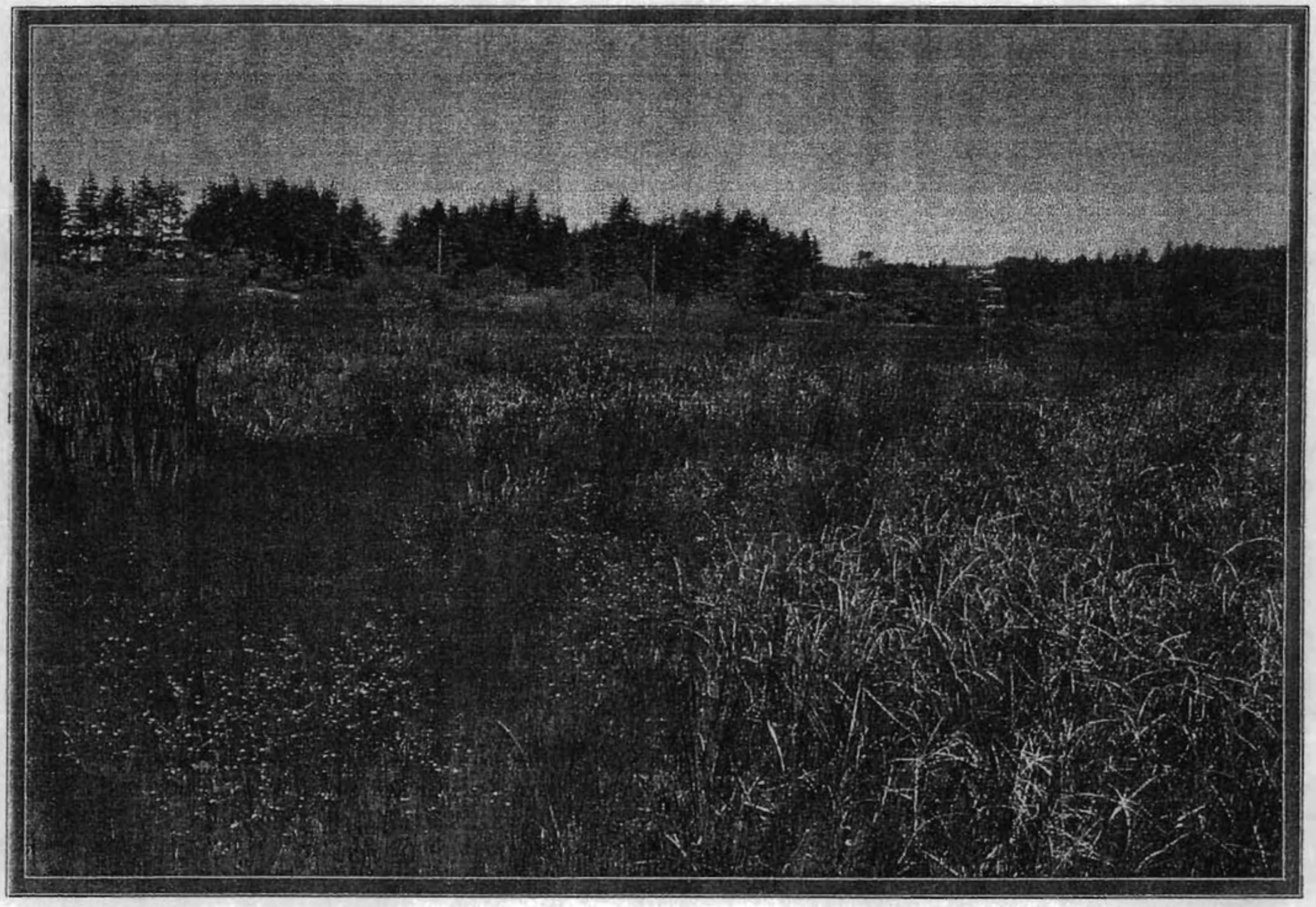
Lower Pony Creek Watershed Assessment and Potential Action Plan



Prepared for
Lower Pony Creek Watershed Committee
North Bend / Coos Bay, Oregon
September 2001

By the team of

Satre Associates, PC / HartCrowser / Earth Design Consultants, Inc.

Table of Contents

Table of Contents

Figures

Tables

Volume 2: Appendices

EXECUTIVE SUMMARY: Lower Pony Creek Watershed Assessment and Potential Action Plan

The Lower Pony Creek Watershed has been undergoing significant change in recent decades, as the area has transitioned from a forested coastal valley to urban and suburban in character. This transition has presented significant issues for the Cities of North Bend and Coos Bay and these issues are the focus of this project. Flooding in the Creek system has become an increasingly regular occurrence in specific areas. Water quality has deteriorated to the point that, in 1998, the Oregon Department of Water Quality listed Pony Creek and Pony Slough as being water quality limited for high bacterial counts. The Creek system supports or has supported salmon runs (now protected under the Endangered Species Act) and is designated Essential Salmonid Habitat by the Oregon Department of State Lands and the Oregon Department of Fish and Wildlife.

The purpose of this project is to assess watershed conditions in the lower Pony Creek and its tributaries, in the cities of Coos Bay and North Bend, Coos County, Oregon. The Study Area for the project is defined as Pony Creek from near Virginia Avenue, upstream approximately 3 miles to the Merritt Lake Dam above Ocean Boulevard. The Study Area encompasses approximately 1300 acres, a little more than 2 square miles.

The inventory phase of this project identifies what hydrology, water quality and riparian / wetland / aquatic habitat parameters exist in the watershed and how they have been altered over time. Land use and development of impervious surfaces have been a primary and significant factor in modifications to the watershed over time. At the present time, hydrology is driven by late season storm events and timed releases from the reservoirs located upstream of Ocean Boulevard. Infiltration of rain water into the ground has been significantly reduced. Riparian and wetland areas have been reduced in area and function by logging, filling and other land development activities. Streams have less dissolved oxygen available, are warmer (approaching temperatures lethal to salmon species) and provide less instream structure and complexity for aquatic life.

The assessment phase of this project has focused on how the existing hydrology, water quality and riparian / wetland / aquatic habitat parameters now function. Small streams are flashier and more erosive, due to the level of impervious surfacing. Specific analysis of localized flooding indicates that siltation, elevation of water levels and elevation of site developments are key factors. The analysis of the tidegate at Crowell Road indicates that it could be functioning better. The low gradient of Pony Creek provides little hydraulic energy to transport sediments or erode stream banks. Water quality does not exceed DEQ standards for bacteriological counts, other than following infrequent and episodic accidental events. Riparian areas have been reduced in numerous reaches, particularly low in the watershed. Water temperatures can be seasonally stressful for salmon species, approaching lethal temperatures in the lower reaches. Several of the higher stream reaches still provide fair riparian cover, cool water and moderate instream complexity. Approximately 70% of the wetlands present historically have been eliminated, particularly estuarine wetlands. The large wetland north of Newmark Avenue is a locally significant wetland feature, providing a range of ecological functions of importance to the overall system, including providing cover for juvenile salmonids.

A number of items have been identified to enhance, repair and restore ecological functions in this watershed. It is important to remember that this is, however, an urban watershed, with attendant constraints and opportunities that accompany that condition. Short term actions have been identified to alleviate localized flooding and begin to improve ecological functioning of hydrologic, water quality and riparian / wetland / aquatic habitat parameters. Long term actions for ecological improvement focus on planning, building code improvements, monitoring and informed landscape management.

Satre Associates, PC
132 East Broadway, Suite 536 *(541) 465-4721*
Eugene, Oregon 97401 *(541) 465-4722 fax*

Earth Design Consultants, Inc.
800 NW Starker Ave, Suite 31
Corvallis, Oregon 97330

Hart Crowser
Five Centerpointe Dr. Suite 240
Lake Oswego, Oregon 97035-8652

1. INTRODUCTION

1.1. Problem Statement and Project Goals

The Lower Pony Creek Watershed has been undergoing significant change in recent decades, as the area has transitioned from a forested coastal valley to urban and suburban in character. This transition has presented significant issues for the Cities of North Bend and Coos Bay and these issues are the focus of this project. Flooding in the Creek system has become an increasingly regular occurrence in specific areas. Water quality has deteriorated to the point that, in 1998, the Oregon Department of Water Quality listed Pony Creek and Pony Slough as being water quality limited for high bacterial counts. The Creek system supports or has supported salmon runs (now protected under the Endangered Species Act) and is designated Essential Salmonid Habitat by the Oregon Department of State Lands and the Oregon Department of Fish and Wildlife.

Citizens and agency staff have come together to better understand the current condition of the Lower Pony Creek, and to chart a course toward an ecologically healthier future for the watershed.

The purpose of this project is to assess watershed conditions in the lower Pony Creek and its tributaries, in the cities of Coos Bay and North Bend, Coos County, Oregon. The Study Area for the project is defined as Pony Creek from near Virginia Avenue, upstream approximately 3 miles to the Merritt Lake Dam above Ocean Boulevard. Three unnamed tributary streams to lower Pony Creek are also included in this project. The "AAA" tributary flows westerly into Pony Creek, running parallel on the south side of Ocean Boulevard in Coos Bay, and enters Pony Creek just below Merritt Lake Dam. The "K-Mart" tributary enters the Study Area just below the parking lot for the K-Mart store located on the south side of Ocean Boulevard, and flows easterly into Pony Creek north of Ocean Boulevard. The "Hospital" tributary arises above the Bay Area Hospital in Coos Bay, and flows northwesterly entering Pony Creek just upstream from Newmark Avenue in North Bend. The Study Area encompasses approximately 1300 acres, a little more than 2 square miles.

The goal for this project is a demonstration of the interrelationships among channel conditions, riparian vegetation, water quality, fish habitat and stream flows. It is hoped that the investigations will provide landowners and public agencies with the knowledge and specific recommendations on strategies that will help alleviate flooding problems while, at the same time, improve water quality and fish habitat.

1.2. The Watershed Committee

The Lower Pony Creek Watershed Committee (LPCWC) is comprised of a mixture of public agency personnel, local governmental representatives and private citizens, all of whom hold a stake in resolving the flooding, water quality and salmonid habitat issues. Members at the present include:

John H. Craig	Project Coordinator / Tech. Review Committee / US Army Corps of Engineers
Dr. Jon Souder	Fiscal Coordinator / Tech. Review Committee / Coos Watershed Association
Pam Blake	Tech. Review Committee / Oregon Department of Environmental Quality
Steve Plinski	Tech. Review Committee / Private Landowner Representative
Rob Schab	Member / Coos Bay – North Bend Water Board
Mike Gray	Member / Oregon Department of Fish and Wildlife
Mike Gaul	Member / Port of Coos Bay
Gary Combs	Member / City of North Bend
Anne Donnelly	Member / Coos Watershed Association

1.3. Consulting Team

Many professionals have contributed to the research, analysis and documentation for the Lower Pony Creek Watershed Assessment and Action Plan. The members of the Satre Associates, PC / HartCrowser / Earth Design Consultants, Inc. team (a.k.a. the Satre Team) include:

Staff	Firm	Assigned Project Responsibilities
Michael W. Shippey	Satre Associates, PC 132 East Broadway, Suite 536 Eugene, Or. 97401	Project Team Leader, Project Management, Field Inventory and Assessment Team Member, Document Production
Ralph Garono	Earth Design Consultants 800 NW Starker Ave, Suite 31 Corvallis, Or. 97330	Aquatic Ecosystem Ecologist, water quality modeling
D. Shane Cherry	HartCrowser, Inc.	Hydrologic Modeling and Channel Condition Assessment
Greta Murdoff	Satre Associates, PC	Riparian, Wetland & Biology Field Team Assistance, GIS operations, Documentation Production
Vincent Martorello	Satre Associates, P.C.	GIS Team Leader, Documentation Production
Chad Hoffman	Satre Associates, PC	Riparian, Wetland & Biology Field Team Assistance
Randall Johnson	HartCrowser, Inc.	Hydrologic Modeling Specialist

Please see Appendices for Project Team Qualifications.

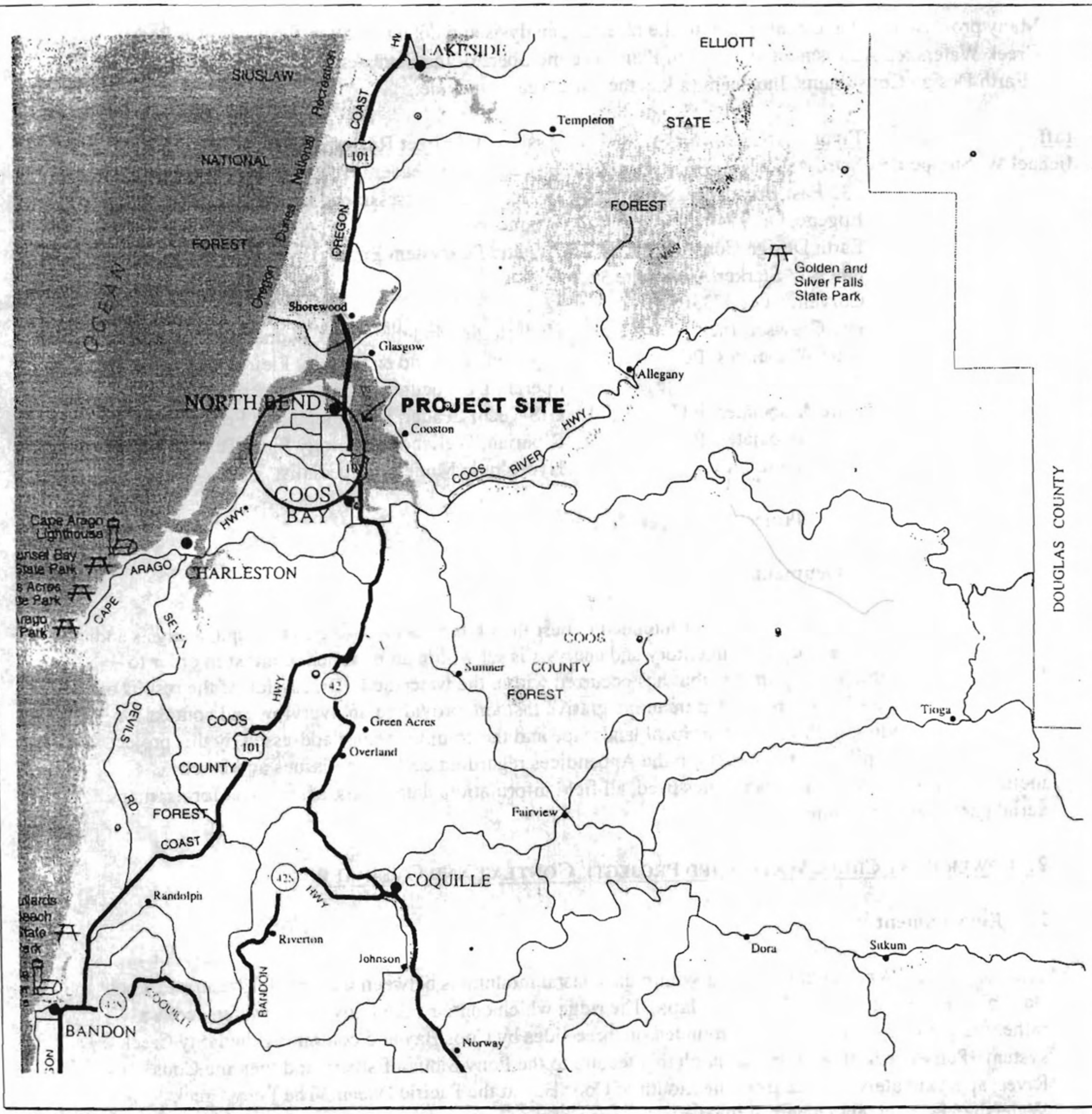
1.4. Layout of This Document

This document is organized in a manner intended to best facilitate understanding of the data, analysis and conclusions being presented. The inventory and analysis is set within an historical context in order to better understand the level of change that has occurred within the watershed. Discussion of the results of the inventory and analysis is presented in an integrative fashion, providing an overview and context for further understanding of this important local landscape and the complex issues addressed by this project. Information is compiled and presented in the Appendices regarding each of the issues addressed, including a discussion of methodologies used, all field information, data forms, assessment forms, maps, aerial photos and site photos.

2. Lower Pony Creek Watershed Project: Context and Overview

2.1. Environment

The Pony Creek Watershed is **located** within the coastal mountains between the Pacific Ocean and Coos Bay (please see Figure 1 for Vicinity Map). The ridge which contains the Pony Creek watershed is a rather unique landscape feature, surrounded on three sides by Coos Bay and containing the Pony Creek system. Pony Creek flows north through this feature to the Pony Slough Estuary and then the Coos River, approximately 7 miles from the mouth of Coos Bay at the Pacific Ocean. The Pony Creek Watershed is considered a part of the central portion of the Coast Range physiographic province of Oregon within the South Coast Drainage Basin (Oregon Water Resources Department) and is identified as a portion of Hydrologic Unit Code #17100304 (Coos River) by the US Geological Survey. The watershed is divided by the Upper Pony Creek Reservoir into an Upper system, where timber production and watershed management focus on protecting the drinking water supply for the Cities of Coos Bay and



Scale: 1" = 5 miles

5 0 5 Miles

N

VICINITY MAP
September 2000
Figure 1

North Bend, and a Lower system, where urbanization has occurred rapidly and significant flooding and water quality issues are now present.

The **climate** for this area is generally mild, and extremely hot summer days or freezing and snowy winter days are rare. Rains are frequent during the fall and winter and are infrequent and light during the summer. Historically, this pattern of rainfall would lead to flooding events which correspond directly to storm events in fall and winter; spring and summer would see low stream elevations and infrequent flood conditions. The growing season is approximately 265 days in length, with frost free days (5 years in 10) between March 1 and November 27.

Topography in the Study Area varies from moderately steep hills in the southern reaches to low tidal floodplains in the north (please see Figure 2 for USGS / Study Area Map). Elevations range from approximately 240 feet at the upper southern reaches of the watershed to sea level.

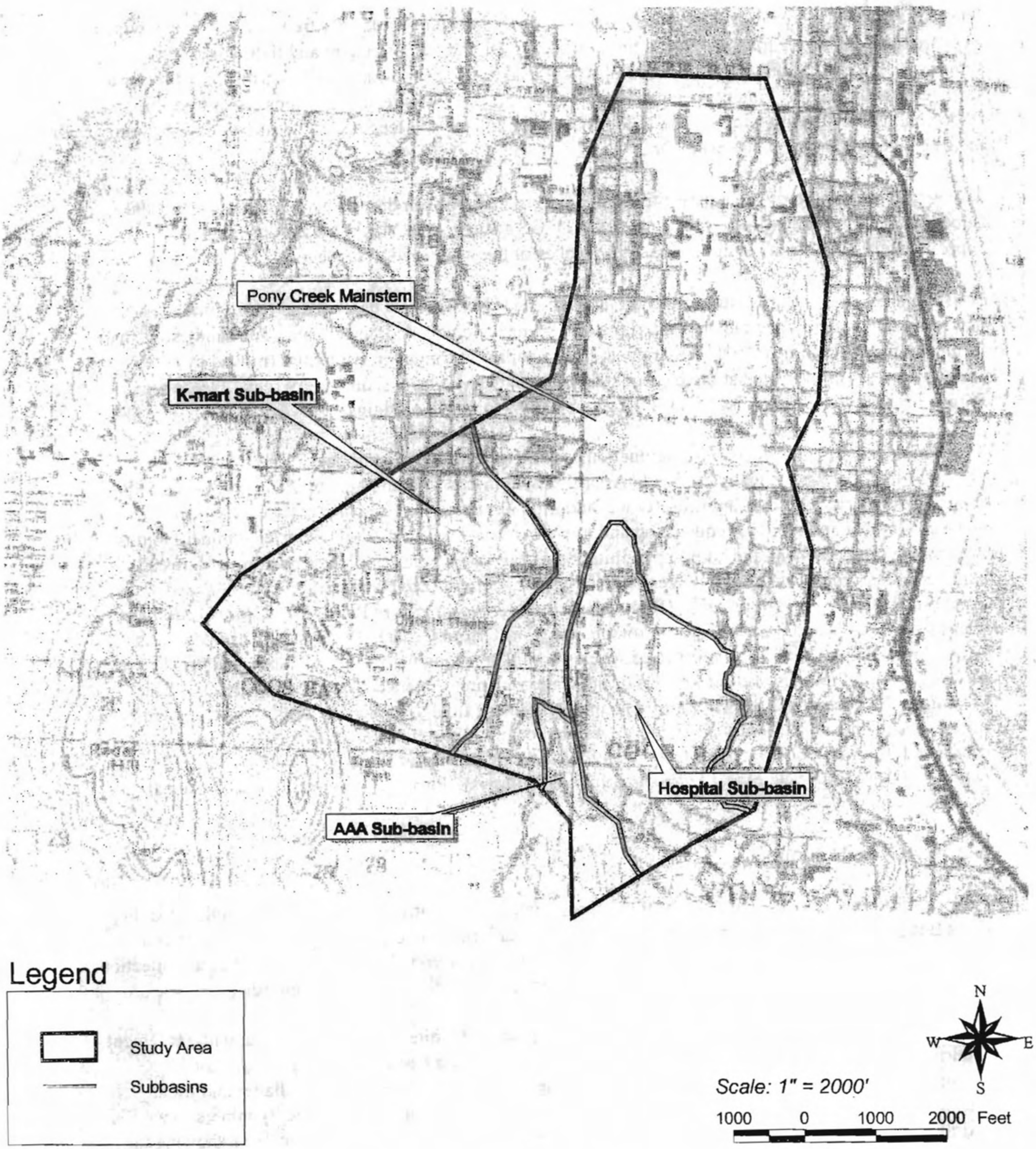
Soils in the Study Area are a mix of Dune Land and sandy, excessively drained and poorly drained soils that formed in eolian (wind blown) material; well drained and poorly drained loamy and sandy soils that formed in marine sediment; and well drained, loamy soils that formed in colluvium (moved by creep, slide or local wash deposited at the base of steep slopes) derived from sedimentary rock. Please see Figure 3 for the Soils Map, displaying soils grouped by geomorphic origins.

