Final Draft

TACOMA SHORELINE INVENTORY AND CHARACTERIZATION

Prepared for:
City of Tacoma

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ACRONYMS AND ABBREVIATIONS

BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
CBNRT	Commencement Bay Natural Resources Trustees
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Capital Improvement Program
CSHI	Comprehensive Scheme of Harbor Improvements
DAHP	Department of Archaeology and Historic Preservation
DNR	Department of Natural Resources
DBH	Diameter at breast height
DPS	distinct population segment
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
LWD	Large Woody Debris
MCA	Marine Catch Area
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MTCA	Model Toxics Control Act
MVDS	Marine View Drive Slope
NGVD	National geodetic vertical datum
NOAA	National Oceanic and Atmospheric Association
NPDES	National Pollution Discharge Elimination System
NRDA	Natural Resource Damage Assessment
OHWM	Ordinary High Water Mark
PHS	Priority Habitats and Species
PMI	Port Maritime Industrial
PSE	Puget Sound Energy
Qvr	Vashon Recessional Outwash
Qvs	Steilacoom Gravels
RCW	Revised Code of Washington
RM	River Mile
SEPA	State Environmental Policy Act
SMA	Shoreline Management Act
SMP	Shoreline Master Program
SSB	Substitute Senate Bill
TMC	Tacoma Municipal Code
TMDL	Total Maximum Daily Load
UGA	Urban Growth Area
USGS	United States Geologic Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area

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1.0 INTRODUCTION

1.1 Background and Purpose

The purpose of this study is to conduct a baseline inventory and characterization of conditions relevant to the shoreline resources of the City of Tacoma, Washington. According to Substitute Senate Bill (SSB) 6012, passed by the 2003 Washington State Legislature, cities and counties are required to amend their local shoreline master programs (SMPs) consistent with the Shoreline Management Act (SMA), Revised Code of Washington (RCW) 90.58, and its implementing guidelines, Washington Administrative Code (WAC) 173-26. Pierce County and the cities within Pierce County are required to complete the amendment process by the end of 2011. Tacoma is currently preparing a comprehensive SMP update. An early step in the process is development of a shoreline inventory and characterization. The inventory and characterization describes current shoreline conditions and provides a basis for updating the City's SMP goals, policies, and regulations. This characterization will help the City identify existing conditions, evaluate the existing functions and values of its shoreline resources, and explore opportunities for conservation and restoration of ecological functions.

This study characterizes ecosystem-wide processes and how these processes relate to shoreline functions. Processes and functions are evaluated at two different scales: (1) a watershed or landscape scale, and (2) a shoreline reach scale. The purpose of the watershed or landscape scale characterization is to identify ecosystem processes that shape shoreline conditions and to determine which processes have been altered or impaired. The intent of the shoreline reach scale inventory and characterization is to: (1) identify how existing conditions in or near the shoreline have responded to process alterations; and (2) determine the effects of the alteration on shoreline ecological functions. These findings will help provide a framework for future updates to the City's shoreline management policies and regulations.

1.2 Report Organization

The information in this report is divided into eleven main sections. The introduction discusses the purpose of this report and describes the regulatory context for shoreline planning. The second section describes the methods, approach, and primary data sources used for this inventory and characterization. The third section provides a profile of the ecosystems surrounding the City. This ecosystem profile discusses regional overview, process controls (e.g., climate, geology), and key ecosystem-wide processes. The fourth, fifth, sixth, and seventh sections are the shoreline inventory, separated into the nearshore marine, Puyallup River, Hylebos Creek, and Wapato Lake shorelines. The inventory provides information regarding land use patterns and the physical and biological characterization of conditions in the vicinity of the shoreline regulatory zone (referred to as the shoreline planning area). Section 8 summarizes conditions for the each shoreline area in the City's planning area, provides an assessment of shoreline functions, and identifies and discusses potential opportunity areas for protection, enhancement, restoration, and public access. Section 9 identifies data gaps. Section 10 provides conclusions. References are contained in Section 11.

Appendices A and B of this report represent a map folio that identifies the City's shoreline planning area and documents various biological, land use, and physical elements at a variety of scales.

1.3 Regulatory Overview

1.3.1 Shoreline Management Act and Shoreline Guidelines

Washington's Shoreline Management Act (SMA) was passed by the State Legislature in 1971 and adopted by the public in a referendum. The SMA was created in response to a growing concern among residents of the state that serious and permanent damage was being done to shorelines by unplanned and uncoordinated development. The goal of the SMA was "to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." While protecting shoreline resources by regulating development, the SMA is also intended to provide for appropriate shoreline use. The SMA encourages public access and use of the shoreline and provision of water-dependent uses, as well as land uses that enhance and conserve shoreline functions and values.

The primary responsibility for administering the SMA is assigned to local governments through the mechanism of local shoreline master programs, adopted under guidelines established by Ecology. The guidelines (WAC 173-26) establish goals and policies that provide a framework for development standards and use regulations in the shoreline. The SMP is based on state guidelines but tailored to the specific conditions and needs of individual communities. The SMP is also meant to be a comprehensive vision of how the shoreline area will be managed over time.

1.3.2 Shoreline Jurisdiction

Under the SMA, the shoreline jurisdiction includes areas that are 200 feet landward of the ordinary high water mark (OHWM) of waters that have been designated as "shorelines of statewide significance" or "shorelines of the state." These designations were established in 1972 and are described in WAC 173-18 and WAC 173-20. Generally, "shorelines of statewide significance" include portions of Puget Sound and other marine waterbodies, rivers west of the Cascade Range that have a mean annual flow of 1,000 cubic feet per second (cfs) or greater, rivers east of the Cascade Range that have a mean annual flow of 200 cfs or greater, and freshwater lakes with a surface area of 1,000 acres or more (RCW 90.58.030). "Shorelines of the state" are generally described as all marine shorelines and shorelines of all other streams or rivers having a mean annual flow of 20 cfs or greater and lakes with a surface area 20 acres or greater (RCW 90.58.030).

