STORM DRAINAGE MASTER PLAN

Draft April 2024

Westech Engineering, Inc.
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STORM DRAINAGE SYSTEM

MASTER PLAN

Draft April 2024

Prepared for:

CITY OF YACHATS, OREGON
PO Box 345

Yachats, OR, 97498

Prepared By:

Westech Engineering, Inc.
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JO. 3096.5010.0

STORM DRAINAGE SYSTEM MASTER PLAN

Draft April 2024

Prepared for:

CITY OF YACHATS, OREGON
PO Box 345

Yachats, OR, 97498

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JULY 15, 1997
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CITY OF YACHATS
STORM DRAINAGE SYSTEM MASTER PLAN

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FOREWORD

USING THIS REPORT

Because this report will be used by many people whose needs for detailed information will differ widely, an Executive Summary has been included at the beginning of this report. This executive summary contains a summary and overview that briefly describes the content and main conclusions of the report. Thus, readers may gain a good general understanding of the direction of the report and its contents by reading the Executive Summary. If a reader wishes to explore the subject in greater detail, the appropriate section in the text can be consulted. Each section has also been generally organized so as to move from the general to the specific.

CITY OF YACHATS
Storm Drainage System Master Plan

Executive Summary

EXECUTIVE SUMMARY

INTRODUCTION

This Storm Drainage System Master Plan assesses the City's existing storm drainage system and provides recommendations for storm drainage within the City of Yachats. Without the benefit of a formal storm drainage master plan, storm drainage improvements are often constructed as needed without analyzing overall system needs and impacts. Although this approach alleviates isolated problems, there is no way of making well-informed decisions regarding improvements to the system or assessing the potential impact of future development.

The City's current development standards require findings that adequate capacity is available in the utility systems prior to development occurring. Without a current storm drainage system master plan that identifies area-wide improvements required with a schedule guiding their construction, implementation of these policies is difficult. Without a community-wide understanding of how the storm drainage system works and how development within the community impacts its performance, it is difficult at best to determine what improvements to the storm drainage system are required by new development.

PROJECT OBJECTIVES

The primary purpose of the master plan is to provide the City with specific engineering recommendations for the management of storm drainage throughout the study area. It is intended that the information contained herein will assist the City in the planning and implementation of capital improvements to the storm drainage system, as well as ongoing system maintenance.

ELEMENTS OF THE MASTER PLAN

■ ■ Section 2, Study Area and Planning Considerations

The City of Yachats is located in Lincoln County approximately 24 miles south of Newport. The primary study area is coincident with the Urban Growth Boundary (UGB) established by the City's Comprehensive Plan. The UGB and City Limits encompass the same area, approximately 640 acres. This study also evaluates areas upstream and downstream of the City to ensure the influences of these areas are properly address in the analysis.

The City has several land use zones including residential (low, medium and high density), commercial, and state parks. The land within the City Limits has not fully developed to the degree allowed by the zoning standards, although some areas are less likely to be developed because of topography. The study evaluates the storm drainage system both according to the current state of development and assuming all land is developed to the full extent allowed by the zoning ordinances.

■ ■ **Section 3, Description of the Existing System**

The City is divided into twenty-three (23) main drainage basins designated in the report by numbers. These basins are shown on Figure 3-1a, a copy of which is provided at the end of this Executive Summary. With all basins considered, the average basin size is roughly 22 acres. The largest basin is Basin 9 with 111 acres, with basin 28 following closely with 98 acres. Without these two basins the average basin size is 15 acres. There are also several very small basins, basins 3, 4, 7, 8, 16, 21, 22, and 23 having 5 or less acres. The majority of these basins are usually not large enough to warrant a master plan analysis, but the topography of the City of Yachats necessitates the small basin size. All basins eventually drain to the Pacific Ocean, with the majority of basin discharging directly to the Pacific Ocean. Overall, the level of development within the UGB is relatively high such that future increases in stormwater runoff are generally expected to be limited.

When all of the various elements of the storm drainage system are totaled, the City has roughly 13,000 feet (two and a half miles) of pipe ranging in size from 4-inches in diameter up to 60-inches in diameter. There are also roughly 110 catch basins and 50 manholes, as well as 2.8 miles of ditches.

■ ■ **Section 4, Hydrologic/Hydraulic Analysis**

The Rational and the Santa Barbara Urban Hydrograph (SBUH) methods are commonly used to calculate runoff, but only the Santa Barbara Urban Hydrograph (SBUH) was used for this study. The Santa Barbara Urban Hydrograph (SBUH) is a computer model that facilitates calculating individual sub-basins then adding the resulting flows together in a routing system that generally replicates the flow through an overall basin. With a wide range of basin sizes, the number of sub-basins in each basin also varied significantly. At the high end, Basin 9 has 7 sub-basins, and at the low end, many basins have only one sub-basin each.

Calculations were performed for existing and future development conditions using 50-year design storms, which is the storm event specified for the analysis when the SBUH calculation method is used. To account for future improvements in the storm drainage conveyance system, the calculations included separate analysis for the existing pipes and ditches (which have limited capacity segments that detain runoff) and also a future hypothetical conveyance system in which all runoff freely flows the full length of the basin. Once the runoff calculations were completed, the predicted flows were used to assess the adequacy of the major trunk lines. Ideally, the trunk lines should have the capacity to carry the 50-year storm without surcharging.

■ ■ **Section 5, Storm System Evaluation and Recommendations**

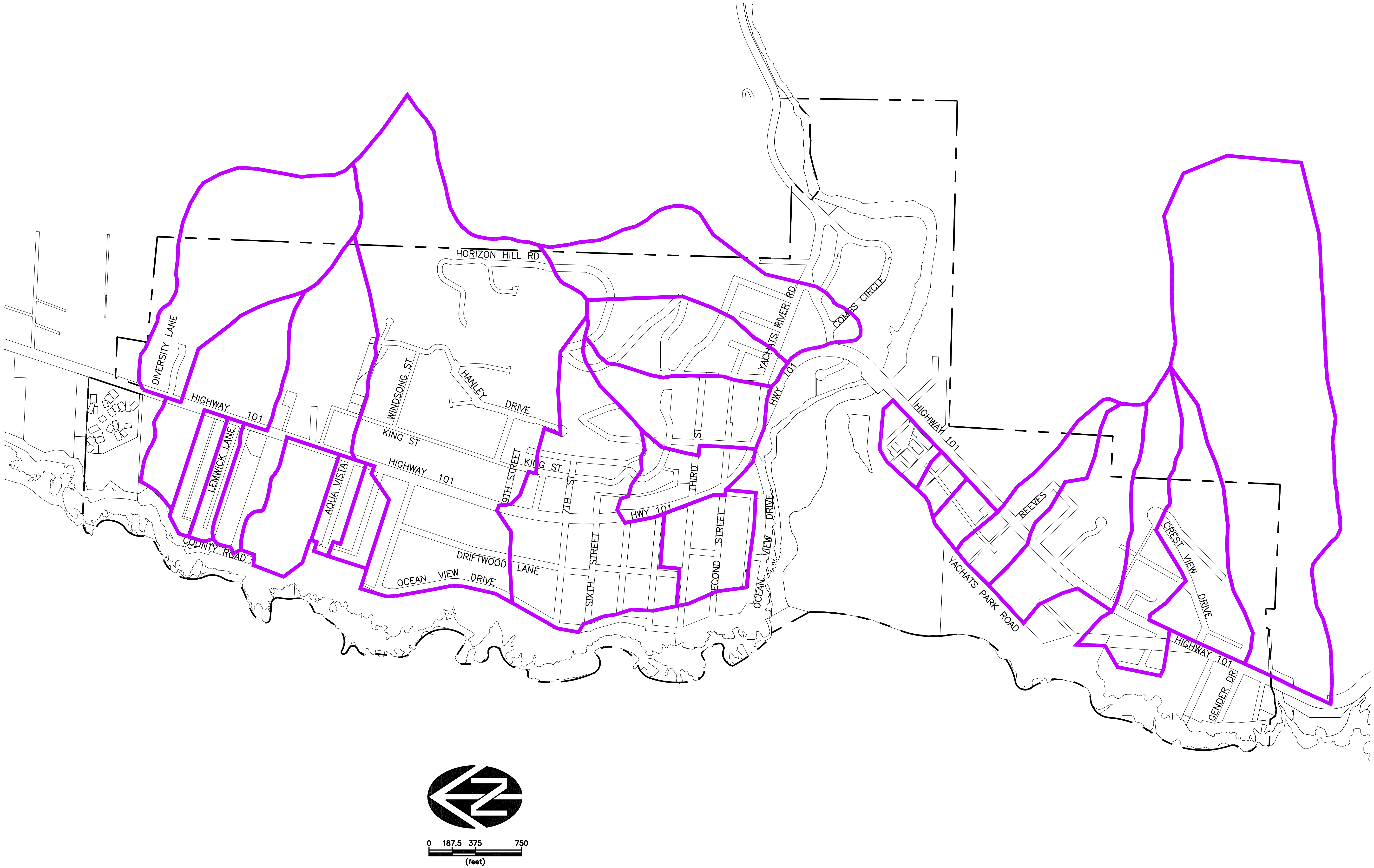
Each basin was evaluated for both existing and future (fully developed) conditions using the Santa Barbara Urban Hydrograph (SBUH) method. Both existing and future land use conditions were analyzed with the existing pipes and ditches and with a future free-flowing conveyance system. The results for all basins are presented in Section 5. Using the estimated runoff, all major drainage elements (pipes and open channels) were evaluated to determine whether or not they had adequate capacity. System segments that were identified as inadequate were analyzed with regard to the appropriate remedy. **Figure 5-4a and Figure 5-4b** provides a complete summary of the proposed improvements required to eliminate the major problem areas. A copy of **Figure 5-4a and Figure 5-4b** is provided at the end of this Executive Summary. It should be noted that although there are many pipes recommended to be increased in size, no pipes in the system are at a critical level. If the calculations indicate a pipe is too small but stormwater problems are rarely if ever seen at that location, and if no significant risks to property appear to exist, it may be appropriate to defer work at that location and monitor the situation as needed.

Following the determination of the recommended improvements, each element was evaluated to determine budget level cost estimates for these improvements. These cost estimates are summarized in **Table 5-24a** (sorted by basin) and **Table 5-24b** (sorted by priority). A copy of **Table 5-24a** and **Table 5-24b** are provided at the end of this Executive Summary.

This section also provides a discussion on stormwater detention explaining the purpose of detention, the most important benefits, and pointing out certain costs and disadvantages. In general, detention is most beneficial to the storm drainage system immediately downstream of a development site. The benefit to the major trunk lines, while it exists, can be less dramatic. The major drawbacks to detention relate to the cost to development, in either money or lost developable ground, or both. Weighing the benefits and drawbacks of detention within the context of Yachats' specific situation, we recommend that the City continue to support its current stormwater detention standards, particularly in areas where storm drainage systems are listed as marginally adequate.

■ ■ Section 6, Design Standards and Management Practices

This section provides a discussion of the standards and procedures the City has adopted to promote an efficient, effective storm drainage system. Included in this section are general discussions of Storm Drainage System Design Standards, Storm Drainage System Construction Standards, and Management Practices. In addition, we have provided information concerning legal and liability issues, as well as system funding issues.



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City of Yachats, Oregon
City of Yachats Stormwater Master Plan

Overall Basin Map

FIGURE
3-1a

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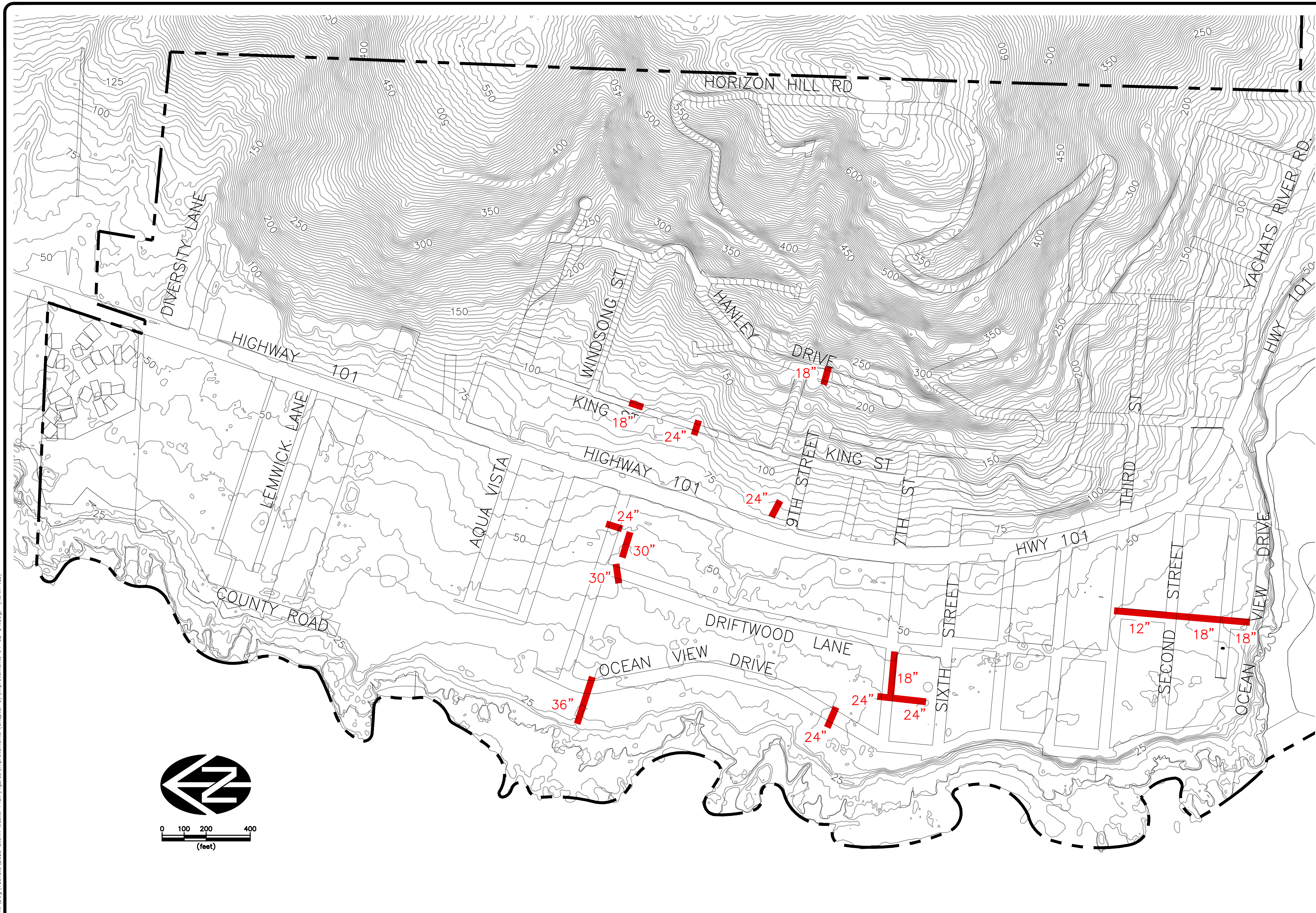

City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Recommended Improvements (North)

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FIGURE 5-4a

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City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Recommended Improvements (South)

FIGURE 5–4b

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TABLE 5-24a

Capital Improvement Project (CIP) Estimated Costs* (Sorted by Basin)

PROJECT	Priority	Basin	Pipe Size (in)	Paved or Unpaved	Length (ft)	Cost/ft ($)	Manholes	Cost/Ea ($)	Inlets	Cost/Ea ($)	Construction Cost ($)	Contingency (10%)	Engineering (16%)	Legal & Admin (10%)	Project Total ($)
Basin 9															
36-inch Pipe, Discharge pipe Marine Drive and Ocean View Drive, 60 ft south	3	9	36	Paved	100	$267	0	$8,000	0	$5,000	$26,650	$2,665	$4,264	$2,665	$36,244
30-inch Pipe, Driftwood Lane and Marine Drive	3	9	30	Paved	62	$234	0	$8,000	0	$5,000	$14,508	$1,451	$2,321	$1,451	$19,731
30-inch Pipe, 25 ft east of Dirftwod Lane	3	9	30	Unpaved	100	$234	0	$8,000	0	$5,000	$23,400	$2,340	$3,744	$2,340	$31,824
24-inch Pipe, Marine Drive, 200 ft west of Highway 101	3	9	24	Paved	65	$195	0	$8,000	0	$5,000	$12,675	$1,268	$2,028	$1,268	$17,238
24-inch Pipe, King Street, 375 ft north of 10th Street	3	9	24	Paved	40	$195	0	$8,000	0	$5,000	$7,800	$780	$1,248	$780	$10,608
24-inch Pipe, lot at 9th Street and Highway 101	3	9	24	Paved	45	$195	0	$8,000	0	$5,000	$8,775	$878	$1,404	$878	$11,934
18-inch Pipe, King Street, 100 ft south of Windsong Street	3	9	18	Paved	25	$163	0	$8,000	0	$5,000	$4,063	$406	$650	$406	$5,525
24-inch Pipe, Hanley Drive and 10th St, 50 ft south	3	9	24	Paved	45	$195	0	$8,000	0	$5,000	$8,775	$878	$1,404	$878	$11,934
													TOTAL, ALL BASIN 9 PROJECTS		**$145,038**
Basin 10															
24-inch Pipe, Discharge Pipe at 789 Ocean View Drive	2	10	24	Paved	60	$195	0	$8,000	0	$5,000	$11,700	$1,170	$1,872	$1,170	$15,912
24-inch Pipe, 7th Street and Ocean View Drive, 200 ft east	3	10	24	Paved	70	$195	0	$8,000	0	$5,000	$13,650	$1,365	$2,184	$1,365	$18,564
24-inch Pipe, South of 7th Street, 200 ft east of Ocean View Drive	3	10	24	Paved	145	$195	0	$8,000	0	$5,000	$28,275	$2,828	$4,524	$2,828	$38,454
18-inch Pipe, 7th St, 200 ft to 420 ft east of Ocean View Drive	3	10	18	Paved	220	$163	0	$8,000	2	$5,000	$45,750	$4,575	$7,320	$4,575	$62,220
													TOTAL, ALL BASIN 10 PROJECTS		**$135,150**
Basin 11															
18-inch Pipe, Ocean View and Pontiac Street	3	11	18	Paved	120	$163	0	$8,000	0	$5,000	$19,500	$1,950	$3,120	$1,950	$26,520
18-inch Pipe, East Second Street to 70 ft into 320 Second Street	3	11	18	Paved	80	$163	0	$8,000	0	$5,000	$13,000	$1,300	$2,080	$1,300	$17,680
12-inch Pipe, Second Street and Pontiac Street	3	11	12	Paved	90	$117	0	$8,000	1	$5,000	$15,530	$1,553	$2,485	$1,553	$21,121
12-inch Pipe, Pontiac Street, Second Street to Third Street	3	11	12	Paved	200	$117	0	$8,000	1	$5,000	$28,400	$2,840	$4,544	$2,840	$38,624
													TOTAL, ALL BASIN 11 PROJECTS		**$103,945**
														TOTAL, ALL PROJECTS	**$384,133**

*Note: These estimates are planning level cost estimates and not based on actual designs. They should be considered as preliminary and subject to change.

TABLE 5-24b

Capital Improvement Project (CIP) Estimated Costs* (Sorted by Priority)

PROJECT	Priority	Basin	Pipe Size (in)	Paved or Unpaved	Length (ft)	Cost/ft ($)	Manholes	Cost/Ea ($)	Inlets	Cost/Ea ($)	Construction Cost ($)	Contingency (10%)	Engineering (16%)	Legal & Admin (10%)	Project Total ($)
Priority 1															
There are no Priority 1 projects.															$0
														TOTAL, ALL PRIORITY 1 PROJECTS	**$0**
Priority 2															
24-inch Pipe, Discharge Pipe at 789 Ocean View Drive	2	10	24	Paved	60	$195	0	$8,000	0	$5,000	$11,700	$1,170	$1,872	$1,170	$15,912
														TOTAL, ALL PRIORITY 2 PROJECTS	**$15,912**
Priority 3															
36-inch Pipe, Discharge pipe Marine Drive and Ocean View Drive, 60 ft south	3	9	36	Paved	100	$267	0	$8,000	0	$5,000	$26,650	$2,665	$4,264	$2,665	$36,244
30-inch Pipe, Driftwood Lane and Marine Drive	3	9	30	Paved	62	$234	0	$8,000	0	$5,000	$14,508	$1,451	$2,321	$1,451	$19,731
30-inch Pipe, 25 ft east of Dirftwod Lane	3	9	30	Unpaved	100	$234	0	$8,000	0	$5,000	$23,400	$2,340	$3,744	$2,340	$31,824
24-inch Pipe, Marine Drive, 200 ft west of Highway 101	3	9	24	Paved	65	$195	0	$8,000	0	$5,000	$12,675	$1,268	$2,028	$1,268	$17,238
24-inch Pipe, King Street, 375 ft north of 10th Street	3	9	24	Paved	40	$195	0	$8,000	0	$5,000	$7,800	$780	$1,248	$780	$10,608
24-inch Pipe, lot at 9th Street and Highway 101	3	9	24	Paved	45	$195	0	$8,000	0	$5,000	$8,775	$878	$1,404	$878	$11,934
18-inch Pipe, King Street, 100 ft south of Windsong Street	3	9	18	Paved	25	$163	0	$8,000	0	$5,000	$4,063	$406	$650	$406	$5,525
24-inch Pipe, Hanley Drive and 10th St, 50 ft south	3	9	24	Paved	45	$195	0	$8,000	0	$5,000	$8,775	$878	$1,404	$878	$11,934
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18-inch Pipe, 7th St, 200 ft to 420 ft east of Ocean View Drive	3	10	18	Paved	220	$163	0	$8,000	2	$5,000	$45,750	$4,575	$7,320	$4,575	$62,220
18-inch Pipe, Ocean View and Pontiac Street	3	11	18	Paved	120	$163	0	$8,000	0	$5,000	$19,500	$1,950	$3,120	$1,950	$26,520
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12-inch Pipe, Second Street and Pontiac Street	3	11	12	Paved	90	$117	0	$8,000	1	$5,000	$15,530	$1,553	$2,485	$1,553	$21,121
12-inch Pipe, Pontiac Street, Second Street to Third Street	3	11	12	Paved	200	$117	0	$8,000	1	$5,000	$28,400	$2,840	$4,544	$2,840	$38,624
														TOTAL, ALL PRIORITY 3 PROJECTS	**$368,221**
														TOTAL, ALL PROJECTS	**$384,133**

*Note: These estimates are planning level cost estimates and not based on actual designs. They should be considered as preliminary and subject to change.

Section 1

INTRODUCTION

SECTION 1 INTRODUCTION

1.1. Background & Need

The City of Yachats is located in Lincoln County on Highway 101 approximately 24 miles south of Newport and approximately 26 miles north of Florence. The urban growth boundary encompasses approximately 640 acres, covering the same area as the city limits. Yachats was incorporated in 1966 and currently has a population of approximately 1,010 (July 2021). The main economic activity in Yachats is centered around tourism. The City is bordered on the eastern side by the Siuslaw National Forest, and the Pacific Ocean is located on the west side.

The City's storm drainage runoff divides into a large number of independent drainage basins that have been numbered starting with 1 at the north end of town and starting with 21 south of Yachats River. This numbering system allows easy recognition whether a basin is north or south of the river. Each of these basins discharge independently to the Pacific Ocean.

Basins north of the river are tied to either streets or topography. Basins west of Highway 101 use streets to dictate the basin. Basins east of Highway 101 are more dependent on topography. Basins south of the river are based on topography and development. Several of the primary basins have been further divided into sub-basins to allow analysis of the flows that occur as runoff proceeds from the upper end of the basin to the discharge point.

Overall, much of the City's storm drainage system appears to be suitable to handle anticipated demands. However, there are a number of areas that will require attention to correct shortcomings which will be addressed in this report.

Building on a detailed analysis of the City's basins and sub-basins, this report provides a comprehensive look at the City's storm drainage system to establish a baseline for future upgrades to the main drainage systems as necessary, reviews requirements for storm drainage detention, and references standards for improvements to local storm drainage facilities.

1.2. Project Objectives

The purpose of this study is to evaluate the City's storm drainage system with respect to its existing and future needs, identify recommended improvements and associated costs necessary to meet those needs, and provide the City with a design guide for future growth and improvement of the City's storm drainage system. It is intended that the information contained herein assist the City in the planning and implementation of capital improvements to the storm drainage system, as well as ongoing system maintenance.

This evaluation and master plan accomplish the following specific objectives.

- Identify and delineate the boundaries of the major drainage basins and sub-basins within the Planning Area.

- Map the existing storm drainage system based on field data collection and as-built drawings.

- Identify current and future storm drain system deficiencies on a prioritized basis, particularly in the following areas:
  - Surcharging, localized flooding, flow routing capacity
  - System reliability
  - Maintenance considerations

- Analyze the major trunk drainage systems under fully developed (buildout) conditions to determine the most cost-effective approach to drainage management within the study area.

- Provide an evaluation of the options for correcting these deficiencies with preliminary construction cost estimates for recommended alternatives.

- Provide specific recommendations to the community and City Council for action.

This report does not include wetland inventory or delineations, on-site environmental investigations, or geotechnical investigations.

1.3. Prior Studies and Work

The most recent studies, reports and documents utilized in the preparation of this master plan are as follows:

- 2009 Oregon Department of Geology and Mineral Industries (DOGAMI) Oregon Lidar: North Coast. (Aerial Lidar Topography Data)

- Oregon Imagery Explorer National Agriculture Imagery Program (NAIP) 2018 Aerial Imagery.

- Flood Insurance Study, Lincoln County, Oregon and Incorporated Areas, by Federal Emergency Management Agency, October 18, 2019

- Flood Insurance Rate Map, Lincoln County, Oregon, and Incorporated Areas, by Federal Emergency Management Agency, October 18, 2019 (Map Number 41041C0803E)

- Flood Insurance Rate Map, Lincoln County, Oregon, and Incorporated Areas, by Federal Emergency Management Agency, October 18, 2019 (Map Number 41041C0811E)

- Flood Insurance Rate Map, Lincoln County, Oregon, and Incorporated Areas, by Federal Emergency Management Agency, October 18, 2019 (Map Number 41041C0815E)

- City of Yachats Storm Drainage Master Plan Addendum, by Dyer Partnership Engineers & Planners, October, 2008.

- City of Yachats Housing Needs Analysis, Cascadia Partners, October, 2022.

- Wastewater System Facilities Plan, City of Yachats, Oregon, by Westech Engineering, Inc., January 2022.

- Water System Master Plan, City of Yachats, Oregon, by Westech Engineering, Inc., August 2021.

- Soil Survey of Lincoln County Area, Oregon, by USDA Soil Conservation Service, July 1975.

- Geologic Hazards Of Lincoln County, Oregon, Schlicker, Deacon, Olcott and Beaulieu, Oregon Department of Geology and Mineral Industries, 1973

- Precipitation-Frequency Atlas of the Western United States (NOAA Atlas 2), Volume X-Oregon, by US Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service.

Section 2

Study Area and Planning Considerations

SECTION 2
STUDY AREA AND PLANNING CONSIDERATIONS

2.1. Introduction

Yachats is situated on the southwestern most portion of Lincoln County. The City is located on Highway 101 approximately 24 miles south of Newport and 26 miles north of Florence. Highway 101 bisects Yachats east to west and provides the major road transportation into and through the City. The only other roads to and from the City are forest development roads.

The City's Comprehensive Plan was developed in 1980 and updated in 2019. The Comprehensive plan established an urban growth boundary (UGB) which encompasses approximately 640 acres, covering is the same as the current City Limits.

2.2. Study Area

The primary area of interest is coincident with the Urban Growth Boundary (UGB) established by the City's Comprehensive Plan. However, since the storm drainage system within the UGB is influenced by runoff from upstream of the City, and to a lesser extent by the performance of the downstream drainage system, these areas were also investigated as part of this study. The total study area as shown on **Figure 2-1** covers approximately 530 acres. (Note: All Section 2 figures are provided at the end of Section 2.)

It is assumed that no significant development will occur within the study area that will require major changes to the existing comprehensive plan designations and zoning, and that there will be no significant expansions of the UGB within the study period. Changes in any of these assumptions could change the recommendations contained in this plan. Should significant changes in any of the above occur, this plan should be updated accordingly.

2.3. Climate and Rainfall Patterns

Since there is no National Weather Service station in Yachats, rainfall and temperature data were examined from Newport, a coastal city 24 miles north of Yachats. While the values are not specifically for Yachats, these values are generally believed to be representative for the immediate area around Yachats. Although there may be daily and weekly variations, the annual average climate is approximately the same. The climate data from Newport is used throughout the remainder of this document.

The study area is located in the central coast along the western foothill of the coast range. The climate in Yachats is relatively moderate throughout the year, characterized by nominal temperatures between 40 and 65 degrees Fahrenheit year-round.

The study area has a predominant winter rainfall climate. Typical distribution of precipitation includes about 45 percent of the annual total from December through February, lesser amounts in the spring and fall, and very little during summer. Rainfall tends to vary inversely with temperatures -- the cooler months are the wettest, the warm summer months the driest.

Extreme temperatures in the study area are rare. Days with a maximum temperature above 70°F occur only 20 times per year on average, and days with minimum temperatures below 32°F occur only 20 times per year on average. Mean high temperatures range from the mid-60s in the summer to about 50°F in the coldest months, while average lows are generally in the low 50s in summer and high 30s in winter.

Snowfall is not typical for the study area, and when it does occur amounts are very low. In the 65 year historical record, snow fell once every 5 years on average.

Relative humidity is highest during early morning hours and is generally 80-100 percent throughout the year. During the afternoon, humidity is generally lowest at 60-80 percent throughout the year.

Winters are likely to be cloudy. Average cloud cover during the coldest months exceeds 70 percent, almost constant cloud cover in January. During summer, however, sunshine is much more abundant with average cloud cover less than 50 percent.

The study area receives an average of approximately 67 inches of precipitation annually, with the majority of the rainfall occurring during the winter months. The wettest year (since 1893) was 1968 when approximately 111 inches of rainfall was measured. The second wettest year was 1996, with approximately 94 inches of rainfall. The driest year was 1944 when the total rainfall in Newport was approximately 43 inches. Approximately 79 percent of the annual precipitation occurs between November 1 and April 30.

Table 2-1 summarizes the 24-hour rainfall intensity data for the Yachats area.

Table 2-1
Storm Event, 24 Hour Rainfall Intensities

Storm Event	24 hour Precipitation (inch)
2-year 24-hour	4.5
5-year 24-hour	5.5
10-year 24-hour	6.0
25-year 24-hour	7.0
50-year 24-hour	8.0
100-year 24-hour	9.0

[1] – From 1973 NOAA Atlas 2, Volume X (Oregon).

2.4. Topography

Yachats is located on the Yachats River estuary near the Coast Range foothills. The City is split south of the city center by the Yachats River. The natural surface drainage across the study area flows to the west, and the existing storm drainage system intercepts and routes flow into the Pacific Ocean. The overall Topography is shown in **Figure 2-2**.

The topography within the study area can be roughly divided into two areas. The area between Highway 101 and the Pacific Ocean, is relatively flat and contains the City's core commercial area as well as residential properties. This area typically has slopes in the 2-10% range. The area to the east of Highway 101 has a flat area containing residential properties, then the slope increases to 15-40%. The elevations along the western boundary of the study area are at sea level. The highest elevations in the central areas are up to the 600 to 700 ft range along the eastern edge of the study area.

2.5. Soils

Several different soil types have been identified and mapped within the study area and appear on **Figure 2-3a**. **Figure 2-3b** categorizes the various soil types by hydrologic soil group and displays the different groups by color. The soils along the Yachats River are generally alluvial bottomland deposits that are composed of silts, sand, and gravel with some local areas of peat. The soils in the relatively flat areas of the City along Highway 101 are generally marine terrace deposits. These deposits are typically fine to medium grain friable sandstone of beach origin with thin interbeds of siltstone. The thickness of these deposits may be up to 75 feet. In upper elevations along the east side of the study area, the soils are generally rocky basaltic formations. None of the soil types outright preclude the construction of typical public stormwater infrastructure from a foundation stability point of view.

This discussion of soil types is based on the information included in the Soil Survey of Lincoln County, Oregon (July 1975) prepared by the Soil Conservation Service (now the Natural Resource Conservation Service). This document shows the approximate location of the soil types in the study area. The reader is referred to the Lincoln County Soil Survey for more detailed definitions and descriptions of the individual soil designations.

2.6. Geologic Hazards

Known geologic hazards within the study area include steep slopes, high seasonal groundwater, seismic concerns, flooding and tsunami concerns.

Steep and unstable slopes are a concern for areas east of Highway 101. Steep slopes can have the potential for either mass movement or slope erosion. Mass movement results from shifting of rock or soil material in response to gravity, such as landslides and rock slides. These mass movements are often precipitated or aggravated by excessive groundwater. Slope erosion is the removal of soils or rock that occurs as a result of sheet flow, resulting in surface erosion or gully erosion. This is primarily caused by private land use practices (mainly land clearing and road construction) that can exacerbate slope erosion. In 1998, a landslide partially destroyed the City's Reedy Creek impoundment and intake structure.

The 2008 U.S. Geological Survey (USGS) National Seismic Hazard Maps display earthquake ground motions for various probability levels across the United States. These factors are applied in the seismic provisions of building codes, insurance rate structures, risk assessments, and other public policy. A review of these maps identifies Oregon as having a relatively high seismic risk. The Oregon Structural Specialty Code shares this assessment and has adopted similar ground motion data as the USGS. Seismic risk factors for structures are typically influenced by a combination of factors including the geographical location, specific building and structural configurations, and local soil types. The construction and rehabilitation of significant structures recommended by this report (buildings and hydraulic structures) will require detailed geotechnical reports and site specific seismic evaluations.

Tsunamis are a great concern in Yachats. Virtually all of the areas west of Highway 101 and some of the areas east of Highway 101 are within the Tsunami inundation zone. Undersea earthquakes can cause destructive tsunamis that strike the coast after the earthquake. The configuration of the Oregon and Washington continental shelf can produce tsunami waves that may appear to rise slowly but can build up to 30 feet or more in height as water surges inland. Tsunamis rarely come as single waves but arrive as multiple crests that may be hours apart. Often the first tsunami is not the largest or most destructive.

Oregon is vulnerable to two types of tsunamis: distant and local. Local tsunamis are generally associated with Cascadia subduction zone earthquakes. Tsunamis from distant undersea earthquakes can take place anywhere in the Pacific Rim and will take several hours to reach the Oregon coast. Because the Cascadia Subduction Zone is so close to the Oregon coast, tsunamis caused by earthquakes along this rift can strike the northern Oregon coast within 20-30 minutes of the earthquake. In many cases, the only tsunami warning will be the earthquake itself.

Since 1995, Oregon has placed restrictions on the construction of certain types of critical and essential facilities within tsunami inundation zones along the coast. In 2013, the Oregon Department of Geology and Mineral Industries (DOGAMI) published a study to define tsunami hazard and inundation zones for Yachats. This study included one inundation map each for distant and local earthquakes. Local source earthquakes (associated with the Cascadian Subduction Zone) generally present a greater threat to Oregon coast cities.

The maximum tsunami run-up within the Yachats study area is 75 to 100 feet above sea level at the time of the tsunami. Similar to 100 year flood elevations, the tsunami run-up elevations are based on assumed worst case seismic events. The actual wave run-up will depend on the magnitude of the seismic event and any mitigating circumstances, such as concurrent submarine landslides. However, it is not economically feasible to design for higher magnitude events.

2.7. Environmentally Sensitive Areas

The Pacific Ocean, Yachats River, and the riparian areas and wetlands adjacent to these natural waterways are considered to be environmentally sensitive areas. **Figure 2-4** shows the locations of designated wetlands within the study area. These wetland areas were identified using the U.S.

Fish and Wildlife National Wetlands Inventory. Any projects that impact jurisdictional wetlands will require permitting through the Oregon Department of State Lands and the US Army Corps of Engineers. Other than the ocean, river and riparian areas, there are four areas considered wetlands in the Yachats city limits.

2.8. Land Use and Community Planning

Land within the City is divided into several different zones based on the type of use allowed (ie. Residential, Commercial, and State Parks). The zoning map (**Figure 2-5**) show the location of the UGB, City limits, and land use zoning designations within the study area. **Table 2-2** summarizes the approximate areas contained under each zoning designation within the City Limits and UGB.

For the purposes of this study, land use was analyzed under:

-both its current state of development and assuming all land within the UGB would develop to the full use of the designated zone.

Land outside the UGB was assumed to remain in agricultural or rural residential use in accordance with current zoning.

Table 2-2
Approximate Areas by Land Use Category (City Limits)

Category	Area (Acres)
Single Family Residential (R-1)	**283**
Single Family & Duplex (R-2)	**32**
Single, Duplex, Multi-Family (R-3)	**61**
Single, Duplex, Multi-Family & Motel (R-4)	**52**
Commercial (C-1)	**21**
Public Facilities (PF)	**10**
State Parks (S-P)	**24**
Estuary Natural (EN)	**8**
Right-of Way/Other	**149**
TOTAL	**640**

As noted by the title of **Table 2-2**, the areas presented are approximate. The total area inside the City Limits and the UGB are based on the respective lines in the AutoCAD figures for this report. These lines may be offset slightly from the actual (real world) location to enhance the visual appearance of the figures. The land use areas include right-of ways within or adjacent to the various zoning designations. This is consistent with the methods used to calculate stormwater runoff where the zoning variables include typical roadways within the different zones rather than separating buildable areas from roadways. This may be different than the approach used for other land use documents, such as a buildable lands inventory which is more specifically interested in how much land is available for development.

2.9. FEMA Flood Insurance Status

In 1968, the U.S. Congress passed the Flood Insurance Act which established a federal program enabling property owners to buy flood insurance at a reasonable cost (FEMA, 1980). In return, communities carry out local floodplain management measures to protect lives and new construction from future flooding. The program is administered by the Federal Insurance Administration within the Federal Emergency Management Agency (FEMA).

Continued encroachments on floodplains decrease the natural flood-control capacity of these land areas, creates the need for expensive manmade flood-control measures and disaster-relief activities, and endangers both lives and property. Projects obtaining federal funding must demonstrate compliance with federal floodplain management regulations and avoid to the extent possible:

- The long and short-term adverse impacts associated with the occupancy and modification of floodplains, and
- Direct or indirect support of floodplain development wherever there is a practicable alternative.

The relevant floodplain for most proposed projects is an area that has a 1-percent chance of a flood occurrence in a given year. The flood of this interval is referred to as the 100-year flood or the base flood. The floodplain management guidelines further require Federal agencies to apply the 0.2 percent or 500-year flood occurrence standard to the location of "critical facilities." Facilities considered "critical facilities" are those whose loss would disrupt utility service to large areas for a considerable period of time or would disrupt utility service to critical facilities such as hospitals. Critical facilities include water treatment plants, wastewater treatment facilities, large pump stations, and centralized operations or communication facilities.

The Yachats River divides the City north and south then empties into the Pacific Ocean. The river generally flows east to west in this location, with flood elevations ranging from sea level to approximately 75 feet.

The Federal Emergency Management Agency (FEMA) has established 100-year floodplain designation and insurance ratings areas along the Yachats River and its tributaries. While sometimes referred to as the "100 year flood", it is more accurate to consider it the flood having a 1 percent chance of occurrence in any year, or a 10 percent chance of occurrence during any 10 year period. The 500 year flood is a flood having a 0.2 percent chance of occurrence in any given year.

Both the City of Yachats and Lincoln County presently participate in the regular phase of the Flood Insurance Program (date of entry into the Regular Program for Yachats was November 1, 1974, while for Lincoln County it was January 17, 1975). According to the FEMA "National

Flood Insurance Program Community Status Book," the City of Yachats is listed as having three maps published for areas within the City Limits.

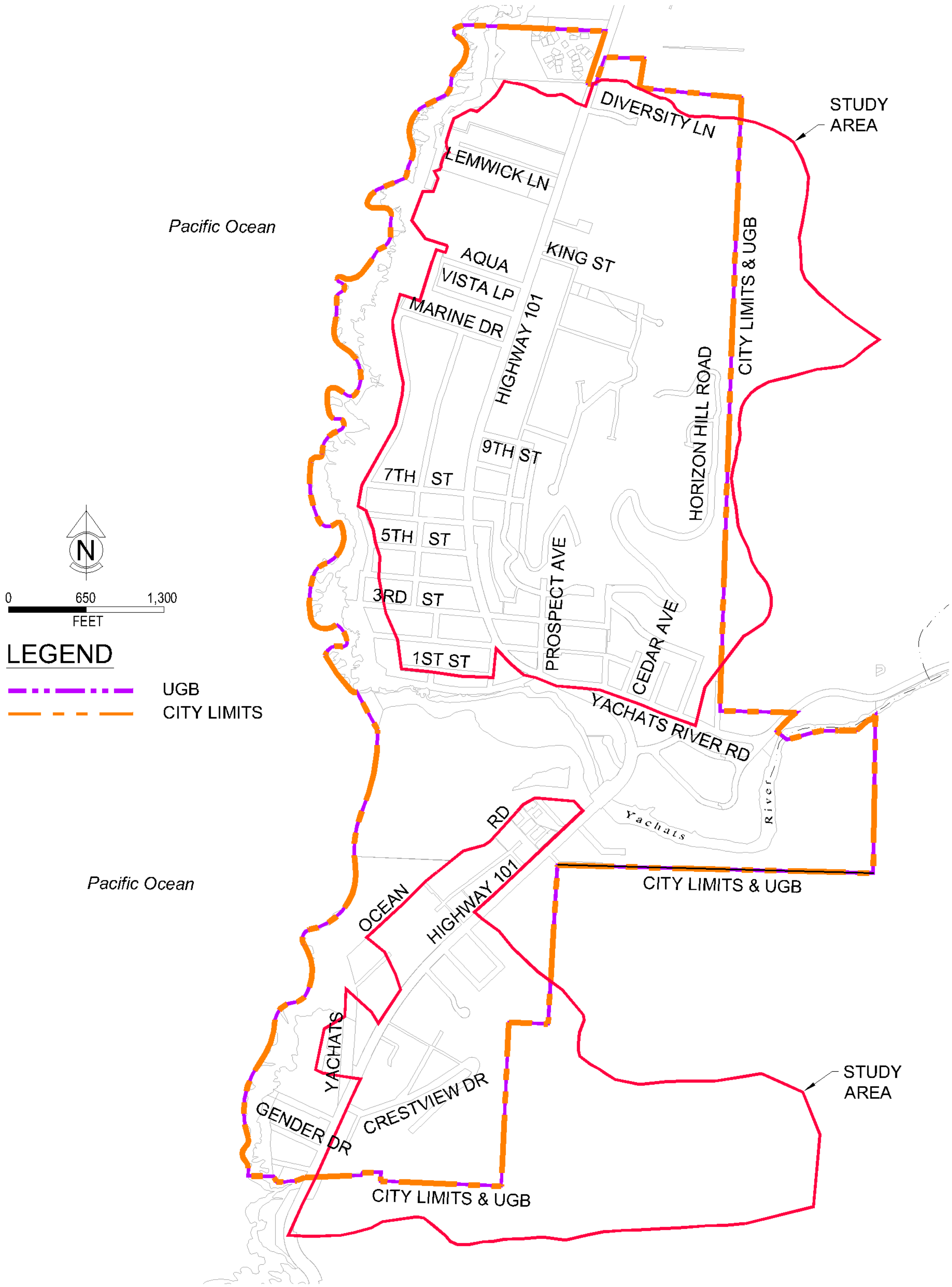
Flood profiles and maps for those portions of the Yachats River within the study area are included in the Flood Insurance Study prepared for the City of Yachats as follows.

