing K-Mart parking lot and its outlet on the north side of Ocean Boulevard approximately 700 feet west of 28th Street.

Present Problems
The existing 42-inch CMP culvert is undersized for the peak runoff that is expected to occur as a result of the 25 and 50-year design storms. The culvert also contains approximately 6-inches of sediment in its invert near the downstream end and some metal corrosion was observed. It should be planned to replace the pipe within 10 to 15 years depending on the rate of deterioration of the pipe. Based on an estimated pipe slope of 0.0042 ft/ft and the calculated maximum runoff, it is recommended that the culvert be replaced with a minimum 60-inch HDPE pipe.

Future System
A significant portion of Basin L is presently undeveloped. Undeveloped land includes 23.69 acres zoned R-2, 19.31 acres zoned R-3, 63.25 acres zoned R-5, 15.57 acres zoned C-2, and 9.91 acres zoned I-C. If all the available land is developed, a maximum of 474 new EDU's is estimated within Basin L.

6.1.13 Basin M

Basin M is encompasses a total of about 277 acres around Pony Creek in the vicinity of Ocean Boulevard. The northerly portion of Basin M extends into the City of North Bend. The basin extends north to Newmark Avenue in North Bend, south to the Lake Merritt dam, east to Woodland Drive, and west to Alderwood Street at Lindberg Avenue.

Soil Type
Bandon Sandy Loam (Map Units 1B and 1C)
Bullards Sandy Loam (Map Units 8B, 8C, 8D and 8E)
Nehalem Silt Loam (Map Unit 40)
Nestucca Silt Loam (Map Unit 41)

Slope
0-50%

Current Zoning
3.87 Acres – Single Family Residential (R-1)
5.03 Acres – Single Family/Duplex Residential (R-2)
33.17 Acres – Multiple Residential (R-3)
6.01 Acres – Residential Certified Factory-Built Home Park (R-5)
20.40 Acres – Single Family, Duplex, and Certified Factory Built Home (R-6)
23.54 Acres – General Commercial (C-2)
26.26 Acres – Industrial-Commercial (I-C)
4.32 Acres – Medical Park (MP)
16.14 Acres – (QP-2)

Peak Runoff

	Subbasin 1	Subbasin 2	Overall
25-Year Storm (Exist.)	6.98 cfs	11.84 cfs	71.41 cfs
50-Year Storm (Exist.)	8.17 cfs	13.39 cfs	87.02 cfs
25-Year Storm (Future)	7.94 cfs	13.72 cfs	75.79 cfs
50-Year Storm (Future)	9.18 cfs	15.30 cfs	91.88 cfs

Existing Storm Drain System
Storm drainage within Basin M includes a number of systems serving areas along Ocean Boulevard. Subbasin 1 includes 12, 15, and 18-inch storm drain piping along the south side of Ocean Boulevard between the Water Treatment Plant and 28th Street. Subbasin 2 is a system serving the neighborhood along Fir Street and Walnut and Lindberg Avenues. Much of the area within Basin M is not included within either subbasin that has been modeled. All of the runoff from Basin M is discharged into Pony Creek or one of its tributaries lying on the north side of Ocean Boulevard.

Present Problems
No existing problems have been identified within Basin M. The storm drains in this basin generally serve small areas and capacity has not been identified as a problem for any of the systems.

Future System
A vacant 3.69 acre parcel zoned R-2 is present on the northwest corner of Fir Street and Lindberg Avenue. There also are several undeveloped parcels present at the north ends of 25th and 26th Streets zoned R-6 and totaling 1.96 acres. Several vacant commercial parcels totaling 1.89 acres are present along Ocean Boulevard near 28th Street. It is estimated that a maximum of 36 new EDU's may be added.

6.1.14 Basin N

Basin N is the watershed area for Upper Pony Creek Reservoir and Lake Merritt and encompasses approximately 2,520 acres south of Ocean Boulevard at Pony Creek. Basin N is primarily undeveloped and no storm drainage components have been identified within this area. A portion of the watershed extends outside of the City Limits to the south.

Soil Type
Bandon Sandy Loam (Map Units 1B, 1C and 1D)
Bullards Sandy Loam (Map Units 8B, 8C, 8D and 8E)
Nestucca Silt Loam (Map Unit 41)
Netarts Loamy Fine Sand (Map Unit 43D)
Templeton Silt Loam (Map Unit 54D and 54E)
Templeton-Bullards Complex (Map Unit 55D)

Slope
0-50%

Current Zoning
13.95 Acres – Multiple Residential (R-3)
16.58 Acres – Industrial-Commercial (I-C)
1623 Acres – (QP-2)

Peak Runoff
Basin N makes up the watershed area for Upper Pony Creek Reservoir and Lake Merritt. The existing dams regulate flows from the basin. Because the flows are controlled and storage is provided within the reservoirs, it is considered irrelevant to attempt to calculate a peak runoff rate from the basin.

Existing Storm Drain System
No existing storm drainage components have been identified within Basin N.

Present Problems
No present problems have been identified in Basin N.

Future System
No future development is anticipated within the portion of the basin zoned QP-2 as it is the watershed for the area's primary drinking water source. As indicated above in the zoning summary, 13.95 acres zoned R-3 and 16.58 acres zoned I-C are present in Basin N, both undeveloped. If these areas are developed, it is expected that surface runoff would be directed to the north into Basin L in order to protect the drinking water source. This would change the boundaries of Basins L and N in the area of potential development. For the purpose of modeling, we have indicated an increase in runoff from the basin due to development, although it should be understood that the post-development runoff would occur by a different path than it presently does. If all the available land is fully developed, it is estimated that a maximum total of 128 new EDU's may be added within Basin N.

6.1.15 Basin O

Basin O encompasses approximately 151 acres along Ocean Boulevard between Butler Road and the Coos Bay-North Bend Water Board office. The basin extends north to Cottonwood Road and south to an east-west trending ridgeline approximately 2,000 feet south of Ocean Boulevard. Runoff generally occurs to the west within Basin O with the final outlet being a 48-inch CMP culvert beneath Ocean Boulevard approximately 600 feet west of the Woodland Drive intersection.

Soil Type
Bullards Sandy Loam (Map Units 8C and 8E)
Gelsel Silt Loam (Map Unit 26C)
Templeton Silt Loam (Map Unit 54D)

Slope
2-50%

Current Zoning
70.07 Acres – Single Family Residential (R-1)
19.45 Acres – Single Family/Duplex Residential (R-2)
20.31 Acres – Residential Professional District (R-4P)
41.14 Acres – Watershed (QP-2)

Peak Runoff

	Subbasin 1	Subbasin 2	Subbasin 3	Subbasin 4
25-Year Storm (Exist.)	12.76 cfs	14.03 cfs	19.65 cfs	9.97 cfs
50-Year Storm (Exist.)	14.52 cfs	15.92 cfs	24.78 cfs	11.54 cfs
25-Year Storm (Future)	12.76 cfs	14.03 cfs	25.78 cfs	9.97 cfs
50-Year Storm (Future)	14.52 cfs	15.92 cfs	31.48 cfs	11.54 cfs

Existing Storm Drain System
<u>Subbasin 1</u> – Piping within Subbasin 1 includes an 8-inch storm drain along Woodland Drive northwest of 20th Street and a 10-inch storm drain within 20th Street from Woodland Drive north to Juniper Avenue. The pipes join west of the intersection of Woodland Drive and 20th Street and then a 12-inch storm drain crosses to the south side of Ocean Boulevard and ties into a 48-inch CMP culvert which discharges into an unnamed tributary of Pony Creek about 750 feet west of 19th Street.

<u>Subbasin 2</u> – Piping within Subbasin 2 includes an 18-inch storm drain along Juniper Avenue which turns south along 19th Street and ties into a 36-inch pipe that crosses Ocean Boulevard. This system also ties into the 48-inch CMP culvert along the south side of Ocean Boulevard.

<u>Subbasin 3</u> – Piping within Subbasin 3 serves the subdivision along Timberline and Evergreen Drives. It includes approximately 1,024 feet of 24-inch diameter CMP, 292 feet of 21-inch, 215 feet of 15-inch, and about 450 feet of 12-inch storm drain piping. This system includes a 24-inch CMP outfall which discharges into an unnamed creek adjacent to the described 48-inch culvert.

<u>Subbasin 4</u> – Piping within Subbasin 4 serves the West Hills subdivision and includes a 111-foot long 12-inch diameter outfall, 756 feet of 10-inch, and approximately 840 feet of 8-inch storm drain piping. This system discharges into an unnamed creek upstream from the above described 48-inch culvert.

Present Problems

Subbasin 1 – The 12-inch storm drain (assumed to be CMP) which crosses Ocean Boulevard and ties into the described 48-inch CMP culvert is undersized to handle calculated peak flows generated by the 25 and 50-year design storms. Based on ground contour information, it is estimated that the 12-inch pipe is laid at a slope in the range of 5.5% to 6%. The full flow capacity of a 12-inch CMP storm drain at 6% slope is approximately 4.7 cfs. Due to the slope, a significant increase in capacity may occur when the pipe becomes surcharged. It is recommended that when the pipe needs replacement minimum 15-inch HDPE pipe be used.

Subbasin 2 – All of the storm drain piping within Subbasin 2 appears to be adequately sized to handle the calculated peak runoff generated by the 25 and 50-year design storms.

Subbasin 3 – As described on the previous page, the existing storm drain piping within Subbasin 3 includes a 24-inch diameter CMP storm drain mainline. The 24-inch pipe is estimated to be laid at a slope of approximately 3.6% and have a full flow capacity of about 23.31 cfs. The storm drain is sized appropriately to handle the calculated peak runoff under existing conditions.

Subbasin 4 – The 12-inch outfall pipe that serves Subbasin 4 appears to be slightly undersized to handle the calculated peak flows generated by the 25 and 50-year design storms. The outfall pipe material is uncertain but it is estimated that the pipe is laid at 3% to 4% slope. A concrete outfall pipe at 4% slope and flowing full has a capacity of approximately 7.14 cfs, while a CMP outfall at 4% slope has a capacity of approximately 3.87 cfs. The existing outfall pipe may surcharge at times during sustained heavy rains. It is recommended that when the outfall needs replacement minimum 12-inch HDPE pipe be used.

Future System

Subbasins 1, 2, and 4 of Basin O are built out and will not include any additional development. Significant development is presently occurring within Subbasin 3. The development will include approximately 1.9 acres of new paved roadways, 1.0 acre of new apartments, and about 11.6 acres of new 1/4 acre residential lots. Storm drainage from the new developments will be tied into existing drainage facilities. Our calculations indicate that the peak runoff, when the basin is fully developed, will slightly exceed the capacity of the existing 24-inch CMP outfall pipe. It is recommended that the existing CMP piping be lined with 22-inch O.D. smooth wall HDPE pipe to increase capacity and extend the useful life of the pipe. Alternatively, new 24-inch HDPE storm drain piping may be placed. Based on the above development description, it is estimated that a total of 54 new EDU’s are estimated within Basin O.

6.1.16 Basin P

Basin P occupies approximately 155 acres of primarily undeveloped land in Eastside. The basin is bounded on the north by the Marshfield Channel, on the west by Isthmus Slough, on the east by 2nd Avenue, and on the south by a slight rise in the terrain approximately 600 feet north of D Street. No storm drainage piping is present within Basin P.

Soil Type
Udorthents (Map Unit 57)
Wintley Silt Loam (Map Units 63B and 63C)

Slope
0-15%

Current Zoning
52.59 Acres – Single Family/Duplex Residential (R-2)
6.00 Acres – Multiple Residential (R-3)
41.07 Acres – Restricted Waterfront Residential (R-W)
4.11 Acres – General Commercial (C-2)
3.22 Acres – Park/Cemetery (QP-1)
1.01 Acres – Public Education Facilities (QP-3)
3.25 Acres – Urban Water Dependent (UW)

Peak Runoff

25-Year Storm (Exist.)	36.62 cfs
50-Year Storm (Exist.)	44.97 cfs
25-Year Storm (Future)	111.4 cfs
50-Year Storm (Future)	128.3 cfs

Existing Storm Drain System
No storm drainage piping is present within Basin P.

Present Problems
None.

Future System
Approximately 92 acres of undeveloped land within Basin P falls within the future planned development owned by the Port of Coos Bay. The Port's master plan for the property includes single family and multiple family housing areas, a commercial area, a marina, an RV and boat storage yard, and recreational trails. If developed, the area would require that new storm drainage be provided. Due to its location adjacent to the slough, it is assumed that stormwater would be piped or pumped directly to the slough and there would not be any impact on existing storm drainage facilities.