Under the SMA, the shoreline area to be regulated under the City's SMP must include all shorelines of statewide significance, shorelines of the state, and their adjacent shorelands, defined as the upland area within 200 feet of the OHWM, as well as any associated wetlands (RCW 90.58.030). "Associated wetlands" means those wetlands that are in proximity to and either influence or are influenced by tidal waters or a lake or stream subject to the SMA (WAC 173-22-030 (1)). These are typically identified as wetlands that physically extend into the shoreline jurisdiction, or wetlands that are functionally related to the shoreline jurisdiction

through surface water connection and/or other factors. The specific language from the RCW describes the limits of shoreline jurisdiction as follows:

> *Those lands extending landward for two hundred feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all associated wetlands and river deltas* (RCW 90.58.030(2)(f)).

Local jurisdictions can choose to regulate development under their SMPs for all areas within the 100-year floodplain or a smaller area as defined above (RCW 90.58.030(2)(f)(i)).

Waterbodies in Tacoma regulated under the SMA and the City's SMP include marine shorelines of Puget Sound and Commencement Bay, the Puyallup River, and Wapato Lake. Portions of Hylebos Creek in the City are also regulated under the City's SMP. The Puyallup River and marine areas waterward of extreme low tide are designated as "shorelines of statewide significance." Wapato Lake and marine areas landward of extreme low tide are designated as "shorelines of the state."

1.3.3 City of Tacoma Shoreline Master Program

The City of Tacoma first adopted its SMP in 1976 as an element of the City's long-range comprehensive Land Use Management Plan. The SMP is organized into two major parts. Part I is the Shoreline Plan, providing long-range goals and policies adopted by resolution. Part II establishes shoreline districts, shoreline environment designations, use regulations, and permitting procedures to govern development and other activities in the City's shorelines. Part II of the SMP was adopted by ordinance and codified as Chapter 13.10 of the Tacoma Municipal Code. The most recent comprehensive amendment of the SMP occurred in 1996 (City of Tacoma, 1996). Minor amendments have been approved since that time.

Local SMPs establish a system to classify shoreline areas into specific "environment designations." The purpose of shoreline environment designations is to provide a uniform basis for applying policies and use regulations within distinctly different shoreline areas. Generally, environment designations should be based on biological and physical capabilities and limitations of the shoreline, existing and planned development patterns, and a community's vision or objectives for its future development. The City's SMP establishes three environment designations: Natural, Conservancy, and Urban. The City's SMP further establishes 14 distinct shoreline districts. Each district has shoreline environment designations, management policies, and use regulations applicable to properties in that district.

1.3.4 Other Plan, Programs, and Regulations Affecting Shorelines

1.3.4.1 City of Tacoma Comprehensive Plan

The City of Tacoma's Comprehensive Plan is the official statement adopted by the City that establishes the long-range vision for the city. The Comprehensive Plan anticipates change for the coming 20 years and establishes direction for the future physical growth, development, and improvement of the city. The plan also fulfills the City's responsibilities to manage growth as mandated by the Washington State Growth Management Act (GMA).

There are five primary elements mandated by the GMA: land use, transportation, housing, capital facilities, and utilities. These five general elements were initially adopted in 1993. Other general elements include the Shoreline Master Program as described above. Among the goals of the Comprehensive Plan is ensuring conservation, protection, enhancement, and proper management of natural resources and shorelines, while providing for a balanced pattern of development and the needs of its citizen.

1.3.4.2 City of Tacoma Land Use Regulatory Code

The key regulatory mechanism that implements the Comprehensive Plan is the Land Use Regulatory Code. This code contains the development regulations that govern the manner by which land is used, developed, or redeveloped. This code is found in Title 13 of the Tacoma Municipal Code (TMC) and includes regulations for platting, zoning, shorelines, and critical areas. The zoning ordinance regulates land use by specifying which uses are appropriate within zoning districts.

1.3.4.3 City of Tacoma Critical Areas

The City of Tacoma's critical area regulations were recently updated and are codified in the Critical Areas Preservation Ordnance (CAPO), TMC 13.11. State laws and regulations require that a jurisdiction's shoreline district "provide a level of protection to critical areas within the shoreline areas that is at least equal to that provided by the local government's critical area regulations adopted pursuant to the GMA for comparable areas other than shorelines" (WAC 173.26.221(2)(a)(ii)).

Critical areas include wetlands, aquifer recharge areas, fish and wildlife habitat conservation areas, geologically hazardous areas, and frequently flooded areas (WAC 173.26.201(3)(c)(ii)). In further describing the approach for critical areas, the guidelines describe standards for "critical saltwater" and "critical freshwater" habitats (WAC 173.26.221(2)(c)). Critical saltwater habitats include kelp beds, eelgrass beds, spawning and holding areas for forage fish, subsistence, commercial, and recreational shellfish beds, mudflats, intertidal habitats with vascular plants, and areas with which priority species have a primary association.

1.3.4.4 City of Tacoma's Open Space Habitat Plan and Green Tacoma Partnership

The City of Tacoma is undergoing the development of an Open Space Habitat Plan. The plan will set forth goals, policies, and implementation plans for Tacoma municipal open spaces and natural area that will be reviewed and adopted by the City Council through the annual update of the City of Tacoma's Comprehensive Plan, anticipated to occur in December 2008. The Open Space Habitat Plan will meet goals nine and ten of the GMA. Goal Nine encourages cities and counties to retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water and develop parks and recreation facilities. Goal Ten encourages cities and counties to protect the environment and enhance Washington's high quality of life, including air and water quality, and the availability of water.

Tacoma's Open Space Habitat Plan will analyze the environmental quality and land use of Tacoma's open spaces and natural areas; identify Natural Corridors; identify additional wetland mitigation sites within the identified Natural Corridors; assess agency and community capacity to

manage and restore natural areas, and provide recommendations for the restoration and management of Tacoma's open spaces. The analysis, plan and associated maps will serve as the basis of information for development of an Open Space Program. The Natural Corridors will include public and acquired private lands to provide a city-wide open space management approach that includes the City's significant critical area, their connection to each other and bordering critical areas within the same watershed. The corridor will identify interrupted critical area corridors, as well as open spaces that support the natural environment through biologically sustainable areas that the City will preserve while also providing a balance between the natural and urban built environment for public recreation and aesthetics.