- FIRM 41041C0811E dated October 18, 2019
- FIRM 41041C0815E dated October 18, 2019
- FIRM 41041C0803E dated October 18, 2019

These maps do not account for all changes to the FEMA floodplain areas. Amendments and revisions may occur based on documentation being submitted to and approved by FEMA. It should be noted that the floodplain status is not generally considered when calculating runoff and determining the required size of pipes or drainageways. This is because there may be significant time difference between the peak runoff of the local storm and the peak flow of the major drainageway typically responsible for major flood events (Pacific Ocean, Yachats River).

Figure 2-6 shows the floodplain areas in the Yachats area.

Figure 2-1 | Study Area Vicinity Map



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DATE: MAR 24

NO.	DATE	DESCRIPTION	BY
1		REVISIONS	

WESTECH ENGINEERING, INC.
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City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Overall Topographic Map

FIGURE
2-2

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Figure 2-3a | Soils Map

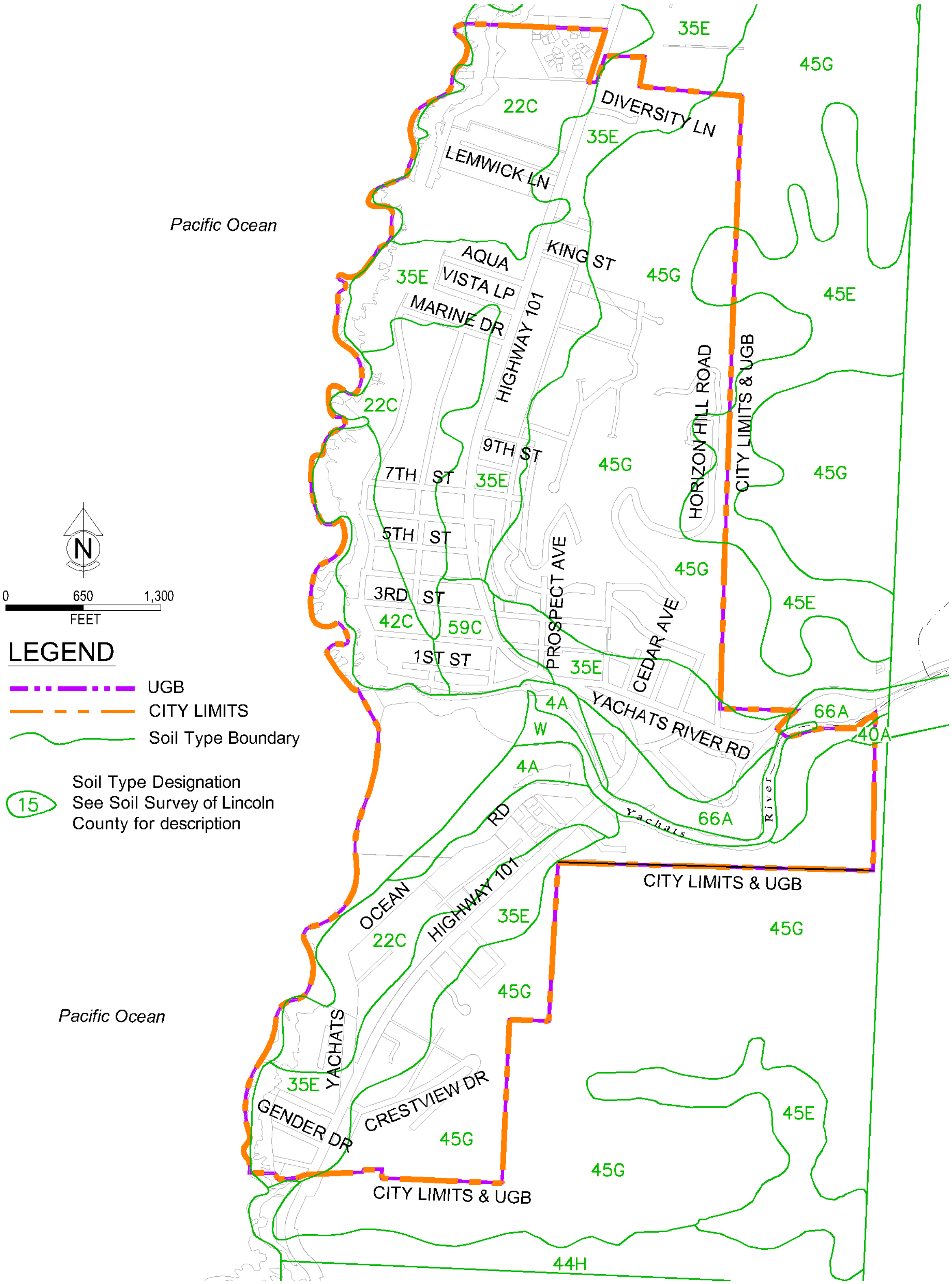


Figure 2-3b | Soil Hydrologic Groups

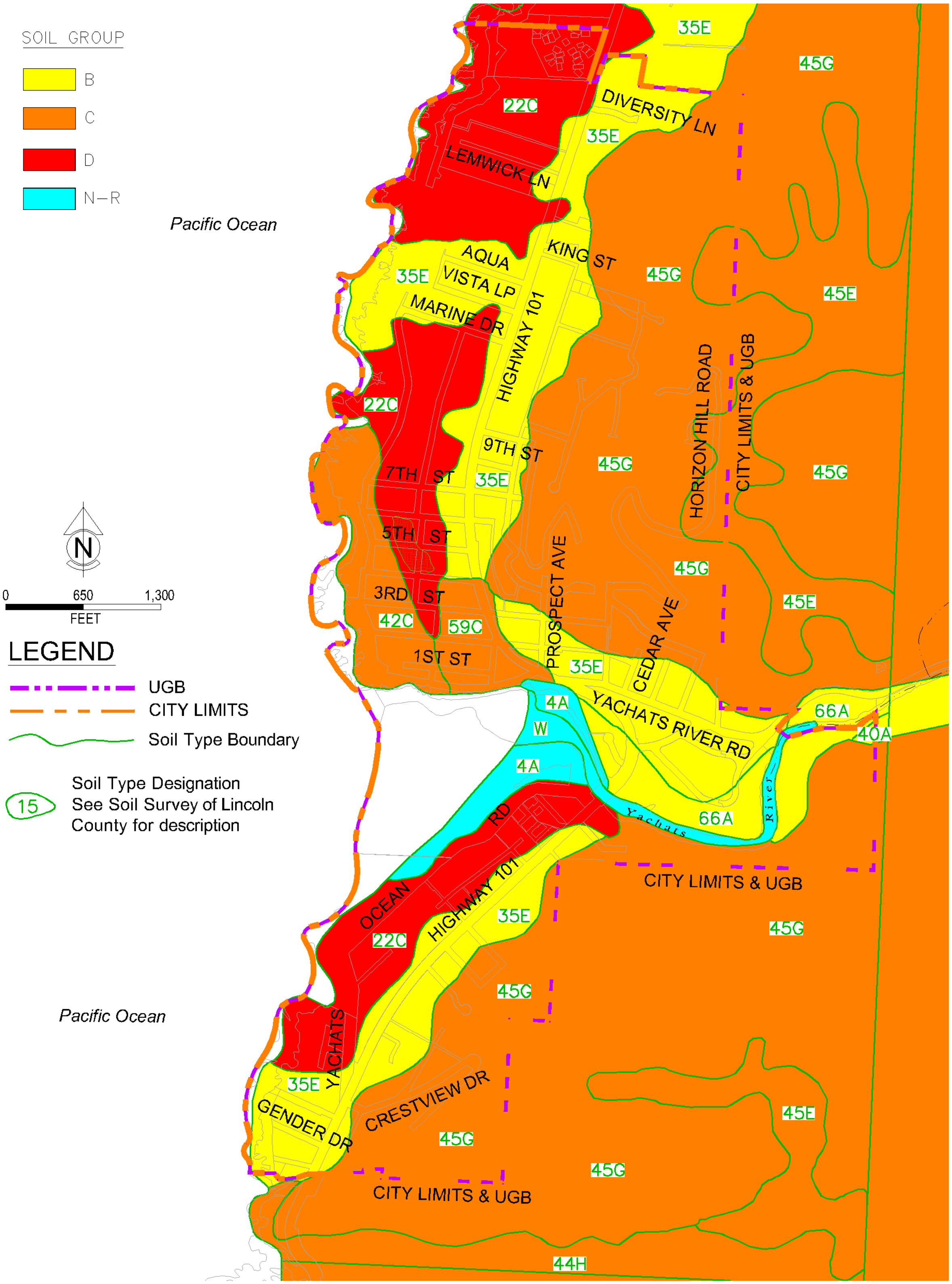


Figure 2-4 | Wetlands Map

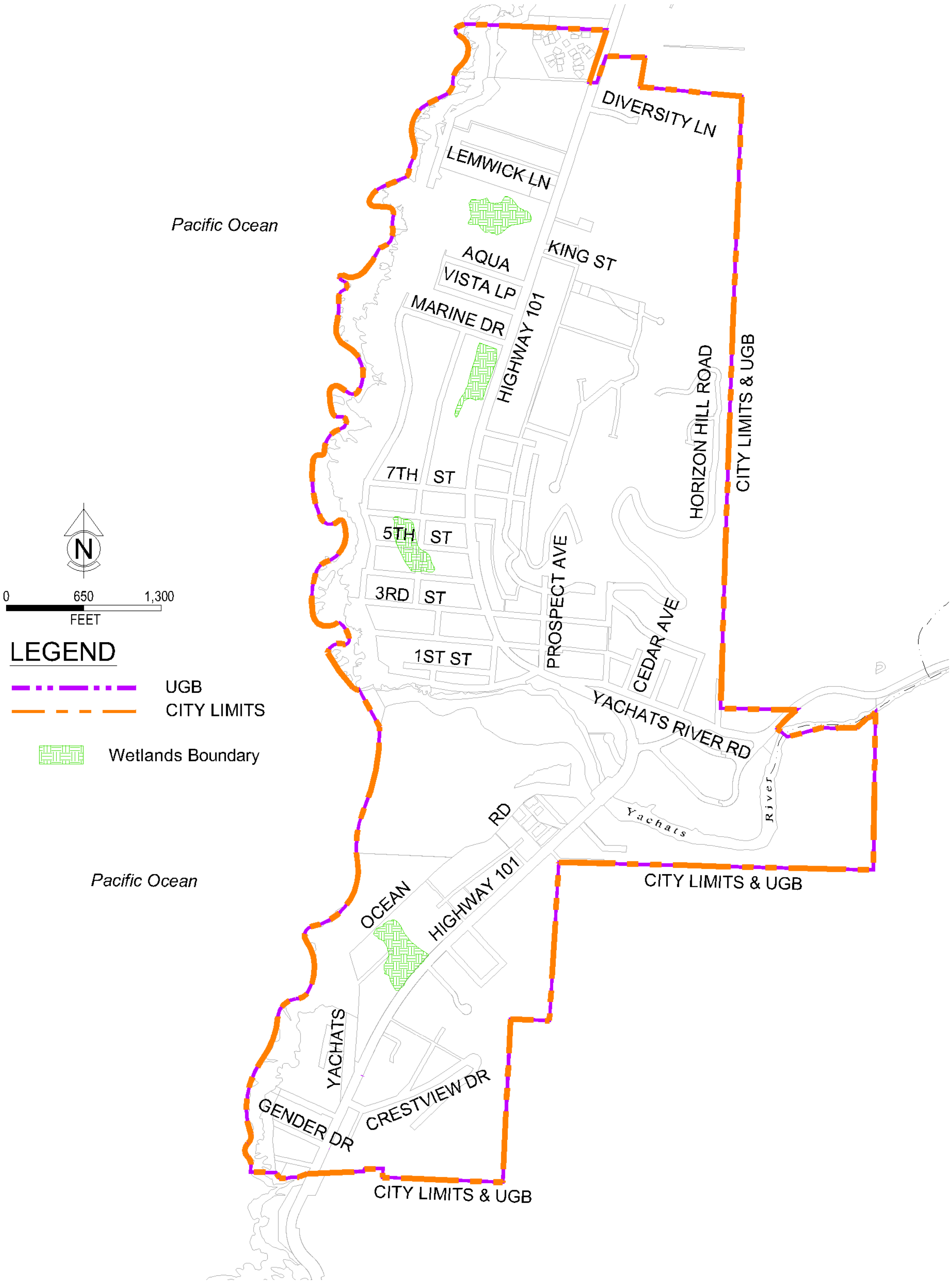


Figure 2-5 | Zoning Designations

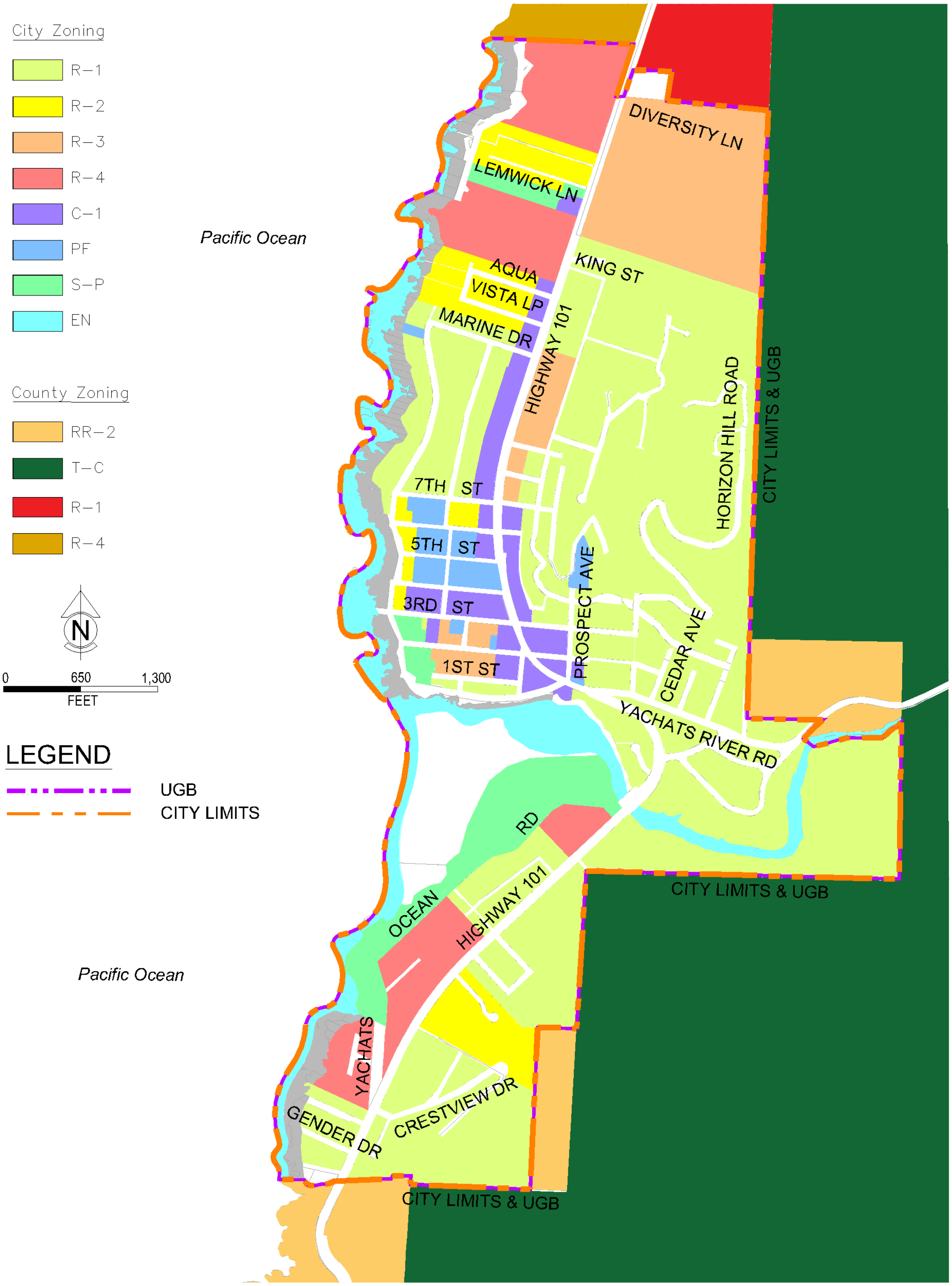
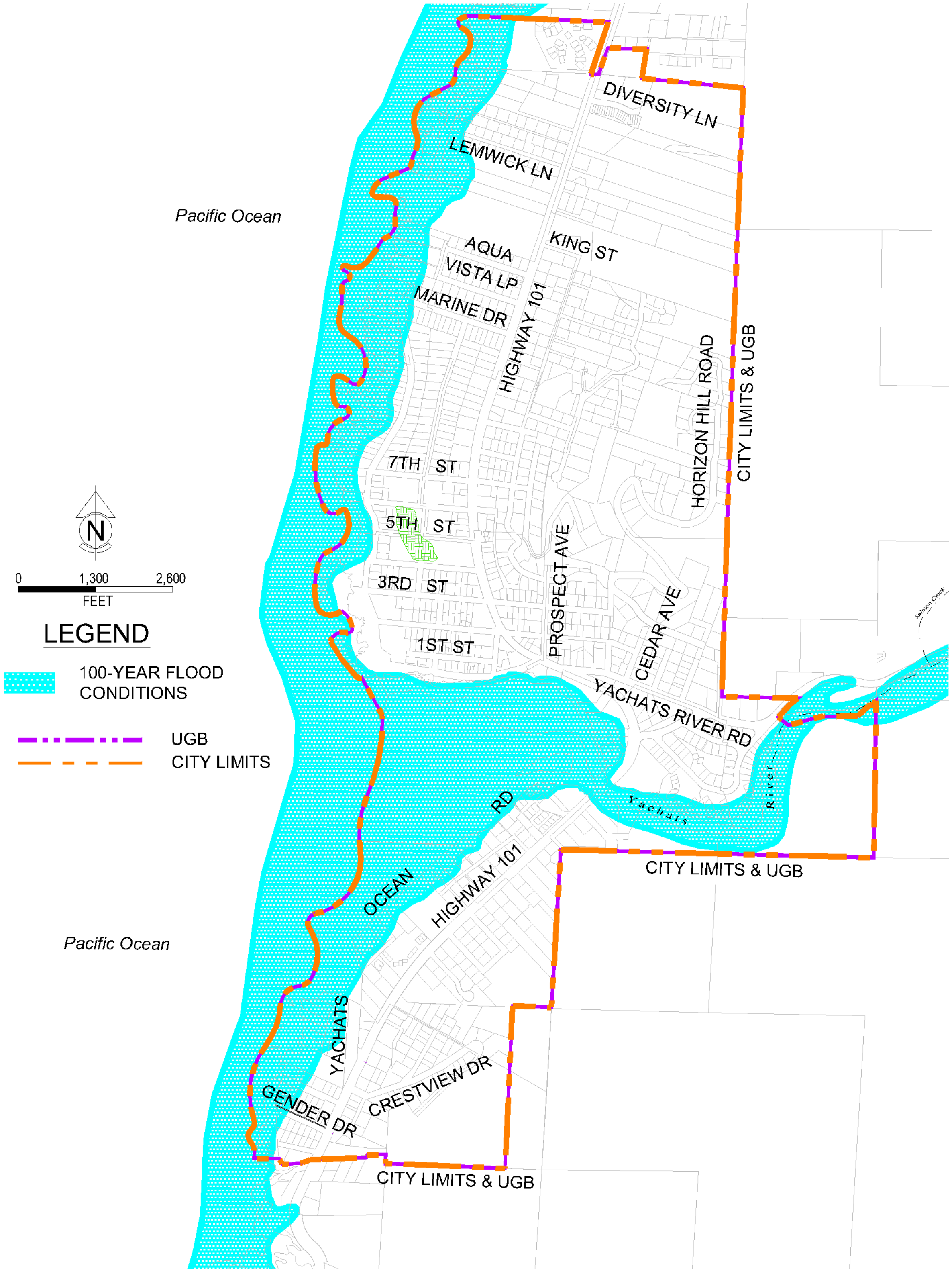


Figure 2-6 | 100-Year Floodplain Map



CITY OF YACHATS
Storm Drainage System Master Plan

Section 3

Description of Existing System

SECTION 3
DESCRIPTION OF EXISTING SYSTEM

3.1. General

The City's existing storm drainage system collects stormwater from open areas, streets, residences, businesses, industries, and public facilities and conveys the runoff that ultimately discharges to the Pacific Ocean. The urban growth boundary and the city limits are currently approximately on the same line and all under City responsibility.

Flow through the storm drainage collection system is by gravity. There are no public storm drainage pump stations in Yachats storm drain system. The existing pipes are made from a variety of materials and in a wide range of conditions from recently constructed sections that are in very good shape to others that are ancient and deteriorated.

This section provides an overview of the existing storm drainage system within the study area and summarizes known or reported problems.

3.2. Stormwater Drainage Basins

As shown on **Figure 3-1a**, the study area is divided into a large number of drainage basins. (Note: All Section 3 figures are provided at the end of this section.) The basins are named in the order they are discharged to the Pacific Ocean starting with the most northern basin and continuing sequentially to the south. Portions of the city inside city limits were not included in the study area for various reasons. The main being the areas not covered are very close to the limits of the Pacific Ocean or Yachats River, where the water naturally drains without the help of a pipe system or the area is too small to be addressed at the master plan level.

The study area is bounded by the Pacific Ocean to the west and densely wooded forest and mountains to the east. Since Yachats is lined by the Pacific Ocean, basins are typically small and drain directly to the ocean with little conveyance needed. Basins 1 through 16 are located on the north side of the Yachats River. Basins 1 through 10 discharge their flow directly to the Pacific Ocean. These basins are bounded by the northern city limits to north above Fourth St as the southern boundary. Basins 11 through 16 are located south of Fourth St but north of Yachats River, and discharge to Yachats River or Yachats Bay. Basins 22 through 28 are located south of Yachats River and end just past the city limits to the south and discharge to the Pacific Ocean.

Roughly half of the basins are further divided into sub-basins which are designated with a letter following the basin number designation. Numbered basins (5, etc.) have letters to differentiate the sub basins (5A, 5B, etc.). Detailed maps are provided to allow a closer review of the basins and sub-basins. The layout for the detailed maps is provided on **Figure 3-1b**. A total of four sub-basin maps are provided. The boundaries for each map are drawn and the map number is listed in the upper left and lower right corners of their respective areas. Significant map overlap was included to allow better visual context for the layout of the storm drain system in each area. The detailed basin maps are labeled **Figure 3-2a** through **Figure 3-2d**.

The basin boundaries were determined based on the topography, layout of the storm drainage system, and field investigation of actual drainage patterns. **Table 3-1** lists the approximate areas within each of the major drainage basins shown.

Table 3-1
Major Drainage Basin Areas

Basin Name	Basin Discharge Location	General Basin Boundary	Area (Acres)
1	Highway 101 at NE Peterson Road	All east of Highway 101 in the area of Diversity Lane to ± 1,500 ft east of the Highway	40
2	Pacific Ocean west of the Fireside Motel	Around the Fireside Motel and ± 1,000 feet east of the Highway	20
3	Pacific Ocean west of Coolidge Lane.	Along Coolidge Lane.	5
4	Pacific Ocean west of Lemwick Lane.	Along Lemwick Lane.	4
5	Pacific Ocean 300 ft south of Lemwick Lane.	West of Highway 101 around Smelt Sands State Recreation Site. To the east of Highway 101, around King Street and ±275 to the north.	29
6	Pacific Ocean west of the Adobe Resort.	West of Highway 101 to the Pacific Ocean, around the Adobe Resort.	11
7	Pacific Ocean west of north Aqua Vista Loop.	West of Highway 101 to the Pacific Ocean, around the north portion of Aqua Vista Loop.	4
8	Pacific Ocean west of south Aqua Vista Loop.	West of Highway 101 to the Pacific Ocean, around the south portion of south Aqua Vista Loop.	4
9	Pacific Ocean 100 feet south of Marine drive.	To the west of Highway 101, around Marine drive, Ocean View Road and Driftwood Lane north of 7th Street. To the east of Highway 101, from south of King Street to 9th Street, ± 1,000 feet east of the City Limits.	111
10	Pacific Ocean 250 feet north of Seventh St.	South of 9th Street to 4th Street from the Pacific Ocean to ± 550 feet east of the City Limits.	44
11	Pacific Ocean at Pontiac Street	To the west of Highway 101 around Third and Second Street.	12

Table 3-1 **Major Drainage Basin Areas (continued)**			
Basin Name	Basin Discharge Location	General Basin Boundary	Area (Acres)
12	Pacific Ocean, south of the intersection of Highway 101 and Ocean View drive.	To the east of and including Highway 101 to Prospect Avenue, north to include a portion of Center Way.	12
13	Pacific Ocean, south of the intersection of Highway 101 and First St.	Prospect Avenue to Loma Avenue, Highway 101 to the south to ± 60 feet north of King Street.	17
14	Pacific Ocean north of Bayview Terrace	Around Cedar Avenue, north of Highway 101 to ± 1,500 feet of Yachats River Road.	18
15	Pacific Ocean north of Bayview Terrace	Around Lori Lane, Lincoln Avenue and Spruce Avenue, as well as area to the north and ± 400 feet past the City limits to the east.	22
21	Pacific Ocean west if Koho Subdivision	Koho Subdivision	4
22	Pacific Ocean, 550’ northeast of Mitchelle Lane	To the west of Highway 101 around Shell Street	3
23	Pacific Ocean, 300 feet northeast of Mitchell Ln	To the west of Highway 101 around Shell Street to the north of Mitchell Lane	4
24	Pacific Ocean, 50 feet north of Mitchell Lane.	Around Mitchell Lane and the north portion of Reeves Circle.	13
25	Pacific Ocean, southwest of the Yachats Inn.	South of Yachats Inn, around Hill Court to past the City Limits	23
26	Pacific Ocean west of Cape View Drive.	Around Yachats Ocean Road, Green Hill, Lilly Ct and Overlook Drive to past the city limits ± 875 feet.	22
27	Pacific Ocean, 220 feet north of Crest View drive.	East of Highway 101, the area around Crest View Drive to past the City limits.	20
28	Pacific Ocean, 80 feet south of Gender Drive.	East of Highway 101, around windy way to ± 2,700 feet past the City limits.	95

Within the study area, several jurisdictions have responsibility for design and maintenance of the storm drainage system. The City is responsible for the all of the system except those parts belonging to the Oregon Department of Transportation (ODOT), Oregon State Parks, and Lincoln County.

ODOT right-of-way in the study area consists of Highway 101. ODOT owns and maintains all of the storm drain infrastructure in this right-of-way.

Oregon State Parks is responsible for the Yachats Ocean Road Natural Site which runs along the coastline from just south of the river to near the south City Limits. Oregon State Parks owns and maintains the storm drainage within the Natural Site.

Lincoln County is currently responsible for Marine Drive and Ocean View Drive; however, the City will be assuming responsibility for these street and the associated storm drainage systems in the near future. Lincoln County will remain responsible for Yachats River Road and Lori Lane including the storm drainage system in those streets.

3.3. Existing System

The schematic **Storm Drainage System Maps** (**Figures 3-2a to 3.2d**) show the location of the existing known drainage system elements for the overall system. A large-scale copy an overall system map is included in **Appendix B**.

The existing storm drainage system is a combination of open channels, storm pipes, and culverts in the well-developed areas of the City, and roadside ditches, cross country ditches and perennial streams, and cross culverts in the less developed areas. The total estimated length of pipe in the drainage system is approximately 13,000 feet (±2.5 miles) with ±110 catch basins and ±50 storm drain manholes. The remainder of the storm drainage system consists of small seasonal streams and constructed open channels, including roadside ditches. A detailed inventory of these channels and ditches was not performed, but the total appears to be in the range of 2.5-3 miles (excluding highway ditches).

Table 3-2 contains a summary of the estimated quantities of piping by size and material type in the storm system by material type and diameter.

Table 3-2 Storm Drainage System, Estimated Piping Quantities						
	Total Estimated Pipe Quantities (feet)					
Pipe Size	HDPE	PVC	CMP	Concrete	DI/Other	Totals
4"		120				120
6"	25	220		95		340
8"	80	45		880		1,005
10"					95	95
12"	2,910	1,110	235	2,570	50	6,875
15"		50	30			80
18"	395		440	240		1,075
24"	875		440			1,315
30"	85					85
60"			140			140
Totals	4,370	1,545	1,285	3,785	145	11,130
Number of Catch Basins = ±85 Number of Manholes = ±20						
PVC = Poly Vinyl Chloride HDPE = High Density Polyethylene CMP = Corrugated Metal Pipe DI = Ductile Iron						

The quantities shown on the table are limited to those within the UGB. As can be seen from this table, there is a variety of pipe materials in the current storm drainage system. The size of the storm drain pipes vary from 4 to 12 inches in diameter for local systems to 18-inch and larger pipes for major collector systems. Pipe materials include concrete, Poly Vinyl Chloride (PVC), High Density Polyethylene (HDPE), corrugated metal (CMP), and ductile iron (DI).

3.4. Typical Storm Drain System Problem Categories

Before addressing particular problems, it is helpful to define the categories of problems likely to be encountered. We have found that problems can generally be divided into the following categories; lack of capacity, lack of facility, end of design life, lack of maintenance, erosion, and on-site problems. Not all categories of problems are present in every system. A short description of each of these categories follows:

3.4.1 Lack of Capacity

This type of drainage problem results from open channels or pipes that are too small to handle the peak storm runoff. This type of problem typically results when upstream development increases the peak flow and volume of runoff, or because the existing system was constructed before storm drainage design standards were established. Therefore, although the storm system may have capacity to handle the runoff from smaller magnitude storms, it is unable to convey the runoff during major storm events. In either case, these portions of the existing system are undersized and need to be improved.

Design standards typically require that as the storm channel or pipe gets larger, it must be designed to convey the flow from a more intense storm event due to the increased risk of property damage should the system fail. For instance, local systems are typically sized based on a 10-year frequency storm, while larger storm drains or ditches serving a major basin must be designed for a 25 or 50 year frequency storm. If the local system overflows, the likelihood of significant property damage is relatively small, while failure of the major systems can result in significant damage to property.

3.4.2 Lack of Facility

Drainage problems in this category are caused by the absence of a drainage system. While this is also technically a capacity issue, it is listed as a separate category to allow for prioritization. Examples include areas where there is no established drainage system, area where there is no catch basin at the low spot in a street, lack of drainage systems deep enough to serve homes set back from the street, or property which is too low to drain to an established drainage system. Any of these cases typically results in ponding water and/or flooding on a regular basis.

3.4.3 End of Design Life

This type of drainage problem is the result of old, damaged, or worn out systems that no longer function as designed. The most common example of this type of problem includes rusted or collapsed pipes or culverts. The correction of these types of problems requires replacement or reconstruction of the existing system.

3.4.4 Lack of Maintenance

Dirt, gravel, sediment, and other debris carried by storm runoff may settle out or become lodged in culverts, pipes, and catch basins, resulting in flooding due to the reduced capacity of the system (sedimentation). This type of problem can be prevented or minimized by routine inspection and cleaning.

A second problem in this category results when ditches or other drainage facilities are located along back lot lines or through undeveloped areas without any provisions for maintenance access. Under this scenario, it is difficult and expensive for the City to maintain the storm drainage facilities on a regular basis, as the costs for obtaining access or restoring the area following maintenance may cost as much as the maintenance work itself.

A final concern under this category is when residents or developers dump debris into ditches during the dry season, which results in flooding when the wet season arrives.

3.4.5 Erosion

Unless erosion control measures are maintained during construction of new developments, rainfall washes soil from areas that have been cleared of vegetation and graded for development. Erosion of streambeds and banks may also occur when development increases runoff flows. Deposition of these sediments downstream contributes to the maintenance problems experienced by the system. The irony of erosion problems is that the flooding caused by this sediment typically occurs far downstream of the source of the problem. Although an analysis of this issue is beyond the scope of this report, the City does require erosion control facilities during construction of new developments.

3.4.6 On-site Problems

Examples of on-site drainage problems include standing water in yards, flooded driveway culverts on small local systems, flooding in private parking lots, and problems related to groundwater and springs. In many cases, the on-site drainage problems are a result of conditions on the site (ie. clogged parking lot catch basins or driveway culverts) that are the responsibility of the private property owner. Evaluation of these types of problems is beyond the scope of this report.

3.5. Yachats Storm Drain System Capacity Problem Areas

The major capacity problem areas and their associated categories are summarized in **Table 3-3.** This list is not all inclusive, but is limited to the major problem areas caused by lack of capacity or lack of stormwater facilities, as well as facilities which are at the end of their useful design life. This list does not address local on-site flooding problems or localized maintenance or erosion issues which can be dealt with by Public Works as part of the ongoing system maintenance, but is limited to those problem areas which will require major capital improvement project to correct. The recommended approach for correcting the capacity issues in these areas is discussed in more detail in Section 5.

Table 3-3
Existing Major Drainage Problem Areas
(Based on analysis or City Input)

Location	Problem Category
Basin 9	
• Outlet from Marine Dr to the Pacific Ocean	• Lack of Capacity (basin undersized or release orifice undersized)
• Marine Dr, from Driftwood Lane to crossing Marine again west of Highway 101	• Lack of Capacity (basin undersized or release orifice undersized)

Basin 9 • King Street, North of 10th and south of Windsong • 9th Street at Highway 101 • Hanley Drive south of 10th Street	•Lack of Capacity (basin undersized or release orifice undersized) •Lack of Capacity (basin undersized or release orifice undersized) •Lack of Capacity (basin undersized or release orifice undersized)
Basin 10 • Outlet from 250 feet north of Seventh St • 7th Street from Ocean View Drive to Driftwood Lane	•Lack of Capacity (basin undersized or release orifice undersized) •Lack of Capacity (basin undersized or release orifice undersized)
Basin 11 •Pontiac Street from Ocean View Drive to Third Street	•Lack of Capacity (basin undersized or release orifice undersized)

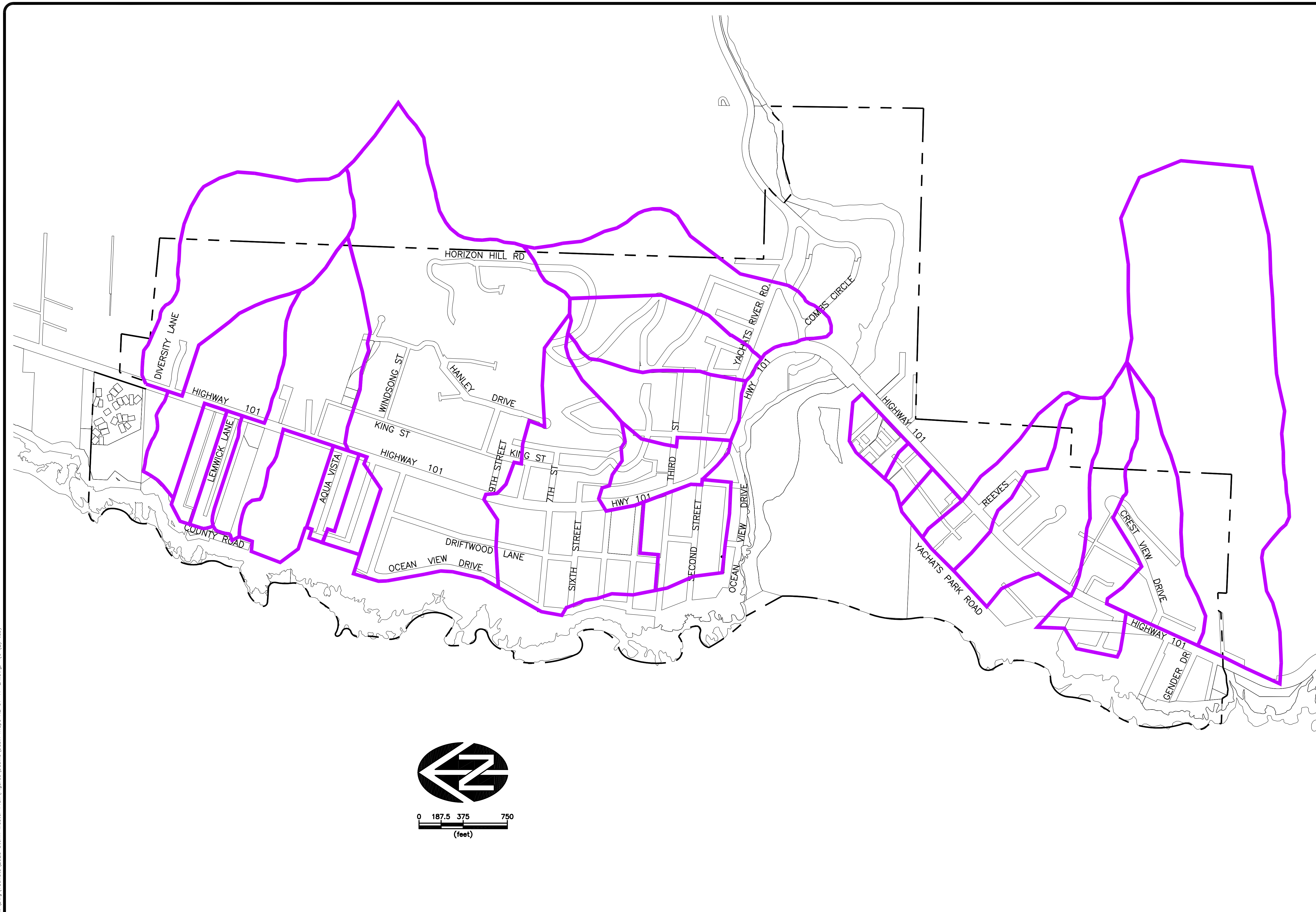
3.6. <u>Existing Storm Drainage Funding Mechanisms</u>

The City currently has five primary mechanisms for funding operations, maintenance, and improvements to the storm drainage system. These include storm drainage SDCs, Storm Drain Maintenance Funds, the Storm Drain Capital Improvement Fund, General Fund Transfers, and Urban Renewal District Project Funds.

The City has a Storm Drainage System Development Charge (SDC) that is charged at the time of development. Revenue generated by the SDC is available to fund certain types of system improvements (ie. those identified on the Capital Improvement Plan (CIP) on which the SDC is based), but can't be used to fund operations or maintenance costs. The SDC is based on the extent of the increased drainage generated. The SDC is $1,834.

Historically the City has spent roughly $25,000 annually on addressing stormwater system Operations. Capital Improvements have been funded from the Urban Renewal District and General Fund Transfers.

Additional information regarding potential storm drainage project funding is provided in Section 6.6.



City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Overall Basin Map

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FIGURE 3–1a

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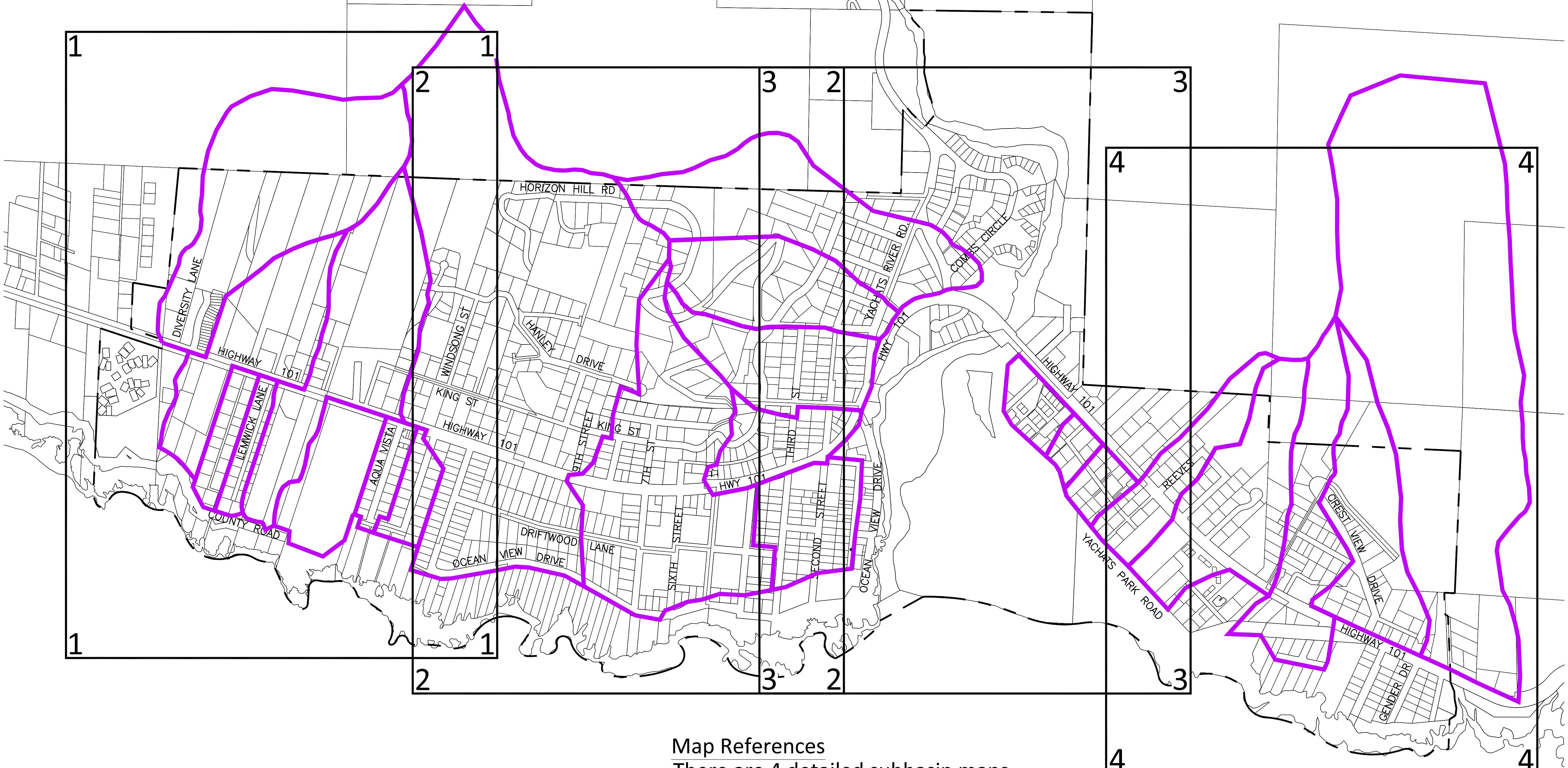

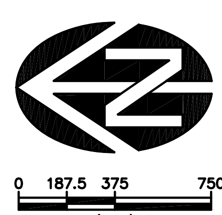

Map References

There are 4 detailed subbasin maps starting with "1" in the northern part of town and ending with "4" in the southern end of town. The area covered by each map is shown by the rectangle with the map number in each corner.