The future runoff volumes have been calculated using the following assumptions. The 92 acres of undeveloped land described above, when developed, would include 20 acres of paved streets, 65 acres of small lot and multi-family residential, a 4-acre commercial district, and 3 acres of parks and open space. An estimated 25-minute time of concentration also has been used in the model of future conditions. Based on the above description of potential future development, a total of 503 new EDU's are estimated within Basin P.

6.1.17 Basin Q

Basin Q occupies approximately 126 acres of primarily undeveloped land in Eastside. Basin Q is bounded on the north by the Marshfield Channel, on the south by D Street, on the east by 9th Avenue, and on the west by 2nd and 4th Avenues. Runoff from Basin Q generally occurs to the north. No storm drainage piping is present within Basin Q.

Soil Type
Gelsel Silt Loam (Map Unit 26C)
Templeton Silt Loam (Map Unit 54E)
Udorthents (Map Unit 57)
Wintley Silt Loam (Map Units 63B and 63C)

Slope
0-50%

Current Zoning
2.82 Acres – Single Family/Duplex Residential (R-2)
11.11 Acres – Multiple Residential (R-3)
2.34 Acres – General Commercial (C-2)
64.28 Acres – Industrial-Commercial (I-C)
4.42 Acres – Park/Cemetery (QP-1)
7.68 Acres – Public Education Facility (QP-3)
3.79 Acres – Buffer (QP-5)
25.37 Acres – Reserved for Future Planning (RFP)

Peak Runoff

25-Year Storm (Exist.)	35.78 cfs
50-Year Storm (Exist.)	43.19 cfs
25-Year Storm (Future)	72.05 cfs
50-Year Storm (Future)	84.28 cfs

Existing Storm Drain System
No storm drainage piping is present within Basin Q. Runoff from Basin Q occurs over the ground surface and generally trends to the north.

Present Problems
None.

Future System
Some future development is possible on approximately 40 acres of undeveloped land zoned I-C and located northerly of the old wastewater treatment plant. Ponds and wetlands occupy the remaining 20 acres of land zoned I-C and are not considered developable. Additionally, there are approximately 10 acres of undeveloped land zoned RFP that could be developed. If developed, these areas would most likely be drained directly to the Bay and would not impact any existing storm drainage facilities.

In order to calculate future runoff volumes we have assumed that 40 acres of undeveloped land zoned I-C would be developed with approximately half the area including paved access and equipment yards, and the other half having gravel access and equipment yards. An estimated 25-minute time of concentration also has been used in the model of future conditions. Based on the anticipated future development, a total of 155 new EDU's are estimated within Basin Q.

6.1.18 Basin R

Basin R occupies approximately 60 acres around the Eastside Boat Ramp. The basin is generally bounded on the east by 2nd Avenue, on the south and west by Isthmus Slough, and on the north by a rise in the terrain approximately 600 feet north of D Street. Drainage generally occurs to the south and west.

Soil Type
Udorthents (Map Unit 57)
Wintley Silt Loam (Map Units 63B and 63C)

Slope
0-15%

Current Zoning
11.69 Acres – Single Family/Duplex Residential (R-2)
18.26 Acres – Multiple Residential (R-3)
2.27 Acres – Restricted Waterfront Residential (R-W)
1.87 Acres – Waterfront Industrial (W-I)
13.97 Acres – Park/Cemetery (QP-1)
7.36 Acres – Urban Water Dependent (UW)

Peak Runoff

25-Year Storm (Exist.)	17.78 cfs
50-Year Storm (Exist.)	21.34 cfs
25-Year Storm (Future)	37.70 cfs
50-Year Storm (Future)	44.10 cfs

Existing Storm Drain System
Storm drainage includes about 1,060 feet of 24-inch CMP with an outfall approximately 400 feet east of the boat ramp. The pipe runs northeast from the outfall to a point approximately 100 feet north of the intersection of Whitty and D Streets. A 12-inch PVC storm drain also is present along the southern 150 feet of Whitty Street and discharges directly into Isthmus Slough.

Present Problems
No capacity problems have been identified with the existing storm drains in Basin R. The 12-inch storm drain on Whitty Street has a CMP flume below the end of the pipe to prevent erosion. The flume pipe is deteriorated and should be replaced.

Future System
Approximately 12.4 acres of vacant land located north of the boat ramp is zoned R-2 and R-W and likely will be developed in the future. This land is part of a larger land holding of the Port of Coos Bay. As described under the Basin P summary, the Port has a master plan for the property which includes single and multiple family housing areas as well as a commercial area and other uses. It is expected that storm drainage will be designed serve the potential development. Runoff likely will be discharged directly into the slough.

In order to calculate future peak runoff from Basin R we have assumed that the described 12.4 acres when developed would include 2.4 acres of paved streets and 10.0 acres of small lot residential. A time of concentration of 20 minutes also has been used for modeling purposes. Based on the anticipated future development, a total of 73 new EDU’s are estimated within Basin R.

6.1.19 Basin S

Basin S occupies a total of approximately 148 acres in the central portion of Eastside. The basin is generally bounded by D Street on the north, by a ridgeline south of I Street on the south, by Isthmus Slough on the west, and by 14th Avenue on the east. Runoff in Basin S generally is to the west.

Soil Type
Gelsel Silt Loam (Map Units 26C, 26D, and 26E)
Templeton Silt Loam (Map Unit 54B)
Udorthents (Map Unit 57)
Wintley Silt Loam (Map Units 63B and 63C)

Slope
0-50%

Current Zoning
31.56 Acres – Single Family/Duplex Residential (R-2)
44.59 Acres – Multiple Residential (R-3)
18.47 Acres – Residential Professional District (R-4P)
17.18 Acres – General Commercial (C-2)
13.10 Acres – Waterfront Industrial (W-I)
2.04 Acres – Park/Cemetery (QP-1)
8.60 Acres – Public Education Facilities (QP-3)

Peak Runoff

	Subbasin 1	Overall
25-Year Storm (Exist.)	12.73 cfs	123.3 cfs
50-Year Storm (Exist.)	14.84 cfs	140.9 cfs
25-Year Storm (Future)	12.73 cfs	123.3 cfs
50-Year Storm (Future)	14.84 cfs	140.9 cfs

Existing Storm Drain System
The primary storm drainage system in Basin S is along F Street east of 9th Avenue. The system includes a 15-inch HDPE outfall pipe on the west side of 9th Avenue approximately 250 feet south of F Street. The 15-inch storm drain extends north along 9th Avenue and then turns east along F Street to 12th Avenue, at which point it reduces to 12-inch piping. The 12-inch piping extends east to 14th Avenue and then 10-inch piping continues south along 14th Avenue approximately 350 feet. F Street has been overlaid in the recent past and new curbs and gutters also have been constructed. Catch basins are present at almost every block tying into the described storm drain.

Present Problems
Due to the relatively steep slope along F Street and the limited area served by the system, the storm drain piping within Basin S appears to be adequately sized to handle the peak runoff generated by the 25 and 50-year design storms.

Future System
Basin S is essentially built out within the City Limits. The steep terrain within much of the basin renders certain areas unsuitable for development. There are two parcels on the southeast corner of the Coos River Highway and I Street, totaling approximately 38 acres, that may be able to be subdivided in the future. The parcels lie outside of the current City Limits and have not been considered herein. Runoff from the northerly 5 acres of these parcels occurs to the north, into the City, and should be analyzed if developed.

6.1.20 Basin T

Basin T occupies a total of approximately 296 acres in the eastern portion of Eastside. The basin is generally bounded by Catching Slough on the north and east, and I Street on the south. The westerly boundary ranges from 14th Avenue to about 10th Avenue. The southern half of the basin includes a hilly area south of the Coos River Highway between about 10th Avenue and the Catching Slough bridge. The northern half of the basin includes tide flats on the north side of the Coos River Highway.

Soil Type
Coquille Silt Loam (Map Unit 12)
Fluvaquents-Histosols Complex (Map Unit 23)
Gelsel Silt Loam (Map Units 26D & 26E)

Slope
0-50%

Current Zoning
88.29 Acres – Single Family/Duplex Residential (R-2)
11.64 Acres – Multiple Residential (R-3)
58.09 Acres – Industrial-Commercial (I-C)
11.29 Acres – Waterfront Industrial (W-I)
0.49 Acre – Park/Cemetery (QP-1)
1.57 Acres – Buffer (QP-5)

Peak Runoff

25-Year Storm (Exist.)	47.62 cfs
50-Year Storm (Exist.)	57.88 cfs
25-Year Storm (Future)	48.01 cfs
50-Year Storm (Future)	58.31 cfs

Existing Storm Drain System
With the exception of a number of culverts at locations where streets or driveways cross streams or drainage ditches, no storm drainage piping is present within Basin P. The primary drainage within the southern half of the basin occurs on the ground surface. An unnamed stream is present running south to north approximately 200 feet west of 16th Avenue south of the Coos River Highway. The stream crosses beneath the highway via a culvert located approximately 50 feet west of 16th Avenue. It is presumed that this culvert is under the jurisdiction of the Oregon Department of Transportation.

Present Problems
No present problems have been identified.

Future System
The southern half of Basin T is nearly built out at this time. The steep terrain in this portion of the basin renders some areas unsuitable for development. Some vacant residential parcels are available at various locations. Additionally, one platted, undeveloped block remains on the north side of I Street between 15th and 16th Avenues. This block includes approximately 2.26 acres that could be developed into approximate 1/3 acre residential lots. It also is expected that approximately 0.71 acres of new paved roadway would be constructed along with development of the lots. This development would account for 7 new EDU's within Basin T.

6.1.21 Basin U

Basin U occupies approximately 56 acres along Ross Slough Road south of the Coos River Highway. The basin is bounded on the north and west by a ridgeline along 18th Avenue which extends down to the highway near the west end of the Catching Slough bridge. It is bounded on the east by Catching Slough and on the south by a ridgeline that extends from a point approximately 550 feet south of I Street at 16th Avenue down to the slough approximately 1,800 feet south of the highway. The basin generally includes steep forested hillsides and about a dozen homes on larger residential lots.

Soil Type
Coquille Silt Loam (Map Unit 12)
Templeton Silt Loam (Map Unit 54F)

Slope
0-70%

Current Zoning
26.72 Acres – Single Family/Duplex Residential (R-2)
7.93 Acres – Rural Shoreland (RS)

Peak Runoff

25-Year Storm (Exist.)	16.29 cfs
50-Year Storm (Exist.)	20.86 cfs
25-Year Storm (Future)	16.29 cfs
50-Year Storm (Future)	20.86 cfs

Existing Storm Drain System
With the exception of a couple of culverts where unnamed streams cross Ross Slough Road, no storm drainage piping is present within Basin U.

Present Problems
No problems have been identified in Basin U.

Future System
Due to the steep terrain, no future development is anticipated in Basin U. Most of the basin is zoned R-2 but significant effort would be required to access any areas suitable for home site development that have not already been developed.

7.0 Basis of Planning

All planning and recommendations must be founded on established and accepted principals, methodologies, and regulations. This section shall establish the methods and principals that will be utilized to prepare and analyze improvement alternatives as well as make final recommendations for improvements.

7.1 Design Criteria

Design criteria for future stormwater conveyance system expansions are based on topography, available and undeveloped land within the storm drainage basin, the existing UGB, and estimated peak flows based on the design storm. Sizing of facilities will be dominated by the anticipated build-out conditions within each storm drainage basin to ensure that the conveyance system has capacity for estimated peak flows.

General design considerations incorporated into the development of alternatives and, ultimately, the final recommendations are discussed below.

7.1.1 Design Period

The design period must be long enough to ensure the new facilities will be adequate for future needs, but short enough to ensure that the facilities are effectively utilized within their economic and practical life.

Storm drainage system planning for piping and conduits will be based on ultimate build-out within the current UGB with considerations for existing and anticipated flows from areas outside of the UGB where applicable. If the UGB is expanded within the planning period, additional planning and analysis will be required for any areas annexed.