Vegetation in the area reflects the combination of soils, climate and disturbance. The Coast Range Province (and more specifically the Study Area) lies within a zone dominated by *Picea sitchensis,* (Sitka Spruce) and characterized by a uniformly wet and mild climate. More intense storm events occur between October and April. Frequent fog and low clouds occur during relatively drier summer months, condensing in tree crowns and adding precipitation as fog drip. Community composition of forested lands includes *Tsuga heterophylla* (Western Hemlock), *Thuja plicata* (Western Redcedar), *Pseudotsuga menziesii* (Douglas Fir), *Alnus rubra* (Red Alder), *Pinus contorta* (Shore Pine), *Umbellularia californica* (California Laurel) and *Chamaecyparis lawsoniana* (Port Orford Cedar). Within the urbanized areas, Shore Pine, Douglas Fir and domestic tree species dominate, along with a mix of native and non-native shrubs, herbs and grasses. Lower reaches of the watershed are influenced by tides, with regular tidal flushing as far upstream as Newmark Street, and backwater / tidally-influenced conditions exhibited even further upstream past Newmark Avenue. Vegetation communities within tidally flushed areas are comprised of a variety of wetland plants, including *Scirpus maritimus* (Saltmarsh bulrush), *Carex lyngbeyii* (Lyngbey's Sedge) and *Salix spp.* (various Willows). Please see Figure 4 for the National Wetland Inventory Map.

2.2. History and Culture

Prior to white settlement in the mid-1850's, approximately 2000 native American Indians inhabited the Coos Bay area. These family groups followed a yearly pattern of food gathering, focusing on coastal fishing and seafood gathering during the summer months, and deer and elk hunting with camas collection during the fall. These foods would be smoked and preserved for the rainy winter months.

Fur traders for the Hudson Bay Company were among the first white persons in the area, with settlement occurring in 1853 at Empire City (southwest of North Bend along Coos Bay) by the Coos Bay Commercial Company. Within ten years Native American Indian encampments, villages and tribal members were dislocated, relocated or removed altogether, and the area was settled by miners, sawmills and the other basic industries still present today. Please see Figure 5 for a map from 1931 showing the white settlements present at that time. Coos Bay itself is the largest port between Portland and San Francisco, and the Bay has been a driving factor in the settlement and industry of the area.

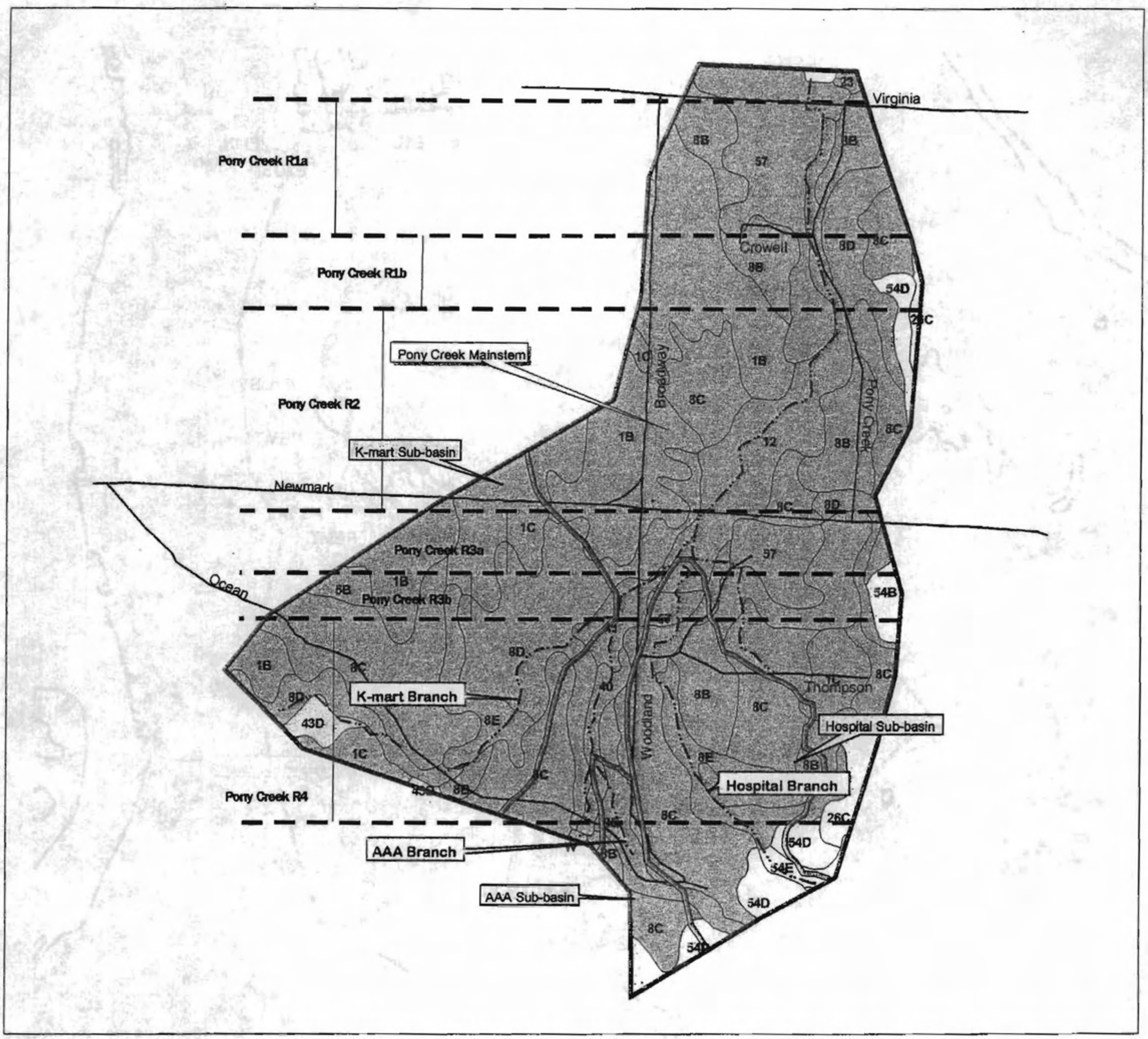


USGS TOPOGRAPHY MAP
September 2001
Figure 2

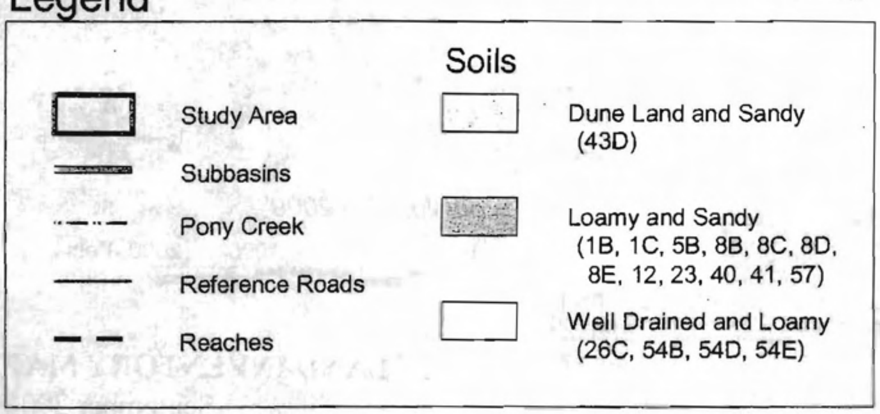
Satre Associates, PC
132 East Broadway, Suite 536 (541) 465-4721
Eugene, Oregon 97401 (541) 465-4722 fax

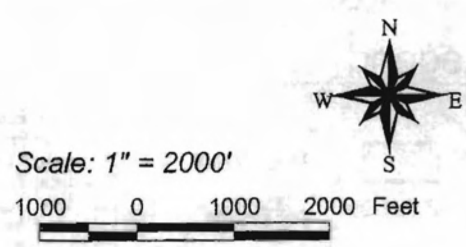
Earth Design Consultants, Inc.
800 NW Starker Ave, Suite 31
Corvallis, Oregon 97330

Hart Crowser
Five Centerpointe Dr. Suite 240
Lake Oswego, Oregon 97035-8652



Legend



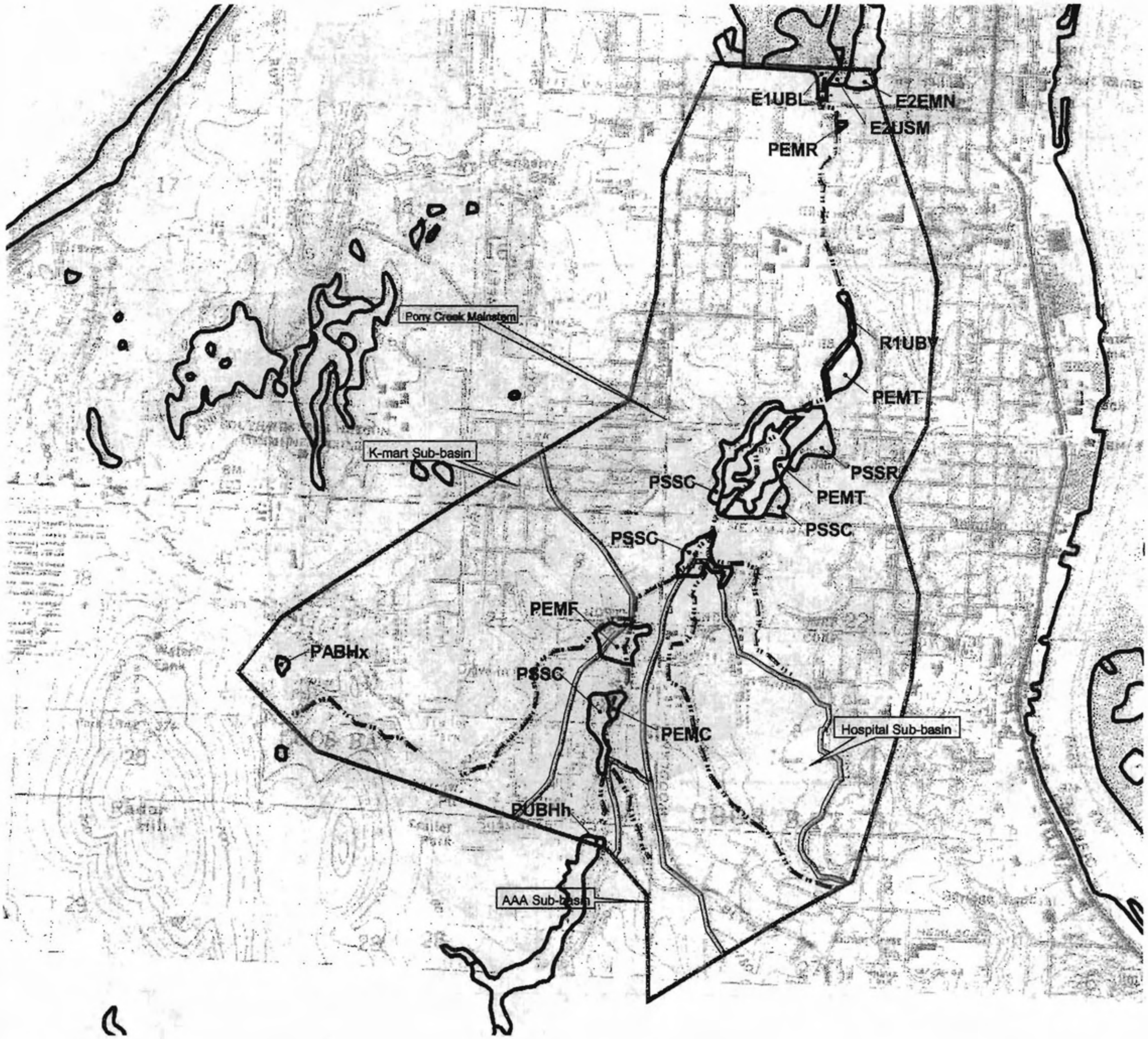


COOS COUNTY SOIL SURVEY MAI
September 2001
Figure 3

Satre Associates, PC
132 East Broadway, Suite 536 (541) 465-4721
Eugene, Oregon 97401 (541) 465-4722 fax

Earth Design Consultants, Inc.
800 NW Starker Ave, Suite 31
Corvallis, Oregon 97330

Hart Crowser
Five Centerpointe Dr. Suite 240
Lake Oswego, Oregon 97035-8652



Legend

	Study Area	Palustrine Aquatic Bed Permanently Flooded excavated (PABHx)
	Subbasins	Palustrine Emergent Seasonally Flooded (PEMC)
	Streams	Palustrine Emergent Seasonal Tidal (PEMR)
		Palustrine Aquatic Bed Permanently Flooded excavated (PABHX)
		Palustrine Emergent Semipermanently Flooded (PEMF)
		Palustrine Emergent Semipermanent Tidal (PEMT)
		Palustrine Aquatic Bed Permanently Flooded excavated (PABHx)
		Palustrine Scrub-Shrub Seasonally (PSSC)
		Palustrine Scrub-Shrub Seasonal Tidal (PSSR)
		Palustrine Unconsolidated Bottom Permanently Flooded (PUBH)
		Palustrine Unconsolidated Bottom Permanently Flooded (PUBH)
		Rivertine Tidal Unconsolidated Bottom Permanent Tidal (RIUBV)

Scale: 1" = 2000'

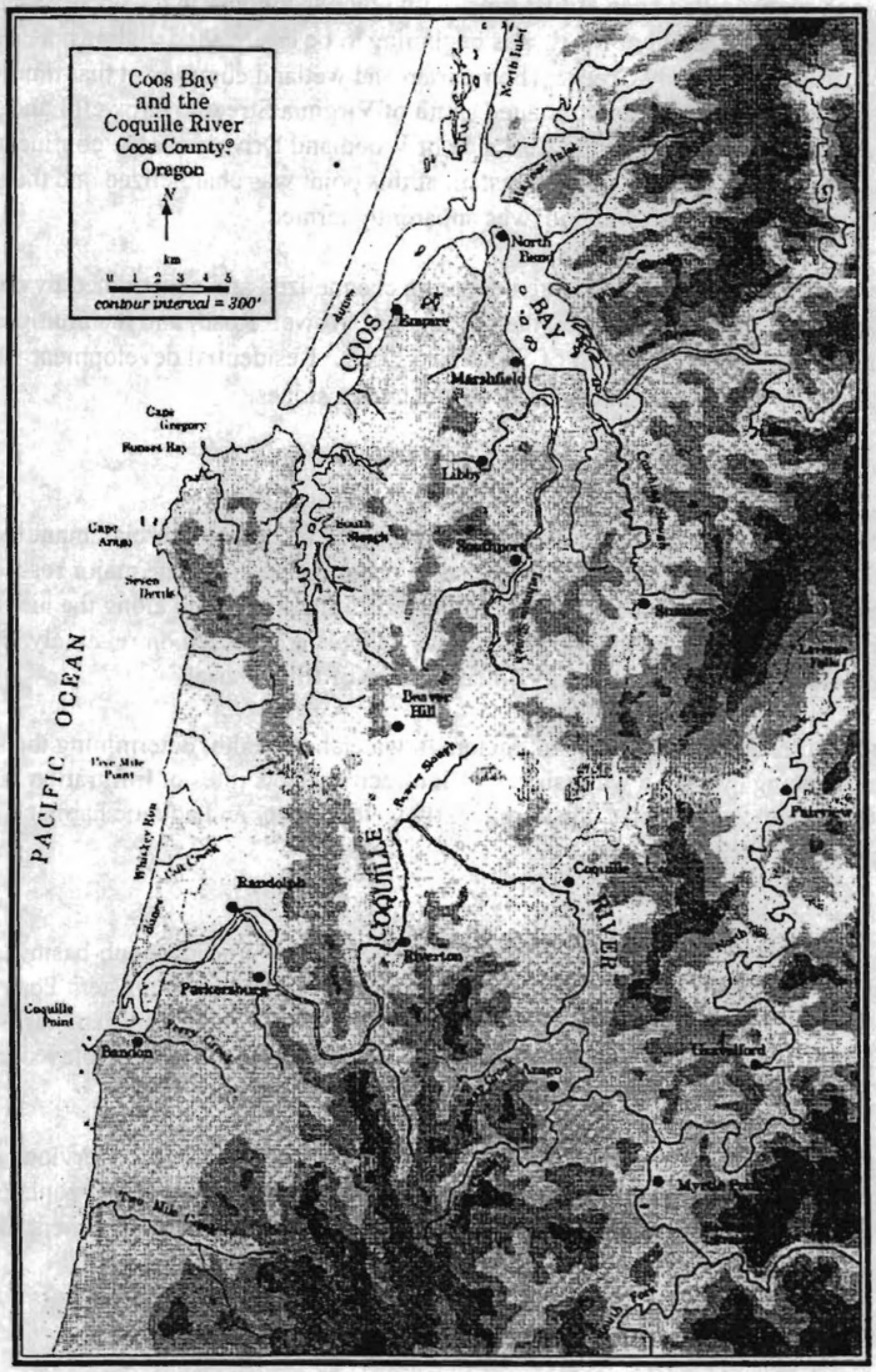
1000 0 1000 2000 Feet

N W E S

NATIONAL WETLAND INVENTORY MAP

September 2001

Figure 4



Coos bay and the Coquille River region showing white settlements established by 1931. SOURCE: Changing Landscapes: Proceedings of the 4th Annual Coquille Cultural Preservation Conference, 2000, Younker, J.

Figure 5

A review of aerial photos from 1939 (please see Appendix A for Aerial Photos) indicates that the Pony Creek watershed was very modified even at that time, with obvious logging in the upper reaches; the lower reservoir was in place; the road network was beginning to be established with residences lining the hillsides east and west of Lower Pony Creek. The riparian and wetland complex at that time, however, was extensive and dynamic. The estuary continued south of Virginia Street to Crowell Lane, whereupon a broad high saltmarsh extended south to the west side of Woodland Drive, near the confluence of Pony Creek mainstem and the Kmart branch. The mainstem at this point was channelized and the surrounding area, which is currently a scrub-shrub wetland, was apparently farmed.

By 1962, the lower reaches of Pony Creek were becoming channelized and constrained by developments such as Pony Village south of Virginia Street, the school near Crowell Road, and the multiple residential development south of Newmark Street, east of Woodland Drive. Residential development was becoming more dense throughout the watershed, particularly on the higher slopes.

2.3. Current Zoning and Land Use

Zoning within the Lower Pony Creek watershed varies among different commercial, manufacturing and residential designations. Commercial zoning is generally congregated along the major roadways, with manufacturing low in the basin near the airport. Residential zoning is located along the hillsides which form the watershed limits on east, south and west edges. Schools are located on relatively level ground within the lower reaches of the basin, probably on large areas of fill material.

Zoning and subsequent land use are significant factors in watershed health, determining the key attribute of "% impervious surfacing" within a watershed which directly affects rates of infiltration and runoff, stream flows and hydrologic character, and subsequently water quality and aquatic habitat.

2.4. Sub-basins

The Lower Pony Creek Watershed can be divided into 4 distinct and significant sub-basins (see previous figures for Sub-basin limits), each draining to one of the major tributaries or mainstem Pony Creek: The Kmart basin, the AAA basin, the Hospital basin, and the Lower Pony Creek Mainstem basin. These various sub-basins are each a unique blend of topography, soils, and land use, as displayed in the following table (Table 1, Sub-Basin Land Use / Impervious Surface Areas Table).

This table is intended to generally display the percent of each sub-basins that is impervious in character, including rooftops, roadways and parking areas, based upon the current land use and zoning. Calculations were made using formulas developed for the Oregon Watershed Assessment Manual (NonPoint Source Solutions, 1997).

Table I Sub-basin Land Use / Impervious Surface Areas

Sub-Basin	Size (Acres)	Topography		Land Use (Acres)	Percent Area of Sub-basin	Approximate Area of Impervious Surfaces	Approximate Percent Sub-basin with Impervious Surfaces	Total Percent of Impervious Surface for Sub-basin
AAA	37.2	Primarily steep gradient, v-shaped, no floodplain, forested	Commercial	0.57	1	0.48	1	28.2
			Residential (1/8 acre or less)	0	0	0	0	
			Residential (1/4 acre)	12.11	33	4.6	12	
			Residential (1/3 – 2 acres)	24.56	66	5.4	15	
Hospital	185.7	Varies from steep, v-shaped and forested to broad with some floodplain	Commercial	88.43	48	75.2	40	68.9
			Residential (1/8 acre or less)	69.56	37	45.2	24	
			Residential (1/4 acre)	19.85	11	7.5	4.0	
			Residential (1/3 – 2 acres)	7.83	4	1.7	0.9	
Kmart	486.8	Varies from moderately steep, v-shaped channel to moderate gradient with some floodplain	Commercial	103.75	34	88.2	29	25.2
			Residential (1/8 acre or less)	47.99	16	31.2	10	
			Residential (1/4 acre)	92.80	30	35.3	12	
			Residential (1/3 – 2 acres)	53.83	18	11.8	4	
Pony Creek Mainstem	652.6	Varies from moderate gradient and moderately confined channel to low gradient with broad floodplain	Commercial	150.11	23.01	127.6	19.55	52.2
			Residential (1/8 acre or less)	145.61	22.31	94.6	14.50	
			Residential (1/4 acre)	254.13	38.94	96.5	14.79	
			Residential (1/3 – 2 acres)	99.18	15.20	21.8	3.34	
Total	1362.3					647.08		47.5

3. WATERSHED PROCESSES: INVENTORY

3.1. Watershed Processes in General

Watershed geomorphology, climate and cultural landscape history set the foundation for watershed processes. Any given watershed reflects a unique combination of the above factors and develops a unique ecological assemblage and pattern. Geomorphology is the study of earth-shaping forces, and influences watershed processes by providing the foundation of topography and sub soil conditions (bedrock type). Topography and bedrock type, in combination with climate and associated erosive and depositional forces, determine soil composition, character and distribution within a watershed. Water provides the central mechanism for movement of soil, energy and nutrients through the landscape, moving down through the soil via percolation or over the soil via headwater channels, creeks, streams and rivers. Vegetation patterns and species assemblages are influenced by climate, hydrology, soils and landscape position within the watershed. Cultural landscape history modifies the physical features of a landscape according to the values, beliefs and technology of the given culture. The above factors all influence the sustainability of habitat conditions within the watershed for both wildlife and humans.