The Open Space Habitat Plan will be completed in partnership with the Green Tacoma Partnership. The Green Tacoma Partnership is a public-private partnership between the City of Tacoma, Metro Parks Tacoma, Tacoma Public Utilities, Cascade Land Conservancy, Tahoma Audubon Society, and the citizens of Tacoma. The Green Tacoma Partnership's goal is to develop and foster community capacity and support to implement the Open Space Habitat Plan. The Green Tacoma Partnership will use the Open Space Program to identify priority projects, allocate project funding, and foster political and community support. The Open Space Habitat Plan will be coordinated with the Shoreline Master Program and critical areas regulatory updates.

1.3.4.5 Commencement Bay Remediation and Restoration

The City of Tacoma has an active and well-established history in nearshore and intertidal restoration, particularly in Commencement Bay. Restoration in the nearshore marine environment of Commencement Bay has occurred over the past 15 to 20 years through the remediation efforts under the Commencement Bay Natural Resource Damage Assessment (CB/NRDA) program. These efforts are part of the implementation of the Commencement Bay Conceptual Restoration Plan (June 1997), which details the restoration components outlined in the preferred alternative – the Integrated Approach – as described in the programmatic Environmental Impact Statement (EIS) prepared for the Commencement Bay cleanup plan. Restoration options for Commencement Bay cleanup were outlined in detail in Volume II - Restoration Options, Commencement Bay Cumulative Impact Study (Shapiro and Associates, June 1993). The Integrated Approach outlined in the EIS includes the implementation of a combination of restoration projects that are designed to maximize the benefits to the damaged natural resources in Commencement Bay, and meet the goals and objectives of the Commencement Bay Natural Resource Trustees. Additional detail on restoration activities is included throughout this report, particularly in Sections 4 (Nearshore Marine Shoreline Planning Area) and 8 (Assessment of Shoreline Functions and Opportunity Areas) of this report.

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2.0 METHODS

2.1 Data Sources

The state master program guidelines state that shoreline inventory and characterizations to support local SMP amendments should be based on scientific and technical information. Inventories should use existing sources of information that are both relevant and reasonably available (WAC 173-26-201(3)(c)).

This report incorporates and builds on past work the City has undertaken relevant to its SMP. In particular, this report incorporates information presented in a shoreline and critical areas mapping and inventory project the City completed in 2004 (GeoEngineers, 2004). The 2004 report and map set are included in this report as Appendix B. References and citations throughout this document to "GeoEngineers, 2004" refer to the mapping and background data sets assembled during that effort. Aside from reconnaissance-level field visits, no new field-based data collection efforts were performed to develop the summaries and characterization included in this document.

The mapping and background data prepared during the 2004 inventory is extensive, and provides the City with substantial information on existing conditions along its shorelines. Information collected and documented includes bulkhead data for the entire shoreline by total armored shoreline length and by bulkhead types, erosion and flood hazard areas, historic fill and intertidal vegetation and habitat, seismic and landslide data, zoning and existing land uses, impervious surfaces, streams, channel migration and floodplains, and more. Appendix B of this report includes 41 maps prepared from the GIS inventory data, as well as a CD that allows the reader to "zoom in" and move around the mapped information at different scales for any of the maps provided. For those readers interested in exploring the GIS inventory data in more detail, access to the GIS metadata is available at the City, and its GIS staff will assist in using the information.

Other key sources of information include City planning documents and technical studies, Pierce County studies and publications, and watershed planning documents for Water Resource Inventory Areas (WRIAs) 10 (Puyallup) and 12 (Chambers-Clover). Mapping information and other studies from state agencies (including Washington Department of Fish and Wildlife, Department of Ecology, and Department of Natural Resources) and the Puyallup Tribe were also used. To analyze spatial patterns and visually display data, numerous cartographic resources were consulted and used in ArcGIS (ArcView 9.1).

2.2 Determining Shoreline Jurisdiction and Planning Area Boundary

This characterization is focused on those shorelines of the state within the city limits of the City of Tacoma. This includes approximately 33.6 miles of marine shoreline (including portions of Puget Sound, the Narrows, and Commencement Bay), 2.7 miles of the Puyallup River (per bank), 0.5 mile of Hylebos Creek (per bank), and Wapato Lake (approximately 1.2 miles and 34 acres surface area). In addition, 3.0 miles of marine shoreline is located in the Browns Point-Dash Point UGA. This is the only UGA with shorelines of the state where annexation is likely to occur over the next several years (Map 1). Finally, the depiction on Map 1 (and others) of "deep

water areas" is intended to graphically represent the areas of the Tacoma Narrows and Commencement Bay within the city's jurisdiction.

The approximate extent of shoreline jurisdiction within the City of Tacoma is shown on Map 1, and referred to throughout this report as the "shoreline planning area." In general, it follows a 200-foot extension from the mapped edge of the approximate ordinary high water mark (OHWM) of shorelines of the state and any bordering, neighboring, or contiguous wetlands, inside the city limits. As noted in Chapter 1, the SMA also defines the shoreline jurisdiction to include "floodways and contiguous floodplain areas landward 200 feet from such floodways" (RCW 90.58.030(2)(f)). This approximate extent of shoreline jurisdiction should be considered useful for planning purposes only, since its resolution is based on relatively coarse mapping. Site-specific delineation of wetlands, floodplains and/or OHWM could result in modifications to the extent of jurisdictional shoreline areas.

Within the City of Tacoma, the floodway of the Puyallup River has been the river channel between its levied banks; thus the shoreline jurisdiction extends 200 feet landward from the river. Recent work by the Federal Emergency Management Agency (FEMA) to update the Flood Insurance Rate Maps for Pierce County and its cities, including Tacoma, has determined that the levies upstream of the Interstate 5 Bridge along the Puyallup River may not contain the extreme flows associated with a 100-year storm. As a result of this recent and still ongoing work, the designated floodway on the south side of the river at the extreme eastern City boundary with the river may be modified. The modification would move the designated floodway outside of the levy at this location, thus in effect expanding the 200-foot shoreline jurisdiction as well. The City will monitor this potential change to the designated floodway and update its shoreline jurisdiction accordingly.