7.1.2 Storm Drain & Culvert Design

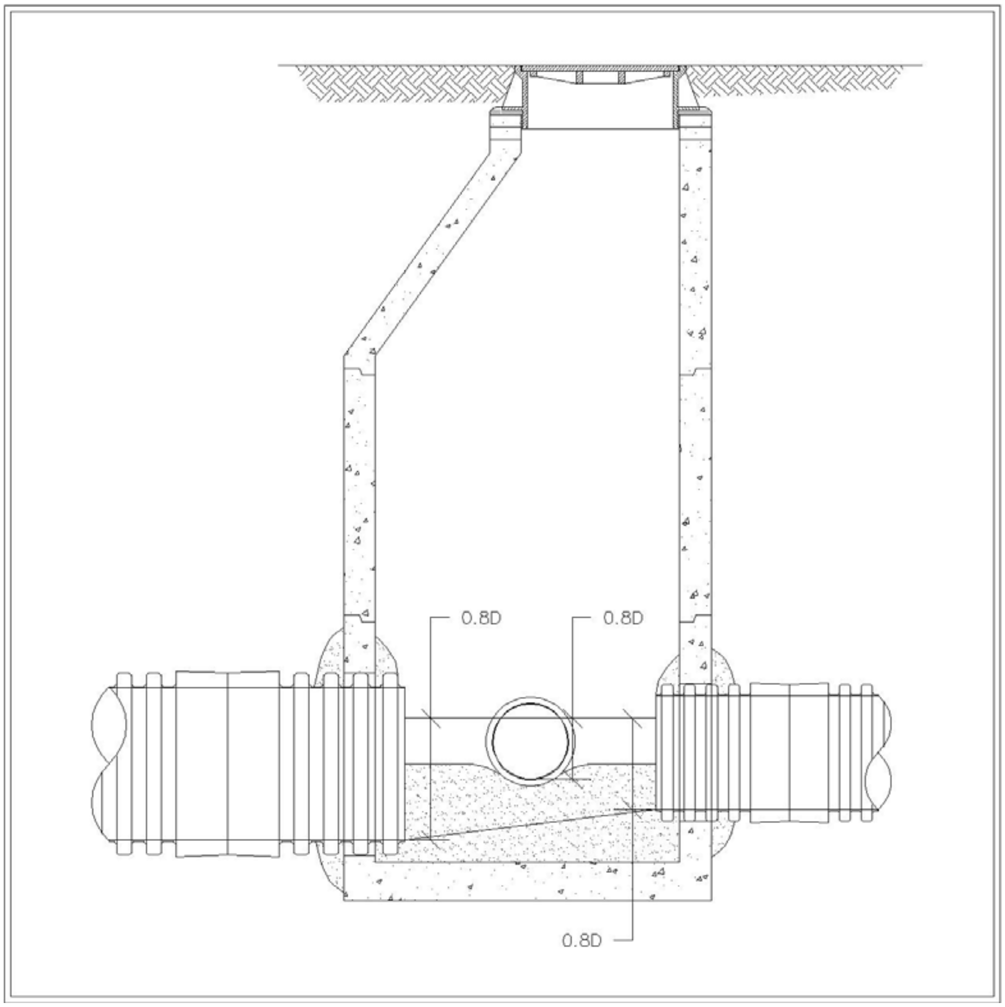
Stormwater conveyance systems should be designed considering natural ground slope, subsurface conditions, capacity requirements, minimum slope considerations, and minimum flow velocities required to maintain solids suspension. Whenever possible, gravity stormwater conveyance systems should be utilized rather than systems that require a pump station.

Stormwater conveyance systems should be designed for the ultimate build-out of a storm drainage basin, taking into account zoning and UGB limitations. This will ensure that the piping is adequate for practically any type and amount of development that may occur within the basin.

The minimum diameter of storm drains should be 10-inches. Smaller pipes are difficult to clean or maintain using modern cleaning, TV-inspection, and repair equipment. Pipe diameter sizing should be based on anticipated flows and master planning, not minimum slope considerations.

Manholes should be spaced no more than 500 feet apart for storm drains up to 24-inches in diameter. Manholes should also be constructed where alignment, slope, or pipe size changes occur. To facilitate self cleaning, a “drop” or elevation change should occur from the inlet side of the manhole to the outlet and should be required to be incorporated into the manhole base. Flow channels in manholes should include a minimum 0.2-foot drop when the flow is straight through the manhole. If a manhole is constructed with a channel where the flow direction changes by 90-degrees with piping of the same size, the channel should include a base with a drop of 0.4-feet between the inlet and outlet pipes. Where manholes join pipes of more than one size, all incoming pipes should be elevated such that the point 0.8 times the diameter above the invert of the incoming pipe is equal to or higher than the point 0.8 times the diameter above the invert of the largest (exiting) pipe. See the diagram below for clarity.

Figure 7-1 – Storm Drain Pipe Elevation Details



Manholes should have a minimum inside diameter of 48-inches at the bottom and have a standard 23-inch manhole access opening and lid. Manholes located in areas where flooding is expected should have bolt down lids to prevent lids from being lifted off by rising water.

Flat top manholes should be utilized for all manhole installations under 6-feet. Otherwise, standard eccentric cone type manholes should be used. New manholes in Coos Bay should not be provided with integrated ladders in the manhole sections.

Minimum pipe slopes are established to ensure that flow velocities are high enough to provide a self-cleaning action for the stormwater conveyance piping. Current conventional design practice recommends that a minimum velocity of two feet per second (fps) be achieved regardless of pipe size to maintain a self-cleaning action. It is desirable to have a velocity of 3 fps or more whenever topography and existing conditions allow. Minimum pipe slope for small diameter laterals should be 2-percent or ¼-inch drop per foot.

Standard methods of determining the slope for self-cleaning velocities are based on pipes flowing at least half-full. Where flows are expected to be less than half-full and adequate grade (topography) exists, a slope should be used that will provide velocities of three fps for full or half full pipes. In general, minimum pipe slopes should be established based on the information in Table 7.1.2.

Table 7.1.2 – Recommended Slopes for Storm Drains (ft/ft)
(Based on a Manning's 'n' of 0.013)

Nominal Pipe Diameter (in)	Minimum Slope (2 fps)	Recommended Slope (3 fps)
10	0.0025	0.0055
12	0.0019	0.0044
15	0.0014	0.0032
18	0.0011	0.0025
21	0.0009	0.0021
24	0.0008	0.0017
27	0.0007	0.0015
30	0.0006	0.0013
36	0.0004	0.0010
42	0.0004	0.0008
48	0.0003	0.0007
60	0.0002	0.0005

While the information in the table above provides the theoretical slopes to attain 2 fps or 3 fps for various pipe sizes, it is not usually considered practical to construct a gravity pipeline at a slope less than 0.2%. Therefore, while pipes larger than 12-inch could be placed at a flatter slope, practical application will result in pipes with higher capacities and flow velocities than if they were placed at the minimum slopes presented above.

7.1.3 Storm Drain Pipe Materials

Traditional materials used in manufacturing pipe and conduits such as ceramics, concrete and metals are being increasingly replaced by pipes made from plastics, which are lighter weight, less expensive, more resistant to corrosion, and have superior flow characteristics. Plastic pipes used for municipal infrastructure improvements are predominantly made from polyethylene or polyvinyl chloride (PVC). Double walled high density polyethylene (HDPE) pipes, having a corrugated exterior and smooth interior, are commonly used in municipal stormwater applications. These pipes offer superior strength and corrosion resistance compared to corrugated metal pipe (CMP) products, and improved hydraulic performance when compared to both CMP and concrete.

Smooth walled rigid plastic pipe (HDPE or PVC) is frequently used to line existing conduits, such as CMP culverts. Although the insertion of a liner within an existing pipe decreases the internal diameter of the conduit, additional capacity is often achieved due to the improved hydraulic performance of the plastic pipe. Therefore, it is frequently desirable to line existing pipes with rigid plastic liners prior to structural failure of the existing pipe. Significant cost savings can be achieved by lining rather than removing and replacing existing pipes.

It is generally touted by plastic pipe manufacturers that a service life of 50 years or more can be expected with plastic pipes. In Technical Release TR-43/2003 "Design Service Life of Corrugated HDPE Pipe" published by the Plastics Pipe Institute, it is concluded, "There is considerable supporting justification for assuming a 100-year or greater design service life for corrugated polyethylene pipe, when properly used and reasonably well installed." The publication describes case studies on corrugated polyethylene pipe measuring tensile strength, elasticity, chemical resistance, and abrasion resistance that support the conclusion stated above. It is also clear in bulletins published by the American Concrete Pipe Association that HDPE storm drain pipe must be properly installed in order to achieve a long service life. The ACPA has recorded numerous cases where HDPE storm drain pipes have failed or deflected significantly within a few years of installation.

For most of the projects within the City of Coos Bay it is expected that double walled HDPE storm drain piping will be preferred due to the relatively low installation costs and their performance characteristics. For projects where pipe lining can be utilized, rigid HDPE or PVC pipe is recommended.

7.2 Basis for Cost Estimate

The construction cost estimates presented in this Plan will include a number of basic components, each of which is discussed in the following sections. The estimates presented are preliminary and are based on the level of detail and planning presented in the Master Plan. As projects proceed and as site specific and new information becomes available, the estimates should be reviewed and updated.

7.2.1 Construction Costs

Construction costs are estimated using a combination of engineering experience with similar past projects, material cost data provided by equipment suppliers, and material and labor cost estimates and indexes published by such sources as the Engineering News Record and others.

Whenever possible, existing as-built drawings were studied to determine the scope of work required for constructing and implementing improvements to existing facilities. When appropriate, preliminary layouts were developed and utilized when preparing construction cost estimates.

Future changes in the cost of labor, equipment and materials will justify comparable changes in the cost estimates provided in this Plan. For this reason, common engineering practice is to tie planning cost estimates to a construction index which is updated regularly in response to changes in the economy and the construction marketplace.

The Engineering News Record (ENR) construction cost index is the most commonly used for engineering planning and estimating purposes. The ENR index is based on a beginning value of 100 established in the year 1913. Average yearly values for the past 14 years are summarized below in Table 7.2.1.

Table 7.2.1 – ENR Index 1990 to 2005

YEAR	INDEX	% CHANGE/YR
1990	4732	2.54
1991	4835	2.18
1992	4985	3.10
1993	5210	4.51
1994	5408	3.80
1995	5471	1.16
1996	5620	2.72
1997	5825	3.65
1998	5920	1.63
1999	6059	2.35
2000	6221	2.67
2001	6343	1.96
2002	6538	3.07
2003	6694	2.39
2004	7308	9.17
2005 (September)	7518	-
2005 (December)	7647	4.64
	Average Annual Change =	3.22

Cost estimates prepared in this plan are based on the September 2005 index. Future costs should be compared to a baseline ENR Index value of 7,518.

If specific ENR index figures are not available, the historical ENR growth pattern has been around 3% per year.

7.2.2 Contingencies

Contingencies are a prudent inclusion in planning cost estimates to account for unforeseen circumstances that may increase costs. For the purposes of this planning document and the preliminary cost estimates provided, a contingency amount between 15 and 25 percent of the estimated construction cost is used depending on the available information, number of unknowns, and other potential unknown factors that could affect the final project costs. After design work is completed for a project and updated construction cost estimates are completed, contingency is typically reduced to 10% for estimates used immediately prior to construction.

While efforts have been made to provide costs for all facets of the proposed projects, it is appropriate that allowances be made for variations in the final design, bidding market conditions, adverse construction conditions, unanticipated specialized investigation and studies, and other difficulties which cannot be foreseen at this time but may tend to increase the final costs of the proposed projects.

7.2.3 Engineering

The cost of engineering services for major capital improvement projects typically include surveying, foundation explorations, preparation of contract documents and project drawings, development of construction and material specifications, bidding services, construction management, inspection, construction staking, start up services, and the preparation of operation and maintenance manuals.

Depending on the size and type of the project and the required scope of engineering services, engineering costs may range between 18 to 25 percent.

In some cases, additional engineering or technical services may be required such as flow studies, predesign reports, environmental reports or others. These additional services would typically be in addition to the regular engineering services covering surveying, design, bidding, construction management, and construction inspection.

For the purposes of conservative planning, the cost estimates prepared in this Master Plan assume that all projects will require a relatively comprehensive and complete scope of engineering services. Therefore, an engineering cost of 20% is assumed for nearly all projects. In the future, if it is determined that some projects will not warrant this level of service, the cost for engineering on those projects can be reduced. On the other hand, smaller and less expensive projects may warrant a higher engineering cost percentage.

7.2.4 Legal and Administrative

Legal and administrative costs include such items as legal counsel review of contracts and contract documents, costs related to obtaining and recording easements and permits, additional city administration expenses occurring during a project, and other miscellaneous legal and administrative costs.

This cost category also includes potential costs for internal budget planning, grant administration, liaison costs, interest on interim loans financing, and other non-construction costs related to the projects.