Channel morphology and the movement of water determine how sediments will be transported through the stream network. Energy, supplied as the movement of water through the stream channel, determines a channel's size, complexity (sinuosity) and transport capability. The physical form of a stream channel at any point is also a dynamic expression of the climate (as it affects stream flows) and the geology (as it affects sedimentation) of a stream basin. Other variables, such as resistance to flow (friction) and bed particle size, also influence important channel variables, such as width, depth, velocity, slope, and pattern. Perturbations (both human and natural) to a fluvial (river) system can result in site-specific channel changes (e.g., changes in cross-sectional geometry at the point of disturbance) and/or channel morphology adjustments longitudinally over an area of stream downstream or upstream from the point of disturbance.

Channels are unique; their responses to natural factors and human-induced modifications are also unique. **Changes in channel form and process occur longitudinally along a stream.** In the downstream direction, the gradient decreases, sinuosity ("curviness") increases, the ratio of bedload to total sediment load decreases, the grain size of material that can be transported decreases, and the total discharge or streamflow increases. Channel resistance is determined by the bank and bed material, vegetation (large wood, riparian vegetation, and roots), and physical form of the channel. Adjustments of channels include a number of factors. There are four means by which the form of a channel can change: 1) the longitudinal profile, 2) channel sinuosity, 3) roughness of bed or bank, and 4) the hydraulic radius.

Water velocity is also a primary organizing factor for a riverine ecosystem, for both the abiotic components (Hynes 1970, Cummins 1988) and the biotic components (Hynes 1970, Merritt and Cummins 1984). At high velocities, water is capable of eroding away the stream substrate and carrying away suspended solids. As the water slows and hydrologic force is reduced, suspended solids settle; therefore, water velocity affects the streambed depth (pools), the patterns in stream meander, the distribution of sediment sizes along the stream bed (boulders, gravel bars, silt or clay deposits) and the type of organic material (coarse vs fine). Suspended sediments in turn affect the amount of light reaching the streambed (important for algal production) and the availability of some nutrients. Fast moving, turbulent water has the potential to have more dissolved oxygen than still water due to mixing. Since different types of organisms have different ecological requirements for current, light, temperature, oxygen, food particle size and substrate, it is easy to see that water velocity can be important in structuring the biological communities within riverine ecosystems.

Sediment delivery and transport are also important factors in stream dynamics for a number of reasons. These include: (1) bedload coarse sediments are necessary for successful salmonid spawning; (2) fine suspended sediments can adversely affect fish and aquatic plants; and (3) sediment depositional patterns can influence the dynamics of the stream channel network (flooding, bank undercutting, and stream bank erosion).

Sediments enter the stream network through a number of processes. For any point along a stream network, sediment load is a combination of sediments entering from the channel upstream and those that enter laterally from the watershed. Sediments are produced through various types of erosion, including sheet and rill, gully, road, trail, stream bank, and roadside erosion; landslides; and debris flows. Erosion is the detachment and transport of material from a surface. Sediments can differ in their source, type (suspended load, bedload, turbidity), and size. Once in the stream, sediments can be transported, deposited (accumulation or aggradation) or be lost (degradation).

The importance of vegetation, both living and dead, cannot be overstated. Vegetation can slow the loss of soils due to erosion. For example, trees, shrubs and forbs act to reduce the impact of rainfall (Pimentel et al. 1995), bind soils to slow erosion, and provide obstacles to slow the overland flow of water (see Proctor 1980 for discussion). Even the structure of unmowed fields and riparian areas can slow soil loss. Dense streamside vegetation provides significant habitat values to terrestrial and aquatic organisms by providing forage, cover, shade, and organic contribution to streamways. The importance of large, dead woody debris is recognized in Pacific Northwest forests and streams. Woody debris is a food source for some organisms at the base of the aquatic food web and it slows down stream velocities to help establish the complex in-stream environments favorable for many organisms, including salmon.

3.2. Watershed Specifics: Hydrology, Sediment Sources and Channel Modifications

Overview and Background

Pony Creek runs generally from its headwaters north through the cities of Coos Bay and North Bend, emptying into the Coos Bay Estuary just north of Virginia Avenue. Two reservoirs operated by the North Bend Coos Bay Water Board (NBCBWB) control flows from the upstream portions of the watershed. The upstream watershed drainage area is approximately 3.9 square miles (FEMA, 1984). The drainage area around the two reservoirs is generally forested with moderate to steep hillside slopes. The U.S. Geologic Survey (USGS) maintained a stream flow gage on Pony Creek at Ocean Boulevard just downstream of the lower reservoir (Merritt Lake). The gage number is 14324580 and the name of the gage is "Pony Creek at Coos Bay, OR". Peak flow data recorded at this gage are summarized in the Appendices.

The downstream watershed, from the outlet of the lower reservoir (Merritt Lake) to the Coos Bay estuary, drains an additional 2.2 square miles. Land use downstream of the lower reservoir is a mix of forested or wetland open space, residential, commercial, and institutional development. The FEMA Flood Study documents that soils in the area are predominantly sands or sandy loams.

For the hydrologic analysis five sub-basins were defined, including drainage areas to three tributaries, K-mart Fork, AAA-Fork, and Hospital Fork. In addition to the tributaries, the area draining directly to the main stem of Pony Creek upstream of Woodland Avenue was defined as the Upper Pony Creek sub-basin. The area draining to Pony Creek downstream of Newmark Street was defined as the Lower Pony Creek sub-basin.

There are two notable flood volume storage areas corresponding to broad, well-established riparian / wetland areas. These two areas are referred to in this analysis as the upper pond and lower pond. The K-mart Fork, AAA-Fork, and Upper Pony Creek sub-basins drain to the upper pond, which is formed by a wetland located upstream of Woodland Avenue. The Hospital Branch combines with outflow from the upper pond and runoff from the Lower Pony Creek sub-basin, and collects in the lower pond, which is a large tidally flushed wetland located between Newmark Avenue and the high school. Flood stage within the area between Newmark Street and Woodland Avenue is influenced by tidal conditions, but the influence is muted by the extensive wetland downstream of Newmark Street and the culvert under Newmark Street.

The normal operation of the reservoirs by NBCBWB directly influences peak flow within the entire Lower Pony Creek system. Currently, the NBCBWB withdraws water from the lower reservoir (Merritt Lake) and controls the flow rate of water leaving the reservoir. When the water level exceeds a certain elevation, water is spilled over the spillway at the top of the dam. In usual practice, the water surface elevation is lowest at the end of summer just prior to the start of the fall rainy season. The peak flows associated with the initial series of storms in the fall are substantially diminished because a substantial volume of water is captured and stored within the reservoir. After the reservoir has filled, the entire runoff associated with each storm is conveyed through the reservoir and the peak flows are no longer diminished by the reservoir. Based on this operating mode, a relatively mundane rainfall event late in the season may result in much greater storm flow in lower Pony Creek compared to a larger rainfall event early in the season. This represents a significant change in the hydrologic character of the entire watershed.

The NBCBWB is currently constructing a substantially larger reservoir higher in the watershed. The new reservoir will substantially increase the storage volume available to intercept and retain storm runoff throughout the wet season. The effectiveness of the new reservoir for reducing peak flows in lower Pony Creek will be determined by the storage volume included within the normal operating range (i.e. between high water and low water within the reservoir).

There is potential for reducing peak flows over a longer portion of the wet season by deliberately controlling the amount of water passed through and over the Merritt Lake dam. In current practice, the reservoir is rapidly filled with all available "excess" water at the beginning of the wet season. In concept, the benefits of peak flow attenuation could be spread over the wet season by more gradually filling the reservoir and spilling a greater portion of the early storm runoff (less than a specified flooding threshold). This change in reservoir management practice would have to be considered within the context of the existing objectives and constraints managed by the NBCBWB.

Although the existing and proposed reservoirs within the upper Pony Creek watershed provide flood control benefits, many of the causes of local flooding and the flow inputs from tributaries in the lower Pony Creek watershed are independent of flows from upstream as discussed later in this document.

Channel Morphology and Process

Channel morphology includes physical attributes of the stream channel such as shape of the channel cross-section, floodplain, channel gradient, sediment bars, etc. Because channel processes directly form the physical attributes of the stream channel, the dominant stream processes can often be directly inferred by observing channel morphology. Stream classification systems that utilize this principal can be used to provide a framework for watershed planning. Specific observations of channel morphology and the inferred processes are described within the following discussion. Channel reaches have been assigned a Rosgen level 1 stream type (Rosgen 1994) to provide a simple characterization of channel morphology.

Throughout the majority of the lower Pony Creek Watershed, the main stem of Pony creek is a low-gradient, unconfined, meandering stream with a relatively wide floodplain. The bankfull width to depth ratio is low (typically less than 10). This morphology corresponds to a type E channel under the Rosgen stream classification system (Rosgen 1994). These channel types are vulnerable to sediment inputs, given their low-gradient, meandering character. These channels typically do not have the hydraulic characteristics to either form or maintain a gravel substrate except in scattered locations. The three tributaries (Hospital Fork, K-Mart Fork, and AAA Fork) follow the same morphology at their downstream ends, and then gradually transition upstream to become slightly steeper, less meandering, and more confined with a larger bankfull width to depth ratio. This morphology corresponds to a type B channel under the Rosgen stream classification system (Rosgen 1994).

Streambed composition throughout the drainage network is predominantly sand with localized pockets of pea-sized gravel in small riffles. Downstream of Woodland Ave. the streambed composition contains an increased proportion of silt and finer material. Streambed composition is consistent with observed geology and soils present within the watershed. Large woody debris is not present in substantial amounts and does not play a significant role in forming channel morphology within the lower watershed.

The very low stream gradient and distinct floodplain leads to over bank flooding within low-lying areas in both developed and undeveloped portions of the watershed. Flooding has been documented within the developed area along the main stem of Pony Creek between Newmark and Woodland Ave. Field evidence of flooding along an undeveloped reach of the K-Mart branch includes an established riparian wetland, overbank deposition, floodway channels on the floodplain, and tree mortality. Within low-lying portions of the watershed immediately surrounding the stream channels, flooding along the stream is a natural process consistent with the stream and floodplain morphology. The FEMA floodplain maps show a relatively narrow floodway along the channel upstream of Newmark Ave. No floodway is mapped downstream of Newmark Ave. In this portion of the watershed the low gradient channel is surrounded on both sides by an extensive wetland, which precludes the formation of a distinct floodway along the channel.

Because of the exceptionally low gradient in the lower portion of the watershed downstream of Woodland Ave, Pony Creek lacks the stream power to indefinitely maintain a well-defined channel. The encroachment of wetland vegetation into the channel from adjacent riparian wetlands constricts flow and leads to sediment deposition within the channel. In larger or steeper stream systems, the encroachment of vegetation is held at bay by peak wet-season flows that wash out vegetation and maintain an open channel. In small, low-gradient streams, the encroachment of vegetation can dominate and prevent an open channel from forming or from being maintained by storm flows. In the absence of an open channel, floodwaters are conveyed less efficiently, backing up water upstream of the constrictions. This process is occurring within the lower portion of Pony Creek.

Flood Prone Areas

Based on field observations, map and aerial photographic interpretation, three main flood prone areas were identified. These are listed and briefly described below, and are shown on the Site Constraints map:

Dental Clinic/Medical Center
In the vicinity of the intersection of Waite Road with Woodland Avenue, there have been reports and photos documenting over bank flooding. The FEMA flood insurance study reported that in 1980, floodwaters nearly reached a medical building in that area. Photographs supplied by the North Bend Department of Public Works show floodwaters surrounding the Woodland Dental Clinic. Flooding has been reported around the medical building and some adjacent apartment complexes. Flooding in this area is produced by a combination of factors including the low gradient, low stream velocity and resulting undefined floodway, which is subject to sedimentation and encroaching vegetation.

Automobile Retail Lot/ Coca Cola Bottling Plant
Anecdotal accounts of flooding in the area located immediately upstream (south) of Newmark Avenue are consistent with the flat topography and low elevations observed during the field reconnaissance. This area includes an automotive dealership lot and the Coca Cola bottling plant. Flooding at this location is due to a similar combination of factors as are present near the Woodland Avenue medical and dental offices, in combination with the additional constraint at the culvert beneath Newmark Avenue.

Pony Village Mall
Pony Village is a shopping mall located just north of the high school and downstream of the tide gate located at Crowell Avenue. This low-lying area is identified as a flood-prone area based on field observations and the FEMA flood insurance study. Flooding in this location would be produced by the combination of storm events and high tides.

3.3 Watershed Specifics: Water Quality, Pollution Sources and Stream Temperature

The stream network in this watershed has been highly modified by past practices. For example, just below the Merritt Lake Dam, the entire Pony Creek Mainstem Channel has been redirected and placed into a constructed channel (Pony Creek EIS 3/99). These stream modifications have a pronounced effect on wildlife use and water quality in Pony Creek and its tributaries.

Potential Sources of Fecal Coliform Bacteria Entering Pony Creek

Direct detection of waterborne pathogens (organisms that cause disease) can be difficult and expensive. Concentrations of fecal coliform bacteria, which are much easier to measure than pathogenic organisms themselves, are frequently measured and used to indicate human health risk. Therefore, the presence of fecal coliform bacteria, not normally pathogenic themselves, in a body of water indicates that waterborne human pathogens, including both bacteria and viruses, *may* be present. If pathogens are present, contact through ingestion of water or contaminated shellfish, or simply direct water contact may result in human illness.

The 1972 Clean Water Act defined two sources of pollution: point and nonpoint. **Point sources** of pollution can be clearly identified, such as those from industry and sewage treatment plants, and often enter the receiving waters *via* a discharge pipe. All point sources discharging into navigable waters are regulated by the National Pollutant Discharge Elimination System (NPDES). **Nonpoint sources** of pollution have no readily identifiable source. Run-off from urban, construction, and agricultural activities and septic tank seepage are examples of nonpoint pollution and can enter the receiving waters *via* overland or underground flow. Pony Creek can potentially receive pathogenic organisms from both point and nonpoint sources. All known Point Sources and potential Nonpoint Sources are mapped on the Site Constraints Map.

Point Sources

POLLUTION DISCHARGE POINTS - The Clean Water Act requires that all point sources discharging pollutants into waters of the United States must obtain an NPDES (National Pollutant Discharge Elimination System) permit. The purpose of the NPDES Program is to protect human health and the environment. By point sources, EPA means discrete conveyances such as pipes or man made ditches. All facilities (excluding individual households) must obtain permits if their discharges go directly to surface waters. Examples of pollutants that may threaten public health and the nation's waters are: human wastes, ground-up food from sink disposals, laundry and bath waters, toxic chemicals, oil and grease, metals, and pesticides (EPA, *http://www.epa.gov/owm/npdes.htm*).

Numerous types of pollutant sources are considered under this program, but some types are not found within this Study Area. Animal feeding operations (AFOs) are agricultural enterprises where animals are kept and raised in confined situations. These are not found in the Study Area. (EPA, *http://www.epa.gov/owmitnet/afo.htm*). Likewise, there are no known applications of livestock waste to agricultural fields in the area.

Several NPDES permitted sites are located within the Study Area. This are shown on Figure 10, Site Conditions Summary Map.

WASTEWATER TREATMENT PLANTS – The discharge of untreated human sewage into Oregon's waterways is prohibited by DEQ. Human sewage is treated before it is released into bodies of water. A properly operating treatment plant is not a source of human water-borne pathogens. However, sewage treatment plants can become a source of untreated sewage when collection systems fail (ruptured pipes), accidental releases, and when water flow through the plant, due to heavy rainfall, exceeds the plant's capacity to treat sewage.

The City of North Bend operates a sewage treatment plant, built in 1912. The design capacity of the plant is 9.30 MGD and it is currently operating at 8.40 MGD. Therefore, the system is operating within the limits of its design. The city's wastewater system is describe as being "in good over-all condition" (Oregon Economic and Community Development Department, http://www.econ. *state.or.us/ COMPROF. HTM*). The North Bend Sanitary Treatment Facility is located near the Airport and discharges near the mouth of Pony Slough, just downstream from the Study Area.

The sewage treatment plant for the City of Coos Bay was built in 1905 and is currently operated by OMI, Inc., a private contractor. The system design capacity is 19.50 MGD and the system utilization is 17.55 MGD. Therefore, the system is operating within its limits of design. Overall, the wastewater system is described as being in "good overall condition and is constantly upgraded" (Oregon Economic and Community Development Department, HTTP://WWW.ECON. ***STATE.OR.US/ COMPROF. HTM***). The Coos Bay Sanitary Treatment Facility is located beyond the Study Area near downtown Coos Bay, along Highway 101.

Neither of these facilities lies within the Lower Pony Creek Watershed Study Area and neither contributes to water quality issues considered for this project. However, sanitary sewer pipes criss-cross the Study Area, and at least 2 sanitary pump stations are located within the Study Area, just north of Ocean Boulevard within the AAA and Kmart tributaries. It is believed these pump stations are the sources for odors discovered during the ODFW habitat survey, and the AAA pump station was the source for an accidental leak of 64,000 gallons in 2000.

Nonpoint Source Data

WILDLIFE DIRECT DEPOSIT - Since fecal coliform bacteria are a component of the normal intestinal flora of warm-blooded animals, wildlife can also contribute the total fecal coliform bacterial load of Pony Creek. Indeed, a recent ODFW study reported beaver ponds and deer excrement along AAA Creek, Kmart Creek, and Pony Creek (*ODFW STREAM SURVEY REPORT, 8 AUG 2000*), and this is one source of fecal coliform contribution.

DOMESTIC ANIMAL DIRECT DEPOSIT - Domestic animal wastes (pets, livestock) can also add to the fecal coliform bacteria loading to Pony Creek. Domestic animal wastes are typically not treated and can be deposited in yards, fields, streets, and sidewalks where they are washed into the stream network during precipitation events. It appears that storm water culverts and ditches drain directly to Pony Creek and other water bodies, rather than through the sanitary facility. It is possible that domestic animal wastes may have contributed to the sewage odor that was reported at 572 m up Kmart Creek from Pony Creek confluence (*ODFW STREAM SURVEY REPORT, 8 AUG 2000*).

FAILING SEPTIC TANKS - Septic tanks that are not properly functioning can release human wastes, including pathogenic organisms and fecal coliform bacteria, into waterways. Both North Bend and Coos Bay have municipal wastewater treatment plants. A recent study reported that there are no known sources of anthropogenic bacteria upstream of Merritt Lake dam (FEIS, 3/99). Numerous parcels below Merritt Lake dam continue to be served by septic tanks, and are displayed on Figure 10, Site Conditions Summary Map. Failing septic tanks may be a contributing source of fecal coliform bacteria to Pony Creek and its tributaries.

Heavy Metal Pollution - Potential Sources

Section 304(a)(1) of the Clean Water Act requires EPA to develop and publish, and from time to time revise, criteria for water quality accurately reflecting the latest scientific knowledge. Water quality criteria developed under section 304(a) are based solely on data and scientific judgments on the relationship between pollutant concentrations and environmental and human health effects.

The metals of concern generally include arsenic, cadmium, chromium (III, VI), copper, lead, mercury, nickel, selenium, silver, and zinc. On EPA's webpages (*http://www.epa.gov/owow/watershed/*), sources of metals can be grouped into five source classes: atmospheric emissions, automotive, industrial, residential, and water supply.

Source Class A: Atmospheric Emissions
These are emissions from stationary point sources (e.g., industrial and commercial) and mobile sources (e.g., tail-pipe emissions from cars and trucks) that indirectly contribute to runoff pollution by affecting the quality of rainfall and dryfall.

Source Class B: Automotive
These are sources associated with the maintenance and operation of automobiles and trucks, exclusive of their respective tail-pipe emissions (which are covered in the Source Class A category). This class specifically addresses wear and tear (e.g., brake pads and tires) and spills and leaks of automotive fluids (e.g., motor oil).

Source Class C: Industrial
These are sources associated with runoff from industrial facilities which expose chemicals to rainfall through such activities as processing, materials handling and storage, and maintenance. Class C sources do not include the area-wide sources (e.g., industrial or mobile emissions) which are covered in Source Class A or the automotive/trucking sources which are covered in Source Class B.

Source Class D: Residential
These are sources associated with residential activities or construction products used in home building. Class D sources do not include area-wide sources associated with atmospheric and automotive emissions. Examples of the sources considered in this source class include: household products, wood preservatives, pesticides, algicides, fertilizers, paints, erosion, and corrosion of downspouts and gutters.

Source Class E: Water Supply
These are sources associated with that portion of the potable water supply which can ultimately enter the stream network through the storm drains. Sources of pollutants are associated with chemical additives (e.g. corrosion inhibitors and algae suppression inhibitors) and corrosion products.

All of the above source classes for heavy metals are found in any urban environment. All of the above can affect downstream systems directly via stormwater sewer systems, localized at the point of outfall. These locations are mapped on Figure 10 Site Conditions Map.

Dissolved Oxygen Concentration and Stream Temperature

Oxygen is necessary for the metabolism of all aerobic organisms. In aquatic ecosystems, dissolved oxygen concentration and water temperature are related. At any time, the dissolved oxygen concentration in a body of water is the result of oxygen entering from the atmosphere, from photosynthetic sources within the stream, and from sources arriving from upstream minus the oxygen consumed by chemical and biological demands (Wetzel, 1975). In addition to its direct role in the aerobic respiration of many aquatic organisms, dissolved oxygen concentration also affects the solubility (therefore, the bioavailability) of many important nutrients, e.g., phosphorus. Solubility of oxygen in water is a non-linear function of temperature and is considerably greater in cold water (Wetzel, 1975). For example, pure water near freezing (0° C), contains 14.16 mg l^{-1} of dissolved oxygen, while water near 17° C contains only 9.37 mg l^{-1} of dissolved oxygen. Salts also decrease water's capacity to hold oxygen so that estuarine or brackish water generally has less dissolved oxygen, for any given temperature, than freshwater.

