City of Yachats

Lincoln County, Oregon

STORM DRAINAGE MASTER PLAN ADDENDUM

OCTOBER, 2008

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Project No. 141.08

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Section 1

Introduction

1.1 BACKGROUND AND NEED

The City of Yachats is a rapidly growing community in Lincoln County, Oregon. U.S. Highway 101 bisects the City, connecting it to the City of Newport, 24 miles to the north, and to the City of Florence, 26 miles to the south. Visitors attracted to the City enjoy the ocean views and numerous amenities such as shops, fine dining, whale watching, and weekend retreats in summer homes and lodging establishments. In recent years, the qualities that have made the City a tourist attraction have also drawn new residents and commercial enterprises. While development has provided many benefits to the City and its economy, it has also placed an increased burden on the City's existing infrastructure. In order to protect the quality of life that has attracted people and commerce, the City has placed an emphasis on maintaining its existing infrastructure and expanding it as required.

The purpose of this study is to provide an amendment of the Comprehensive Storm Drainage Plan completed in May 1993 by H.G.E. Engineers and Planners. The City will need a plan to ensure that new development does not create hydraulic overloads in sections of the storm system. A prioritized list of storm drainage improvement projects that accommodate growth within the City will be developed.

1.2 SCOPE OF STUDY

The Dyer Partnership has been authorized by the City of Yachats to provide master planning and engineering services as further described below. These services will develop an Addendum to the Comprehensive Storm Drainage Plan. The following items are included in the scope of this study.

1.2.1 Watershed Map Of The Drainage Basins

Two base maps of the watershed basin study area were developed based on current topographic maps, aerial photos, developer's plans, field investigations and City staff information. The existing drainage system was incorporated based on utility drawings, developers' subdivision plans investigation, and City staff knowledge. The maps include the boundaries of subbasins, direction of drainage, improved streets, existing storm drain facilities, and waterways. Figures A-1, A-2, A-5, and A-6 are based on an ODOT base maps, utility maps, and local mapping from past projects. The maps were developed in AutoCAD 2006 format and are in Appendix A of this report.

1.2.2 Hydrology Study For Projected Future Land Uses

A hydrology study of the area was performed including an assessment of local soils based on current Lincoln County soils maps, existing development and impervious area, projected development based on current city planning documents, local topography, city staff input, site investigations, and hydrograph data. The drainage area was broken into appropriate sub-basins and the information for each basin is presented in tabular format.

1.2.3 Hydraulic Model To Size Culverts And Ditches

The information obtained in the previous steps was used to build a hydraulic model of the drainage system using HydroCAD Stormwater Modeling system computer software. The model includes data sets for 25-year storms for projected conditions based on a 20-year study period. The model input and output data is tabulated and presented. Areas of current projected deficiencies are identified and discussed. A drainage basin map was developed illustrating the location of each deficiency.

1.2.4 Prioritized Capital Improvements

The projects recommended are prioritized and described. A map delineating the recommended projects is included. A tabular presentation of the projects in priority order has been prepared. Cost estimates include a breakout between anticipated City costs, Developer costs, and costs eligible for SDC funding.

1.3 PREVIOUS STUDIES AND INFORMATION

This report is an addendum to the Comprehensive Storm Drainage Plan for the City of Yachats (Project #3999) prepared May 1993. Other information used to prepare this report includes the USGS contour maps, and survey-mapping databases prepared and periodically updated for the City of Yachats by The Dyer Partnership. Soils information was obtained from the Soil Survey of Lincoln County, Oregon by the USDA Soil Conservation Service.

1.4 AUTHORIZATION

The Dyer Partnership, Engineers & Planners, Inc. was retained by the City of Yachats to prepare a “Storm Drain Master Plan Amendment”, and was authorized to proceed with services on February 10, 2008.

1.5 ACKNOWLEDGMENTS

This plan is the result of contributions made by a number of individuals and agencies. We wish to acknowledge the efforts of John McClintock, Public Works Director, and the staff of the City of Yachats.

Section

2

Study Area

2.1 Location and Definition of Study Area

The study area for this amendment is located within the Urban Growth Boundary of the City of Yachats. This area encompasses residential areas, commercial areas, coastal forest lands, and wetlands. The boundary for the storm water drainage area of this study is illustrated in Appendix A as Figure A-2.

2.2 Study Area Characteristics

2.2.1 Climate

The climate of Yachats is moist, marine, and temperate. Temperatures average 43° F in January and 64° F in August. The yearly mean temperature is approximately 53°F. Extreme temperatures range from 5 to 106°F. Yachats experiences prevailing northwest winds from May through August. During the winter and early spring months, the winds are generally from the southwest. Average wind velocities range from 15 to 25 miles per hour with winter gusts of up to 100 mph reported.

Yachats receives an average of about 72 inches of precipitation per year. Nearly all precipitation occurs as rainfall, with the majority (approximately 69%) falling between the months of November and March. Rainfall amounts for November, December and January average approximately 14 inches per month. The wettest month is December with a historic average of approximately 15 inches of rainfall. The driest month is July with a historic average of less than one inch of rainfall. Records show that the average maximum 24-hour rainfall is 5.8 inches. A maximum mean 24-hour rainfall of 8.2 inches is recorded for the month of January.

2.2.2 Topography & Natural Drainage Courses

This study area for the City of Yachats rests on marine terrace materials, which in turn overlie sandstone and basaltic rock formations. To the west is rocky, coastal shoreline. Mountainous forestland rises towards the western boundary of the study area. The study area is generally flat along the Pacific Ocean, with steep sloping hills towards the eastern boundary. All of the drainage basins and streams drain west toward the Pacific Ocean. Mean elevations for the study area range from about 0 to 700 feet. Most of the developed areas have an average elevation of 40 feet or less.

Basin boundaries and runoff patterns were defined from the Comprehensive Storm Drainage Plan, aerial photography, USGS mapping, City topographic maps, Subdivision plans and existing survey data. For the purposes of this plan, the study area was divided into sixteen major drainage basins. Portions of some drainage basins may extend out of the study area. The basins are described in Section 3.

2.2.3 Soils

There are three general classifications of surficial geologic formations found in the local Yachats area. A map showing these formations is included in the appendix. The formations are described as follows:

- **Quaternary Alluvium (Qal)** - These soils are alluvial bottomland deposits generally composed of silts, sand, and gravels. Within Yachats, in the lower lying areas of the Yachats drainage, these soils can be more specifically described as sandy silts, clayey silts, silty clays, and some local areas of peat. Qal soils are found in the lower elevations of Yachats around the confines of the Yachats River.

- **Basalt of Yachats (Teyb) –** These soils are characterized by rocky basaltic formations, 10 to 20 feet thick, found in the upper elevations to the east of the City**.** The formations commonly display irregular jointing and include pillow basalt, basaltic conglomerates, and basaltic sandstone in the northern part of the outcrops.

- **Quaternary Marine Terrace Deposits (Qmt) –** These soils are flat-lying marine terrace deposits overlain in places by semiconsolidated dune sand. The deposits are typically fine to medium grained friable sandstone of beach origin with thin interbeds of siltstone. Thicknesses may vary from 20 feet up to 75 feet. Qmt soils cover most of the Yachats Urban Growth Boundary (UGB) area, including the area to the south of the Yachats River mouth.

A soils map for the City of Yachats is located in the Appendix as Figure A-3.

2.2.4 Geologic Hazards

There are several areas within Yachats that are susceptible to geologic hazards. These hazards include coastal and river flooding, high groundwater, landslides, earthquakes associated with fault zones, tsunamis, and coastal and river erosion. A discussion of each hazard and expected locations are discussed below.

- **Coastal and River Flooding.** Flooding in Yachats is unpredictable and may occur at any time throughout the year. High tides, ocean currents, low barometric pressure, winds, and rain contribute to flooding unpredictability. Generally, flooding occurs along coastal rivers whenever westerly storm winds and high tides coincide with heavy precipitation runoff. Major flooding occurred on the Lincoln County coastline in early December of 1967. Prolonged 50 mph southwesterly winds and tides exceeding 10 and 11 feet caused floods and related damage to the entire county coastline. Though most of the City is located above the flood plain, the areas adjacent to the Yachats River mouth area identified as being prone to flooding.

- **Earthquakes and Tsunamis.** Earthquakes are the products of deep-seated faulting and the subsequent release of large amounts of energy. A complex system of northwest and northeast trending normal faults comprise the majority of faults in Lincoln County. Some minor, concealed faults pass through the study area; however, none of the faults within the Lincoln County area are recognized as master earthquake producing.

  Tsunami waves are sea waves generated by seismic activity, producing wavelengths of sometimes more than 100 miles and amplitudes of only a foot or so. The waves can grow to tremendous heights in shallower water, inflicting extensive damage to coastal developments. Tsunamis occur in a series of waves, sometimes over a period of several hours. Tsunamis are immediately preceded by a noticeable rise or fall of seawater. The last tsunami to hit the Oregon Coast was in March 1964, about six hours after the Good Friday Earthquake in Alaska. Relatively minor damage resulted in Lincoln County; however, four lives were lost—as a result of drowning—at Beverly Beach State Park.

- **High Groundwater.** High groundwater is characteristic along the northern borders of the City of Yachats. This water may be due to perched water, springs, hillside seepage, or saturated soil conditions following periods of wet weather.

- **Coastal Erosion.** Yachats's Urban Growth Area includes thousands of feet of shoreline along the Pacific Ocean and Yachats River terminus. These areas are susceptible to extensive erosion by waves and the elements of weather. However, much of the shoreline in the vicinity of the study area is characterized by rocky coastline that is relatively protected from wind and wave actions.

- **High Wind.** Strong wind is a regular occurrence in Yachats with high wind occurring only occasionally during severe storms. Only minor damage is expected from a high windstorm, with a 90 mph wind statistically occurring once in every 100 years.

2.2.5 Environmental Issues

The areas in and around the City of Yachats are known for their beauty and their coastal flavor. Numerous public viewpoints, walking trails, and other local treasures are favorites of residents and visitors alike.

The Yachats estuary serves as a habitat for a number of fish and wildlife species. The coastal headlands, tidal areas, and uplands are all sensitive natural areas, each supporting its own ecosystem of diverse species of wildlife and vegetation.

2.2.6 Precipitation

Annual rainfall in the area (based on National Oceanic and Atmospheric Administration (NOAA) data) is approximately seventy (70) inches, most of this falling between the November to March time period. Snowfall during the year is slight. The mean yearly total is less than one inch. When snow fall occurs, it is generally during the December to March time period.

Storm water drainage planning is not necessarily concerned with the annual rainfall total occurring in a region; rather, storm water planning is more concerned with the type, intensity, and the daily rainfall total of the storms. These elements, known as the design storm, are used to analyze the drainage system and its components. A further discussion of the Yachats design storm and its use to analyze drainage components is provided in Chapter 5.

2.3 Economic Conditions & Trends

Population growth and development, generally in Yachats and specifically in the study area, will occur and is anticipated to accelerate in the immediate future. The City has basic commercial amenities and also lies within a reasonable distance of the Cities of Florence and Newport where larger, more urban amenities are readily accessible. During the summer months, the scenic vistas attract a large number of tourists. Commercial enterprises cater to this seasonal influx of visitors. Tourism and the emergence of the City as a popular retirement location have helped to spur growth rates in recent years. City services to these residents will include water, sewer, streets, and storm drainage. The 2000 U.S. Bureau of Census reports the median household income for residents inside the City of Yachats city limits is $32,308 (with a population of 617). Approximately 40% of the workforce is employed in industries heavily influenced by tourism, such as retail sales, food service, entertainment, and property leasing. Less than 15% of the local jobs are in production industries such as agriculture, manufacturing, or construction.

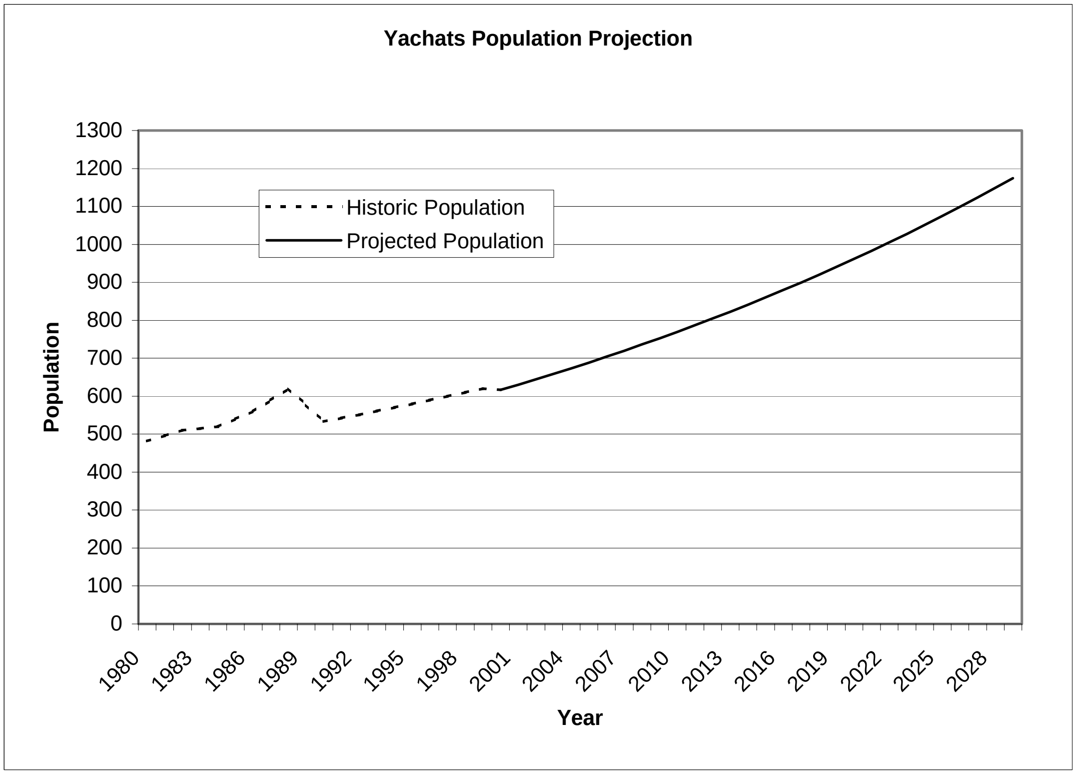
A copy of the City's Zoning map was used to aide in the projected growth patterns of the City. A copy of this map is located in the Appendix as Figure A-6.

2.4 Population

Since 1990 Yachats has experienced a growth rate higher than most other communities in Oregon. Economic conditions were difficult in the early 1980s due to the decline of the forest products industry, and some uncertainty remains over the availability of timber and lumber. Yachats' livability characteristics, however, especially for retired persons and those enjoying outdoor recreation, have attracted a long-term growing populace to the Oregon Coast regardless of the local economic climate.

Based on United States Census data, the City of Yachats' population increased from 533 to 617 between 1990 and 2000. This increase equates to an average annual growth rate of 1.5%. During this same period, the average County growth rate was 1.35%. The growth rate for the previous 20-year planning period (1978-1998) was approximately 1.8%. Growth is expected to continue at a rate similar to that experienced in the community during the last decade. A conservative growth rate of 2.25% per year has been selected for projections used in this Facilities Plan over the next 25 years (to the year 2029), which matches the growth rate chosen for other recent planning efforts for the City of Yachats. The county currently does not have a coordinated growth rate, but both Lincoln County and the Department of Land Conservation and Development agreed that 2.25% was a reasonable growth rate for the purposes of this study. This projected growth trend, along with the historic growth in the City over the last 20 years, is shown below in Figure 2.3.1.

FIGURE 2.3.1
HISTORIC AND PROJECTED GROWTH, CITY LIMITS AND CURRENT UGB



Population is used indirectly for planning storm water systems. While the rate of population growth is indicative of the amount of land that would be developed, land use is employed for forecasting hydraulic loads in storm drain analysis. Within the study area, the primary type of development considered is residential. The storm water run-off generated is then a function of density and soil type.

Section

3

Existing Conditions

3.1 Existing Drainage Basins

Within this Master Plan Amendment Study there are sixteen basins divided into a total of thirty-three subbasins. Figure A-2 in the Appendix shows these basins and the approximate general flow patterns for surface runoff within these basins. The basins were broken down into smaller subbasin areas to increase the level of accuracy within the computer model. The slopes and terrain in some areas make absolute boundaries between basins subjective in some cases. Additional basin descriptions can be found in Section 6 of this study.

The typical storm drain basin for Yachats begins at the top of the coastal mountains to the east of Highway 101. Most of the upper hillsides are forested with slopes exceeding 25 percent grade. Development increases towards the lower sections of the basins and storm water collects in roadside ditches and culverts. The lower sections of the basins are developed with mostly residential housing and small commercial development in select areas. The arterial ditches and culverts connect to larger culverts that cross under Highway 101 and convey storm water to the Pacific Ocean.

3.2 Existing Storm Drainage Facilities

The only storm drain structures which exist within the planning area are ditches, catch basins, and road culverts. As noted in previous reports, the majority of ditches are overgrown with vegetation which reduces flow and aggravates the ponding of water. These ditches will require re-grading and periodic removal of vegetation to provide adequate drainage.

Many of the existing culverts are obstructed with debris and require cleaning. Some of the existing ditches have become overgrown and restrict storm water runoff, while other ditches and culverts appear to be in good working condition. The following photos show some typical culverts and ditches that are obstructed or overgrown.

Figure 3.1.1-Mainline Culvert at Yachats Ocean Road
Note the restricted ditch line upstream of the culvert inlet

Figure 3.1.2-South Side Cape Ranch Road
Note the obstructed culvert inlet

Figure 3.1.4-Mainline Culvert along HWY 101 near Cape Ranch Road
Note the obstructed culvert inlet

Figure 3.1.2-Mainline Culvert Located at 232 Highway 101
Note the obstructed culvert inlet

Some of the existing ditches appear to be in good condition throughout the study area. A well-functioning storm water ditch will be free of obstructions and provide a relatively clean flow path for the storm water flows. The following pictures depict what a good clean ditch and culvert entrance should look like.