A cost equal to 3% of the estimated construction cost is used for the estimates in this Plan.

7.2.5 Land Acquisition Costs

Some projects will require the acquisition of land for placement of new piping, pump stations, or other system components when available property is not available on an existing site or within an existing public right-of-way. In some cases, a property owner will require reimbursement for providing an easement across his/her property.

An effort was made in the plan to anticipate and identify which projects would require land or easement acquisition. For these projects, costs have been included for the purchase of additional properties for the improvements.

Property costs can vary depending on location, market volatility, owner’s willingness to sell, and many other factors. In some cases, the City may have to condemn property when an owner is unwilling to sell and no alternative site is available. If needed, the condemnation process also has significant costs associated with it.

When a project is undertaken, the City should review the potential need for land acquisition. If it is determined that additional land is required, the costs for the acquisition of that land should be reviewed and updated based on the land cost climate at the time.

7.2.6 Other Studies and Special Investigations

In some cases, predesign reports, environmental reports, special flow studies, and other investigations may be required prior to beginning actual design activities for a project. These studies may be driven by funding or regulatory agencies or by special needs of a specific project.

An effort has been made to identify projects where these special studies will most likely be required. However, the need for these investigations and studies will be confirmed on a case by case basis throughout the planning period.

7.3 Regulatory Criteria

Planning, design, and construction of stormwater facilities must take into consideration all applicable regulatory criteria. Appropriate coverage of the applicable regulatory issues is provided in the City's Stormwater Master Plan for the east side of the City (Dyer Partnership, 2004, Section 4).

In addition to the information discussed in the 2004 Stormwater Plan, the City should develop a development review process that requires developers to properly study, plan, and design facilities for their development that can handle and appropriately transmit drainage water to an ultimate outlet point.

A sample Drainage System Design Standards Manual has been provided in the Appendix to this Master Plan for the City to use as a basis for establishing a stormwater manual for developers and their engineers. The design manual includes all information and guidelines required for a land developer to meet typical regulatory requirements and ensure that an appropriate level of effort has gone into planning and design of stormwater facilities.

8.0 Development and Evaluation of Projects

8.1 Storm Drain System Piping Projects

Storm drain system piping projects have been developed to address existing capacity deficiencies, maintenance needs, and future development capacity requirements. Alternatives, recommendations, and specific project costs are discussed for each basin in the sections below.

8.1.1 Basin A

The existing storm drain outfall pipe within Basin A is undersized to handle the calculated peak runoff generated by the 25 and 50-year design storms. Although the pipe is undersized, it has not been reported to be a problem in terms of causing street flooding or contributing to flooding on private property. It is likely that the storm drain surcharges during periods of heavy rainfall but not to the extent that significant street flooding results. In order to increase capacity to meet the calculated peak runoff from the 25-year design storm it is recommended that the existing outfall pipe be replaced with a minimum 15-inch diameter double-wall high density polyethylene (HDPE) pipe. Because no nuisance flooding has been reported this project is considered a low priority and should be scheduled when maintenance repairs are undertaken or at the time of any additional connections to the storm drain system.

The outfall pipe was not located during our reconnaissance due to thick brush in its vicinity. The storm drain manhole indicated on the mapping to be at the intersection of Fenwick and St. John Streets also was not located and may have been paved over. Therefore, the material and condition of the existing storm drain at this location has not been determined. It is recommended that a maintenance and evaluation project be scheduled at this location to assess the condition of the existing pipe.

A cost estimate for project B1 is provided below:

Table 8.1.1 – Storm Drain System Project A1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 6,400.00	$ 6,400.00
2	Construction Facilities/Temporary Controls	ls	1	$ 3,800.00	$ 3,800.00
3	15" HDPE Storm Drain Piping	lf	355	$ 110.00	$ 39,050.00
4	Manhole Connection	ea	3	$ 1,000.00	$ 3,000.00
5	AC Pavement Repair/Trench Patching	lf	360	$ 25.00	$ 9,000.00
		Construction Total			$ 61,250.00
		Contingency (20%)			$ 12,250.00
		Subtotal			$ 73,500.00
		Engineering (20%)			$ 14,700.00
		Administrative Costs (3%)			$ 2,205.00
		Total Project Cost			**$ 90,405.00**

8.1.2 Basin B

The existing storm drain outfall pipe in Basin B is undersized for the calculated peak runoff generated by the 25 and 50-year design storms. Although the piping is undersized, it has not been reported to be a problem in terms of causing flooding on streets or private property. It is likely that the storm drain surcharges during periods of heavy rainfall but not to the extent that significant flooding occurs.

Furthermore, the westerly 500 feet of this storm drain is located in an undeveloped area. If surcharging does occur, it is unlikely that it would be noticed. In order to increase capacity to meet the calculated peak runoff rate from the 25-year design storm it is recommended that the existing outfall pipe be replaced with a minimum 24-inch diameter HDPE storm drain pipe. Alternatively, the existing CMP storm drain may be lined with a 24-inch outside diameter (O.D.) HDPE or other rigid plastic pipe to increase capacity and prolong its useful life.

The outfall pipe appears to be in reasonably good shape at this time, although its age is uncertain. The typical life of CMP is on the order of 30 to 35 years. It is recommended that the pipe's condition be monitored periodically in order to plan for maintenance ahead of time. A television inspection of the entire length of the CMP storm drain is recommended at this time.

TV

A cost estimate for project B1 is provided below:

Table 8.1.2 – Storm Drain System Project B1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 7,100.00	$ 7,100.00
2	Construction Facilities/Temporary Controls	ls	1	$ 4,300.00	$ 4,300.00
3	24" O.D. Rigid Pipe Liner	lf	360	$ 130.00	$ 46,800.00
4	SD Manhole Removal & Replacement	ea	1	$ 10,000.00	$ 10,000.00
		Construction Total			$ 68,200.00
		Contingency (20%)			$ 13,640.00
		Subtotal			$ 81,840.00
		Engineering (20%)			$ 16,368.00
		Administrative Costs (3%)			$ 2,455.20
		Total Project Cost			**$ 100,663.20**

8.1.3 Basin C

There is existing storm drain piping within basin C along Norman Avenue from an outfall approximately 350 north of Newmark Avenue extending south to Lund Avenue. The original storm drain along Norman Avenue was installed in about 1977 and consisted of 12-inch concrete pipe. During a road widening project along Newmark Avenue in 2003, the northerly 411 feet of storm drain was replaced with 18-inch HDPE piping, from the manhole on the south side of Newmark Avenue to the outfall. The subsequent 297 feet of 12-inch concrete pipe south of Newmark Avenue is undersized and only able to handle about one-third of the calculated peak runoff at this point as generated by the 25-year design storm. In order to increase capacity, it is recommended that the existing 297 feet of 12-inch concrete pipe extending south from the manhole located on the south side of Newmark Avenue at Norman Avenue be replaced with 18-inch diameter HDPE piping.

Street flooding is considered a moderate possibility on Norman Avenue near Newmark Avenue due to the capacity deficiency of the existing storm drain. If street flooding does occur, it has the potential to impact traffic on both Norman and Newmark Avenues, and cause some property damage in the adjacent apartments.

A cost estimate for project C1 is provided below:

Table 8.1.3 – Storm Drain System Project C1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 5,700.00	$ 5,700.00
2	Construction Facilities/Temporary Controls	ls	1	$ 3,400.00	$ 3,400.00
3	18" HDPE Storm Drain Piping	lf	300	$ 120.00	$ 36,000.00
4	Manhole Connection	ea	2	$ 1,000.00	$ 2,000.00
5	AC Pavement Repair/Trench Patching	lf	300	$ 25.00	$ 7,500.00
		Construction Total			$ 54,600.00
		Contingency (20%)			$ 10,920.00
		Subtotal			$ 65,520.00
		Engineering (20%)			$ 13,104.00
		Administrative Costs (3%)			$ 1,965.60
		Total Project Cost			**$ 80,589.60**

8.1.4 Basin D

Project D1 – An existing storm drain system is present along Lakeshore Drive from Chickses Creek east to Stillwater Avenue. The system includes 18-inch diameter CMP from the outfall at Chickses Creek to Seagate Street and 12-inch pipe thereafter to the east. A 12-inch storm drain also extends south along Seagate Street to Edwards Avenue, and then east to Fenwick Street. Storm drain pipes extending south at Seabreeze Terrace and Morrison Street also tie into the 18-inch storm drain along Lakeshore Drive. Another drainage system is present along Tideview Terrace and Seabreeze Terrace with an outfall pipe daylighting just west of the intersection of Chickses Drive and Tideveiw Terrace. Storm drain piping within this system includes 12 and 15-inch CMP, along with a new 15-inch HDPE outfall pipe.

The 18-inch CMP storm drain piping and outfall within Lakeshore Drive are undersized for the peak runoff generated by the 25 and 50-year design storms. There is a moderate possibility of street flooding along Lakeshore Drive between Chickses Drive and Morrison Street during periods of heavy rainfall due to surcharging of the storm drainage system. It is recommended that the 18-inch piping from the outfall to Morrison Street be replaced with minimum 24-inch HDPE pipe.

A cost estimate for project D1 is provided below:

Table 8.1.4A – Storm Drain System Project D1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 13,000.00	$ 13,000.00
2	Construction Facilities/Temporary Controls	ls	1	$ 7,800.00	$ 7,800.00
3	24" HDPE Storm Drain Piping	lf	625	$ 130.00	$ 81,250.00
4	Manhole Connection	ea	7	$ 1,000.00	$ 7,000.00
5	AC Pavement Repair/Trench Patching	lf	625	$ 25.00	$ 15,625.00
		Construction Total			$ 124,675.00
		Contingency (20%)			$ 24,935.00
		Subtotal			$ 149,610.00
		Engineering (20%)			$ 29,922.00
		Administrative Costs (3%)			$ 4,488.30
		Total Project Cost			**$ 184,020.30**

Project D2 – Storm drain piping along Tideview and Seabreeze Terraces is adequately sized to serve the area drained. At present, there is an area of disturbance in the pavement along Seabreeze Terrace just north of Lakeshore Drive suggesting that there may be a problem along the existing 12-inch CMP storm drain. A television inspection of the pipe should be performed to determine if a problem exists.

All the storm drain piping along Tideview and Seabreeze Terraces as well as Lakeshore Drive was installed in 1979 and is expected to be nearing the end of its useful life. Television inspections should be performed on all piping in this area to determine the state of deterioration. It is assumed that by the end of the planning period all the piping will need to be replaced or lined.

The following improvements are recommended. The 18-inch CMP storm drain piping along Lakeshore Drive from Morrison Street to Seabreeze Terrace should be slip lined with 18-inch outside diameter smooth wall HDPE pipe. The 15-inch CMP storm drain along Tideview Terrace and Lake Court should be lined with 14-inch outside diameter HDPE pipe and the remaining void grouted. The 12-inch CMP storm drain piping along Tideview Terrace and the north half of Seabreeze Terrace should be lined with 12-inch O.D. HDPE pipe. The 12-inch CMP along the south half of Seabreeze Terrace should be replaced with 12-inch HDPE storm drain pipe.

A cost estimate for project D2 is provided below:

Table 8.1.4B – Storm Drain System Project D2

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 30,550.00	$ 30,550.00
2	Construction Facilities/Temporary Controls	ls	1	$ 18,325.00	$ 18,325.00
3	18" O.D. Rigid Pipe Liner	lf	570	$ 120.00	$ 68,400.00
4	14" O.D. Rigid Pipe Liner	lf	490	$ 110.00	$ 53,900.00
5	12" O.D. Rigid Pipe Liner	lf	485	$ 100.00	$ 48,500.00
6	12" HDPE Storm Drain Pipe	lf	180	$ 100.00	$ 18,000.00
7	SD Manhole Removal & Replacement	ea	4	$ 10,000.00	$ 40,000.00
8	AC Pavement Repair/Trench Patching	lf	625	$ 25.00	$ 15,625.00
		Construction Total			$ 293,300.00
		Contingency (20%)			$ 58,660.00
		Subtotal			$ 351,960.00
		Engineering (20%)			$ 70,392.00
		Administrative Costs (3%)			$ 10,558.80
		Total Project Cost			**$ 432,910.80**

Project D3 – The existing 60-inch CMP culvert which passes beneath Lakeshore Drive at Chickses Creek is estimated to be at least 27 years old at present. Consequently, it is expected to reach the end of its useful life within the planning period. It is anticipated that the Corps of Engineers and Department of State Lands will require that the culvert be replaced with a bottomless arch or box culvert. For planning purposes we will assume that a 95-foot long, 72-inch wide, 42-inch tall concrete box culvert is used. A 72” by 42” box culvert would have approximately equal capacity as that of a 60-inch HDPE pipe.