Stream temperature is important for several reasons. First, as mentioned, temperature directly affects the amount of dissolved oxygen that water contains and, therefore, the productivity of the stream. Second, aquatic organisms have varying tolerances to temperature: salmon in particular, are sensitive to warm temperatures. According to a fact sheet published by DEQ, most Oregon salmonids require water temperatures to be about 10° C or cooler for spawning and less than 17.8° C for all other life stages (fry, juveniles). Temperatures become lethal at approximately 23 - 25° C. Oregon DEQ temperature standards are based on a 7-day moving average of the high temperatures in a stream. There are also many indirect effects of stream temperature on the nature of streams. For example, temperature affects the viscosity of water; therefore cold water travels a little slower and transports more suspended particulates than warm water.

Both dissolved oxygen concentration and temperature fluctuate on daily and seasonal time scales. In aquatic ecosystems, this variability makes it difficult to interpret instantaneous measurements (discrete in time and space), which are often recorded by water quality monitoring teams. Because of this variability temperature and oxygen data loggers are frequently used to make measurements at frequent, repeated intervals in streams.

Water temperature and in-stream photosynthetic oxygen production is largely dependent on the amount of solar radiation reaching the stream. The maximum amount of sunlight reaching the stream generally occurs at solar noon. Net in-stream oxygen production is replaced by oxygen consumption during the night, and stream temperatures generally reach their minimum in the hours just before dawn. During the day, factors that affect the amount of sunlight reaching the stream include shade due to riparian vegetation, bank height, and topography (aspect), as well as, the depth and clarity of the water. Seasonally, snowmelt and the influence of ground water (springs) can also influence stream temperatures.

For Lower Pony Creek, 7-day average temperature spreadsheets have been calculated for each branch, based upon data provided by the Lower Pony Creek Watershed Committee. These are included in Appendix C. As can be seen on the charts, many reaches of the Creek system provide, on average, suitable temperatures to allow for spring, fall or winter seasonal spawning; however, summer temperatures are uniformly high for successful spawning and approach stressful levels for all life stages.

3.4. Watershed Specifics: Riparian, Wetland and Aquatic Habitats

Riparian areas are those areas adjacent to a water resource that display transitions between terrestrial and aquatic zones. These areas provide beneficial contributions such as forage and cover resources to a large number of organisms, as well as provide for flood storage and amelioration, erosion control, bank or slope stabilization, streamside shade, stream temperature moderation and contribution of organic material (large and small) to streams. This is the streamside zone where vegetative material accumulates, where humidity is typically higher and temperatures typically cooler.

Wetlands can be part of a riparian zone or a separate water resource entirely. Wetlands are, by definition, areas where regular inundation or saturation of the upper soil profile occurs frequently enough to favor the establishment and dominance of wet-tolerant (hydrophytic) plant species. Wetlands can range from freshwater to brackish to saltwater conditions, and from herb-dominated prairie wetlands to forested swamps. Wetlands provide many ecological functions, including groundwater / surface water exchange, flood amelioration and flood pulse desynchronization, water quality enhancement by virtue of nutrient uptake, and numerous habitat functions for a wide variety of creatures.

Aquatic areas are the connecting element in watersheds, providing the drainage linkage for removal / runoff of water from a basin, as well as the corridor for movement of nutrients, creatures and energy up and down the watershed. In the case of salmon, aquatic areas provide the corridor for migration upstream for spawning and downstream for rearing and eventual arrival at the ocean. Anadromous fish have also been identified as providing the crucial delivery of ocean-based minerals and nutrients to upper reaches of a watershed, making these minerals available for future generations of salmon juveniles and other species.

Riparian Areas

The condition of riparian and wetland areas reflects the history of disturbance, whether human or ecological in origins, and has a strong influence on the quality of aquatic habitat. For example, the southern end of the Study Area has portions which are relatively undisturbed. Where riparian areas have not been confined and manipulated, transitions in mature riparian composition have developed through time. The northern half of the K-mart branch was once logged, and hillsides are currently forested by

Douglas firs, transitioning to Red Alder nearer the streamside. The AAA branch has changed little since 1939, with steep banks vegetated by Douglas firs and Red Alder. The Hospital branch has transitioned from a shrub / deciduous forest to a heavily forested riparian area, with steep hillslopes vegetated with Red Alder - Douglas Fir - Western Hemlock. The upper reaches of these streams provide uniformly fresh, slowly flowing water, with hydrology driven primarily by storm events and releases from the upstream reservoirs. Stream temperatures are generally slightly cooler, water is generally more oxygenated and habitat conditions are more favorable for aquatic species, particularly salmonid species.

The lower reaches of the streams in the Study Area are generally more impacted by cultural developments. This includes channelization and culverting of the streams, removal or minimization of adjacent wetland and riparian areas, and extensive paving. Hydrology is a mix of fresh or brackish tidally influenced water, particularly north of Newmark Avenue. In-stream temperatures tend to be warmer, particularly during summer months, providing reduced habitat conditions for aquatic species. Riparian composition in the lower reaches includes maturing communities of Red Alder - Willow - Myrtle in less managed areas to ornamental plantings of various shrubs and trees.

Within the approximately 1,300 acres of the Lower Pony Creek Watershed Assessment Study Area, riparian areas total approximately 109.6 acres, with some areas relatively broad (>100', as indicated by recent aerial photographs). The majority of riparian areas, however, are quite narrow (<50') or not present at all. The Riparian Width and Characterization forms for each Riparian Reach and Bank are included in the Appendices, along with aerial and site photos and maps.

Wetland Areas

The National Wetland Inventory Map (USFWS, 1994; see Figure 3) identifies numerous features in the Study Area as potential wetlands. The following table lists the acreages of the current NWI mapped wetlands as well as others identified by recent field work and analysis of historic aerial photographs (1939 stereo pairs), categorized by Cowardin classifications.

TABLE II NWI MAPPED COWARDIN CLASSES

Stream and Reach	Classification Wetland and Deep Water Habitats (Cowardin)	Present Extent	Approximate Historic Extent
Pony Creek R1a	Palustrine Emergent Seasonal Tidal (PEMR)	0.9 acres	
	Estuarine Subtidal Unconsolidated Bottom Subtidal (E1UBL)		24.5 acres
	Estuarine Intertidal Unconsolidated Shore Irregularly Exposed (E2USM)		22.0 acres
Pony Creek R1b	Riverine Tidal Unconsolidated Bottom Saturated/Semipermanent/Seasonal (R1Ubv)	0.5 acres	1.8 acres
Pony Creek R2	Palustrine Emergent Seasonal Tidal (PEMR)	9.6 acres	13.2 acres
	Palustrine Scrub-Shrub Seasonally Flooded (PSSC)	6.1 acres	
	Palustrine Scrub-Shrub Seasonal Tidal (PSSR)	3.7 acres	25.4 acres
	Palustrine Emergent Semipermanent Tidal (PEMT)	19.1 acres	41.4 acres
Pony Creek R3a	Palustrine Scrub-Shrub Seasonally Flooded (PSSC)	5 acres	
	Palustrine Emergent Semipermanent Tidal (PEMT)		10.7 acres
Pony Creek R3b	Palustrine Emergent Seasonally Flooded (PEMC)	Not mapped on NWI	
	Palustrine Emergent Semipermanent Tidal (PEMT)		2.0 acres
	Palustrine Emergent Seasonal Tidal (PEMR)		15.2 acres

Pony Creek R4	Palustrine Scrub-Shrub Seasonally Flooded (PSSC)	4.1 acres	11.1 acres
	Palustrine Emergent Semipermanently Flooded (PEMF)	5.5 acres	
	Palustrine Emergent Seasonally Flooded (PEMC)	1.3 acres	
	Palustrine Emergent Seasonal Tidal (PEMR)		4.9 acres
K-Mart	Palustrine Unconsolidated Bottom Seasonally Flooded (PUBC)	Not mapped on NWI	6.9 acres
Hospital	Palustrine Scrub-Shrub Seasonally Flooded (PSSC)	Not mapped on NWI	13.8 acres
AAA	Palustrine Scrub-Shrub Seasonally Flooded (PSSC)	Not mapped on NWI	2.7 acres
	TOTAL WETLAND HABITATS	**55.8 acres**	**195.6 acres**

Only seven wetland features were identified, totaling approximately 55.8 acres. Wetlands have become restricted to streamside areas through time, due to constraints of urbanization, such as roads, utilities, and commercial and residential developments.

Particularly lost over time have been estuarine wetlands (nearly 50 acres). The lowest reaches of Pony Creek (R1a, R1b, R2) continue to be tidally flushed, resulting in a brackish habitat. Slightly upstream reaches (R3a, lower portion of Hospital branch) are tidally influenced, although entirely freshwater.

Aquatic Habitat

Pony Creek is designated by the Oregon Division of State Lands as Essential Salmon Habitat from the mouth of Pony Slough, upstream to the confluence of the Kmart Branch and Pony Creek Mainstem. The fish species of concern include Coho Salmon (*Oncorhynchus kisutch)*, Chinook Salmon (*Oncorhynchus tshawytscha)*, Steelhead Trout (*Oncorhynchus mykiss*) and Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii)*.

Habitat for spawning salmonids in the Lower Pony Creek system was historically limited by the silty and sandy substrate, with most spawning occurring in the upper reaches of the greater Pony Creek watershed. This habitat is now further limited by the presence of the reservoirs on the Pony Creek mainstem south of Ocean Boulevard and by other local factors such as seasonally high stream temperatures. Historically, juvenile coastal cutthroat and coho salmon could have been present in the Lower Pony Creek system, but are seldom seen at this time. In 1983, the Oregon Department of Fish and Wildlife began stocking coho in the Lower Pony Creek, in order to re-establish this species locally. From 1991 to 1996, steelhead were also stocked in the lower creek in an attempt to re-establish viable populations in the system. The failure of these efforts to take hold in Lower Pony Creek probably has to do with the absence of suitable spawning habitat. From 1988 to 1998, ODFW operated a nearby hatchery for rearing Chinook for educational purposes.

The life stages for all anadromous salmonids are shown generally on Figure 7, Life Cycle of Anadromous Salmonids. Habitat requirements are described below:

Species	Habitat requirements

Coastal Cutthroat Trout/ *Oncorhynchus clarkii clarkii*	Migrate to ocean and estuaries for less than a year, then return to freshwater to spawn during first winter or spring. May migrate to ocean for another year prior to spawning. Spawn in very small tributaries. Young fry occupy channel margin and backwater habitats for several weeks. Juveniles use low velocity pools and side channels with complex instream habitat.
Coho Salmon/ *Oncorhynchus kisutch*	Mature fish migrate from ocean into freshwater in fall, spawn between November through February. Adults die within 2 weeks after spawning. Juveniles spend at least one summer and one winter in fresh water. Migrate to ocean in spring. Prefer highly complex, low gradient small cool streams
Steelhead Trout/ *Oncorhynchus mykiss irideus*	Juveniles rear one to four years in freshwater, then migrate to salt water for one to three years. Adults generally spawn in winter and spring. May spawn more than once, returning to salt water between spawning runs. Prefer conifer rain forest ecosystems with instream wood, floodplains, ponds, braided channels and coastal marshes and bogs.
Chinook Salmon / *Oncorhynchus tshawytscha*	Mature fish migrate into freshwater from April through December, few during summer months. Juveniles rear in streams and estuaries, migrate downstream in second spring and enter ocean during first summer or fall. Adults return after 4 to 7 years to spawn in low gradient streams (less than 3%) and prefer sizable pools nearby for maturing prior to spawning.

Based upon information in the 1995 Biennial Report on the Status of Wild Fish in Oregon, Oregon Department of Fish and Wildlife.

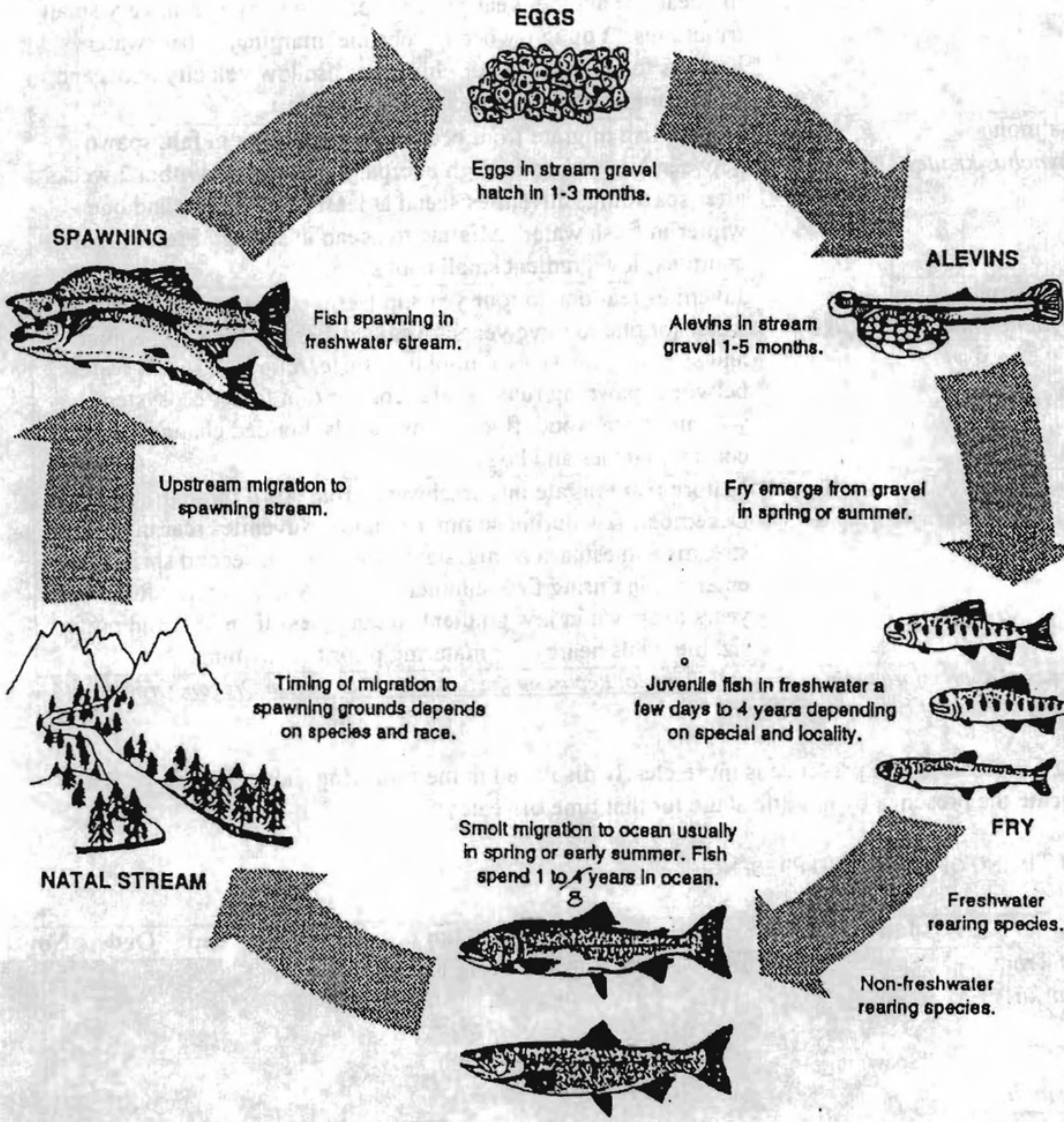
The timing for possible fish presence is more clearly displayed in the following Table. Toned cells and labels indicate the presence by any life stage for that time of year:

TABLE III TIMING OF SALMONID PRESENCE

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coastal Cutthroat Trout/ *Oncorhynchus clarkii clarkii*	Spawning			Fry Rearing / Juvenile Out-migration (< 1 yr)			New Juvenile development				In-migration / Spawning / Rearing	
Coho Salmon/ *Oncorhynchus kisutch*	Spawning		Juvenile out-migration			Fry rearing (> 6 mos)			Adult In-migration		Spawning	
Steelhead Trout/ *Oncorhynchus mykiss*	Spawning			Juvenile out-migration			Juvenile rearing (1 - 4 years)				In-migration / Spawning	
Chinook Salmon / *Oncorhynchus tshawytscha*	Spawning			Adult in-migration Fry development (15 mos.)			Juvenile out-migration			In-migration / Spawning		

As can be seen by the above, if habitat conditions are appropriate for the species, all four species might be found throughout the year in the Pony Creek system.

During sampling of the lower portion of the Kmart branch in the mid-1990's, ODFW found cutthroat trout to be present. During the Aquatic Inventory Project conducted by the Oregon Department of Fish and Wildlife in summer of 2000, numerous salmon fry were identified in a variety of reaches.



Typical life cycle of andromous salmonids. (Adopted from Adams and White, 1990)

Figure 6

A recent study of the tidally influenced portions of Lower Pony Creek was conducted by ODFW to determine the presence of fish species in the backwater. The study found only two species present: three-spline stickleback and staghorn sculpin. No salmonids were found during this study.

The results of the Riparian, Wetland and Aquatic Habitat inventory phase of this project are displayed in the following table, incorporating the existing and field information:

TABLE IV SUMMARY OF RIPARIAN, WETLAND AND AQUATIC HABITAT AREAS

Reach Code	Aquatic Habitat/Reach Length (ft)	General Description	Riparian Area (acres)	General Description	Wetland Area (acres)	General Description
R1a	1,770	Tidal brackish; Geometric channel, 30' ave. width; sandy	4.2	Narrow (< 50'), manicured	0.5	Estuarine, Creekside
R1b	958	Tidal influenced fresh; Geometric channel, 15' ave. width; sandy	3.3	Narrow (<50'), weedy, less manicured	0.4	Estuarine, creekside
R2	2,667	Tidal influenced fresh, less confined, 30-40' ave. width, broad floodplain	48.2	Broad (>250'), diverse high marsh area	37.8	Saltmarsh, large and diverse
R3a	812	Freshwater; 20' ave. width, Floodplain	4.1	Diverse, wooded / shrub dominated	4.1	Shrubs, mod. Diversity
R3b	604	Freshwater; confined, 10' ave. width; sandy	1.0	Narrow (<50'), shrub lined	0.0	N/a
R4	2,687	Freshwater, 10' ave. width; mix of riffle / pool / glide; some gravels	17.0	Broad, forested / shrub / herb areas	5.3	Changing hydrology due to beaver activity; diverse
Kmart	2,041	Odorous, algal mats; mix of riffle / pools; 10' ave. width	11.6	Moderately broad, forested, mature	3.6	Broad; low areas tidal influence
AAA	1,250	Shallow, 3' ave. width; thick vegetation	2.8	Moderately broad, forested, mature	0.2	Small; creekside
Hospital	4,271	freshwater; 4' ave. width	17.4	Varies from mod. Broad to narrow. mature	0.7	Diverse marsh in lower portions
TOTAL	17,060 feet		109.6 acres		52.6 acres	

3.5. Watershed Specific Issues Inventory Summary

The Lower Pony Creek Watershed has been inventoried for hydrologic functions, for water quality parameters and for historic and current riparian / wetland / aquatic habitat structure and function. The

Table V Summary of Inventory of Resource Areas

Reach Code	Hydrologic Character	Water Quality Character	General Aquatic Habitat Description	General Riparian Area Description (within 50' of bankful stage)	General Wetland Area Description
R1a	Low gradient; flooding controlled by extreme tidal elevations; w/in 100 year FEMA floodplain; vegetation encroaching, sediment deposition within channel	Little or no shading	Tidal; Geometric channel; sandy and organic channel bottom; riprap both sides; glides dominant	Narrow (<50'), manicured; grass and forb dominated; Managed seral stage	Estuarine, Creekside
R1b	Low gradient; vegetation encroaching, sediment deposition within channel	Little shading	Tidal; Geometric channel; sandy and organic channel bottom; riprap both sides; glides dominant	Narrow (<20'), non-manicured; grass and forb dominated, weedy; Early seral stage	Estuarine, creekside
R2	Lower Pond; Influenced by tide elevations	Moderate shading	Tidal flushing, less confined, broad floodplain; predominately glides with some pools; silt and organic sediments	Broad, diverse high marsh area; grass and forb dominated; Mature seral community	Saltmarsh, large and diverse
R3a	Flood-prone due to low-gradient storm drains with insufficient capacity to drain quickly	Moderate shading	Freshwater; mod. Floodplain; primarily glides with some riffles and pools; silt and organic and sand sediments forming stream substrate; gravel added by locals	Diverse, wooded / shrub community; grass and forb dominated; Mature seral community	Shrubs, mod. Diversity
R3b	Flood-prone; close proximity of buildings to channel; vegetation encroachment into channel; low gradient; small elevation difference between channel and buildings; beavers; culvert capacity limited beneath Waite Rd.	Moderate shading;	Fresh; confined; primarily glides with some riffles and pools; silt and organic and sand sediments forming stream substrate; gravel added by locals	Narrow (<20'), shrub edge; grass and forb dominated; Early seral stage	N/a
R4	Upper Pond	Well shaded; orange slime + oil present near Ocean Boulevard;	Freshwater; silt and organics; primarily glides with some riffles and step/falls	Broad, forested / shrub / herb areas; Mid-seral stage	Changing hydrology due to beaver activity; diverse vegetation
Kmart	Flooding evidenced	Reports of sewage odor and petrol odor; reported wild animal feces; lower reaches provided little shading; upper portions well shaded	Odorous, algal mats; mix of riffle / pools	Mod. Broad; grass and forb dominated in lower portion, shrub dominated in upper portion; Mid-seral stage	Broad; low areas tidally influenced
AAA	Constrained by roads and hillsides; moderate stream gradient	Reported wild animal feces; mixed moderate to good shading in lower areas, little to moderate shading in upper areas; report orange murky water and oil at upper areas;	Shallow, thickly vegetated; predominately glides and riffles; silt and organic material are dominant substrate type.	Moderately broad, forested and shrub dominated low, grass and forb dominated in upper portions; Mature seral stage nearest stream	Small; creekside
Hospital	Lower portions: Flood-prone; close proximity of buildings to channel; vegetation encroachment into channel; low gradient; small elevation difference between channel and buildings; beavers; culvert capacity limited beneath Waite Rd.	Reported wild animal feces; some areas provided little shading; primarily glides and riffles in low areas, riffles in upper reaches.	Silt and organic material dominate stream substrate	Varies from moderately broad to narrow (<5'); Mid - to Early seral stage	Diverse marsh in lower portions

inventory information is summarized and displayed on the previous Table V: Summary of Inventory of Resource Areas.