City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Overall Basin Sheet Reference Map

FIGURE 3–1b

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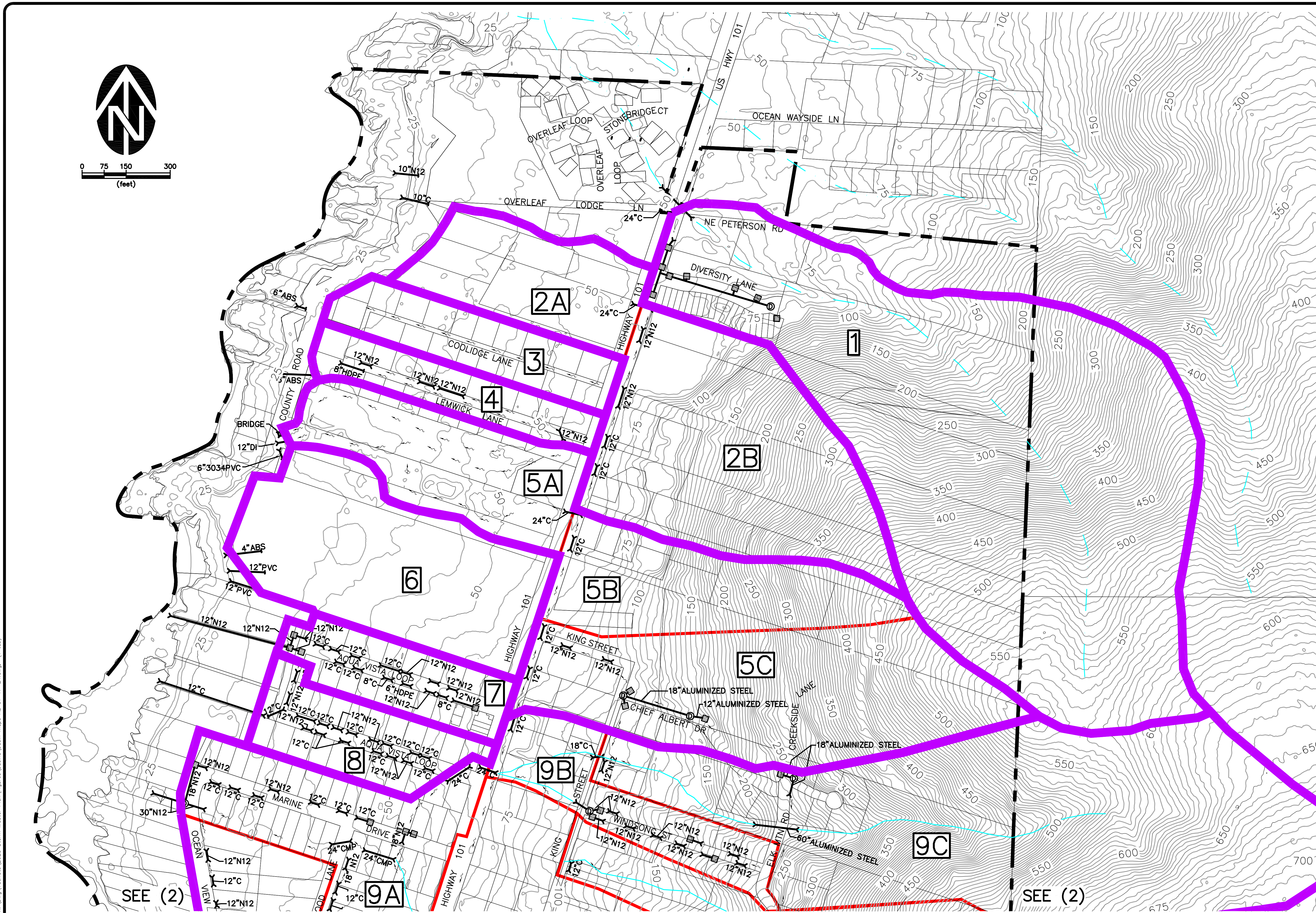

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City of Yachats, Oregon
City of Yachats Stormwater Master Plan
Sub-Basin Map (1)

FIGURE
3-2a

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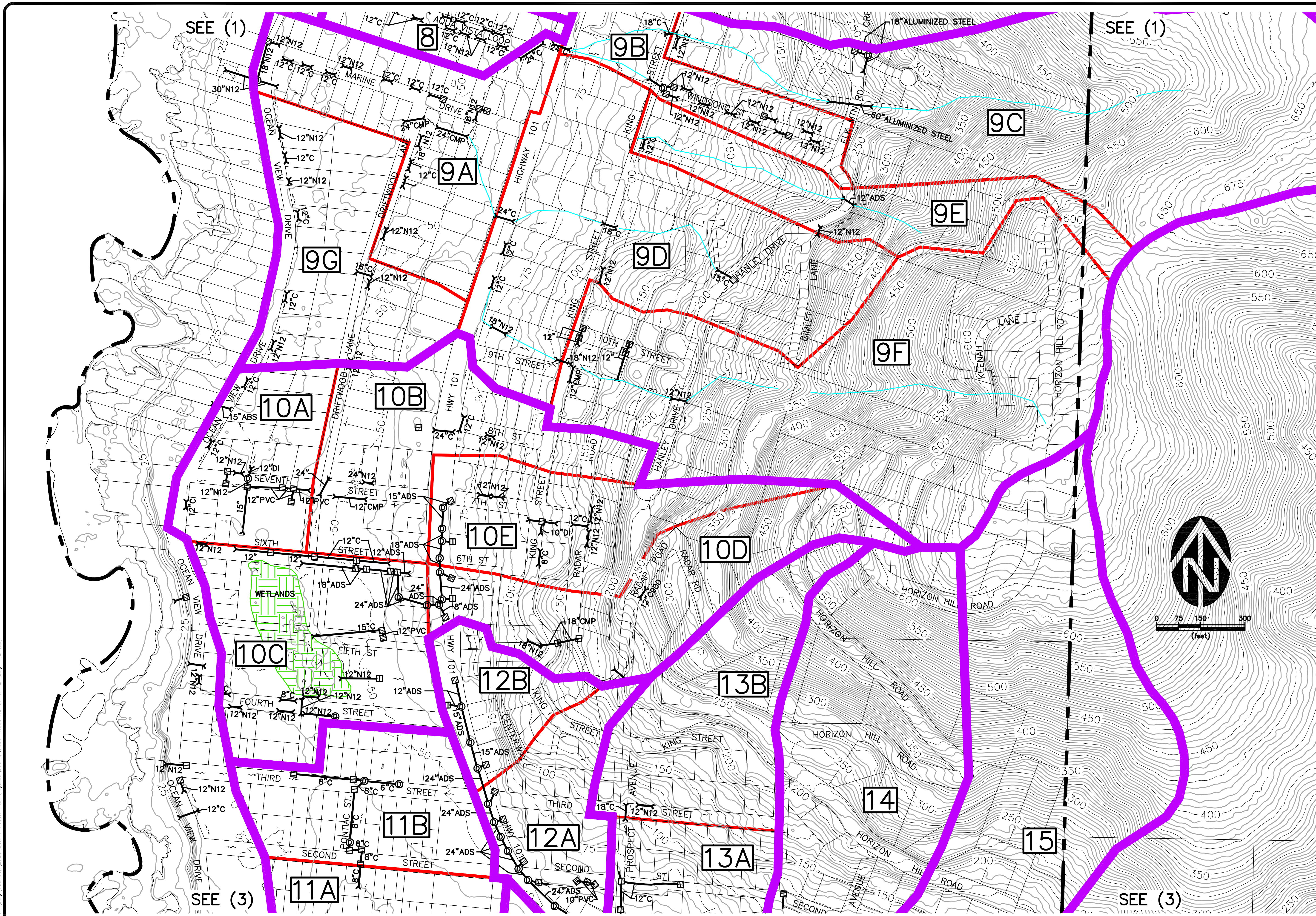

City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Sub-Basin Map (2)

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FIGURE 3–2b

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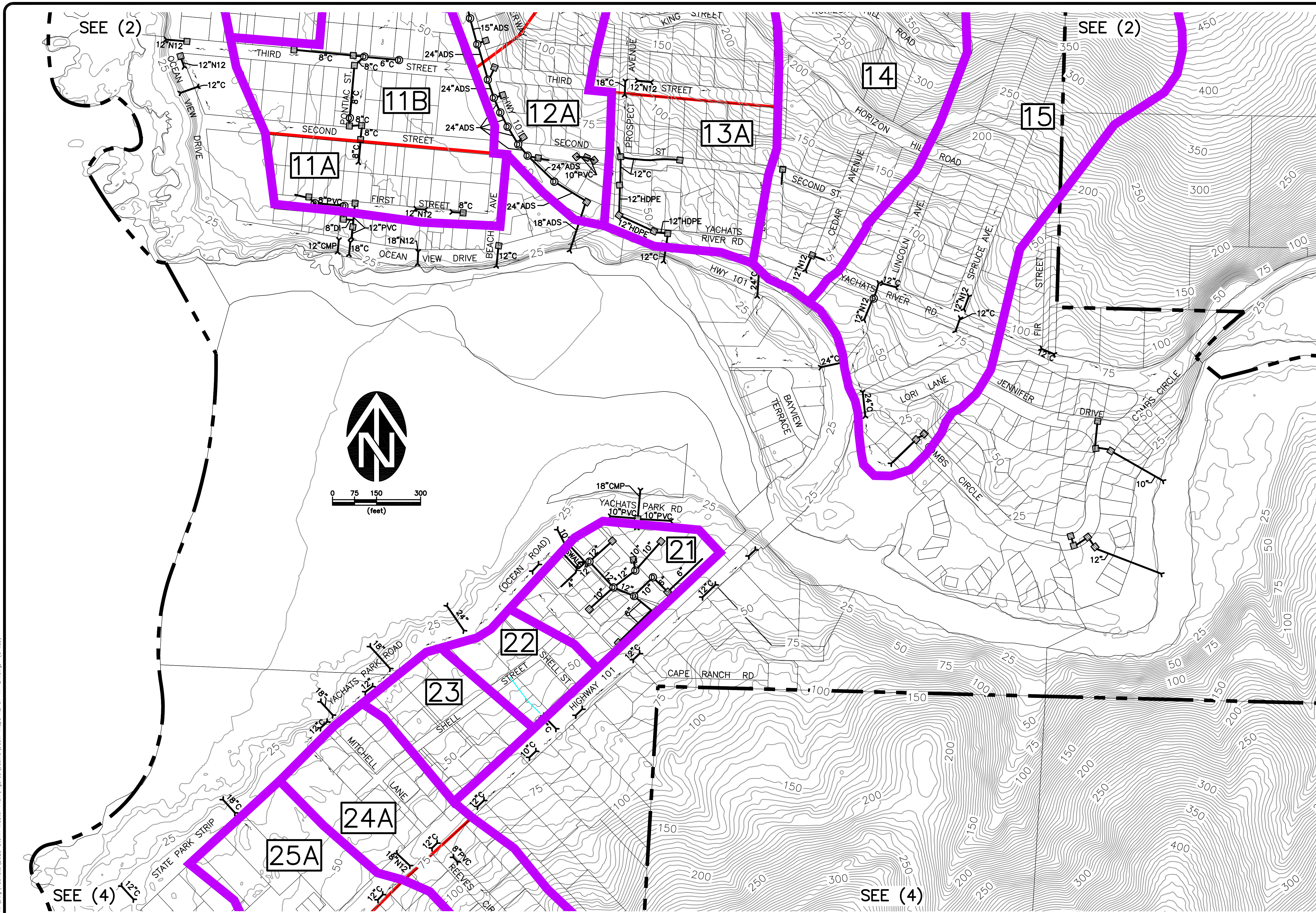

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City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Sub-Basin Map (3)

FIGURE 3-2c

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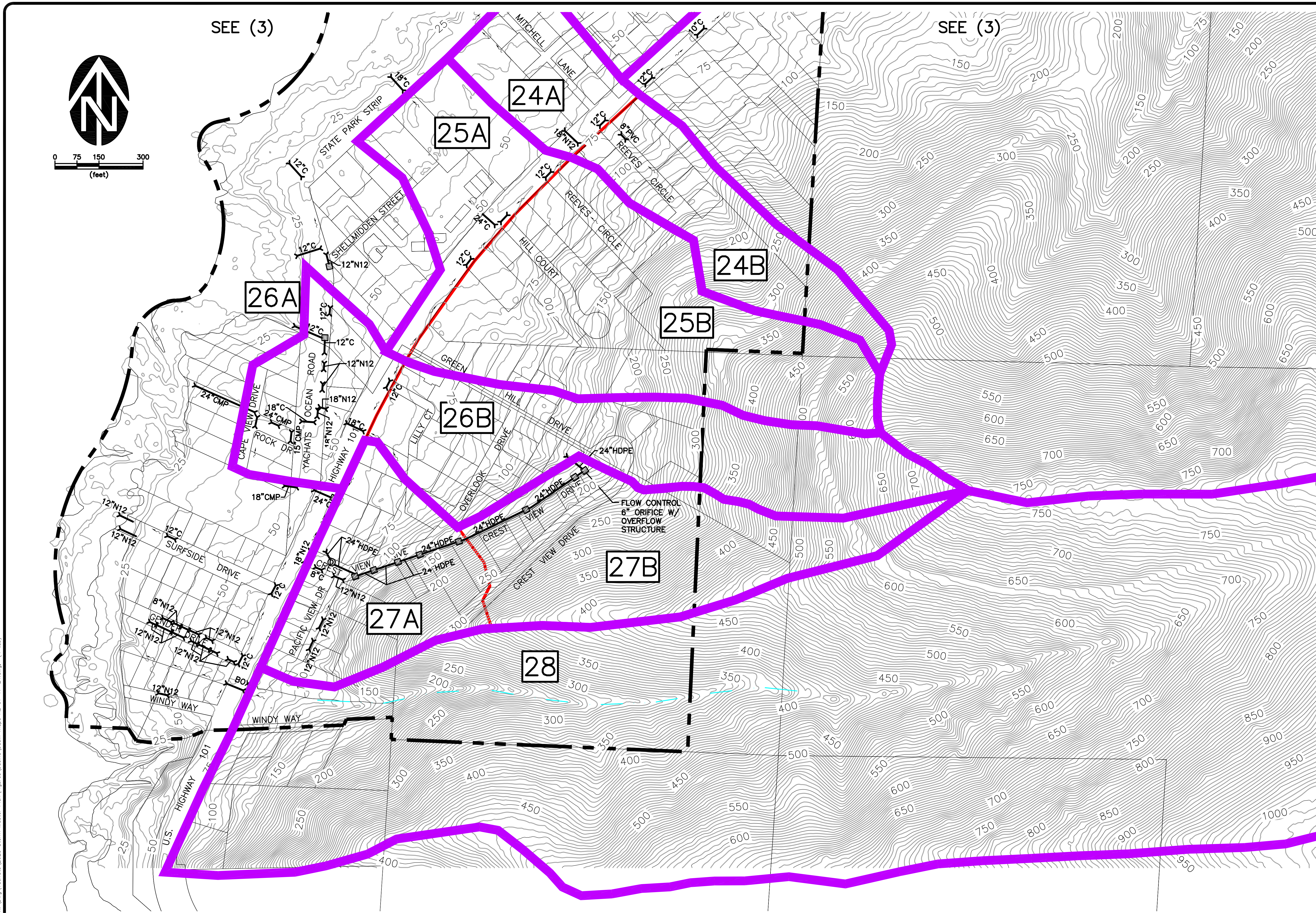

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City of Yachats, Oregon
City of Yachats Stormwater Master Plan
Sub-Basin Map (4)

FIGURE
3-2d

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Section 4

Hydrologic/Hydraulic Analysis

SECTION 4
HYDROLOGIC/HYDRAULIC ANALYSIS

4.1. Introduction

This section is included to present the technical and mathematical principles used to complete the analysis of Yachats' storm drainage system. A thorough understanding of this section is not required to understand or make use of the results of the analysis which are presented in Section 5. Readers whose primary objective is to find out what parts of the storm drainage system aren't working well and need attention may wish to review this section briefly to familiarize themselves with terminology and concepts before moving on to Section 5. If a particular concept or issue becomes of interest later, this section is available for reference as needed.

4.2. Hydrology Analysis Procedure

4.2.1 Modeling Methodology

The purpose of the drainage system capacity evaluation was to identify elements of the existing drainage system that cannot accommodate current and/or projected future storm water flows. The calculation of peak flows and runoff volumes within drainage basins is essential to any storm drainage master planning effort. Peak flows are used to size ditches, culverts, and pipe systems during the design process for new facilities.

To calculate the runoff for public storm drainage improvements, the Rational Method and the Santa Barbara Urban Hydrograph (SBUH) are commonly used. However, the Rational Method is not well suited to a progressive analysis of a series of basins that feed into each other. The use of the Rational Method is also generally limited to basins less than 300 acres. While all of the basins in this study are less than 300 acres, proper analysis dictated that they be further divided into sub-basins which were analyzed independently and then combined as flows were routed downstream.

Because of these issues for this study, the calculation of peak flows was accomplished using the HydroCAD mathematical computer simulation model developed by HydroCAD Software Solutions LLC. using the Santa Barbara Urban Hydrograph (SBUH) calculation method.

Santa Barbara Urban Hydrograph (SBUH) Method

The SBUH procedure involves defining sub-basins of the drainage basin of interest according to two basic hydrologic characteristics, the soil type and the time of concentration, then applying a model storm to that basin. The soil type involves the type of soil (as defined by the Soil Conservation Service soil maps), the use related to the parcel (residential, commercial, various types of agricultural activities, etc.), and judgement of relative quality of soil within that use (good, fair, poor). Using these parameters a curve number (CN) was selected to represent each of the various areas within the drainage basin and used as input in the computer model.

The model storm used is a 24-hour rainfall event, where the total rainfall is distributed in time-related increments based on the appropriately selected region of the country. The type of storm used for this study is the Type IA. This represents typical storm patterns for the West Coast from the coastline to the first major mountain range (Cascades, Sierras, etc.). The total rainfall is dependent on the magnitude of the event as described by the expected frequency: 2-year (4.5-inches), 5-year (5.5-inches), 10-year (6.0-inches), 25-year (7.0-inches), 50-year (8.0-inches), or 100-year (9.0-inches). These totals are mapped in the National Oceanic and Atmospheric Administration (NOAA) *Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume X – Oregon*. Information on the various input parameters used for the SBUH method are presented in **Appendix C**.

Table 4-1 provides a summary for runoff using SBUH calculations for selected hypothetical conditions, including a 10-acre site, a time of concentration of 20 minutes and Class 'C' soils. This summary illustrates the effects of different storm events and different soil types.

Table 4-1
Representative SBUH Peak Runoff (cfs)
10 acre site, Time of Concentration = 20 Minutes, Class 'C' Soils

Zone	Storm	5-year 5.5 in/hr	10-year 6.0 in/hr	25-year 7.0 in/hr	50-year 8.0 in/hr
City & UGB Areas					
R-1	CN = 83	7.8	8.5	10.6	12.6
R-2	CN = 86	8.3	9.3	11.4	13.5
R-3	CN = 86	8.3	9.3	11.4	13.5
C-1	CN = 94	10.2	11.2	13.2	15.3
PF	CN = 74	5.1	6.1	8	9.9
S-P	CN = 74	5.1	6.1	8	9.9
EN*	-	-	-	-	-
OS	CN = 74	5.1	6.1	8	9.9
Lincoln County Areas					
RR-2	CN = 77	5.9	6.9	8.8	10.8
A-C	CN = 74	5.1	6.1	8	9.9
T-C	CN = 73	4.9	5.8	7.7	9.6

*EN, Estuary Natural, was not analyzed in this study as flow is considered discharged when it reaches EN.

4.2.2 Design Storm Frequency

The selection of the design storm requires the determination of the degree of protection desired from the storm drainage system. A design storm with a low probability of being exceeded, such as the 100-year design storm (1% chance of being exceeded any given year), provides a high degree of safety in the drainage system design. However, the cost of such a system is relatively high compared to a system based on a design storm with a high exceedance probability. On the other hand, a system designed for a 2-year storm (50% chance of being exceeded any given year) will result in a lower cost drainage system whose capacity will be exceeded every few years, with possible property damage, public inconvenience and personal hazard.

To determine a design storm for drainage planning purposes, the following factors must be considered:

- The cost of the additional level of protection (ie. sizing system to convey a larger storm)
- The size of the drainage basin
- The extent of probable property damage if the system fails
- The availability of storage within the drainage system.

The size of the drainage area has a dramatic impact on the recommended level of protection. As the size of the drainage area increases, so does the total amount of runoff. As previously noted, design standards typically require that as the storm channel or pipe gets larger, it must be designed to convey the flow from a more intense storm event due to the increased risk of property damage should the system fail.

For illustrative purposes, consider that if a small local system overflows, the likelihood of significant property damage is relatively small while failure of the major systems can result in significant damage to property. Conversely, if the drainage facilities of a large drainage basin (such as one with 50 times the flow of smaller basins) is undersized by as little as 10%, those excess flows will be five times greater than the entire flow through the small basin and may produce serious flooding damage.

Under certain circumstances, a detailed cost-benefit analysis may be appropriate for determining the appropriate magnitude storm to be used. As an example, a large construction project in or near a floodplain might warrant a study of the cost of conveying various quantities of stormwater compared to the expected cost of damage for each additional incremental rise in floodwater elevation. However, such an analysis is generally beyond the scope of a report such as this. Instead, standard guidelines relating the magnitude of storm to be considered in the various portions of a storm drainage system are commonly used.

With all these factors in mind, **Table 4-2** outlines the design storm frequencies typically employed in storm system analysis, and thus utilized for this report. This level of protection is consistent with other Cities.

Table 4-2
Design Storm Frequency

Area	Frequency (rational method)
Residential areas	10-year storm
Commercial and high value districts	10-year storm
Trunk lines (18" pipe and larger)	25-year storm
Minor creeks and drainage ways (not shown as a flood plain on the Flood Insurance Rate Map (FIRM))	50-year storm
Major creeks (shown as a flood plain on the FIRM)	100-year storm

Since the Santa Barbara Urban Hydrograph uses rainfall that is distributed over 24 hours, it tends to calculate peak flows that are lower than the Rational method. Due to this, the 50-year design storm was used for all SBUH calculations for this study. Although a 25-year storm could be used for smaller city streets, 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. Due to the fact Highway 101 runs directly through the City of Yachats a 50-year design storm was used for uniformity as many basins are split by Highway 101.

4.3. Hydraulic Analysis

4.3.1 General

A typical public storm drainage system generally consists of three main elements; pipes, culverts, and open channels (manmade ditches or natural streams). While other elements exist, such as pumps, dams, ponds, and water quality features, the pipes, culverts, and open ditches serve as the primary means of conveying stormwater through and out of the City.

The following sections provide a brief summary of the standard mathematical analysis used to determine the capacity of a given element. Like a chain, a storm drainage system is only as good as its weakest link. Thus, in completing an analysis of a storm drainage system it becomes necessary, as a minimum, to evaluate all of the major elements to identify any “weak link.” For this study the evaluation included all major trunk lines down to those that handle the drainage for at least a full sub-basin. Local collection systems within a sub-basin were not specifically addressed.

4.3.2 Pipe Flow - Manning's Formula

A large portion of Yachats' storm drainage system is made up of pipe elements. The drainage is collected by an inlet structure, such as a catch basin, and conveyed from point to point through a series of pipes connected by structures, such as manholes or junction boxes. Most pipes within the storm drainage system were assumed to be flowing full under open channel flow conditions. "Open Channel" in a pipe system refers to uniform gravity flow in a long pipe segment, not open to the air such as a ditch.

The formula used to evaluate pipes under these circumstances is Manning's Formula, which is expressed as:

$$Q = \frac{1.486}{n} \times A \times R^{2/3} \times S^{1/2}$$

where:
- Q = flow, cubic feet per second
- A = cross-sectional area, square feet
- R = hydraulic radius, feet
- S = slope, feet/feet
- n = Manning roughness coefficient

The roughness factor for pipes varies according to the material used and the age of the pipe material. For this planning effort, a minimum "n" value of 0.013 shall be used in Manning's formula for the design of all smooth wall storm pipes regardless of pipe material. In theory, new PVC sewers have manufacturer's "n" value of as low as 0.009. However, sand and grit as well as slime accumulations on the pipe walls over time tend to render a true, or operational, "n" value of 0.013. Hence, an "n" value of less than 0.013 for smooth wall pipe is not recommended for design purposes. For corrugated pipes an "n" of 0.024 value was used, and is recommended for design purposes.

Using the equation above it becomes a straightforward matter to calculate the capacity of any given pipe segment given a few simple, specific pieces of information. The cross sectional area can be readily computed from the pipe diameter. The hydraulic radius is defined as the cross sectional area divided by the wetted perimeter and is included in the formula because the friction resistance opposing the flow occurs at the wetted perimeter. For this study the interest is in the maximum capacity of the pipe, so all pipes are assumed to be flowing full. The slope is self explanatory, and the "n" value is discussed above. **Table 4-3** presents the computed capacity of a variety of pipe sizes and slopes assuming the pipes have a Manning's "n" of 0.013 and are flowing full:

Table 4-3 **Pipe Capacity** (Flowing Full (cfs), Manning's "n" = 0.013)							
	Pipe Size (inches)						
Slope (%)	12	18	24	30	36	42	48
0.2	1.6	4.7	10	18	30	45	64
0.4	2.3	6.7	14	26	42	64	91
0.6	2.8	8.2	18	32	52	78	112
0.8	3.2	9.4	20	37	60	90	129
1.0	3.6	10.5	23	41	67	101	144
1.2	3.9	11.5	25	45	73	111	158
1.4	4.2	12.5	27	49	79	119	170
1.6	4.5	13.3	29	52	85	128	182
1.8	4.8	14.1	30	55	90	135	193
2.0	5.1	14.9	32	58	95	143	204
2.2	5.3	15.6	34	61	99	150	214
2.4	5.5	16.3	35	64	104	156	223
2.6	5.8	17.0	37	66	108	163	232
2.8	6.0	17.6	38	69	112	169	241
3.0	6.2	18.2	39	71	116	175	249
Note: Flows for pipes larger than 18" are rounded to the nearest whole number.							

4.3.3 Culvert Flow

Culverts are distinguished from pipes in that they are open at both ends, rather than connected to structures such as catch basins or manholes. Culverts function under several distinct conditions depending on the depth of flow at their upstream and downstream ends. The desired condition for a properly sized channel and culvert is to have the downstream water surface level below the top of the pipe, and the upstream water surface level at or below the top of the pipe. In this condition the culvert is not having any significant impact on the flow and is simply conveying the water underground from one section of channel to another.

If the downstream channel water surface level is below the top of the culvert, but the flow from upstream is greater than the full flow capacity of the culvert, the water surface height at the upstream end will rise. This will increase the water pressure at the upstream end, which will then force water through the pipe at a higher rate. This condition is described as inlet control. Under this condition the water surface elevation will stabilize at the point where the water is being forced through the culvert at the same rate that it is arriving from upstream.

If the downstream channel is undersized, the normal depth of flow will rise above the top of the outlet pipe. In order for water to continue to flow through the pipe, the water at the upstream end must rise also. This condition is described as outlet control. Since outlet control also results in a higher than normal upstream water surface elevation, it is generally considered to be an undesirable condition and should be corrected whenever possible.

Both inlet and outlet control capacities are frequently determined using nomographs that allow a simple, graphical solution for a wide range of pre-computed conditions. Sample nomographs for concrete and corrugated metal pipes for both inlet and outlet control are presented in **Appendix D.**

The final condition that may be relevant to culvert flow is that of a pipe flowing full. Just as open channels have a "normal" condition, so do pipes. The physical properties of a pipe define its capacity in the absence of bends, obstructions, changes in size, etc. This is described in more detail in the following section.

4.3.4 Open Channel Flow - Manning's Formula

In addition to the piped system, the City has a substantial number of roadside ditches and some minor open drainages that are generally outside the current City limits. The following discussion is provided as a resource to aid in the evaluation the existing open channels, as well as any open drainageways that might be proposed in the future.

Any analysis of open ditches should address at least two main issues. The first is the ability of the ditch to carry the anticipated flows. The second, and more subtle consideration, is ensuring that they are properly designed to accept flows from piped systems or other ditches discharging to them. If the water surface in the ditch becomes too high, water in piped systems or adjacent roadside ditches tends to back up and resist the flow of water trying to enter the main ditch. If such a situation occurs frequently, the slow drainage in the piped system can allow sediment to settle out and accumulate, thereby creating further reductions in system capacity as well as maintenance problems.

Under conditions described as "normal flow", the depth of water in an open ditch can be determined using Manning's equation:

$$Q = \frac{1.486}{n} \times [Y \times (B + Z \times Y)] \times \{\frac{[Y \times (B + Z \times Y)]}{[B + 2Y \times (1 + Z^2)^{1/2}]}\}^{2/3} \times S^{1/2}$$

where:
- Q = Flow (cfs)
- n = Manning's coefficient (0.035 used for open channel with a natural bottom, 0.013 used for open channel with a concrete bottom)
- Y = Flow Depth (feet)
- B = Channel Bottom Width (feet)
- Z = Channel Side Slopes (Z horizontal: 1 Vertical)
- S = Channel Slope (ft/ft)

Normal flow occurs where the ditch or waterway is consistent with no changes in slope, no bends, or obstructions such as culverts or weirs. While normal flow is a best case situation, it provides a reliable estimate for flow depth at a given flow volume for man-made channels with consistent cross sections and gradual bends.

When an open drainageway encounters a culvert, the effect on the flow is dependent on the flow relative to the size and capacity of the culvert. If culvert capacity is large relative to the flow, it is unlikely that it will have a significant impact on the open channel flow in the ditch. However, if the flow in the ditch approaches or exceeds the capacity of the culvert, the conditions for normal flow can be violated and other methods must be applied to estimate the depth of flow in the ditch.

While the details of the culvert flow were described in the preceding section, the primary effect of an undersized culvert on open channel flow is to raise the water surface elevation on the upstream end of the culvert. This higher water surface elevation impedes normal flow for some distance upstream of the culvert. This upstream region is described by a backwater curve that can be calculated either by hand or computer programs.

For the purposes of this study, backwater analysis was not conducted. It is important that culverts on the main drainage channels not be points of flow restrictions that cause significant backwater conditions.

4.4. Computed Stormwater Flows for Existing and Future Conditions

The baseline for analysis in this study are the existing conditions. Using the 'CN' values for current zoning, land uses, and estimated conditions, the basins were modeled under 50-year storm event condition for the SBUH analysis. Where the current use does not match the zoning, such as land still being farmed in the R-1 zone, the runoff coefficient for the actual use was employed in the study for existing conditions. Where there is a mixture of uses, a runoff coefficient based on a weighted average was computed. The 'CN' numbers used in this modeling for the Yachats City Limits and Yachats UGB are shown in **Table 4-4**, while the 'CN' numbers for outside the Yachats UGB are shown in **Table 4-5**

With possible 'CN' numbers ranging from 61 (for well drained, sandy meadows) to 95 (for paved surfaces), the numbers used in this study are restricted to a relatively narrow range. In areas where the natural soil drains readily, there can be a large change in 'CN' number from undeveloped to developed conditions.

The time of concentration was estimated for each basin in three segments; overland sheet flow, shallow overland flow, and piped or open channel flow. For overland sheet flow, the ground slope, soil condition, and flow length was estimated based on typical parameters for each area. **Table 4-6** shows representative values for these parameters used in this study.

For future conditions, all areas were assumed to be fully developed according to their respective zoning conditions. **Table 4-7** provides a summary of runoff coefficients and times of concentration for all sub-basins in both existing and future conditions.

In addition to the consideration of existing and developed conditions, the capacity of the existing storm drainage conveyance system was taken into account. If a portion the existing system lacks the capacity to carry all of the runoff coming to it, the stormwater will be backed up (detained) upstream of that part of the system. If that part of the system is upgraded to carry more runoff, then the detention characteristic will be removed and downstream areas will see more runoff than previously. Based on this issue, computer modeling was performed for both the existing (potentially inadequate) storm drain system and a hypothetical future free flowing storm drainage system. Existing and free flow calculations were performed for both existing and fully developed land use conditions.

The SBUH stormwater runoff computed based on the input parameters listed above is included in this report as **Appendix C**. The peak flow values from these calculations are used in Section 5 to evaluate the adequacy of the main trunk lines and culverts.

Table 4-4
Typical Sub-basin 'CN' Parameter (Yachats City Limits/UGB)

	'CN' By Soil Type			
ZONE	A	B	C	D
R-1 – Single Family Residential	61	75	83	87
R-2 – Single, Duplex, Multi-Family	71	80	86	90
R-3 – Single, Duplex, Multi-Family	71	80	86	90
R-4 - Single, Duplex, Multi-Family & Motel	77	85	90	92
C-1 – Commercial	89	92	94	95
PF - Public Facilities	Varies	Varies	Varies	Varies
S-P - State Parks	Varies	Varies	Varies	Varies
EN – Estuary Natural	Varies	Varies	Varies	Varies
Open Space*	39	61	74	80

*For calculation purposes of undeveloped areas

Table 4-5
Typical Sub-basin 'CN' Parameter (Outside City Limits/UGB)

	'CN' By Soil Type			
ZONE	A	B	C	D
RR-2 –Rural Residential	46	65	77	82
A-C – Agricultural Conservation	39	61	74	80
T-C – Timber Conservation	36	60	73	79

Table 4-6 Typical Sub-Basin Time of Concentration Parameters	
Overland Sheet Flow in hours (minutes)	
	100’
n=0.016	
s = 2%	0.08 (5)
s = 1%	0.10 (6)
n=0.025	
s = 2%	0.11 (7)
s = 1%	0.15 (9)
n=0.15	
s = 2%	0.18 (11)
s = 1%	0.24 (14)
n=0.24	
s = 2%	0.27 (16)
s = 1%	0.36 (21)
n=0.40	
s = 2%	0.38 (23)
s = 1%	0.52 (31)
Manning’s coefficients used as follows: 0.016 –Commercial; 0.025 –Industrial; 0.15 Residential Areas, Farm; 0.24 – Parks, Open Space; 0.40 – Forest	

Shallow Concentrated Flow in hours (minutes)		
	Paved	Unpaved
s = 4%	N/A	0.009 (0.5)
s = 2%	0.010 (0.6)	0.012 (0.7)
s = 1%	0.014 (0.8)	0.017 (1.0)
Times shown are per 100 foot of distance traveled.		

Pipe Flow
Typical average velocity of 4 ft/sec to 6 ft/sec.

Table 4-7 Sub-Basin Characteristic Summary					
		SBUH 'CN'		Time of Concentration (minutes)	
Sub-basin	Size (acres)	Existing	Future	Existing	Future
1	40	74	79	29	29
2A	6	82	91	12	12
2B	14	79	84	13	13
3	5	84	84	10	10
4	4	88	88	10	10
5A	7	88	88	11	11
5B	7	70	84	11	11
5C	15	74	79	10	10
6	11	73	85	11	11
7	4	83	83	9	9
8	4	81	81	9	9
9A	11	70	81	11	11
9B	5	74	77	9	9
9C	29	74	77	17	17
9D	19	77	81	12	12
9E	7	62	83	9	8
9F	28	72	80	14	12
9G	10	77	77	14	14
10A	6	77	77	9	9
10B	10	80	82	9	9
10C	11	84	84	23	23
10D	10	77	82	16	16
10E	8	78	82	16	16

Table 4-7 Sub-Basin Characteristic Summary Continued					
		SBUH 'CN'		Time of Concentration (minutes)	
Sub-basin	Size (acres)	Existing	Future	Existing	Future
11A	5	86	86	11	11
11B	8	89	89	5	5
12A	6	90	90	3	3
12B	4	89	89	6	6
13A	6	79	79	10	10
13B	10	81	83	14	14
14	19	75	81	14	12
15	31	78	80	21	16
21	4	83	83	10	10
22	3	75	75	12	12
23	3	70	75	10	10
24A	5	79	79	5	5
24B	7	73	76	16	16
25A	6	72	85	7	6
25B	17	79	80	10	10
26A	6	90	90	8	8
26B	14	78	78	14	14
27A	8	78	81	8	8
27B	12	76	80	13	13
28	97	73	74	19	19

Section 5

Storm System Evaluation & Recommendations

SECTION 5
STORM SYSTEM EVALUATION & RECOMMENDATIONS

5.1. Introduction

In the previous sections, we presented the background information and methodology used in completing the analysis of Yachats' stormwater system. In this section we bring the pieces together to identify shortcomings in the stormwater system and then make recommendations to correct those problems. The remainder of this section is organized as follows:

- Basin Evaluations. These provide a brief description of the basin area, a table presenting key stormwater runoff data, and a description of the basin stormwater facilities. Where such exist, stormwater facility problems are noted.
- Recommended Improvements. This section lists the recommended changes to the existing stormwater system that were identified in the basin evaluations presented above.
- Basis of Cost Estimates. This section addresses assumptions of cost estimation.
- Stormwater Drainage System Capital Improvement Plan (CIP) Elements. This section assigns a priority to the recommended improvements and provides a cost estimate for the recommended changes.
- Stormwater Detention. This provides a brief discussion explaining stormwater detention and why it is part of the overall stormwater management system.

It should also be noted that many of the basins in this analysis are smaller than would normally warrant a Master plan scale, but the topography and overall system make it necessary to fully encompass and study the City of Yachats. Basins typically included are at least 8-10 acres or more, where in this analysis, basins as small as 4 acres are identified and analyzed.

5.2. Basin 1 Evaluation

Basin 1 consists of approximately 40 acres that was evaluated as a single basin for the purposes of this study. Much of the undeveloped area of Basin 1 is extremely steep, and/or zoned Timber Conservation. Because of this little future development of Basin 1 is expected.

The estimated runoff for Basin 1 is presented in **Table 5-1**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-1 **Basin 1 Sub-Basin Runoff Estimates**				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
1-existing	39.62	29	74	35
1-future	39.62	29	79	39

Basin 1 discharges through a 24-inch pipe under Highway 101 at the north edge of city limits. Based on the calculations the 24-inch pipe has adequate capacity. However, since it crosses Highway 101 the responsibility for sizing the culvert is ODOT's.

5.3. Basin 2 Evaluation

Basin 2 consists of approximately 20 acres that have been divided into two sub-basins for the purposes of this study. Sub-basin 2A is partially developed, while Sub-basin 2B is largely undeveloped. However, due to the steep terrain in the undeveloped area of Sub-basin 2B, future development and increased stormwater runoff are not anticipated.

The estimated runoff for Basin 2 is presented in **Table 5-2**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-2 **Basin 2 Sub-Basin Runoff Estimates**				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
2A-existing	6	12	82	8
2A-future	6	12	91	10
2B-existing	14	13	79	18
2B-future	14	13	84	20

As with Basin 1, the main stormwater system is along Highway 101 with the key being a 24-inch pipe crossing the highway. The 24-inch pipe appears to be sized to handle the anticipated runoff, but final pipe size responsibility is ODOT's. On the west side of the highway the drainage path is poorly defined across private property. No specific problems are known to exist in this area.

5.4. Basin 3 Evaluation

Basin 3 consists of approximately 5 acres that was evaluated as a single basin for the purposes of this study. Much of this basin is already highly developed such that future development will have little impact on increasing the stormwater runoff. The area within this basin is privately owned; so, the design, installation and maintenance is the responsibility of the private property owners.

The estimated runoff for Basin 3 is presented in **Table 5-3**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-3
Basin 3 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
3-existing	5	10	84	7
3-future	5	10	84	7

Basin 3 discharges through a 6-inch pipe directly to the Pacific Ocean, collecting flow from Coolidge Lane.

The 6-inch pipe is undersized. However, given the general character of the basin, the storm drain infrastructure is not considered critical. Should the private property owners want improvements to the storm drainage system in this area, they would need to design and install the improvements.

5.5. Basin 4 Evaluation

Basin 4 consists of approximately 4 acres that was evaluated as a single basin for the purposes of this study. Much of this basin is already highly developed such that future development will have little impact on increasing the stormwater runoff. The area within this basin is privately owned; so, the design, installation and maintenance is the responsibility of the private property owners.

The estimated runoff for Basin 4 is presented in **Table 5-4**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-4
Basin 4 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
4-existing	4	10	88	6
4-future	4	10	88	6

Basin 4 discharges directly to the Pacific Ocean through a 6-inch outfall pipe.

The 6-inch pipe is undersized. However, given the general character of the basin, the storm drain infrastructure is not considered critical. Should the private property owners want improvements to the storm drainage system in this area, they would need to design and install the improvements.

5.6. Basin 5 Evaluation

Basin 5 consists of approximately 30 acres that have been divided into three sub-basins for the purposes of this study. Sub-basin 5A is mostly developed, while Sub-basin 5B and 5C are largely undeveloped. Future development will likely increase stormwater runoff.

The estimated runoff for Basin 5 is presented in **Table 5-5**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-5
Basin 5 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
5A-existing	7	11	88	12
5A-future	7	11	88	12
5B-existing	7	11	70	8
5B-future	7	11	84	11
5C-existing	15	10	74	17
5C-future	15	10	79	20

Basin 5 discharges to the ocean from an open drainageway that runs from Highway 101 to a wooden bridge that is approximately 150 feet southwest of the Smelt Sands State Recreation Site parking lot. The drainageway from the highway to the ocean is not well defined in some areas, but the area is undeveloped and there are no known problems in this area.

The stormwater runoff crosses Highway 101 through a 24-inch culvert approximately 400 ft north of King Street. The runoff flows to the crossing culvert in a ditch that runs north from King Street with a several 12-inch culverts along the way. The 24-inch crossing culvert appears to be adequately sized, but some of the 12-inch roadside culverts may be undersized. Since all of these pipes are in the highway right-of-way, responsibility for designing, installing and maintaining them is ODOT's.

5.7. Basin 6 Evaluation

Basin 6 consists of approximately 11 acres that was evaluated as a single basin for the purposes of this study. Although this basin is largely undeveloped, the remaining portion is partially wetlands which may decrease the amount of development that is able to be done.

The estimated runoff for Basin 6 is presented in **Table 5-6**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-6 **Basin 6 Sub-Basin Runoff Estimates**				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
6-existing	11	73	11	13
6-future	11	85	11	17

Most, if not all, of the area of Basin 6 is private property associated with the Adobe Resort. Therefore, all stormwater infrastructure within Basin 6 is private. The design, installation and maintenance of the storm drain system in Basin 6 is the responsibility of the private property owner(s).