Figure 3.1.5-Mainline creek off 101 north of 7th street
Note the clean meandering ditch free of obstructions

Figure 3.1.6-Mainline overflow culvert at Lori Lane
Note the clean culvert inlet

Figure 3.1.7-Mainline Culvert at corner of Yachats Ocean Road and HWY 101
Note the ditch free of major obstructions

Section

4

Planning Criteria

4.1 Federal & State Regulations

The State of Oregon does not regulate storm water discharge from small cities or municipalities; however, as cited in 40 CFR 122.26 of the Code of Federal Regulation (CFR), the U.S. Environmental Protection Agency (EPA) may require permits for some storm water discharge. These permits are required as part of the National Pollutant Discharge Elimination System (NPDES) program. The purpose of this program is to monitor and prevent storm water runoff from polluting the waters of the state. Currently, municipal sources that need to obtain permits are classified as either Phase I or Phase II municipal separate storm sewer systems (MS4s). Phase I MS4s are municipalities with populations greater than 100,000, while regulated Phase II (or "small") MS4s are those municipalities with populations less than 100,000 located within Census Bureau-defined Urbanized Areas. Federal regulations also provide EPA and the states with the discretion to require other MS4s outside of Urbanized Areas to apply for a permit. Currently the cities of Portland, Salem, and Gresham, along with Clackamas County, were listed as having NPDES Phase I permits.

As currently regulated, the City of Yachats is not required by Federal Law to permit or monitor its storm water discharges. However, specific industrial facilities or businesses, located within the City itself, may be required to hold such permits for their storm water discharge. These facilities should already be regulated by the Oregon Department of Environmental Quality (DEQ) according to CFR regulations. Otherwise, storm water discharges occurring within the City are not regulated by outside agencies. Given the current trends in environmental control, the City can anticipate future requirements on its storm water discharge points. Predicting or anticipating the future requirements of storm water permits for the City of Yachats is a difficult task because the current permits are for larger population areas with much different demographics. The City should review the current NPDES permits to see how other municipalities are currently regulated. A link to the DEQ website containing these permits is: http://www.deq.state.or.us/wq/stormwater/municipalph1.htm

4.2 Local Drainage Regulations & Review Procedures

The City of Yachats currently has an ordinance pertaining to storm water for new development (Ordinance No. 143). The City requires that a developer address storm water issues by providing adequate facilities for runoff generated from the proposed site. The intention of these ordinances is to protect lower developments from excess flows.

Review procedures require the developer to provide for all on-site drainage as well as participate in the improvement of downstream drainage systems if the runoff from the improved property causes these downstream facilities to be overloaded. It requires all new drainage facilities to be sized to accommodate future runoff from potential upstream developments. A brief description of common drainage review criteria is provided below.

4.2.1 General Provisions.

The review body should approve a development request only when adequate provisions for storm and flood water runoff have been made, as determined by the City Engineer. The storm water drainage system must be separate and independent of any sanitary sewerage system. Where possible, inlets should be provided, ensuring surface water is not carried across intersections or allowed to flood streets. Surface water drainage patterns and proposed storm drainage must be shown on every development proposal plan. All proposed storm sewer plans and systems must be approved by the City Engineer as part of the tentative plat or site plan review process.

Ditches will not be allowed without specific approval of the City Engineer. Open natural drainage ways of sufficient width and capacity to provide for flow and maintenance may be permitted. By definition, an open natural drainage way is a natural path that has the specific function of transmitting natural stream water or storm water runoff from a point of higher elevation to a point of lower elevation.

4.2.2 Easements.

Where a subdivision or development property is traversed by a water course, drainage way, channel or stream, there shall be provided a public storm water easement or drainage right-of-way conforming substantially with the lines of such water course and such further width as the City Engineer determines will be adequate for conveyance and maintenance. Improvements to the drainage way, or streets or parkways parallel to the water course may be required.

4.2.3 Accommodation Of Upstream Drainage.

A culvert or other drainage facility shall be large enough to accommodate potential runoff from its entire upstream drainage area, whether inside or outside of the development. The City Engineer will review and approve the size requirements of the facility, based on provisions of the City of Yachats Storm Drain Master Plan Addendum and sound engineering principles, assuming conditions of maximum potential watershed development permitted by the City of Yachats Comprehensive Plan.

4.2.4 Effect On Downstream Drainage.

Where it is anticipated by the City Engineer that additional runoff resulting from the development will overload an existing drainage facility, the review body should withhold approval of the development until provisions have been made for improvement of said potential condition.

4.2.5 Drainage Management Practices.

Development must employ drainage management practices approved by the City Engineer, which minimize the amount and rate of surface water runoff into receiving streams or drainage facilities, or onto adjoining properties. Drainage management practices must include, but are not limited to, one or more of the following:

- Temporary ponding or detention of water;
- Permanent storage basins;
- Minimization of impervious surfaces;
- Emphasis on natural drainage ways;
- Prevention of water flowing from the development in an uncontrolled fashion;
- Stabilization of natural drainage ways as necessary below drainage and culvert discharge points for a distance sufficient to convey the discharge without channel erosion;
- Runoff from impervious surfaces must be collected and transported to a natural drainage facility with sufficient capacity to accept the discharge; and
- Other practices and facilities designed to transport storm water and improve water quality.

4.2.6 Design Requirements For New Development.

All new development within the City must, where appropriate, make provisions for the continuation or appropriate projection of existing storm sewer lines or drainage ways serving surrounding areas. Extensions may be required through the interior of a property to be developed where the City determines that the extension is needed to provide service to upstream properties.

4.2.7 NPDES Permit Requirements.

A National Pollutant Discharge Elimination System (NPDES) permit must be obtained from the Department of Environmental Quality for construction activities including clearing, grading, and excavation that disturb one or more acres of land The developer must complete NPDES General Permit form 1200-C for storm water discharge associated with construction activities. For construction activities disturbing 20 or more acres, the plan must be prepared and stamped by an Oregon Registered Professional Engineer, Oregon Registered Landscape Architect, or Certified Professional in Erosion and Sediment Control. Addition information regarding the NPDES Storm Water Regulations for Construction Activities may be found on the Internet at:

www.deq.state.or.us/wq/stormwater/swpconstrapp.htm#app

4.2.8 Small MS4 Requirements

Small MS4 stands for Small Municipal Separate Storm Sewer System. It is defined as a publicly owned conveyance or system of conveyances from ditches, curbs or underground pipes that divert storm water into the surface waters of the state. A small MS4 is subject to storm water regulation if it is located within an "Urbanized Area" as defined by the U.S. Census Bureau in the 2000 (or later) census. The Bureau of the Census has defined an "Urbanized Area" as a central place (or places) adjacent to a densely settled surrounding territory that together have a residential population of at least 50,000 and an average density of at least 1,000 people per square mile. Yachats does not currently appear to meet the definition of an Urbanized Area, but should anticipate future inclusion since the history of this set of regulations has been to include small areas over time. Communities subject to this regulation are required to design their programs to do the following: reduce the discharge of pollutants to the "maximum extent practicable" (MEP), protect water quality and satisfy the appropriate water quality requirements of the (Federal) Clean Water Act. Implementation of the MEP standard will require the development and implementation of best management practices and the achievement of measurable goals to satisfy each of the following six minimum control measures:

- **Public Education and Outreach**
  Distributing educational materials and performing outreach to inform citizens about the impacts polluted storm water runoff discharges can have on water quality.

- **Public Participation/Involvement**
  Providing opportunities for citizens to participate in program development and implementation, including effectively publicizing public hearings and/or encouraging citizen representatives to participate on a storm water management panel.

- **Illicit Discharge Detection and Elimination**
  Developing and implementing a plan to detect and eliminate illicit discharges to the storm sewer system (includes developing a system map and informing the community about hazards associated with illegal discharges and improper disposal of waste).

- **Construction Site Runoff Control**
  Developing, implementing and enforcing an erosion and sediment control program for construction activities that disturb one or more acres of land (controls could include silt fences and temporary storm water detention ponds).

- **Post-Construction Runoff Control**
  Developing, implementing and enforcing a program to address discharges of post-construction storm water runoff from new development and redevelopment areas. Applicable controls could include preventive actions such as protecting sensitive areas (e.g., wetlands) or the use of structural BMPs such as grassed swales or porous pavement.

- **Pollution Prevention/Good Housekeeping**
  Developing and implementing a program with the goal of preventing or reducing pollutant runoff from municipal operations. The program must include municipal staff training on pollution prevention measures and techniques (e.g., regular street sweeping, reduction in the use of pesticides or street salt, or frequent catch-basin cleaning

Additional information may be obtained from the Internet regarding the Small MS4 program:

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

4.3 Civil Law Criteria

Storm drainage for non-urbanized areas is not regulated by state or federal agencies. However, the State of Oregon provides civil laws pertaining to drainage. Civil drainage laws prescribe the entitlement of a property owner to have normal natural drainage ways maintained. Under this doctrine, a landowner must accept water that naturally flows across his property, but the owner is entitled to not have the natural drainage changed or substantially increased. Similarly, this law provides that a landowner must not obstruct the natural drainage way if the upper drainage way is properly discharged.

The Oregon Department of Transportation Hydraulics Manual provides a summary of Oregon drainage law. The three basic elements of drainage that must be followed, according to civil law as interpreted by ODOT, are:

- A landowner may not divert water to adjoining land that would not otherwise flow there. Diverted water is further described by ODOT as water routed from one drainage area to another, and water collected and discharged that would normally infiltrate, pond, or evaporate.
- A landowner may not divert or change the place where water flows onto a lower property. ODOT interprets this element to limit diversion of water from grading and paving work and/or improvements to storm water collection systems.
- An upper landowner may not accumulate large quantities of water, then release it, greatly accelerating the flow onto a lower property. The ODOT interpretation notes that noncompliance with this element occurs when the flow of water has been substantially increased.

Clearly, violations of Oregon drainage law are subjective. Where questions arise, ODOT recommends that its engineering staff acquire easements to avoid the potential for litigation. Natural drainage ways have been impacted by development and, consequently, are no longer readily apparent. In such cases, corrections made by the City should be particularly sensitive to the potential for rerouting drainage to properties that cannot be proven as the original drainage way. Future developments within the City, and City improvements to the existing drainage system, should be required to subscribe to the City’s legal interpretation of Oregon drainage law. Where questionable conditions may exist, the City should seek or require acquisition of easements.

Section

5

Hydrological Analysis

5.1 Storm Frequency

An essential part of storm water analysis is the selection of the design storm or storm frequency that will be used. Selection of the design storm includes economic and statistical relations. The frequency chosen for a storm depends upon such factors as the existing drainage system, the nature of the contributing areas, and the cost of storm drainage improvements.

The design storm is the total amount of rainfall that will occur over a period of time based on the statistical evaluation of precipitation records. Typical intervals for storm frequencies are 2, 5, 10, 25, 50, and 100 years. A 25-year storm can be expected to occur once within a 25-year period. The 25-year storm could occur any year during a 25-year time span, although each year it only has a 4 percent chance of occurring. The 25-year storm could conceivably occur for several years, or even twice in a given year, although statistically, it would not be probable.

Economic factors are considered when selecting the design storm in the engineering analysis. For instance, a drainage system sized for the 100-year storm will result in a larger, more costly drainage system than for a more frequent storm. Conversely, a drainage system designed for the frequent storm, though less costly, may not prevent property flooding, damage to public facilities, or the potential loss of life. Costs of improvements must be compared to the potential risks.

Selection of the storm frequency for this analysis is based on individual basins and projects. Based on the State of Oregon Department of Transportation Hydraulics Manual, a 50-year recurrent storm should be utilized for facilities draining through state highways and a 25-year storm can be used for smaller city streets. In cases where roadway overtopping is a problem, the 100-year storm may be used.

For development anticipated within the study area, a storm with a recurrent interval of 25 years is selected as appropriate for City Streets and Neighborhoods. The rainfall total for this storm is approximately 6.8 inches in a 24-hour period. The 50-year rainfall event for the City of Yachats is a 7.0 inch rainfall event in a 24-hour period. Rainfall conditions tend to vary across the study area, and directly to the south of the City of Yachats at Cape Perpetua. Discussions about rainfall intensities and durations lead to the determination that it is appropriate to model the City with a 7.0 inch rainfall event.

5.2 Channelization

As storm water flows downstream, it travels in some type of channel, for example, ditch, culvert, natural creek, and pipes. A common mathematical formula used to characterize the hydraulic behavior of these conduits is the Manning's Equation, which is generally expressed as:

$$Q=(1.49/n)*A*R^{2/3}*S^{1/2}$$

Where:
Q=Channel Flow (cfs)
A=Cross-Sectional Area (sf)
R=Hydraulic Radius=A/P (ft)
P=Wetted Perimeter (ft)
S=Channel Slope (ft/ft)
n=Manning's Roughness Coefficient

Channels vary widely in their hydraulic performance. The roughness coefficient, n, is used to describe the texture of the channel in terms of the material of construction. Materials differ in surface friction. If a channel is made up of a rough surface, there is more friction as the water flows through the channel and more energy is used to overcome that friction. The result is lower water velocities and therefore lower flows. Table 5.2 lists some commonly used Manning's "n" values for different pipe and channel surfaces.

TABLE 5.2.1
TYPICAL MANNING'S ROUGHNESS COEFFICIENTS

SURFACE OR MATERIAL	MANNING'S "n"
Finished Concrete	0.012
Unfinished Concrete	0.014
Plastic Pipe	0.009
Brick	0.016
Cast Iron	0.015
Concrete Pipe	0.015
Bare Earth	0.022
Corrugated Metal Flumes	0.025
Corrugated Metal Pipe	0.026
Rubble	0.030
Earth with Stones and Weeds	0.035

5.3 Analysis Method

The term "storm water" typically refers to rainfall runoff, snowmelt runoff, and surface runoff and drainage. Effective storm water management includes the accurate sizing of storm water conveyance systems, specifically, culverts, catch basins, detention/retention ponds, and storm drainage pipelines. Sizing for conveyance systems is generally estimated by using instantaneous peak runoff from a storm of specified frequency.

There are numerous methods for estimating peak runoff. For purposes of this study, the Rational Method and the Soil Conservation Service Runoff Method (TR-20 model) are used to estimate peak runoff values.

While the Rational Method is in common use for engineering analysis of drainage basins, its use is most applicable for analyzing areas with simple drainage systems. For this study, an alternate analysis tool, the SCS Method, was used for developed areas with complex drainage system.

The following sections describe the methods in the analysis.

5.3.1 Rational Method

The Rational Method is based upon the concept of mass balance and relates rainfall intensity to runoff intensity. The Rational Method incorporates the use of the rational formula, which is generally expressed as:

$$Q_p = CIA$$

Where:
Q_p = peak discharge (cfs)
C = runoff coefficient (dimensionless)
I = rainfall intensity (in/hr)
A = watershed area (ac)

Once values for runoff coefficient, rainfall intensity, and watershed area have been determined, peak discharge (Q_p) values for drainage basins in the area are calculated. Each of the parameters in the formula is described below.

Runoff Coefficients
Values for C, the runoff coefficient, are readily available in most hydrology or engineering handbooks. Some common C values are listed in Table 5.3.1.

TABLE 5.3.1
COMMON RUNOFF COEFFICIENTS

AREA DESCRIPTION	RUNOFF COEFFICIENT
Downtown Business	0.70 to 0.95
Neighborhood	0.50 to 0.70
Single Family (Residential)	0.30 to 0.50
Detached Multi-units (Residential)	0.40 to 0.60

AREA DESCRIPTION	RUNOFF COEFFICIENT
Attached Multi-units (Residential)	0.60 to 0.75
Light Industrial	0.50 to 0.80
Parks, Cemeteries	0.10 to 0.25
Unimproved	0.10 to 0.30

Rainfall Intensity

Rainfall intensity (I) is the intensity (inches per hour) of rainfall for a given design storm at a given time in the storm. Intensity is typically determined from Rainfall Intensity, Duration, and Frequency (IDF) curves. IDF curves are used to determine rainfall intensity associated with a specific storm frequency. The water modeling software used in this study creates the IDF curves used in the modeling of the City's system.

Time of Concentration

Rainfall duration in a drainage basin is computed by determining the time of concentration for that drainage basin. Time of concentration (t_c) is defined as the longest travel time it takes a particle of water to reach a discharge point in a watershed. While traveling towards a discharge point, a water particle may experience sheet flow, shallow concentrated flow, open channel flow, or a combination of these. Once the drainage route and surfaces have been identified, Manning's equation is used to calculate the travel time of a water particle through a drainage basin.

$$T_c = \frac{L}{.6} \quad \text{where} \quad L = \frac{l^{.8}\,(s+1)^{.7}}{1900\,Y^{.5}}$$

$$\text{and} \quad S = \frac{1000}{CN} - 10$$

T_c = Time of concentration [hours]
L = Lag time [hours]
l = Hydraulic length of watershed [feet]
Y = Average land slope [percent]
S = Potential maximum retention [inches]
CN = Weighed Curve Number

Area

The final variable in the rational formula is the watershed area (A). Watershed area is determined from topographic maps of the area.

<u>5.3.2 Soil Conservation Service Method</u>

The SCS method, commonly referred to as SCS TR-20, is a more sophisticated storm water analysis tool than the Rational Method. Rather than simply determining the peak discharge, TR-20 utilizes a synthetic rainfall distribution to generate a hydrograph showing the runoff peak and volume. This method provides a more accurate assessment of the runoff volume because it sums the total volume discharged from the basin, rather than just the peak discharge.

The SCS method is based on combining unit hydrographs resulting from bursts of rainfall that vary in magnitude, but occur in a predictable pattern. This pattern is defined by SCS as a rainfall distribution curve. Though variations in the storm intensity are synthetic, runoff generated from the storm is based on local characteristics, such as regional rainfall totals, soil permeability classifications, intensity of development, drainage slopes, area of impact, and even the time lag created by conveyance of flows through the drainage elements.

The benefits of the SCS method are that areas within a basin, called subbasins, can be simultaneously modeled with other subbasins by combining hydrographs using excess runoff and time to peak runoff. This process allows for a more accurate prediction of the peak discharge and calculation of the total runoff volume.

In comparison, the simplicity of the Rational Method requires the results to be more conservative than the SCS Method. Consequently, by using the more complex method, smaller pipe may be used if sufficient detail of the basin is available. A brief description of the fundamentals of the SCS method is provided below.