A cost estimate for project D3 is provided below:

Table 8.1.4C – Storm Drain System Project D3

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 12,800.00	$ 12,800.00
2	Construction Facilities/Temporary Controls	ls	1	$ 7,700.00	$ 7,700.00
3	72" x 42" Concrete Box Culvert	lf	95	$ 350.00	$ 33,250.00
4	Excavation & Backfill	cy	1550	$ 40.00	$ 62,000.00
5	Aggregate Base	cy	50	$ 40.00	$ 2,000.00
6	AC Pavement	ton	50	$ 100.00	$ 5,000.00
		Construction Total			$ 122,750.00
		Contingency (20%)			$ 24,550.00
		Subtotal			$ 147,300.00
		Engineering (20%)			$ 29,460.00
		Administrative Costs (3%)			$ 4,419.00
		Total Project Cost			**$ 181,179.00**

8.1.5 Basin E

No specific storm drain piping deficiencies were identified or projects developed for Basin E.

8.1.6 Basin F

A 12-inch concrete storm drain is present along the north side of Newmark Avenue from Mill Street east to Main Street. Water is discharged into an open ditch on the south side of Newmark west of Mill Street and then passes through a 24-inch concrete culvert that daylights through a tide wall at the west end of Newmark Avenue.

The existing 12-inch concrete storm drain piping along the north side of Newmark Avenue is undersized for the peak runoff generated by the 25 and 50-year design storms. Because Newmark Avenue and South Empire Boulevard make up the Cape Arago Highway (State Highway 240), it is recommended that the 50-year design storm be utilized for sizing of drainage facilities. Based on our calculation of the peak runoff generated by the 50-year design storm, the existing 12-inch concrete pipe should be replaced with minimum 18-inch HDPE pipe between Empire Boulevard and Cammann Street.

A cost estimate for project F1 is provided below:

Table 8.1.6 – Storm Drain System Project F1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 32,300.00	$ 32,300.00
2	Construction Facilities/Temporary Controls	ls	1	$ 19,400.00	$ 19,400.00
3	18" HDPE Storm Drain Piping	lf	1460	$ 120.00	$ 175,200.00
4	Catch Basin Removal & Replacement	ea	10	$ 3,000.00	$ 30,000.00
5	SD Manhole Removal & Replacement	ea	1	$ 10,000.00	$ 10,000.00
6	New SD Manhole	ea	2	$ 6,000.00	$ 12,000.00
7	AC Pavement Repair/Trench Patching	lf	1260	$ 25.00	$ 31,500.00
		Construction Total			$ 310,400.00
		Contingency (20%)			$ 62,080.00
		Subtotal			$ 372,480.00
		Engineering (20%)			$ 74,496.00
		Administrative Costs (3%)			$ 11,174.40
		Total Project Cost			**$ 458,150.40**

8.1.7 Basin G

Basin G encompasses the area drained by the north fork of First Creek and includes four separate storm drain systems within the basin. The storm drain systems are described below.

Subbasin 1 – The first system includes a 24-inch CMP storm drain outfall located on the west side of Madison Street one-half block north of Garfield Avenue. The storm drain extends east to Morrison and the piping transitions to concrete someplace mid-block. At Morrison Street, an 18-inch concrete pipe then extends south to Garfield Avenue where a 10-inch concrete pipe continues south and a 15-inch concrete pipe ties in from the east. The 10-inch pipe extends one block south to Pacific Avenue, transitions to 12-inch concrete, and continues two more blocks to Webster Avenue. The 15-inch pipe extends one block east to Schoneman Street and then a 12-inch pipe extends south from there two blocks to the east end of Arago Avenue.

Subbasin 2 – The second system includes an 18-inch CMP storm drain along Webster Avenue from a point approximately 120 feet west of Fillmore Street to Madison Street. At Madison Street 12-inch pipes extend to the north and south one block each way.

Subbasin 3 – The third system includes a 24-inch HDPE storm drain that daylights within the Fulton Avenue right-of-way approximately 150 feet west of Madison Street. At Madison Street the piping transitions to 15-inch and extends east about 800 feet and then transitions again to 12-inch and continues east to Prefontaine Drive. A 15-inch pipe also ties in from the north at Morrison Street. It extends one block to Blanco Avenue where 12-inch pipe continues east along Blanco approximately 500 feet.

Subbasin 4 – The fourth storm drain system includes 24-inch HDPE piping along Kentucky Avenue from Fillmore Street to the Schoneman Street right-of-way. From there 12-inch pipe continues east to Prefontaine Drive where 12-inch pipes extend north and south about 250 feet and 150 feet, respectively. The outfall for this system is a 24-inch HDPE pipe within the Fillmore Street right-of-way about 100 feet north of Kentucky Avenue.

Recommended Improvements

Subbasin 1 – The primary problems with the existing piping in Basin G are in Subbasin 1. The 24-inch storm drain located between Madison and Morrison Streets one-half block north of Garfield Avenue is undersized to handle the calculated peak runoff generated by the 25 and 50-year design storms. The pipe is estimated to be laid at a slope of 1%, or slightly less. Based on this slope, the CMP portion of the pipe has a capacity of about 12.29 cfs, while the concrete portion of the pipe has a capacity of about 22.68 cfs. The calculated peak runoff at the lowest portion of the subbasin is 61.13 cfs using the 25-year design storm. Based on the calculated peak runoff rate and the apparent pipe capacity it is expected that a storm equal to the 25-year storm would cause significant street flooding in this area as well as some flooding on private property. City personnel have confirmed that this storm drain system has overflowed in the past.

The 18-inch and 10-inch concrete pipes which extend south along Morrison Street upstream of the 24-inch pipe also are undersized for the calculated peak runoff at the respective points in the system. According to our analysis using the 25-year design storm the peak runoff at the respective points in the storm drain system predicts flows of approximately twice the capacity of the 18-inch pipe and about three times the capacity of the 10-inch pipe.

Based on the identified capacity deficiencies the following storm drain piping improvements are recommended. The existing 24-inch pipe from the outfall to the manhole located midway between Madison and Morrison Streets should be replaced with minimum 30-inch HDPE piping, the existing 24-inch pipe from the described manhole to Morrison Street should be replaced with minimum 27-inch HDPE piping, the existing 18-inch pipe should be replaced with minimum 24-inch HDPE piping, and the 10-inch pipe should be replaced with minimum 12-inch HDPE piping.

A cost estimate for project G1 is provided below:

Table 8.1.7A – Storm Drain System Project G1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 20,000.00	$ 20,000.00
2	Construction Facilities/Temporary Controls	ls	1	$ 12,000.00	$ 12,000.00
3	30" HDPE Storm Drain Piping	lf	280	$ 140.00	$ 39,200.00
4	27" HDPE Storm Drain Piping	lf	230	$ 135.00	$ 31,050.00
5	24" HDPE Storm Drain Piping	lf	135	$ 130.00	$ 17,550.00
6	12" HDPE Storm Drain Piping	lf	240	$ 100.00	$ 24,000.00
7	Catch Basin Removal & Replacement	ea	2	$ 3,000.00	$ 6,000.00
8	SD Manhole Removal & Replacement	ea	3	$ 10,000.00	$ 30,000.00
9	AC Pavement Repair/Trench Patching	lf	420	$ 25.00	$ 10,500.00
		Construction Total			$ 190,300.00
		Contingency (20%)			$ 38,060.00
		Subtotal			$ 228,360.00
		Engineering (20%)			$ 45,672.00
		Administrative Costs (3%)			$ 6,850.80
		Total Project Cost			**$ 280,882.80**

Subbasin 2 – A minor capacity problem exists in Subbasin 2 of Basin G. The 18-inch CMP outfall pipe along Webster Avenue west of Fillmore Street is slightly undersized for the calculated peak runoff from the 25-year design storm. Based on ground contours, it is estimated that the pipe is laid at approximately 2.3% slope. Therefore, the calculated full flow capacity of the 18-inch CMP storm drain is 8.65 cfs, approximately two-thirds the peak runoff rate predicted using the 25-year design storm. In order to increase capacity, it is suggested that the CMP outfall pipe be replaced with 18-inch HDPE piping west of Fillmore Street. Capacity requirements would actually be met using minimum 15-inch HDPE pipe.

A cost estimate for project G2 is provided below:

Table 8.1.7B – Storm Drain System Project G2

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 2,400.00	$ 2,400.00
2	Construction Facilities/Temporary Controls	ls	1	$ 1,450.00	$ 1,450.00
3	18" HDPE Storm Drain Piping	lf	140	$ 120.00	$ 16,800.00
4	Manhole Connection	ea	1	$ 1,000.00	$ 1,000.00
5	Gravel Surfacing	cy	40	$ 40.00	$ 1,600.00
		Construction Total			$ 23,250.00
		Contingency (20%)			$ 4,650.00
		Subtotal			$ 27,900.00
		Engineering (20%)			$ 5,580.00
		Administrative Costs (3%)			$ 837.00
		Total Project Cost			**$ 34,317.00**

8.1.8 Basin H

No specific storm drain piping deficiencies were identified or projects developed for Basin H.

8.1.9 Basin I

No specific storm drain piping deficiencies were identified or projects developed for Basin I.

8.1.10 Basin J

The storm drain system in Basin J discharges to Middle Empire Lake through a new 48-inch diameter HDPE pipe that crosses Newmark Avenue approximately 200 feet east of LaClair Street. Storm drainage piping splits on the south side of Newmark Avenue and includes a 24-inch pipe that extends easterly along Newmark and turns south into the Wal Mart property. A 36-inch pipe extends south through a vacant lot, then a 24-inch pipe turns west to LaClair Street, and then 15 and 10-inch piping continues south along LaClair Street.

The existing 15 and 10-inch piping along LaClair Street south of Milligan Avenue are undersized for the peak runoff generated by the 25-year design storm under existing land use conditions. An undeveloped 10.41 acre parcel zoned C-2 is present on the southeast corner of LaClair and Thomas Streets. When developed, a significant increase in the peak runoff volume is expected. In order to meet existing and future peak flow requirements, the existing piping should be replaced with minimum 21-inch HDPE storm drain pipe from Milligan Avenue to Thomas Street, 15-inch HDPE storm drain pipe from Thomas Street to the manhole located on the west side of LaClair approximately 400 feet south of Thomas Street, and 12-inch HDPE pipe from said manhole to the storm drain manhole located on the east side of LaClair approximately 340 feet north of Ocean Boulevard and near the southwest lot corner of the residence addressed 305 LaClair Street.

A cost estimate for project J1 is provided below:

Table 8.1.10 – Storm Drain System Project J1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 13,800.00	$ 13,800.00
2	Construction Facilities/Temporary Controls	ls	1	$ 8,300.00	$ 8,300.00
3	21" HDPE Storm Drain Piping	lf	100	$ 125.00	$ 12,500.00
4	15" HDPE Storm Drain Piping	lf	420	$ 110.00	$ 46,200.00
5	12" HDPE Storm Drain Piping	lf	300	$ 100.00	$ 30,000.00
6	Manhole Connection	ea	8	$ 1,000.00	$ 8,000.00
7	AC Pavement Repair/Trench Patching	lf	550	$ 25.00	$ 13,750.00
		Construction Total			$ 132,550.00
		Contingency (20%)			$ 26,510.00
		Subtotal			$ 159,060.00
		Engineering (20%)			$ 31,812.00
		Administrative Costs (3%)			$ 4,771.80
		Total Project Cost			**$ 195,643.80**

8.1.11 Basin K

Basin K encompasses the area around the junction of Ocean Boulevard and Newmark Avenue extending south to Radar Hill. The basin is further bounded by Main Street on the west and Norman Avenue on the east. Basin K is drained by the east and west forks of Chickses Creek and includes three separate storm drain systems. The storm drain systems are described below.

Subbasin 1 – Piping within Subbasin 1 includes a 30-inch CMP outfall located approximately 250 feet north of Newmark Avenue and about 170 feet west of Schoneman Street. The 30-inch pipe extends south to the intersection of Newmark and Schoneman and then 18-inch piping continues south along Schoneman to Flanagan Avenue. Two pipes tie into the storm drain at Salmon Avenue, a 10-inch pipe from the west, and a 15-inch pipe from the east.