5.8. <u>Basin 7 Evaluation</u>

Basin 7 consists of approximately 4 acres that was evaluated as a single basin for the purposes of this study. This basin is already highly developed such that future development will have little impact on increasing the stormwater runoff.

The estimated runoff for Basin 7 is presented in **Table 5-7**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-7 **Basin 7 Sub-Basin Runoff Estimates**				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
7-existing	4	83	9	6
7-future	4	83	9	6

Basin 7 discharges directly to the Pacific Ocean through a 12-inch outfall pipe. Flow is collected from the lots along the northern section of Aqua Vista Loop through a series of culverts and ditches. The culverts are typically 12-inch pipe, which is generally adequate for ditches in small, local areas like this.

5.9. <u>Basin 8 Evaluation</u>

Basin 8 consists of approximately 4 acres that was evaluated as a single basin for the purposes of this study. The basin is fully developed.

The estimated runoff for Basin 8 is presented in **Table 5-8**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-8 **Basin 8 Sub-Basin Runoff Estimates**				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
8-existing	4	81	9	6
8-future	4	81	9	6

Basin 8 discharges directly to the Pacific Ocean through a 12-inch outfall pipe. Flow is collected from the lots along the southern section of Aqua Vista Loop through a series of culverts and ditches. The culverts are typically 12-inch pipe, which is generally adequate for ditches in small, local areas like this.

5.10. Basin 9 Evaluation

Basin 9 is the largest basin in this study with a total of approximately 110 acres that extends from the ocean to over half a mile east of Highway 101. Overall, the areas of Basin 9 that can be developed are substantially developed. The areas east of Hanley Drive and Elk Mountain Lane are very steep and significant development is not anticipated in those areas.

The estimated runoff for Basin 9 is presented in **Table 5-9**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-9 **Basin 9 Sub-Basin Runoff Estimates**				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
9A-existing	11	11	70	11
9A-future	11	11	81	15
9B-existing	5	9	74	5
9B-future	5	9	77	6
9C-existing	29	17	74	36
9C-future	29	17	77	39
9D-existing	19	12	77	21
9D-future	19	12	81	23
9E-existing	7	9	62	5
9E-future	7	8	83	11

Table 5-9 continued Basin 9 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
9F-existing	28	14	72	32
9F-future	28	12	80	40
9G-existing	10	14	77	11
9G-future	10	14	77	11

Sub-basin 9A discharges to the ocean through the City pump station site on Ocean View Drive south of Marine Drive. Agency Creek is the main drainageway through Sub-basin 9A passing through the lots on the south side of Marine Drive and crosses Driftwood Lane before splitting northeast and southeast. Agency Creek continues upstream to the northeast runs north to cross Marine Drive, then northeast to Highway 101 at the discharge of Sub-basin 9B near the southern intersection with Aqua Vista Loop. The southeast branch is a secondary drainageway that intersects Highway 101 approximately 500 feet north of 9th Street at the discharge of Sub-basin 9D.

Sub-basin 9B discharges to Sub-basin 9A through the 24-inch pipe crossing Highway 101. Two ditches come together east of Highway 101, one from the east and one from the northeast. The east ditch carries runoff from Windsong Street while the northeast ditch carries runoff from the discharge of Sub-basin 9C where the ditch crosses King Street approximately 200 ft north of Windsong Street.

The runoff from Sub-basins 9D, 9E, and 9F discharge from Sub-basin 9D through a 24-inch culvert crossing Highway 101 roughly 450 ft north of 9th Street. Upstream of the highway culvert a drainage way comes from the east from an 18-inch culvert crossing King Street approximately 400 ft north of 10th Street. A ditch on the east side of King Street carries runoff from Sub-Basin 9E which primarily serves a drainageway south of Windsong Street. Sub-basin 9F covers a fairly large area running from King Street east to Horizon Hill Road and discharges to Sub-basin 9D at King Street and 9th Street.

The final part of Basin 9 is Sub-basin 9G which runs from Ocean View Drive to Driftwood Lane in the north and from Ocean View Drive to Highway 101 in the south. It discharges to Sub-basin 9A near the north end of Ocean View Drive.

As stated in other sections of this report, Basin 9 has no critical pipes. The methodology used in this report is very conservative in that it estimates runoff values that are generally on the higher end of the range. For consistency, a 50-year event was used for all calculations. However, in smaller, more local areas, the 50-year runoff may be higher than necessary. Based on this, it may be appropriate on a case-by-case basis to review actual conditions observed in the field and prioritize work accordingly. If the calculations indicate a pipe is too small but stormwater problems are rarely if ever seen at that location, and if no significant risks to property appear to exist, it may be appropriate to defer work at that location and monitor the situation as needed.

5.11. <u>Basin 10 Evaluation</u>

Basin 10 consists of approximately 45 acres that have been divided into five sub-basins for the purposes of this study. Sub-basin 10A is almost fully developed. Sub-basin 10C includes community wetlands which are discussed in the Section 5.12. Sub-basins 10B, 10D and 10E are partially developed and it is estimated stormwater will increase in these areas once fully developed.

The estimated runoff for Basin 10 is presented in **Table 5-10**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-10
Basin 10 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
10A-existing	6	9	77	8
10A-future	6	9	77	8
10B-existing	10	9	80	11
10B-future	10	9	82	11
10C-existing	11	23	84	17
10C-future	11	23	84	17
10D-existing	10	16	77	11
10D-future	10	16	82	13
10E-existing	8	16	78	9
10E-future	8	16	82	10

Basin 10 discharges to the ocean through a 15-inch pipe crossing Ocean View Drive approximately 200 ft north of 7th Street. Runoff to the discharge comes from the east from Sub-basin 10B, and from the south from Sub-basins 10C, 10D and 10E.

Some of the pipes in Sub-Basin 10A appear to be undersized, starting with the 15-inch crossing Ocean View Drive. Because of the existing overall characteristic of the basin, the undersized pipes may not be causing significant problems at this time. Where upstream pipes and culverts are undersized or ditches or other areas provide natural detention, downstream pipes may be protected from seeing the estimated fully developed runoff.

For Sub-basin 10B, field investigation was unable to determine the runoff path downstream of the 24-inch pipe crossing Highway 101 at 8th Street, and ODOT was unable to provide additional information about this area. Furthermore, the runoff from Sub-basins 10C, 10D, and 10E discharge to Sub-basin 10A through the west side of the sewer treatment plant. The pipe through the sewer treatment plant appears to be undersized, but the community wetland may be acting as a detention area. These factors combined with the ditches downstream of 7th Street appear to be mitigating any immediate problems with the drainage in Basin 10, particular in Sub-basin 10A. Any new storm drainage infrastructure in Basin 10 should generally be installed starting at the lower end of the basin and working up, otherwise smaller problem areas at the upper end will just be moved downstream and combined with other flows to create larger problems lower in the basin.

A more detailed discussion of the community wetland in Sub-basin 10C is provided in the following section. Since the protection of the wetland and maintenance of the runoff required to maintain wetland health and function is directly related to the overall management of stormwater in Basin 10, this section and the following section must be considered together when modifications to Basin 10 stormwater infrastructure are planned.

5.12. Community Wetlands in Basin 10

The City of Yachats values the Community Wetland in the park west of City Hall and wants to protect and preserve it as a community asset. While wetland health and preservation are outside the focus of typical stormwater master plans, this section is included to provide the City with information that may be useful to the City in its efforts to protect and enhance the wetland.

Figure 5-3a provides an overview of the area which contributes runoff that flows to and through the wetland. The wetland is located in Sub-basin 10C. In addition, runoff from Sub-basins 10D and 10E flows to the wetland.

Figure 5-3b is an enlarged map of the area of the wetland. The locations where stormwater runoff flows into the wetland are marked by the letters “A” through “E”. The following is a summary of each of these inflow locations.

Inflow Location “A” carries the largest volume of stormwater runoff including flow from all of Sub-basins 10D and 10E, plus the northeast corner of Sub-basin 10C. Not only is this the largest area, it is also the area with the greatest traffic volume, the most paved area, and the largest amount of development and general activity. As such, this runoff has the highest potential for conveying pollutants that could be harmful to the wetland. Fortunately, this flow arrives at the downstream end of the wetland. As such, the impact of any pollutants entering the wetland may be limited since they would probably only pass through a small part of the wetland and be conveyed downstream in a short time.

If the City wanted to take measures to reduce the potential for pollution impacts from stormwater inflow at Location “A”, there are a couple of possibilities the City may want to consider. One option might be to construct a stormwater treatment facility between the piped discharge and the main wetland area. A wetland specialist could provide the City with recommendations on the viability and most effective approach for this type of stormwater treatment.

A second option might be to route this stormwater flow such that it discharges farther downstream and thus never enter the wetland. As discussed elsewhere in this report, the existing stormwater pipes from the sewer treatment plant site downstream to the pipe across Ocean View drive are currently undersized. As part of the work to replace the undersized pipes, a larger pipe could be installed in the undeveloped right-of-way on the east side of the sewer treatment plant and continue downstream away from the wetland.

One obvious thing to keep in mind is that wetlands need water, so routing a large amount of stormwater runoff away from the wetland could have adverse impacts on the wetland. Those impacts could be more significant than impacts from the pollutants being carried by the stormwater. With that in mind, a combination system where the low flows which typically carry more highly concentrated pollutant loads to a treatment system, and higher flows are routed separately either into the wetland or bypassing it. A variety of scenarios can be envisioned, and a wetland specialist would be needed to provide the necessary guidance on the best approach for this situation.

Inflow Locations "B" and "C" are similar. They collect stormwater runoff from small areas with relatively low traffic volume. As such, the risk of a substantial pollutant load from stormwater runoff is probably not very high.

The situation for Inflow Location "D" falls somewhere between Inflow Location "A" and those of "B" and "C". The contributing area includes Fourth Street and a portion of Pontiac Street, so the paved area and traffic is larger than either "B" or "C". However, there is more of an open channel from Fourth Street to the main wetland area which likely provides some natural treatment, and also the potential to enhance that treatment with appropriate channel upgrades.

Finally, the runoff entering the wetland at Inflow Location "E" travels overland for a comparatively long distance before entering the main wetland area. Since the majority of Ocean View Drive appears to drain away from the wetland, the paved area draining to the wetland appears to be fairly small. The combination of overland flow and a small amount of paved area should result in a low probability of risk to pollutants entering the wetland in this location.

5.13. <u>Basin 11 Evaluation</u>

Basin 11 consists of approximately 13 acres that have been divided into two Sub-basins for the purposes of this study. This basin is fully developed.

The estimated runoff for Basin 11 is presented in **Table 5-11**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-11
Basin 11 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
11A-existing	5	11	86	7
11A-future	5	11	86	7
11B-existing	8	5	89	13
11B-future	8	5	89	13

Basin 11 discharges to the Yachats Bay through an 18-inch outfall pipe on the south end of the basin. This outfall pipe is undersized. A 12-inch pipe transfers the water to a ditch then three 8-inch pipes in series along Pontiac St. All three 8-inch pipes are undersized as well as the 12-inch pipe leading to the outfall pipe. These pipes are undersized for current and future stormwater events.

5.14. Basin 12 Evaluation

Basin 12 consists of approximately 10 acres that have been divided into two sub-basins for the purposes of this study. Much of this basin is already substantially developed such that future development will have little impact on increasing the stormwater runoff.

The estimated runoff for Basin 12 is presented in **Table 5-12**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-12
Basin 12 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
12A-existing	6	3	90	10
12A-future	6	3	90	10
12B-existing	4	6	89	6
12B-future	4	6	89	6

Basin 12 discharges through a 18-inch pipe to Yachats Bay. This flow is routed under Highway 101 and Ocean View Drive from a 24-inch pipe running under Highway 101 to Third Street. Sub-basin 12B starts north of Third Street where a 24-inch, 15-inch, and 12-inch pipe run in series with catch basins along Highway 101 to catch all stormwater flow from Sub-basins 12A and 12B. These pipes are within the ODOT right-of-way and outside of City jurisdiction.

5.15. Basin 13 Evaluation

Basin 13 consists of approximately 16 acres that have been divided into two sub-basins for the purposes of this study. Sub-basin 13A is fully developed and Sub-basin 13B is partly developed.

The estimated runoff for Basin 13 is presented in **Table 5-13**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-13 Basin 13 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	‘CN’	Q (cfs)
13A-existing	6	10	79	8
13A-future	6	10	79	8
13B-existing	10	14	81	13
13B-future	10	14	83	14

Basin 13 discharges to Yachats Bay through a 12-inch outfall pipe. This pipe allows flow under Highway 101 at the intersection of First Street. Flow is conveyed through a 12-inch pipe along Highway 101 after two 12-inch pipes and a ditch on running south on Prospect Avenue. At Third Street and Prospect Sub-basin 13B has an 18-inch culvert and a ditch from King Street to Third Street. The only pipes that have problems are the 12-inch discharge pipe and the 12-inch pipe running under Highway 101. As stated above, these pipes are outside of City control and not analyzed any further in this report.

5.16. Basin 14 Evaluation

Basin 14 consists of approximately 19 acres that was evaluated as a single basin for the purposes of this study. Basin 14 is largely undeveloped.

The estimated runoff for Basin 14 is presented in **Table 5-14**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-14 Basin 14 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	‘CN’	Q (cfs)
14-existing	19	14	75	21
14-future	19	12	81	25

Basin 14 discharges to Yachats Bay through a 24-inch outfall pipe. The outfall pipe receives flow from a ditch running down Cedar Avenue and parts of Horizon Hill Road. Although the basin may undergo development, the 24-inch pipe is adequate for current and future flows.

5.17. Basin 15 Evaluation

Basin 15 consists of approximately 31 acres that was evaluated as a single basin for the purposes of this study. Approximately one fifth of basin 15 is outside the UGB and will remain undeveloped. The rest of this basin is partly undeveloped.

The estimated runoff for Basin 15 is presented in **Table 5-15**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-15 Basin 15 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
15-existing	31	21	78	34
15-future	31	16	80	38

In Basin 15, a 24-inch pipe runs under Highway 101 after collecting flow from Lincoln Avenue, Spruce Avenue, Lori Lane and property to the north. The 24-inch pipe is adequate to handle flows.

5.18. Basin 21 Evaluation

Basin 21 consists of approximately 4 acres that was evaluated as a single basin. Much of this basin is already substantially developed. Since all areas in Basin 21 are private, the analysis information is for reference only.

The estimated runoff for Basin 21 is presented in **Table 5-16**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-16 Basin 21 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
21-existing	4	10	83	6
21-future	4	10	83	6

Basin 21 has a 10-inch discharge pipe from the private detention basin on site. No other analysis was completed for basin 21.

5.19. Basin 22 Evaluation

Basin 22 consists of approximately 3 acres that was evaluated as a single basin for the purposes of this study. This basin is nearly fully developed.

The estimated runoff for Basin 22 is presented in **Table 5-17**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-17 Basin 22 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
22-existing	3	12	75	3
22-future	3	12	75	3

Basin 22 discharges to the Pacific Ocean through a 24-inch outfall pipe. Flow is collected from the northeast portion of Shell Street and the surrounding properties. The 24-inch outfall pipe is the only pipe being analyzed in this basin and there are no current or future problems expected.

5.20. Basin 23 Evaluation

Basin 23 consists of approximately 3 acres that was evaluated as a single basin for the purposes of this study. Much of this basin is already substantially developed such that future development will have little impact on increasing the stormwater runoff.

The estimated runoff for Basin 23 is presented in **Table 5-18**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-18 Basin 23 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
23-existing	3	10	70	4
23-future	3	10	75	4

Basin 23 follows closely to Basin 22. Basin 23 has a 12-inch discharge pipe to carry all flow from a portion of Shell Street to the Pacific Ocean. This is the only pipe being analyzed in the basin and does not have any issues.

5.21. Basin 24 Evaluation

Basin 24 consists of approximately 12 acres that have been divided into two sub-basins for the purposes of this study. Sub-basin 24A is largely developed while Sub-basin 24B is only partially developed.

The estimated runoff for Basin 24 is presented in **Table 5-19**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-19 Basin 24 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	‘CN’	Q (cfs)
24A-existing	5	5	79	7
24A-future	5	5	79	7
24B-existing	7	16	73	7
24B-future	7	16	76	8

Basin 24 discharges to the Pacific Ocean from an 18-inch outfall pipe. The flow is conveyed by a 12-inch pipe under Mitchell Lane. A ditch behind the lots of Mitchelle Lane runs all the way to Highway 101, where an 18-inch pipe transfers flow from Sub-basin 24B to Sub-basin 24A. Flow is collected from Mitchell Lane and the north portion of Reeves Circle as well as the surrounding properties.

The methodology used in this report is very conservative in that it estimates runoff values that are generally on the higher end of the range. For consistency, a 50-year event was used for all calculations. However, in smaller, more local areas, the 50-year runoff may be higher than necessary. Based on this, it may be appropriate on a case-by-case basis to review actual conditions observed in the field and prioritize work accordingly. If the calculations indicate a pipe is too small but stormwater problems are rarely if ever seen at that location, and if no significant risks to property appear to exist, it may be appropriate to defer work at that location and monitor the situation as needed.

5.22. Basin 25 Evaluation

Basin 25 consists of approximately 23 acres that have been divided into two Sub-basins. Both 24A and 24B are partially developed. A portion of Sub-basin 25B is outside the UGB.

The estimated runoff for Basin 25 is presented in **Table 5-20**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-20 Basin 25 Sub-Basin Runoff Estimates				
Sub-basin	Size (acres)	Tc (minutes)	‘CN’	Q (cfs)
25A-existing	6	7	72	7
25A-future	6	6	85	10
25B-existing	17	10	79	23
25B-future	17	10	80	24

Basin 25 is discharged to the Pacific Ocean through an 18-inch pipe. A ditch conveys the flow from Highway 101, where a 24-inch pipe transfers flow from east to west of Highway 101. The

18-inch discharge pipe is slightly undersized. Basin 25 collects flow from the south portion of Reeves Circle, Hill Court and property to the southeast.

Similarly to Basin 24, if the calculations indicate a pipe is too small but stormwater problems are rarely if ever seen at that location, and if no significant risks to property appear to exist, it may be appropriate to defer work at that location and monitor the situation as needed.

5.23. Basin 26 Evaluation

Basin 26 consists of approximately 22 acres that have been divided into two Sub-basins for the purposes of this study. This Basin is partially developed, but most of the undeveloped area is outside the UGB and will not be developed, so the stormwater is not expected to increase.

The estimated runoff for Basin 26 is presented in **Table 5-21**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-21
Basin 26 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
26A-existing	6	8	90	10
26A-future	6	8	90	10
26B-existing	14	14	78	17
26B-future	14	14	78	17

Basin 26 discharges to the Pacific Ocean through a 24-inch outfall pipe off of Cape View Drive. A series of ditches and pipes continue south east to Highway 101 to Sub-basin 26B. A ditch connects the 24-inch pipe to another 24-inch pipe running along Rock Drive. A ditch then transfers flow from three 18-inch pipes running under and along Yachats Ocean Road. Another ditch conveys flow from an 18-inch pipe running under Highway 101. A ditch next to Highway 101 and overland flow are the only means of transferring flow from Sub-basin 26B to Sub-basin 26A. This includes parts of Green Hill Drive, Crest View Drive, and Overlook Drive.

The 18-inch pipe running under Yachats Ocean Road is the only pipe in Basin 26 that has any issues, other than the ODOT pipe running under Highway 101.

5.24. Basin 27 Evaluation

Basin 27 consists of approximately 20 acres that have been divided into two Sub-basins. Sub-basin 27A is partially developed and Sub-basin 27B is largely undeveloped. Future development will likely increase stormwater runoff, but only slightly because a large portion of Sub-basin 27B is outside of the UGB.

The estimated runoff for Basin 27 is presented in **Table 5-22**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-22
Basin 27 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
27A-existing	8	8	78	11
27A-future	8	8	81	12
27B-existing	12	13	76	14
27B-future	12	13	80	16

Basin 27 discharges to the Pacific Ocean through a 24-inch outfall pipe. A ditch runs south along Highway 101 transferring flows from a pipe network that comes down Crest View Drive. This includes a series of 24-inch pipes with catch basins between them. Sub-basin 27B continues the series with two more 24-inch pipes connected to the pipes in Sub-basin 27A. There are no current or future issues predicted in this basin.

5.25. Basin 28 Evaluation

Basin 28 consists of approximately 95 acres that was evaluated as a single basin for the purposes of this study. Basin 28 extends far past the city limits and UGB. While a large portion is undeveloped, this area is also outside the UGB and is not likely to be developed. The stormwater runoff is not expected to increase significantly because of this.

The estimated runoff for Basin 28 is presented in **Table 5-23**. This information is also shown on the runoff analysis maps presented at the end of Section 5.

Table 5-23
Basin 28 Sub-Basin Runoff Estimates

Sub-basin	Size (acres)	Tc (minutes)	'CN'	Q (cfs)
28-existing	97	19	73	95
28-future	97	19	74	98

Basin 28 discharges to the east of Highway 101 in between Windy Way and Gender Drive through a 2' x 5' Box Culvert. A large ditch transfers flow from the large and undeveloped basin to the east. The current box culvert is adequate to transfer flow under Highway 101 to the Pacific Ocean.

Even though the box culvert is estimated to be adequately sized, there have been substantial problems at this location in the past. The problems have generally been caused by debris accumulating on the culvert grate and blocking flow from reaching the culvert. When that has occurred, the runoff eventually overtops the highway and runs down Gender Drive causing erosion. While studying this situation in the past, Westech suggested to the City that a "beehive" style grate might help by providing more open space on multiple sides for the water to bypass debris accumulated on parts of the grate.

5.26. Recommended Storm Drainage Improvements

In the discussions of the various basins above, a number of storm drainage system problem areas were identified. This section will present the recommend improvements for each of these problem areas. There are a number of basins for which no improvements are recommended. Only basins with recommended improvements are addressed in this section. The recommended improvements are summarized on **Figure 5-4a** and **Figure 5-4b** at the end of Section 5.

As stated in earlier sections, no pipes in the City of Yachats are so undersized to be critical. All pipes discussed needing to be replaced should be looked at on a case-by-case basis and monitored to watch for problems in the immediate areas of stated pipes. The pipes need not be replaced until visible problems arise and if no significant risks to properties appear to exist. The following recommendations do not include pipes in ODOT, State Parks or County right of way.

5.26.1 Basin 9

The following improvements are recommended for Basin 9. In Sub-basin 9A, the 24-inch outfall pipe is recommended to be replaced with a 36-inch pipe. The two 24-inch pipes, the first transferring flow under Driftwood Lane, and the pipe directly to the east, are recommended to be replaced with a 30-inch pipes. The 18-inch pipe crossing Marine drive close to Highway 101 is recommended to be a 24-inch pipe.

Sub-basin 9D includes two pipes in need of improvements. The 18-inch pipe under King Street north of 10th Street is recommended to be replaced with a 24-inch pipe and the 18-inch pipe on the lot near the intersection of 9th Street and Highway 101 is recommended to be increases to a 24-inch pipe as well.

In Sub-basin 9E the 12-inch pipe south of Windsong Street along King Street is recommended to be replaced with an 18-inch pipe.

The 12-inch pipe under Hanley Drive in Sub-basin 9F is recommended to be replaced with an 18-inch pipe at minimum and a 24-inch pipe at maximum.

5.26.2 Basin 10

Sub-basin 10A has four undersized pipes in its area. The 15-inch outfall pipe should be replaced with a 30-inch outfall pipe. The 12-inch pipe under Seventh Street should be replaced with a 24-inch pipe and the connecting 12-inch pipe running east under Seventh Street should be replaced with an 18-inch pipe. The 12-inch pipe leading to the south of Seventh Street towards Sub-basin 10C should be replaced with a 24-inch pipe.

5.26.3 Basin 11

The 12-inch pipe leading to the discharge in Basin 11 is slightly undersized and is recommended be replaced with an 18-inch pipe. There are three 8-inch pipes under Second Street and along Pontiac Street are undersized. The 8-inch pipe in between lots south of Second street should be replaced with an 18-inch pipe. The 8-inch pipe under Second Street should be replaced with a 12-inch pipe and the 8-inch pipe along Pontiac Street should be replaced with a 12-inch pipe.

5.27. Basis of Cost Estimates

The cost estimates are based on numerous assumptions due to the relative lack of detail available at the master planning stage. The basic assumptions are summarized below.

5.27.1 Accuracy of Cost Estimates

It is important to note that the cost estimates are made without detailed engineering data or designs. The accuracy or precision of cost estimates is a function of the level to which alternatives are developed (i.e., detail and design) and the techniques used in preparing the actual estimate. Estimates are typically divided into three basic categories as follows:

1. Planning Level Estimates. These are order-of-magnitude estimates made without detailed engineering data. This type of estimate is normally accurate within +35% to –25% (i.e., final cost may be as much as 35% more or 25% less than the estimated amount). A relatively large contingency is typically included to reduce the risk of underestimating. This is particularly important since many times the project financing must be secured before the detailed design can proceed.

2. Budget Estimates. This type of estimate is prepared during preliminary design once the actual alignments are determined and potential conflicting utilities are identified. This type of estimate is typically accurate to within ±25%.

3. Engineer's Estimate. This estimate is prepared based on well-defined engineering data, typically when the construction plans and specifications are completed, and is sometimes called a definitive estimate. Since this type of estimate is based on comprehensive plans and elevations, piping and instrument diagrams, electrical diagrams, equipment data sheets, structural drawings, geotechnical data, and a complete set of specifications, the engineer's estimate is expected to be accurate within +15 percent to -5 percent (i.e., 15% more to 5% less than the estimate).

Since the recommended improvements (during the master planning process) are not typically developed in sufficient detail for a more precise estimate, the estimates presented in this document are planning level (order-of-magnitude) estimates. Even though the final project cost may vary from the estimates contained in the master plan, the estimates are necessary to evaluate and plan for the projects.

5.27.2 Adjustment of Cost Estimates over Time

As the costs of material, labor and equipment rise over time, comparable changes will occur in the costs presented in this study. A commonly used indicator of these changes in construction costs is the Engineering News-Record (ENR) construction cost index. It is computed from the prices for structural steel, Portland cement, lumber, and common labor, and is based on a value of 100 in the year 1913. The construction costs developed in this analysis are based on current ENR 20 cities index. The costs presented herein can be related to those at any time in the past or future by applying the ratio of the then-prevailing cost index to index number used at present.

5.27.3 Engineering & Administrative Costs & Contingencies

The cost of engineering services for major projects typically covers special investigations, pre-design reports, topographic surveying, geotechnical investigations, contract drawings and specifications, construction administration, inspection, etc. Depending on the size and type of project, engineering costs may range from 16 to 25 percent of the contract cost when all of the above services are provided. The lower percentage applies to large projects without extensive permitting or coordination with existing utilities or other agencies. The higher percentage applies to smaller, more complex projects, or where full time inspection is required by the funding agencies.

The City will have administrative costs associated with any construction project. These include internal planning and budgeting/payments, administration of engineering and construction contracts, legal services, and coordination with regulatory and funding agencies. For a typical project, the City's administrative, legal and permitting costs are expected to be about 10 percent of the contract cost. The total cost for engineering, legal and administration is assumed to be 25 to 30 percent of the construction plus contingencies.

5.27.4 Construction Costs Estimates

Preliminary construction costs for the improvements recommended in this report are based on a number of assumptions as follows. The cost estimates reflect projects bid in late winter or early spring for summer construction. The costs do not reflect a detailed investigation of existing utilities and soils. It is important to note that the cost estimates are planning level estimates, not engineering estimates, and are intended to be within the range of plus 35% to minus 25% of the actual project cost.

The construction costs are based on the size of pipe required, and whether or not the pipe is in a paved area and therefore requires crushed rock backfill and paved trench surface restoration. The construction costs are intended to represent all construction costs, including mobilization, bonds, permits, insurance and all of the various miscellaneous costs associated with each project. In addition to construction costs, a 10% contingency, 16% for engineering services, and 10% for legal and project administration are listed to provide a comprehensive estimate of all costs associated with the project.

The preliminary cost estimates attached are based on a number of assumptions, including the following:

- Standard depth mainlines (ie. 6' cover or less over top of pipe).
- Adequate right-of-way or easements exist or can be acquired to construct the storm lines shown. Easement acquisition costs are not included.
- HDPE pipe used for all pipe 18-inches and larger, & PVC for pipes 15-inches and smaller. If concrete pipe must be used due to actual shallow design cover depths or agency requirements, construction costs will be greater.
- Granular backfill & pavement patching will be required where noted (ie. improvements constructed separately from street improvements). Construction costs will decrease if storm drains are constructed as part of a street project or outside of street areas.
- Storm drainage improvements can be provided without extensive traffic control.
- Does not include wetland delineation, mitigation or landscaping.
- Assumes dry weather construction.
- Bore prices assume the use of PVC pipe as carrier conduit through casing (ie. smaller OD than concrete pipe or HDPE).
- 2024 construction dollars (ENR 20 Cities Construction Cost Index = 13532).
- Prices shown include engineering design as part of a major improvement project. Unit design costs may increase for minor small scale projects.

These construction costs are planning level estimates, but they should help the City in the process of planning and allocating resources in the most cost-effective manner. All costs are estimates of probable costs and do not reflect changes that could include increasing labor costs, material, and phased construction dates.

Once the master plan is adopted by the City, the projects listed can be selected for completion through the City's budgeting process. The steps for completion are:

- Project identification and planning level cost estimate (completed by master plan)
- Project selection and secure project financing
- Retain consulting engineer for project
- Prepare pre-design report if necessary for review by regulatory agencies and to refine cost estimates
- Preparation of plans, specifications and final engineering cost estimates
- Bidding and contract award
- Construction

5.28. Stormwater Drainage Capital Improvement Cost Estimates & Priorities

This section is provided to compile, prioritize, and provide cost estimates for the various recommended improvements discussed above. The priorities assigned to the improvements are based on the following definitions.

- **Priority 1** (Near Term Improvements) - These are those projects representing existing system deficiencies (currently needed to meet existing and near future projected stormwater runoff flows) or problem areas needing immediate attention. It is recommended that Priority 1 improvements be accomplished as soon as practical considering financing, construction time requirements and timing associated with other related projects.

- **Priority 2** (Vital Future Improvements) - These are improvements that will be needed in the future to meet projected development conditions and design flows, or where there are moderate capacity deficiencies. Although not necessary at this time, they should be considered as improvement projects that will be upgraded to Priority 1 in the future.

- **Priority 3** (Long Term Improvements/Possible Future Need) - These improvements are needed to improve system reliability and convey future design flows if land develops to zone intensities. While important, they are not considered to be critical at the present time, or are deemed less desirable due to cost/benefit or impact standpoint. These improvements should be incorporated into street or other utility improvement projects that may allow for concurrent construction, or they may be constructed by developers in conjunction with the utility improvements associated with the development project.

The estimated cost for each project is listed in **Table 5-24a** (sorted by basin) and **Table 5-24b** (sorted by priority).

TABLE 5-24a

Capital Improvement Project (CIP) Estimated Costs* (Sorted by Basin)

PROJECT	Priority	Basin	Pipe Size (in)	Paved or Unpaved	Length (ft)	Cost/ft ($)	Manholes	Cost/Ea ($)	Inlets	Cost/Ea ($)	Construction Cost ($)	Contingency (10%)	Engineering (16%)	Legal & Admin (10%)	Project Total ($)
Basin 9															
36-inch Pipe, Discharge pipe Marine Drive and Ocean View Drive, 60 ft south	3	9	36	Paved	100	$267	0	$8,000	0	$5,000	$26,650	$2,665	$4,264	$2,665	$36,244
30-inch Pipe, Driftwood Lane and Marine Drive	3	9	30	Paved	62	$234	0	$8,000	0	$5,000	$14,508	$1,451	$2,321	$1,451	$19,731
30-inch Pipe, 25 ft east of Dirftwod Lane	3	9	30	Unpaved	100	$234	0	$8,000	0	$5,000	$23,400	$2,340	$3,744	$2,340	$31,824
24-inch Pipe, Marine Drive, 200 ft west of Highway 101	3	9	24	Paved	65	$195	0	$8,000	0	$5,000	$12,675	$1,268	$2,028	$1,268	$17,238
24-inch Pipe, King Street, 375 ft north of 10th Street	3	9	24	Paved	40	$195	0	$8,000	0	$5,000	$7,800	$780	$1,248	$780	$10,608
24-inch Pipe, lot at 9th Street and Highway 101	3	9	24	Paved	45	$195	0	$8,000	0	$5,000	$8,775	$878	$1,404	$878	$11,934
18-inch Pipe, King Street, 100 ft south of Windsong Street	3	9	18	Paved	25	$163	0	$8,000	0	$5,000	$4,063	$406	$650	$406	$5,525
24-inch Pipe, Hanley Drive and 10th St, 50 ft south	3	9	24	Paved	45	$195	0	$8,000	0	$5,000	$8,775	$878	$1,404	$878	$11,934
													TOTAL, ALL BASIN 9 PROJECTS		**$145,038**
Basin 10															
24-inch Pipe, Discharge Pipe at 789 Ocean View Drive	2	10	24	Paved	60	$195	0	$8,000	0	$5,000	$11,700	$1,170	$1,872	$1,170	$15,912
24-inch Pipe, 7th Street and Ocean View Drive, 200 ft east	3	10	24	Paved	70	$195	0	$8,000	0	$5,000	$13,650	$1,365	$2,184	$1,365	$18,564
24-inch Pipe, South of 7th Street, 200 ft east of Ocean View Drive	3	10	24	Paved	145	$195	0	$8,000	0	$5,000	$28,275	$2,828	$4,524	$2,828	$38,454
18-inch Pipe, 7th St, 200 ft to 420 ft east of Ocean View Drive	3	10	18	Paved	220	$163	0	$8,000	2	$5,000	$45,750	$4,575	$7,320	$4,575	$62,220
													TOTAL, ALL BASIN 10 PROJECTS		**$135,150**
Basin 11															
18-inch Pipe, Ocean View and Pontiac Street	3	11	18	Paved	120	$163	0	$8,000	0	$5,000	$19,500	$1,950	$3,120	$1,950	$26,520
18-inch Pipe, East Second Street to 70 ft into 320 Second Street	3	11	18	Paved	80	$163	0	$8,000	0	$5,000	$13,000	$1,300	$2,080	$1,300	$17,680
12-inch Pipe, Second Street and Pontiac Street	3	11	12	Paved	90	$117	0	$8,000	1	$5,000	$15,530	$1,553	$2,485	$1,553	$21,121
12-inch Pipe, Pontiac Street, Second Street to Third Street	3	11	12	Paved	200	$117	0	$8,000	1	$5,000	$28,400	$2,840	$4,544	$2,840	$38,624
													TOTAL, ALL BASIN 11 PROJECTS		**$103,945**
														TOTAL, ALL PROJECTS	**$384,133**

*Note: These estimates are planning level cost estimates and not based on actual designs. They should be considered as preliminary and subject to change.

TABLE 5-24b

Capital Improvement Project (CIP) Estimated Costs* (Sorted by Priority)

PROJECT	Priority	Basin	Pipe Size (in)	Paved or Unpaved	Length (ft)	Cost/ft ($)	Manholes	Cost/Ea ($)	Inlets	Cost/Ea ($)	Construction Cost ($)	Contingency (10%)	Engineering (16%)	Legal & Admin (10%)	Project Total ($)
Priority 1															
There are no Priority 1 projects.															$0
														TOTAL, ALL PRIORITY 1 PROJECTS	**$0**
Priority 2															
24-inch Pipe, Discharge Pipe at 789 Ocean View Drive	2	10	24	Paved	60	$195	0	$8,000	0	$5,000	$11,700	$1,170	$1,872	$1,170	$15,912
														TOTAL, ALL PRIORITY 2 PROJECTS	**$15,912**
Priority 3															
36-inch Pipe, Discharge pipe Marine Drive and Ocean View Drive, 60 ft south	3	9	36	Paved	100	$267	0	$8,000	0	$5,000	$26,650	$2,665	$4,264	$2,665	$36,244
30-inch Pipe, Driftwood Lane and Marine Drive	3	9	30	Paved	62	$234	0	$8,000	0	$5,000	$14,508	$1,451	$2,321	$1,451	$19,731
30-inch Pipe, 25 ft east of Dirftwod Lane	3	9	30	Unpaved	100	$234	0	$8,000	0	$5,000	$23,400	$2,340	$3,744	$2,340	$31,824
24-inch Pipe, Marine Drive, 200 ft west of Highway 101	3	9	24	Paved	65	$195	0	$8,000	0	$5,000	$12,675	$1,268	$2,028	$1,268	$17,238
24-inch Pipe, King Street, 375 ft north of 10th Street	3	9	24	Paved	40	$195	0	$8,000	0	$5,000	$7,800	$780	$1,248	$780	$10,608
24-inch Pipe, lot at 9th Street and Highway 101	3	9	24	Paved	45	$195	0	$8,000	0	$5,000	$8,775	$878	$1,404	$878	$11,934
18-inch Pipe, King Street, 100 ft south of Windsong Street	3	9	18	Paved	25	$163	0	$8,000	0	$5,000	$4,063	$406	$650	$406	$5,525
24-inch Pipe, Hanley Drive and 10th St, 50 ft south	3	9	24	Paved	45	$195	0	$8,000	0	$5,000	$8,775	$878	$1,404	$878	$11,934
24-inch Pipe, 7th Street and Ocean View Drive, 200 ft east	3	10	24	Paved	70	$195	0	$8,000	0	$5,000	$13,650	$1,365	$2,184	$1,365	$18,564
24-inch Pipe, South of 7th Street, 200 ft east of Ocean View Drive	3	10	24	Paved	145	$195	0	$8,000	0	$5,000	$28,275	$2,828	$4,524	$2,828	$38,454
18-inch Pipe, 7th St, 200 ft to 420 ft east of Ocean View Drive	3	10	18	Paved	220	$163	0	$8,000	2	$5,000	$45,750	$4,575	$7,320	$4,575	$62,220
18-inch Pipe, Ocean View and Pontiac Street	3	11	18	Paved	120	$163	0	$8,000	0	$5,000	$19,500	$1,950	$3,120	$1,950	$26,520
18-inch Pipe, East Second Street to 70 ft into 320 Second Street	3	11	18	Paved	80	$163	0	$8,000	0	$5,000	$13,000	$1,300	$2,080	$1,300	$17,680
12-inch Pipe, Second Street and Pontiac Street	3	11	12	Paved	90	$117	0	$8,000	1	$5,000	$15,530	$1,553	$2,485	$1,553	$21,121
12-inch Pipe, Pontiac Street, Second Street to Third Street	3	11	12	Paved	200	$117	0	$8,000	1	$5,000	$28,400	$2,840	$4,544	$2,840	$38,624
														TOTAL, ALL PRIORITY 3 PROJECTS	**$368,221**
														TOTAL, ALL PROJECTS	**$384,133**

*Note: These estimates are planning level cost estimates and not based on actual designs. They should be considered as preliminary and subject to change.

5.29. Stormwater Detention

The primary purpose of stormwater detention is to mitigate the impacts of development on downstream drainage systems. As property develops, the increased impervious area generates increased runoff based on a couple of factors. First, a larger portion of the rainfall is discharged from the site since pervious surfaces (bare or vegetated ground) allow a portion of the water to soak into the ground and be retained. Second, impervious surfaces allow the stormwater to travel more quickly resulting in a greater concentration of water in a shorter time period thus producing higher peak runoff rates. By capturing the runoff from developed areas in a detention facility, the opportunity is created to release the runoff at a controlled rate, typically related to the estimated flow of the undeveloped condition.

The City of Yachats' current detention standard requires development to control runoff to that generated by a 5-year storm under existing conditions except where there are no downstream capacity issues. The detention facility must then be sized to contain the difference between a 25-year storm post-development and the 5-year storm under existing conditions.

Figures 5-5 and 5-6 show the runoff from a hypothetical 5-acre site. It is a grassy field in its undeveloped condition, and developed as a commercial site. Figure 5-5 provides a comparison of undeveloped runoff and developed runoff for a 10-year storm event. This gives a picture of pre-developed and post-developed runoff based on the same storm event. Since the City standards require calculations based on a 5-year pre-developed storm and a 25-year post-developed storm, Figure 5-5 presents runoff for those events and also shows the discharge from a detention basin where the release is restricted to the peak flow of the 5-year storm event.

There are several benefits provided by detention. The first relates to the local system immediately downstream of the site. As shown by Figure 5-6, the peak release rate from the detention facility is limited to the peak flow rate from a 5-year storm in the predeveloped condition. The resulting 2.2 cfs discharge is much more easily handled by the receiving stormwater conveyance system than would be the case if the developed 5.8 cfs discharge occurred undetained.

Another potential benefit of detention relates to controlling the demand placed on the trunk lines. The impact of detention is cumulative. As multiple sub-basins discharge into the main stormwater conveyance the impact of undetained runoff increases. This issue is particularly important for Yachats, since the time of concentration is relatively short for all basins, resulting in comparatively large increases in basin runoff. The timing consideration is important. For larger basins where one end of the basin is a long distance from the other end, the peak flows become offset in time and do not add together to produce the same magnitude of combined peak.