Synthetic storm distribution
The basis of the TR-20 Method is the “synthetic storm." This storm is based on SCS research that suggests the intensity of rainfall within a storm occurs in a predictable pattern. The SCS has applied this to the entire continental United States and developed rainfall mass distributions for four geographic locations. Storms occurring in Yachats and most of the Pacific Northwest have been classified as type 1A storms. Type 1A storms represent the Pacific maritime climate with wet winters and dry summers. Rainfall gradually increases until about the 10-hour point and then gradually decreases. In Appendix A, The NRCS storm type distribution is illustrated in Figure 5. The rainfall distribution hydrograph for a Type 1A 24-hour storm is illustrated in Figure 6.

Soil classification
The type of soil and ground cover occurring within a basin are used in the SCS Method. This information determines the amount of rainfall retained on the surface and the excess rainfall generating runoff. Soil and ground covers are classified by curve numbers (CN) similar to the coefficient of runoff, C, used with the Rational Method. Typical CN values used for the City of Yachats are provided below in Table 5.3.2. Soil within the current study area is largely classified as either poor or very poor draining, requiring use of curve numbers for soil groups C and D in the analysis of the City's drainage system. A few well-draining soils were modeled as type A.

For the study area, development was assumed to be residential with a density of 1/4 acre or 1/3 acre. Due to the hardpan which is present in a majority of the study area and to the flat slopes, the determination of soil group (i.e. A,B,C or D) was conservative, tending to assume poorer draining conditions.

TABLE 5.3.2
TYPICAL CN VALUES

GROUND COVER CHARACTERISTICS		**CURVE NUMBER FOR SOIL GROUP**			
Ground Cover Type and Condition	Percent Impervious	A well drained	B moderate	C poor	D very poor
Streets, Roads, Parking Lots	100	98	98	98	98
Urban Commercial Districts	85	89	92	94	95
Residential: 1/8 acre or less	65	77	85	90	92
Residential: 1/4 acre	38	61	75	83	87
Residential: 1/3 acre	30	57	72	81	86
Residential: > acre	25	54	70	80	85
Wooded: No Forest Litter	Poor	45	66	77	83
Wooded: Some Forest Litter	Fair	36	60	73	79
Wooded: Heavily Forested	Good	30	55	70	77

Rainfall
Storm rainfall is determined from the design frequency or design storm as previously mentioned. Total rainfall for the design storm used in Yachats is based on the National Oceanic and Atmospheric Administration (NOAA) Precipitation Maps for the Western United States.

Time of concentration
As in the Rational Method, the time of concentration is an important parameter in the SCS Method. Unlike the Rational Method, the SCS utilizes t_c to determine the time to peak discharge, rather than the time of peak rainfall.

Time to Peak
The Time to Peak, T_p, is the amount of time to the peak discharge. The time to peak is calculated with the unit hydrograph and time of concentration. The time to peak is not equal to the time of concentration.

Peak Runoff
The peak runoff is the peak amount of runoff discharged during a rainfall event. The peak runoff is calculated with the SCS method, and varies greatly with the slope and land use of the area in the drainage area. The peak flow is usually in cubic feet per second, and is used to size structures associated with the storm drain system.

$$Q = \frac{(P-.2S)^2}{P+.8S} \quad (Q=0 \ \text{if} \ P<.2S)$$

$$\text{where} \quad S = \frac{1000}{CN} - 10$$

Q = Precipitation excess (runoff) [inches]
P = Cumulative precipitation [inches]
S = Potential maximum retention [inches]
CN = SCS Curve Number[1]

5.3.3 Unit Hydrograph

Runoff generated from a storm can be described by a hydrograph. A hydrograph is a predicted discharge wave that, similar to a bell curve, starts slowly then increases with time to a peak before decreasing to its pre-storm levels.

A unit hydrograph is a dimensionless hydrograph, hypothetically generated by one inch of excess precipitation resulting from a uniformly distributed storm of uniform duration over a uniform area. The peak discharge (the y ordinate) and the time of peak discharge (the x axis) for the unit hydrograph is plotted as fractions of the peak and time to peak runoff, respectively. This standardized hydrograph is used to generate site-specific hydrographs by combining rainfall and time to the unit values. The calculation, called runoff generation, is performed as described below.

Runoff Generation
In order to dimension the unit hydrograph and generate runoff according to TR-20 predictions, rainfall is assumed to fall on an area in a “burst." The burst of rain is assumed to flow downstream where it is collected and discharged from the area over an extended time interval.

The duration of the discharge is extended because not all of the rainfall reaches the discharge at the same time. Some of the flow is retained because of soil characteristics; some is delayed because of distance and velocity of travel.

At the same time that the water from farthest point of the basin reaches the discharge point, the lower areas of drainage are also contributing to the flow. The sum creates the peak discharge, which is shown on the y axis of the hydrograph. The time of the peak is similarly based on the time of travel and plotted as the x axis. Both the discharge and time of travel are utilized to dimension the unit hydrograph.

Once dimensioned, the unit hydrograph provides the runoff from one interval of the storm's duration. To predict the impact from an entire storm, it is necessary to generate and sum hydrographs for each storm interval. Each new hydrograph generated is based on the mass of rainfall occurring at that particular time, as predicted by the SCS synthetic rainfall distribution curve. As each burst of rainfall generates a new runoff hydrograph, it is added to the preceding hydrograph with its axis displaced by the time between bursts. Once the entire storm is summed, a single hydrograph results. This hydrograph depicts the runoff prediction for that subbasin.

Hydrograph routing.
Within each basin, there are often several subbasins, each generating a runoff hydrograph. In order to observe the effects of a storm on an entire basin, it is necessary to route each subbasin hydrograph throughout the system. Since each hydrograph is based on the time of concentration, it is possible to add each subbasin hydrograph at its discharge point. The process is repeated until all of the hydrographs have been routed through the entire basin and summed at the point of discharge. This process is called hydrograph routing.

5.3.4 Computer Model

The storm drain analysis was done using HydroCad™ packaged computer applications. Consequently, a large level of detail was applied to establish runoff characteristics. In addition to calculating the peak discharge, the SCS method can also calculate the total quantity of water produced from the storm. This information is useful to determine the extent of downstream flooding or the size of ponds needed to contain and release runoff without creating significant increases in the quantity of discharged water. Data sheets from the computer model are included in Appendix C.

Section

6

Storm Drain Model

6.1 Projected Developed Conditions

The City's plat maps, proposed development plan maps, aerial photos, utility atlas maps, and discussion with City staff were used to predict development within the study area. Typically those areas which are currently platted are assumed to develop at a density of 8 homes per acre. The unplatted areas are assumed to develop at a typical rate of 4 homes per acre. The lower density rate of the unplatted areas is based primarily on the geography of the areas. Most of the unplatted areas are on steep hillsides which typically do not promote the development of more than 4 homes per acre. Platted areas are projected to develop at a typical rate of 8 homes per acre. A summary of the curve design assumption and resulting curve numbers (CN) used for modeling are shown below in Table 6.1.1.

TABLE 6.1.1
HYDROLOGIC CURVE NUMBERS FOR
FUTURE GROWTH BASED ON LAND USE

Basin	*Description*	*Area (Acres)*	*Buildout Conditions Average CN*
1A	1/4 Acre Residential and Forest	18.5	57
1B	1/4 Acre Residential	12.1	75
1C	1/8 Acre Residential	20.4	87
2A	1/4 Acre Residential and Forest	38.4	63
2B	1/8 Acre Residential	29.6	85
3A	1/4 Acre Residential	10.0	75
4A1	Forest	15.5	63
4A2	Forest	15.5	68
4B	1/4 and 1/8 Acre Residential	30.0	87
5A	1/4 Acre Residential and Forest	25.5	83
5B	1/4 and 1/8 Acre Residential	15.8	90
6A	1/8 Acre Residential	14.3	90
6B	1/8 Acre Residential and Brush	22.5	84
7A	1/8 Acre Residential	5.0	85
7B	1/8 Acre Residential and Commercial	5.5	87
8A	1/8 and 1/4 Acre Residential and Commercial	17.0	82
8B	1/8 and 1/4 Acre Residential and Commercial	21.0	81
8C	1/4 Acre Residential and Commercial	19.0	78
9A	1/8 Acre Residential	18.0	80

9B	1/8 Acre Residential	5.0	85
10A	1/4 Acre Residential	11.0	75
10B	1/4 Acre Residential	12.0	75
11	1/3 Acre Residential and Forest	16.0	59
12A	1/4 Acre Residential	26.0	69
12B	1/8 Acre Residential	17.0	92
13A	1/4 Acre Residential and Forest	19.5	65
13B	1/8 Acre Residential	6.0	92
14A	1/8 Acre Residential and Forest	17.0	71
14B	1/8 Acre Residential	10.0	92
15A	1/4 Acre Residential and Forest	23.0	72
15B	1/8 Acre Residential	10.0	92
15C	1/8 Acre Residential	9.0	92
16	Forest	81.0	55

6.2 Discharge Estimates

Present and future discharge estimates for each drainage basin were developed according to the methodology in Section 5. The HydroCad™ computer program was used to forecast peak storm flows for the developed condition. A summary of the flow projections and basin parameters for fully developed land use in each basin is provided below in Table 6.2.1. Note that Runoff values are for flow generated within each subbasin and do not include flow entering the subbasin from upstream. The total runoff for each basin consists of the sum of the subbasin values within it.

TABLE 6.2.1
PROJECTED PEAK FLOWS & BASIN PARAMETERS

Basin	Area (Acres)	Buildout Conditions Average CN	Buildout Runoff (CFS)	Buildout Time to Peak Runoff (Hours)	Basin Length (Feet)	Average Slope for Modeling (%)	% Increase In Runoff (CFS) from Existing Conditions
1A	18.5	57	7.8	8.1	1,500	33.0	***0%***
1B	12.1	75	12.5	8.0	320	4.7	***42%***
1C	20.4	87	28.9	8.0	860	3.5	***10%***
2A	38.4	63	23.0	8.1	1,825	27.0	***22%***
2B	29.6	85	39.1	8.1	1,150	3.5	***37%***
3A	10.0	75	10.1	8.0	800	5.0	***0%***
4A1	15.5	63	15.5	8.1	1,710	32.0	***65%***
4A2	15.5	68	12.5	8.1	1,710	32.0	***56%***
4B	30.0	87	40.5	8.1	1,600	3.4	***6%***
5A	25.5	83	33.1	8.0	1,960	24.5	***8%***
5B	15.8	90	20.8	8.2	1,910	1.6	***6%***
6A	14.3	90	21.8	7.9	1,010	21.0	***6%***
6B	22.5	84	24.3	8.3	1,910	1.6	***11%***
7A	5.0	85	6.7	8.0	850	3.0	***11%***
7B	5.5	87	7.9	7.9	300	3.0	***4%***

8A	17.0	82	21.6	8.0	1,600	24.0	***3%***
8B	21.0	81	25.6	8.0	2,310	24.0	***3%***
8C	19.0	78	21.2	8.0	2,300	24.0	***3%***
9A	18.0	80	21.3	8.0	1,900	18.0	***15%***
9B	5.0	85	6.9	7.9	500	5.0	***25%***
10A	11.0	75	11.3	8.0	775	11.0	***7%***
10B	12.0	75	12.1	8.0	900	6.3	***4%***
11	16.0	59	7.0	8.2	1,610	12.0	***0%***
12A	26.0	69	20.2	8.1	1,600	12.0	***35%***
12B	17.0	92	26.9	7.9	450	7.0	***5%***
13A	19.5	65	13.0	8.1	2,000	29.0	***35%***
13B	6.0	92	9.5	7.9	600	7.0	***5%***
14A	17.0	71	14.8	8.1	2,200	29.0	***20%***
14B	10.0	92	15.8	7.9	700	7.0	***3%***
15A	23.0	72	29.5	8.1	2,550	30.0	***28%***
15B	10.0	92	15.8	7.9	700	7.0	***5%***
15C	9.0	92	14.2	7.9	750	7.0	***9%***
16	81.0	55	23.4	8.4	3,175	19.0	***0%***

6.3 Model Basin Results

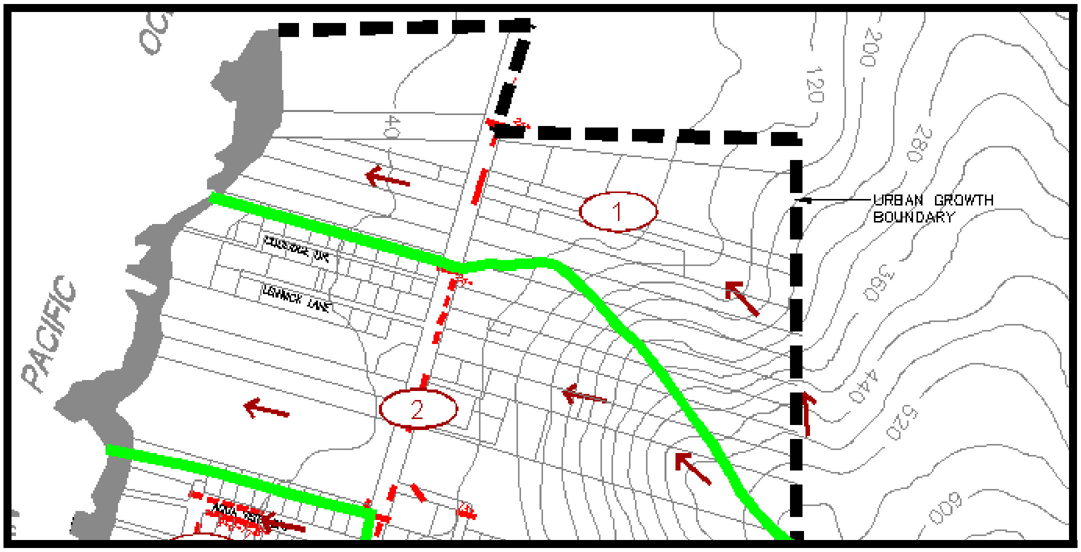
The following subsection provides graphical descriptions of the drainage requirements for each subbasin at two levels. The first planning level is based only on the terrain and slope of the basin. For each subbasin, culvert sizes and ditch sizes are recommended to accommodate the anticipated flow through the main drainage course. This information is useful as it provides a quick check of the fundamental drainage requirement for each subbasin against future plans for development, which may vary from a more detailed plan.

For the purpose of this study, all culverts were modeled with a slope of 0.025 ft/ft (0.25%) and a friction factor equal to that of N-12 HDPE storm culvert. The ditches were modeled with a trapezoidal shape having a 1:1 slope on the sides. The ditches were modeled as earth ditches with some grass, and winding in direction. The design slope for the ditches is 0.03 ft/ft (0.3%). In some instances the natural grade and condition of the basins will differ from the grades used in the study. Recalculation and design efforts will be required to ensure that adequate drainage is obtained. These situations should be resolved in design efforts when improvements or developments are made.

A graphical presentation of basic drainage requirements for all subbasins is presented as Figure A-5, which shows fundamental ditch and culvert sizes required for various portions of the study area. Figure A-5 also provides the more detailed planning information for each site specific projects based upon existing and anticipated development patterns.

A brief summary of findings for each basin is provided:

Basin 1:



The upper most area of Basin 1 is dense forest located within Subbasin 1A. This basin drains into Basin 1B. Throughout the planning period, it is not anticipated that significant development will occur in Subbasin 1A. Most of the area has slopes in excess of 30 percent which are not conducive to development. It was anticipated that only ten percent of the basin area would be developed into 1/4-acre residential parcels.

Subbasin 1A:

Storm drainage within Subbasin 1A should be designed with a minimum of 1-foot trapezoidal ditches and 15-inch mainline culverts. Culverts that are not part of the main basin drainage may be reduced in size if grades and conditions provide adequate drainage. The severe slopes of the basin will require riprap and erosion control devices to prevent the storm water velocities from damaging infrastructure.

Subbasin 1B:

Subbasin 1A flows into Subbasin 1B. Subbasin 1B is partially platted and has an average slope between 4 and 5 percent. Throughout the study period it is anticipated that the 12-acre basin will be fully developed into 1/4-acre residential parcels.

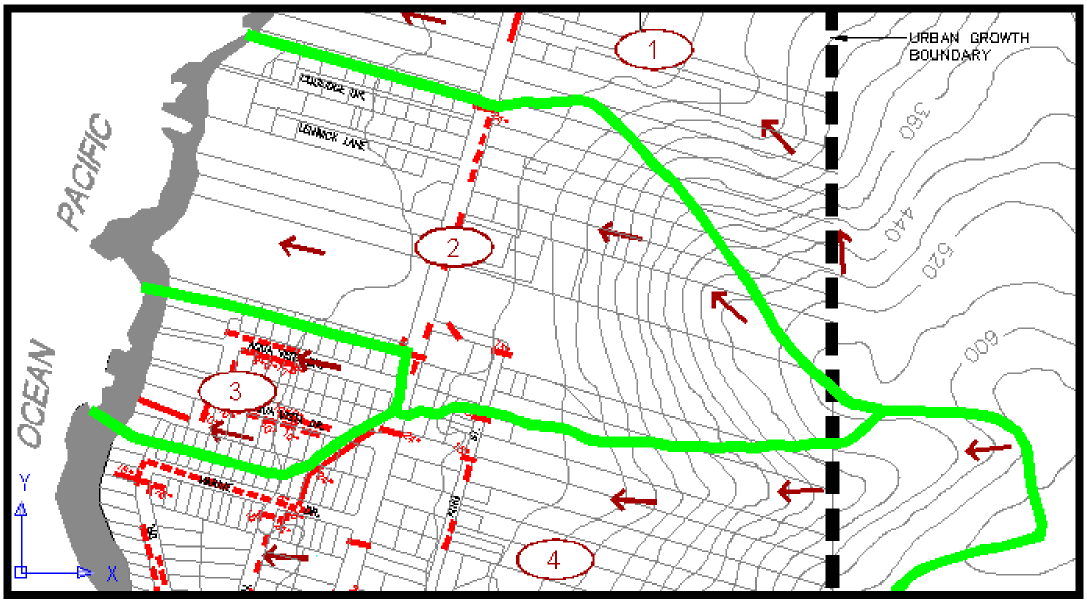
The existing culvert that crosses Highway 101 appears to be adequately sized for future development of the basin. Tributary ditches should have a minimum of 1-foot trapezoidal ditches and 18-inch culverts on the main tributaries to the main drainage. The mainline drainage downstream of Highway 101 should have a minimum of a 2-foot trapezoidal ditch, and culverts should have capacity exceeding a 27-inch culvert at design slopes.