Section 4 will begin the Analysis of this information, in order to gain a better understanding of the interrelatedness of the various findings.

4. SPECIFIC ISSUES: ASSESSMENT

4.1. Watershed Processes in General

Basin hydrology, geology and soils, landscape topography, climate and land use drive the physical channel processes that occur within a stream system. Physical channel processes include flooding, erosion, sediment transport, and channel migration. Dynamic channel processes create and maintain in-stream and riparian / wetland habitat for fish and wildlife. In urban watersheds, historically natural channel processes often impact homes and businesses along with roads, utilities, and other infrastructure developments, and these processes are "tamed" by efforts to constrict and fix the channel in a particular position. Additionally, the processes of flooding, erosion, and channel adjustment can be dramatically modified as a result of increased stormwater runoff, surface erosion, increased impervious surfaces and constriction of the floodplain through development. This modification of the stream processes has implications for sediment transport and depositional patterns, vegetative structure and vigor, water quality and water temperature, and the overall habitat value for fish, wildlife and human neighbors.

A factor which significantly influences urban watershed hydrology, water quality and the presence and composition of riparian / wetland and aquatic habitats, is land use and the extent of impervious (paved or otherwise covered) surfaces. As the percentage of watershed surfaces that are transformed to impervious surfaces increases, water which historically percolated through the soil to the groundwater table becomes surface water, resulting in increased quantity and velocity of surface runoff. This increased quantity can lead to localized flooding and "flashy" stream responses to storm events. As the velocity of a stream increases, the erosive force and potential increases, allowing for increased sediment mobilization (erosion) and transport. These sediments can settle within culverts and other restriction points, exacerbating the flood problem by reducing the overall capacity of these structural elements and the streamways that lead to them. Pollutants which collect on impervious surfaces can be directly transported into streamways, increasing bacterial and petrochemical load in the stream. And impervious surfaces are often constructed within former riparian and wetland areas, directly reducing or eliminating the water quality enhancement, flood pulse desynchronization and habitat functions these areas historically performed. Aquatic habitats can be silted-in and "concretized" by fine sediments, eliminating the gravel streambeds required for fish spawning areas.

The Oregon Watershed Assessment Manual identifies 20% - 30% impervious surface within a watershed as a threshold for significantly altering peak flows from small storm events.

4.2 Assessment Specifics: Hydrology, Sediment Sources and Channel Modification

To evaluate flooding potential, hydrologic and hydraulic analyses were performed for the flood prone areas identified in the Lower Pony Creek watershed. First, estimates of peak runoff were calculated for sub-basins defined in the k watershed downstream of Merritt Lake Dam. Estimates of sub-basin hydrographs and peak runoff are contained in the Appendix B. Peak flow calculations are based on the Santa Barbara Urban Hydrograph Method. It was assumed for all modeling that impervious surfaces are connected to the urban storm sewer system.

Peak flows were estimated at places of interest within the drainage area. These locations are shown and described in the Appendices. The flows were calculated by combining runoff hydrographs from contributing sub-basins. Since the wetland areas effectively function like detention ponds, the attenuation of peak flows was incorporated into estimates of peak flow for elements located downstream of wetlands.

Hydraulic capacity was calculated for specific elements in flood prone areas, including channel sections and culverts. Table C-1 in Appendix B shows the assessed elements and their hydraulic capacity in comparison with expected peak flows in the area. This focused analysis is limited to individual sections and local channel reaches. No attempt was made to incorporate potential affects of other nearby elements.

The key questions that define the focus of the hydrologic and hydraulic analysis are listed below:

1) Where does flooding pose a problem within developed areas?
2) What are the main factors contributing to local flooding problems?
3) What corrective actions would alleviate some of the problems? (see Action Plan)
4) How does the Tide Gate at Crowell Road function during several scenarios?

Flood prone areas were identified based on field observations, analysis of maps and aerial photographs, anecdotal accounts, and review of background documents and other studies. Factors contributing to local flooding problems were identified through field reconnaissance and evaluated through focused hydraulic analysis (please see Appendix B).

Assessment of Factors Contributing to Flooding Problems at Specific Locations

1. Woodland Dental Clinic / Medical Center

At the time of the field reconnaissance, a fresh beaver dam located within the wetland downstream backed water up the Hospital branch to within 1 ft of the road surface at Waite Road. Standing water was observed within the storm drain drop inlets along Waite Road approximately 8 inches below the road surface. Several commercial and residential buildings have been constructed within the low-lying, low-gradient area just downstream of the ravine containing Hospital Fork. From topographic maps it appears that the Woodland Medical Center now sits in what was once a wetland area, which previously provided natural detention (peak reduction) for storm flows from Hospital Fork.

The stream in this reach has limited gradient and lacks the stream power to flush out encroaching vegetation. While the stream channel appears to have adequate capacity, with average amounts of bank vegetation, continued encroachment would decrease channel capacity. Because the area is located immediately downstream of a higher gradient confined reach of the Hospital Fork, it is prone to sediment deposition. The capacity of the culvert under Waite Road was observed to be half full of sediment and probably has only 1/3 of its design capacity. Even if it were cleared of sediment, the culvert probably cannot pass flows for storms much larger than the 2-year storm.

Although the City of North Bend currently removes sediment and cleans out the culvert at Waite Road at least once per year, the culvert continues to fill up with sediment. This occurs and will continue to occur as long as the local water surface gradient is very flat. As described above, the beaver activity just downstream of Waite Road causes the water to back up through the culvert. During high flow conditions, water flows over the road and there is not enough head (difference in water surface elevation from upstream to downstream of the culvert) to drive water through the culvert and flush out the sediment. Please see the analysis of this culvert in Appendix B.

To summarize, the following factors contribute to the flooding problems in this area:

- Alteration of upstream hydrology, which has eliminated seasonal channel-shaping and channel-clearing high flows (early rain storm retention for refilling of depleted reservoirs);
- Encroachment on the natural channel and floodplain by urban development;
- Exceptionally low stream gradient, resulting in sedimentation and diminished channel capacity;
- Shallow channel;
- Encroachment of vegetation into the channel, limiting channel capacity;
- Limited capacity of the culvert under Waite Road by virtue of sediment within the culvert;
- Beaver activity.

2. Automobile Retail Lot/ Coca Cola Bottling Plant

Flooding potential in this area does not appear to be a function of stream channel or hydraulic structures in Pony Creek. Analysis of channel cross-section suggests that the channel could convey nearly a 25-yr flood. Flooding may be related to low-gradient storm drains that lack the capacity to quickly drain water from this low-lying area to Pony Creek. Additional review of the local storm drain system is needed to evaluate this hypothesis.

To summarize, the following factors contribute to the flooding problems in this area:

- Apparent low gradient storm drains with insufficient capacity.

3. Pony Village Mall

Results of the hydraulic analysis of the stream channel, culverts and bridges in the vicinity of Pony Village suggest that there is adequate capacity to convey flows up to the 100-year storm. At low tide, neither the channel nor the bridges constrict flow conveyance enough to cause flooding. The tide gate is the local structure that limits and controls conveyance capacity just upstream of the Mall area. Because the Mall is located downstream of the tide gate, flooding in this area is controlled by extreme tidal elevations and not by peak flows from upstream. According to the FEMA flood insurance study, portions of the mall are considered to be within the 100-year flood plain. It was reported in that document that this situation would occur if peak flows associated with a large storm coincided with a high tide condition. Pipe size and head determine capacity of the stormwater system. During a high tide, the water surface at storm drain outfalls is much higher than normal, and close to the same elevation as the ground surface at storm drain inlet structures. This condition dramatically reduces the capacity of the stormwater collection system and can result in local flooding around storm drain inlet structures.

To summarize, the following factors contribute to the flooding problems in this area:

- Appears that flooding occurs during combined high tide and storm events, due to reduced rate of outfall.

Effects of the Tide Gate at Crowell

As described previously, the tide gate at Crowell Road is the focal point of hydraulic control for the lower reaches of Pony Creek. The following is a discussion of the tide gate operation, interaction of storm flows and tidal events, and the main scenarios of concern related to flooding.

Tide Gate Operation

The tide gate is intended to be a passive means of limiting tidal inflow. It's design uses hydraulic principles to allow maximum outflow capacity, and provide reduced inflow capacity. It utilizes two concepts of hydraulic control, and is designed to operate without mechanical controls.

Head difference. As water builds up behind the culverts, the difference in water surface elevation or "head" drives the water through the culvert. The force of the water swings the gate open, so that the outflow capacity is predominantly a function of culvert capacity. Some capacity will be lost since the water probably cannot push the gates completely open. A force balance analysis (Tables 8 and 9, Appendix B) showed that, depending on the flow condition, the reduced outflow capacity ranged from about 75% to 85%. Note that this assumes the gates to be quite heavy (2000 lb unsubmerged, 1500 lb submerged).

Orifice control. To minimize the amount of tidewater flowing into the lower pond (the pond area upstream of the tide gates), the gates swing shut and limit the area through which water can pass. This is called orifice control. The capacity is then a function of both head difference and inlet size. The tide gates cover approximately 50% of the culvert opening.

Storm flow/Tide Level Interaction

The interaction of storm runoff, detention in the lower pond, tidal elevation, and flow through the culvert/tide gate structure is very complex. An analysis of these conditions is contained in Appendix B. In the analysis the dynamic hydraulic conditions during a storm were simplified into two general flow conditions:

Inflow. When the incoming storm water does not fill the lower pond (pond area upstream of the tide gate) fast enough to match or exceed tide stage, the pond acts as a reservoir being filled with both storm water and tidal inflow. The pond stage is a function of increasing storage volume.

Outflow. When the incoming storm water fills the lower pond fast enough that pond stage exceeds tide stage, the pond empties to the bay. The pond stage is a function of culvert/tide gate outflow capacity.

Flooding Scenarios

The main scenarios of concern when considering these interactions are tidal inflow (low flow, high tide), synchronized peaks (high flow, high tide), and offset peaks (high flow, low tide). The low flow/low tide condition is of no significance when considering flooding issues. An additional situation was assessed (No Tidal Input) to determine if one-way tide gates would provide any benefits. A summary of analysis results is shown in Table 1, Appendix B.

Tidal Inflow. To assess the effectiveness of the tide gate, the tidal inflow situation was analyzed. A tide cycle and the corresponding pond stage were simulated as described in Appendix B. The tide range was estimated based on estimates of lower low water and higher high water for Coos Bay reported this year (NOAA, 2000). It was found that during a cycle with negligible storm flow the tide gate keeps the pond water level lower than the tide water level. Peak pond stage was estimated at approximately 6.5 feet during an 8-foot tide (see Tables 1 and 6, Appendix B). The analysis also suggests that pond stage remains above 6 feet for approximately 1.5 hours. *When operating correctly the gate appears to serve an important function in keeping water levels down.* This is particularly important in the Medical Center/Dental Clinic area. There are low lying areas with elevation less than 6 feet, and Waite Road and the parking areas around buildings in the area had elevations between 6.5 and 7 feet. *A properly operating tide gate reduces the potential for tidal flooding of this area.*

Synchronized peaks. To assess the potential impacts of synchronized peaks, a tidal cycle and a runoff hydrograph were aligned such that the peak flow and peak tide elevation coincided (see Table

4, Appendix B). An inflow condition exists initially with storm flow and tide water filling the pond. Shortly after the peak, an Outflow Condition is created as pond stage exceeds tide elevation. The height of pond stage above tide elevation is based on head required to pass the storm flow through the culvert. *The analysis showed that the pond level could rise to approximately 7 feet for the 2-year storm, and approximately 8 feet during the 100-year storm.* This situation did not increase peak duration (greater than 6 foot pond stage) for smaller storms (1.5 hours for 2-year storm), but did increase duration for the larger storms (2.3 hours for the 100-year storm).

Offset peaks. To assess the potential impacts of offset peaks, a tidal cycle and a runoff hydrograph were aligned such that the peak flow and low tide elevation coincided (see Table 5, Appendix B). At low tide, an outflow condition exists with peak storm flows passing through the pond at fairly low head elevations. However, as shown in Table 5, the trailing limb of the hydrograph maintains fairly high flows for a long period of time. As the tide rises again, the situation reverts to an Inflow Condition. With the pond area being filled by both storm flows and tidal inflow, the pond stage is greater than under the tidal inflow condition. The analysis showed that the water surface in the pond could rise to between 6.6 feet (2-year storm) and 7.0 feet (100-year storm). There was also a slight increase in peak stage duration: 1.8, 2.0 and 2.3 hours for the 2-, 10-, and 100-year storms, respectively.

No Tidal Input. A fourth analysis was performed to see if there was potential advantage in installing a one-way tide gate that allows no tidal inflow. The situation assumed that the tide gate would discharge storm flows until the tide elevation exceeded the pond stage. The pond would fill with storm flow until pond stage again exceeded tide elevation, and the pond would begin to empty. *The analysis suggests that significant reduction in peak flows could be achieved.* Estimated peak stage was 4.9 and 6.6 feet for the 2-year and 100-year storms, respectively. Time at high stage was also reduced to 1 hour for the 100-year storm. The peak stage did not reach 6 feet for the 2-year or 10-year storms. The head required to pass water through a one-way tide gate was not included in the estimate. If the head requirement is substantial, there may be no advantage during the larger storms, but it is not likely to negate the advantages during the smaller more frequent storms, because head loss is a function of flow rate.

Sediment Sources

Soils in the lower watershed are predominately formed from sedimentary marine terraces, and generally have moderate to low soil erodibility factors. Please see Figure 7 for Map of Soil Erodibility. However, silts and organic sediments dominate Pony Creek and its tributaries (*ODFW Stream Survey Report, 8 Aug 2000*) as follows:

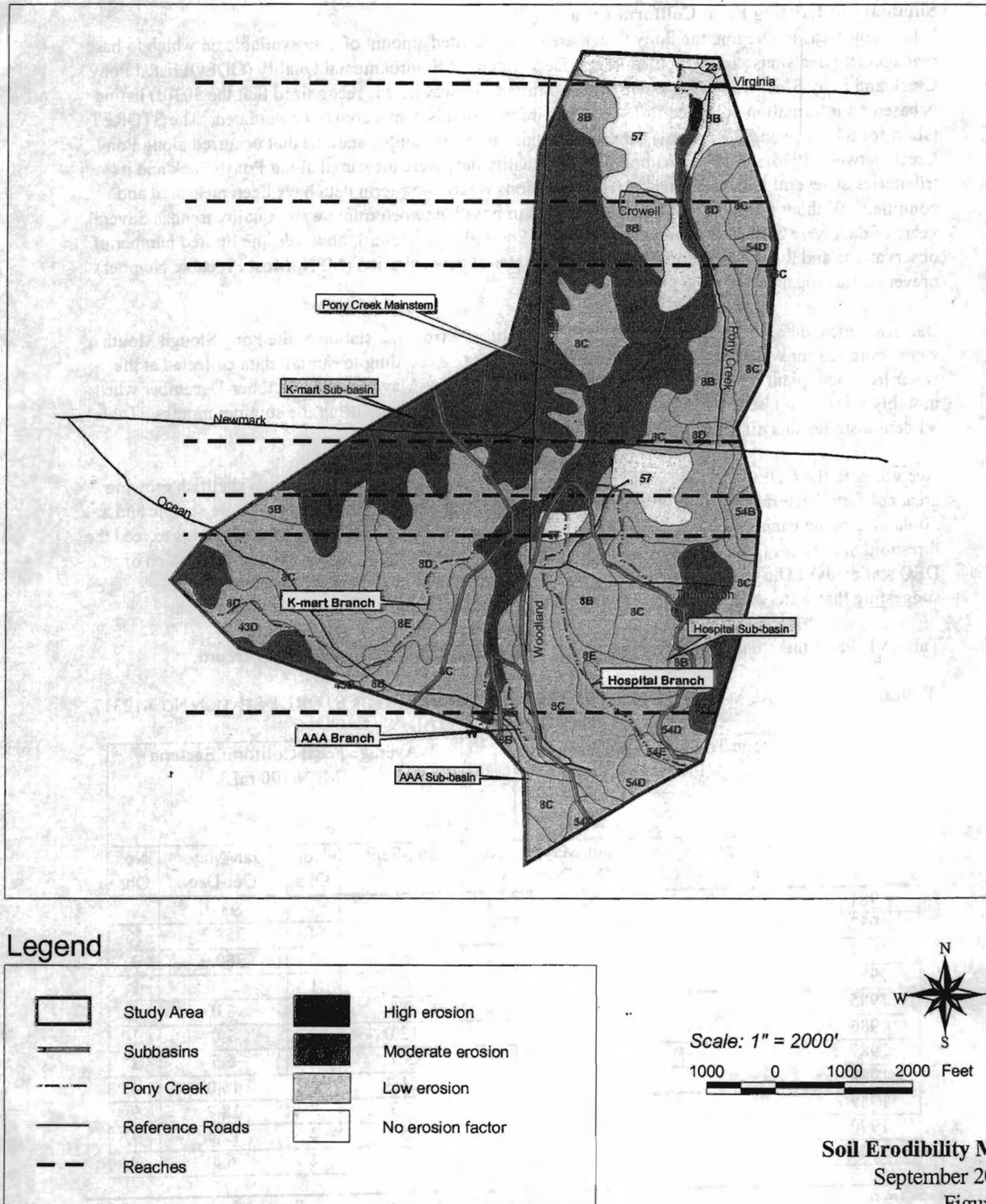
Reach Code	Percent Sand	Percent Silt and Organics
R1a		89
R1b		89
R2		95
R3a	27	59
R3b	27	59
R4		77
K-mart	70	30
AAA		80-90
Hospital	29	60-90

The Pony Creek watershed was clear-cut several times in the distant past and more recently has been partially logged. Logging has probably increased the sediment loading to the reservoir and stream network (FEIS, 3/99). However, Merritt and Upper Pony Creek Reservoir trap sediments and bedload that would otherwise enter the Lower Pony Creek system.

Due to the low gradient of Pony Creek there is little energy to transport sediments or actively erode stream banks, maintaining more open channels. The ODFW stream surveys found only a small proportion of actively eroding stream banks (generally, 0-1% of the reach length) in AAA, Kmart, and Pony Creeks (*ODFW Stream Survey Report, 8 Aug 2000*). The relatively low gradient of the stream coupled with the controlled release of water from the dams reduces the amplitude of hydrologic peaks (spates), particularly early rainy season events, that could potentially transport sediment and free up potential salmonid spawning gravel.

Given the small occurrence of streambank erosion identified during the ODFW Stream Survey, sediment contribution to the Lower Pony Creek system should therefore be considered the result of erosion and mass-wasting from upland and riparian areas.

Human land use practices in upland and riparian areas can dramatically affect the frequency and timing of pulses of sediments that enter the stream by removing vegetation and exacerbating slumping and hillside erosion. Examples of land use practices include: vegetation removal for agriculture or site development; timber harvest; road building; stream channel modifications; hydrologic modification by damming or developing impervious surfaces and gravel mining. Consequences of erosion are many and are not confined to source areas, but are also felt downstream as sediments accumulate at changes in stream gradient and flow characteristics.



Soil Erodibility Map
September 2001
Figure 7

Satre Associates, PC
132 East Broadway, Suite 536 (541) 465-4721
Eugene, Oregon 97401 (541) 465-4722 fax

Earth Design Consultants, Inc.
800 NW Starker Ave, Suite 31
Corvallis, Oregon 97330

Hart Crowser
Five Centerpointe Dr. Suite 240
Lake Oswego, Oregon 97035-8652

4.3. Assessment Specifics: Water Quality, Pollution Sources, and Stream Temperature

Summary of Existing Fecal Coliform Data

Like many areas in Oregon, the Pony Creek area has a limited amount of data available on which to base management decisions. In 1998, the Oregon Department of Environmental Quality (ODEQ) listed Pony Creek and Pony Slough as being water quality limited. However, it is recognized that the 303(d) listing is based on information collected in 1983. This information is considered to be outdated. The STORET (short for STOrage and RETrieval) database contains only six sample stations that occurred along Pony Creek between 1975 and 1997. Although water quality data were measured along Pony Creek and its tributaries at several locations, there are few locations where long-term data have been measured and compiled. Without replicated long-term data, it is impossible to determine water quality trends. Several years of data were available from station 412317 (Pony Slough Mouth); however, the limited number of observations and the procedure used to measure bacterial concentration (MPN, Most Probable Number) prevent a statistical comparison.

Bacteriological data, both total coliform and fecal coliform, from the station at the Pony Slough Mouth were compiled for wet and dry seasons from 1981-present. According to rainfall data collected at the water treatment plant from 1975-1999, wet months are January-May and from October-December when monthly rainfall can be two to three orders of magnitude greater than during the summer months. Table VI demonstrates this difference in bacteria counts.

According to the ODEQ numeric standards for fresh and estuarine waters, other than shellfish growing area, coliform bacteria concentrations cannot exceed 406 organisms / 100 mL for a single sample and a 30-day log mean cannot exceed 126 organisms / 100 mL. In 1981-1982, single sample counts exceed the threshold 8-10 times (please see Appendix E Regulatory Context for a more in-depth presentation of DEQ standards). The 406 organisms / 100 mL threshold has not been exceeded since that time, suggesting that water quality has improved in recent times, at least for the period of record.

Table VI shows this trend as the average (arithmetic) concentration for the period of record.

TABLE VI TOTAL AND FECAL COLIFORM BACTERIAL COUNTS FOR STORET STATION NO. 412317, PONY SLOUGH MOUTH

	Average Total Coliform Bacteria [MPN/100 mL]				Average Fecal Coliform Bacteria [MPN/100 mL]			
	Dry		Wet		Dry			
Year	Jun-Sept	No. Obs	Jan-May, Oct-Dec	No. Obs	Jun-Sept	No. Obs	Jan-May, Oct-Dec	No. Obs
1981			240.0	1			93.0	1
1982	8.3	4	408.7	15	3.0	4	253.3	15
1983	23.5	2	447.7	3	9.5	2	369.0	3
1984	7.0	1	48.0	2	3.0	1	23.0	2
1985			88.0	3	9.0	1	3.0	3
1986					12.0	2	3.0	1
1987					5.7	3	6.5	2
1988					21.3	4	15.0	4
1989					3.3	3	18.7	9
1990					35.3	4	12.4	7
1991					6.3	4	6.4	8

1992					4.0	4	17.6	10
1993					4.3	4	13.0	7
1994					33.0	1	31.2	9

Recently collected data was also provided by the Coos Watershed Association as part of the Marshfield High School Bacteriological Study. Detailed collection and culture methodologies were not provided with these data so interpretation is difficult. As they stand, these data suggest that total coliform counts increase rapidly in the urban setting of Pony Creek just below the dam collection site. Although E. coli counts are well below the ODEQ bacteriological standard of 406 CUFFS / 100 mL, the total coliform counts exceed all counts ever reported in the STORET database (Table VI) and suggest that there may have been some sort of error.