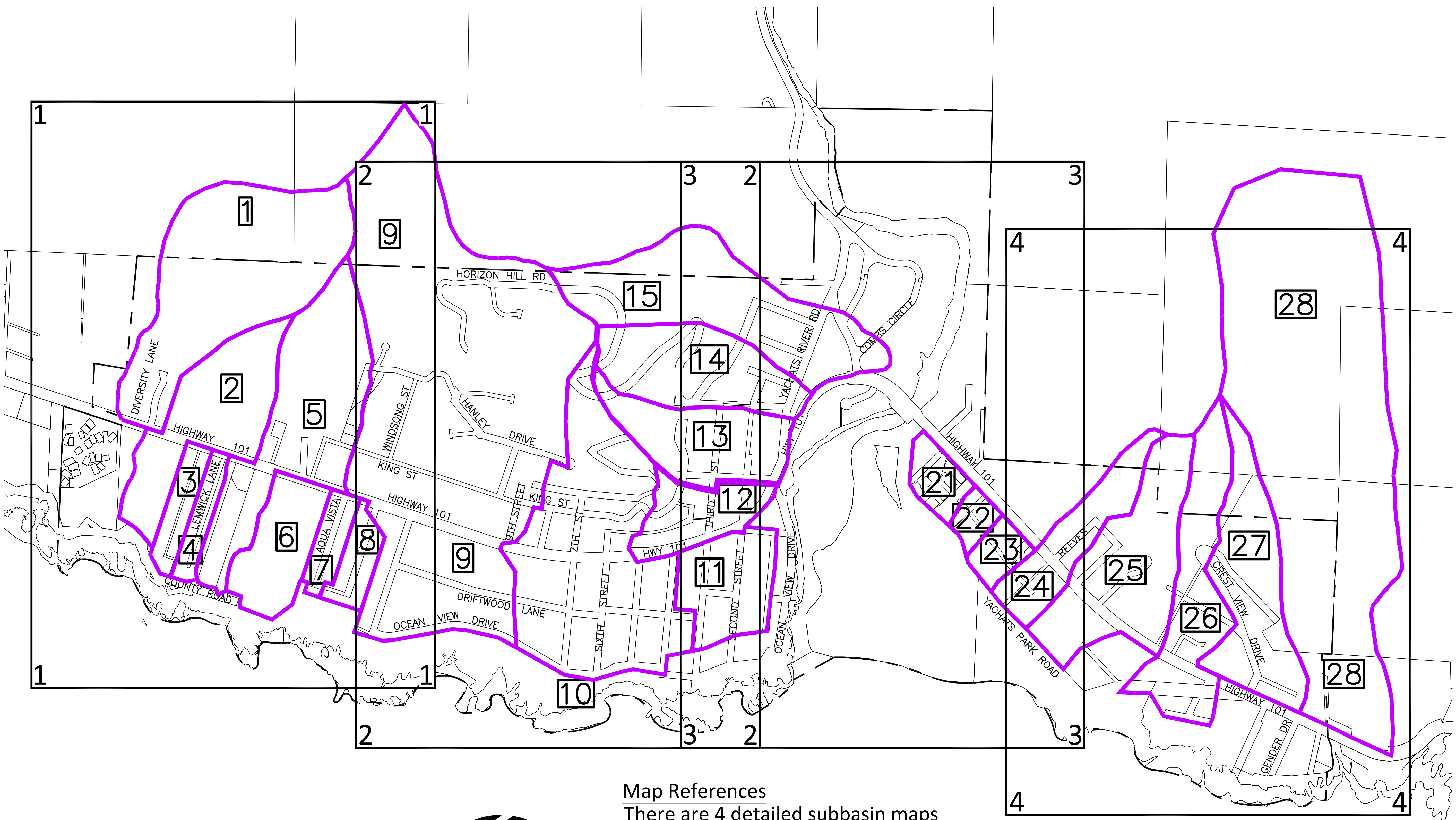
In addition to the benefits to the capacity demands of the conveyance system, detention provides benefits for a reduction in erosion and silt discharge impacts caused by the stormwater system. Detention systems typically capture some sediment in the storage area and the flow control structure. Downstream of detention, reduced flows in open channels cause less erosion than would typically be experienced under higher flows. Finally, at basin discharges to major drainageways, the reduced flows cause less erosion when the combined basin flow discharges into the creek or river.

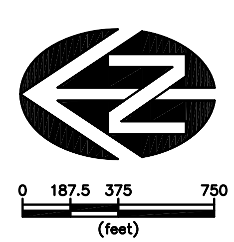
While stormwater detention has potential benefits when properly implemented, it is not without costs. One potential cost is loss of developable land. Some of the simplest and least expensive detention facilities are ponds created on the site. A second method of creating detention capacity is to do so underground in vaults or pipes. While this method is more expensive to construct, it typically allows the development of a greater percentage of the site. Whether constructed above or below ground, there is a cost to the development to provide a detention facility. Once in existence, these facilities become a long-term maintenance responsibility, which incurs additional cost.

Therefore, for both the interest of the local system adjacent to potential development sites, and the major system trunk lines, we believe it makes good sense for the City of Yachats to employ some sort of detention requirement. The detention requirement currently adopted as part of the City's Public Works Design Standards, and briefly discussed above, limiting runoff to the 5-year, existing conditions value, and requiring detention for the difference between the pre-developed 5-year and post-developed 25-year events is a fairly common standard. We continue to believe that this standard is appropriate for the City of Yachats.

As described above, the basic principle of detention is to capture the runoff from a site, hold it in some form of storage, and release it at a reduced rate to the downstream stormwater facility. As mentioned, this can be done it a number of different ways. Among the options used for storage landscape area ponds, parking lot ponds, underground pipes and parking lot swales are relatively common. Different forms of storage can be combined at one facility, such as a parking lot pond and an underground pipe. Several examples are shown in **Figures 5-7** through **5-10**.

The most common method of controlling the discharge rate is a flow control structure with an orifice that restricts the ability of the water to flow into the discharge pipe. Flow control orifices are typically installed in manholes or stormwater inlets. An example of a flow control manhole is provided by **Figure 5-11** and a flow control Type III inlet is shown by **Figure 5-12**.





Map References

There are 4 detailed subbasin maps starting with "1" in the northern part of town and ending with "4" in the southern end of town. The area covered by each map is shown by the rectangle with the map number in each corner.

NO.	DATE	DESCRIPTION	BY
1			
		REVISIONS	

VERIFY SCALE

BAR IS ONE-HALF INCH ON ORIGINAL DRAWING

0 .5"

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City of Yachats, Oregon
City of Yachats Stormwater Master Plan

Overall Storm Runoff
Sheet Reference Map

FIGURE
5-1

JOB NUMBER
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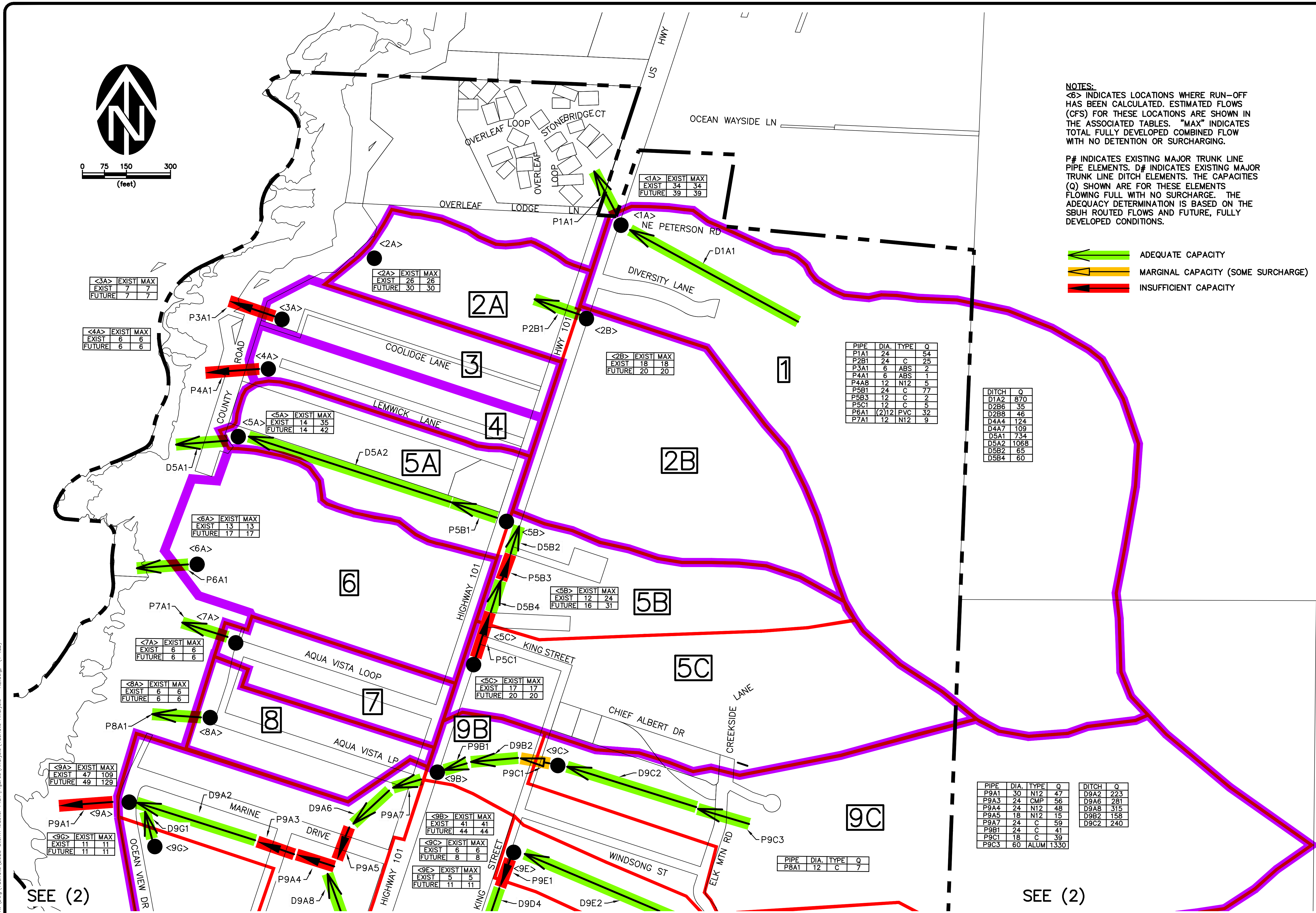

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FUTURE	6	6

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EXIST	13	13
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FUTURE	16	31

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FUTURE	6	6

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EXIST	17	17
FUTURE	20	20

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FUTURE	6	6

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EXIST	47	109
FUTURE	49	129

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EXIST	11	11
FUTURE	11	11

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EXIST	41	41
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FUTURE	11	11

NOTES:

<6> INDICATES LOCATIONS WHERE RUN-OFF HAS BEEN CALCULATED. ESTIMATED FLOWS (CFS) FOR THESE LOCATIONS ARE SHOWN IN THE ASSOCIATED TABLES. "MAX" INDICATES TOTAL FULLY DEVELOPED COMBINED FLOW WITH NO DETENTION OR SURCHARGING.

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ADEQUATE CAPACITY

MARGINAL CAPACITY (SOME SURCHARGE)

INSUFFICIENT CAPACITY

PIPE	DIA.	TYPE	Q
P1A1	24		54
P2B1	24	C	25
P3A1	6	ABS	2
P4A1	6	ABS	1
P4A8	12	N12	5
P5B1	24	C	77
P5B3	12	C	2
P5C1	12	C	5
P6A1	(2)12	PVC	32
P7A1	12	N12	9

DITCH	Q
D1A2	870
D2B6	35
D2B8	46
D4A4	124
D4A7	109
D5A1	734
D5A2	1068
D5B2	65
D5B4	60

PIPE	DIA.	TYPE	Q
P8A1	12	C	7

PIPE	DIA.	TYPE	Q
P9A1	30	N12	47
P9A3	24	CMP	56
P9A4	24	N12	48
P9A5	18	N12	15
P9A7	24	C	59
P9B1	24	C	41
P9C1	18	C	39
P9C3	60	ALUM	1330

DITCH	Q
D9A2	223
D9A6	281
D9A8	315
D9B2	158
D9C2	240

NO.	DATE	DESCRIPTION	BY
1			

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City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Storm Runoff Map (1) North

FIGURE 5-2a

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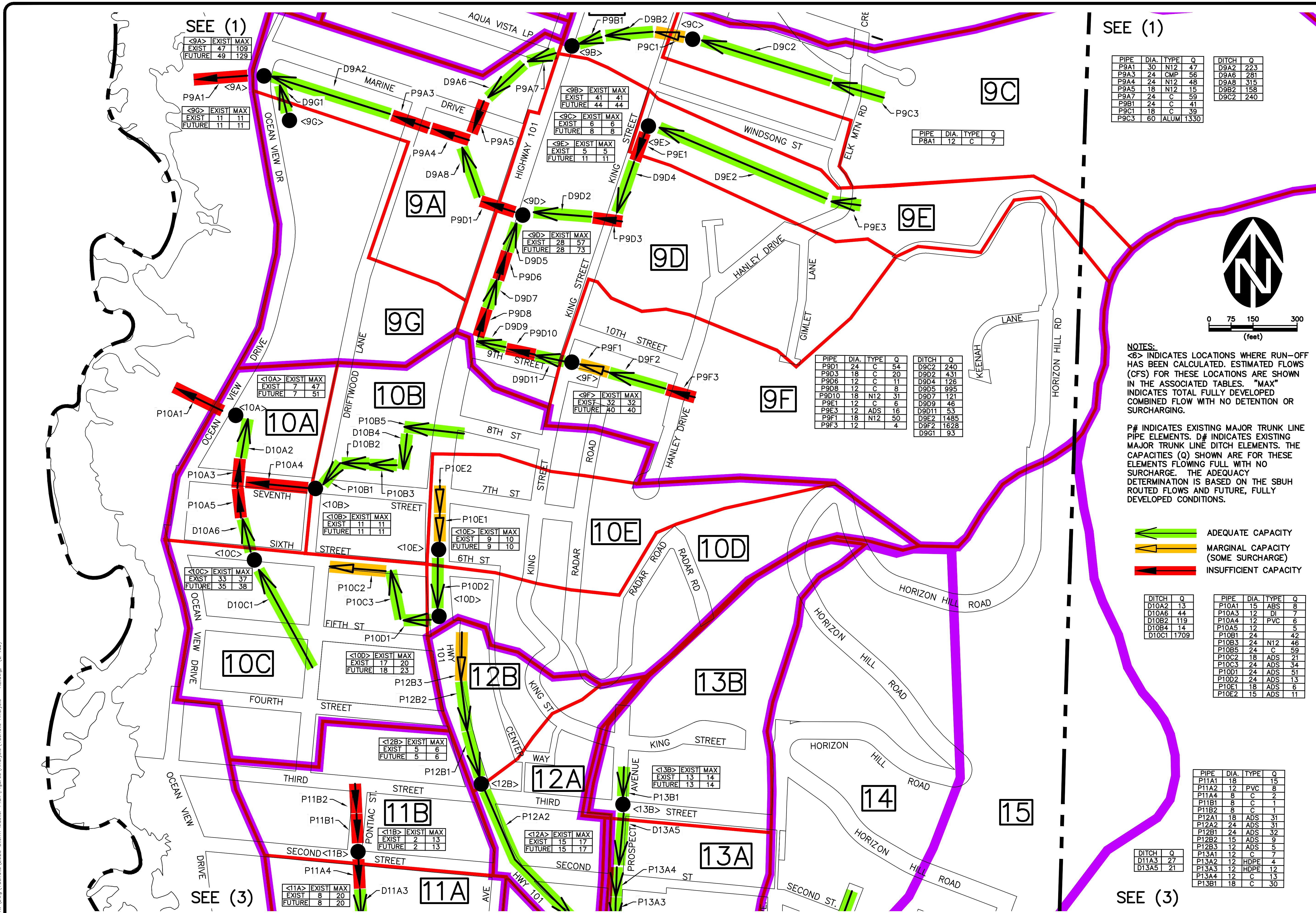

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ADEQUATE CAPACITY
MARGINAL CAPACITY (SOME SURCHARGE)
INSUFFICIENT CAPACITY

PIPE	DIA.	TYPE	Q
P9A1	30	N12	47
P9A3	24	CMP	56
P9A4	24	N12	48
P9A5	18	N12	15
P9A7	24	C	59
P9B1	24	C	41
P9C1	18	C	39
P9C3	60	ALUM	1330

DITCH	Q
D9A2	223
D9A6	281
D9A8	315
D9B2	158
D9C2	240

PIPE	DIA.	TYPE	Q
P8A1	12	C	7

PIPE	DIA.	TYPE	Q
P9D1	24	C	54
P9D3	18	C	20
P9D6	12	C	11
P9D8	12	C	8
P9D10	18	N12	31
P9E1	12	C	6
P9E3	12	ADS	16
P9F1	18	N12	50
P9F3	12		4

DITCH	Q
D9C2	240
D9D2	431
D9D4	126
D9D5	995
D9D7	121
D9D9	46
D9D11	53
D9E2	1485
D9F2	1628
D9G1	93

DITCH	Q
D10A2	13
D10A6	44
D10B2	119
D10B4	14
D10C1	1709

PIPE	DIA.	TYPE	Q
P10A1	15	ABS	8
P10A3	12	DI	7
P10A4	12	PVC	6
P10A5	12		5
P10B1	24		42
P10B3	24	N12	46
P10B5	24	C	59
P10C2	18	ADS	21
P10C3	24	ADS	34
P10D1	24	ADS	51
P10D2	24	ADS	13
P10E1	18	ADS	6
P10E2	15	ADS	11

DITCH	Q
D11A3	27
D13A5	21

PIPE	DIA.	TYPE	Q
P11A1	18		15
P11A2	12	PVC	8
P11A4	8	C	2
P11B1	8	C	1
P11B2	8	C	1
P12A1	18	ADS	31
P12A2	24	ADS	31
P12B1	24	ADS	32
P12B2	15	ADS	9
P12B3	12	ADS	5
P13A1	12	C	7
P13A2	12	HDPE	4
P13A3	12	HDPE	12
P13A4	12	C	13
P13B1	18	C	30

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City of Yachats Stormwater Master Plan

Storm Runoff Map (2) North Central

FIGURE 5–2b

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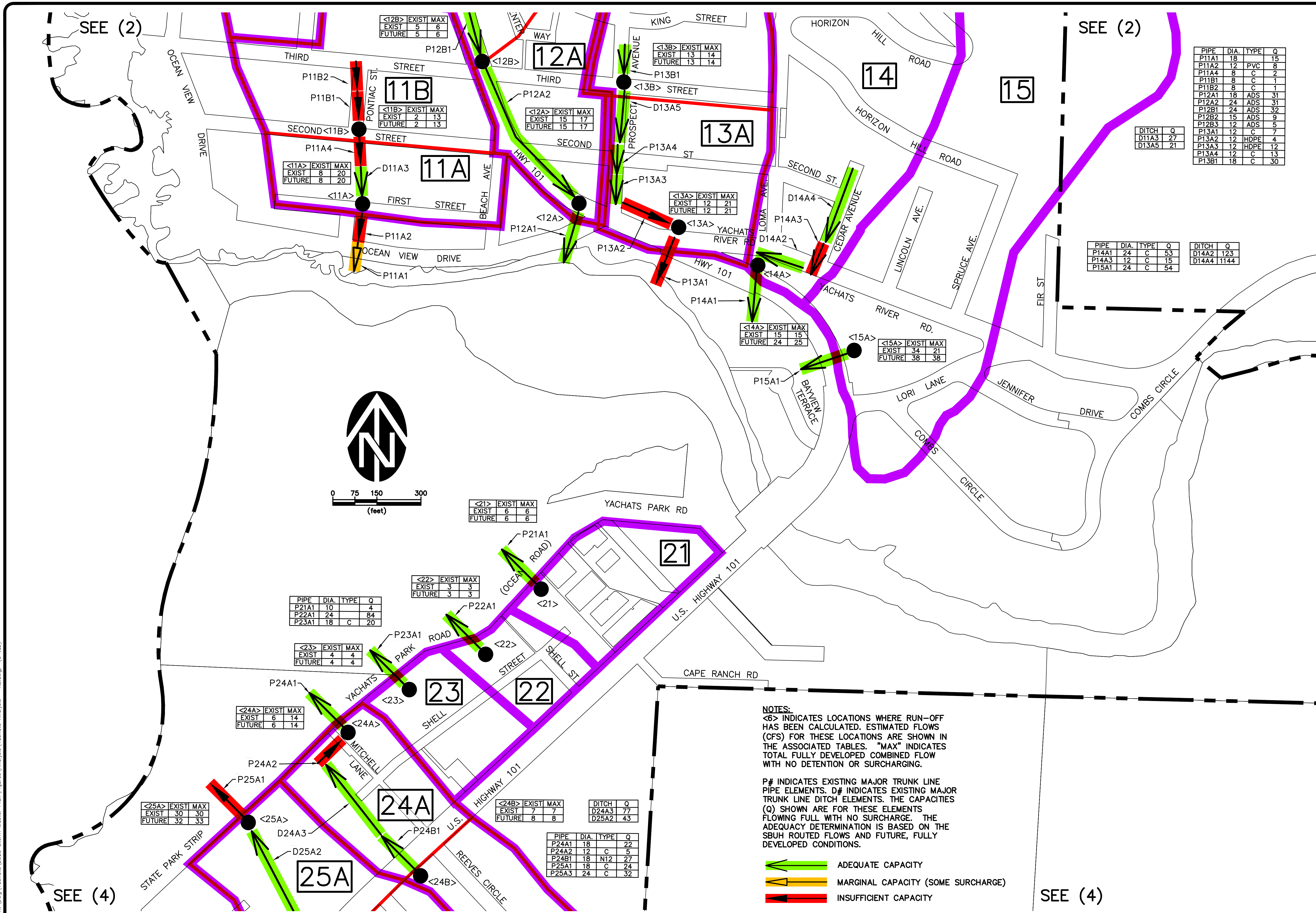

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FUTURE	2	13

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FUTURE	15	17

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FUTURE	8	20

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EXIST	12	21
FUTURE	12	21

<14A>	EXIST	MAX
EXIST	15	15
FUTURE	24	25

<15A>	EXIST	MAX
EXIST	34	21
FUTURE	38	38

PIPE	DIA.	TYPE	Q
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P11A2	12	PVC	8
P11A4	8	C	2
P11B1	8	C	1
P11B2	8	C	1
P12A1	18	ADS	31
P12A2	24	ADS	31
P12B1	24	ADS	32
P12B2	15	ADS	9
P12B3	12	ADS	5
P13A1	12	C	7
P13A2	12	HDPE	4
P13A3	12	HDPE	12
P13A4	12	C	13
P13B1	18	C	30

DITCH	Q
D11A3	27
D13A5	21

PIPE	DIA.	TYPE	Q
P14A1	24	C	53
P14A3	12	C	15
P15A1	24	C	54

DITCH	Q
D14A2	123
D14A4	1144

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P22A1	24		84
P23A1	18	C	20

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FUTURE	4	4

<24A>	EXIST	MAX
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FUTURE	6	14

<25A>	EXIST	MAX
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FUTURE	32	33

<24B>	EXIST	MAX
EXIST	7	7
FUTURE	8	8

DITCH	Q
D24A3	77
D25A2	43

PIPE	DIA.	TYPE	Q
P24A1	18		22
P24A2	12	C	5
P24B1	18	N12	27
P25A1	18	C	24
P25A3	24	C	32

NOTES:
<6> INDICATES LOCATIONS WHERE RUN-OFF HAS BEEN CALCULATED. ESTIMATED FLOWS (CFS) FOR THESE LOCATIONS ARE SHOWN IN THE ASSOCIATED TABLES. "MAX" INDICATES TOTAL FULLY DEVELOPED COMBINED FLOW WITH NO DETENTION OR SURCHARGING.

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ADEQUATE CAPACITY
MARGINAL CAPACITY (SOME SURCHARGE)
INSUFFICIENT CAPACITY

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City of Yachats Stormwater Master Plan

Storm Runoff Map (3) Central

FIGURE
5-2c

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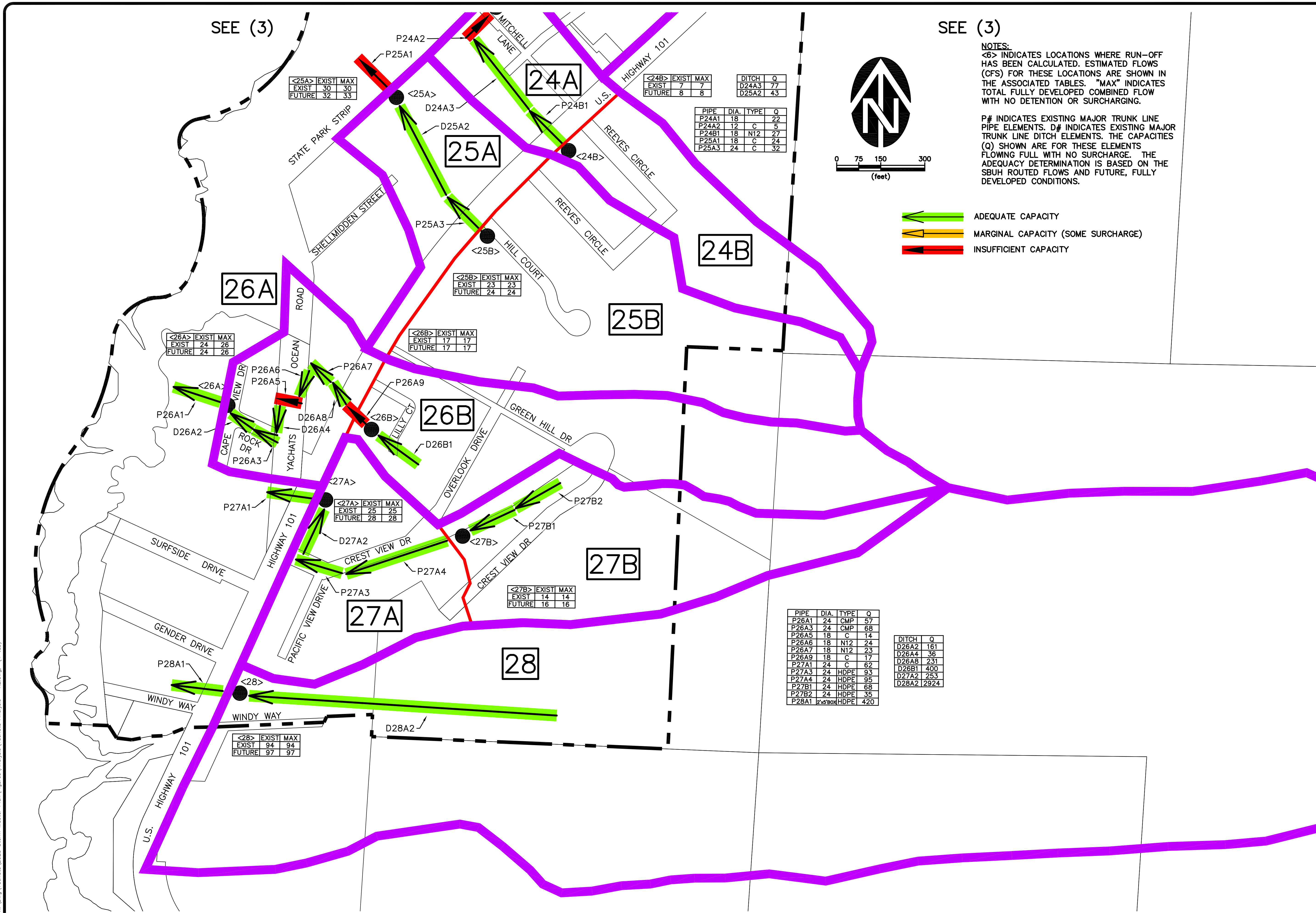

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<24B>	EXIST	MAX
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FUTURE	8	8

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D24A3	77
D25A2	43

PIPE	DIA.	TYPE	Q
P24A1	18		22
P24A2	12	C	5
P24B1	18	N12	27
P25A1	18	C	24
P25A3	24	C	32

<25B>	EXIST	MAX
EXIST	23	23
FUTURE	24	24

<26B>	EXIST	MAX
EXIST	17	17
FUTURE	17	17

<26A>	EXIST	MAX
EXIST	24	26
FUTURE	24	26

<27A>	EXIST	MAX
EXIST	25	25
FUTURE	28	28

<27B>	EXIST	MAX
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FUTURE	16	16

<28>	EXIST	MAX
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FUTURE	97	97

PIPE	DIA.	TYPE	Q
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P26A3	24	CMP	68
P26A5	18	C	14
P26A6	18	N12	24
P26A7	18	N12	23
P26A9	18	C	17
P27A1	24	C	62
P27A3	24	HDPE	93
P27A4	24	HDPE	95
P27B1	24	HDPE	68
P27B2	24	HDPE	35
P28A1	2'x5'BOX	HDPE	420

DITCH	Q
D26A2	161
D26A4	36
D26A8	231
D26B1	400
D27A2	253
D28A2	2924

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City of Yachats Stormwater Master Plan

Storm Runoff Map (4) South

FIGURE 5–2d

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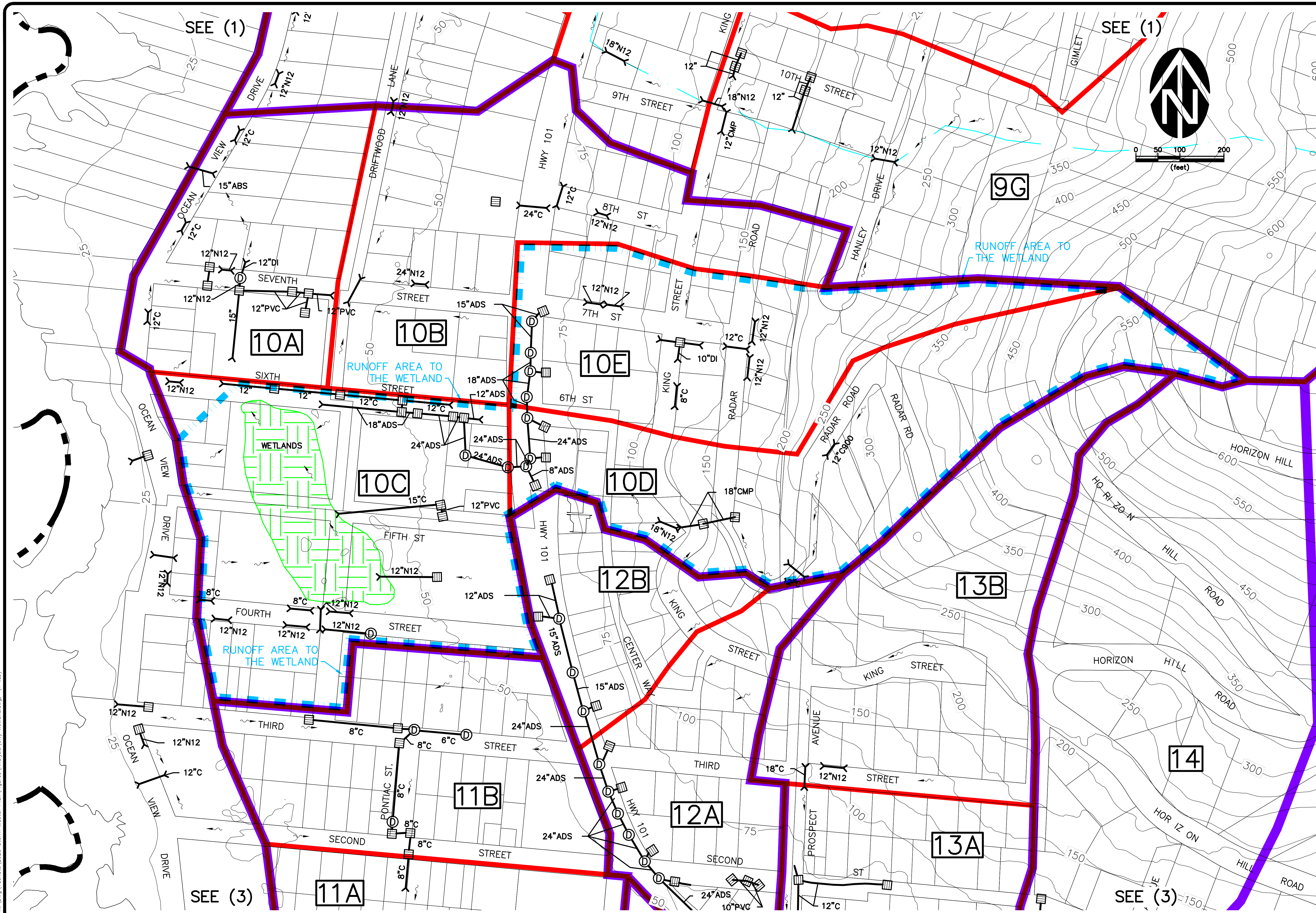

City of Yachats, Oregon
City of Yachats Stormwater Master Plan

Community Wetland Drainage Area Map

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FIGURE
5–3a

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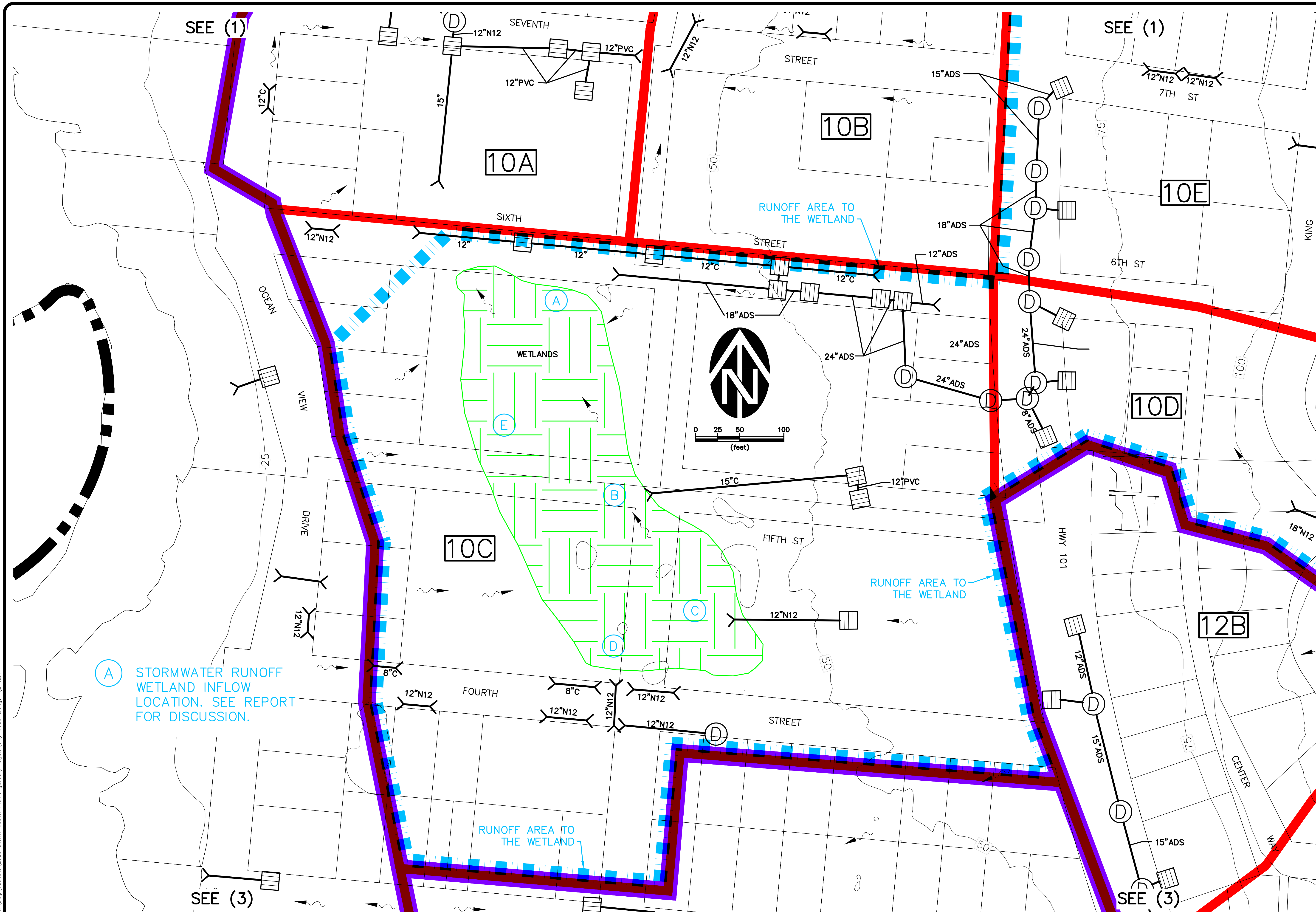

City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Community Wetland Inflow Location Map

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FIGURE
5-3b

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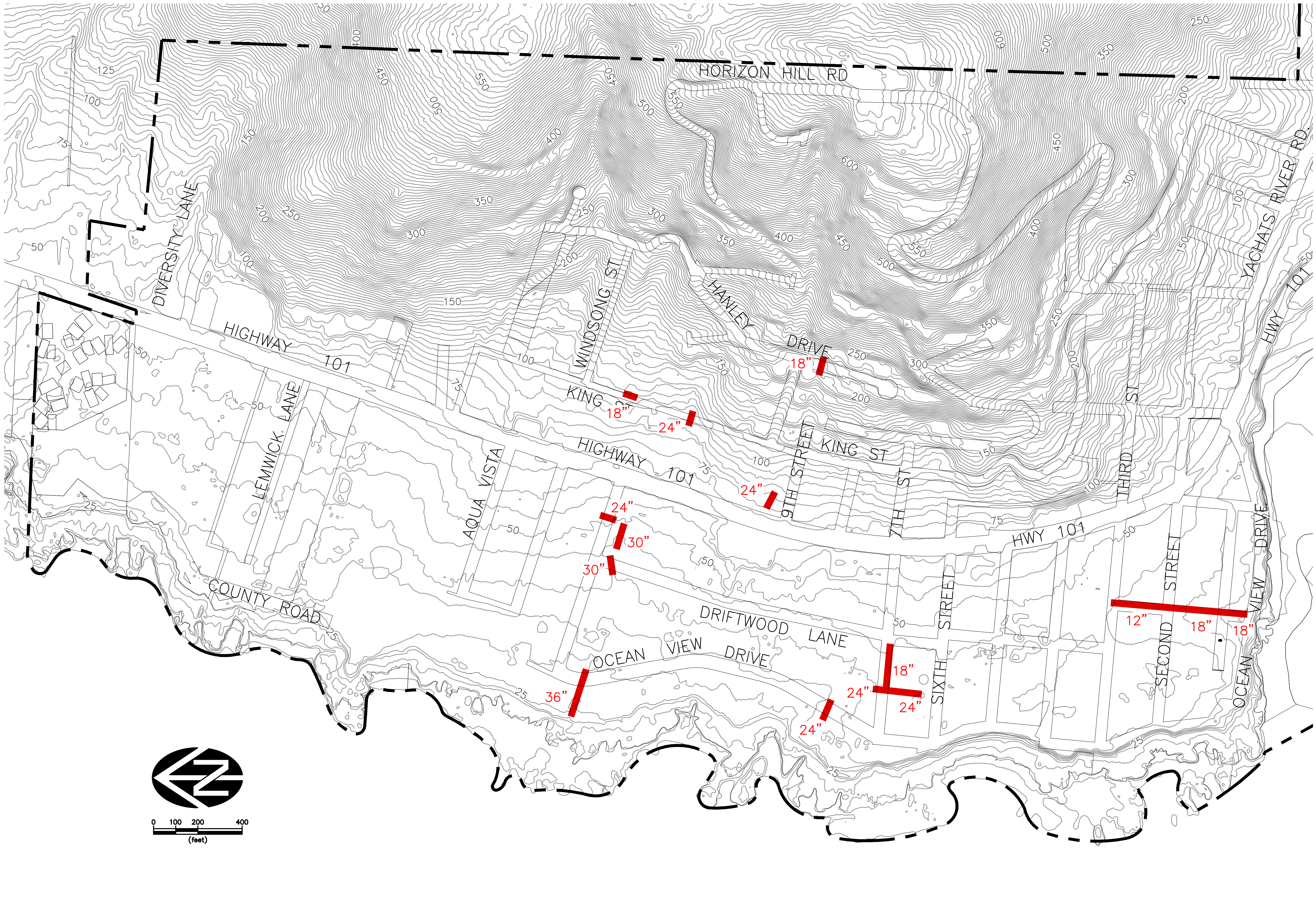

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City of Yachats, Oregon
City of Yachats Stormwater Master Plan

Recommended Improvements (North)

FIGURE
5-4a

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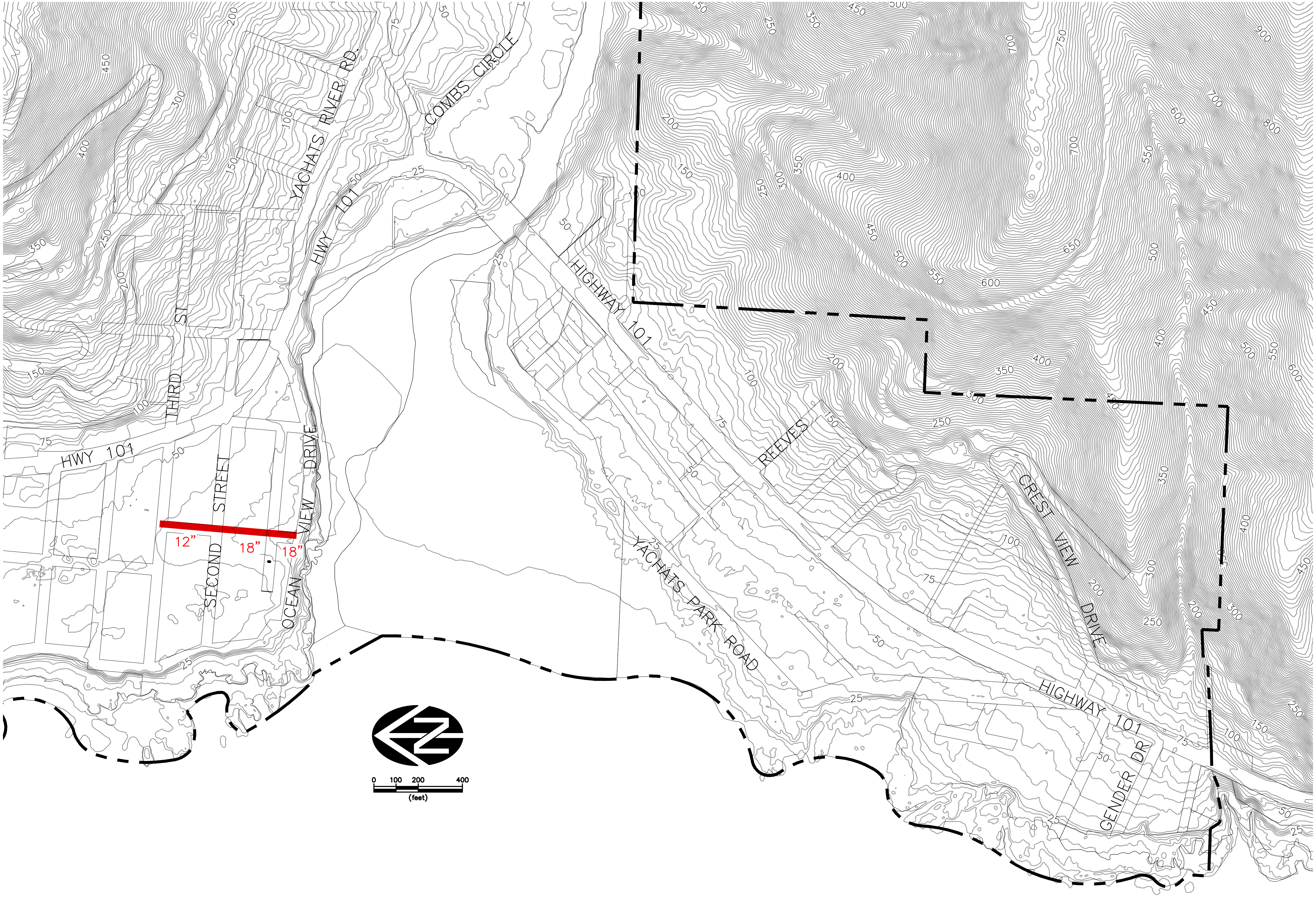

City of Yachats, Oregon

City of Yachats Stormwater Master Plan

Recommended Improvements (South)

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FIGURE 5–4b

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Figure 5-5 | Pre & Post Development Runoff