Subbasin 1C:

Subbasin 1C is the last subbasin within Basin 1. Subbasins 1A and 1B both combine with the flows in this basin. For modeling purposes, Subbasin 1C was modeled with the equivalent of 1/8-acre residential parcels. The lots are currently fairly large, but development will lead to smaller parcels being developed over time.

The mainline ditches should have a minimum 2-foot trapezoidal ditch. The mainline culverts should have an equivalent capacity equal to a 27-inch culvert. Tributary culverts and ditches will be considerably smaller in size.

Basin 2:



Basin 2 was divided into two subbasins for modeling. The uppermost area of Basin 2 is dense forest located within Subbasin 2A. This basin drains into Basin 2B. Throughout the planning period, it is not anticipated that significant development will occur in Subbasin 2A. Most of the area has slopes in excess of 28 percent which are not conducive to development. It was anticipated that 15 acres of the basin area would be developed into 1/4-acre residential parcels.

Subbasin 2A:

Storm drainage within Subbasin 2A should be designed with 1.5-foot minimum trapezoidal ditches and 21-inch mainline culverts. Culverts that are not part of the main basin drainage may be reduced in size if grades and conditions provide adequate drainage. The severe slopes of the basin will require riprap and erosion control devices to prevent the storm water velocities from damaging infrastructure.

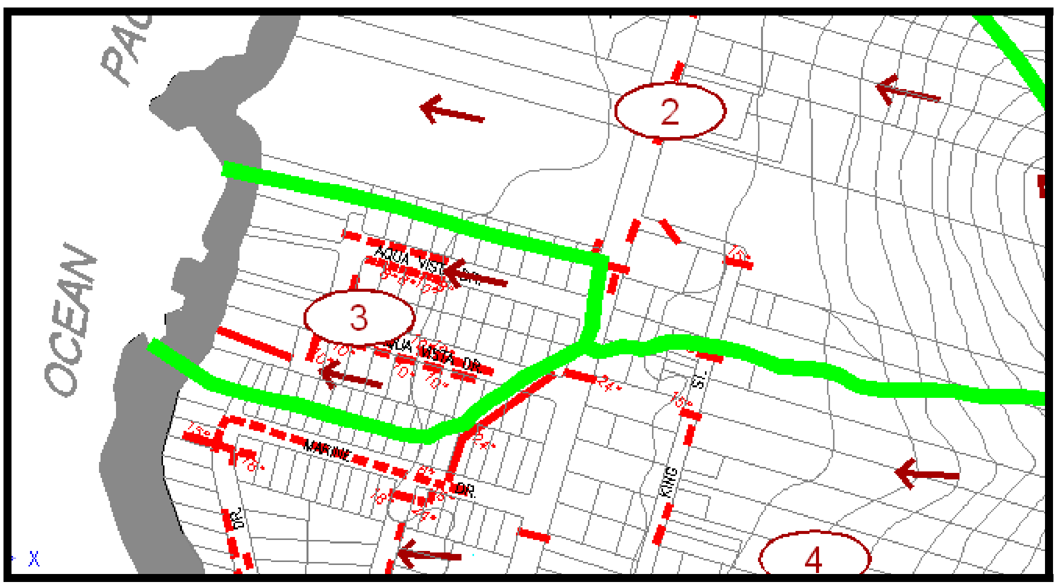
<u>Subbasin 2B:</u>

Subbasin 2B is partially platted and has an approximate average slope of 3.5 percent. Most of the basin is privately owned with little or no City storm water improvements. For modeling purposes, it was assumed that at full development, the area would have a drainage coefficient equal to that of 1/8-acre residential areas, or 65 percent impervious area.

The existing culvert that crosses Highway 101 appears to be adequately sized for the current development of the basin. At full development the culvert or culverts that cross the Highway should have a combined capacity exceeding that of a 30-inch culvert. The slopes of the existing culvert appear to exceed our design grades, and may prove to be adequately sized to handle full build-out flow, if properly maintained and mainline ditches are cleaned. Mainline ditches downstream of the Highway culvert should be 2-foot trapezoidal ditches.

The main tributary ditches of Subbasin 2A should have 1.5-foot minimum trapezoidal ditches and 18-inch culverts on the main tributaries to the main drainage.

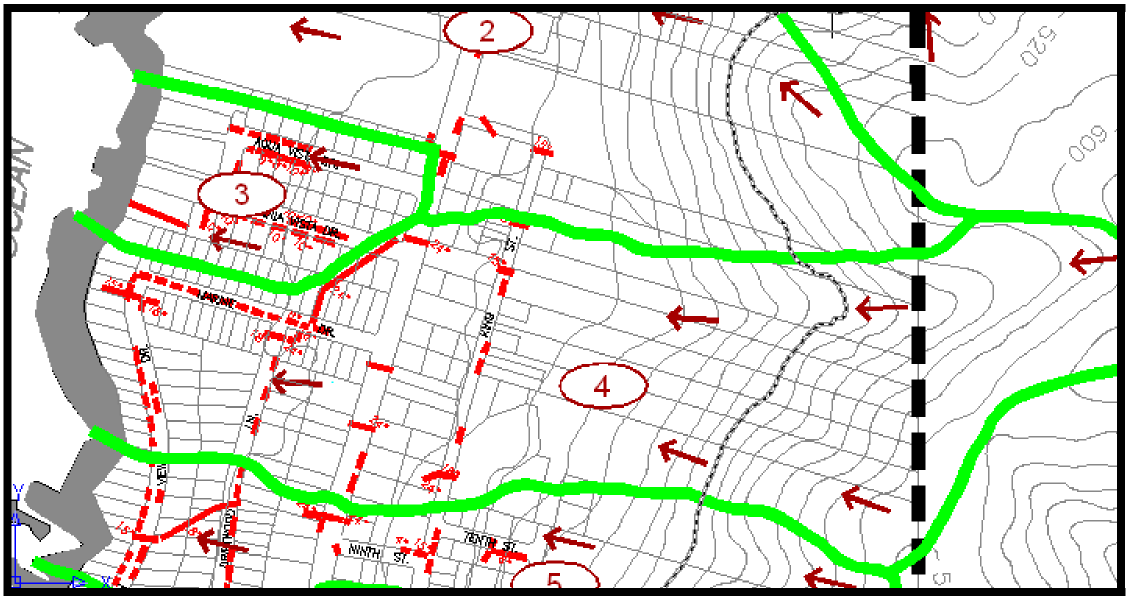
Basin 3:



Basin 3 is a relatively small basin located to the west of Highway 101; it encompasses the Aqua Vista Drive area. The area was modeled to have residential lots equivalent to 1/4-acre lots as determined from the plat maps. The area modeled was reduced to only 10 acres due to the majority of the westernmost properties in the basin draining directly into the Pacific Ocean.

The existing drainage area has mostly 10-inch drain pipe in the basin. The culverts should be 15-inches minimum in diameter from mainline to the Pacific Ocean. Culverts with a minimum of 12 inches are recommended along the sides of Aqua Vista Drive. The ditches in the basin should be 1-foot minimum trapezoidal ditches. The mainline ditch to the ocean from Aqua Vista Drive should be a 1.5-foot trapezoidal ditch or larger.

Basin 4:



Basin 4 was broken into three subbasins for the modeling of the system. Subbasins 4A1 and 4A2 are similar in geometry and size and both flow into Subbasin 4B. Subbasin 4B flows into the Pacific Ocean.

<u>Subbasins 4A & 4B:</u>

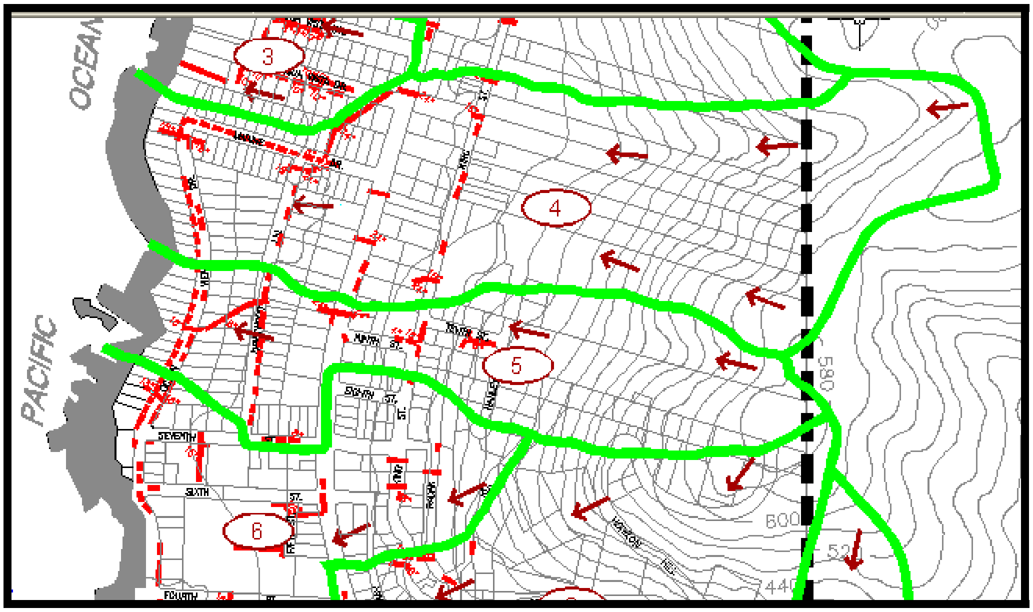
Despite extreme slopes of Subbasins 4A and 4B, significant development is anticipated in these basins. The basins were modeled as a combination of woods, and ¼ and 1/8 acre residential areas. Drainage from these two Subbasins will require 18-inch culverts and 1.5-foot trapezoidal ditches. The steep slopes will lead to high velocities within the storm drain system, and riprap will be required at culvert entrances and exits. Exposed earth ditches will be prone to erosion.

<u>Subbasin 4C:</u>

The existing culverts that cross Highway 101 appear to be in adequate condition and have adequate capacity to meet the buildout of the basin. Slopes of the culverts should be verified and the ditches should have a minimum 2-foot trapezoidal shape.

The existing mainline culverts along Marine Drive in the basin appear to be undersized. To adequately handle design flows, the existing 18-inch and 24-inch culverts should be upsized to a minimum 36-inch diameter. Tributary culverts appear to be adequately sized from modeling and City staff reports. The City has recently upsized a section of the mainline culvert adjacent to Main Pump Station. Ideally upstream section of this pipe should also be of the same diameter and material for continuity of the system. Slopes of the ground in this area may promote the use of 30-inch culverts.

Basin 5:



Basin 5 has two subbasins. The uppermost area of Basin 5 is dense forest located within Subbasin 5A. This basin drains into Basin 5B. Throughout the planning period, it is not anticipated that significant development will occur in Subbasin 5A. Some of the basin will experience growth as developers have been working on plans to provide residential housing in the area. Most of the area has slopes in excess of 25 percent; they are not conducive to dense development. It was anticipated that 14.5 acres of the basin area would be developed into 1/4-acre residential parcels. A portion of this basin has been platted at the time of this study.

<u>Subbasin 5A:</u>

Storm drainage within Subbasin 5A should be designed with 1.5-foot minimum trapezoidal ditches and 24-inch mainline culverts. Culverts that are not part of the main basin drainage may be reduced in size if grades and conditions provide adequate drainage. The severe slopes of the basin will require riprap and erosion control devices to prevent the storm water velocities from damaging infrastructure. The soil classification within this basin does not promote good drainage.

<u>Subbasin 5B:</u>

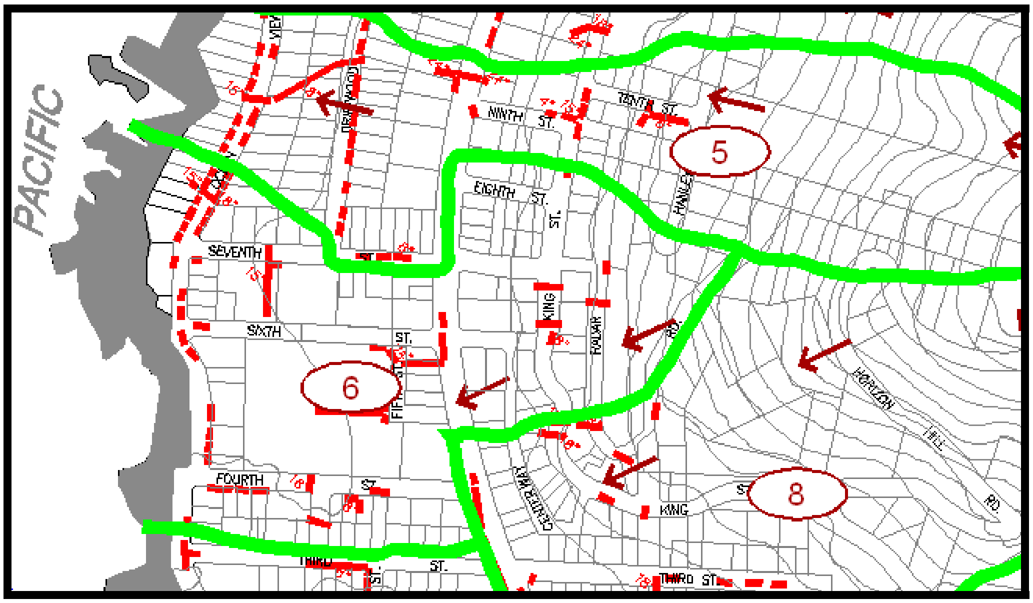
For modeling purposes it was assumed that at full development, the area would have a drainage coefficient equal to that of 1/8-acre residential areas, or 65 percent impervious area.

The existing 24-inch culvert that crosses Highway 101 appears to be adequately sized for the current development of the basin. The slopes of the existing culvert should be verified but appear to exceed our design grades. Developers within this basin should verify grades and document that the culverts are adequately sized.

Mainline ditches downstream of the Highway culvert should be 2-foot trapezoidal ditches. Mainline culverts downstream of Highway 101 shall have the capacity of 27-inch culverts at our design grade.

The main tributary ditches of Subbasin 5A should have 1.5-foot minimum trapezoidal ditches and 18-inch culverts on the main tributaries to the main drainage.

Basin 6:



Basin 6 has two subbasins which were modeled in HydroCAD. The lower subbasin, 6B, is comprised of man-made wetlands. Due to the wetlands, no improvements or analysis was conducted that would jeopardize the wetlands.

Subbasin 6A:

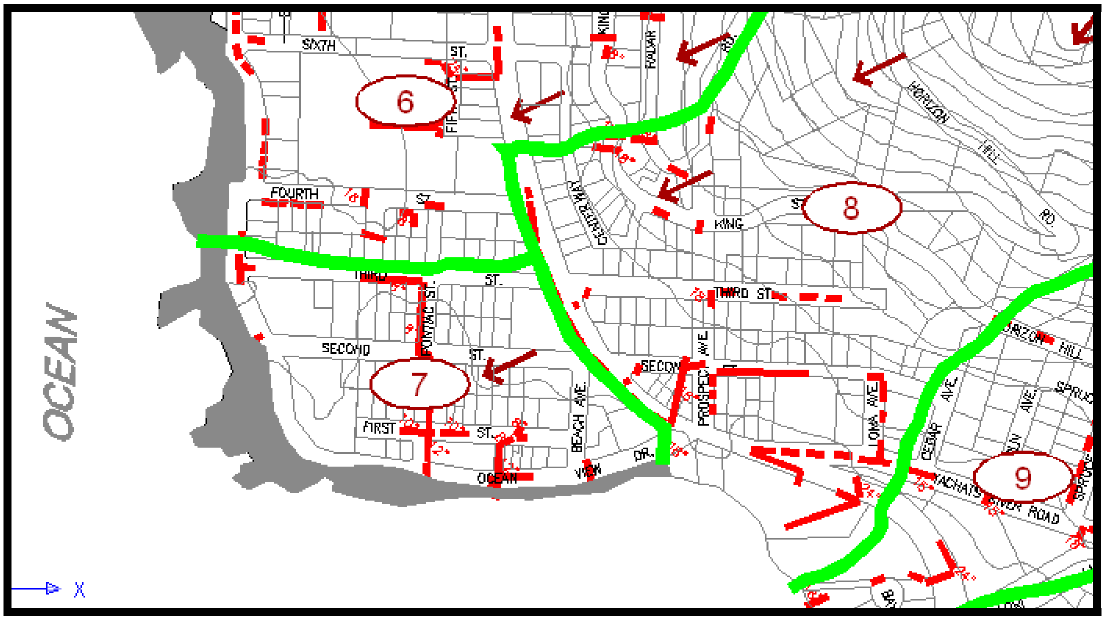
Storm drainage within Subbasin 6A should be designed with 1.5-foot minimum trapezoidal ditches and 21-inch mainline culverts. Culverts that are not part of the main basin drainage may be reduced in size if grades and conditions provide adequate drainage. The severe slopes of the basin will require riprap and erosion control devices to prevent the storm water velocities from damaging infrastructure. Some of the uppermost culverts in the basin are 8-inch culverts, and should be upsized to 12-inch when possible.

The culvert that flows under Highway 101 is currently a 24-inch culvert and should be adequately sized, assuming grades and maintenance are performed on the culvert.

Subbasin 6B:

Subbasin 6B receives runoff from Subbasin 6A. Subbasin 6B is mostly man-made wetlands. The culverts that drain the wetlands were not evaluated due to the desire of the City to preserve the wetlands. If the City wanted to drain the wetlands, culverts equivalent to a 24-inch diameter with 2-foot trapezoidal ditches would be required.