TABLE VII. TOTAL COLIFORM (TC) AND E. COLI (EC) COUNTS FOR SIX STATIONS ALONG PONY CREEK AND ITS TRIBUTARIES

	***Upstream*----------**											**---*Downstream***
Date	Below Dam		Kmart at Ocean		AAA Creek		Waite Road		Newmark Road		N. Bend High School	
	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC
6/21/00 (1)	39	20	8,664	20	7,970	40	771	<10	8,664	182	3,968	51
6/21/00 (2)	636	74	4,611	10								
8/30/00	246	10	6,866	9	2,187	41	1,903	122	2,351	6,866	6,866	215
9/18/00	503	36	2,187	73	1,280	89	1,669	471	2,595	1,483	1,483	86

Figure 8 represents bacterial sources within a watershed context. It is provided as a checklist of all potential sources of coliform bacterial to Pony Creek. Without more detailed information, it is difficult to say with any degree of certainty which of these potential bacterial sources is the most important to the total bacterial loading of Pony Creek. Considering the urban nature of the study area, animal feeding operation, manure application, sludge application, marine mammals, and human direct deposits are unlikely to be of any importance. However, areas in which these activities occur, especially if upstream of lower Pony Creek, should be mapped because under certain conditions they can contribute to the bacteria loading of Pony Creek.

Periodically, there are events such as the recent accidental release of 68,000 gallons of sewage by the City of Coos Bay into Pony Creek. Episodic events can have dire short-term consequences on Pony Creek's water quality; however, they are difficult to plan for and may have relatively short-lived effects. Bypassing sewage treatment during high flow events and accidental sewage spills probably do occur and should be monitored. If they occur frequently then action (such as increasing a plant's capacity) is warranted. In addition, odors detected during Stream Habitat Surveys may derive from sanitary sewage pump stations and should be investigated.

Some septic tanks are located within the Study Area. Available information suggests that failing septic tanks probably do not significantly contribute to the total bacterial loading but this should be verified by a careful inventory of all known systems.

Wildlife and domestic animals are most likely the leading cause of bacterial loading in the study areas. It is difficult to manage wildlife; however, domestic animal wastes can be managed by disposing of them properly and avoiding areas that are connected to waterways. Enhancing riparian vegetation can also increase the time of travel (and therefore increase cell die off) and remove contaminants from surface runoff before they enter the water.

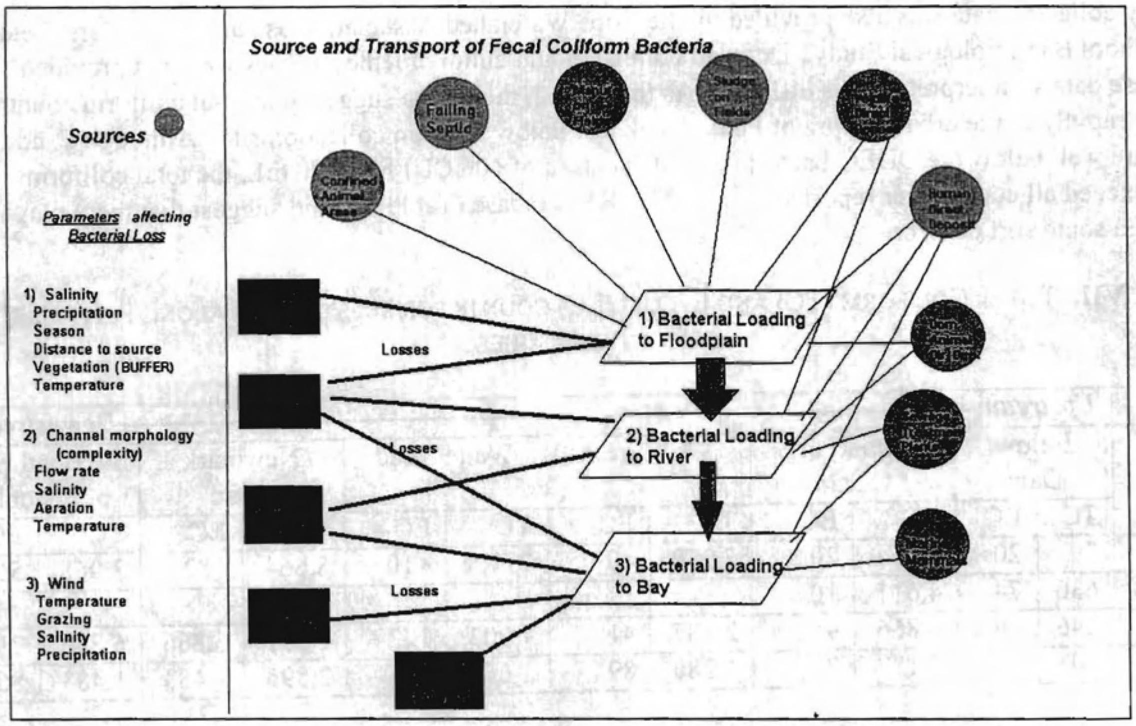


Figure 8. Conceptual model: Potential sources and factors affecting die off of fecal coliform bacteria in a coastal watershed. *Source: Miller, J. A. and R. J. Garono. 1995. A summary of the Scientific/ Technical Advisory Committee's Biochemical Water Quality Issue Forum. Tillamook Bay National Estuary Project, Garibaldi, OR. 29 pp.*

Summary of Existing Water Temperature Data

Human modifications to Pony Creek and its watershed have had a negative effect on stream temperatures. Logging (as recently as 1980) and on-going urbanization have removed a substantial portion of the vegetation providing shade to riparian zones in the study area. Please see Figure 9, Historic vs. Current Wetland Habitat Areas.

The July 2000 ODFW Stream Survey study reports the following stream temperatures:

TABLE VIII. AQUATIC HABITAT INVENTORY OBSERVATIONS ON RIPARIAN CANOPY CLOSURE AND DOMINANT VEGETATION. REACHES ARE RANKED ACCORDING TO ODFW BENCHMARKS FOR REACH-AVERAGE SHADE FOR WESTERN OREGON STREAMS < 12 M IN WIDTH.

Tributary	Reach	% Shade/Canopy Closure	ODFW Benchmark	Predominant Vegetation
Pony Creek	1	0 %	Undesirable	grass / forbs
	2	0-40%	Undesirable	grass/forbs
	3	10-48%	Undesirable	grass/forbs
	4	93-100	Desirable	shrub
Kmart Creek	1	5-50%	Undesirable	grass/forbs
	2	78-90%	Desirable	shrub

AAA Creek	1	30-95 %	Mixed	shrub
	2	0-40%	Undesirable	grass/forbs
Hospital Creek	1	3-55%	Undesirable	grass/forb
	2	45-99%	Mixed	grass/forb/shrub

Note that only 4 reach areas displayed potential desirable riparian canopy cover, which has a direct effect on the solar exposure and resulting potential for stream water warming.

In addition to removal of shading riparian vegetation, water releases from the dams along Pony Creek can influence water temperatures. During periods of low stream flow, shallow water warms more quickly than deeper water. Therefore, manipulation of water release rates can be used to manage water temperatures.

As with bacteriological data, there are very few long-term stream temperature records in the STORET database. At station 412317 (Pony Slough Mouth) there were 142 observations made between 1981 and 1992. Summer temperatures (June-September) were extracted from the database and annual averages calculated (Table IX). While the number of observations is too low to calculate a 7-day moving average, the summer stream temperatures exceed the criterion established for rearing life stages of salmonids (17.8 o C) on several occasions as late as 1995.

TABLE IX STREAM TEMPERATURE DATA FROM STORET STATION # 412317, PONY SLOUGH MOUTH (DEGREES CELSIUS)

Year	Summer Temp °C (June-Sept)	No. Obs.	Year	Summer Temp °C (June-Sept)	No. Obs.
1981			1990	18.0	3
1982	14.6	4	1991	15.9	4
1983	17.0	2	1992	17.0	4
1984	15.0	1	1993	15.8	4
1985			1994	17.5	4
1986	18.0	1	1995	18.3	2
1987	15.0	2	1996	15.7	3
1988	16.3	3	1997		
1989	17.1	4	1998	14.7	1

The Coos Watershed Association, as part of the Marshfield High School Bacteriological Study, provided recently collected stream temperature data (Table X). Detailed collection and culture methodologies were not provided with these data, making interpretation difficult. However, although these summertime temperatures come close to the DEQ stream temperature threshold, the water temperature exceeds it only once at the North Bend High School site on July 21, 2000.

TABLE X STREAM TEMPERATURES MEASURED AT SIX STATIONS ALONG PONY CREEK AND ITS TRIBUTARIES (DEGREES CELSIUS)

	Upstream					*Downstream*
Date	Below Dam	Kmart at Ocean	AAA Creek	Waite Road	Newmark Road	N. Bend High School
7/21/00	15.3	14.5	13.4	13.8	16.4	18.9
8/30/00	15.5.	14.2	13.3	13.8	16.6	16.3
9/18/00	14.8	14.1	13.2	13.1	15.2	15.3
10/04/00	11.6	13.9	11.4	·11.7	13.7	14.2

Finally, the Coos Watershed Association collected continuous stream temperatures at six sites in 1999 using temperatures data loggers. From these data, 7-day averages can be calculated and patterns in stream temperature known. Only summary data were provided. These summaries showed only the 7-day average for the warmest days of the summer. It should be noted that stream temperatures are affected not only by the amount of solar radiation hitting the water, but also from the temperature of the water coming from upstream, which in this case includes water released from reservoirs. A 7-day average for the entire period of record should be examined to elucidate patterns in water temperatures. For the six sites monitored, the highest 7-day average exceeded the ODEQ threshold of 17.8°C (64°F) at four sites: Pony Creek at Ocean, Kmart, Virginia, and North Bend High School.

4.4. Assessment Specifics: Riparian, Wetland and Aquatic Habitats

Riparian Habitats

A summary of the Riparian Condition is provided in Table XI Riparian Condition Summary. This table displays the findings of the ODFW Aquatic Habitat Inventory Project, augmented with additional findings from more recent field investigations and aerial photo interpretation.

As can be seen from Table XI, the upper reaches of all streams generally have broader riparian zones, are in a more mature seral stage, contain the small amounts of Large Woody Debris present within the watershed and generally have cooler stream temperatures. Lower reaches in all streams generally have narrower riparian edges, are in younger seral stages (or maintained for ornamental purposes), have uniformly low amounts of Large Woody Debris and generally poor (seasonally lethal) stream temperatures.

The reaches which appear to be most intact at this time are the upper regions of the Hospital Branch, the upper regions of the AAA Branch, and Reach 3a of Pony Creek Mainstem. These areas are more mature and diverse, and appear to be providing shading of their respective streams, resulting in cooler stream temperatures.

The assessment of riparian functions and conditions was conducted according to the methodology described in the Urban Riparian Inventory & Assessment Guide, developed for the Oregon Division of State Lands, 1998. The information was collected from existing documentation, augmented with field information developed during the inventory phase of the project. The Riparian Function Assessment Forms for each Riparian Reach and Bank are included in Appendix D. These forms are comprised of a set of assessment questions leading to a formula for rating the specific function and condition as high, medium, or low. It should also be noted that the assignment of left bank vs right bank is made looking downstream.

In general, the Pony Creek reaches rated consistently high for functions of water quality according to the Riparian Function Assessment method (it should be noted that this rating does not consider the width of the riparian area, but rather a number of other parameters related to soil stabilization). Flood management ratings were low for the tributaries and medium for most of the Pony Creek reaches, reflecting the relationship between size of drainage basin and size of floodplain. The upper reaches of Lower Pony Creek rated high for functions of thermal regulation and wildlife habitat, while the northern reaches rated medium. These results indicate the extent, maturity and composition of vegetative cover, diversity in landscape features (such as adjacent wetlands, complexity of stream channels) and the presence of persisting hydrology.

Table XI Riparian Condition Summary

Reach	Channel Habitat Type	Land Use	Current Riparian Condition	Current Seral Stage	Current LWD Condition	Current Shading Condition	Current Water Temp
R1a	Unconstrained by land use in broad valley with multiple terraces	Urban property	Narrow; dominated by grasses and forbs	Managed for ornamental purposes	Low throughout	Little or no Shading	Poor to seasonally lethal
R1b	Unconstrained by land use in broad valley with multiple terraces	Urban property	Narrow; dominated by grasses and forbs	Early stage	Low throughout	Little shading	Generally good to poor, seasonally lethal
R2	Channel unconstrained with multiple channels in wide floodplain	Wetlands, urban property	Broad, diverse; dominated by grasses and forbs	Mature stage	Low	Moderate shading	
R3a	Channel constrained by land use within a broad floodplain.	Urban property	Diverse woody community; dominated by grasses and forbs	Mature stage	Low throughout	Moderate shading	Good to seasonally poor
R3b	Channel unconstrained in wide floodplain	Urban property	Narrow; shrub community, dominated by grasses and forbs	Early stage	Low	Moderate shading	
R4	Channel is alternating terrace - and - hillslope - constrained in a wide floodplain	Urban property	Broad; forested / shrub / herb communities;	Mid-seral stage	low	Well Shaded	Good to seasonally fair
Kmart	Low: unconstrained with multiple channels in wide floodplain; High: single channel unconstrained with multiple terraces	Low: Wetlands, urban property; High: second-growth timber and urban property	Moderately broad; dominated by grasses and forbs in lower portion, shrubs and young conifers in upper portion;	Early stage lower portions, young seral stage higher in sub-basin	Low throughout	Lower portions little shading Upper portions well shaded,	Fair to seasonally poor, low in sub-basin
AAA	Constrained by roads and hillslopes.	Urban property low, second growth timber in higher portions	Moderately broad, forested and shrubs low, forbs and grasses in upper portions	Mid-seral stage nearest stream	Low in lower portion, some present in higher areas.	Good to moderate shading in lower areas; little to moderate in upper areas	Good to seasonally fair
Hospital	Unconstrained with a wide floodplain in lower area; Higher areas are hillslope constrained in a moderate v-shaped valley.	Urban property throughout with second growth timber in higher areas	Moderately broad forested to narrow	Low: early stage; High: mid stage	Low throughout	Little to moderate shading	Fair to seasonally poor low in sub-basin

The results of this analysis are displayed in Table XII, Riparian Function Assessment Summary.

Wetland Habitats

Since 1939, approximately 140 acres (or over 70%) of wetlands historically occurring in the Lower Pony Creek Watershed have been lost to land altering activities: clearing of vegetation, filling for urban development, draining for other purposes. The diversity of wetland types has been diminished as well. In particular, the system has lost the majority of estuarine wetlands located low in the basin, half of the wetlands located just north of Newmark Avenue, and apparently much of the wetlands associated with streamways in the upper reaches of tributaries. This severe loss of wetland area and diversity of types has resulted in much diminished wetland functions for the system as a whole. Please see Figure 9, Historic vs Current Wetland Areas.

The assessment of wetland functions and conditions is based upon definitions and understandings contained within the Hydrogeomorphic Methodology for the Assessment of Wetland Functions (HGM) and the Oregon Freshwater Wetland Assessment Methodology (OFWAM), both developed over the last several years for the Oregon Division of State Lands.

Given that wetlands within the Pony Creek watershed are now consistently associated with riparian areas, using HGM terminology most remaining wetlands can be classified as Riverine Flow-through hydrodynamics and Forested, Shrub or Herbaceous dominated wetlands. One notable exception present within the Study Area is the large estuarine marsh which lies just north of Newmark Road. This area, although still associated with flowing water, can be characterized as Estuarine fringe with bi-directional hydrodynamics and shrub or herbaceous dominated marsh. This site is a remnant of the historic Pony Creek estuarine wetland system, although the hydrology has been altered with the installation of the tidegate at Crowell Road.

The above classifications imply differences in function. For example, "Riverine flow-through" indicates no or little retention / impoundment of water within the wetlands, implying that the wetland is watered by flooding action from the adjacent stream, resulting in a seasonal pattern of inundation / saturation and drying. "Estuarine Bi-directional" indicates that the wetland area is flushed by tidal action, resulting in a regular and frequent cycle of inundation and drying. Dominance by a diversity of vegetation types (forested / shrub / herbaceous) indicates a broad variety of wetland habitat types and associated provisions of habitat functions to vicinity wildlife. Dominance by fewer species indicates fewer habitat types are being provided, offering habitat suitable for fewer species.

Using the OFWAM, we have analyzed the functions of two areas: the first is a fictional wetland of intermediate size, representative of the streamside wetlands which receive sufficient hydrology seasonally to support herbaceous wetland vegetation (designated W-1); and the second is specifically the large wetland complex which lies just north of Newmark Avenue (designated W-Newmark). The results of this analysis are displayed in the following Table XIII Wetland Function Assessment Summary.

CURRENT AND HISTORIC EXTENT OF WETLANDS

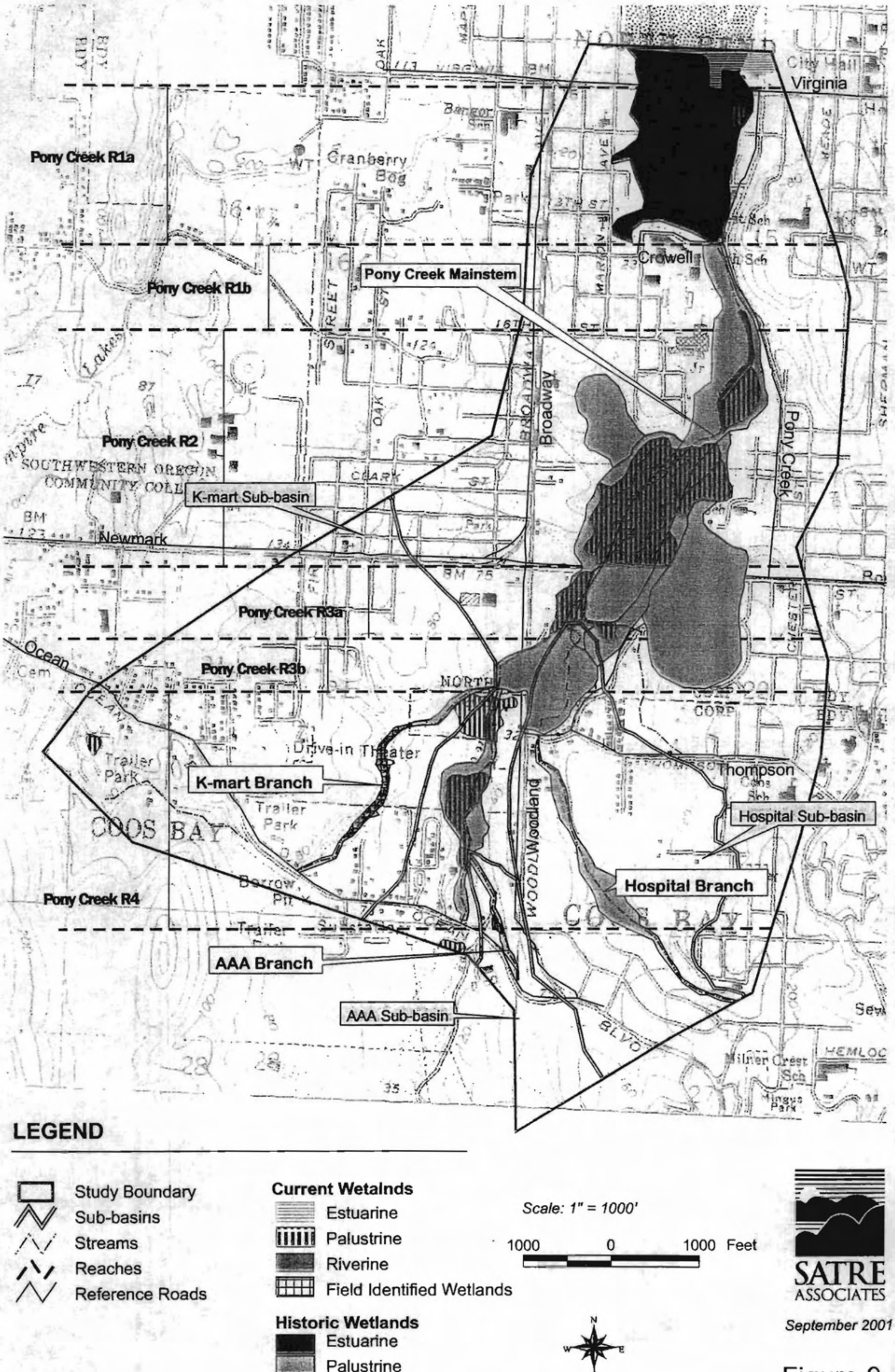


Figure 9

Table XII Riparian Function Assessment Summary

Reach Code	Reach Length (feet)	Average Actual Riparian Width (feet)	Water Quality Functions	Flood Management Functions	Thermal Regulation Functions	Wildlife Habitat Functions
R1a - R	1,771	12 - 60	High	Medium	Medium	Medium
R1a - L	1,771	12 - 70	Medium	Medium	High	Medium
R1b - R	958	12 - 60	High	Medium	Medium	Medium
R1b - L	958	12 - 70	Medium	Medium	Medium	Medium
R2 - R	2,667		High	Medium	Low	Medium
R2 - L	2,667		High	Medium	Low	Medium
R3a - R	812		High	Medium	Low	Medium
R3a - L	812		High	Medium	Low	Medium
R3b - R	604	5 - 10	Medium	Medium	Medium	Medium
R3b - L	604	5 - 7	Medium	Medium	Medium	Medium
R4 - R	2,687		High	High	High	High
R4 - L	2,687		High	High	High	High
AAA - R	1,250	5	High	Medium	High	High
AAA - L	1,250	5	High	Low	High	High
Hospital - R	4,271	5	High	Low	High	High
Hospital - L	4,271	5	High	Low	High	High
Kmart - R	2,041		High	Low	High	High
Kmart - L	2041		High	Low	High	High

TABLE XIII WETLAND FUNCTION ASSESSMENT SUMMARY

Functions	W-1	W-Newmark
Wetland Acreage	0.5 - 5.0 acres	39 acres
Wildlife Habitat	Provides some wildlife habitat functions	Provides diverse habitat functions
Fisheries Habitat	Habitat is impacted or degraded	Habitat is impacted or degraded
Water Quality	Functions impacted	Provides intact functions
Hydrologic Control	Functions impacted	Provides intact functions
Sensitivity to Future Impacts	Potentially sensitive	Potentially sensitive
Enhancement Potential	High potential for enhancement	High potential for enhancement
Education	Potential for educational use	Appropriate for educational use
Recreation	No recreational opportunity	Potential for recreational use
Aesthetic Quality	Moderately pleasing	Aesthetically pleasing
Wetland for Special Protection	Some areas in ESH	Essential Salmon Habitat

As can be seen from the above comparison, the size of a wetland can be significant for ecological functions such as water quality, hydrologic control and habitat provisions. Half of the wetlands remaining in the watershed conform to the above general character. Even a large wetland, however, can have impacted functions and be sensitive to future impacts in this urbanizing setting.