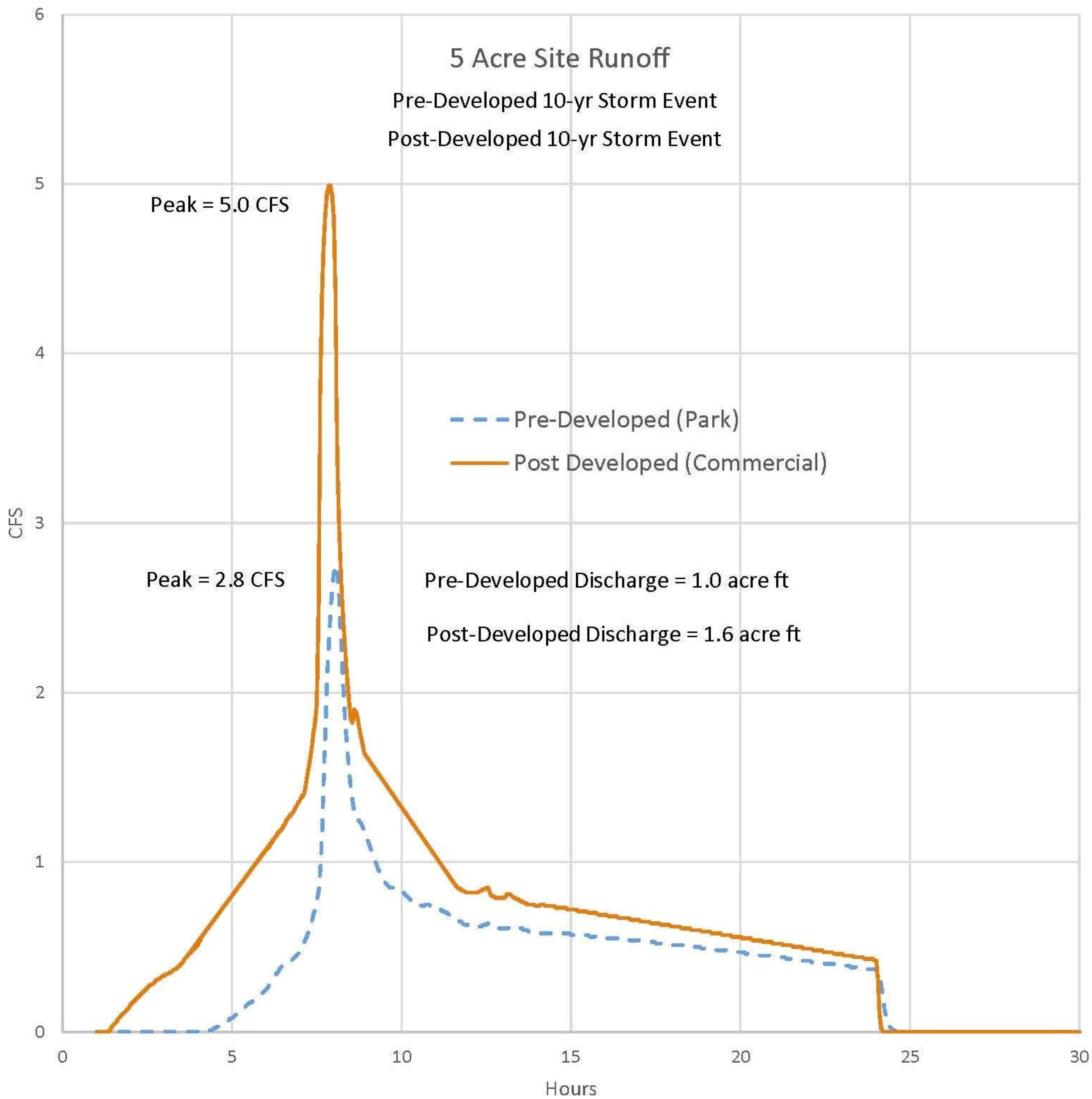


Figure 5-6 | Site Runoff With Detention

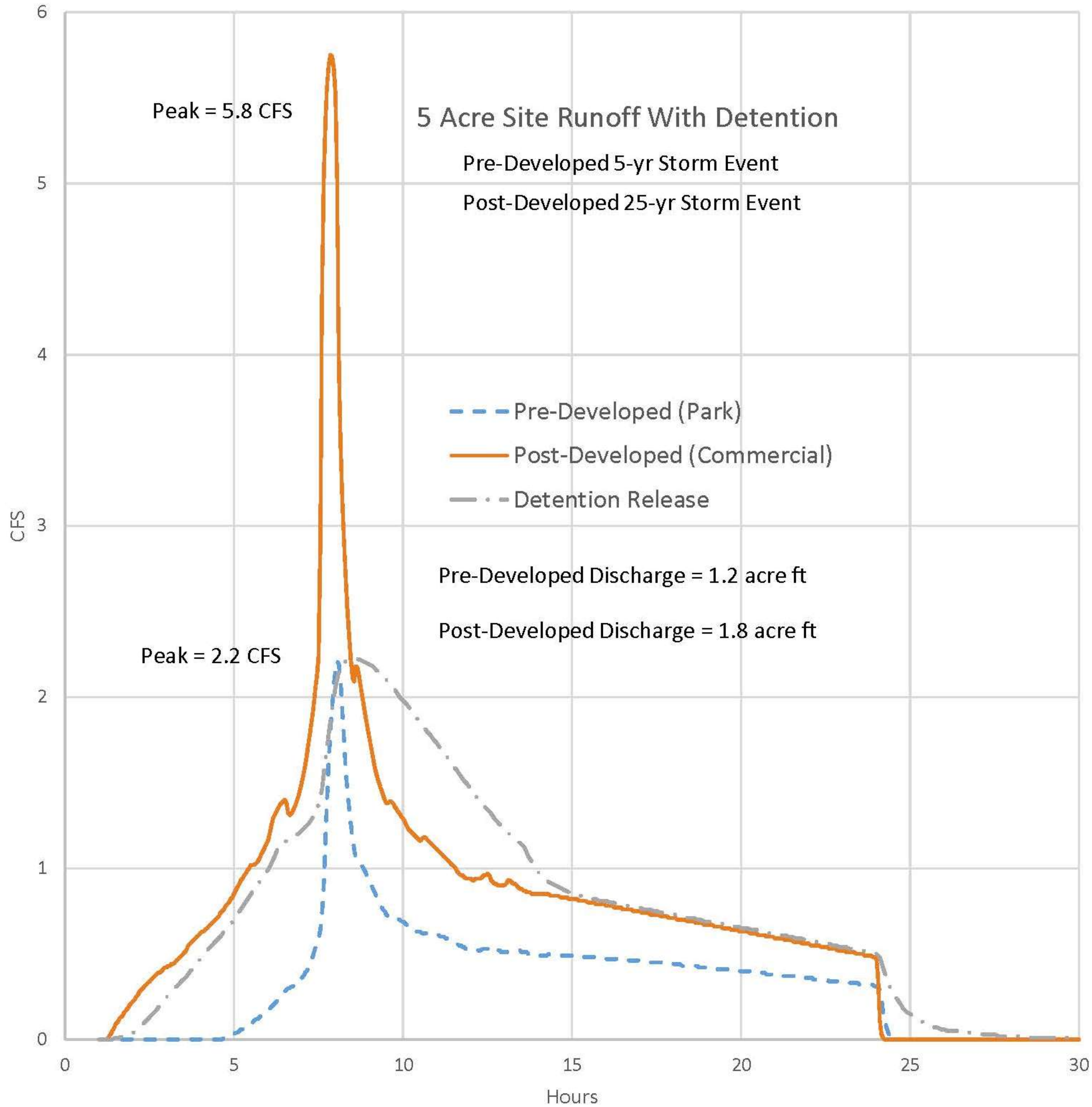


Figure 5-7 | Combined Landscape Area Detention and Pipe Detention

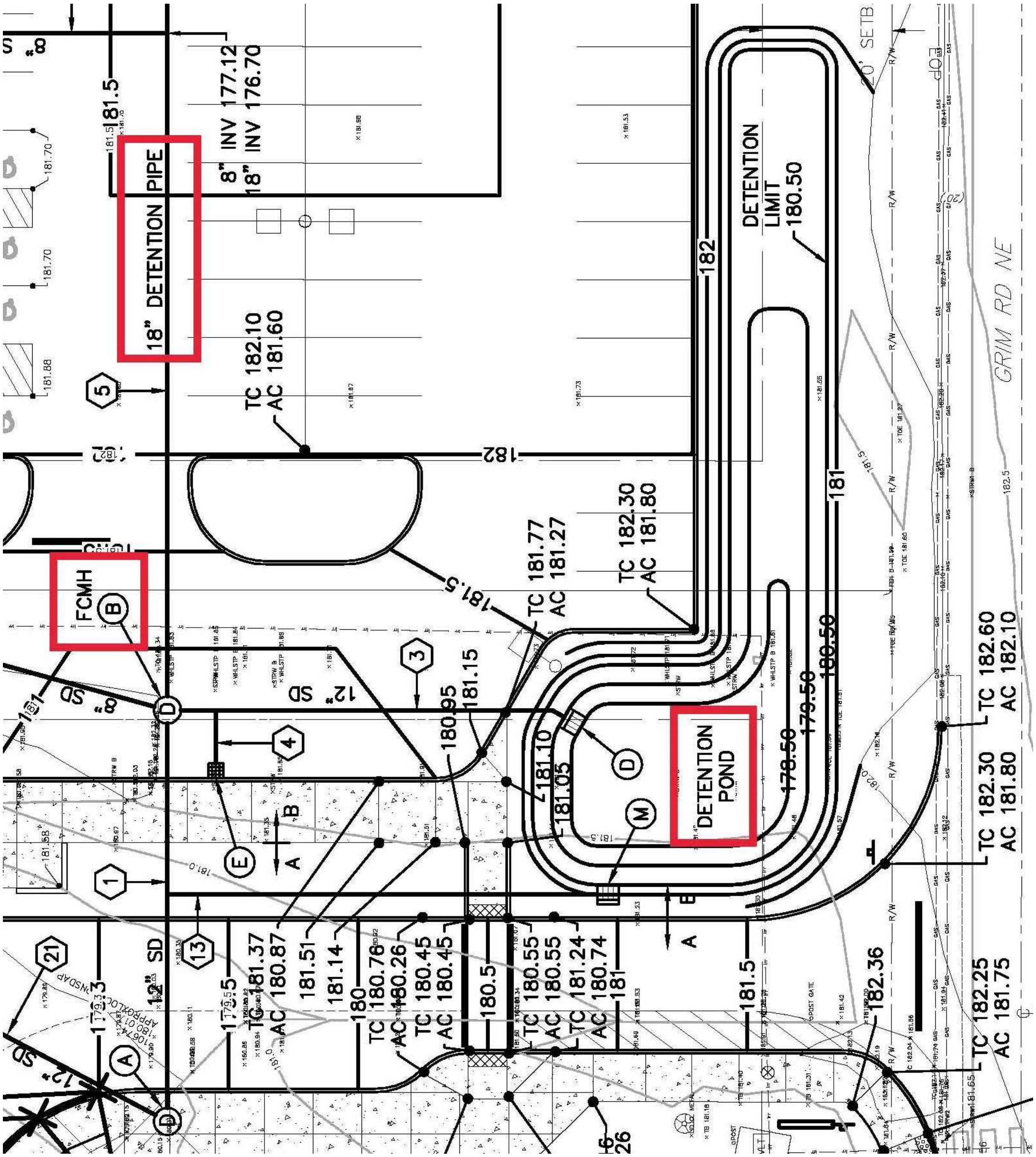


Figure 5-8 | Pipe Detention

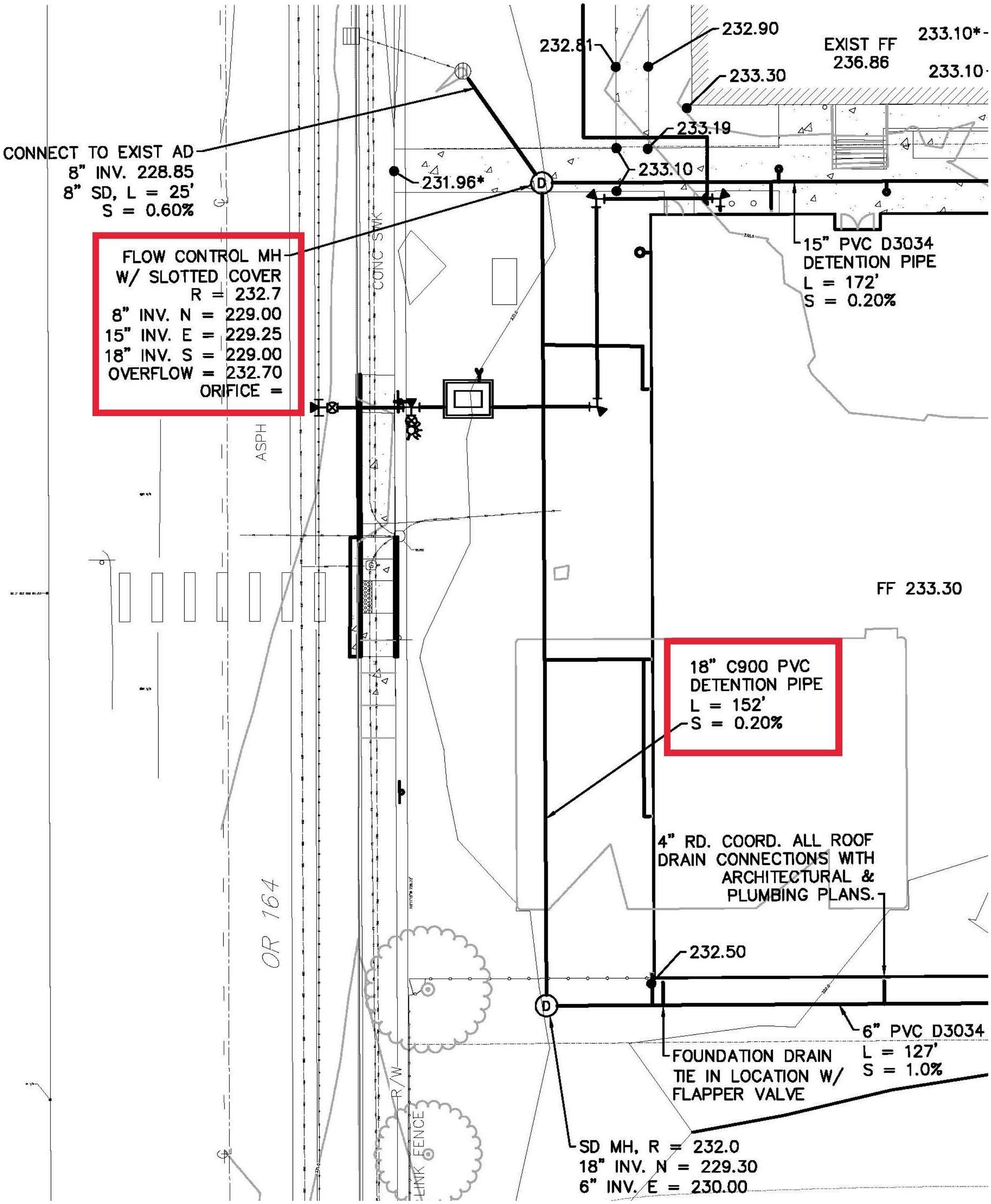


Figure 5-9 | Parking Lot Detention

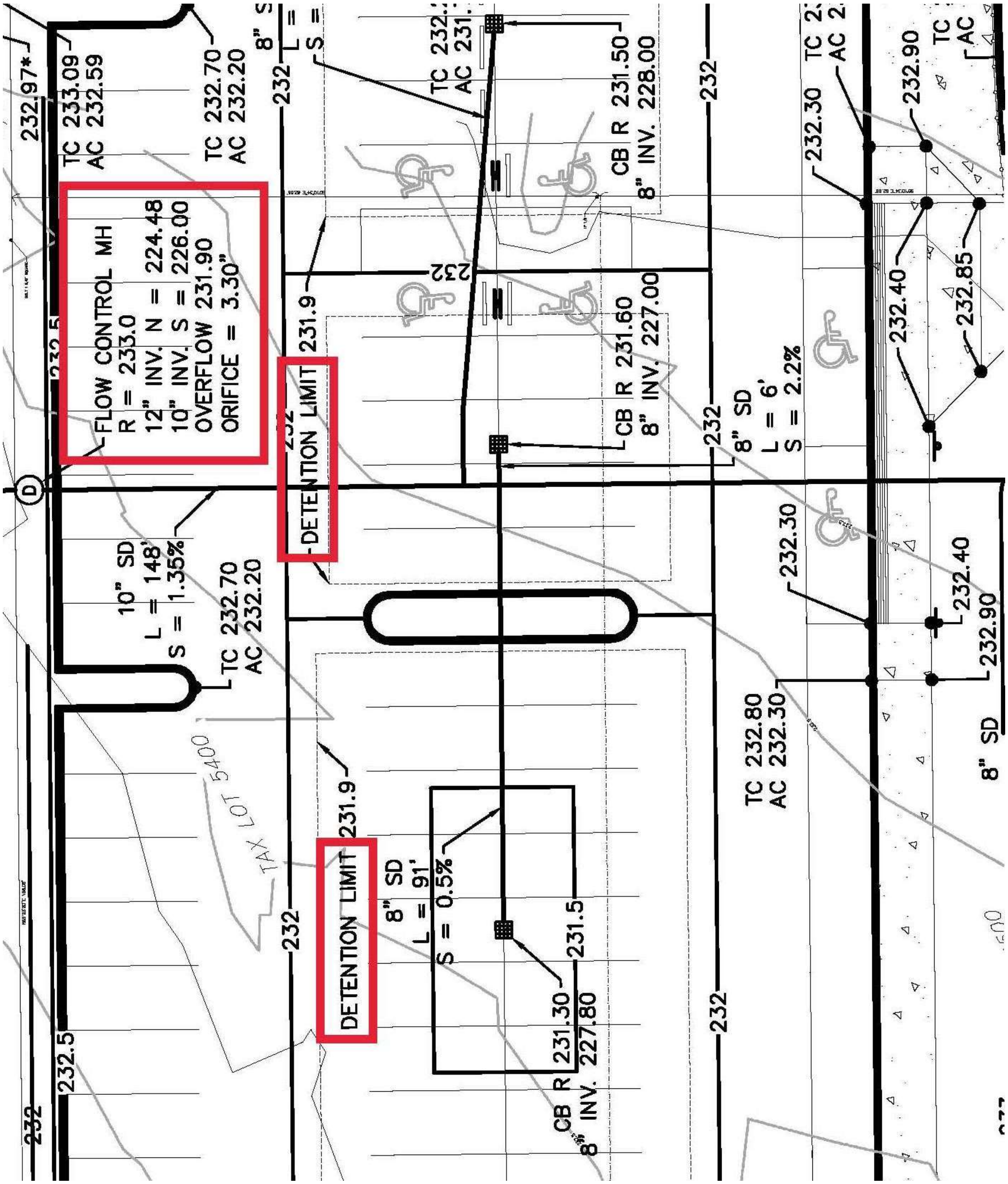


Figure 5-10 | Parking Lot Swale Detention

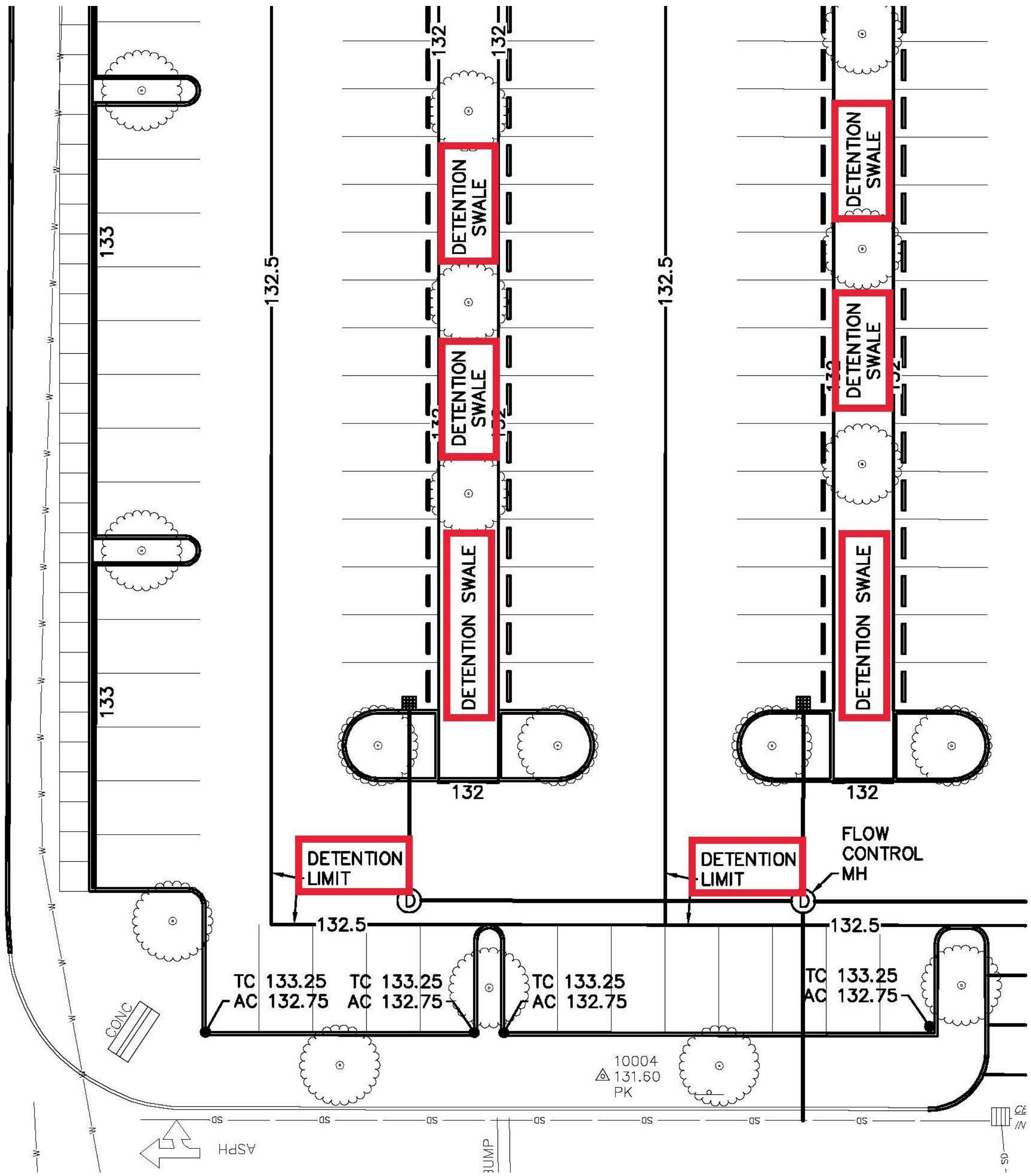


Figure 5-11 | Flow Control Manhole

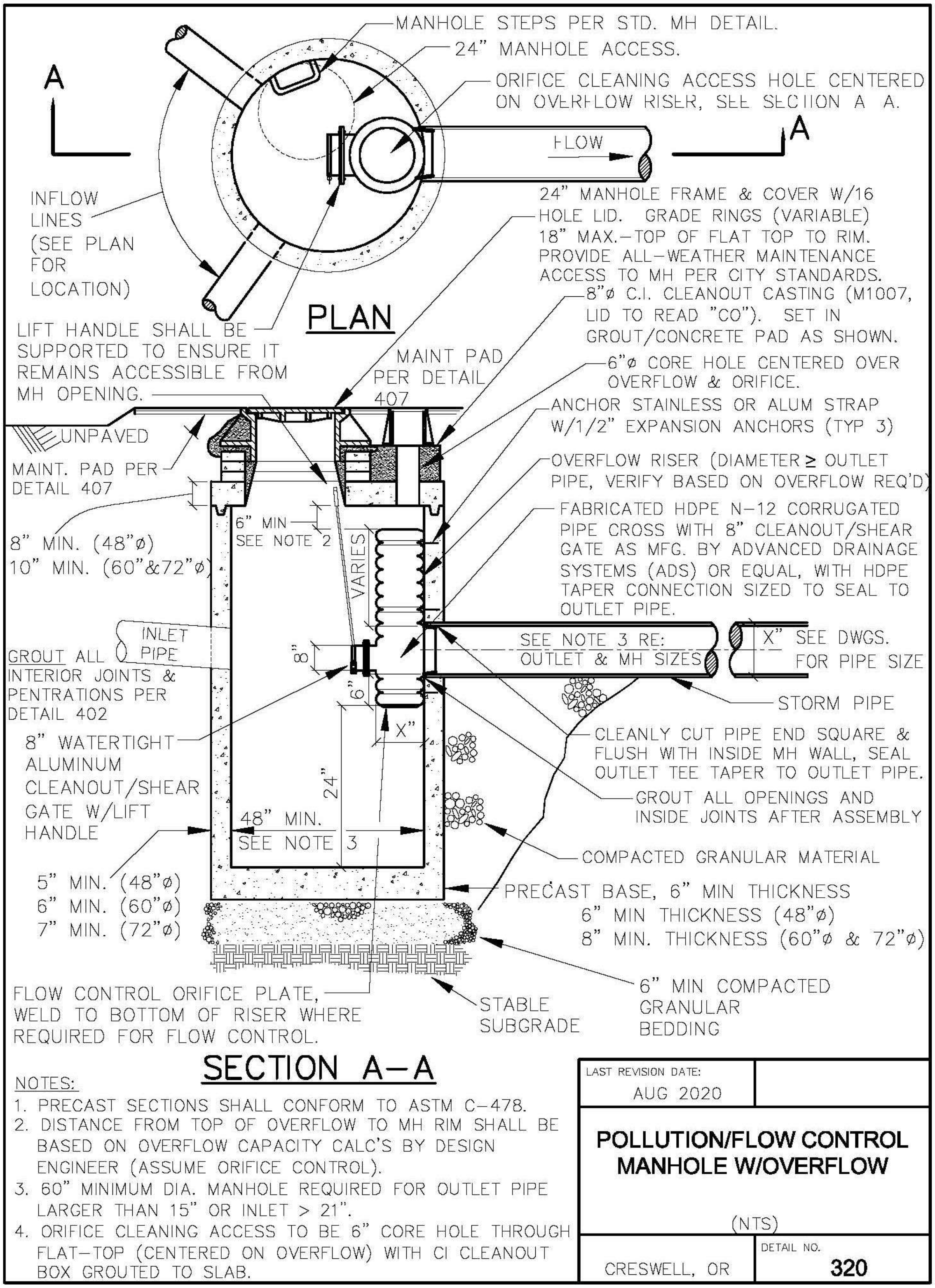
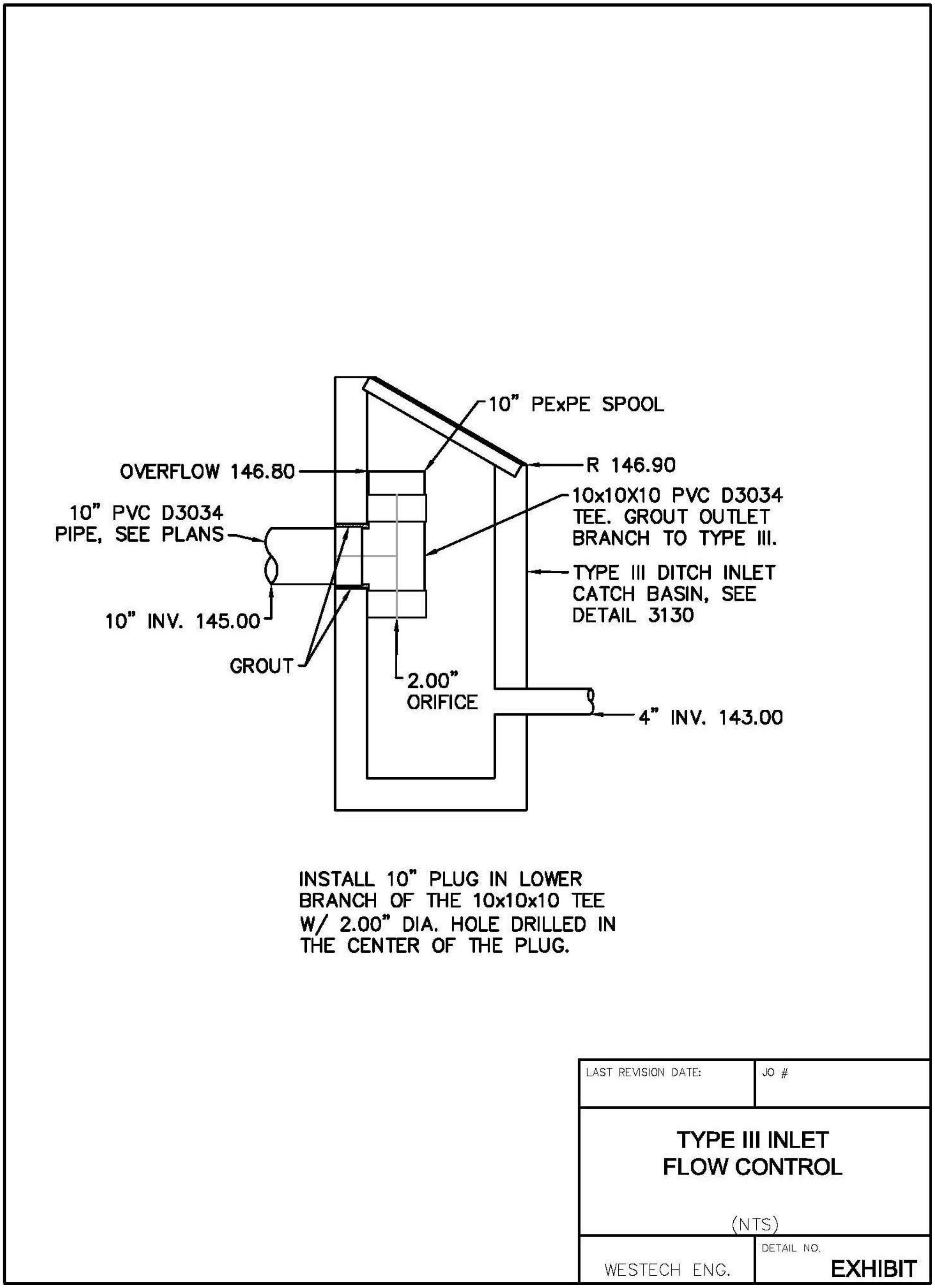


Figure 5-12 | Flow Control Type III Inlet



CITY OF YACHATS
Storm Drainage System Master Plan

Section 6

Design Standards & Management Practices

SECTION 6
Design Standards & Management Practices

6.1. General

This section provides information and recommendations to the City regarding design standards and management practices for the City's storm drainage system. Design standards aid the City in providing direction to developers seeking to extend or improve the drainage system to serve new developments. Another concern of the City's is the operation and maintenance of existing storm drainage facilities. The second part of this section provides suggestions intended to help the City develop procedures and standards for the management of storm drainage facilities.

6.2. Current Yachats Storm Drainage System Design Standards

The City has adopted Public Works Design Standards (PWDS) that are intended to provide guidelines for the design of public facilities that will provide an adequate service level for the present development as well as for future development. The PWDS cannot provide for all situations. They are intended to assist but not to substitute for competent work by design professionals.

These standards were drafted with the intent that they:

- Be consistent with current City Ordinances;
- Provide design guidance criteria to the private sector for the design of public improvements within the City of Yachats;
- Be of adequate design to safely manage all volumes of water generated upstream and on the site to an approved point of disposal;
- Provide points of disposal for stormwater generated by future upstream developments;
- Prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property;
- Prevent the capacity of downstream channels and storm drainage facilities from being exceeded;
- Have sufficient structural strength to resist erosion and all external loads which may be imposed;
- Maximize the use of the City's natural drainage system;

- Be designed in a manner to allow economical future maintenance; and

- Require the use of design and materials to provide a system with a minimum practical design life of not less than 50 years.

Based on the analysis of the City's storm drainage system carried out for this report, the City's current Public Works Design Standards are appropriate as adopted. For specific information regarding current City requirements, the Public Works Design Standards should be obtained from the City of Yachats.

6.3. Storm Drainage System Construction Standards

The City does not presently have construction standards specifically tailored for stormwater system improvements under City jurisdiction, although the Standard Specifications for Public Works Construction as jointly prepared by the Oregon Department of Transportation (ODOT) and Oregon Chapter of the American Public Works Association (APWA) are adopted by reference in the PWDS, subject to the acceptable materials as listed in the PWDS. Until the City develops Public Works Construction Standards (PWCS) specifically tailored to the City's infrastructure, it is recommended that the City continue to use the ODOT/APWA standards.

These PWCS will provide a uniform set of standards for use by contractors during the construction of storm drainage improvements. However, even the best PWCS cannot provide for all situations. They are intended to assist but not to substitute for competent work by experienced professional contractors.

6.4. Storm System Management Practices

In order to ensure that the City's storm drainage system continues to function effectively, and to maintain the full capacity of the existing storm drainage system, a regular program of maintenance is recommended.

A successful maintenance program should include the following objectives:

- Provide for public safety
- Reduce potential of property damage by obstructed facilities
- Evaluate and upgrade maintenance priorities
- Reduce impact on City's resources
- Maintain capacity and integrity of storm drainage system
- Identify future maintenance needs
- Add projects to the stormwater CIP as appropriate
- Reduce nuisance water on public streets

The most important objectives of the maintenance program should be to provide for public safety and reduce unplanned storm water flow or flooding on private and public property. It also allows access to public roads to be maintained during storm events for emergency and private vehicles.

Priorities should be established and re-evaluated yearly to ensure that resources are allocated reasonably and fairly. In this manner, limited City resources are not used for resolving minor storm drainage problems when major facilities are in need of repair or improvement. As repairs are made and yearly evaluations are performed, new problem areas and other maintenance requirements can be identified and prioritized. Another benefit is that City residents visibly see that their concerns are being addressed by the City.

For purposes of evaluating the storm drainage maintenance requirements for the City, typical maintenance requirements were developed for each type of structure in the system along with typical maintenance requirements for different conditions. **Table 6-1** outlines typical maintenance requirements for pipes and culverts, while **Table 6-2** outlines those for catch basins.

Table 6-1
Recommended Maintenance Standards For Pipes & Culverts

Maintenance Category	Condition Requiring Maintenance	Recommended Maintenance
Sediment and debris	Accumulated sediment exceeds 20% of the pipe diameter	Clean pipe of all sediment and debris
Vegetation	Vegetation that reduces free movement of water through pipes	Remove all vegetation so water flows freely through pipes
Damaged pipe	Protective coating is damaged and rust causing more than 50% of deterioration to any part of pipe	Repair or replace pipe
	Any dent that decreases the end area of pipe by more than 20%	Repair or replace pipe
Debris barrier plugged	Trash or debris plugging more than 20% of the barrier openings	Clear barrier of all debris
Damaged/missing bars	Bars are missing or entire barrier missing	Replace bars per design
	Bars are loose and rust is causing 50% deterioration to any part of barrier	Repair or replace barrier to design

Table 6-2 **Recommended Maintenance Standards For Catch Basins**		
Maintenance Category	Condition Requiring Maintenance	Recommended Maintenance
Trash and debris (including sediment)	Trash or debris of more than 1/2 cu ft located in front of the catch basin opening or blocking capacity of basin by >10 percent	Clean trash or debris from in front of catch basin opening
	Sediment, trash or debris in the basin greater than 1/3 to 1/2 the depth of the sump	Remove sediment, trash and debris from catch basin
	Sediment, trash or debris in any inlet or outlet pipe blocking more than 1/3 the diameter	Remove sediment, trash and debris from catch basin
Structural damage or deterioration of curb or frame	Deterioration of curb at inlet location	Replace curb across inlet location
	Damage to diamond plate covers in sidewalk	Repair or replace cover
Cracks in basin walls or bottom	Cracks wider than ½ inch or longer than 3 ft, any evidence of soil particles entering catch basin through cracks, or structure is unsound	Basin repaired or replaced
	Cracks wider than ½ in and longer than 1 ft at the joint of any pipe or any evidence of soil particles entering catch basin through crack	Repair/grout cracks
Settlement/misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment	Basin reset or replaced
Fire or chemical hazard	Chemicals such as natural gas, oil, and gasoline in storm drain system	Remove flammable or hazardous chemicals
Vegetation	Vegetation growing across and blocking more than 10 percent of basin	Remove vegetation blocking basin
	Vegetation growing in inlet/outlet or roots at pipe joints	Remove vegetation and roots

Based on these typical maintenance requirements, a sample maintenance budget worksheet was developed using assumed production rates and unit costs for the various maintenance functions. The level of service and assumed unit costs for the various maintenance functions are presented in **Table 6-3**. This should not be regarded as a final budget number, but is intended only to provide a sample for use in developing a realistic budget as the City implements funding programs for storm system maintenance. In summary, the maintenance budget should allow for cleaning of all catch basins bi-annually, all pipes on a 5-year cycle, and other maintenance, repair, replacement, and system inventory requirements as shown.

To develop a storm system maintenance program for the City, the following recommendations should be implemented:

- Once funding mechanisms are in place, allocate an amount determined by Public Works as the Storm System Maintenance Budget for repairs of "minor" storm drainage facilities. **Table 6-3** can be used a starting point for developing this budget.

- Implement routine inspections of system elements (i.e., catch basins, culverts, etc.) to observe debris accumulation and structural conditions, and to evaluate the required procedures, materials, equipment, personnel, urgency, time, and cost for maintenance activities.

- Develop a storm drainage database to inventory system elements, record maintenance actions and inspection logs, and monitor public concerns (complaints of local problem areas).

- Regularly evaluate database to determine maintenance patterns and refine manpower and budgetary requirements.

- Obtain access easements to existing public facilities from private owners.

- Inspect and evaluate detention ponds (schedule maintenance when capacity is reduced by one-third due to sedimentation).

- Provide an emergency fund to deal with catastrophic events effecting storm drainage facilities.

Table 6-3
Sample Maintenance Budget Worksheet

Item No.	Category	Number to be Maintained	Frequency (times/yr)	Standard #/Length per day	Crew Size	Total days per year	Labor Cost/ Crew day	Equipment Cost (% Labor)	Preliminary Maintenance Costs: Labor Cost	Material Cost	Equipment Cost	Total Cost	Percent of Total Budget
1	Inspect Catch Basins	85	0.25	30	1	0.7	$600	50%	$425	$0	$213	$638	1%
2	Clean Catch Basins	85	0.25	15	2	1.4	$1,200	100%	$1,700	$0	$1,700	$3,400	5%
3	Storm Manhole Inspections	20	0.25	30	1	0.2	$600	50%	$100	$0	$50	$150	0%
4	Clean Major Culvert/Pipe Inlets	5	1	4	1	1.3	$600	100%	$750	$0	$750	$1,500	2%
5	Clean Storm Lines	11,000	0.25	1000	2	2.8	$1,200	100%	$3,300	$0	$3,300	$6,600	9%
6	Clean/Regrade Major Ditches	7,600	0.5	1000	2	3.8	$1,200	100%	$4,560	$0	$4,560	$9,120	13%
7	Clean/Regrade Roadside Ditches	7,400	0.25	2000	2	0.9	$1,200	200%	$1,110	$0	$2,220	$3,330	5%
8	Repair Major Culverts	2	0.2	1	2	0.4	$1,200	40%	$480	$0	$192	$672	1%
9	Repair Storm Lines	50	0.05	2	2	1.3	$1,200	100%	$1,500	$0	$1,500	$3,000	4%
10	Repair/replace Catch Basins	85	0.05	2	2	2.1	$1,200	50%	$2,550	$2,400	$1,275	$6,225	9%
11	Outfall Inspection/Maintenance	15	1	1	1	15.0	$600	0%	$9,000	$0	$0	$9,000	13%
12	Complaint Response	30	1	1	1	30.0	$600	0%	$18,000	$0	$0	$18,000	26%
13	System Inventory Reconnaissance	1	6	1	1	6.0	$600	0%	$3,600	$0	$0	$3,600	5%
													92%
				Total crew days/yr		65.8							
				Sub-total: All Maintenance Categories					$47,075	$2,400	$15,761	$65,235	
								Administration & Overhead @ 8%				$5,219	
								Grand Total				$70,453	

6.5. Legal/Liability Issues

This section presents a general background on drainage-related legal/liability issues and should not be used in lieu of advice from the City's legal counsel. Therefore, the following items present a basis for further investigation by the City into potential liabilities with storm drainage master planning and implementation of improvements. Historically, the basis for stormwater litigation has been a tort action, as follows:

- In the State of Oregon, the civil law doctrine of drainage (Modified Civil Rule) applies when it comes to assessing legal liability for flooding, erosion and drainage alterations. Under this doctrine, adjoining landowners are entitled to have the normal course of natural drainage maintained. The lower owner must accept water that naturally comes to their land from above, but they are entitled not to have the normal drainage substantially changed or substantially increased in a manner that significantly impacts the land. The lower landowner may not obstruct the runoff from the upper land, if the upper landowner is properly discharging the water (Reference 1).

- A municipality undertaking a public drainage improvement is treated like a private party (Harbison v. City of Hillsboro) and is liable for damage resulting from negligence or an omission of duty (Reference 2).

- Municipalities are generally under no legal duty to construct drainage improvements unless public improvements require drainage facilities (Denver v. Mason) (Reference 3).

- Municipalities are not liable for damages due to overflow of its drainage system in cases of extraordinary/unforeseeable rains or floods. (McQuillan) (Reference 4).

- Municipalities will likely be liable in cases where they take responsibility for collection of surface waters which are then released onto private property which has not historically received runoff, where dams/diversions cause an overflow onto another's land, or where there is failure to exercise reasonable care in the maintenance and repair of drainage improvements (Reference 4).

REFERENCES

1. Hydraulics Manual, Oregon Department of Transportation, Highway Division, prepared by the Hydraulics Unit, January 1990.

2. Drainage Management Study and Financial Program, City of Gresham, Oregon, prepared by KCM, December 1981.

3. Kelly Creek Basin, Storm Drain Master Plan, City of Gresham, Oregon, prepared by URS, September 1988.

4. Comprehensive Storm Drainage Master Plan, City of Hillsboro, prepared by URS, July 1988.

6.6. Funding Issues

This section describes the range of alternative funding sources that municipalities have used in implementing drainage improvements. Additional information on current storm drainage system funding mechanisms is provided in Section 3.6.

There are three major groups that finance public facilities. These groups include the general taxpayers, facility users, and owners of benefited properties. Selecting the proper funding sources to finance a public facility is a policy responsibility of local elected officials. Projects are likely to use more than one funding source to be completed. Striking a balance between the cost to serve and the ability to pay is a difficult task. Debt will be issued to cover any costs not covered by other funding sources. Revenue bonds will be used as the debt funding mechanism, although it is expected that the City will pursue lower cost loans, grants, and developer contributions whenever possible to reduce future costs for its ratepayers. The actual approval of debt is still a function of the budgeting process and must be adopted by the City Council before the issuance of any new debt.