Subbasin 2 – Piping within Subbasin 2 includes a 30-inch CMP outfall located approximately 250 feet north of Newmark Avenue next to the Nancy Devereux Center (1200 Newmark Avenue). The 30-inch pipe extends south to Newmark Avenue, and then ties into storm drain piping along the south edge of Ocean Boulevard which extends to LaClair Street. The piping configuration at the intersection of Ocean Boulevard and Newmark Avenue is uncertain due to incomplete records in this area. Piping along Ocean Boulevard includes about 150 feet of 21-inch piping, 1,120 feet of 18-inch pipe, 920 feet of 15-inch pipe, and 600 feet of 12-inch pipe. Storm drains also tie in from the south at Wallace Street and Radar Road.

Subbasin 3 – Piping within Subbasin 3 includes a 21-inch CMP outfall located on the west side of Ackerman Street approximately 450 feet north of Newmark Avenue. The 21-inch pipe extends about 150 feet south along Ackerman Street, transitions to 18-inch pipe and continues south to Newmark Avenue, turns east along the south side of Newmark and extends to Wallace Street, and then extends about 400 feet south along Wallace Street.

The existing 21 and 30-inch diameter CMP outfalls within Basin K are undersized for the peak runoff generated by the 25 and 50-year design storms under gravity flow conditions. In each case, the pipes are situated relatively deep and several feet of surcharge could occur before water would begin to pond on the ground surface. Because each of the pipes crosses Newmark Avenue (and the Subbasin 2 pipe also crosses Ocean Boulevard) it is recommended that they be sized using the 50-year design storm.

Recommended Improvements

Subbasin 1 – The 30-inch diameter CMP storm drain which extends from behind the restaurant addressed 1088 Newmark Avenue east to Schoneman Street, and then south to the intersection of Schoneman and Newmark should be replaced with minimum 30-inch HDPE storm drain piping. New 30-inch HDPE storm drain piping should be continued south to the intersection of Schoneman Street and Salmon Avenue. From Salmon Avenue south to Maryland Avenue 27-inch HDPE storm drain piping should be used. South of Maryland Avenue to Flanagan Avenue the existing piping should be replaced with 18-inch HDPE storm drain pipe. New catch basins should be installed at the intersection of Schoneman Street and Newmark Avenue.

A cost estimate for project K1 is provided below:

Table 8.1.11A – Storm Drain System Project K1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 39,300.00	$ 39,300.00
2	Construction Facilities/Temporary Controls	ls	1	$ 23,600.00	$ 23,600.00
3	30" HDPE Storm Drain Piping	lf	725	$ 140.00	$ 101,500.00
4	27" HDPE Storm Drain Piping	lf	590	$ 135.00	$ 79,650.00
5	18" HDPE Storm Drain Piping	lf	510	$ 120.00	$ 61,200.00
6	Catch Basin Removal & Replacement	ea	4	$ 3,000.00	$ 12,000.00
7	Manhole Connection	ea	15	$ 1,000.00	$ 15,000.00
8	AC Pavement Repair/Trench Patching	lf	1800	$ 25.00	$ 45,000.00
		Construction Total			$ 377,250.00
		Contingency (20%)			$ 75,450.00
		Subtotal			$ 452,700.00
		Engineering (20%)			$ 90,540.00
		Administrative Costs (3%)			$ 13,581.00
		Total Project Cost			**$ 556,821.00**

Subbasin 2 – The existing 30-inch diameter CMP storm drain which has its outfall behind 1200 Newmark Avenue and extends to the south side of Ocean Boulevard at Newmark should be replaced with minimum 30-inch HDPE storm drain piping. New 30-inch HDPE should continue along the south side of Ocean Boulevard to the catch basin located in front of the business addressed 1275 Ocean Boulevard. From that point, 27-inch HDPE piping should be placed to the catch basin located near the northeast corner of the site addressed 1293 Ocean Boulevard. From the described catch basin to the storm drain manhole at Wallace Street, existing piping should be replaced with 24-inch HDPE storm drain pipe. New 21-inch HDPE pipe then should be installed from Wallace Street to Radar Road.

The recommended improvements should be considered a Priority 2 project as there is a reasonable risk of flooding on two major arterial streets as a result of rainfall exceeding the 25-year design storm. The risk of flood damage occurring to private property is slight.

A cost estimate for project K2 is provided below:

Table 8.1.11B – Storm Drain System Project K2

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 46,100.00	$ 46,100.00
2	Construction Facilities/Temporary Controls	ls	1	$ 27,700.00	$ 27,700.00
3	30" HDPE Storm Drain Piping	lf	710	$ 140.00	$ 99,400.00
4	27" HDPE Storm Drain Piping	lf	150	$ 135.00	$ 20,250.00
5	24" HDPE Storm Drain Piping	lf	410	$ 130.00	$ 53,300.00
6	21" HDPE Storm Drain Piping	lf	570	$ 125.00	$ 71,250.00
7	Catch Basin Removal & Replacement	ea	7	$ 3,000.00	$ 21,000.00
8	New SD Manhole	ea	6	$ 10,000.00	$ 60,000.00
9	AC Pavement Repair/Trench Patching	lf	1750	$ 25.00	$ 43,750.00
		Construction Total			$ 442,750.00
		Contingency (20%)			$ 88,550.00
		Subtotal			$ 531,300.00
		Engineering (20%)			$ 106,260.00
		Administrative Costs (3%)			$ 15,939.00
		Total Project Cost			**$ 653,499.00**

Subbasin 3 – The existing 21-inch diameter CMP storm drain, which discharges into the easterly fork of Chickses Creek on the west side of Ackerman Street approximately 450 feet north of Newmark Avenue, should be replaced with minimum 21-inch HDPE pipe from the outfall to the storm drain manhole located on the east side of Ackerman approximately 300 feet north of Newmark. The existing 18-inch piping along the east side of Ackerman Street should be replaced with 18-inch HDPE pipe from the described manhole and extending south to the south side of Newmark Avenue.

A cost estimate for project K3 is provided below:

Table 8.1.11C – Storm Drain System Project K3

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 11,800.00	$ 11,800.00
2	Construction Facilities/Temporary Controls	ls	1	$ 7,100.00	$ 7,100.00
3	21" HDPE Storm Drain Piping	lf	200	$ 125.00	$ 25,000.00
4	18" HDPE Storm Drain Piping	lf	400	$ 120.00	$ 48,000.00
5	Catch Basin Removal & Replacement	ea	3	$ 3,000.00	$ 9,000.00
6	Manhole Connection	ea	4	$ 1,000.00	$ 4,000.00
7	AC Pavement Repair/Trench Patching	lf	280	$ 30.00	$ 8,400.00
		Construction Total			$ 113,300.00
		Contingency (20%)			$ 22,660.00
		Subtotal			$ 135,960.00
		Engineering (20%)			$ 27,192.00
		Administrative Costs (3%)			$ 4,078.80
		Total Project Cost			**$ 167,230.80**

8.1.12 Basin L

The primary drainage from Basin L is along a tributary stream to Pony Creek. The stream passes through an approximate 1,190-foot long 42-inch CMP culvert (Culvert L1-C) which begins west of the existing K-Mart parking lot and terminates on the north side of Ocean Boulevard approximately 700 feet west of 28th Street. The existing culvert is undersized for the peak runoff that is expected to occur as a result of the 25 and 50-year design storms. Additionally, the culvert is approximately 30 years old, contains approximately 6-inches of sediment in its downstream invert, and is significantly corroded. It should be planned to replace the pipe within 5 to 10 years depending on the rate of deterioration. Based on an estimated pipe slope of 0.42% and the calculated peak runoff, it is recommended that the culvert be replaced with minimum 60-inch HDPE storm drain piping. The recommended 60-inch HDPE pipe would have adequate capacity for the peak runoff predicted under fully developed conditions upstream of the pipe. Due to the increase in peak runoff predicted under fully developed conditions, 35% SDC eligibility is recommended for this project.

We understand that a portion of pipe is on private property and is considered the property owner's responsibility for maintenance. For this reason, we have separated the recommended replacement project into two parts, public and private.

A cost estimate for project L1 within the Ocean Boulevard right-of-way is provided below:

Table 8.1.12A – Storm Drain System Project L1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 8,900.00	$ 8,900.00
2	Construction Facilities/Temporary Controls	ls	1	$ 5,300.00	$ 5,300.00
3	60" HDPE Storm Drain Piping	lf	190	$ 200.00	$ 38,000.00
4	Catch Basin Removal & Replacement	ea	1	$ 3,000.00	$ 3,000.00
5	New 72" SD Manhole	ea	1	$ 15,000.00	$ 15,000.00
6	Curb & Gutter Removal & Replacement	lf	50	$ 40.00	$ 2,000.00
7	Sidewalk Removal & Replacement	sf	250	$ 20.00	$ 5,000.00
8	AC Pavement Repair/Trench Patching	lf	100	$ 50.00	$ 5,000.00
9	Traffic Control	ls	1	$ 3,000.00	$ 3,000.00
		Construction Total			$ 85,200.00
		Contingency (20%)			$ 17,040.00
		Subtotal			$ 102,240.00
		Engineering (20%)			$ 20,448.00
		Administrative Costs (3%)			$ 3,067.20
		Total Project Cost			**$ 125,755.20**

A cost estimate for project L2 outside the Ocean Boulevard right-of-way is provided below:

Table 8.1.12B – Storm Drain System Project L2

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 32,300.00	$ 32,300.00
2	Construction Facilities/Temporary Controls	ls	1	$ 19,400.00	$ 19,400.00
3	60" HDPE Storm Drain Piping	lf	1000	$ 200.00	$ 200,000.00
4	Catch Basin Removal & Replacement	ea	2	$ 3,000.00	$ 6,000.00
5	New 72" SD Manhole	ea	1	$ 15,000.00	$ 15,000.00
6	AC Pavement Repair/Trench Patching	lf	750	$ 50.00	$ 37,500.00
		Construction Total			$ 310,200.00
		Contingency (20%)			$ 62,040.00
		Subtotal			$ 372,240.00
		Engineering (20%)			$ 74,448.00
		Administrative Costs (3%)			$ 11,167.20
		Total Project Cost			**$ 457,855.20**

8.1.13 Basin M

No existing problems have been identified within Basin M. The storm drains in this basin generally serve small areas and capacity has not been identified as a problem for any of the systems.

8.1.14 Basin N

No storm drainage piping has been identified within Basin N, and consequently, no deficiencies were identified or projects developed.

8.1.15 Basin O

Basin O includes four separate storm drainage systems serving individual residential areas. The areas served and piping included in each system are as follows:

Subbasin 1 – Piping within Subbasin 1 includes an 8-inch storm drain along Woodland Drive westerly of 20th Street and a 10-inch storm drain within 20th Street from Woodland Drive north to Juniper Avenue. The pipes join west of the intersection of Woodland Drive and 20th Street and then a 12-inch storm drain crosses to the south side of Ocean Boulevard and ties into a 48-inch CMP culvert (Culvert O2-C) which discharges into an unnamed tributary of Pony Creek about 750 feet west of 19th Street.

Subbasin 2 – Piping within Subbasin 2 includes an 18-inch storm drain along Juniper Avenue which turns south along 19th Street and ties into a 36-inch pipe that crosses Ocean Boulevard approximately 120 feet west of 19th Street. This system also ties into the 48-inch CMP culvert (Culvert O2-C) along the south side of Ocean Boulevard.

Subbasin 3 – Piping within Subbasin 3 serves the Westgate subdivision. It includes approximately 1,024 feet of 24-inch diameter CMP, 292 feet of 21-inch, 215 feet of 15-inch, and about 450 feet of 12-inch storm drain piping. This system includes a 24-inch CMP outfall which discharges into an unnamed creek adjacent to the described 48-inch culvert.

Subbasin 4 – Piping within Subbasin 4 serves the West Hills subdivision and includes a 111-foot long 12-inch diameter outfall on the west side of West Hills Boulevard approximately 100 feet south of Ocean

Boulevard. The system also includes approximately 756 feet of 10-inch and 840 feet of 8-inch storm drain piping. This system discharges into an unnamed creek upstream from the above described 48-inch culvert (Culvert O2-C).

Recommended Improvements

Subbasin 1 – The 12-inch storm drain (assumed to be CMP) which crosses Ocean Boulevard and ties into the described 48-inch CMP culvert is undersized to handle calculated peak flows generated by the 25 and 50-year design storms. The condition of the pipe is uncertain at this time, but the pipe is approximately 30 years old and nearing the end of its expected useful life. The pipe should be televised to ascertain its condition. When the pipe needs replacement, minimum 15-inch HDPE pipe is recommended.