Aquatic Habitats

The several salmonid species of concern for this study are Coho (*Oncorhynchus kisutch*), Chinook (*Oncorhynchus tshawytscha*), Steelhead (*Oncorhynchus mykiss*) and Coastal Cutthroat (*Oncorhynchus clarki clarki*). Each of these species has a unique set of habitat requirements for their various life stages, including seasonal as well as physical requirements. These requirements are displayed in Table XIV.

This generalized depiction of salmon migration, reproduction and life stages, in combination with an understanding of the habitat conditions required and present, allow us to predict where and when salmonids might be present (toned cells) and, if they are not, why not.

According to the Oregon Watershed Assessment Manual, 5 general classes of characteristics determine habitat suitability for salmonids. These are flow regime, water quality, habitat structure, food sources and biotic interactions.

Historically, the flow regime in the Pony Creek system was determined by storm events. Large storms occurred throughout the late fall / winter / early spring months, providing sufficient water quantity and velocity to move stream channels, wash silts and sands from gravels, recruit and distribute large woody debris through the system. Hillsides were forested with Sitka Spruce, Red Alder and other indigenous species which provided mature habitat qualities, as well as sufficient rooting structure to "knit" the soil surface together. Sufficient water percolated through the soil surface to be released during drier seasons and to cool summer stream temperatures.

TABLE XIV SALMONID LIFE STAGE AND HABITAT REQUIREMENTS

COMMON NAME	SCIENTIFIC NAME	WHERE LISTED IN OREGON	SPAWNING HABITAT	TIME OF YEAR	REARING HABITAT	TIME OF YEAR	OCEAN REARING
Chinook	*Oncorhynchus tshawytscha*	Snake River Fall-run ESU Snake River Spring/Summer-run ESU Lower Columbia River ESU Upper Willamette River ESU Upper Columbia River Spring-run ESU	Prefer mainstem and / or lower tributary reaches, with deep holding pools available. Gravel size ranges from 0.5-20 cm.	Fall (although may actually range from April to December)	Estuaries. Abundant instream structure, especially woody debris and stream bank vegetation.	Spring-summer Juveniles may spend weeks to a year or more in freshwater.	2-4 years
Coho	*Oncorhynchus kisutch*	Southern Oregon ESU Oregon Coast ESU	Small, relatively low gradient tributaries / streams. Prefers smaller (0.5 – 8 cm) gravel for spawning substrate.	Fall or early winter	Slower flowing pools (may use lakes for rearing when available). Prefer complex instream stream structures and shaded streams with tree-lined banks.	Spring-summer Juveniles rear in streams one to two years.	Typically migrate to sea in the spring of their second year and spend 16-20 months before returning to freshwater as 3-year old adults.
Coastal Cutthroat Trout	*Oncorhynchus clarki clarki*	Not listed, but now under the ESA jurisdiction of the U.S. Fish and Wildlife Service.	Favor small or moderate-size watersheds with extensive low gradient areas in their lower reaches. Spawning occurs in the small tributaries, preferably in reaches above those utilized by coho. Spawning gravel: 0.5-8 cm in size.	Late winter to early spring	Channel margins and backwaters for early rearing, low velocity pools and side channels for later rearing. Tidal sloughs, marshes, and swamps as holding areas during estuarine rearing.	Spring-summer Juveniles reside in freshwater for two, three, or more years and defend their territory.	1 year, typically not overwintering in saltwater.
Steelhead	*Oncorhynchus mykiss*	Upper Columbia River ESU Snake River Basin ESU Lower / Middle Columbia River ESU Upper Willamette River ESU Oregon Coast ESU (Candidate for listing)	Prefer large or moderate size watersheds with high gradient throughout, selecting sites in the mainstem or more robust tributaries. Prefer lower flow conditions than coho and Chinook. Spawning substrate: 0.5-8 cm gravels.	Varies: usually late winter to spring (lasting up to six months), some return to drainages in spring, summer, or fall.	Freshwater pools and riffles, establishing territories in swift flows, where amount of substrate is relatively high.	Spring-summer Juveniles spend an average of two to three years in freshwater.	1-3 years

Salmon in the Pony Creek system found suitable spawning habitat in the upper reaches of the watershed, but probably not the lower portions. The higher forested slopes kept water temperatures within optimum ranges while providing vegetative input to the food chain, and the hillside / terrace topography provided the complex of low and moderate gradient streambed sufficient to develop graveled spawning beds and well-oxygenated water.

With more intense use of the land came alterations to all parameters of salmonid habitat. Reservoirs and dams were built, altering the flow regime to one in which early and large storm events are ameliorated, resulting in reduced hydrologic power for maintaining the historic stream characteristics, such as distribution of large woody debris and the flushing of fines from gravel beds. Timbering operations and later land clearing for urban purposes has reduced riparian zones, impacting shading of streams and resulting in a significant increase in stream temperatures, as well as recruitment of woody debris for forage and cover into the stream system. Land development has increased the impervious surfaces in the watershed with a further resultant "flashiness" of the drainage system, as well as input of bacteriological and chemical toxins to the streams. Habitat structures have been removed to enhance the ability of streams to transport water and stream complexity ahs been simplified by the elimination of historic multiple channels, resulting in reduced cover within the streams for juvenile salmonids.

The ODFW survey (July 2000) found that there is a limited amount of spawning habitat for Coho salmon now within the Lower Pony Creek study area. Most stream gradients within the Lower Pony Creek study area are very low (0.5 - 1%). Streambeds are generally very silty or sandy in the lower reaches and moderately silty in the higher reaches of the Study Area. Few spawning areas are available due to their small size and the level of siltation. The spawning habitat that is available was judged to be of low suitability due to small size of gravels and high embeddedness (>60%).

All but two of the ODFW Stream Report reaches would be deemed "undesirable" rearing habitat by ODFW standards of percent shade / canopy closure. Table XV, Aquatic Habitat Functions Assessment Summary, displays and rates functions for each reach.

Fish Passage Barriers

Given the low gradient of much of the Study Area, the most potentially significant fish passage barrier is the tidegate at Crowell Road. Given that this is currently non-functioning (chained in open position) this does not present a problem. Additionally, several culverts are perennially sedimented to 2/3 of capacity, such as the culvert at Woodland Avenue.

Table XV Aquatic Habitat Function Assessment Summary

Reach Code	Reach Length (feet)	Sufficient Flow Regime? (to maintain historic stream character)	Suitable Water Quality? (cool temps, high dissolved oxygen, low levels of pollutants)	Desirable Habitat Structure? (pools, riffles, substrate, cover, depth and complexity)	Adequate Food Sources? (maintenance of natural inputs to stream, retention)	Beneficial Biotic Interactions? (competition, pedator / prey, disease - parasite relations)
R1a	1,771	Yes, although somewhat modified	Poor to seasonally lethal temperatures;	Low mix of channel habitats; LWD low; Low stream complexity; very low gravels present	Very low recruitment from narrow riparian zone; tidal flushing provides nutrient input and retention	Unknown
R1b	958	Yes, although somewhat modified	Generally good to seasonally poor temperatures;	Low mix of channel habitats; LWD non-existent; Low stream complexity; very low gravels;	Low recruitment from narrow riparian zone; tidal flushing provides nutrient input and retention	Unknown
R2	2,667	Yes, although somewhat modified	Generally good to seasonally poor temperatures;	Low mix of channel habitats; LWD non-existent; moderate stream complexity; very low gravel content	Good recruitment from diverse wetland / riparian zone; tidal flushing provides nutrient input and retention	Unknown
R3a	812	No, extensively modified	Generally good to seasonally poor temperatures;	Low mix of channel habitats; LWD very low; low stream complexity; some gravels added;	Good recruitment from diverse wetland / riparian zone;	Unknown
R3b	604	No, extensively modified	Generally good to seasonally poor temperatures;	Low mix of channel habitats; LWD very low; low stream complexity; few gravels	Good recruitment from diverse wetland / riparian zone;	Unknown
R4	2,687	No, extensively modified	Generally good to fair temperatures;	Good mix of channel habitats; some LWD present; few gravels, some cobbles present	Good recruitment from mixed riparian areas;	Unknown
AAA	1,250	Yes, substantially unchanged	Fair to seasonally poor temperatures, slightly cooler in higher areas;	Good mix of channel habitats; LWD non-existent in lower portions, present in higher areas; some gravels and cobbles present	Good recruitment from mixed riparian areas along higher zones	Unknown
Hospital	4,271	Yes, substantially unchanged	Good to seasonally fair temperatures;	Low mix of channel habitats; low amounts of LWD throughout; gravels and cobbles non-existent	Good recruitment from mixed riparian areas along higher zones	Unknown
Kmart	2,041	Yes, substantially unchanged	Fair to seasonally poor temperatures, low in the basin, slightly cooler in higher areas;	Good mix of channel habitats; poor LWD, better in higher areas; some gravel and cobbles in upper areas;	Good recruitment from mixed riparian areas along higher zones	Unknown

As can be seen from Table XV, aquatic habitat functions throughout the Lower Pony Creek watershed are at best somewhat modified and at worst lethal to aquatic organisms, including salmon species. Comparing Salmonid Life Stage and Habitat Requirements with the Assessment of Aquatic Habitat, it becomes apparent that some requirements continue to be met within the watershed, while others do not. This also varies by species, as shown below. The most suitable reaches are also indicated and discussed.

Species	Spawning Habitat Suitability	Rearing Habitat Suitability
Chinook Salmon	Most suitable: R1a, R1b, R2, R3a, R3b, and lower portions of AAA, Kmart, Hospital - limited by few deep pools available; few gravels; low mix of channel habitat features; little LWD present; water temperatures could be stressful in summer.	Most suitable: R1a, R1b, R2 - limited by insufficient instream structure (LWD); narrow riparian zones provide limited stream bank vegetation, although R2 provides very good bank vegetation. Water temperatures in summer could be stressful to salmonids.
Coho Salmon	Most suitable: R3b, R4, AAA, Kmart, Hospital - limited by gravel availability;	Most suitable: R2, R3b, pools in AAA, Kmart, Hospital - limited by warm stream temperatures during summer; low instream complexity;
Coastal Cutthroat Trout	Most suitable: R4, upper portions of AAA, Kmart, Hospital - limited by gravel availability;	Most suitable: R2, R3a, R3b, pools in AAA, Kmart - limited by warm stream temperatures during summer; lack of stream complexity;
Steelhead Trout	Most suitable: higher portions of AAA, Kmart - limited by gravel availability; low gradient streams even in upper reaches;	Most suitable: higher portions of AAA, Kmart - limited by lack of gravelly substrate; lack of channel habitat mix;

As seen in the above analysis, even the reaches that are identified as providing the most suitable characteristics for spawning and rearing habitat for the various species are limited by multiple parameters. These parameters represent opportunities and direction for enhancement actions along the most suitable reaches.

Please see Figure 10 for Current Wetland, Riparian and Aquatic Habitats Map.

4.5. Watershed Specific Issues Assessment Summary

We now have an understanding of the hydrologic character of the watershed, how the increasing level of impervious surfacing within the watershed is affecting flow dynamics, how low and high stream flows interact with low and high tides, why sediment is accumulating and flooding is occurring in several locations. We have an understanding of pollution sources, annual and seasonal stream temperatures and the relationship with impervious surfaces versus riparian zones. We have a strong sense of the change that has occurred within the watershed to riparian / wetland / and aquatic habitats, where the remaining areas are located and how they are functioning. Some of this understanding is mapped on Figure 11, Site Constraints Map.

The relationship between hydrology, water quality and riparian / wetland / aquatic habitat, is a complex relationship, particularly in an urban setting. People bring to a watershed a particular set of expectations and desires for their environment, as well as the ability to modify a landscape quickly and extensively.

CURRENT EXTENT OF WETLAND, RIPARIAN, AND AQUATIC HABITATS

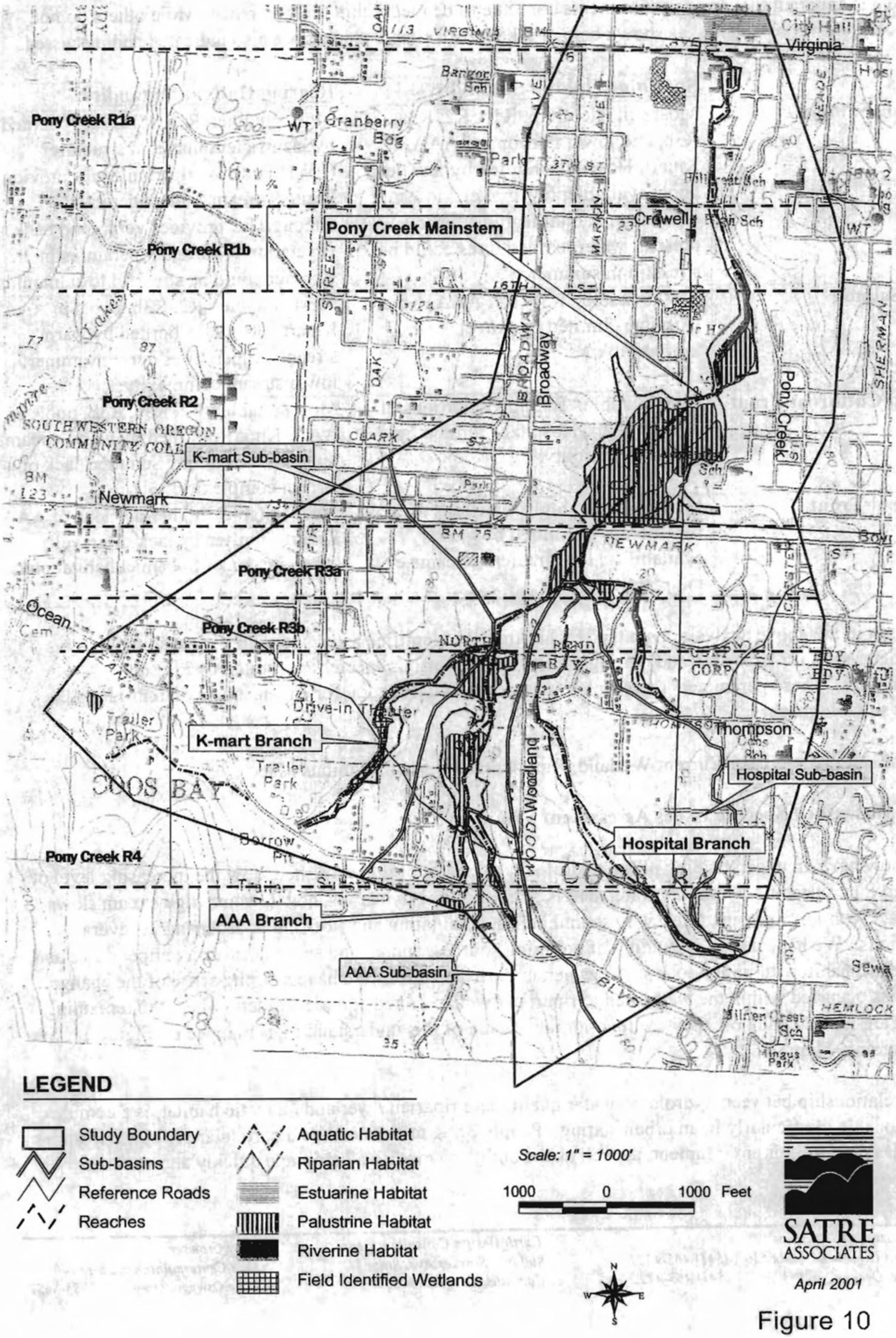


Figure 10

Natural processes can be unknowingly yet significantly altered, producing results which may be contrary to social and cultural desires. These results may also be not easily reversed. Successful restoration efforts will be based upon a sound understanding of these relationships.

The Lower Pony Creek watershed area is varied in topography, but dominated by soils of a sandy and silty nature. The drainages are low gradient streams, with stream velocities established by the rate of water released from the Merritt Lake Dam and the slope of the stream channels. Stream velocities are therefore quite low, with a resultant inability for the Creek to transport large volumes or large sized particles of sediment. This is evidenced by the heavy siltation of the streambed in the majority of reaches of the Lower Pony Creek Study Area. As a result of the inability to transport sediment, the Creek has become shallower and herbaceous and shrubby wetland vegetation is encroaching into what was historically a more dynamic stream channel, with peak flows occurring in response to smaller storm events. Fortunately (as regarding the rate of siltation of the streambed) the two dams that separate Upper from Lower Pony Creek also block a significant portion of the sediment contributed by reaches above the dams.

The Creek is further limited physically by the series of culverts, tidegates, levees, roads, parking lots and building footprints which impinge upon the historic floodplain / wetland / riparian complex, as well as increase the amount of surface runoff sent to the stream system. The ability to convey quantities of water beyond the normal flow is diminished. As mentioned earlier, urbanization of a watershed leads to an exaggeration of the impact of more frequent storm events (due to increased impervious surfaces, diminished percolation through the soil, decreased coefficients of runoff friction and so forth) and these become the primary shapers of channel morphology, as well as the more frequent cause of discomfort and inconvenience to persons / businesses located nearby. This is the situation in several locations, specifically near Waite / Woodland just south of Newmark.

The physical limitation also affects the quality of the water, by elevating stream temperatures through reduced riparian shading and the related reduction in dissolved oxygen, and the increased contribution of runoff pollutants, animal wastes, fertilizers, pesticides, herbicides, and leakage from sanitary facilities (pipes and septic systems). Suspicious odors and algal mats were noted in several reaches, particularly the Kmart branch, and much of the riparian system has been removed from near the high school, downstream to the mouth of the Creek.

Altered hydrology, siltation of streambeds, reduced riparian and wetland vegetated zones, increased stream temperatures and decreased dissolved oxygen have all impacted the ability of this system to support aquatic life, particularly salmonid species, as they prefer cooler waters for spawning and rearing habitat.

Recommendations for enhancement and restoration needs be considered for site specific and watershed-wide applicability. Numerous suggestions will be made and considered in the Action Plan, which follows.

SITE CONSTRAINTS

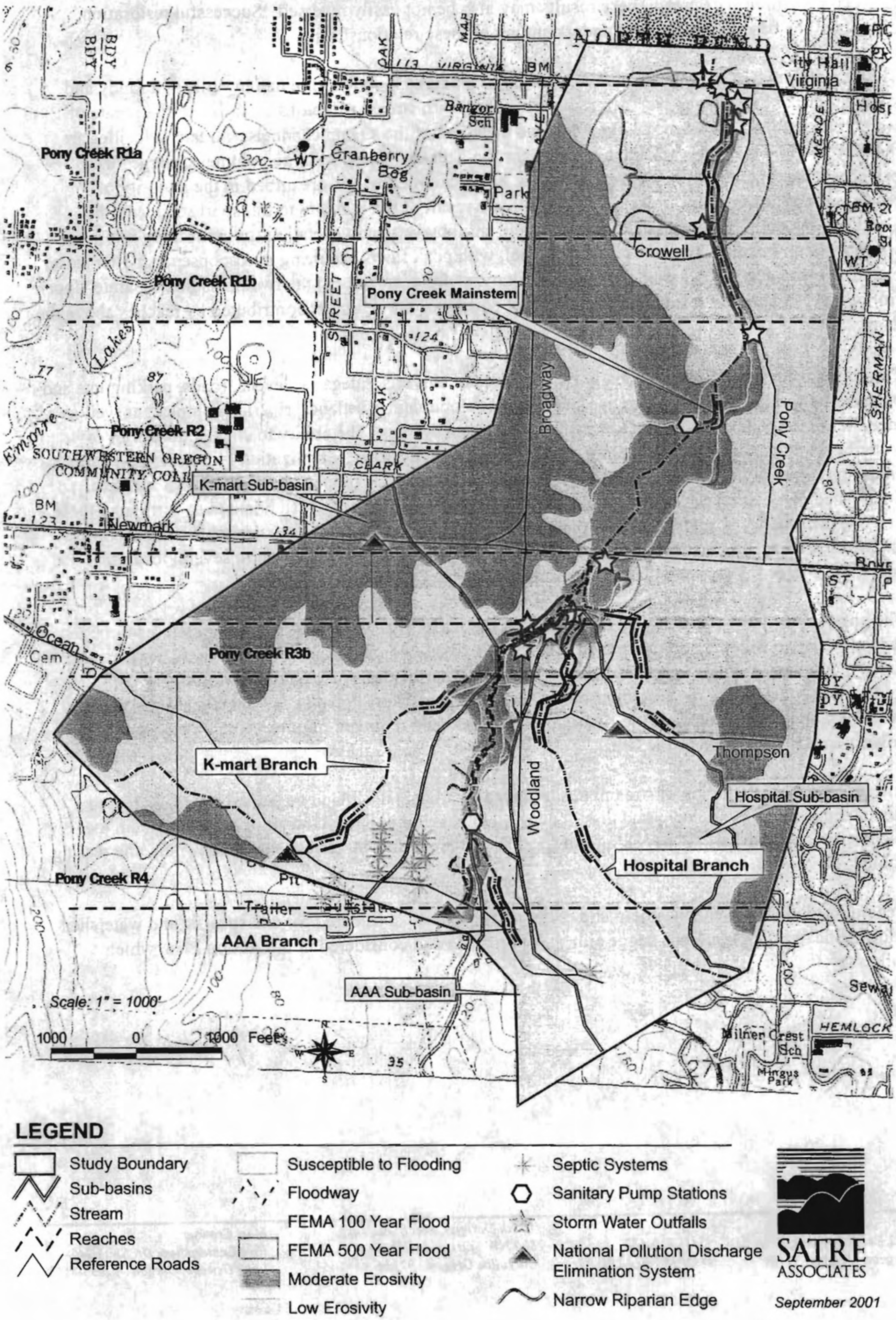


Figure 11

5. POTENTIAL ACTION PLAN

As identified in the previous sections of this document, there exists many broad-scale and long-term as well as site scale and short-term opportunities to improve the ecological condition of the Lower Pony Creek Watershed.