Basin 7:

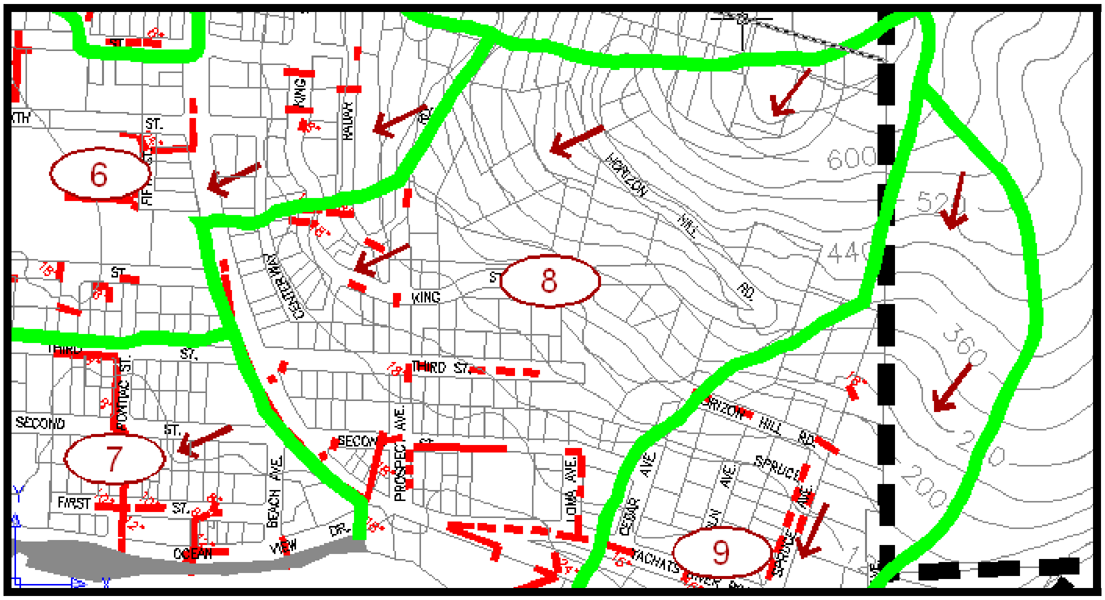


Basin 7 has been modeled with two small subbasins having a buildout density of 1/8-acre residential housing. The existing drainage area is composed of mostly 8-inch drain pipe in the upper portion of the basin.

The culverts should be a minimum of 12-inch diameter from mainline drainage paths to the Pacific Ocean. It is important to note that the existing 12-inch diameter culvert appears to have adequate capacity due to the steep grade of the culvert. City staff has indicated that erosion and or clogging of the culvert has not been an issue in the past. The mainline culvert to the ocean should have capacity equivalent to an 18-inch culvert at our design grade.

A minimum of 12-inch culverts is recommended along Pontiac Street. The existing 8-inch lines are not current standard and may lead to maintenance and capacity issues. The mainline ditches in the basin should have 1.5-foot minimum trapezoidal ditches.

Basin 8:



Basin 8 is comprised of three main drainage subbasins: 8A, 8B, and 8C. All three of the subbasins drain toward Highway 101 where they are collected into a drainage system that conveys the water toward a main outlet into the Yachats River on the west side of Prospect Avenue. Subbasin 8C does not combine with the other two subbasins. The upper east section of the basins is primarily 1/4-acre residential, and the lower sections of the basins along Highway 101 are commercial businesses. There are some areas of 1/8-acre residential in each basin.

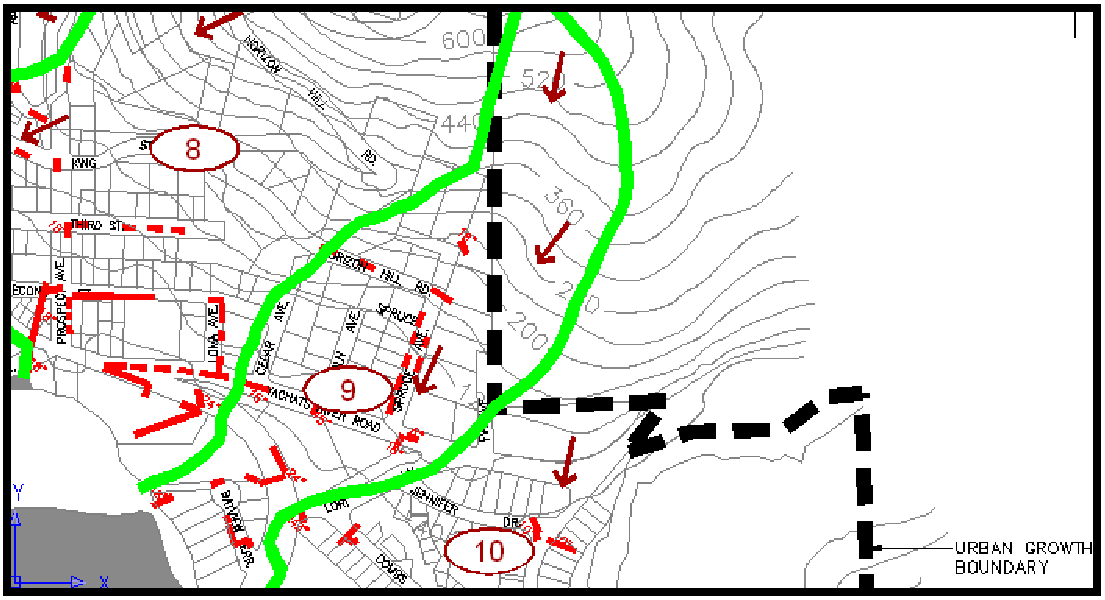
All three of the subbasins should have mainline culvert capacities equivalent to 21-inch pipes. The ditches should be 1.5-foot trapezoidal ditches with erosion control in the steeper areas.

The mainline Highway culverts downstream of Subbasin 8B should have capacity exceeding that of a 27-inch culvert. The design grades used in modeling were conservative, and design calculations may allow the use of a smaller culvert along the front of the businesses on the Highway. Many of the catch basins appeared to be in need of maintenance and upsizing.

The culvert crossing Highway 101 for Subbasin 8C should have capacity equivalent to a 21-inch culvert. This culvert is located to the south of Prospect Avenue and to the west of Loma Avenue, across Highway 101.

Arterial collector culverts for the basin should be 12-inch diameter culverts at a minimum.

Basin 9:



Basin 9 has two subbasins that were modeled in HydroCAD. The lower subbasin, 9B, encompasses the Bayview Terrace area. Most of the area is projected to be 1/8-acre lots at full buildout.

<u>Subbasin 9A:</u>

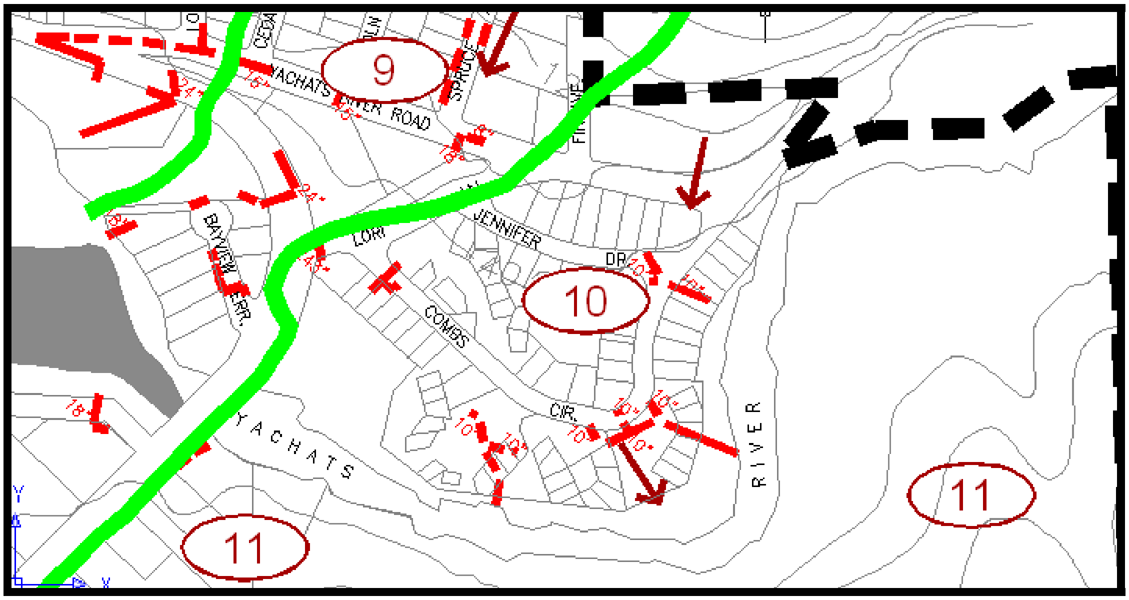
Storm drainage within Subbasin 9A should be designed with 1.5-foot minimum trapezoidal ditches and 21-inch mainline culverts. Culverts that are not part of the main basin drainage may be reduced in size if grades and conditions provide adequate drainage. The severe slopes of the basin will require riprap and erosion control devices to prevent the storm water velocities from damaging infrastructure.

The culvert that flows under Highway 101 below Yachats River Road is currently a 24-inch culvert and should be adequately sized, assuming grades and maintenance are performed on the culvert. There appears to be a storm water overflow culvert located at the Lori Lane intersection. The overflow culvert would provide relief to the Highway crossing in the event that the Highway culverts become obstructed.

<u>Subbasin 9B:</u>

Subbasin 9B receives runoff from Subbasin 9A. The mainline culvert that flows through the Bayview Terrace area is currently an 18-inch culvert. Modeling has indicated that the culvert should have capacity equivalent to a 24-inch culvert to meet build out conditions of Basin 9. The main ditch should have a 2-foot trapezoidal shape at the design grade.

Basin 10:

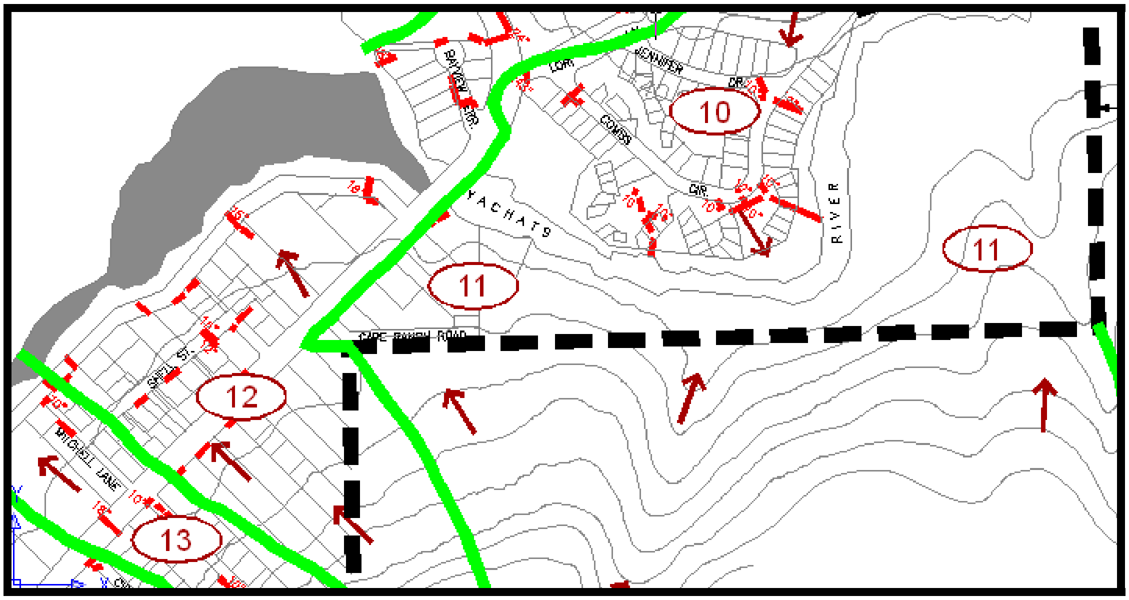


Basin 10 was modeled with two smaller subbasins, 10A and 10B. The area was modeled with a buildout density of 1/4-acre residential housing. The existing drainage area is composed of mostly 10-inch drain pipe. Discussions with the City indicated that the lot sizes are not predicted to change throughout the design period of the study. They did indicate that this area is prone to flooding-related issues.

Both subbasins should have mainline culverts with capacities equivalent to 18-inch culverts and ditches with a trapezoidal shape of 1.5 feet. Modeling has indicated that existing 10-inch culverts are undersized to meet the design storm runoff.

The high tides experienced during the winter months appear to compound the storm water runoff issues in this region. Further discussion of solutions to these flooding events can be found in Section 7.

Basin 11:

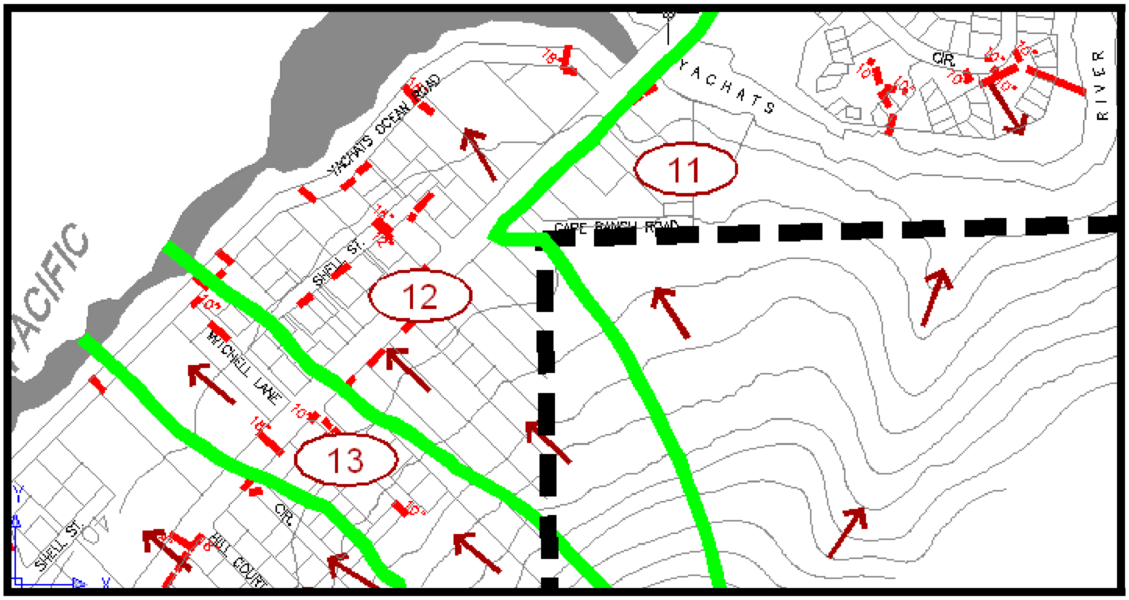


Basin 11 is a relatively undeveloped basin located to the south of the Yachats River. The basin has a relatively small section to the west that drains towards the Highway. The remainder of the basin flows directly into the Yachats River through natural drainage paths and was not evaluated. The City did not anticipate building facilities and infrasture on the eastern portion of the basin due to the geography of the area. The section of the basin evaluated was primarily 1/3-acre residential lots.

The mainline culverts along Highway 101 should have capacity equivalent to a 12-inch diameter culvert. The mainline ditches should be a 1-foot trapezoidal shape.

It appears that the existing culverts have adequate capacity to meet the design flows with proper maintenance of the system.

Basin 12:



Basin 12 has two subbasins, 12A and 12B. The uppermost area of Basin 12 is dense forest located within Subbasin 12A. This basin drains into Basin 12B. Throughout the planning period, it is not anticipated that significant development will occur in Subbasin 12A. Most of the area has slopes in excess of 25 percent which are not conducive to development. It was anticipated that the basin area would be developed into 1/4-acre residential parcels. A portion of this basin has been platted at the time of this study.

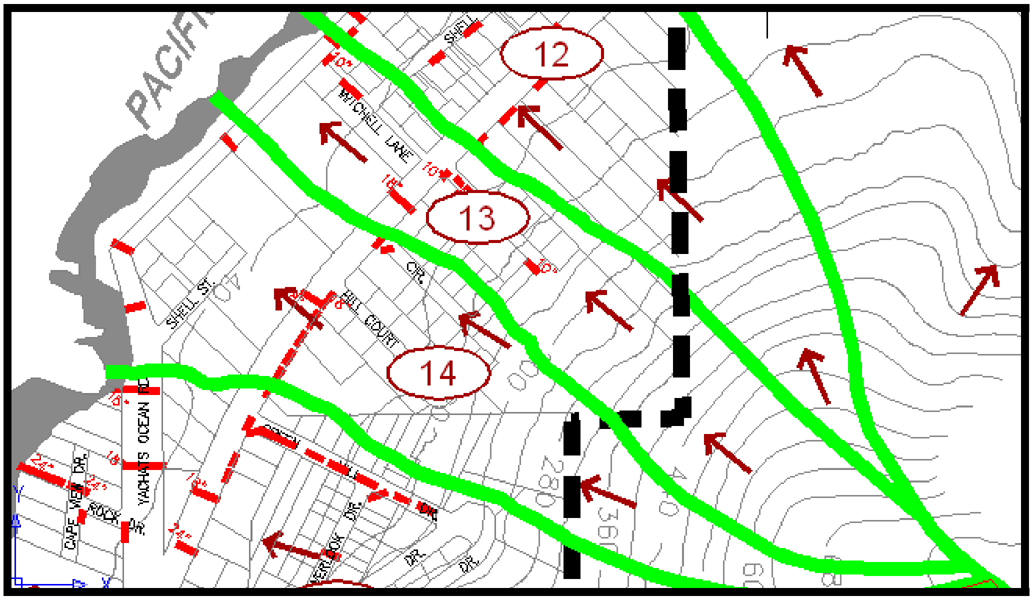
<u>Subbasin 12A:</u>

Storm drainage within Subbasin 12A should be designed with 1.5-foot minimum trapezoidal ditches and 21-inch mainline culverts. The culverts along Highway 101 serve as part of the mainline culvert, and should be equivalent to the 21-inch pipe. Culverts that are not part of the main basin drainage may be reduced in size if grades and conditions provide adequate drainage. The severe slopes of the basin will require riprap and erosion control devices to prevent the storm water velocities from damaging infrastructure.

<u>Subbasin 12B:</u>

Subbasin 12B includes a large portion of area that flows through various drainage paths to the Pacific Ocean. The tributary culverts in this area should be sized with a capacity equivalent to an 18-inch diameter culvert. The mainline culverts that collect water from Subbasin 12A should have capacity equivalent to a 27-inch culvert to accommodate buildout runoff. The mainline ditches should be 2-foot trapezoidal ditches clear of obstructions. Erosion control will be needed in the steeper areas of Basin 12.