6.6.1 State/Federal Grants and Loans

Various grant/loan programs are available at both the federal and state level. However, no single grant/loan program is available on a consistent, on-going basis for funding of local stormwater management. With communities competing on both a state-wide and even nation-wide basis, and with constraints on how grant/loan money is to be used, these sources can only serve to supplement an existing local funding program for stormwater management.

6.6.2 Debt Financing

General obligation bonds and revenue bonds are two commonly used forms of debt financing for public infrastructure improvements. General obligation bonds, primarily used for major capital improvements, are subject to voter approval and are backed by the full credit of the government issuing them. Revenue bonds, on the other hand, may be sold and secured only by those specific revenue sources which are earmarked for their payment.

6.6.3 System Development Charges

These charges are imposed on new development as a way of recovering costs for that portion of existing system capacity solely attributable to new development or for that portion of required system up-sizing. System development charges can begin to answer questions of who should pay for required up-sizing of the stormwater system due to new development, or how historical payers into the system can recover their costs in oversizing facilities that enable future growth.

6.6.4 Fee-In-Lieu of On-Site Detention

These fees afford a land developer the option of either constructing an on-site stormwater detention facility in accordance with established design criteria, or paying a fee into a fund dedicated to the construction of an off-site or regional stormwater detention facility serving multiple properties. These fees tend to promote siting and construction of regional versus on-site detention facilities. However, cash flow necessary for a regional stormwater detention facility may not necessarily coincide with the required construction timing.

6.6.5 Local Improvement Districts and Special Assessments

The concept of deriving funding from local improvement or special assessment districts is founded on quantifying benefits. For water, sewer or street improvements, these benefits can often be easily identified and thus quantified. However, drainage differs in the respect that upstream or hillside properties that are major contributors of runoff may not be specific recipients of benefits.

6.6.6 Plan Review and Inspection Fees

These fees are intended to recover the expense of examining development plans to ensure consistency with comprehensive land use and stormwater master plans, and to ensure that construction standards and regulations are met at the construction site. These fees are not intended to be a primary revenue generating source.

6.6.7 Stormwater Service Charges

Another method gaining popularity for financing stormwater management is the utility-based service charge. Historically, the concept of considering stormwater as a public utility attracted very few communities. However, as other more conventional funding sources became difficult to obtain, and as federal requirements increase, the service charge concept has generated greater appeal. Service charges for stormwater management reflect a rationale that those who contribute to stormwater problems should logically contribute to the costs of providing mitigative services.

One common approach to stormwater service charges is a monthly utility fee based on the impervious area on a typical single family residential lot, which is generally referenced by the term Equivalent Dwelling Unit (EDU). Stormwater EDUs typically have 2,500-3,000 square feet of impervious area. Non-single family parcels are charged the stormwater fee on a prorated basis. If the EDU is based on 3,000 sf and a commercial property has 15,000 sf, that property would be charged five times the standard EDU fee.

Westech Engineering recommends that Yachats consider adopting a stormwater service charge. Under current circumstances it is anticipated that the fee will be in the range of $3-$5 per EDU. The analysis to develop the basis for the fee should be included in the follow on efforts as described in Section 6.6.10 below.

6.6.8 Ad Valorem Taxes

Ad valorem taxes are taxes levied on a property as a direct result of "value added" to the subject property. However, with stormwater there is no clear correlation between property value and contribution of runoff. Ad valorem taxes could provide a significant source of revenue, however with the apparent lack of equity, should not be considered a primary source for funding stormwater programs.

6.6.9 Tax Increment Financing

Tax increment financing consists of using annual tax increment revenues to make payments on debt, usually in the form of bank loans or revenue bonds. The proceeds of the loans or bonds are used to finance the urban renewal projects authorized in the Plan. Loans or bonds may be either long-term or short-term.

Tax increment revenues equal most of the annual property taxes imposed on the cumulative increase in assessed value within an urban renewal area over the total assessed value at the time an urban renewal plan is adopted. (Under current law, the property taxes for general obligation [GO] bonds and local option levies approved after October 6, 2001 are not part of the tax increment revenues.)

At the time an urban renewal plan is adopted, the county assessor calculates the total assessed value of the area and establishes this value as the “frozen base” for the area. Taxes from that frozen base continue going to all of the taxing jurisdictions. Growth above the base is called the “increment”. Taxes from the increment, called tax increment revenue, go to the urban renewal agency for projects within the urban renewal area.

Tax Increment Financing allows cities to borrow against future tax increases in designated areas to create funds for infrastructure improvements or loans and grants to make development feasible in difficult locations. As projects are completed, thereby increasing the tax base, the additional tax revenues are used to pay off debt used to finance the projects.

TIF financing allows the urban renewal agency to receive the incremental taxes from all of the taxing districts in the plan area. The fire district, library district, school district, and community college are entities that give up current tax growth in the urban renewal area for the duration of the urban renewal agency. These other agencies forgo the incremental taxes to help improve the area with hopes that they will receive more taxes in the future when development is completed. School districts are not directly affected because they receive taxes based on the total taxes received by the State and then allocated by the number of seats that are filled in the school in a given year.

6.6.10 Follow-on Funding Analysis Efforts

As noted in Section 3.6, the City plans to analyze and update the City's stormwater system development charge (SDC) based upon the information presented in this master plan. This will be a follow-on effort separate from and building on the master plan. In addition to updating the stormwater SDC, the City's follow-on funding analysis efforts will include an evaluation and possibly the adoption of a stormwater service charge as discussed in Section 6.6.7 above. These analysis efforts may also include other issues should such be recommended by the professionals retained by the City to conduct the analysis.

CITY OF YACHATS
Storm Drainage System Master Plan

Lincoln County Soil Survey Information

Appendix A

United States Department of Agriculture

NRCS

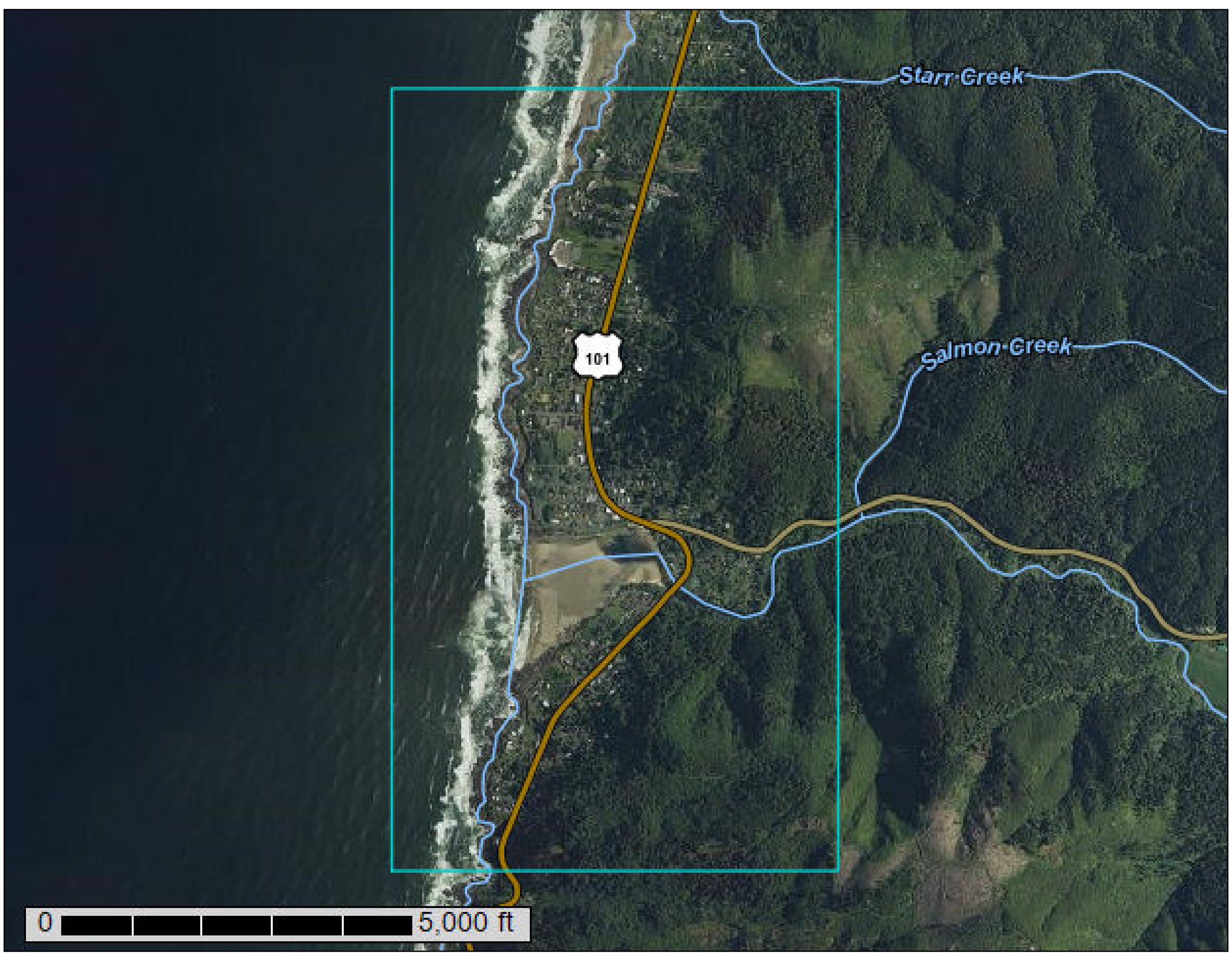
Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Lincoln County Area, Oregon

Yachats Soil Map



September 26, 2023

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

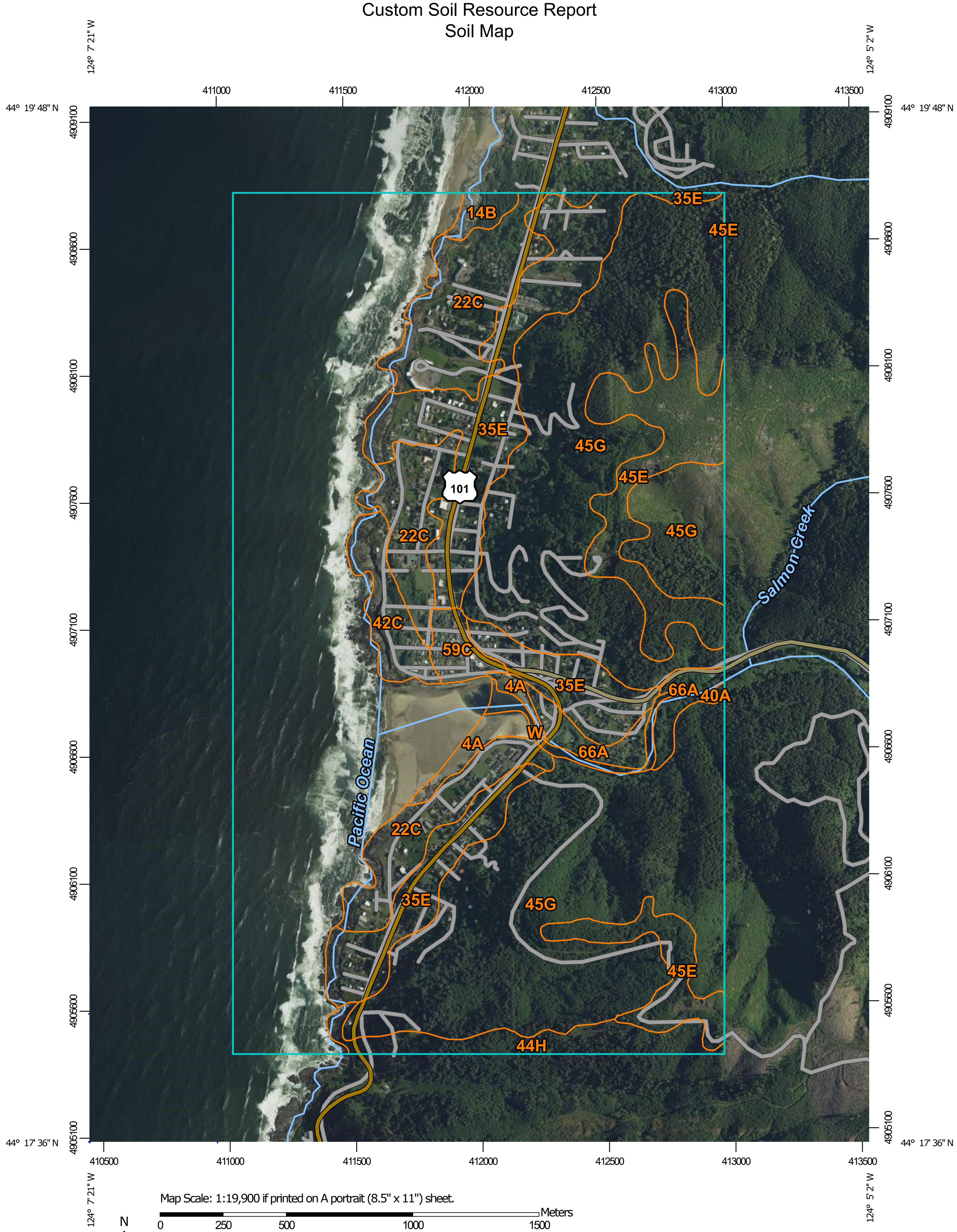
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:19,900 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 250, 500, 1000, 1500

Feet: 0, 500, 1000, 2000, 3000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lincoln County Area, Oregon
Survey Area Data: Version 20, Sep 14, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 23, 2020—May 28, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
4A	Beaches, 1 to 3 percent slopes	13.9	0.9%
14B	Depoe loam, 0 to 7 percent slopes	7.8	0.5%
22C	Gleneden silty clay loam, 2 to 12 percent slopes	142.8	8.7%
35E	Lint silt loam, 5 to 25 percent slopes	184.0	11.3%
40A	Nehalem silt loam, 0 to 3 percent slopes	1.0	0.1%
42C	Nelscott loam, 3 to 12 percent slopes	26.6	1.6%
44H	Neskowin-Rock outcrop complex, 20 to 99 percent slopes	34.8	2.1%
45E	Neskowin-Salander silt loams, 5 to 35 percent slopes	103.8	6.4%
45G	Neskowin-Salander silt loams, 35 to 65 percent slopes	559.2	34.2%
59C	Urban land-Nelscott complex, 0 to 12 percent slopes	13.0	0.8%
66A	Yachats very fine sandy loam, 0 to 3 percent slopes	25.7	1.6%
W	Water	8.8	0.5%
Totals for Area of Interest		**1,634.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Lincoln County Area, Oregon

4A—Beaches, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 25bl
Elevation: 0 to 10 feet
Mean annual precipitation: 60 to 80 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 180 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Beaches: 75 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Beaches

Setting

Landform: Beaches

Typical profile

H1 - 0 to 60 inches: stratified sand to gravel

Properties and qualities

Slope: 1 to 3 percent
Depth to water table: About 0 to 72 inches
Frequency of flooding: Very frequent

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: Yes

Minor Components

Beaches, gravelly

Percent of map unit: 15 percent
Landform: Beaches
Hydric soil rating: Yes

Beaches, bedrock substratum

Percent of map unit: 5 percent
Landform: Beaches
Hydric soil rating: Yes

14B—Depoe loam, 0 to 7 percent slopes

Map Unit Setting

National map unit symbol: 2575

Elevation: 50 to 300 feet
Mean annual precipitation: 60 to 90 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 180 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Depoe and similar soils: 80 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Depoe

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Stratified marine deposits derived from mixed sources

Typical profile

Oi - 0 to 3 inches: slightly decomposed plant material
H1 - 3 to 7 inches: loam
H2 - 7 to 19 inches: loam
H3 - 19 to 52 inches: cemented material
H4 - 52 to 60 inches: fine sand

Properties and qualities

Slope: 0 to 7 percent
Depth to restrictive feature: 12 to 20 inches to ortstein
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: D
Ecological site: F004AB407OR - Coastal Headland
Hydric soil rating: Yes

Minor Components

Depoe, loamy substratum

Percent of map unit: 2 percent
Landform: Marine terraces
Hydric soil rating: Yes

22C—Gleneden silty clay loam, 2 to 12 percent slopes

Map Unit Setting

National map unit symbol: 257t
Elevation: 40 to 300 feet
Mean annual precipitation: 60 to 90 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 180 to 300 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Gleneden and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gleneden

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from mixed sources

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
H1 - 1 to 12 inches: silty clay loam
H2 - 12 to 26 inches: silty clay
H3 - 26 to 61 inches: clay

Properties and qualities

Slope: 2 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: F004AB407OR - Coastal Headland
Forage suitability group: Somewhat Poorly Drained (G004AY017OR)
Other vegetative classification: Somewhat Poorly Drained (G004AY017OR)
Hydric soil rating: No

Minor Components

Depoe

Percent of map unit: 3 percent
Landform: Marine terraces
Hydric soil rating: Yes

35E—Lint silt loam, 5 to 25 percent slopes

Map Unit Setting

National map unit symbol: 2595
Elevation: 50 to 450 feet
Mean annual precipitation: 60 to 90 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 180 to 300 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Lint and similar soils: 80 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lint

Setting

Landform: Marine terraces
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Silty alluvial and eolian deposits derived from mixed sources

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
Oe - 2 to 5 inches: moderately decomposed plant material
H1 - 5 to 24 inches: silt loam
H2 - 24 to 65 inches: silt loam

Properties and qualities

Slope: 5 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very high (about 22.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: F004AB405OR - Coastal Salt Spray Forest
Forage suitability group: Well Drained >15% Slopes (G004AY013OR)
Other vegetative classification: Well Drained >15% Slopes (G004AY013OR)
Hydric soil rating: No

Minor Components

Depoe

Percent of map unit: 2 percent
Landform: Marine terraces
Hydric soil rating: Yes

40A—Nehalem silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 259m
Elevation: 10 to 700 feet
Mean annual precipitation: 60 to 100 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 160 to 265 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Nehalem and similar soils: 80 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nehalem

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium derived from mixed sources

Typical profile

H1 - 0 to 18 inches: silt loam
H2 - 18 to 51 inches: silt loam
H3 - 51 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 36 to 72 inches
Frequency of flooding: OccasionalNone

Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): 2w
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B
Ecological site: F004AB006OR - Udic Flood Plain Forest
Forage suitability group: Well Drained <15% Slopes (G004AY014OR)
Other vegetative classification: Well Drained <15% Slopes (G004AY014OR)
Hydric soil rating: No

Minor Components

Brenner

Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

42C—Nelscott loam, 3 to 12 percent slopes

Map Unit Setting

National map unit symbol: 259v
Elevation: 50 to 300 feet
Mean annual precipitation: 60 to 90 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 180 to 300 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Nelscott and similar soils: 85 percent
Minor components: 4 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nelscott

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy eolian deposits over stratified marine deposits derived from mixed sources

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
H1 - 1 to 16 inches: loam
H2 - 16 to 30 inches: silty clay loam
H3 - 30 to 37 inches: loamy fine sand
H4 - 37 to 49 inches: cemented material
H5 - 49 to 60 inches: stratified fine sand to silt loam

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: 24 to 40 inches to ortstein
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 22 to 38 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F004AB405OR - Coastal Salt Spray Forest
Forage suitability group: Moderately Well Drained <15% Slopes (G004AY016OR)
Other vegetative classification: Moderately Well Drained <15% Slopes (G004AY016OR)
Hydric soil rating: No

Minor Components

Depoe

Percent of map unit: 4 percent
Landform: Marine terraces
Hydric soil rating: Yes

44H—Neskowin-Rock outcrop complex, 20 to 99 percent slopes

Map Unit Setting

National map unit symbol: 25b2
Elevation: 50 to 1,100 feet
Mean annual precipitation: 70 to 90 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 160 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Neskowin and similar soils: 60 percent
Rock outcrop: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Neskowin

Setting

Landform: Headlands
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Colluvium derived from volcanic rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
H1 - 1 to 20 inches: silt loam
H2 - 20 to 24 inches: silt loam
H3 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 20 to 80 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F004AB404WA - Coastal Upland Warm Forest
Hydric soil rating: No

Description of Rock Outcrop

Typical profile

R - 0 to 60 inches: unweathered bedrock

Properties and qualities

Slope: 20 to 99 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

45E—Neskowin-Salander silt loams, 5 to 35 percent slopes

Map Unit Setting

National map unit symbol: 25b3
Elevation: 50 to 1,100 feet
Mean annual precipitation: 70 to 100 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 160 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Neskowin and similar soils: 50 percent
Salander and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Neskowin

Setting

Landform: Headlands
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from volcanic rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
H1 - 1 to 20 inches: silt loam
H2 - 20 to 24 inches: silt loam
H3 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 5 to 35 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F004AB404WA - Coastal Upland Warm Forest
Hydric soil rating: No

Description of Salander

Setting

Landform: Headlands
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from volcanic rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
H1 - 2 to 30 inches: silt loam
H2 - 30 to 62 inches: silty clay loam

Properties and qualities

Slope: 5 to 35 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very high (about 22.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F004AB404WA - Coastal Upland Warm Forest
Hydric soil rating: No

45G—Neskowin-Salander silt loams, 35 to 65 percent slopes

Map Unit Setting

National map unit symbol: 25b4
Elevation: 50 to 1,100 feet
Mean annual precipitation: 70 to 100 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 160 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Neskowin and similar soils: 50 percent
Salander and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Neskowin

Setting

Landform: Headlands
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from volcanic rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
H1 - 1 to 20 inches: silt loam
H2 - 20 to 24 inches: silt loam
H3 - 24 to 28 inches: unweathered bedrock

Properties and qualities

Slope: 35 to 65 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: F004AB404WA - Coastal Upland Warm Forest
Hydric soil rating: No

Description of Salander

Setting

Landform: Headlands
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from volcanic rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
H1 - 2 to 30 inches: silt loam
H2 - 30 to 62 inches: silty clay loam

Properties and qualities

Slope: 35 to 65 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very high (about 22.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F004AB404WA - Coastal Upland Warm Forest
Hydric soil rating: No

59C—Urban land-Nelscott complex, 0 to 12 percent slopes

Map Unit Setting

National map unit symbol: 25cd

Elevation: 50 to 300 feet
Mean annual precipitation: 60 to 90 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 180 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 55 percent
Nelscott and similar soils: 30 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Nelscott

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy eolian deposits over stratified marine deposits derived from mixed sources

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
H1 - 1 to 16 inches: loam
H2 - 16 to 30 inches: silty clay loam
H3 - 30 to 37 inches: loamy fine sand
H4 - 37 to 49 inches: cemented material
H5 - 49 to 60 inches: stratified fine sand to silt loam

Properties and qualities

Slope: 0 to 12 percent
Depth to restrictive feature: 24 to 40 inches to ortstein
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 22 to 38 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F004AB405OR - Coastal Salt Spray Forest
Forage suitability group: Moderately Well Drained <15% Slopes (G004AY016OR)
Other vegetative classification: Moderately Well Drained <15% Slopes (G004AY016OR)
Hydric soil rating: No

Minor Components

Depoe

Percent of map unit: 5 percent
Landform: Marine terraces
Hydric soil rating: Yes

66A—Yachats very fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 25d4
Elevation: 10 to 200 feet
Mean annual precipitation: 80 to 100 inches
Mean annual air temperature: 49 to 52 degrees F
Frost-free period: 160 to 260 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Yachats and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Yachats

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

Ap - 0 to 9 inches: very fine sandy loam
A - 9 to 19 inches: loam
C1 - 19 to 39 inches: fine sandy loam
C2 - 39 to 54 inches: fine sandy loam
C3 - 54 to 60 inches: very fine sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: FrequentNone
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B
Ecological site: F004AB006OR - Udic Flood Plain Forest
Forage suitability group: Well Drained <15% Slopes (G004AY014OR)
Other vegetative classification: Sitka spruce/salmonberry-wet (903), Well Drained <15% Slopes (G004AY014OR)
Hydric soil rating: No

Minor Components

Brenner

Percent of map unit: 5 percent
Landform: Depressions on flood plains
Other vegetative classification: Poorly Drained (G004AY018OR)
Hydric soil rating: Yes

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

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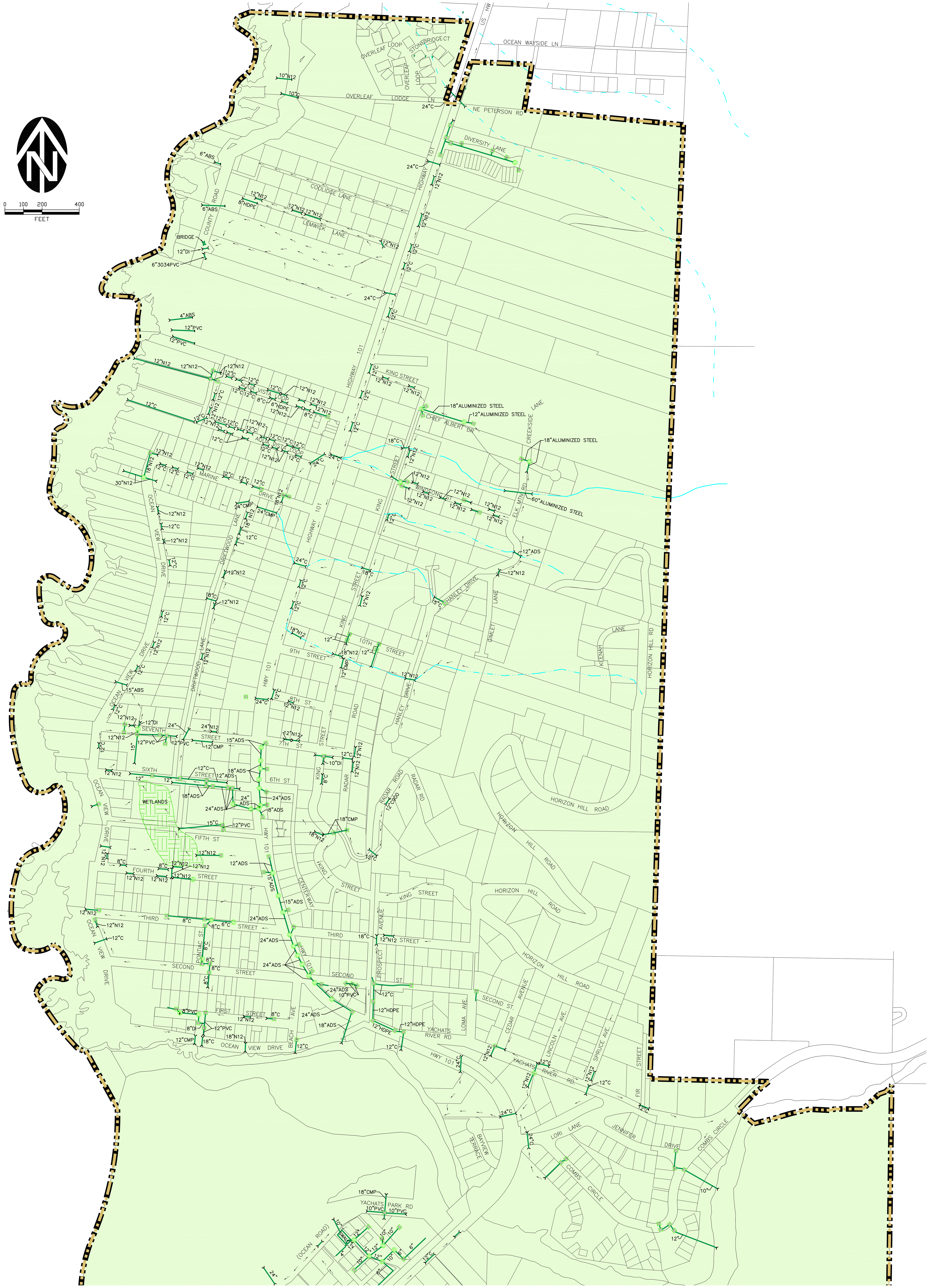
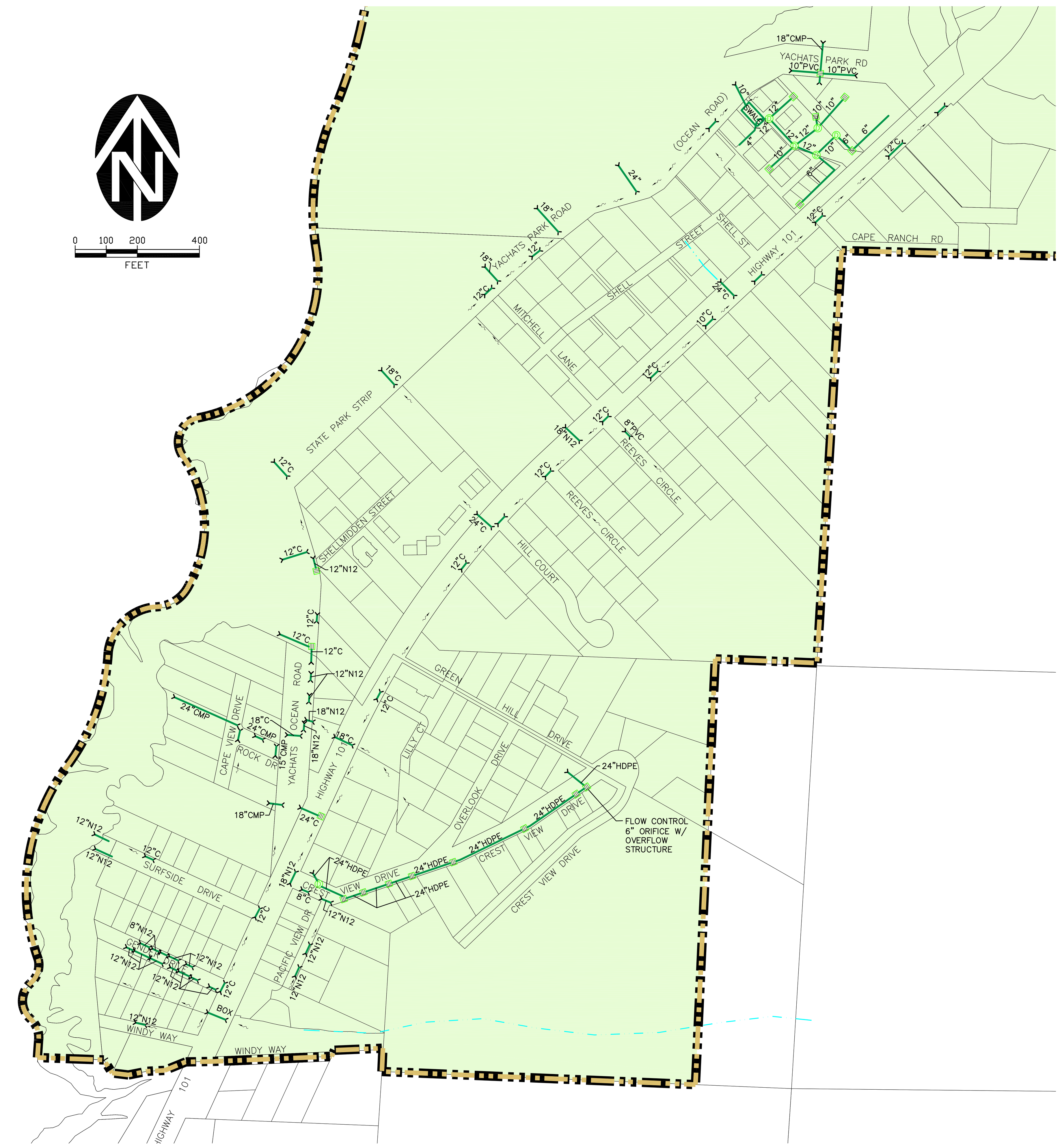
CITY OF YACHATS
Storm Drainage System Master Plan

Yachats Storm Drainage System Maps

Appendix B





LEGEND

- Urban Growth Boundary
- City Limits
- Existing Storm Drain Pipe
- Storm Drain Manhole
- Storm Drain Catch Basin
- Culvert Pipe End

NOTE:
THESE MAPS ARE SCHEMATIC UTILITY MAPS ONLY & DO NOT SHOW EXACT LOCATIONS OF UTILITIES. FIELD VERIFY ALL LOCATIONS PRIOR TO DESIGN OR CONSTUCTION.

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City of Yachats, Oregon

Overall Storm Drainage Map

APRIL 2024

Sub-Basin Summaries

Appendix C

Yachats Storm Drainage Master Plan
JO 3096.5010.0
April 2024

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8.0 inches

Basin 1

Sub-Basin 1A

Area	CN	Description
22.35	74	R-3
17.27	73	T-C
39.62	74	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
7	Sheet Flow	0.4	100	0.1
		Length	Slope	V-factor
15	Shallow Overland	1450	0.1	5
		Length	Velocity	
6	Length & Velocity	2250	6	
29	TOTAL (minutes)			

Basin 2

Sub-Basin 2A

Area	CN	Description
5.78	82	R-4
5.78	82	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
2	Shallow Overland	150	0.03	7
		Length	Velocity	
4	Length & Velocity	700	3	
12	TOTAL (minutes)			

Sub-Basin 2B

Area	CN	Description
14.25	79	R-3
14.25	79	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.4	100	0.15
		Length	Slope	V-factor
5	Shallow Overland	500	0.1	5
		Length	Velocity	
2	Length & Velocity	750	6	
13	TOTAL (minutes)			

Basin 3

Sub-Basin 3A

Area	CN	Description
4.53	84	R-2
4.53	84	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	100	0.02	16.1
		Length	Velocity	
3	Length & Velocity	950	6	
10	TOTAL (minutes)			

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8.0 inches

Area CN Description — Time of Concentration
Area CN Description — Time of Concentration

Basin 4

Sub-Basin 4A

Area	CN	Description
3.53	88	R-2
0.16	80	S-P
3.69	88	Sub-Basin Total

Time of Concentration

Minutes	Segment			
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	100	0.02	16.1
		Length	Velocity	
3	Length & Velocity	1000	6	
10	TOTAL (minutes)			

Basin 5

Sub-Basin 5A

Area	CN	Description
0.77	92	C-1
0.65	90	R-2
2.96	82	S-P
2.84	92	R-4
7.22	88	Sub-Basin Total

Time of Concentration

Minutes	Segment			
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	215	0.05	16.1
		Length	Velocity	
3	Length & Velocity	1000	5	
11	TOTAL (minutes)			

Sub-Basin 5B

Area	CN	Description
2.69	70	R-1
4.78	70	R-3
7.47	70	Sub-Basin Total

Time of Concentration

Minutes	Segment			
		'n'	Length	Slope
2	Sheet Flow	0.15	100	0.2
		Length	Slope	V-factor
7	Shallow Overland	1000	0.2	5.0
		Length	Velocity	
1	Length & Velocity	400	10.0	
11	TOTAL (minutes)			

Sub-Basin 5C

Area	CN	Description
12.9	74	R-1
1.67	74	R-3
14.57	74	Sub-Basin Total

Time of Concentration

Minutes	Segment			
		'n'	Length	Slope
2	Sheet Flow	0.15	100	0.2
		Length	Slope	V-factor
6	Shallow Overland	800	0.2	5.0
		Length	Velocity	
1	Length & Velocity	700	9	
10	TOTAL (minutes)			

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8.0 inches

Area CN Description — Time of Concentration

Area CN Description — Time of Concentration

Basin 6

Sub-Basin 6A

Area	CN	Description
11.37	73	R-4
11.37	73	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
2	Shallow Overland	200	0.05	7.0
		Length	Velocity	
3	Length & Velocity	950	5	
11	TOTAL (minutes)			

Basin 7

Sub-Basin 7A

Area	CN	Description
3.13	80	R-2
0.94	92	C-1
4.07	83	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	150	0.05	16.1
		Length	Velocity	
2	Length & Velocity	720	5	
9	TOTAL (minutes)			

Basin 8

Sub-Basin 8A

Area	CN	Description
3.92	80	R-2
0.527	92	C-1
4.447	81	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	150	0.05	16.1
		Length	Velocity	
2	Length & Velocity	600	5	
9	TOTAL (minutes)			

Yachats Storm Drainage Master Plan
JO 3096.5010.0
April 2024

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8 inches

Basin 9

Sub-Basin 9A

Area	CN	Description
7.05	70	R-1
3.5	70	C-1
10.55	70	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	**Slope**	**V-factor**
1	Shallow Overland	225	0.03	16.1
		Length	**Velocity**	
4	Length & Velocity	900	4	
11	TOTAL (minutes)			

Sub-Basin 9B

Area	CN	Description
4.81	74	R-1
4.81	74	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	**Slope**	**V-factor**
1	Shallow Overland	200	0.1	16.1
		Length	**Velocity**	
2	Length & Velocity	1000	10	
9	TOTAL (minutes)			

Sub-Basin 9C

Area	CN	Description
12.9	75	R-1
16.15	73	T-C
29.05	74	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05
		Length	**Slope**	**V-factor**
11	Shallow Overland	1050	0.1	5.0
		Length	**Velocity**	
1	Length & Velocity	750	10	
17	TOTAL (minutes)			

Sub-Basin 9D

Area	CN	Description
11.31	75	R-1
7.2	80	R-3
18.51	77	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	**Slope**	**V-factor**
5	Shallow Overland	450	0.1	5.0
		Length	**Velocity**	
1	Length & Velocity	700	10	
12	TOTAL (minutes)			

Yachats Storm Drainage Master Plan
JO 3096.5010.0
April 2024

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8 inches

Area CN Description — Time of Concentration

Area CN Description — Time of Concentration

Sub-Basin 9E

Area	CN	Description
6.67	61	R-1
0.53	73	T-C
7.2	62	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05
		Length	Slope	V-factor
3	Shallow Overland	300	0.1	5.0
		Length	Velocity	
1	Length & Velocity	750	10	
9	TOTAL (minutes)			

Sub-Basin 9F

Area	CN	Description
26.9	75	R-1
1.08	73	T-C
27.98	72	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
5	Shallow Overland	500	0.1	5.0
		Length	Velocity	
3	Length & Velocity	1500	10	
14	TOTAL (minutes)			

Sub-Basin 9G

Area	CN	Description
8.7	75	R-1
0.91	92	C-1
9.61	77	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
6	Shallow Overland	930	0.03	16.1
		Length	Velocity	
2	Length & Velocity	500	4	
14	TOTAL (minutes)			

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BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall: 8 inches

Basin 10

Sub-Basin 10A

Area	CN	Description
3.61	75	R-1
0.86	83	R-2
1.5	80	PF
5.97	77	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	200	0.04	16.1
		Length	Velocity	
2	Length & Velocity	500	4	
9	TOTAL (minutes)			

Sub-Basin 10B

Area	CN	Description
3.81	77	R-1
1.52	80	R-2
1.53	75	R-3
2.72	88	C-1
9.58	80	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	550	0.1	20.3
		Length	Velocity	
2	Length & Velocity	700	7	
9	TOTAL (minutes)			

Sub-Basin 10C

Area	CN	Description
1.21	85	R-2
6.87	80	PF
3.06	93	C-1
11.14	84	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
12	Sheet Flow	0.25	100	0.01
		Length	Slope	V-factor
7	Shallow Overland	400	0.02	7.0
		Length	Velocity	
4	Length & Velocity	650	3	
23	TOTAL (minutes)			

Sub-Basin 10D

Area	CN	Description
8.02	75	R-1
0.67	82	PF
1.07	92	C-1
9.76	77	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
9	Shallow Overland	950	0.12	5.0
		Length	Velocity	
1	Length & Velocity	550	8	
16	TOTAL (minutes)			

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall: 8 inches

Sub-Basin 10E

Area	CN	Description
5.8	75	R-1
0.72	80	R-3
1.25	92	C-1
7.77	78	Sub-Basin Total

Time of Concentration

Minutes	Flow Type	Parameter 1	Parameter 2	Parameter 3
		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
9	Shallow Overland	950	0.12	5.0
		Length	Velocity	
1	Length & Velocity	550	8	
16	TOTAL (minutes)			

Basin 11

Sub-Basin 11A

Area	CN	Description
2.99	83	R-3
1.39	94	C-1
0.17	84	PF
4.55	86	Sub-Basin Total

Time of Concentration

Minutes	Flow Type	Parameter 1	Parameter 2	Parameter 3
		'n'	Length	Slope
8	Sheet Flow	0.15	100	0.01
		Length	Slope	V-factor
2	Shallow Overland	275	0.02	20.3
		Length	Velocity	
1	Length & Velocity	250	3	
11	TOTAL (minutes)			

Sub-Basin 11B

Area	CN	Description
4.34	94	C-1
2.9	82	R-3
0.51	81	PF
7.75	89	Sub-Basin Total

Time of Concentration

Minutes	Flow Type	Parameter 1	Parameter 2	Parameter 3
		'n'	Length	Slope
1	Sheet Flow	0.016	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	300	0.05	20.3
		Length	Velocity	
3	Length & Velocity	500	3	
5	TOTAL (minutes)			

Basin 12

Sub-Basin 12A

Area	CN	Description
0.14	84	PF
1.96	81	R-1
3.94	93	C-1
6.04	89	Sub-Basin Total

Time of Concentration

Minutes	Flow Type	Parameter 1	Parameter 2	Parameter 3
		'n'	Length	Slope
1	Sheet Flow	0.016	100	0.05
		Length	Slope	V-factor
1	Shallow Overland	300	0.2	20.3
		Length	Velocity	
1	Length & Velocity	600	8	
3	TOTAL (minutes)			

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8 inches

Sub-Basin 12B

Area	CN	Description
1.51	83	R-1
2.26	93	C-1
3.77	89	Sub-Basin Total

Time of Concentration

Minutes	Segment			
		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05
		Length	Slope	V-factor
1	Shallow Overland	600	0.2	20.3
		Length	Velocity	
1	Length & Velocity	400	8	
6	TOTAL (minutes)			

Basin 13

Sub-Basin 13A

Area	CN	Description
5.57	77	R-1
0.75	92	C-1
6.32	79	Sub-Basin Total

Time of Concentration

Minutes	Segment			
		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
4	Shallow Overland	400	0.12	5.0
		Length	Velocity	
1	Length & Velocity	550	8	
10	TOTAL (minutes)			

Sub-Basin 13B

Area	CN	Description
0.23	84	PF
9.56	81	R-1
9.79	81	Sub-Basin Total

Time of Concentration

Minutes	Segment			
		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
8	Shallow Overland	750	0.11	5.0
		Length	Velocity	
1	Length & Velocity	350	7	
14	TOTAL (minutes)			

Basin 14

Sub-Basin 14A

Area	CN	Description
18.56	75	R-1
18.56	75	Sub-Basin Total

Time of Concentration

Minutes	Segment			
		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05
		Length	Slope	V-factor
9	Shallow Overland	1000	0.15	5.0
		Length	Velocity	
1	Length & Velocity	400	8	
14	TOTAL (minutes)			

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BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall: 8 inches

Basin 15

Sub-Basin 15A

Area	CN	Description
23.6	80	R-1
7.14	73	T-C
30.74	78	Sub-Basin Total

Time of Concentration

Minutes	Type	'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05

Minutes	Type	Length	Slope	V-factor
15	Shallow Overland	1600	0.12	5.0

Minutes	Type	Length	Velocity
1	Length & Velocity	500	8

Minutes	Type
21	TOTAL (minutes)