It is important to acknowledge, however, that the watershed is becoming / has become urbanized, and that it is therefore not realistic to expect the watershed to function as it did in pre-urbanized times. This change is significant and substantially irreversible, and it is important to adjust restoration expectations in order to identify activities which will be truly restorative as well as cost-effective.

Within an urban watershed, *it is not reasonable* to expect that:

Hydrology will function as it did prior to development of dams, roads, culverts, roofs, parking lots, other impervious surfaces and storm sewer systems;

Water quality will be as good as it was prior to introduction of domestic pets and farm animals, septic sewage systems, leaking sanitary pipes and pump stations, and high levels of pollutants from impervious surfaces washed into the stream system following the first rain of the year;

Streamside vegetation will be as diverse and extensive as it was when it was only controlled by cycles of fire and flood, rather than controlled by filling, logging, lopping, chopping, clipping and mowing;

Stream temperatures will be as cool as they were when multiple stream channels flowed through streamside vegetation, with summer flows augmented by cool water stored in the soil;

Wildlife and fish species will be present in the same numbers and species as they were historically; and

The Watershed will look like a non-urbanized landscape.

However, within an urban watershed *it is reasonable* to expect that:

Flooding will be an infrequent, localized and directed occurrence;

Soil will be stabilized on hillsides;

Water quality will be good except for the infrequent accidental episode;

Streamside vegetation will be diverse, lush and provide optimal wildlife habitat;

Stream temperatures will be cool enough and water quality good enough to support numerous fish species;

Stream courses will be complex and dynamic enough to provide adequate forage and cover for multiple life stages of fish;

The Watershed will be a rich, diverse and aesthetically pleasing place to live.

It is generally acknowledged (and made explicit in "Practical Methods for Stream and Watershed Rehabilitation", Moses and Morris 2001) that urban watershed restoration projects must include stabilization activities for hillsides and channels. Sediment yield must be reduced as much as possible by 1) enhancing water storage and infiltration on hillsides, 2) decreasing the erosive potential of runoff, and 3) stabilizing eroding channels and hillslopes. Recommendations for these activities are included in the Long-Term Actions.

It should be noted that the short-term actions are designed to alleviate the immediate needs of property owners, whereas the longer-term actions will bring a broader scale, more sustainable and beneficial response for the issues present in the watershed. It should also be noted that each Action Item in the Plan will have advantages and disadvantages unique to the item.

5.1. Short – Term Action Items

Short-term action items have been identified to specifically address the immediate issues of flooding, diminished water quality and degraded aquatic habitat. It should be recognized that these items will generally be costly to maintain in the long term and should be seen only as temporary.

Hydrology Action Items

Dental Clinic/Medical Center

Remove beaver dams to maintain channel conveyance capacity. Clean accumulated sediment out of the culvert under Waite Street.

Consider developing sediment basins just upstream of problem culverts.

Maintain an open channel through selective vegetation maintenance and removal.

Repair the tidegate or replace with a unidirectional gate to reduce flooding.

Automobile Retail Lot/ Coca Cola

Maintain an open channel through selective vegetation maintenance and removal

Pony Village

The capacity of stream channel and hydraulic structures does not appear to impact flooding. There are no specific recommendations in this section.

Channel capacity-increasing actions would help with flooding in the immediate vicinity of the activity. However, they would require continual maintenance, as sediments will transport back into the excavated area. Would also potentially impact water quality and habitat, and might require state and federal permits.

Water Quality, Point and Nonpoint Sources and Temperature Action Items

Track down source of suspicious odors reported by ODFW crews. Inspect sanitary pump stations and pipelines for leaks.

Monitor stream channels for algal mats which may indicate high nutrient loadings. Look at relating these to the various potential pollutant sources shown on Figure #11, Site Constraints Map.

Complete a thorough investigation of septic systems that may exist within the study area and upslope.

Begin planting shade-providing riparian vegetation.

Institute a public education program that promotes the wise use of water in the watershed, how toxic materials placed into storm drains affects water quality and ecological health downstream of the outfall, and the value of vegetated riparian areas for maintaining cool stream temperatures.

Initiate requirements for storm water outfall retention on-site and for flow dissipation structures. By reducing the volume of water even temporarily, the peak flows from storm events are distributed over more time, more closely mimicing historic responses to storm events. These basins could also function as groundwater recharge locations if properly design. By reducing the velocity of runoff coming into the stream, soils are less likely to be mobilized and transported downstream.

Riparian, Wetland and Aquatic Habitat Action Items

Protect from further degradation and loss, those areas remaining which provide high existing riparian, wetland and aquatic habitat values.

Institute a public education program that promotes the value of vegetated riparian areas.

Identify and correct barriers to fish passage within the entire Pony Creek system, such as improperly operating tide gates (Crowell Road, others), inadequately sized culverts (Newmark).

Install instream woody debris structures to add habitat complexity for aquatic organisms.

Begin planting shade-providing riparian vegetation. Areas which are deficient in riparian zone width are identified on the Site Constraints Map, Figure #11.

Recommendation:

In the very short term continue to remove beaver dams, accumulated sediments and encroaching vegetation from within the channels in the vicinity of flooding locations, in order to meet City responsibilities. Conduct repairs to the tidegate, since the hydrologic analysis shows that having it locked open is the worst possible scenario. Consider replacing the gate with a one-way tidegate, as this appears to offer reductions in peak water elevations upstream.

Continue the monitoring program for water quality and stream temperature. Conduct additional field inventory work for water quality degrading inputs, including septic systems and leaking sanitary sewer components, and erosive storm sewer outfalls. Continue monitoring programs for fish presence and passage barriers.

The issue of beavers is a difficult one. They are well-known to be beneficial for a large number of ecological parameters, including retention of water in the watershed and the provision of aquatic / wetland habitat that would not be present otherwise. As one of the major landscape-refining elements in coastal and northwest landscapes, we owe much of our heritage of vegetative patterns, wildlife assemblages and fisheries vigor to the beaver. In this situation, however, the beaver are exacerbating a difficult situation by raising normal high water elevations in the vicinity of buildings that have been flooding. By raising normal high water elevations the beaver activities are also decreasing the capacity of the floodplain to disperse flood waters. In the short term, beavers are part of the problem.

Prioritize areas of highest value for protection from further development, such as the large wetland complex north of Newmark Street, the Kmart tributary / Pony Creek Mainstem confluence, the wetland west of Woodland Avenue, the floodplain near the Woodland Medical Center and the upper reaches of all streams. Construct instream woody structures in stream reaches currently lacking LWD (refer to ODFW Aquatic Habitat Inventory for stream reach segments), and, where space allows, let streams redevelop some of their historic dynamic character and resulting complexity by meandering and multiplying. Commence riparian enhancement plantings with native, locally grown species, in areas identified as currently inadequate, particularly the lower reaches of Pony Creek.

As quickly as possible, steps should also be taken to initiate broad-scale sediment stabilization on hillsides and stream banks. On hillsides, these measures should include tighter municipal Erosion and Sediment Control Plan requirements for building permits for site development activities; emphasize use of bioengineering methods for site and slope stabilization; and installation of sediment basins upstream of problem culverts. These basins would not only trap sediments but might mimic historic short rapids and falls, allowing for cleaning of gravels just downstream. Would need to be kept short to comply with ODFW fish passage requirements.

Planting of woody vegetation back from the edge of channels is believed to reduce the occurrence of encroachment by herbaceous material into the channel. Fast-growing native trees (such as red alder) could be planted 5' back from the edge of water and, in combination with removal of herbaceous plants from within the channel, would result in a less-obstructed channel over time.

It is also possible to "kick-start" riparian reforestation by seeding appropriate species and mulching with wood chips / leaf litter that will offer protection and nutrients to developing seedlings. This also benefits forest soil by imitating the accumulated duff found in more mature forested environments.

5.2. LongerTerm Action Items

Hydrology Action Items

Dental Clinic/Medical Center

Increase capacity of the culvert under Waite Street after further analysis, by replacement. Consider moving to open-bottom arch culvert pipe or bridge / viaduct.

Maintain sedimentation basin upstream from choked culverts;

Consider and move toward a property trade between the City of North Bend and the Woodland Medical Center owners, to allow for significant floodplain / wetland / riparian restoration at this important location.

Automobile Retail Lot/ Coca Cola

Evaluate the capacity of the local stormwater conveyance system to determine if upgrades are necessary and where they may be most beneficial.

Continue and expand the policy of on-site detention of storm water, to mimic historic runoff quantities to the low-gradient Lower Pony Creek system. In particular, the upper reaches of the various Pony Creek branches may present significant siting opportunities for detention basins, in a pattern which mimics the presence of more beaver and beaver dams in the Pony Creek system. These could be designed with multiple functions in mind, such as provision of aquatic habitat and ground water recharge.

Implement a policy of reduced impervious systems throughout the watershed, using such strategies as pervious pavement, rooftop gardens, clustered developments, reduced road widths, on-site detention / percolation basins, wetland restoration.

Facilitate the development of a reservoir / water release strategy that more closely mimics historic basin hydrology. This strategy would recognize the need for peak events early in the rainy season, as well as providing adequate hydrology in summer to maintain tolerable stream temperatures for aquatic organisms.

Water Quality, Point and Nonpoint Sources and Temperature Action Items

Refine monitoring strategy: Evaluate the results from earlier mapping and determine the locations at which additional information on stream temperature and water quality is desired. Move away from one-time measurements and toward regular or continuous water quality monitoring. Also, target extreme weather events for more frequent (i.e., 3-5 times per day for the duration of the event) monitoring.

Identify on-going municipal practices which contribute to degradation of water quality, such as street sweeping to drains; insufficient control of storm runoff; lack of sufficient inventory and maintenance of storm and sanitary sewer systems;

Facilitate the development of a reservoir / water release strategy that more closely mimics historic basin hydrology. This strategy would recognize the need for peak events early in the rainy season, as well as providing adequate hydrology in summer to maintain tolerable stream temperatures for aquatic organisms.

Consider human-specific fecal bacterial monitoring program to separate the potential for waterborne human pathogens from ambient wildlife fecal coliform bacteria.

Promote development activities only on non-erodible soils and beyond floodplains. More than half of the watershed possesses this soil characteristic, and the vast majority of the watershed is beyond any floodplain.

Continue the riparian planting effort until all reaches have developed a mature and diverse riparian edge. Ensure sufficient vegetation develops to shade as much of the streams as possible, and that native plantings are selected appropriate to the elevation of the site and the size of the stream. Continue the water temperature monitoring effort in order to determine the effectiveness of the plantings.

Riparian, Wetland and Aquatic Habitat Action Items

The City of North Bend should apply for monies to conduct a formal Local Wetland and Riparian Areas Inventory and Assessment. This program, managed by the Oregon Division of State Lands, would refine the information developed in this document and allow for even more-informed decision making by the community.

Prioritize areas where enhancements / repairs to the existing habitat areas could be most easily made, and make them available to local groups and developers as designated for riparian, wetland and aquatic habitat mitigation. These enhancements could include reprofiling of steep stream banks, additional riparian area plantings; broadening / re-establishment of wetland terraces within the riparian zone; addition of specific habitat components to the creek system (such as large woody debris placements, instream boulder structures, and off-channel linear backwater areas) and additional side channels through vegetated areas. Where it does not create conflict, beavers could be re-introduced.

Identify and acquire properties within the watershed that would provide multiple ecological benefits. Protect by public ownership, enhance with volunteer activities. Move toward a greenway of public ownership along all stream banks, that might include pervious trail development, interpretive signage, vista points. Get people aware, involved and develop a sense of stewardship for the watershed.

Identify on-going municipal practices which contribute to degradation of riparian / wetland / aquatic habitat, such as street sweeping to drains; insufficient control of storm runoff; lack of sufficient inventory and maintenance of storm and sanitary sewer systems, mowing within riparian areas, use of deicing chemicals that are harmful to water quality and aquatic habitats.

Identify and implement an appropriately-scaled riparian setback which complements the standards applied by the Division of Land Conservation and Development during the periodic review process. Several alternatives exist: the Safe Harbor option establishes a 50 foot setback, while the Urban Riparian Areas Inventory methodology utilizes a distance from the edge of the water resource equivalent to the Potential Tree Height (often 90 - 120 feet).

Initiate a program of riparian / wetland / floodplain restoration within and beyond the Study Area. This may include elevating / moving existing buildings from the floodplain, replacing undersized / partially sediment culverts, shifting of levees or dikes.

Improve the access for salmon to historic spawning areas in the upper reaches of the Pony Creek watershed. This will need to be negotiated with the North Bend Coos Bay Water Board.

Continue with a program to add complexity and diversity within all streams. This includes instream structures, such as large woody debris, as well as allowing streams to develop multiple braided channels through vegetated areas.

Continue to develop alternatives to the use of the automobile. Mass transit, pedestrian / bicycling alternatives, more mixed-use landscape development can all contribute to a reduced need for roads and impervious surfaces, and the attendant environmental impacts that result from reliance upon the automobile.

6. GLOSSARY OF TERMS

Aerobic - A situation in which molecular oxygen is a part of the environment.

Anaerobic - A situation in which molecular oxygen is absent (or effectively so) from the environment.

Bioavailability – Nutrients that are present in forms which can readily be used by organisms.

Biosolids - Biosolids are the nutrient-rich organic materials resulting from the treatment of sewage sludge (the name for the solid, semisolid or liquid untreated residue generated during the treatment of domestic sewage in a treatment facility). When treated and processed, sewage sludge becomes biosolids which can be safely recycled and applied as fertilizer to sustainably improve and maintain productive soils and stimulate plant growth.

Channelize - To straighten the bed or banks of a stream, or to line with concrete or other materials.

Degraded - Lowered in quality from adverse impacts such as vegetation removal, invasion of nonnative species and/or draining.

Dike - A bank (usually earthen) constructed to control or confine water.

Dissolved Oxygen – Amount of oxygen gas (O_2) dissolved in a given volume of water at a particular temperature and pressure.

Dominance - A descriptor of vegetation that is related to the standing crop of a species in an area, usually measured by height, areal cover or basal area (for trees).

Dominant Species - A plant species that exerts a controlling influence on or defines the character of a community.

Emergent Plant - A rooted herbaceous plant species that has parts extending above a water surface.

Eutrophication – The depletion of oxygen levels through an increase in organic and mineral nutrients.

Fill Material - Any material placed in an area to increase surface elevation.

Flooded - A condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from high tides, or any combination of sources.

Flood Prone Area - A topographic feature such as a depression, swale or 100-year floodplain within the riparian area which is prone to flooding.

Forb – A broad-leaved, non-woody plant that dies back to the ground each year.

Glide – A slow moving, relatively shallow type of run.

Growing Season - The portion of the year when soil temperatures at 19.7 inches below the soil surface are higher than biologic zero (5° C). Can be approximated by the number of frost-free days.

Herb - A nonwoody individual of a macrophytic species, or seedlings of woody plants that are less than 3.2 feet in height.

Hydric Soil - A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation.

Hydrologic Basin - An area of land that drains into a particular river or body of water, usually defined by topography.

Hydrophytic Vegetation - The sum total of macrophytic plant life growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

Impervious Surface - A surface that cannot effectively absorb or infiltrate water, such as roads, parking lots, and sidewalks.

Indicator Status - One of the categories that describes the estimated probability of a plant species occurring in wetlands.

Inundation - A condition in which water from any source temporarily or permanently covers a land surface.

Man-Induced Wetland - Any area that develops wetland characteristics due to some activity of humans.

Macrophyte – Any plant, especially aquatic plant, large enough to be discerned by the naked eye.

Pathogen – An organism, usually a microorganism, capable of producing disease.

Ponded - A condition in which water stands in a closed depression. Water may be removed only by percolation, evaporation, and / or transpiration.

Reach - A segment of a riparian area with relatively homogeneous physical characteristics. Its length parallel to the water resource can be determined by major changes in vegetation type, slope or by changes in land use.

Reference Site - An undisturbed area that exhibits the potential natural vegetation under a particular set of conditions. Used as a model for restoration, disturbed sites, or where permission was not granted to enter the property for data collection.

Riparian - Those areas associated with streams, lakes and wetlands where vegetation communities are predominantly influenced by their association with water.

Riparian Area - An area adjacent to a water resource which affects or is affected by the water resource.

Sample Plot - An area of land used for measuring or observing existing conditions.

Soil - Unconsolidated mineral and organic material that supports, or is capable of supporting, plants, and which has recognizable properties due to the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over time.

Soil Series - A group of soils having horizons similar in differentiating characteristics and arrangement in the soil profile, except for texture of the surface horizon.

Surface Runoff - Water that flows over the surface of the land as a result of rainfall or snowmelt. Surface runoff enters streams and rivers to become channelized stream flow.

Top of Bank - Topography break at the top of the streambank; point at which flood water leaves the channel.

Transect - A line on the ground along which observations are made at some interval.

Vegetation Layer - Canopy, midstory, and groundcover levels of vegetation, commonly represented by trees, shrubs and herbaceous plant species. Determined by vegetation height.

Watershed - The area drained by a tributary or a river system.

Wetlands - Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

7. REFERENCES

Color Communications, Inc., "EarthColors Soil Color Book", 1997.

City of North Bend, North Bend School District, National Park Service, "Pony Creek Greenway, A Concept Plan", 1999.

Department of the Army, U.S. Army Corps of Engineers, Waterways Experiment Station Environmental Laboratory, "Corps of Engineers Wetlands Delineation Manual", Technical Report Y-87-1, January 1987.

FEIS, Coos Bay - North Bend Water Board Water Supply Expansion Project, Corps of Engineers Action ID: 94-010, March 1999.

Guard, B. Jennifer, "Wetland Plants of Oregon and Washington", Lone Pine Publishing, 1995.

Hitchcock and Cronquist, "Flora of the Pacific Northwest", University of Washington Press, 1998.

Hynes, H. B. N. 1970. "The Ecology of Running Waters". Liverpool University Press, Liverpool, UK. 555 p.

Independent Multidisciplinary Science Team. 1999. Recovery of Wild Salmonids in Western Oregon Forests: Oregon Forest Practices Act Rules and the Measures in the Oregon Plan for Salmon and Watersheds. Technical Report 1999-1 to the Oregon Plan for Salmon and Watersheds, Governor's Natural Resources Office, Salem, Oregon.

Miller, J. and R. Garono, "Tillamook Bay National Estuary Project: Issue Forum Summaries", 1994. Technical Report 01-94.

NOAA (National Oceanic and Atmospheric Administration). 2000. Tidal Differences and Other Constants, data retrieved for Coos Bay, Oregon, using Station 9419750 CRESCENT CITY, PACIFIC OCEAN, CA as reference station [online report], revised December 2000. URL: http://co-ops.nos.noaa.gov/tab2wc1b.html#132

NonPoint Source Solutions, "Draft Oregon Watershed Assessment Manual, October 1997.

Oregon Department of Fish and Wildlife, "Aquatic Inventory Project: Stream Reports", August 2000.

Oregon Department of Fish and Wildlife, "1995 Biennial Report on the Status of Wild Fish in Oregon", 1995.

Oregon Division of State Lands, "Urban Riparian Inventory and Assessment Guide, A Tool for Oregon Land Use Planning", March, 1998.

Oregon Division of State Lands, "Oregon Freshwater Wetland Assessment Methodology", Wetlands Program, Oregon Division of State Lands, Salem, Oregon, April, 1996.

Oregon Natural Heritage Program, "Rare, Threatened and Endangered Species of Oregon", Oregon Natural Heritage Program, Portland, Oregon, 1998.

Technical Report 1999-1 to the Oregon Plan for Salmon and Watersheds, Governor's Natural Resources Office, Salem, Oregon.

U.S. Department of Agriculture, Forest Service, "Natural Vegetation of Oregon and Washington", General Technical Report PNW-8, 1973.

U.S. Department of Agriculture, Natural Resource Conservation Service, "Soil Survey of Coos County Area, Oregon", issued September 1987 (1981 data).

U.S. Department of Agriculture, Natural Resource Conservation Service, West National Technical Center, "Western Wetland Flora, Field Office Guide to Plant Species", date unknown.

U.S. Department of Agriculture, Soil Conservation Service, "Hydric Soils of the State of Oregon", 1987.

U.S. Department of Agriculture, Soil Conservation Service, "Hydric Soils in Lane County Area, Oregon", 1990.

U.S. Department of Agriculture, et. al., "Stream Corridor Restoration: Principles, Processes, and Practices," October 1998.

U.S. Fish and Wildlife Service, Cowardin, L.M., et. al., "Classification of Wetlands and Deepwater Habitats of the United States", December 1979.

U.S. Fish and Wildlife Service, Reed, Porter B., "National List of Vascular Plant Species That Occur in Wetlands: Northwest (Region 9)", 1996 National Summary.

U.S. Fish and Wildlife Service, National Wetland Inventory, "Coos Bay, Oregon, 7.5 Minute Quadrangle", 1994.

U.S. Geological Survey, "Coos Bay, Oregon, 7.5 Minute Topographic Quadrangle", photorevised 1986.

Wetzel, R. G. 1975. Limnology. W. B. Saunders Co. Philadelphia, PA. 743 p.