Basin 13:

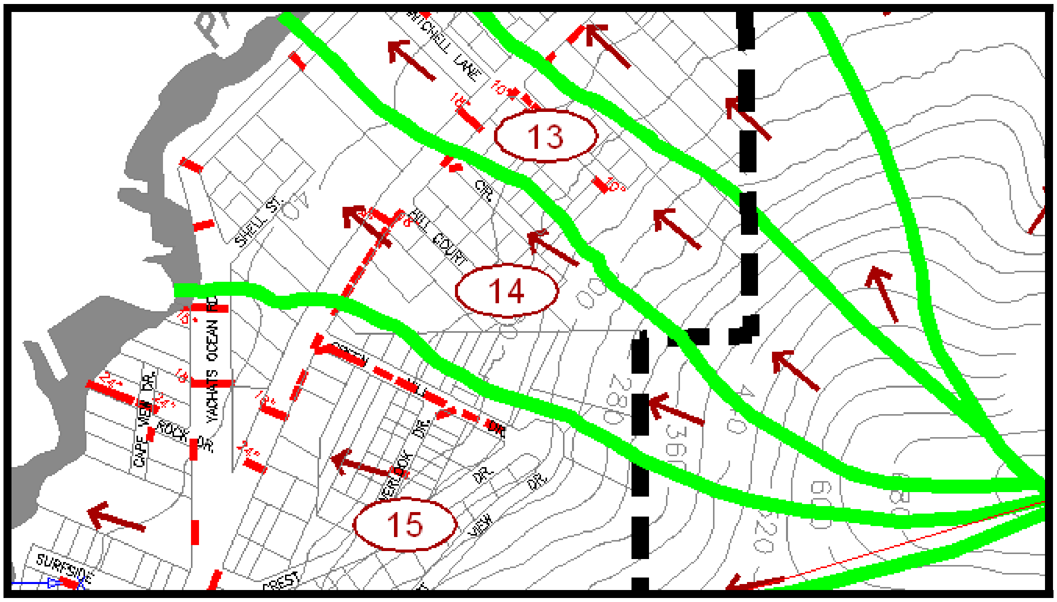


Basin 13 was modeled with two subbasins, 13A and 13B. Subbasin 13A was modeled with a buildout density of 1/8-acre residential housing over approximately 10 acres of the subbasin. The remainder of the subbasin appears too steep for development. Subbasin 13B was modeled with a buildout density of 8 homes per acre.

Both subbasins should have mainline culverts with capacities equivalent to 18-inch culverts and ditches with a trapezoidal shape of 1.5 feet.

The Highway 101 culvert should be adequately sized, assuming the slope exceeds the design slope and the mainline ditches remain clear and unobstructed.

Basin 14:



Basin 14 was modeled with two subbasins, 14A and 14B. Subbasin 14A was modeled with a buildout density of 1/8-acre residential housing over approximately 8 acres of the subbasin. The remainder of the subbasin appears to steep for development. Subbasin 14B was modeled with a buildout density of 8 homes per acre.

<u>Subbasin 14A:</u>

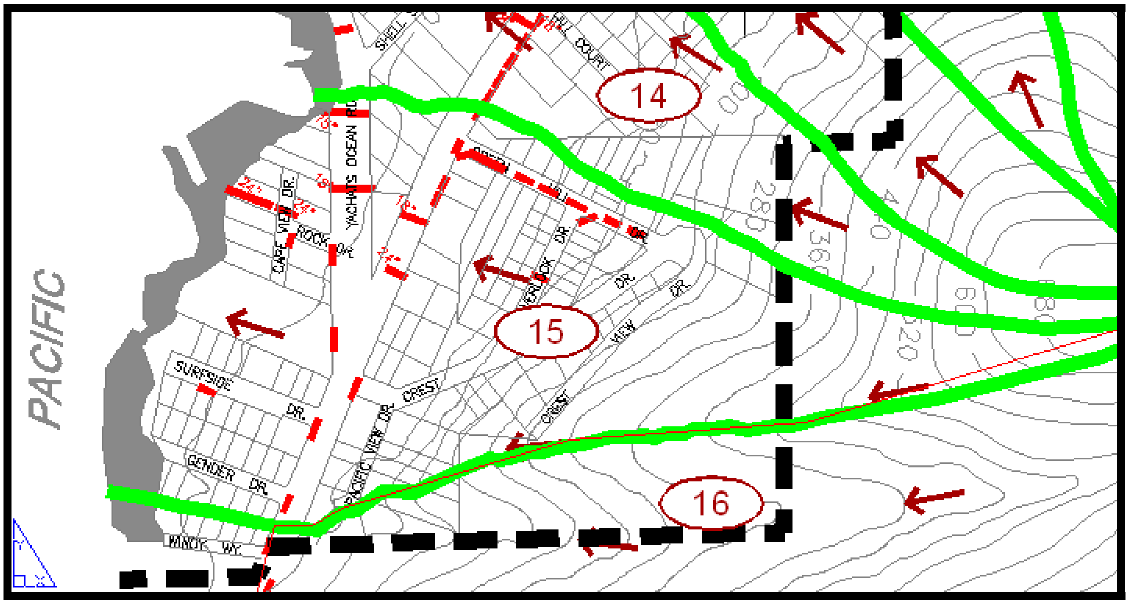
Subbasin 14A should have mainline culverts with capacity equivalent to 18-inch culverts at design slopes. The ditches should be 1.5-foot minimum trapezoidal ditches clear of obstructions.

The Highway 101 culvert should be adequately sized assuming the slope exceeds the design slope and the mainline ditches remain clean and unobstructed.

<u>Subbasin 14B:</u>

Subbasin 14B should have mainline culverts with capacity equivalent to 24-inch culverts at design slopes. The ditches should be a minimum of 2-foot trapezoidal ditches clear of obstructions. The flat topography makes modeling of the subbasin difficult. There appear to be many meandering ditches that combine to accommodate the main drainage from the basin. Emphasis was placed on one mainline ditch and culvert system to convey storm water runoff from the subbasin.

Basin 15:



Basin 15 was modeled with three subbasins: 15A, 15B, and 15C. Subbasin 15A was modeled with a buildout density of 1/4-acre residential housing over approximately 9 acres of the subbasin. The remainder of the subbasin appears too steep for development. Subbasins 14B and 14C were modeled with a buildout density of 8 homes per acre. The soils within this basin provide poor permeability.

<u>Subbasin 15A:</u>

Subbasin 15A should have mainline culverts with capacity equivalent to 18-inch culverts at design slopes. The ditches should be 1.5-foot minimum trapezoidal ditches clean of obstructions.

The Highway 101 culverts should be adequately sized, assuming the slope exceeds the design slope and the mainline ditches remain clear and unobstructed.

<u>Subbasin 15B:</u>

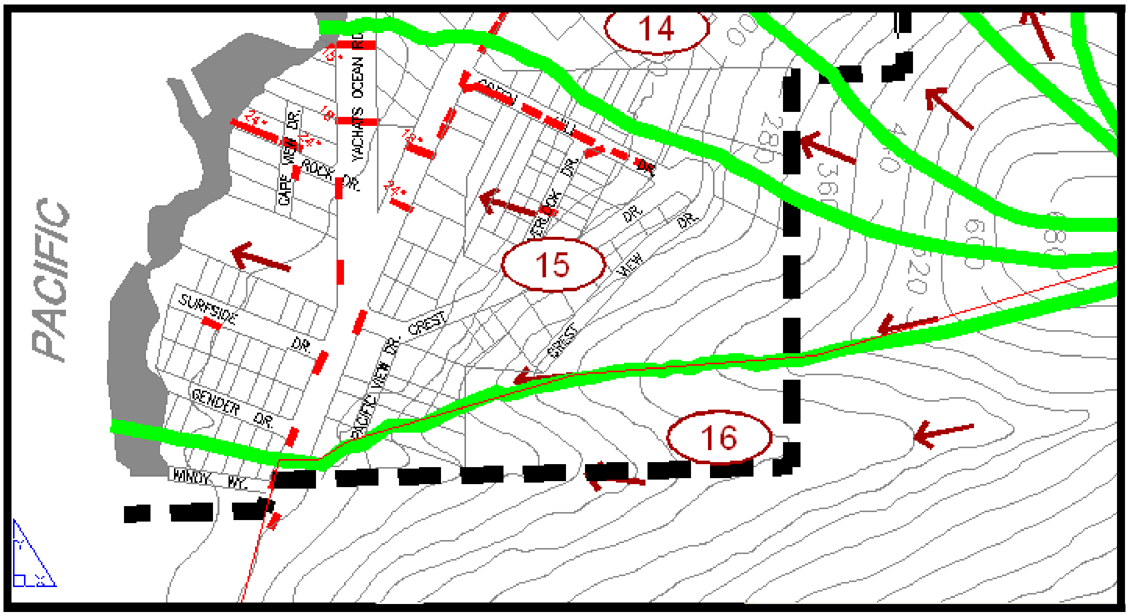
Subbasin 15B should have mainline culverts with capacity equivalent to 24-inch culverts at design slopes. The ditches should be 2-foot minimum trapezoidal ditches clear of obstructions. The flat topography makes modeling of the subbasin difficult. There appear to be many meandering ditches that combine to accommodate the main drainage from the basin. Emphasis was placed on one mainline ditch and culvert system to convey storm water runoff from the subbasin.

<u>Subbasin 15C:</u>

Subbasin 15C should have mainline culverts with capacity equivalent to 18-inch culverts at design slopes. The ditches should be 1.5-foot minimum trapezoidal ditches clear of obstructions.

The City is recommended to upsize the culvert located along Gender Drive and Surfside Dr. to 24-inch culverts to accommodate flows in the event the Highway Culvert in Basin 16 becomes obstructed.

Basin 16:



Basin 16 is the southernmost basin within the city limits. The basin is primarily forestlands with slopes exceeding 20 percent. Development of this basin is not anticipated throughout the planning period.

The basin was modeled as one basin, and the Highway culvert should have capacity exceeding that of a 24-inch culvert. It appears that the culvert is adequately sized for the design storm system. The ditches upstream and downstream of the highway culvert should be 1.5-foot minimum trapezoidal culverts clear of obstructions.

Due to past problems with the Highway Culvert clogging with debris, it is recommended that the City pursue a maintenance schedule with the Oregon Department of Transportation. The installation of a screen or debris diversion mechanism is also recommended.

It is recommended that the City upsize the culverts located along Gender Drive and Surfside Dr. of Basin 15 to 24-inch culverts to accommodate flows in the event the Highway Culvert in Basin 16 becomes obstructed. The ditch downstream of the culvert should be free of obstruction.

Section 7

Recommended Plan

7.1 Proposed Storm Drain Improvements

With the use of the hydraulic storm model, consideration of existing and planned development, and City staff input, a recommended improvement plan has been established for the City of Yachats Storm Water System.

This section contains the estimated costs for improvements anticipated within the next 20 years in the City of Yachats Study Area. The majority of improvements shown that are needed to increase capacity should be the responsibility of developers as each parcel is developed. Some culverts are undersized to meet current storm water flows, and these costs should not be the responsibility of developers.

A number of factors were considered in developing projects. Due to the smooth-wall nature of the plastic pipe material, it is recommended that drainage culverts include the use of PVC or N-12 HDPE pipe rather than CMP, to avoid future problems with corrosion and to provide much greater storm flow capacity per inch diameter of culvert.

A map showing the location of proposed improvements projects and project priorities is included in Appendix A as Figure A-5. The project priorities are ranked from Priority 1 through Priority 3, with Priority 1 being the highest priority projects.

7.2 Basis of Cost Estimates

The magnitude cost estimates in the plan have four components: construction costs, engineering costs, legal and administrative costs, and property acquisition costs. The cost estimates are preliminary in nature and are based on large scale planning detail. As projects enter the individual planning stage, that is, closer to being realized, more information will be gathered and the cost estimates will be refined. Actual costs will differ from what is shown here.

7.2.1 Construction Cost

The magnitude construction costs in this capital improvement plan are based on current averages of actual bidding results from similar work. Future changes in the cost of labor, equipment, and materials will require that these costs be updated. The Engineering News Record (ENR) construction cost index is the most common method of updating construction cost estimates. The index for May 2008 was 8,140. Future yearly ENR indices can be used to calculate the cost of projects for their construction year based on the ratio of the ENR index at that time divided by the ENR index of 8,140.

A contingency factor of 20 percent of the construction and engineering cost was added to the total project cost. Because the cost estimates presented are based on low precision mapping and conceptual layouts, allowances must be made for variations in final quantities, bidding market conditions, adverse construction conditions, and other difficulties which were not included but may occur.

7.2.2 Engineering Cost

The cost of engineering services for projects typically include special investigations, a pre-design report, surveying, geotechnical exploration, preparation of contract drawings and 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 project, engineering costs may range from 15 to 25 percent of the contract cost when all of the above services are provided. The lower percentage applies to large projects without complicated mechanical systems. The higher percentage applies to small, complicated projects. The engineering costs for design and construction used in this study average 20 percent of the construction cost.

7.2.3 Environmental Review and Permits

A number of the recommended projects involve replacing piping that crosses Highway 101. The State of Oregon Highway Department will require a permit for each highway crossing within their jurisdiction. The Department of State Lands (DSL) requires a permit for any project in a wetland or body of water that involves more than 50 cubic yards of fill or removal.

It is assumed that DSL permits will not be required for the recommended projects.

7.2.4 Legal and Administrative Cost

An allowance of three percent of construction cost was added for legal and administrative services. This allowance is intended to include internal project planning and budgeting.

7.2.5 Property Acquisition Cost

Costs for property acquisition and easements were not included in the cost estimate. At the beginning of each project, an evaluation of existing easements, both recorded and prescriptive should be made. It may be necessary to purchase easements or properties for routing storm drainage.

7.3 Cost Estimates

Cost estimates were developed for each Site Specific Improvement. The costs do not include storm water treatment or commercial development features for wetlands mitigation, or detention basin or bio-swale costs which are borne by the developer and are unique for each planned development. The unit costs are in 2008 dollars and, as such, must be updated for future projects. See Table 7.4.1, Section 5, and Figure A5 in the Appendix for project descriptions and locations.

Table 7.3.1-Project No. 1 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$650	$650
2	Demolition and Site Preparation	LS	1	$500	$500
3	12" Storm Drain - Class C Backfill	LF	80	$40	$3,200
4	Ditching 1 ft btm. x 1 ft deep	LF	200	$7	$1,400
5	Asphalt R&R	TON	10	$120	$1,200
6	Rip Rap	TON	10	$50	$500
7	Misc. Appurtenances	LS	1	$170	$170
		Project Subtotal			***$7,620***
		Engineering			***$1,550***
		Contingency			***$1,700***
		Legal Admin.			***$230***
		Permitting			***$100***
		Project Total			***$11,200***

Table 7.3.2-Project No. 2 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$875	$875
2	Demolition and Site Preparation	LS	1	$660	$660
3	18" Storm Drain - Class C Backfill	LF	80	$60	$4,800
4	Ditching 1.5 ft btm. x 1.5 ft deep	LF	250	$8	$2,000
5	Asphalt R&R	TON	10	$120	$1,200
6	Rip Rap	TON	10	$50	$500
7	Misc. Appurtenances	LS	1	$245	$245
		Project Subtotal			***$10,280***
		Engineering			***$2,060***
		Contingency			***$2,260***
		Legal Admin.			***$300***
		Permitting			***$100***
		Project Total			***$15,000***

Table 7.3.3-Project No. 3 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$3,120	$3,120
2	Demolition and Site Preparation	LS	1	$2,340	$2,340
3	18" Storm Drain - Class C Backfill	LF	80	$60	$4,800
4	24" Storm Drain - Class C Backfill	LF	80	$80	$6,400
5	Ditching 1.5 ft btm. x 1.5 ft deep	LF	150	$8	$1,200
6	Ditching 2 ft btm. x 2 ft deep	LF	150	$9	$1,350
7	Rock Excavation	CY	80	$150	$12,000
8	Asphalt R&R	TON	30	$120	$3,600
9	Rip Rap	TON	30	$50	$1,500
10	Misc. Appurtenances	LS	1	$300	$300
		Project Subtotal			***$36,610***
		Engineering			***$7,350***
		Contingency			***$7,940***
		Legal Admin.			***$1,000***
		Permitting			***$300***
		Project Total			***$53,200***

Table 7.3.4-Project No. 4 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$1,600	$1,600
2	Demolition and Site Preparation	LS	1	$1,200	$1,200
3	24" Storm Drain - Class C Backfill	LF	80	$80	$6,400
4	Rock Excavation	CY	40	$150	$6,000
5	Ditching 2 ft btm. x 2 ft deep	LF	150	$9	$1,350
6	Asphalt R&R	TON	10	$120	$1,200
7	Rip Rap	TON	10	$50	$500
8	Misc. Appurtenances	LS	1	$290	$290
		Project Subtotal			***$18,540***
		Engineering			***$3,700***
		Contingency			***$4,000***
		Legal Admin.			***$560***
		Permitting			***$300***
		Project Total			***$27,100***

Table 7.3.5-Project No. 5 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$1,700	$1,700
2	Demolition and Site Preparation	LS	1	$1,250	$1,250
3	27" Storm Drain - Class C Backfill	LF	80	$90	$7,200
4	Rock Excavation	CY	40	$150	$6,000
5	Ditching 2 ft btm. x 2 ft deep	LF	150	$9	$1,350
6	Asphalt R&R	TON	10	$120	$1,200
7	Rip Rap	TON	10	$50	$500
8	Misc. Appurtenances	LS	1	$300	$300
		Project Subtotal			***$19,500***
		Engineering			***$4,000***
		Contingency			***$4,220***
		Legal Admin.			***$580***
		Permitting			***$300***
		Project Total			***$28,600***

Table 7.3.6-Project No. 6 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$800	$800
2	Demolition and Site Preparation	LS	1	$600	$600
3	12" Storm Drain - Class C Backfill	LF	100	$40	$4,000
4	Ditching 1 ft btm. x 1 ft deep	LF	200	$7	$1,400
5	Asphalt R&R	TON	15	$120	$1,800
6	Rip Rap	TON	10	$50	$500
7	Misc. Appurtenances	LS	1	$200	$200
		Project Subtotal			***$9,300***
		Engineering			***$1,900***
		Contingency			***$2,020***
		Legal Admin.			***$280***
		Permitting			***$3,000***
		Project Total			***$16,500***

Table 7.3.7-Project No. 7 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$3,750	$3,750
2	Demolition and Site Preparation	LS	1	$2,820	$2,820
3	12" Storm Drain - Class C Backfill	LF	600	$40	$24,000
4	Catch Basin	EA	4	$1,500	$6,000
5	Asphalt R&R	TON	20	$120	$2,400
6	Rip Rap	TON	20	$50	$1,000
7	Tidegates	EA	2	$1,500	$3,000
8	Misc. Appurtenances	LS	1	$200	$1,190
		Project Subtotal			***$44,160***
		Engineering			***$8,840***
		Contingency			***$9,500***
		Legal Admin.			***$1,350***
		Permitting			***$450***
		Project Total			***$64,300***