The combined shoreline planning area as shown on Map 1 is approximately 3,471 acres (approximately 5.4 square miles) and represents approximately 10 percent of the City's total land area.

2.3 Approach to Characterizing Ecosystem-Wide Processes and Shoreline Functions

SMA guidelines require local jurisdictions to evaluate ecosystem-wide processes during SMP updates. Ecosystem-wide processes that create, maintain, or affect the City's shoreline resources were characterized using an adapted version of the five-step approach to understanding and analyzing watershed processes described in *Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes* (Stanley et al., 2005). This approach defines watershed processes as the delivery, movement, and loss of water, sediment, nutrients, toxins, pathogens, and large woody debris. While the methodology described in Stanley et al. is focused on freshwater resources, the concepts and approach are applied to the marine nearshore environment to describe nearshore coastal processes, including littoral drift; coastal erosion; sediment supply, transport, and deposition; and functions provided by nearshore marine riparian vegetation. The processes are qualitatively described using available reports and spatial information related to topography, geology, soils, land cover, and other themes. This approach is most appropriate at the watershed scale. However, examining conditions and processes at the watershed and City-wide scales informs local shoreline planning by providing a broader

understanding of how ecosystem-wide processes form and influence conditions in the shoreline planning area.

Natural processes, and alterations to those processes, are described at a variety of geographic scales based on existing reports and readily available mapping information.

2.4 Approach to Inventory and Characterization of Jurisdictional Shorelines

The inventory of shorelines of the state in Tacoma at the shoreline reach scale is intended to characterize conditions in and adjacent to the jurisdictional shorelines of regulated waterbodies. The shoreline planning area roughly approximates the regulatory limits of the City's SMP as described above. GIS data were used to quantify certain conditions in this area (e.g., spatial extent of zoning or land uses). Aerial photography, review of existing reports, and brief field reconnaissance were used to qualitatively describe conditions in the shoreline.

For purposes of the inventory and characterization, shoreline planning areas were divided into reaches based on shoreline type (i.e., marine, river, or lake). A variety of physical and biological factors were considered in delineating reach breaks, including topography and land cover, hydrology, existing land use patterns, and biological resources. Reach break boundaries generally coincide with boundaries of the existing shoreline districts, but may encompass several districts in each reach. Shoreline reach boundaries are shown on Map 1 and are described generally in the following table.

Table 2-1. Shoreline Planning Area Reaches

Reach No.	Reach Name	Corresponding Shoreline Districts
1	Puget Sound - Tacoma Narrows	S-1, S-2, S-3
2	Puget Sound - Point Defiance	S-4, portion of S-5
3	Commencement Bay - Ruston Way	Portion of S-5, S-6, S-7
4	Commencement Bay – Industrial Waterways	S-8, S-10, S-11, portion of S-12
5	Puyallup River	S-9, portion of S-10
6	Hylebos Creek	Portion of S-10
7	Commencement Bay – Marine View Drive	Portion of S-12
8	Wapato Lake	S-14
9	Browns Point-Dash Point UGA	n/a
10	Marine – Deep Water (Commencement Bay and Narrows)	S-13

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3.0 ECOSYSTEM PROFILE

Ecosystem-wide processes are the actions and forces occurring in the landscape that form and maintain the City of Tacoma's shorelines. Ecosystem-wide processes act in combination to influence the function of shorelines in the City. These processes focus primarily on hydrology, specifically the flow characteristics of surface and groundwater, and occur both at the watershed scale and at the local reach scale. Examples of shoreline functions include sediment transport, habitat structure, nutrient filtering, and riparian vegetation, which provide temperature control and organic inputs. Changes in land use patterns and development across the landscape, not solely at the water's edge, may affect these processes and change shoreline functions.

This chapter describes how ecosystem-wide processes affect the function of the City's shorelines as required under the new shoreline guidelines outlined in WAC 173-26-210(3)(d). Information is presented at a watershed-scale and provides a basis for understanding shoreline management in relation to the broader landscape context. This watershed-scale overview is intended to provide context for the reach-scale discussion provided in Sections 4 through 7. The landscape analysis approach to understanding and analyzing watershed processes developed by Stanley et al. (2005) was used and adapted to complete this section of the report. Terms used in this section are defined in the document entitled *Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes* (Stanley et al., 2005).

This chapter is organized to provide:

- An overview of the region, including physical description, land use changes, and existing habitats;
- A discussion of the process controls that influence the form and ecological functioning of the Puyallup River, Hylebos Creek; marine shoreline, and Wapato Lake; and
- A discussion of key ecosystem-wide processes within the City of Tacoma.

Process controls are defined as the landscape factors that set the stage for ecosystem-wide processes. Process controls include factors such as local climate, topography, and geology, each of which determines the type of processes that will occur in a region. For example, the climate (e.g., amount and type of precipitation), topography (e.g., steep or low gradient), and geology/soils (e.g., permeable or impermeable deposits) of a region act together to influence the hydrologic processes (e.g., surface and groundwater movement and storage) within a watershed. These ecosystem processes also control the physical form of the landscape and the type and extent of habitats that occur throughout the ecosystem. Ecosystem processes function at multiple scales, from the watershed scale to site-specific habitat scale (Figure 3-1).