TV

A cost estimate for project O1 is provided below:

Table 8.1.15A – Storm Drain System Project O1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 5,800.00	$ 5,800.00
2	Construction Facilities/Temporary Controls	ls	1	$ 3,500.00	$ 3,500.00
3	15" HDPE Storm Drain Piping	lf	230	$ 110.00	$ 25,300.00
4	Catch Basin Removal & Replacement	ea	1	$ 3,000.00	$ 3,000.00
5	New SD Manhole	ea	1	$ 10,000.00	$ 10,000.00
6	Curb & Gutter Removal & Replacement	lf	40	$ 40.00	$ 1,600.00
7	Sidewalk Removal & Replacement	sf	200	$ 20.00	$ 4,000.00
8	AC Pavement Repair/Trench Patching	lf	110	$ 25.00	$ 2,750.00
		Construction Total			$ 55,950.00
		Contingency (20%)			$ 11,190.00
		Subtotal			$ 67,140.00
		Engineering (20%)			$ 13,428.00
		Administrative Costs (3%)			$ 2,014.20
		Total Project Cost			**$ 82,582.20**

Subbasin 2 – All of the storm drain piping within Subbasin 2 appears to be adequately sized to handle the calculated peak runoff generated by the 25 and 50-year design storms. As in other areas, the piping is within this subbasin is likely 30+ years old. It is recommended that television inspection be performed to determine the condition of the pipe and replacement plans be made accordingly.

TV

Based on its assumed age, the 36-inch pipe which crosses Ocean Boulevard likely is CMP and may be significantly deteriorated. Although no additional capacity is required in this section of piping it is recommended that plans be made to line or replace the existing pipe for maintenance reasons. We have assumed that lining of the pipe is possible if the manhole located on the north side of Ocean Boulevard approximately 120 feet west of 19th Street is removed to provide access and then replaced following pipe lining. Pipe lining should be performed using nominal 32-inch outside diameter smooth wall HDPE pipe with the annulus between the host pipe and the liner pressure grouted in place. Existing piping within 19th Street at the intersections of Ocean Boulevard and Woodland Drive also should be replaced with new 18-inch HDPE storm drain pipe.

A cost estimate for project O2 is provided below:

Table 8.1.15B – Storm Drain System Project O2

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 11,200.00	$ 11,200.00
2	Construction Facilities/Temporary Controls	ls	1	$ 6,700.00	$ 6,700.00
3	32" O.D. Rigid Pipe Liner	lf	245	$ 140.00	$ 34,300.00
4	18" HDPE Storm Drain Piping	lf	250	$ 120.00	$ 30,000.00
5	SD Manhole Removal & Replacement	ea	1	$ 10,000.00	$ 10,000.00
6	Manhole Connection	ea	5	$ 1,000.00	$ 5,000.00
7	Curb & Gutter Removal & Replacement	lf	40	$ 40.00	$ 1,600.00
8	Sidewalk Removal & Replacement	sf	200	$ 20.00	$ 4,000.00
9	AC Pavement Repair/Trench Patching	lf	180	$ 25.00	$ 4,500.00
		Construction Total			$ 107,300.00
		Contingency (20%)			$ 21,460.00
		Subtotal			$ 128,760.00
		Engineering (20%)			$ 25,752.00
		Administrative Costs (3%)			$ 3,862.80
		Total Project Cost			**$ 158,374.80**

Subbasin 3 – As described on the previous page, the existing storm drain piping within this subbasin includes a 24-inch diameter CMP storm drain mainline. The 24-inch pipe is estimated to be laid at a slope of approximately 3.6% and have a full flow capacity of about 23.31 cfs. The storm drain is sized appropriately to handle the calculated peak runoff under existing conditions. The calculated peak runoff resulting from the 25-year design storm under fully developed future conditions is 25.78 cfs. Because the calculated peak runoff is only slightly over the calculated pipe capacity, no additional capacity is considered necessary.

As with many of the other CMP storm drains, piping within the described system is nearing the end of its useful life. It is recommended that television inspection be completed to determine the condition of the pipe. When repairs are required, it is possible that a portion or all of the repairs could be completed by slip lining the existing piping with smooth wall HDPE pipe, or equivalent. Although the inside diameter would be decreased, the capacity would increase due to improved pipe wall friction properties.

Because the condition of the pipe in the Westgate area is uncertain the scope of repairs necessary at this time is indeterminate. For estimation purposes, a cost estimate for project O3 is provided below for lining all the 24-inch CMP pipe within the local system with 22-inch outside diameter smooth wall HDPE pipe. The cost estimate should be modified if only portions of the system require maintenance.

A cost estimate for project O3 is provided below:

Table 8.1.15C – Storm Drain System Project O3

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 20,250.00	$ 20,250.00
2	Construction Facilities/Temporary Controls	ls	1	$ 12,150.00	$ 12,150.00
3	22" O.D. Rigid Pipe Liner	lf	1024	$ 125.00	$ 128,000.00
4	SD Manhole Removal & Replacement	ea	3	$ 10,000.00	$ 30,000.00
5	Curb & Gutter Removal & Replacement	lf	40	$ 40.00	$ 1,600.00
6	AC Pavement Repair/Trench Patching	lf	100	$ 25.00	$ 2,500.00
		Construction Total			$ 194,500.00
		Contingency (20%)			$ 38,900.00
		Subtotal			$ 233,400.00
		Engineering (20%)			$ 46,680.00
		Administrative Costs (3%)			$ 7,002.00
		Total Project Cost			**$ 287,082.00**

Subbasin 4 – The 12-inch outfall pipe that serves Subbasin 4 appears to be slightly undersized to handle the calculated peak flows generated by the 25 and 50-year design storms. The outfall pipe material is uncertain but it is estimated that the pipe is laid at 3% to 4% slope. A concrete outfall pipe at 4% slope and flowing full has a capacity of approximately 7.14 cfs, while a CMP outfall at 4% slope has a capacity of approximately 3.87 cfs. The calculated peak runoff using the 25-year design storm is 9.97 cfs. The existing outfall pipe may surcharge at times during sustained heavy rains. It is recommended that when the outfall needs replacement minimum 12-inch HDPE pipe be used.

It is recommended that television inspection be conducted for the existing piping within the West Hills neighborhood to determine if any maintenance is required. Maintenance plans should be developed based on the inspection results.

No specific project is recommended at this time for storm drain piping within the West Hills area.

Culvert O2-C – This includes a 48-inch CMP culvert along the south side of Ocean Boulevard from about 100 feet east of 19th Street to approximately 800 feet west of 19th Street. It appears to be in fair condition with moderate corrosion at the invert. As with other pipes installed during the widening of Ocean Boulevard, the pipe is 30+ years old. It is recommended that the pipe be televised to determine if any current problems exist. Due to the age of the pipe it is expected that repairs will be required within the planning period.

For the purposes of planning it is assumed that the pipe will be lined with 48-inch outside diameter HDPE or PVC pipe.

A cost estimate for project O4 is provided below:

Table 8.1.15D – Storm Drain System Project O4

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 21,000.00	$ 21,000.00
2	Construction Facilities/Temporary Controls	ls	1	$ 12,600.00	$ 12,600.00
3	48" O.D. Rigid Pipe Liner	lf	900	$ 150.00	$ 135,000.00
4	72" SD Manhole Removal & Replacement	ea	2	$ 15,000.00	$ 30,000.00
5	AC Pavement Repair	ton	30	$ 100.00	$ 3,000.00
		Construction Total			$ 201,600.00
		Contingency (20%)			$ 40,320.00
		Subtotal			$ 241,920.00
		Engineering (20%)			$ 48,384.00
		Administrative Costs (3%)			$ 7,257.60
		Total Project Cost			**$ 297,561.60**

8.1.16 Basin P

No specific storm drain piping deficiencies were identified or projects developed for Basin P.

8.1.17 Basin Q

No specific storm drain piping deficiencies were identified or projects developed for Basin Q.

8.1.18 Basin R

Storm drainage includes about 1,060 feet of 24-inch CMP with an outfall approximately 400 feet east of the boat ramp. The pipe runs northeast from the outfall to a point approximately 100 feet north of the intersection of Whitty and D Streets. A 12-inch PVC storm drain also is present along the southern 150 feet of Whitty Street and discharges directly into Isthmus Slough.

No capacity problems have been identified with the existing storm drains in Basin R. The 12-inch storm drain on Whitty Street has a CMP flume below the end of the pipe to prevent erosion. The flume pipe is deteriorated and should be replaced. The recommended maintenance is considered minor and should be completed by City staff. No additional improvement projects have been developed for Basin R.

8.1.19 Basin S

Culvert S1-C includes an approximate 48-inch wide, 18-inch tall box culvert across 6th Avenue approximately 300 feet south of F Street in Eastside. It is in relatively poor condition and should be replaced. The culvert serves to drain the tidal mud flat area located between F and H Streets and 6th and 9th Avenues. Stormwater from portions of Basin S east of 6th Avenue is routed into the tidal mudflat area upstream of the culvert. The peak runoff from the portion of Basin S upstream of the culvert has been calculated at 107.9 cfs using the 50-year design storm. It is suggested that this flow be used for sizing a new culvert. If circular pipe is used, a minimum 36-inch HDPE pipe at 1.5% slope is recommended in order to meet the calculated peak runoff. Due to the location of the culvert in a tidal area it may be required to use a bottomless or box culvert. If this is the case, a minimum 48-inch wide, 24-inch tall concrete box culvert at 1.5% slope is recommended in order to handle the calculated peak runoff.

In order to provide a conservative estimate of cost for replacement of the culvert it has been assumed that a concrete box culvert will be used.

A cost estimate for project S1 is provided below:

Table 8.1.19 – Storm Drain System Project S1

Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Bonds, Insurance, Overhead, Mobilization Costs	ls	1	$ 4,000.00	$ 4,000.00
2	Construction Facilities/Temporary Controls	ls	1	$ 2,400.00	$ 2,400.00
3	48" x 24" Concrete Box Culvert	lf	60	$ 250.00	$ 15,000.00
4	Excavation & Backfill	cy	300	$ 40.00	$ 12,000.00
5	Aggregate Base	cy	25	$ 40.00	$ 1,000.00
6	AC Pavement	ton	40	$ 100.00	$ 4,000.00
		Construction Total			$ 38,400.00
		Contingency (20%)			$ 7,680.00
		Subtotal			$ 46,080.00
		Engineering (20%)			$ 9,216.00
		Administrative Costs (3%)			$ 1,382.40
		Total Project Cost			**$ 56,678.40**

8.1.20 Basin T

No specific storm drain piping deficiencies were identified or projects developed for Basin T.

8.1.21 Basin U

No specific storm drain piping deficiencies were identified or projects developed for Basin U.

8.2 Cleaning and Televising

As discussed in the previous section, a number of projects were developed to televise specific sections that have been identified as potential maintenance problems. Because no specific information was available as to the state of existing problems, no specific projects could be developed for these piping sections at this time.

For the piping sections identified, it is recommended that they be thoroughly cleaned and televised to allow for a careful engineering evaluation and development of projects to correct any existing deficiencies.

This work can be completed using City equipment and operations staff (OMI) or by entering into a contract with a cleaning and televising contractor.

Outside of the specific areas identified in Section 8.1, the City should develop a program to regularly and systematically televise the entire system. Through this approach, the entire storm drain system will be cleaned and deficiencies can be discovered and corrected over a period of time.

All television inspection tapes should be provided to the engineering staff at the City for review. Deficiencies should be noted and catalogued for potential improvement projects. Serious deficiencies should be corrected immediately.

8.3 Storm Drain System Management and Maintenance

A program of regular investment in system maintenance will do much to eliminate major system overhauls, replacement projects, and costly system breakdowns. The storm drain system is continuously deteriorating. The state of deterioration is unique to each section of pipe based on the age of the pipe, soil conditions, and characteristics of flows within the pipe.

In the Wastewater Collection System Master Plan it was recommended that a software package (Cartegraph) be purchased to aid in the organization and management of system maintenance efforts. If such a package is purchased, it would be useful to apply it to storm drain system management as well as the sanitary sewer system. Please reference Section 7.4 of the Wastewater Collection System Master Plan (2006, HBH Consulting Engineers) for details regarding the suggested software.

9.0 Recommended Plan

9.1 Introduction

This Stormwater System Master Plan has identified a number of capacity deficiencies and potential maintenance issues in the storm drain piping network owned and maintained by the City of Coos Bay. To address these deficiencies, improvement projects have been developed that will correct, repair, replace, or upgrade system components that are currently deficient or are projected to be deficient within the planning period.