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8 inches

Basin 21

Sub-Basin 21A
PRIVATE

Area	CN	Description
3.54	85	R-4
0.85	75	R-1
4.39	83	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
8	Sheet Flow	0.15	100	0.01
		Length	Slope	V-factor
1	Shallow Overland	250	0.08	16.1
		Length	Velocity	
1	Length & Velocity	200	6	
10	TOTAL (minutes)			

Basin 22

Sub-Basin 22A

Area	CN	Description
2.5	75	R-1
2.5	75	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
8	Sheet Flow	0.15	100	0.01
		Length	Slope	V-factor
1	Shallow Overland	215	0.08	16.1
		Length	Velocity	
3	Length & Velocity	950	6	
12	TOTAL (minutes)			

Basin 23

Sub-Basin 23A

Area	CN	Description
3.43	70	R-1
3.43	70	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
8	Sheet Flow	0.15	100	0.01
		Length	Slope	V-factor
1	Shallow Overland	200	0.08	16.1
		Length	Velocity	
1	Length & Velocity	500	6	
10	TOTAL (minutes)			

Basin 24

Sub-Basin 24A

Area	CN	Description
2.94	75	R-1
1.8	85	R-4
4.74	79	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
1	Sheet Flow	0.016	100	0.01
		Length	Slope	V-factor
1	Shallow Overland	250	0.06	16.1
		Length	Velocity	
2	Length & Velocity	650	5	
5	TOTAL (minutes)			

Yachats Storm Drainage Master Plan
JO 3096.5010.0
April 2024

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8 inches

Sub-Basin 24B

Area	CN	Description
5.81	73	R-1
1.27	73	T-C
7.08	73	Sub-Basin Total

Area CN Description

Time of Concentration				
		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
8	Shallow Overland	750	0.1	5.0
		Length	Velocity	
3	Length & Velocity	1150	7	
16	TOTAL (minutes)			

Time of Concentration

Basin 25

Sub-Basin 25A

Area	CN	Description
6.27	72	R-4
6.27	72	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
1	Sheet Flow	0.016	100	0.01
		Length	Slope	V-factor
3	Shallow Overland	250	0.03	7.0
		Length	Velocity	
2	Length & Velocity	550	4	
7	TOTAL (minutes)			

Sub-Basin 25B

Area	CN	Description
5.48	74	R-1
8.22	84	R-2
3.5	73	T-C
17.2	79	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
2	Shallow Overland	200	0.12	5.0
		Length	Velocity	
3	Length & Velocity	1350	8	
10	TOTAL (minutes)			

Basin 26

Sub-Basin 26A

Area	CN	Description
0.45	86	S-P
5.19	90	R-4
5.64	90	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
1	Sheet Flow	0.016	100	0.01
		Length	Slope	V-factor
4	Shallow Overland	350	0.04	7.0
		Length	Velocity	
2	Length & Velocity	615	5	
8	TOTAL (minutes)			

BASIN CHARACTERISTICS - EXISTING CONDITIONS

50-yr 24 hr Rainfall 8 inches

Area CN Description

Time of Concentration

Area CN Description

Time of Concentration

Sub-Basin 26B

Area	CN	Description
5.39	78	R-1
3.15	86	R-2
5.08	73	T-C
13.62	78	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
4	Shallow Overland	450	0.12	5.0
		Length	Velocity	
4	Length & Velocity	1700	8	
14	TOTAL (minutes)			

Basin 27

Sub-Basin 27A

Area	CN	Description
8.45	78	R-1
8.45	78	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05
		Length	Slope	V-factor
3	Shallow Overland	300	0.12	5.0
		Length	Velocity	
1	Length & Velocity	550	8	
8	TOTAL (minutes)			

Sub-Basin 27B

Area	CN	Description
8.19	77	R-1
3.98	73	T-C
12.17	76	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05
		Length	Slope	V-factor
5	Shallow Overland	500	0.1	5.0
		Length	Velocity	
3	Length & Velocity	1300	7	
13	TOTAL (minutes)			

Basin 28

Sub-Basin 28A

Area	CN	Description
11.06	74	R-1
85.88	73	T-C
96.94	73	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
6	Shallow Overland	500	0.08	5.0
		Length	Velocity	
8	Length & Velocity	3000	6	
19	TOTAL (minutes)			

BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Basin 1

Sub-Basin 1A

Area	CN	Description
22.35	82	R-3
17.27	73	T-C
39.62	78	Sub-Basin Total

Time of Concentration

Minutes	Type	'n' / Length	Length / Slope / Velocity	Slope / V-factor
7	Sheet Flow	0.4	100	0.1
15	Shallow Overland	1450	0.1	5
6	Length & Velocity	2250	6	
29	TOTAL (minutes)			

Basin 2

Sub-Basin 2A

Area	CN	Description
5.78	91	R-4
5.78	91	Sub-Basin Total

Time of Concentration

Minutes	Type	'n' / Length	Length / Slope / Velocity	Slope / V-factor
6	Sheet Flow	0.15	100	0.02
2	Shallow Overland	150	0.03	7
4	Length & Velocity	700	3	
12	TOTAL (minutes)			

Sub-Basin 2B

Area	CN	Description
14.25	84	R-3
14.25	84	Sub-Basin Total

Time of Concentration

Minutes	Type	'n' / Length	Length / Slope / Velocity	Slope / V-factor
6	Sheet Flow	0.4	100	0.15
5	Shallow Overland	500	0.1	5
2	Length & Velocity	750	6	
13	TOTAL (minutes)			

Basin 3

Sub-Basin 3A

Area	CN	Description
4.53	84	R-2
4.53	84	Sub-Basin Total

Time of Concentration

Minutes	Type	'n' / Length	Length / Slope / Velocity	Slope / V-factor
6	Sheet Flow	0.15	100	0.02
1	Shallow Overland	100	0.02	16.1
3	Length & Velocity	950	6	
10	TOTAL (minutes)			

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BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall | 8 | inches

Area CN Description — Time of Concentration
Area CN Description — Time of Concentration

Basin 4

Sub-Basin 4A

Area	CN	Description
3.53	88	R-2
0.16	80	S-P
3.69	88	Sub-Basin Total

Time	Type			
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	100	0.02	16.1
		Length	Velocity	
3	Length & Velocity	1000	6	
10	TOTAL (minutes)			

Basin 5

Sub-Basin 5A

Area	CN	Description
0.77	92	C-1
0.65	90	R-2
2.96	82	S-P
2.84	92	R-4
7.22	88	Sub-Basin Total

Time	Type			
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	215	0.05	16.1
		Length	Velocity	
3	Length & Velocity	1000	5	
11	TOTAL (minutes)			

Sub-Basin 5B

Area	CN	Description
2.69	84	R-1
4.78	84	R-3
7.47	84	Sub-Basin Total

Time	Type			
		'n'	Length	Slope
2	Sheet Flow	0.15	100	0.2
		Length	Slope	V-factor
7	Shallow Overland	1000	0.2	5.0
		Length	Velocity	
1	Length & Velocity	400	10.0	
11	TOTAL (minutes)			

Sub-Basin 5C

Area	CN	Description
12.9	78	R-1
1.67	86	R-3
14.57	79	Sub-Basin Total

Time	Type			
		'n'	Length	Slope
2	Sheet Flow	0.15	100	0.2
		Length	Slope	V-factor
4	Shallow Overland	500	0.2	5.0
		Length	Velocity	
2	Length & Velocity	1000	9	
8	TOTAL (minutes)			

BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Area	CN	Description		Time of Concentration			

Area CN Description Time of Concentration

Basin 6

Sub-Basin 6A

Area	CN	Description
11.37	85	R-4
11.37	85	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
2	Shallow Overland	200	0.05	7.0
		Length	Velocity	
3	Length & Velocity	950	5	
11	TOTAL (minutes)			

Basin 7

Sub-Basin 7A

Area	CN	Description
3.13	80	R-2
0.94	92	C-1
4.07	83	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	150	0.05	16.1
		Length	Velocity	
2	Length & Velocity	720	5	
9	TOTAL (minutes)			

Basin 8

Sub-Basin 8A

Area	CN	Description
3.92	80	R-2
0.527	92	C-1
4.447	81	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	150	0.05	16.1
		Length	Velocity	
2	Length & Velocity	600	5	
9	TOTAL (minutes)			

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BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Basin 9

Sub-Basin 9A

Area	CN	Description
7.05	75	R-1
3.5	92	C-1
10.55	81	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02

		Length	Slope	V-factor
1	Shallow Overland	225	0.03	16.1

		Length	Velocity
4	Length & Velocity	900	4

11	TOTAL (minutes)

Sub-Basin 9B

Area	CN	Description
4.81	77	R-1
4.81	77	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02

		Length	Slope	V-factor
1	Shallow Overland	200	0.1	16.1

		Length	Velocity
2	Length & Velocity	1000	10

9	TOTAL (minutes)

Sub-Basin 9C

Area	CN	Description
12.9	81	R-1
16.15	73	T-C
29.05	77	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05

		Length	Slope	V-factor
11	Shallow Overland	1050	0.1	5.0

		Length	Velocity
1	Length & Velocity	750	10

17	TOTAL (minutes)

Sub-Basin 9D

Area	CN	Description
11.31	81	R-1
7.2	80	R-3
18.51	81	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02

		Length	Slope	V-factor
5	Shallow Overland	450	0.1	5.0

		Length	Velocity
1	Length & Velocity	700	10

12	TOTAL (minutes)

BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Area CN Description

Time of Concentration

Sub-Basin 9E

Area	CN	Description
6.67	84	R-1
0.53	73	T-C
7.2	83	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05
		Length	Slope	V-factor
2	Shallow Overland	200	0.1	5.0
		Length	Velocity	
1	Length & Velocity	850	10	
8	TOTAL (minutes)			

Sub-Basin 9F

Area	CN	Description
26.9	83	R-1
1.08	73	T-C
27.98	80	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
3	Shallow Overland	300	0.1	5.0
		Length	Velocity	
3	Length & Velocity	1700	10	
12	TOTAL (minutes)			

Sub-Basin 9G

Area	CN	Description
8.7	75	R-1
0.91	92	C-1
9.61	77	Sub-Basin Total

Time of Concentration				
		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
6	Shallow Overland	930	0.03	16.1
		Length	Velocity	
2	Length & Velocity	500	4	
14	TOTAL (minutes)			

BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Basin 10

Sub-Basin 10A

Area	CN	Description
3.61	75	R-1
0.86	83	R-2
1.5	80	PF
5.97	77	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	200	0.04	16.1
		Length	Velocity	
2	Length & Velocity	500	4	
9	TOTAL (minutes)			

Sub-Basin 10B

Area	CN	Description
3.81	77	R-1
1.52	80	R-2
1.53	80	R-3
2.72	92	C-1
9.58	82	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
6	Sheet Flow	0.15	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	550	0.1	20.3
		Length	Velocity	
2	Length & Velocity	700	7	
9	TOTAL (minutes)			

Sub-Basin 10C

Area	CN	Description
1.21	85	R-2
6.87	80	PF
3.06	93	C-1
11.14	84	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
12	Sheet Flow	0.25	100	0.01
		Length	Slope	V-factor
7	Shallow Overland	400	0.02	7.0
		Length	Velocity	
4	Length & Velocity	650	3	
23	TOTAL (minutes)			

Sub-Basin 10D

Area	CN	Description
8.02	81	R-1
0.67	82	PF
1.07	92	C-1
9.76	82	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
9	Shallow Overland	950	0.12	5.0
		Length	Velocity	
1	Length & Velocity	550	8	
16	TOTAL (minutes)			

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BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall: 8 inches

Sub-Basin 10E

Area	CN	Description
5.8	81	R-1
0.72	80	R-3
1.25	92	C-1
7.77	83	Sub-Basin Total

Time of Concentration

Minutes	Type			
		'n'	Length	Slope
5	Sheet Flow	0.15	100	0.03
		Length	Slope	V-factor
9	Shallow Overland	950	0.12	5.0
		Length	Velocity	
1	Length & Velocity	550	8	
16	TOTAL (minutes)			

Basin 11

Sub-Basin 11A

Area	CN	Description
2.99	83	R-3
1.39	94	C-1
0.17	84	PF
4.55	86	Sub-Basin Total

Time of Concentration

Minutes	Type			
		'n'	Length	Slope
8	Sheet Flow	0.15	100	0.01
		Length	Slope	V-factor
2	Shallow Overland	275	0.02	20.3
		Length	Velocity	
1	Length & Velocity	250	3	
11	TOTAL (minutes)			

Sub-Basin 11B

Area	CN	Description
4.34	94	C-1
2.9	82	R-3
0.51	81	PF
7.75	89	Sub-Basin Total

Time of Concentration

Minutes	Type			
		'n'	Length	Slope
1	Sheet Flow	0.016	100	0.02
		Length	Slope	V-factor
1	Shallow Overland	300	0.05	20.3
		Length	Velocity	
3	Length & Velocity	500	3	
5	TOTAL (minutes)			

Basin 12

Sub-Basin 12A

Area	CN	Description
0.14	84	PF
1.96	81	R-1
3.94	93	C-1
6.04	89	Sub-Basin Total

Time of Concentration

Minutes	Type			
		'n'	Length	Slope
1	Sheet Flow	0.016	100	0.05
		Length	Slope	V-factor
1	Shallow Overland	300	0.2	20.3
		Length	Velocity	
1	Length & Velocity	600	8	
3	TOTAL (minutes)			

BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Sub-Basin 12B

Area	CN	Description
1.51	83	R-1
2.26	93	C-1
3.77	89	Sub-Basin Total

Time of Concentration

Min	Type	'n' / Length	Length / Slope / Velocity	Slope / V-factor
4	Sheet Flow	0.15	100	0.05
1	Shallow Overland	600	0.2	20.3
1	Length & Velocity	400	8	
6	TOTAL (minutes)			

Basin 13

Sub-Basin 13A

Area	CN	Description
5.57	77	R-1
0.75	92	C-1
6.32	79	Sub-Basin Total

Time of Concentration

Min	Type	'n' / Length	Length / Slope / Velocity	Slope / V-factor
5	Sheet Flow	0.15	100	0.03
4	Shallow Overland	400	0.12	5.0
1	Length & Velocity	550	8	
10	TOTAL (minutes)			

Sub-Basin 13B

Area	CN	Description
0.23	84	PF
9.56	83	R-1
9.79	83	Sub-Basin Total

Time of Concentration

Min	Type	'n' / Length	Length / Slope / Velocity	Slope / V-factor
5	Sheet Flow	0.15	100	0.03
8	Shallow Overland	750	0.11	5.0
1	Length & Velocity	350	7	
14	TOTAL (minutes)			

Basin 14

Sub-Basin 14A

Area	CN	Description
18.56	81	R-1
18.56	81	Sub-Basin Total

Time of Concentration

Min	Type	'n' / Length	Length / Slope / Velocity	Slope / V-factor
4	Sheet Flow	0.15	100	0.05
7	Shallow Overland	800	0.15	5.0
1	Length & Velocity	600	8	
12	TOTAL (minutes)			

BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Basin 15

Sub-Basin 15A

Area	CN	Description
23.6	82	R-1
7.14	73	T-C
30.74	80	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
4	Sheet Flow	0.15	100	0.05
		Length	Slope	V-factor
10	Shallow Overland	1000	0.12	5.0
		Length	Velocity	
2	Length & Velocity	1000	8	
16	TOTAL (minutes)			

BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Basin 21

Sub-Basin 21A

PRIVATE

Area	CN	Description
3.54	85	R-4
0.85	75	R-1
4.39	83	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
8	Sheet Flow	0.15	100	0.01

		Length	Slope	V-factor
1	Shallow Overland	250	0.08	16.1

		Length	Velocity
1	Length & Velocity	200	6

10	TOTAL (minutes)

Basin 22

Sub-Basin 22A

Area	CN	Description
2.5	75	R-1
2.5	75	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
8	Sheet Flow	0.15	100	0.01

		Length	Slope	V-factor
1	Shallow Overland	215	0.08	16.1

		Length	Velocity
3	Length & Velocity	950	6

12	TOTAL (minutes)

Basin 23

Sub-Basin 23A

Area	CN	Description
3.43	75	R-1
3.43	75	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
8	Sheet Flow	0.15	100	0.01

		Length	Slope	V-factor
1	Shallow Overland	200	0.08	16.1

		Length	Velocity
1	Length & Velocity	500	6

10	TOTAL (minutes)

Basin 24

Sub-Basin 24A

Area	CN	Description
2.94	75	R-1
1.8	85	R-4
4.74	79	Sub-Basin Total

Time of Concentration

		'n'	Length	Slope
1	Sheet Flow	0.016	100	0.01

		Length	Slope	V-factor
1	Shallow Overland	250	0.06	16.1

		Length	Velocity
2	Length & Velocity	650	5

5	TOTAL (minutes)

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BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Area CN Description — Time of Concentration

Area CN Description — Time of Concentration

Sub-Basin 24B

Area	CN	Description
5.81	77	R-1
1.27	73	T-C
7.08	76	Sub-Basin Total

Time	Component	'n' / Length	Length / Slope / Velocity	Slope / V-factor
5	Sheet Flow	0.15	100	0.03
8	Shallow Overland	750	0.1	5.0
3	Length & Velocity	1150	7	
16	TOTAL (minutes)			

Basin 25

Sub-Basin 25A

Area	CN	Description
6.27	85	R-4
6.27	85	Sub-Basin Total

Time	Component	'n' / Length	Length / Slope / Velocity	Slope / V-factor
1	Sheet Flow	0.016	100	0.01
2	Shallow Overland	150	0.03	7.0
3	Length & Velocity	650	4	
6	TOTAL (minutes)			

Sub-Basin 25B

Area	CN	Description
5.48	78	R-1
8.22	84	R-2
3.5	73	T-C
17.2	80	Sub-Basin Total

Time	Component	'n' / Length	Length / Slope / Velocity	Slope / V-factor
5	Sheet Flow	0.15	100	0.03
2	Shallow Overland	200	0.12	5.0
3	Length & Velocity	1350	8	
10	TOTAL (minutes)			

Basin 26

Sub-Basin 26A

Area	CN	Description
0.45	86	S-P
5.19	90	R-4
5.64	90	Sub-Basin Total

Time	Component	'n' / Length	Length / Slope / Velocity	Slope / V-factor
1	Sheet Flow	0.016	100	0.01
4	Shallow Overland	350	0.04	7.0
2	Length & Velocity	615	5	
8	TOTAL (minutes)			

BASIN CHARACTERISTICS - FUTURE CONDITIONS

50-yr 24 hr Rainfall 8 inches

Sub-Basin 26B

Area	CN	Description
5.39	78	R-1
3.15	86	R-2
5.08	73	T-C
13.62	78	Sub-Basin Total

Time of Concentration

Minutes	Type	'n' / Length	Length / Slope	Slope / V-factor
6	Sheet Flow	0.15	100	0.02
4	Shallow Overland	450	0.12	5.0
4	Length & Velocity	1700	8	
14	TOTAL (minutes)			

Basin 27

Sub-Basin 27A

Area	CN	Description
8.45	81	R-1
8.45	81	Sub-Basin Total

Time of Concentration

Minutes	Type	'n' / Length	Length / Slope	Slope / V-factor
4	Sheet Flow	0.15	100	0.05
3	Shallow Overland	300	0.12	5.0
1	Length & Velocity	550	8	
8	TOTAL (minutes)			

Sub-Basin 27B

Area	CN	Description
8.19	83	R-1
3.98	73	T-C
12.17	80	Sub-Basin Total

Time of Concentration

Minutes	Type	'n' / Length	Length / Slope	Slope / V-factor
4	Sheet Flow	0.15	100	0.05
5	Shallow Overland	500	0.1	5.0
3	Length & Velocity	1300	7	
13	TOTAL (minutes)			

Basin 28

Sub-Basin 28A

Area	CN	Description
11.06	83	R-1
85.88	73	T-C
96.94	74	Sub-Basin Total

Time of Concentration

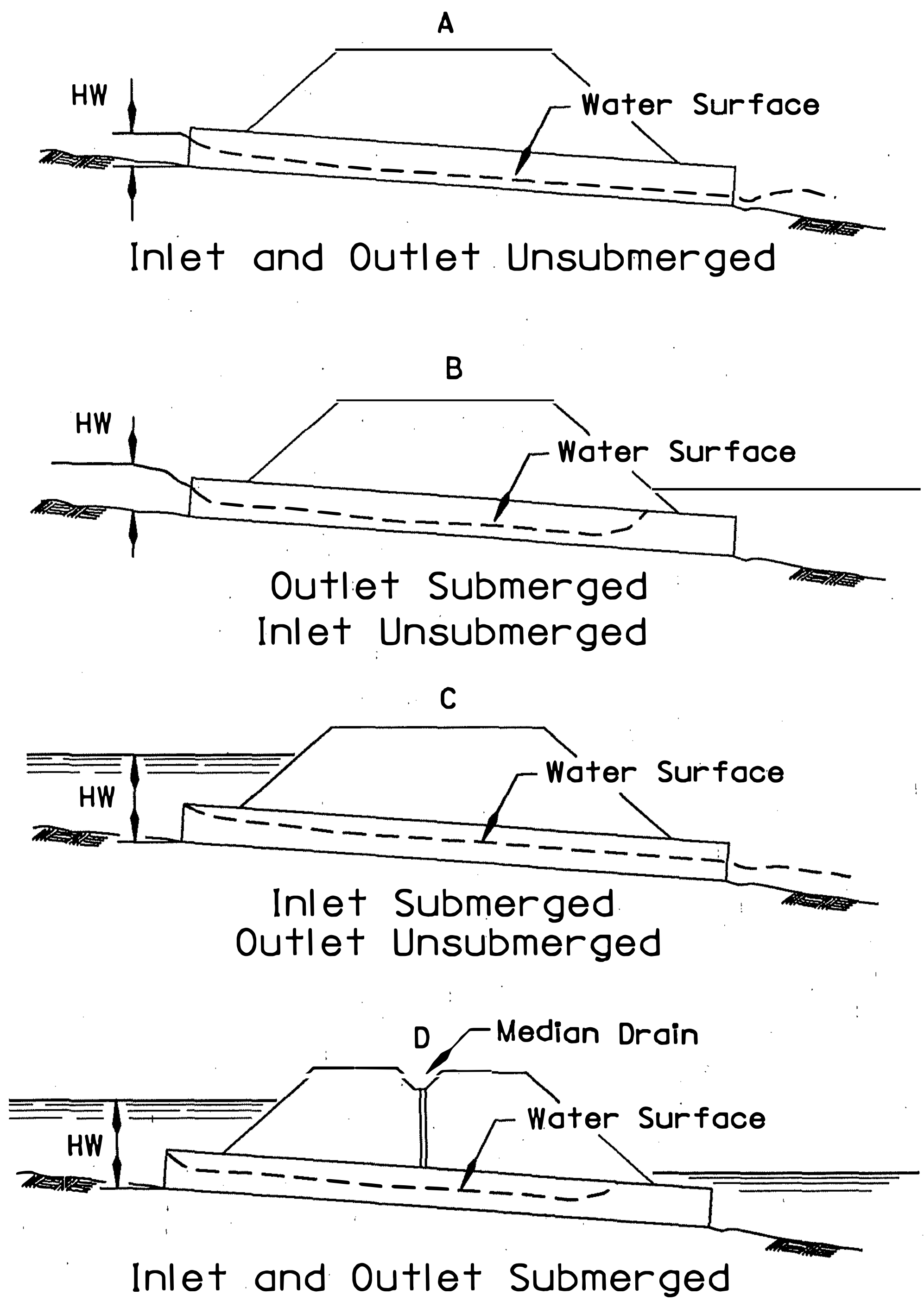
Minutes	Type	'n' / Length	Length / Slope	Slope / V-factor
5	Sheet Flow	0.15	100	0.03
6	Shallow Overland	500	0.08	5.0
8	Length & Velocity	3000	6	
19	TOTAL (minutes)			

CITY OF YACHATS
Storm Drainage System Master Plan

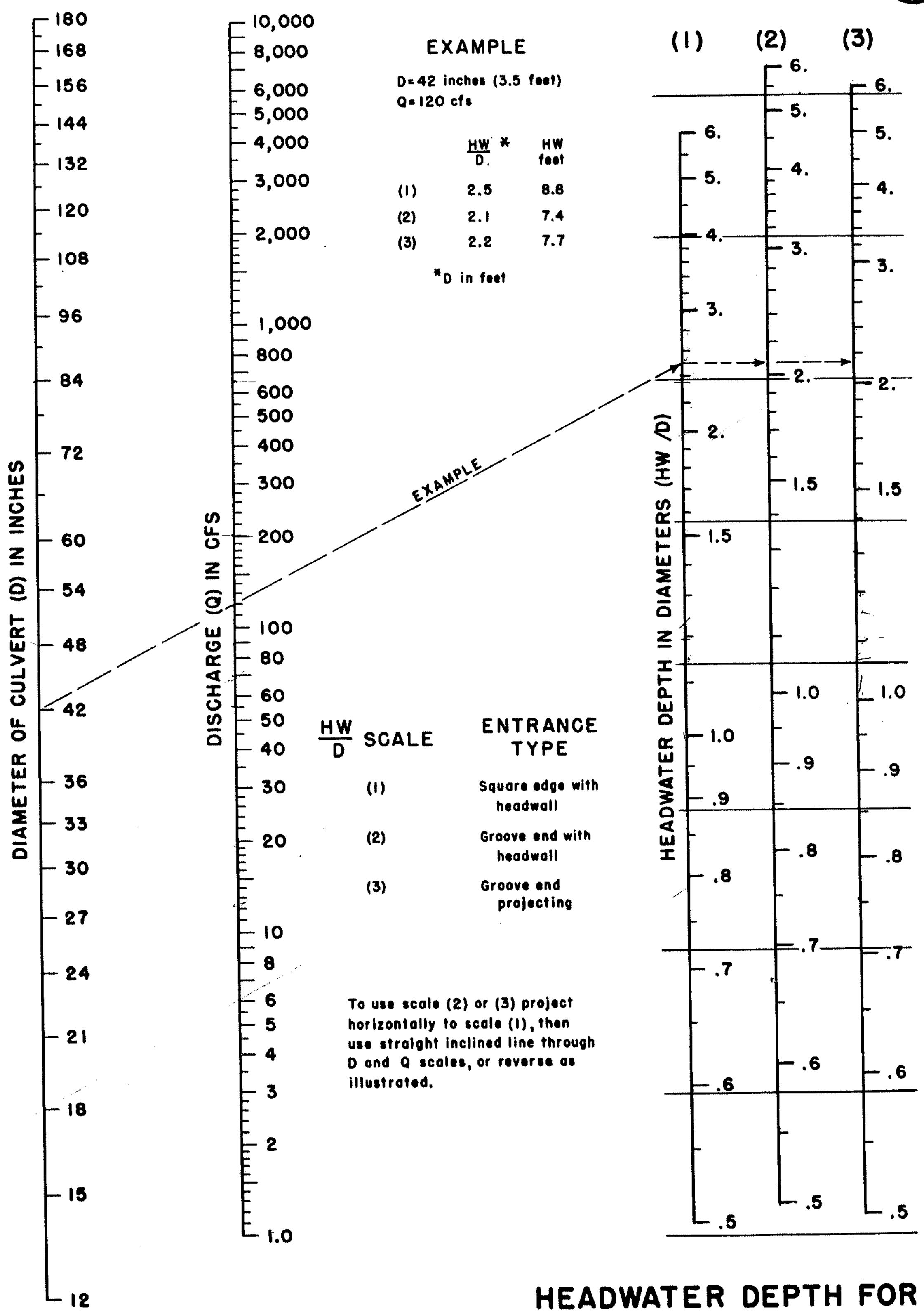
Sample Inlet Control and Outlet Control Nomographs

Appendix D

Figure 4.6



Types of Inlet Control

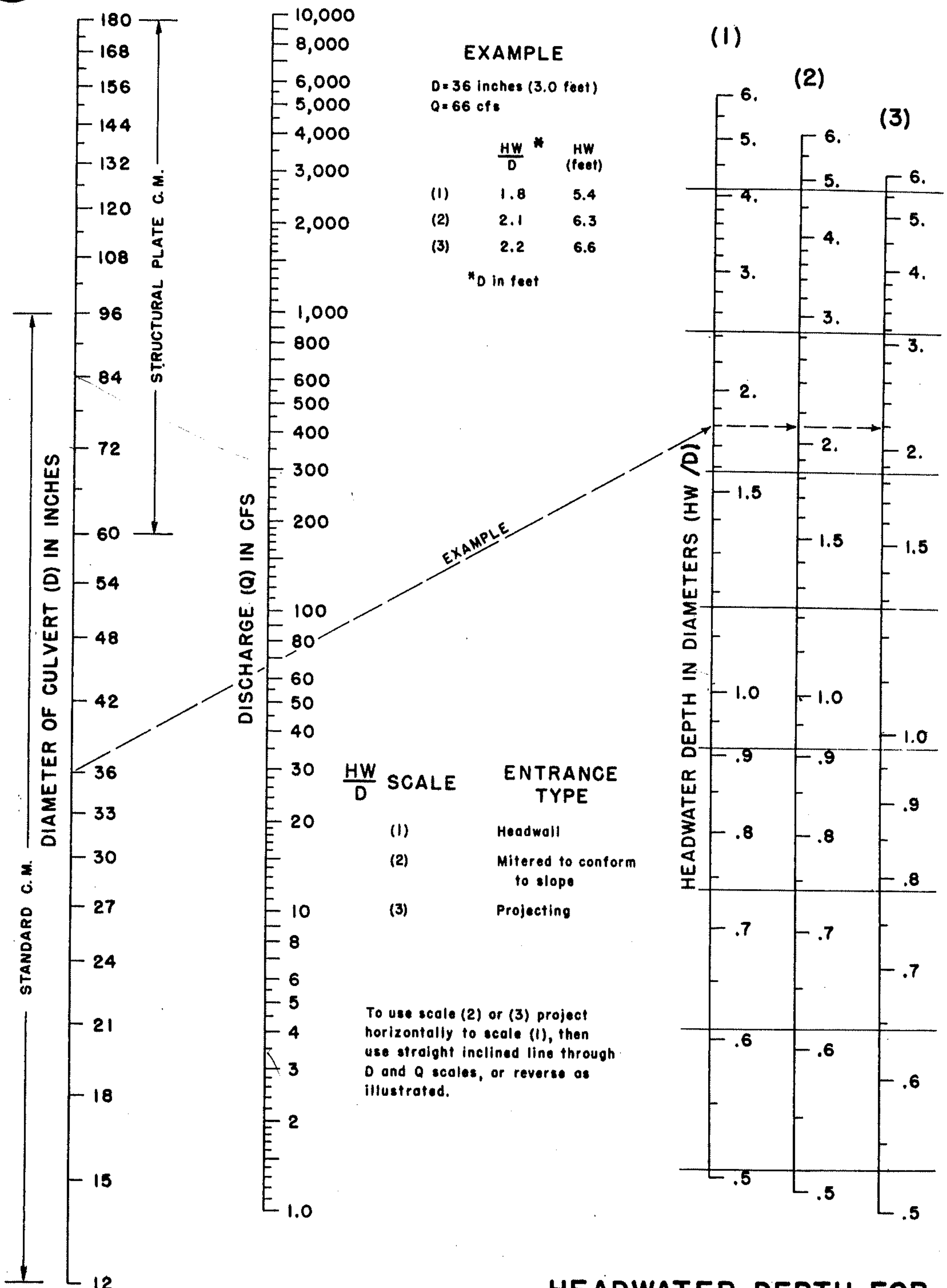


HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

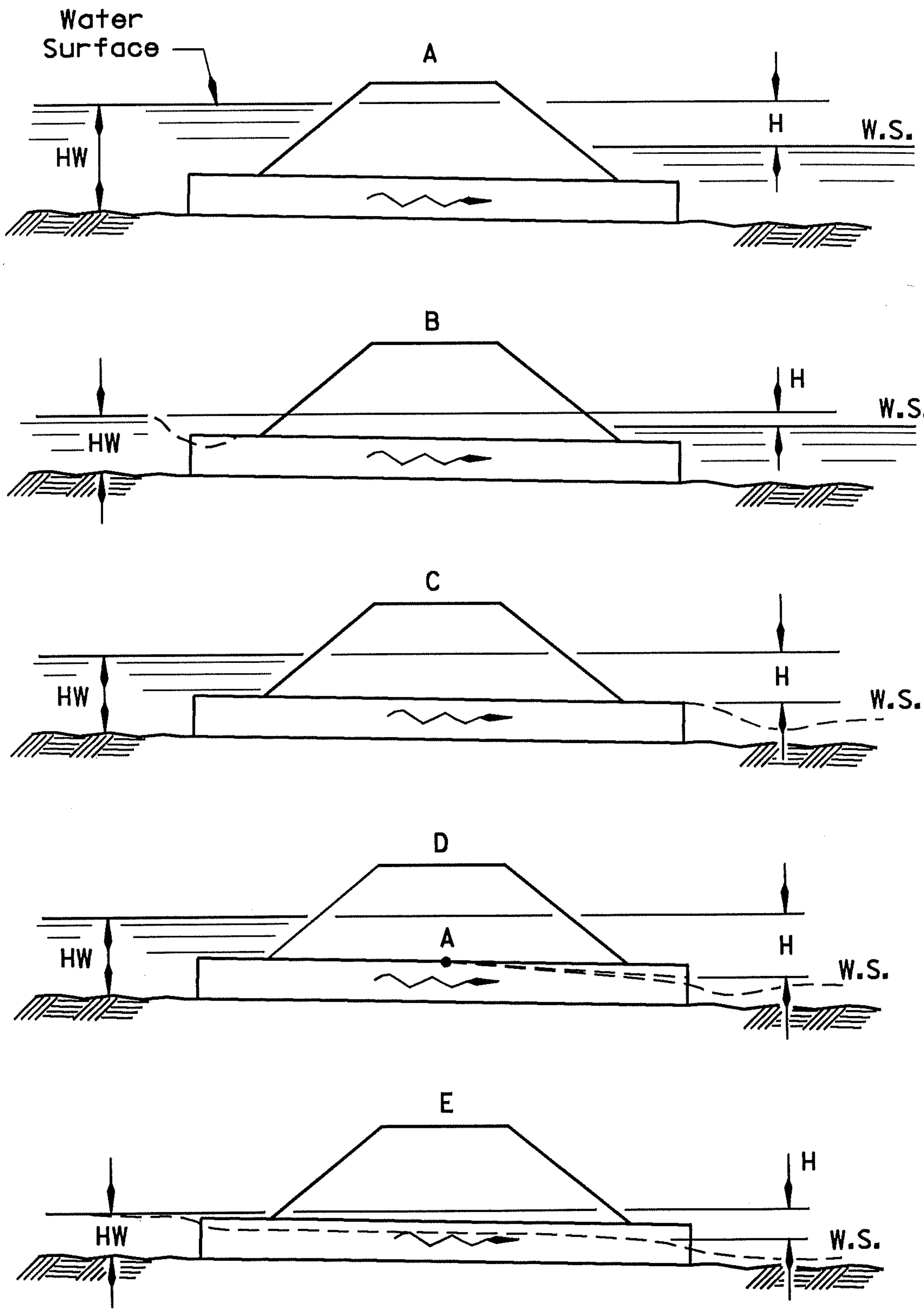
INLET CONTROL NOMOGRAPH 4.1.2



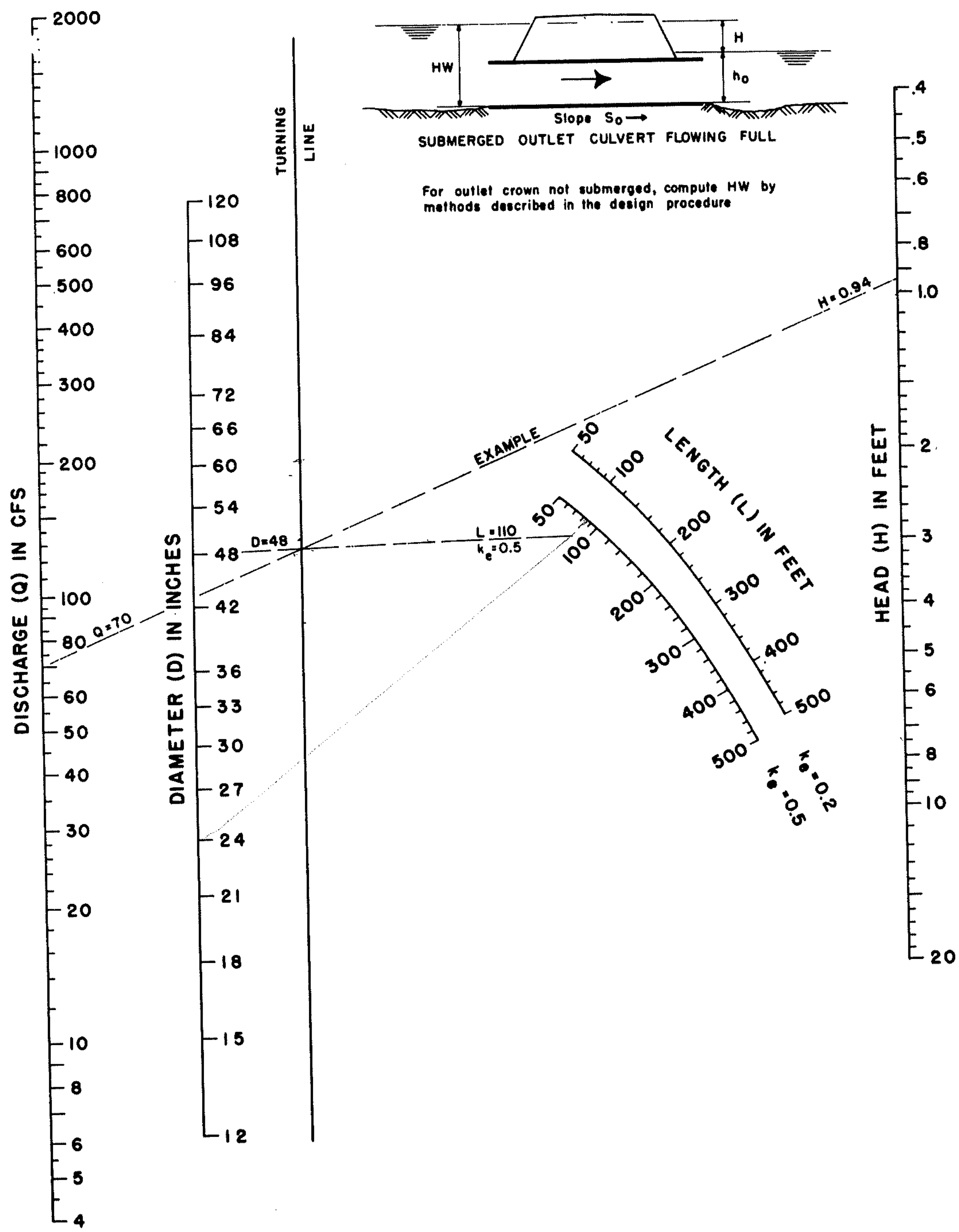
BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

Figure 4.7



Types of Outlet Control

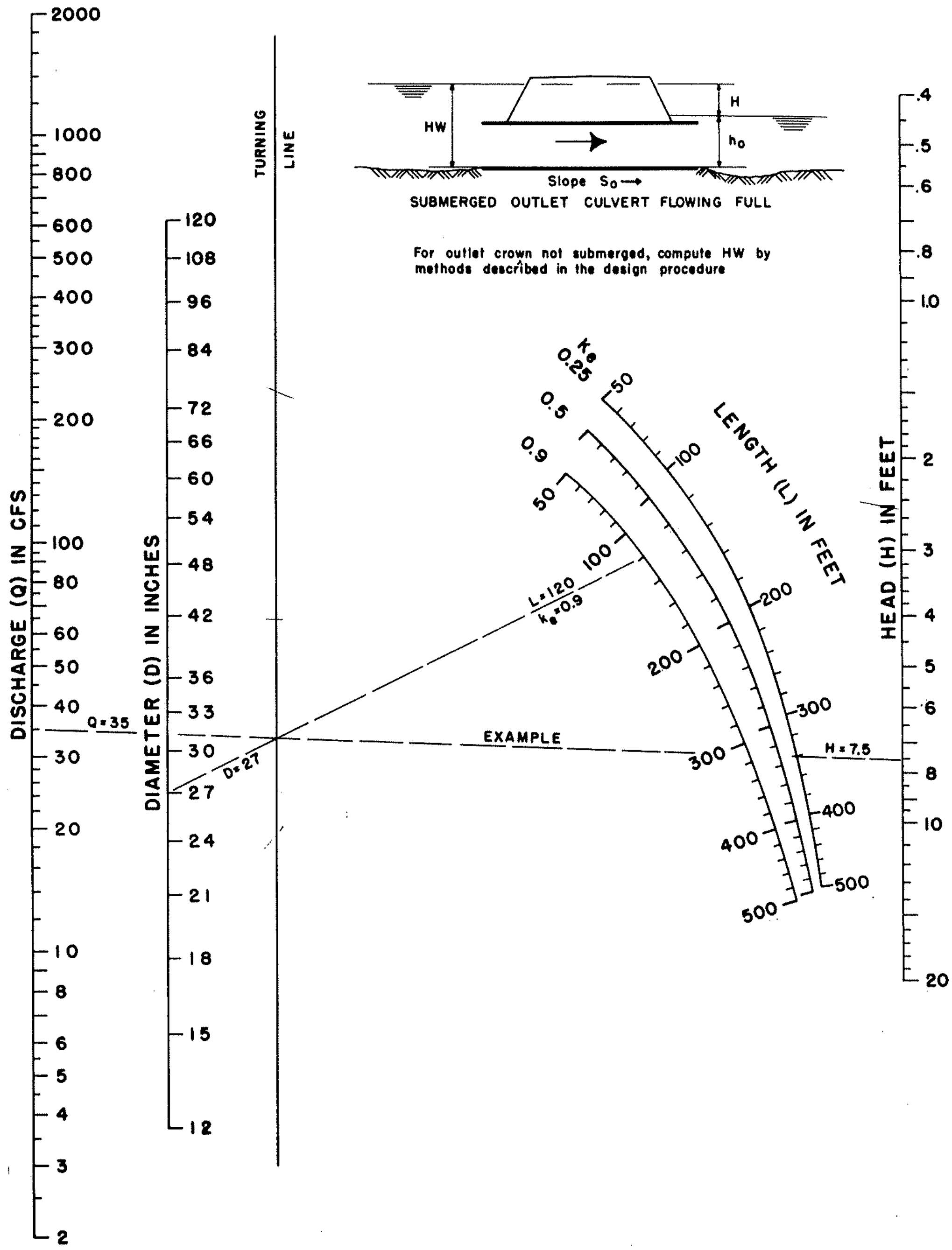


HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL

$n = 0.012$

BUREAU OF PUBLIC ROADS JAN. 1963

OUTLET CONTROL NOMOGRAPH 4.2.2



HEAD FOR STANDARD C. M. PIPE CULVERTS FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963