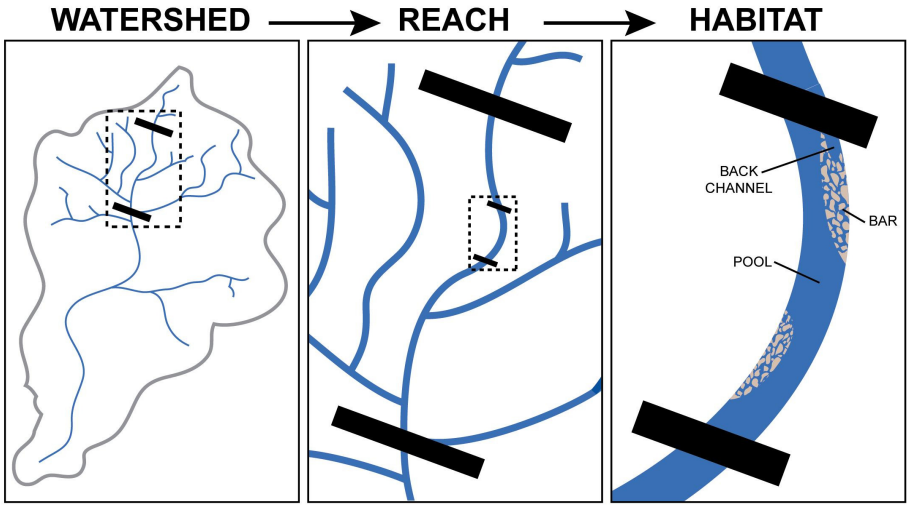

Figure 3-1. Relationship of Scales

3.1 Regional Overview

The City of Tacoma is situated in the Puget Sound Lowlands and lies at the mouth of the Puyallup River Valley, at the edge of the tidal waters of Commencement Bay in the Puget Sound (Map 1). Two headlands frame the City and Commencement Bay – Point Defiance to the west and Browns Point to the east. Tacoma Narrows, a narrow channel, forms the western edge of the City.

Tacoma is located at the mouth of the Puyallup River and on the broad upland areas that surround Commencement Bay. The City is characterized by commercial, industrial, and urban residential development. The City has long been of regional economic importance due to the suitability of Commencement Bay as a port and container terminal, and the valuable resources, including timber and coal, which could be easily transported to the port area via the Puyallup River. The broad, flat Puyallup River floodplain also offered valuable agricultural land.

Changes that occurred within the natural environment surrounding Tacoma can be traced back to the earliest European settlements in the region, which began in 1851. Shortly following these first European settlements, commercial forestry began within the surrounding area and moved up into the upper watersheds. The heaviest logging occurred from the 1940's through the 1970's. Agriculture also started shortly after the first settlements. Tide flats and tidal marshes were filled to accommodate railroad structures as early as 1877 (Lower Puyallup Watershed Management Committee, 1992, U.S. Army Corps of Engineers et al, 1993).

The City of Tacoma was incorporated in 1875. By the 1890's, the Tacoma Land Company began dredging the Puyallup River channel. Dam construction followed in 1903 and the beginning of channel realignment by 1908 (Kerwin, 1999). By the 1930's the construction of the City (now Thea Foss), St. Paul, Blair, and Hylebos Waterways was completed. The major channelization of the Puyallup River was completed by the 1970's. The once meandering, braided, and complex channel of the Puyallup River was reduced to the single confined channel

that we see today. Intertidal mudflats within the nearshore Commencement Bay and Puyallup River delta, which were historically estimated to cover 2,100 acres in the City, have been reduced to 180 acres (U.S. Army Corps of Engineers et al., 1993; Kerwin, 1999).

3.1.1 Shoreline Description

The City of Tacoma includes portions of two Water Resource Inventory Areas (WRIAs), the Puyallup River Watershed (WRIA 10) and the Chambers/Clover Creek Watershed (WRIA 12). Much of the marine nearshore areas of Commencement Bay are included in WRIA 10.The nearshore areas of the Tacoma Narrows and a portion of Commencement Bay to just east of Puget Creek in the Ruston Way area are included in WRIA 12. The Puyallup River is the largest stream draining WRIA 10, with Swan Creek being the largest tributary stream to the Puyallup River within the City. Hylebos Creek, also located within WRIA 10, is an independent tributary that drains to Commencement Bay within the City. Several other small independent tributaries to Commencement Bay drain WRIA 10, including Wapato Creek and other drainage features (Gulches) draining the slopes along the northern plateau above Marine View Drive. Chambers Creek is the largest stream draining WRIA 12; however, this stream lies outside the City limits to the south. Flett Creek is the largest tributary within the City draining to the Chambers Creek basin.

The Puyallup River is a shoreline of statewide significance (WAC 173-18-310) that travels approximately 54 miles from its headwaters on the southwest slopes of Mount Rainier to its mouth at Commencement Bay. The entire Puyallup River basin covers 1,065 square miles and consists of 728 rivers and streams, with the largest tributaries being the White and Carbon Rivers (Kerwin, 1999). The Puyallup River is fed primarily by the Tahoma and Puyallup Glaciers on the southwest slope of Mount Rainier. The Carbon River originates from the Carbon Glacier located on the north slope of Mount Rainier, and the White River is fed primarily by the Emmons Glacier on the northeast slopes of Mount Rainer.

The City of Tacoma lies between River Miles (RM) 0.0 and 2.8 on the Puyallup River in the Lower-Puyallup River basin (Map 2). The City and its urban growth area occupy approximately 27.1 square miles, or 2.5 percent of the land area included in WRIA 10. The portion of the Puyallup River within the City and its potential annexation area (PAA) is approximately 5.2 percent of the total length of the river.

Hylebos Creek enters the Hylebos Waterway in Tacoma and drains to Puget Sound's Commencement Bay. Hylebos Creek drains approximately 18,300 acres, and contains 25 miles of stream, 11 named lakes, and 250 acres of wetlands (Kerwin, 1999). There are two major tributaries to Hylebos Creek, referred to as the West and East Forks. The headwaters of the West Fork of the Hylebos are located in the City of Federal Way near South 320th Street (Pierce County, 2005). The East Fork originates in King County near North Lake and Lake Killarney in the Federal Way annexation area. The confluence of the two forks lies east of Interstate-5 within the City of Milton. From the confluence of these forks in Milton downstream, the Hylebos Creek itself is considered a shoreline of the state due to its mean annual flow of greater than 20 cfs (Kresch, 1998). Approximately one-half mile of the Hylebos Creek lies within the City of Tacoma, from about USGS River Mile (RM) 0.00 to RM 0.51.