Table 7.3.8-Project No. 8 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$4,550	$4,550
2	Demolition and Site Preparation	LS	1	$2,850	$2,850
3	24" Storm Drain - Class C Backfill	LF	40	$80	$3,200
4	Highway Crossing	LF	40	$300	$12,000
5	Rock Excavation	CY	40	$150	$6,000
6	Ditching 2 ft btm. x 2 ft deep	LF	150	$9	$1,350
7	Asphalt R&R	TON	120	$120	$14,400
8	Rip Rap	TON	10	$50	$500
9	Misc. Appurtenances	LS	1	$300	$300
		Project Subtotal			***$45,150***
		Engineering			***$9,050***
		Contingency			***$9,800***
		Legal Admin.			***$1,400***
		Permitting			***$3,000***
		Project Total			***$68,400***

Table 7.3.9-Project No. 9 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$4,520	$4,520
2	Demolition and Site Preparation	LS	1	$2,850	$2,850
3	24" Storm Drain - Class C Backfill	LF	40	$80	$3,200
4	Highway Crossing	LF	40	$300	$12,000
5	Ditching 2 ft btm. x 2 ft deep	LF	150	$9	$1,350
6	Rock Excavation	CY	40	$150	$6,000
7	Asphalt R&R	TON	120	$120	$14,400
8	Rip Rap	TON	10	$50	$500
9	Misc. Appurtenances	LS	1	$230	$230
		Project Subtotal			***$45,050***
		Engineering			***$9,000***
		Contingency			***$9,800***
		Legal Admin.			***$1,350***
		Permitting			***$3,000***
		Project Total			***$68,200***

Table 7.3.10-Project No. 10 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$26,500	$26,500
2	Demolition and Site Preparation	LS	1	$16,500	$16,500
3	12" Storm Drain - Class C Backfill	LF	100	$40	$4,000
4	24" Storm Drain - Class C Backfill	LF	900	$80	$72,000
5	27" Storm Drain - Class C Backfill	LF	60	$90	$5,400
6	Utility Relocate	LS	1	$7,500	$7,500
7	Highway Crossing-27" Storm Drain	LF	40	$400	$16,000
8	Asphalt R&R	TON	400	$120	$48,000
9	Manholes	EA	3	$3,000	$9,000
10	Concrete Curb	LF	900	$25	$22,500
11	Sidewalk	SF	1200	$10	$12,000
12	Catch Basins	EA	10	$1,500	$15,000
13	Rock Excavation	CY	50	$150	$7,500
14	Rip Rap	TON	10	$50	$500

Table 7.3.10-Project No. 10 Cost Estimate continued

15	Misc. Appurtenances	LS	1	$4,100	$4,100
		Project Subtotal			***$266,500***
		Engineering			***$53,300***
		Contingency			***$57,600***
		Legal Admin.			***$8,000***
		Permitting			***$3,000***
		Project Total			***$388,400***

Table 7.3.11-Project No. 11 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$2,100	$2,100
2	Demolition and Site Preparation	LS	1	$1,310	$1,310
3	24" Storm Drain - Class C Backfill	LF	80	$80	$6,400
5	Ditching 1.5 ft btm. x 1.5 ft deep	LF	150	$8	$1,200
6	Rock Excavation	CY	20	$150	$3,000
7	Asphalt R&R	TON	50	$120	$6,000
8	Rip Rap	TON	10	$50	$500
9	Misc. Appurtenances	LS	1	$320	$320
		Project Subtotal			***$20,830***
		Engineering			***$4,200***
		Contingency			***$4,550***
		Legal Admin.			***$620***
		Permitting			***$200***
		Project Total			***$30,400***

Table 7.3.12-Project No. 12 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$2,200	$2,200
2	Demolition and Site Preparation	LS	1	$1,400	$1,400
3	27" Storm Drain - Class C Backfill	LF	80	$90	$7,200
5	Ditching 2 ft btm. x 2 ft deep	LF	150	$9	$1,350
6	Rock Excavation	CY	20	$150	$3,000
7	Asphalt R&R	TON	50	$120	$6,000
8	Rip Rap	TON	10	$50	$500
9	Misc. Appurtenances	LS	1	$360	$360
		Project Subtotal			***$22,010***
		Engineering			***$4,400***
		Contingency			***$4,600***
		Legal Admin.			***$660***
		Permitting			***$230***
		Project Total			***$31,900***

Table 7.3.13-Project No. 13 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$2,600	$2,600
2	Demolition and Site Preparation	LS	1	$1,600	$1,600
3	30" Storm Drain - Class C Backfill	LF	100	$100	$10,000
5	Ditching 2 ft btm. x 2 ft deep	LF	150	$9	$1,350
6	Rock Excavation	CY	20	$150	$3,000
7	Asphalt R&R	TON	50	$120	$6,000
8	Rip Rap	TON	10	$50	$500
9	Misc. Appurtenances	LS	1	$520	$520
		Project Subtotal			***$25,570***
		Engineering			***$5,150***
		Contingency			***$5,510***
		Legal Admin.			***$770***
		Permitting			***$300***
		Project Total			***$37,300***

Table 7.3.14-Project No. 14 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$950	$950
2	Demolition and Site Preparation	LS	1	$650	$650
3	18" Storm Drain - Class C Backfill	LF	80	$60	$4,800
4	Ditching 1.5 ft btm. x 1.5 ft deep	LF	200	$8	$1,600
5	Asphalt R&R	TON	10	$120	$1,200
6	Rip Rap	TON	15	$50	$750
7	Misc. Appurtenances	LS	1	$240	$240
		Project Subtotal			***$10,190***
		Engineering			***$2,000***
		Contingency			***$2,210***
		Legal Admin.			***$300***
		Permitting			***$300***
		Project Total			***$15,000***

Table 7.3.15-Project No. 15 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$1,200	$1,200
2	Demolition and Site Preparation	LS	1	$900	$900
3	18" Storm Drain - Class C Backfill	LF	100	$60	$6,000
4	Ditching 1.5 ft btm. x 1.5 ft deep	LF	250	$8	$2,000
5	Asphalt R&R	TON	20	$120	$2,400
6	Rip Rap	TON	20	$50	$1,000
7	Misc. Appurtenances	LS	1	$280	$280
		Project Subtotal			***$13,780***
		Engineering			***$2,800***
		Contingency			***$3,000***
		Legal Admin.			***$420***
		Permitting			***$300***
		Project Total			***$20,300***

Table 7.3.16-Project No. 16 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$2,400	$2,400
2	Demolition and Site Preparation	LS	1	$1,800	$1,800
3	18" Storm Drain - Class C Backfill	LF	140	$60	$8,400
4	Ditching 1.5 ft btm. x 1.5 ft deep	LF	400	$8	$3,200
5	Asphalt R&R	TON	40	$120	$4,800
6	Rock Excavation	CY	40	$150	$6,000
7	Rip Rap	TON	20	$50	$1,000
8	Misc. Appurtenances	LS	1	$500	$500
		Project Subtotal			***$28,100***
		Engineering			***$5,650***
		Contingency			***$6,100***
		Legal Admin.			***$850***
		Permitting			***$300***
		Project Total			***$41,000***

Table 7.3.17-Project No. 17 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$2,000	$2,000
2	Demolition and Site Preparation	LS	1	$1,500	$1,500
3	18" Storm Drain - Class C Backfill	LF	100	$60	$6,000
4	Ditching 1.5 ft btm. x 1.5 ft deep	LF	150	$8	$1,200
5	Asphalt R&R	TON	40	$120	$4,800
6	Rock Excavation	CY	40	$150	$6,000
7	Rip Rap	TON	20	$50	$1,000
8	Misc. Appurtenances	LS	1	$500	$500
		Project Subtotal			***$23,000***
		Engineering			***$4,600***
		Contingency			***$4,790***
		Legal Admin.			***$690***
		Permitting			***$300***
		Project Total			***$33,560***

Table 7.3.18-Project No. 18 Cost Estimate

Item	Description	Units	Quantity	Unit Cost	Subtotal
1	Const. Fac. & Temp. Controls	LS	1	$2,000	$2,000
2	Demolition and Site Preparation	LS	1	$1,500	$1,500
3	18" Storm Drain - Class C Backfill	LF	100	$60	$6,000
4	Ditching 1.5 ft btm. x 1.5 ft deep	LF	150	$8	$1,200
5	Asphalt R&R	TON	40	$120	$4,800
6	Rock Excavation	CY	40	$150	$6,000
7	Rip Rap	TON	20	$50	$1,000
8	Misc. Appurtenances	LS	1	$500	$500
		Project Subtotal			***$23,000***
		Engineering			***$4,600***
		Contingency			***$510***
		Legal Admin.			***$690***
		Permitting			***$300***
		Project Total			***$29,100***

7.4 System Development Charge Eligibility

The storm water master plan addendum suggests projects which will prepare the system for future use. With proper financial structures in place, the city can recover the costs of the future system from those who benefit from the utility.

The purpose of Table 7.4.1 below is to provide an estimate of those portions of the projects which are anticipated to be paid by developers as part of the development costs. Maintenance projects are typically not SDC-eligible.

Drainage improvements paid by the City for anticipated development and growth, being exclusively for the benefit of new development, are typically 100% SDC-eligible.

With the exception of Project Number 18, all of the City's recommended projects are improvement projects to increase capacity for future growth.

To be reimbursed for the project expenses, the City must adopt and establish Storm Water SDCs. If adopted, the City may be reimbursed for the project expenses as SDCs are paid. It is important to point out that the City will only be reimbursed the amount generated by the SDC charges. If the SDCs are not high enough to cover project expenses, the City will have to look at alternative funds to pay for the projects.

Storm Water Improvements that are not site specific, or that are added to the project list and/or completed may also be SDC-eligible. Further review will be expected in a SDC study that would establish SDC rates.

Table 7.4.1 Project SDC Eligibility

Project Number	Project Priority	Description	Basin	Total Project Cost	City Cost - SDC Eligible
1	3	Upsize Culvert to 12" N-12 Pipe	15	$11,200	100%
2	2	Install 18" N-12 Culverts	15	$15,000	100%
3	2	Install 24-inch N-12 Culvert and 18-inch N-12 Culvert	14	$53,200	100%
4	2	Install 24-inch N-12 Culvert	12	$27,100	100%
5	2	Install 24-inch N-12 Culvert	12	$28,600	100%
6	3	Clean/Replace Culverts with 12" N-12 Pipe	12	$16,500	100%
7	2	Install Pressure Sewer and Tidegates	10	$64,300	100%
8	1	Install 24-inch N-12 Culvert	9	$68,400	100%
9	3	Install 21-inch N-12 Culvert	8	$68,200	100%
10	1	Upsize Culverts and Catch Basins	8	$388,400	100%
11	1	Install 21-inch N-12 Culvert	6	$30,400	100%
12	1	Install 27-inch N-12 Culvert	5	$31,900	100%
13	1	Install 30-inch N-12 Culvert	4	$37,300	100%
14	1	Install 18" N-12 Culvert	2	$15,000	100%
15	2	Install 18" N-12 Culvert	2	$20,300	100%
16	1	Install 18" N-12 Culvert	4	$41,000	100%
17	1	Install 18" N-12 Culvert	4	$33,560	100%
18	1	Install 24-inch N-12 Culvert	16	$38,910	0%
			TOTAL CONSTRUCTION COSTS	**$989,270**	
			TOTAL SDC ELIGIBLE	**$950,360**	

Introduction

Section

1

Study Area

Section

2

Existing Conditions

Section

3

Planning Criteria

Section

4

Hydrological Analysis

Section

5

Storm Drain Model

Section

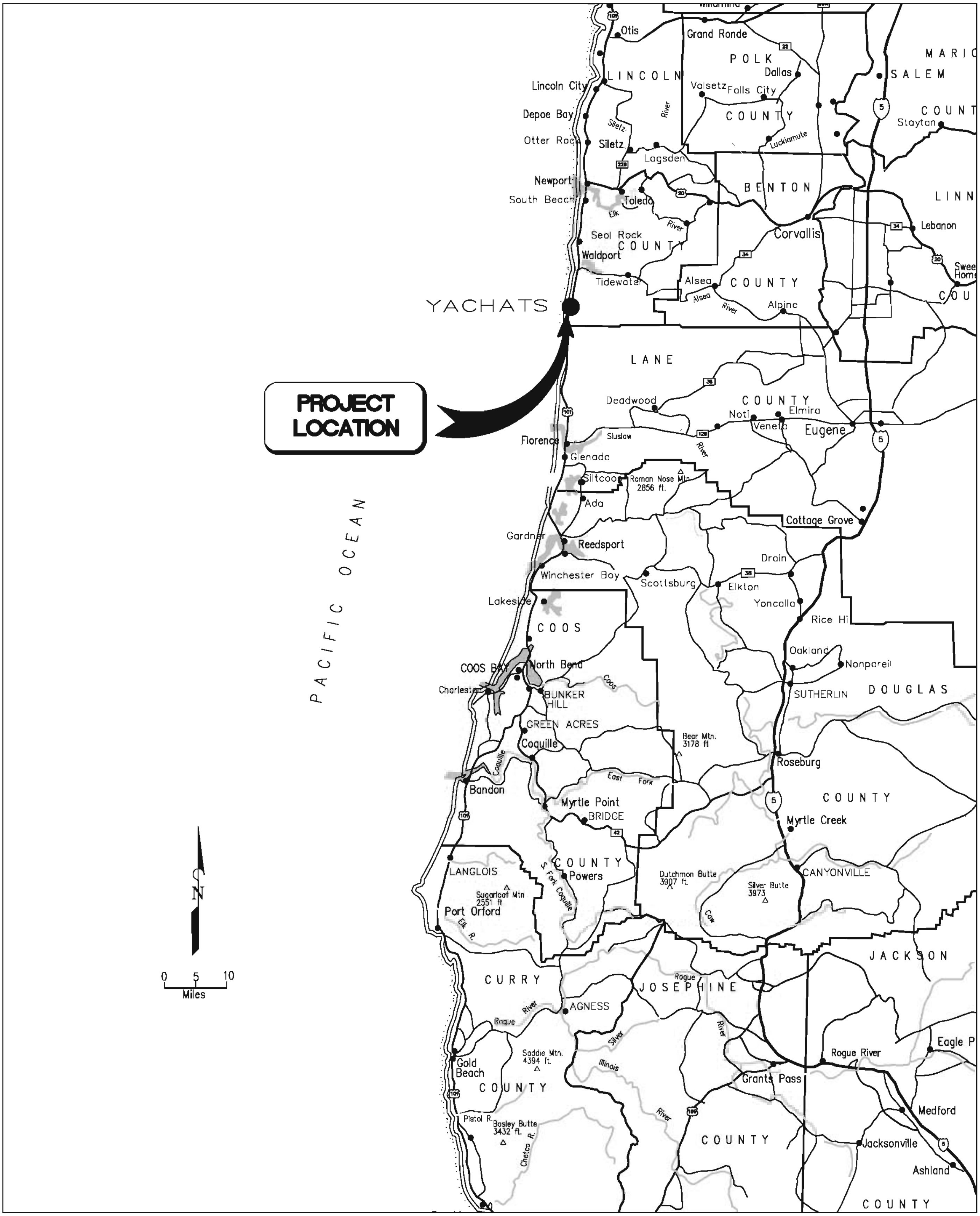
6

Recommended Plan

Section

7

Appendices



THE DYER PARTNERSHIP ENGINEERS & PLANNERS, INC.	**CITY OF YACHATS** **STORM DRAINAGE MASTER PLAN ADDENDUM**	FIGURE NO.
DATE: OCTOBER, 2008 PROJECT NO.: 141.08	**PROJECT LOCATION MAP**	**A-1**