Cost estimates have been prepared for each project, including potential costs for design, construction, contingency, and project administration. The projects and their associated costs make up the basis for the recommended plan that the City of Coos Bay is to follow throughout the planning period.

Determination of which projects are to be undertaken and the order in which they are undertaken is dependent on a number of variables. New development, system failures, priority maintenance issues, and other factors will drive the selection of projects during the planning period.

The purpose of this Chapter of the Master Plan is to provide the City with a "starting place" for which to begin their stormwater planning. This Section will provide a summary of the developed projects, present a proposed prioritization for the projects, and undertake a discussion on the implementation of the recommended plan.

It is understood that the prioritization and schedule developed in this Plan will be subject to change based on the variables discussed above. The City should develop and maintain a "living and functional" Capital Improvement Plan (CIP) that includes the highest priority projects developed in this Plan.

It is very possible that a project that is not currently considered a high priority can become one due to a catastrophic system failure or, perhaps, due to unanticipated development pressure. In this case, the City must react and reprioritize projects accordingly.

It is also possible that system components that have not been identified as having a potential deficiency during the planning period will become deficient, necessitating an improvement project. In these cases, the City must develop projects to correct previously unknown or unexpected deficiencies and add projects to the CIP and the project priority list.

9.2 Project Cost Summary

Projects were developed throughout the City's stormwater drainage system and in many of the basins to correct existing deficiencies, address maintenance issues, and/or to provide for future system capacity.

The projects developed in Chapter 8 for storm drain piping improvements are summarized in Table 9.2.

Table 9.2 – Storm Drain System Improvement Project Summary

Project Number	Project Name (Description)	Total Project Cost
A1	Fenwick Street Storm Drain Improvements	$90,405.00
B1	Margaretta Street Storm Drain Lining	$100,663.20
C1	Norman Avenue Storm Drain Improvements	$80,589.60
D1	Lakeshore Drive Storm Drain Improvements	$184,020.30
D2	Seabreeze/Tideview Terrace Storm Drain Improvements	$432,910.80
D3	Lakeshore Drive @ Chickses Creek Culvert Replacement	$181,179.00
F1	Newmark Avenue Storm Drain Improvements	$458,150.40
G1	Madison and Morrison Street Storm Drain Improvements	$280,882.80
G2	Webster Avenue Storm Drain Improvements	$34,317.00
J1	LaClair Street Storm Drain Improvements	$195,643.80
K1	Schoneman Street Storm Drain Improvements	$556,821.00
K2	Ocean Boulevard @ Newmark Storm Drain Improvements	$653,499.00
K3	Ackerman Street Storm Drain Improvements	$167,230.80
L1	Ocean Boulevard @ K-Mart Storm Drain Improvements	$125,755.20
L2	K-Mart Storm Drain Improvements	$457,855.20
O1	Ocean Boulevard @ Woodland Drive Storm Drain Improvements	$82,582.20
O2	Ocean Boulevard @ 19th Street Storm Drain Lining	$158,374.80
O3	Westgate Storm Drain Improvements	$287,082.00
O4	Ocean Boulevard @ 19th Street Culvert Lining	$297,561.60
S1	6th Avenue South of F Street Culvert Replacement	$56,678.40
	Total	**$4,882,202.10**

In addition to the projects summarized above, other recommendations were made in Chapter 8 including the development of a maintenance and inventory database system and systematic television inspection program to locate problem areas. While these programs have costs associated with them, specific budgets were not developed as part of the CIP (Capital Improvement Plan). For planning purposes, a minimum annual budget of $20,000 is suggested for inventory and inspection of existing storm drain piping.

9.3 Project Prioritization

It is difficult to rate piping projects with a priority status. When considering prioritizing piping projects, the following should be considered:

1. Is there a deficiency that could result in a total failure of the piping section?
2. The length of time the deficiency has caused problems for the City and for residents.
3. Availability and source of funding.
4. Coordination of project with other improvements (water, sewer, streets, etc).
5. Development pressures requiring the upsizing of pipe to increase capacity.

With these inputs in mind, the following priority summary was prepared for the storm drain system improvement projects:

Table 9.3 – Storm Drain System Project Prioritization Summary

	Priority Rating	Project Number	Project Name (Description)	Total Project Cost
A	1	G1	Madison and Morrison Street Storm Drain Improvements	$280,882.80
A	2	L1	Ocean Boulevard @ K-Mart Storm Drain Improvements	$125,755.20
A	3	O4	Ocean Boulevard @ 19th Street Culvert Lining	$297,561.60
A	4	O2	Ocean Boulevard @ 19th Street Storm Drain Lining	$158,374.80
A	5	O1	Ocean Blvd. @ Woodland Dr. Storm Drain Improvements	$82,582.20
A	6	S1	6th Avenue south of F Street Culvert Replacement	$56,678.40
B	7	K1	Schoneman Street Storm Drain Improvements	$556,821.00
B	8	K2	Ocean Blvd. @ Newmark Storm Drain Improvements	$653,499.00
B	9	K3	Ackerman Street Storm Drain Improvements	$167,230.80
B	10	D1	Lakeshore Drive Storm Drain Improvements	$184,020.30
B	11	D2	Seabreeze/Tideview Terrace Storm Drain Improvements	$432,910.80
B	12	F1	Newmark Avenue Storm Drain Improvements	$458,150.40
B	13	O3	Westgate Storm Drain Improvements	$287,082.00
B	14	D3	Lakeshore Drive Culvert Replacement	$181,179.00
B	15	B1	Margaretta Street Storm Drain Lining	$100,663.20
B	16	C1	Norman Avenue Storm Drain Improvements	$80,589.60
B	17	G2	Webster Avenue Storm Drain Improvements	$34,317.00
B	18	A1	Fenwick Street Storm Drain Improvements	$90,405.00
C	19	L2	K-Mart Storm Drain Improvements	$457,855.20
C	20	J1	LaClair Street Storm Drain Improvements	$195,643.80
			Total	**$4,882,202.10**

9.4 Implementation Plan

Implementation of a plan to repair or replace piping sections and initiate new maintenance and management practices in the City's storm drainage system represents a complicated and costly decision for the City of Coos Bay.

It may be considered presumptuous for a master plan to develop a schedule or direct a City to undertake projects in a particular order or on a specific timeline. However, it is appropriate to provide some "broad strokes" with regard to the findings and recommendations in the plan and point the City in the proper general direction.

This section will attempt to discuss a potential schedule and discuss financing if the City undertakes the high priority projects recommended in the plan.

9.4.1 Schedule

While many have attempted to provide rigid schedules in master planning efforts, they are almost never followed in practice. Budget processes, seasonal issues, depressions, and other issues change the proposed schedule from almost the first day. It is, perhaps, more important to identify the highest priority projects and recommend that the City undertake those projects as soon as funding is available.

In Sections 9.2 and 9.3 projects were ranked and listed in order of priority. While the content and project prioritization previously presented may be argued, the list will provide the City with a starting place when considering what projects to place on their capital improvement list and in what order those projects should be undertaken.

Table 9.3 identifies three separate project groups, A, B, and C, which are roughly defined as follows:

> **Group A:** These are the highest priority projects that should be undertaken as soon as adequate funding is available. It should be considered that these projects should be undertaken within the next 5 years with highest projects on the list to be addressed in the next year or two.
>
> **Group B:** These projects, while not of the highest priority, should be on the City's capital improvement planning window beyond the 5-year horizon. As Group A projects are completed, Group B projects should be moved to Group A status. System degradation or failures, project coordination, or other occurrence may require the movement of Group B projects to Group A status ahead of schedule. New projects that are developed that are not critical, should be grouped in Group B until funding is available.
>
> **Group C:** Group C projects are either of low priority or are dependent on development. If development in an area necessitates the implementation of a Group C improvement, the project should be moved to Group A status assuming that adequate funding is available to undertake it. Some projects may remain in Group C indefinitely if the need for the project or the development requiring it never arises.

Based on these definitions the Group A projects are priority projects that should be undertaken as soon as funding is available. And as stated previously, it is recommended that all Group A projects be completed within the next 5 years. All other projects are dependent upon funding, the completion of Group A projects, or development pressures. The City should maintain a "living" capital improvement list and project schedule based on these general guidelines.

9.4.2 Potential Financing Options

The City will soon be considering undertaking numerous storm drain system improvement projects. The overall cost of these projects will be millions of dollars.

Unlike projects involving water or wastewater system improvements, funding assistance is not typically available for storm drain system improvements since public health is not at stake. Non-grant funding includes bonds, loans, system development charges (SDC's), capital construction funds (sinking funds), local improvement districts, and others.

Loans and bonds will be available to the City with interest rates on the order of 5 percent depending on the status of the federal prime rates, the length of the payback term, the source of revenue used to payback the funds (user rates, general fund taxes, etc.), and other variables.

The City should not obtain loans with payback terms longer than the design life of the improvements that are being constructed. Piping materials commonly used today have expected useful lives significantly longer than that of products commonly used in the past. Because of this, loans with terms of 20 years, or slightly more, are acceptable for storm drain system improvements.

The City of Coos Bay does not presently have a specific user fee for storm drain system maintenance that is charged to rate payers. It is presumed that a portion of the rates collected for sanitary sewer collection and treatment is diverted to cover storm drain system projects as necessary. In order to appropriately fund the storm drain system improvement projects identified herein it is recommended that the City modify its rate structure to include a separate storm drain maintenance and improvement category. Any of several different methods could be used to determine usage fees for each rate payer. It is recommended for simplicity that charges be determined on an Equivalent Dwelling Unit (EDU) basis as introduced in Sections 3.4.2 and 3.4.3. Under the described system, each single family dwelling would be charged an equal rate for one EDU. Commercial and industrial customers would be charged a rate for a number of EDU's calculated based on the amount of impermeable surface present on the site. In this way, customers having larger areas of impermeable surface, and which generate greater volumes of runoff, would be responsible for a greater portion of system maintenance and improvement fees. Because the storm drain projects recommended herein will require significant capital for construction and repayment of loans or bonds, it is recommended that the City determine a basic rate structure sufficient to cover all existing maintenance costs prior to considering the improvement projects. Once baseline user fees have been determined, fee increases, as discussed in the following section, to cover the cost of the recommended improvements can be applied.

9.4.3 Potential Impacts to Rate Payers

The impact to rate payers will depend on the projects that the City undertakes, the schedule that they follow, and the rate structure that is established. The priority projects developed in this plan are summarized below:

Table 9.4.3 – Project Prioritization Summary

Priority	Description	Total
A	Group A - High Priority Projects	$1,001,835.00
B	Group B - Lower Priority Projects	$3,226,868.10
C	Group C - Low Priority and Development Dependent Projects	$653,499.00
	Total	**$4,882,202.10**

To provide a glimpse into a conservative impact to rate payers, the following scenarios are provided:

Scenario 1: It is assumed that the City will undertake all the projects in the Priority A group for a total project cost of $1,001,835.00. Because the projects will be primarily maintenance based, and in some cases capacity building to serve areas that are already developed, the projects will not be SDC eligible. Likewise, it is unlikely that local improvement districts would be approved for maintenance of existing systems. Based on these factors, the total cost impact to rate payers will be entirely based on a funding source that requires payback (loan, bond, etc.).

Principal: $1,001,835.00
Interest Rate: 5% per year
Term: 20 years (240 months)
Monthly Payment: $6,611.67
EDU's: 4,352

Based on these terms, the rate increase per EDU required to pay back a loan of the indicated principal amount is approximately $1.52 per month.

Scenario 2: In this scenario, it is assumed that the City will aggressively pursue the proposed projects by obtaining funding to complete both Priority A and Priority B groups. Under this more aggressive approach, the following impact to ratepayers applies:

Principal: $4,228,703.10
Interest Rate: 5% per year
Term: 20-years (240 months)
Monthly Payment: $27,907.57
EDU's: 4,352

Based on these terms, the rate increase per EDU required to pay back a loan of the indicated principal amount is approximately $6.41 per month.

The final rate increases established by the City must consider all the variables discussed above. Raising rates is a difficult step for any community to make. However, the City is responsible to maintain the existing storm drainage system and increase system capacity where development has been allowed to occur upstream of insufficiently sized facilities. Adequate funding must be raised to finance repairs of a constantly degrading infrastructure, promote development where land is available, and overcome inflation. These increases will, inevitably, require raising user rates within the City of Coos Bay.