The south and southeastern portions of the City are located within WRIA 12, which drains an area of approximately 179.5 square miles. The City occupies approximately 43.7 square miles, or 24.3 percent of the land area included in WRIA 12. In addition, WRIA 12 contains many small independent drainages including Crystal Creek, Narrows Creek, Crystal Springs, and 16 smaller drainages, (Gulches) that drain the western plateau either toward the Tacoma Narrows (west) or toward Commencement Bay (north). The 34-acre Wapato Lake is also located within WRIA 12 and the City of Tacoma. Wapato Lake is made up of three hydrologically connected waterbodies. The northernmost waterbody is essentially an open-water wetland complex. The upper waterbody opens up into a larger, middle waterbody, with wetlands surrounding the fringe. The lower waterbody constitutes the main lake area and contains the majority of development, which is primarily restricted to Wapato Park and its amenities. A stormwater bypass exists at the southwestern end of the middle waterbody. This bypass routes the stormwater flows around the main lake to Ward's Lake and then to the Flett Holding Basins. A dike was constructed in 1981 when the lake was dredged and "restored." The dike was designed to keep sediments in the stormwater from entering the wetlands and the main lake area.

3.1.2 Land Use and Land Cover

Tacoma is the second largest urban center in the Puget lowlands. Its land uses and cover are similar to other highly urbanized city centers. In general, there have been three key phases of changing land use between 1800 and the present.

Prior to the mid-1800s, the area around Tacoma was characterized by both a significant delta system where the Puyallup River meets Commencement Bay, and dense forestlands on the floodplain and surrounding uplands (Kerwin, 1999, Collins et al., 2003). As populations in western Washington grew, timber harvesting throughout the watershed and establishment of agriculture on floodplains represented the first phase of land use changes. Filling of tidelands within Commencement Bay began as early as 1877 with the initial installation of railroad beds (U.S. Army Corps of Engineers et al, 1993; Kerwin, 1999; Simenstad, 2000).

The presence of a deepwater embayment (Commencement Bay) resulted in the early establishment of a port that influenced the development of the City. A significant channel change occurred naturally in 1906 when the White River moved south to entirely flow into the Puyallup River. This alteration initiated a series of projects intended to manage the size, location, and behavior of the Puyallup River and its tributaries (King County, 1988). Between 1908 and 1917, significant relocation, armoring, and diking of the Puyallup River was completed. Much of the work was completed under the auspices of the Inter-County River Improvement District, which was formed as an organization to share costs between King and Pierce Counties to address river issues surrounding the White River's movement into the Puyallup basin (King County, 1988).

River projects continued through the 1970s, resulting in the channelization and construction of levees along significant portions of the lower Puyallup River. Once the system of channels and levees was completed, river management shifted to the removal of in-channel sediments to preserve the flood-carrying capacity of the system. In the late 1980s, dredging was restricted, and in the late 1990s, further restrictions were imposed following the listing of salmonid species as threatened under the Endangered Species Act (ESA). Therefore, the carrying capacity of the

lower Puyallup River has generally decreased as sediments deposited in the White, Carbon and Puyallup River deltas now build up within the leveed channels (USGS, 1990; Kerwin, 1999).

Today, much of the upper watershed of the Puyallup River is in forest land uses, either within the Mt. Rainier National Park, Mt. Baker-Snoqualmie National Forest, or privately held timber operations (Kerwin, 1999). Agricultural land uses dominate the floodplains of the middle and upper portions of the watershed (Kerwin, 1999, Collins and Sheikh, 2005). Urban land uses also exist in the middle and upper portions of the watershed, including the cities of Puyallup, Auburn, Orting, Federal Way, Fife, Sumner, Buckley, Enumclaw and Milton. Urban land uses are typically located on either alluvial valley or on the relatively level surrounding uplands. The City of Tacoma also includes substantial industrial and commercial land uses along the Interstate 5 corridor extending west through the Port of Tacoma.

At the end of World War II, the urban population within the cities in the Puyallup watershed increased substantially (Washington Office of Financial Management Historical Data).

3.1.3 Habitat and Species Usage

A number of fish and wildlife species use the shorelines in Tacoma for habitat. Critical fish and wildlife habitat conservation areas are those areas identified as being of critical importance to the maintenance of fish and wildlife species (TMC 13.11.510), and which, if altered, may reduce the likelihood that the species will survive and reproduce (TMC 13.11.520).

3.1.4 Federally Listed Species

Several species listed under the ESA are known to occur or could potentially occur within the City's shoreline planning area. Federally listed species that have been documented within the shoreline jurisdiction include bald eagle, Puget Sound Evolutionarily Significant Unit (ESU) Chinook salmon and Coastal/Puget Sound Distinct Population Segment (DPS) bull trout. In August of 2005, the National Oceanic and Atmospheric Administration – National Marine Fisheries Division (NOAA Fisheries) designated "critical habitat" in the region, protected as essential to the conservation of listed salmon ESUs. Critical habitat for Puget Sound ESU Chinook salmon includes the entire reaches of Puyallup River and Hylebos Creek within the City's shoreline planning area as well as the marine nearshore areas (NOAA Fisheries, 2005). In September of 2005, the US Fish and Wildlife Service designated "critical habitat" for the Coastal/Puget Sound Distinct bull trout. The entire lengths of the Puyallup River and the marine shoreline within the City's Shoreline Planning Area were designated as critical habitat for bull trout (Federal Register, Vol. 69, No. 122).

The Southern Resident Population killer whale and Steller sea lion, although not documented as occurring in Commencement Bay, have the potential to occur within this area. Killer whales have been sighted periodically in Commencement Bay. The last report sighting was February 2006. It is unknown if the group spotted was transient or members of the Southern Resident Population (Orca Network, 2006). Critical Habitat has been proposed for killer whales, including Puget Sound marine waters deeper than 20 feet (6.1 meters) (Federal Register, 2006). No Critical Habitat for Steller sea lion has been designated within Puget Sound. Table 3-1 below

documents the state and federally listed species and designated Critical Habitat that are known to occur along the freshwater and marine shorelines of the City of Tacoma.

Table 3-1. Federal and State Listed Species in Tacoma.