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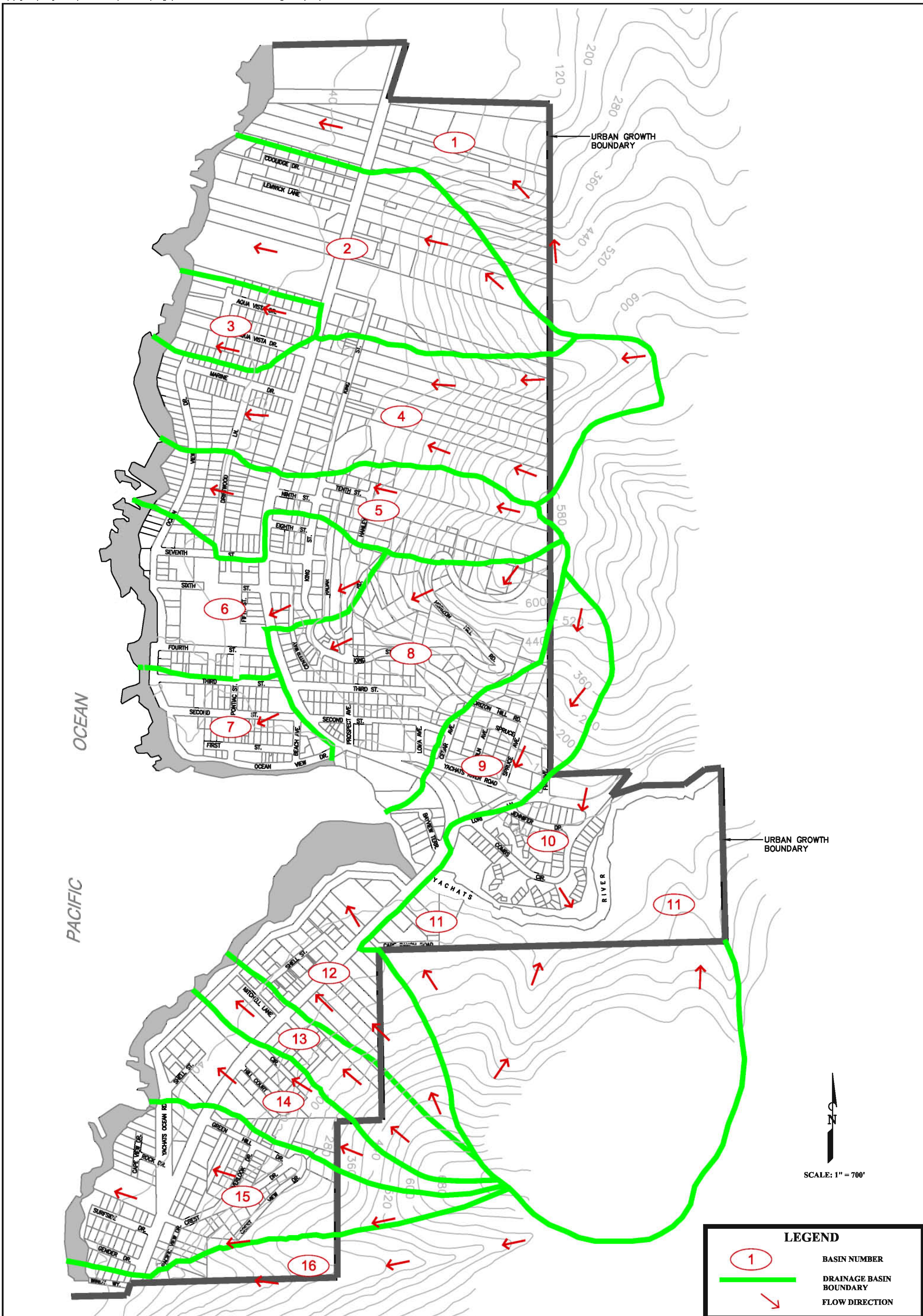
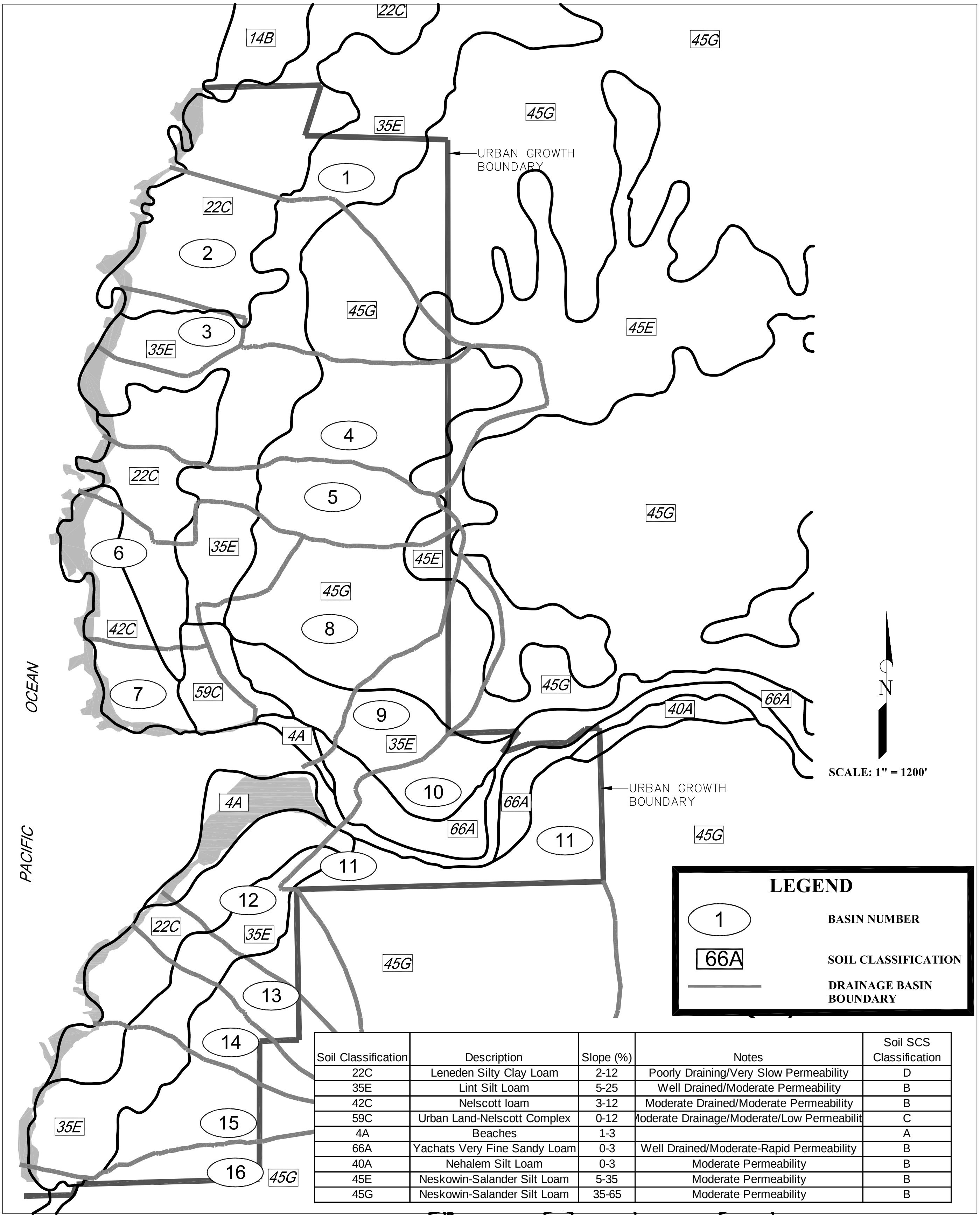


THE DYER PARTNERSHIP ENGINEERS & PLANNERS	CITY OF YACHATS STORM DRAINAGE MASTER PLAN ADDENDUM	FIGURE NO.
DATE: OCTOBER, 2008	BASIN MAP	A-2
PROJECT NO.: 141.08		



Soil Classification	Description	Slope (%)	Notes	Soil SCS Classification
22C	Leneden Silty Clay Loam	2-12	Poorly Draining/Very Slow Permeability	D
35E	Lint Silt Loam	5-25	Well Drained/Moderate Permeability	B
42C	Nelscott loam	3-12	Moderate Drained/Moderate Permeability	B
59C	Urban Land-Nelscott Complex	0-12	loderate Drainage/Moderate/Low Permeabilit	C
4A	Beaches	1-3		A
66A	Yachats Very Fine Sandy Loam	0-3	Well Drained/Moderate-Rapid Permeability	B
40A	Nehalem Silt Loam	0-3	Moderate Permeability	B
45E	Neskowin-Salander Silt Loam	5-35	Moderate Permeability	B
45G	Neskowin-Salander Silt Loam	35-65	Moderate Permeability	B

THE DYER PARTNERSHIP
ENGINEERS & PLANNERS, INC.

DATE: OCTOBER, 2008
PROJECT NO.: 141.08

CITY OF YACHATS
STORM DRAINAGE MASTER PLAN ADDENDUM

SOILS MAP

FIGURE NO.
A-3

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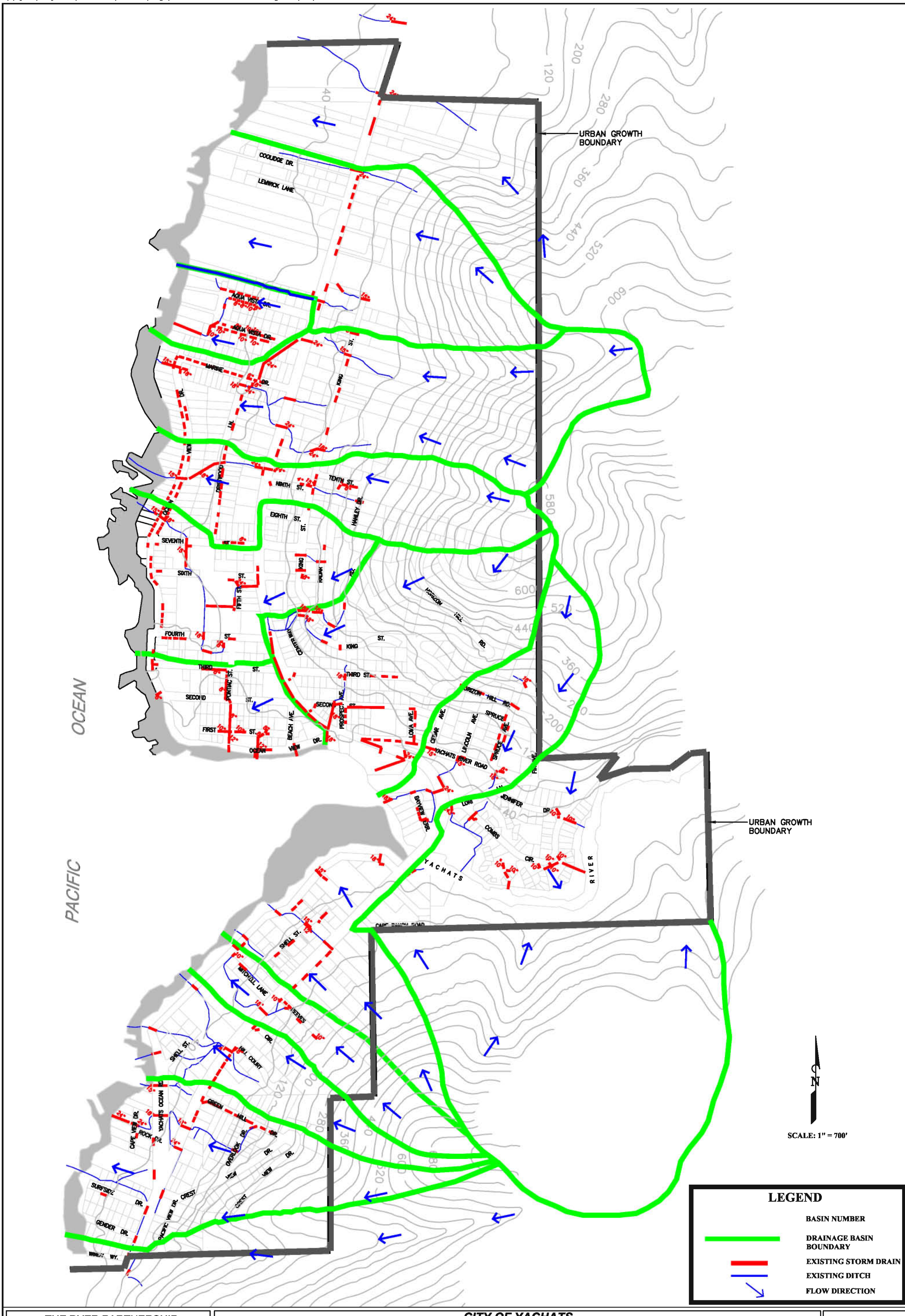
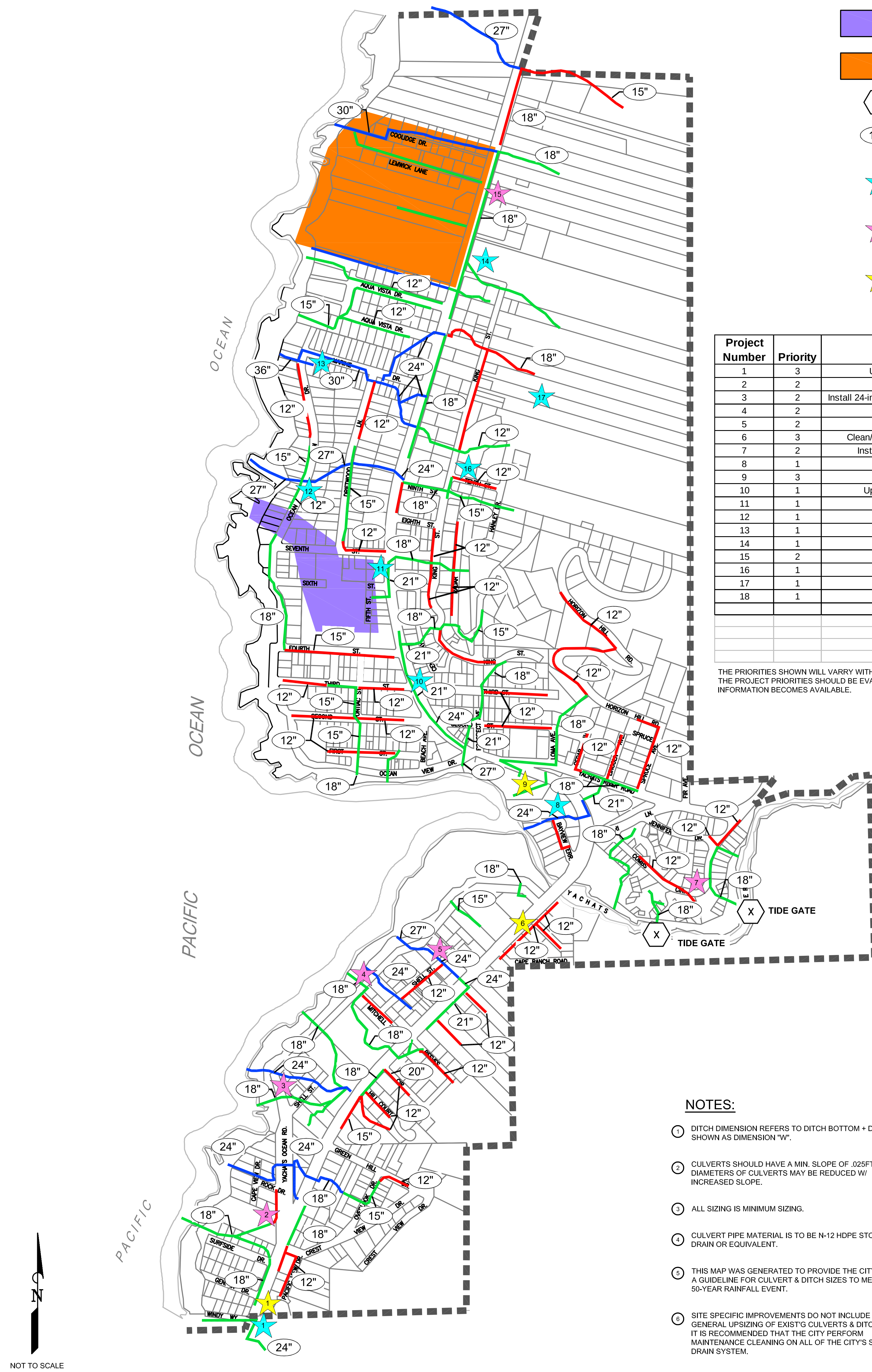


THE DYER PARTNERSHIP ENGINEERS & PLANNERS	CITY OF YACHATS STORM DRAINAGE MASTER PLAN ADDENDUM	FIGURE NO.
DATE: OCTOBER, 2008	EXISTING SYSTEM MAP	A-4
PROJECT NO.: 141.08		



LEGEND

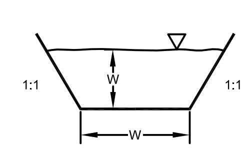
- 1' TRAPAZOIDAL DITCH W/ 1:1 SLOPING SIDES SLOPE = .03 FT / FT
- 1.5' TRAPAZOIDAL DITCH W/ 1:1 SLOPING SIDES SLOPE = .03 FT/FT
- 2' TRAPAZOIDAL DITCH W/ 1:1 SLOPING SIDES SLOPE = .03 FT/FT
- MAN MADE WETLANDS. NO IMPROVEMENTS EVALUATED.
- PRIVATE PROPERTY. PROPERTY OWNERS PERFORM MAINTENANCE ON THESE ROADWAYS
- X — TIDEGATE. MATCH CULVERT DIAMETER.
- 12" — GENERAL CULVERT SIZE. SITE SPECIFIC IMPROVEMENT. (SEE NOTE 6)
- PRIORITY 1
- PRIORITY 2
- PRIORITY 3

Project Number	Priority	Description	Estimated Project Cost
1	3	Upsize Culvert to 12" N-12 Pipe	$11,200
2	2	Install 18" N-12 Culverts	$15,000
3	2	Install 24-inch N-12 Culvert and 18-inch N-12 Culvert	$53,200
4	2	Install 24-inch N-12 Culvert	$27,100
5	2	Install 24-inch N-12 Culvert	$28,600
6	3	Clean/Replace Culverts with 12" N-12 Pipe	$16,500
7	2	Install Pressure Sewer and Tidegates	$64,300
8	1	Install 24-inch N-12 Culvert	$68,400
9	3	Install 21-inch N-12 Culvert	$68,200
10	1	Upsize Culverts and Catch Basins	$388,400
11	1	Install 21-inch N-12 Culvert	$30,400
12	1	Install 27-inch N-12 Culvert	$31,900
13	1	Install 30-inch N-12 Culvert	$37,300
14	1	Install 18" N-12 Culvert	$15,000
15	2	Install 18" N-12 Culvert	$20,300
16	1	Install 18" N-12 Culvert	$41,000
17	1	Install 18" N-12 Culvert	$33,560
18	1	Install 24-inch N-12 Culvert	$38,910
		Total	$989,270
		Total Priority 1	$684,870
		Total Priority 2	$208,500
		Total Priority 3	$95,900

THE PRIORITIES SHOWN WILL VARRY WITH DEVELOPMENT SCHEDULES AND IMPROVEMENTS WITHIN A BASIN. THE PROJECT PRIORITIES SHOULD BE EVALUATED ON A YEARLY BASIS OR AS REVISED TIMELINES AND INFORMATION BECOMES AVAILABLE.

NOTES:

1. DITCH DIMENSION REFERS TO DITCH BOTTOM + DEPTH. SHOWN AS DIMENSION "W".
2. CULVERTS SHOULD HAVE A MIN. SLOPE OF .025FT/FT. DIAMETERS OF CULVERTS MAY BE REDUCED W/ INCREASED SLOPE.
3. ALL SIZING IS MINIMUM SIZING.
4. CULVERT PIPE MATERIAL IS TO BE N-12 HDPE STORM DRAIN OR EQUIVALENT.
5. THIS MAP WAS GENERATED TO PROVIDE THE CITY WITH A GUIDELINE FOR CULVERT & DITCH SIZES TO MEET A 50-YEAR RAINFALL EVENT.
6. SITE SPECIFIC IMPROVEMENTS DO NOT INCLUDE THE GENERAL UPSIZING OF EXIST'G CULVERTS & DITCHES. IT IS RECOMMENDED THAT THE CITY PERFORM MAINTENANCE CLEANING ON ALL OF THE CITY'S STORM DRAIN SYSTEM.



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OCTOBER, 2008

CITY OF YACHATS

STORM DRAINAGE MASTER PLAN ADDENDUM

RECOMMENDED IMPROVEMENT MAP

FIGURE NO.

A-5