Common name	Scientific name	Federal Status	State Status	Critical Habitat
Bald eagle	*Pandion Haliaeetus leucocephalus*	Threatened	Threatened	No
Peregrine falcon	*Falco peregrinus*	Species of Concern	State Sensitive	No
Purple martin	*Dryocopus pileatus*	None	Candidate	No
Puget Sound/ Strait of Georgia coho salmon	*Oncorhynchus kisutch*	Species of Concern	None	No
Puget Sound Chinook salmon	*Oncorhynchus tshawytscha*	Threatened	Candidate	Yes
Puget Sound steelhead	*Oncorhynchus mykiss*	Proposed threatened	None	No
Coastal/Puget Sound bull trout	*Salvelinus confluentus*	Threatened	Candidate	Yes
Coastal cutthroat trout	*Oncorhynchus clarkii clarkia*	Species of Concern	None	No
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	Species of Concern	None	No
Southern Resident Population killer whale	*Orcinus orca*	Endangered	Endangered	Proposed
Steller sea lion	*Eumotopias jubatus*	Threatened	Threatened	No
Western pond turtle	*Clemmys marmorata*	Species of Concern	Endangered	No

On March 29, 2006, NOAA Fisheries proposed federal listing of Puget Sound ESU steelhead, which occur within the City's shoreline planning area. Review of the proposed listing, with a period of public comment and an investigation of possible "critical habitat" designation, is underway. A final decision regarding federal Puget Sound ESU steelhead listing is expected in 2007 (Federal Register, Vol. 71, No. 60).

3.1.5 Priority Habitats and Species

The Washington Department of Fish and Wildlife (WDFW) publishes the Priority Habitats and Species (PHS) list for Washington State, which includes a catalog of habitats and species considered to be priorities for both conservation and management. Priority species include those species that, due to their population status, require specific protective measures to perpetuate their existence. This includes State Endangered, Threatened, Sensitive, and Candidate species (see Table 3-1 above); species congregations considered vulnerable; and those species of recreational, commercial, or tribal importance that are vulnerable. Priority habitats are those habitat types or elements with unique or significant value to a diverse assemblage of species,

which may consist of unique vegetation types or dominant plant species, a described successional stage, or a specific structural element (WDFW, 2005).

WDFW PHS maps and data are updated routinely, but may contain dated field based observation data for individual species and locations. The WDFW PHS data should not be considered exhaustive. That is, species may be present that are not documented in PHS. Priority species documented in the City include Chinook salmon, coho salmon, chum salmon, pink salmon, sockeye salmon, steelhead, bull trout, bald eagle, peregrine falcon, purple martin, western pond turtle, seabird nesting colonies, waterfowl concentrations and harbor seal/California sea lion haul-out sites. According to WDFW PHS maps, the City's shoreline planning area contains the following priority habitats: riparian areas, urban natural open spaces, wetlands, cliffs and bluffs, estuarine zones, and lagoons. Priority habitats and species along the City's shoreline planning areas are described in detail in Sections 4 through 7.

3.2 Watershed Process Controls

3.2.1 Climate

Tacoma is located in the greater Puget Lowland of western Washington. This area surrounding Puget Sound has a maritime climate with cool winters, dry summers, and a distinct rainy season from fall through spring. Precipitation in the Puget Lowland varies considerably because of mountain effects. The Tacoma area watershed receives on average between 37 and 42 inches of rain per year, with approximately 70 percent of the precipitation falling between October and March (Jones et al., 1999). Winds are generally from the southwest during the rainy season and from the northwest during the dry summer months.

The Puyallup River responds to precipitation events and snowpack development in the western Cascade Mountain range. Annual precipitation in the western Cascades averages between 60 and 100 inches per year (NCDC, undated summary). Higher elevations and lower temperatures result in snowpack development in the contributing area to the Puyallup, Carbon, and White Rivers. Snowmelt typically dominates the high flow periods of the spring and early summer. Snowpack depths can range from around 50 inches at lower elevations to several hundred inches above 5,000 feet in elevation.

3.2.2 Topography

Tacoma includes both low-lying valley associated with the Puyallup River floodplain and broad upland plateaus to the west and northeast of Commencement Bay. Steep bluffs transition between the upland plateaus and the river floodplain. The upland plateau is a broad area with relatively low relief lying between approximate elevations of 200 to 400 feet above sea level. Coastal bluffs that descend to waters of Puget Sound are found near Browns Point and Point Defiance. The floodplain lies at or below elevation 20 (feet NGVD 29) and is relatively featureless except for minor swales that are remnants of former meander channels.

The upland surface comprises numerous north-trending ridges and swales, which in turn control orientations of many of the upland stream channels. The upland surface also exhibits several large topographic channels and numerous closed depressions; some occupied by small lakes and poorly drained areas.

3.2.3 Geology and Soils

Tacoma lies in the southern portion of the Puget Lowland, an elongated topographic and structural depression filled with a complex sequence of glacial and nonglacial sediments that overlie bedrock. In general, the total thickness of the Quaternary-age basin fill varies from zero in scattered locations to greater than 3,000 feet. The depth to bedrock beneath Tacoma is approximately 1,000 to 1,700 feet (Jones, 1996; Buchanan-Banks et al., 1994).

The area has been glaciated six or more times in the past 2 million years. Each glacial event may have left a sequence of lacustrine, advance outwash, glaciomarine drift, till, and recessional outwash deposits distributed in a complex pattern, both stratigraphically and laterally. These glacial sequences were partially to completely eroded in some locations by either subsequent glaciations or erosion during nonglacial periods. The last glacial ice sheet, known as the Vashon, is estimated to have been on the order of 3,000 feet thick. The Vashon ice sheet receded from the area about 13,500 years ago. During interglacial periods, fluvial and lacustrine sediments were deposited in river valleys and depressions. In recent time, fill, colluvium, and beach sediments were also deposited in some locations.

Geologic mapping in the vicinity of the City of Tacoma includes Smith (1972 and 1976) and Walsh (1987). The geology of the area has recently been remapped, and a revised geologic map is to be published soon (Troost, in review, and Troost et al., in review) and is shown on Map 3.

The topography and near surface geology of the watershed is largely the product of the last glaciation (Vashon Stade of the Fraser glaciation), which receded from the area about 13,500 years ago. The Vashon glaciation left a layer of till and recessional sand and gravel deposits that mantle the upland plateaus north and south of the Puyallup River. The till and recessional deposits overlie Vashon outwash sand and gravel, and older glacial and nonglacial deposits that overlie bedrock at great depths.

The Tacoma Narrows was similarly formed by the glacial processes that created the larger Puget Sound fjord. Local topography and post-glacial faulting (e.g., along the Tacoma fault zone) have resulted in the relatively shallow sill that occurs within the Narrows. This sill influences tide-forced currents within the Sound, and forms the divide between the Main and Southern basins (Ecology, 2002).

The Vashon and older deposits in the Tacoma area form a sequence of sand and gravel layers separated by finer grained layers of clay and silt or tight, well-graded soils, which are exposed in places along the steep slopes that lie between the upland plateau and the lowland floodplain. The Vashon and older deposits comprise several aquifers and aquitards within the subsurface, which control subsurface water movement from the upland to the lowland as well as to the locations of streams and creeks that occupy former outwash channels (Jones et al., 1999).

Lodgment till from the Vashon glaciation mantles much of the upland area but is generally absent from the steeper slopes at the edge of the upland and in the lowland. Lodgment till is an unsorted mixture of sand, gravel, silt, and clay deposited at the base of a glacier and has been compacted to a very dense state by the great weight of the overriding ice. This type of till has very low permeability and typically acts as an aquitard, restricting the downward flow of

groundwater and reducing recharge of deeper aquifers. Till occurs at or very near the ground surface in the central portion of the watershed where strong north-south ridges and swales left by the passage of glacial ice cross the upland surface south of the Puyallup River. Surface runoff in this portion of the upland is likely to be rapid with very little infiltration of precipitation.

The ground surface along the upland margins and within former large outwash channels is underlain by a veneer of recessional outwash and ice contact deposits, which cover the till below. These deposits allow infiltration and control subsurface flow and localize the ponding of water and wetland formation on the upland surface.

Ice contact deposits were deposited during stagnation and melting of the ice sheet. These deposits consist of sand and gravel, similar to recessional outwash, but are more variable and often contain lenses of very silty material, till, and lacustrine silt and clay, which impede infiltration and groundwater flow. Such ground has an irregular surface and may be marked by closed depressions. Water infiltration and subsurface flow within these deposits are variable, and water is commonly ponded in closed depressions.

The glacial ice sheet blocked drainage of rivers and streams from the Cascades, diverting water along the ice front and forming large bodies of water between the glacier and the mountain front. As the ice sheet retreated northward, these large lakes found spillway outlets resulting in dramatic releases of large volumes of water, which eroded channels in the uplands and deposited sand and gravel. Two outlets of a former large proglacial lake that occupied the area at and north of the present Puyallup River Valley cross the upland surface in the southern portion of the City and adjacent areas to the south. The southwest-trending South Tacoma Channel lies west of and roughly parallel with Interstate 5. This prominent feature is evident on the geologic map (Map 3). The slightly older and broader Clover Creek Channel trends northwesterly and crosses the upland surface just south of SR- 512. Within these channels, scoured surfaces of progressively younger age have been delineated (Troost, in review). Each surface falls within a narrow range of elevations and is indicated on the geologic map (Map 3). These large meltwater flows across the upland left a layer of openwork sand, gravel, and cobbles (Steilacoom gravel). These highly permeable deposits at or near the ground surface are significant recharge areas and are highly susceptible to contamination.

The Puyallup River lies in a deep valley cut into the upland. The valley is a former arm of Puget Sound that has been filled with fluvial sediments since retreat of the last glaciation. Sediment filling the valley includes ordinary alluvium and overbank flood deposits as well as lahar (mudflow) deposits originating from Mount Rainier. One such lahar is the Osceola Mudflow, which occurred approximately 5,700 years ago and extended the valley fill seaward (Vallance and Scott, 1997; Dragovich et al., 1995). The large volume of sediment from lahars filled and altered the Puyallup River channel, floodplain, and delta system.

In addition to catastrophic lahar deposition, surface rupture associated with valley-parallel faulting may have altered the Puyallup River channel. Recent geologic investigations suggest that the lower Puyallup River valley may coincide with what has been called the Tacoma fault zone (Brocher et al., 2004). Uplift and ground surface rupture of the valley floor may have caused sudden avulsions of the Puyallup River.

3.3 Key Ecosystem Processes Related to Shoreline Functions

The process controls discussed above provide the foundation for key ecosystem processes that occur within the shorelines of the City of Tacoma. These process controls will affect shoreline functions within nearshore marine, riverine areas, or lakes differently; therefore, these areas are discussed separately below.

Consistent with our modified use of the approach provided in Stanley et al 2005, key ecosystem processes are discussed for each shoreline type. For the nearshore marine environment, special focus is applied to coastal tidal flow and bluff erosional processes. For the Puyallup River and the Hylebos, the most important processes are related to sediment transport, water quality and organic debris. For Wapato Lake, the focus is on surface water flow and water quality. Also discussed are alterations to any of these processes that affect the level of ecosystem functioning.

3.3.1 Processes Affecting Marine Shorelines

Marine shorelines within the City of Tacoma occur at the interface of upland hillsides and Puget Sound. Both coastal and upland processes influence the morphology and ecological functioning of these marine shorelines. With more than 16 miles of coastline, the marine shoreline is the largest component of the shorelines within the City of Tacoma. Over 6 miles of marine shoreline are located along the east side of the Tacoma Narrows, and the remaining length occurs within Commencement Bay or along Ruston Way. The primary coastal circulation processes that occur in this portion of Puget Sound are tides and wind-driven waves.

Tides are the dominant coastal circulation and water quality process in this portion of Puget Sound (Ebbesmeyer et al., 1986 in EVS, 1995). In addition, wind-driven waves generated by storms can play a significant role in surface layer direction and speed, thereby influencing local sediment transport and beach morphology (Shipman, 2004).

The tide range in Puget Sound and Commencement Bay provides the baseline elevations for the morphology and ecological functioning of the marine intertidal shoreline. NOAA maintains a tide gauge in Commencement Bay, which was installed in 1996. Gauge data indicate that the mean daily range is 8.1 feet, and that the difference between Mean Lower Low Water (MLLW) and Mean Higher High Water (MHHW) is 11.8 feet using NGVD 29 as the datum (NOAA gauge number 9446484).

On the Tacoma Narrows side, the tidal flux is forced through a 4,000 foot-wide, 140-foot deep channel, resulting in significant flow velocities that impact the character of the shoreline. Flow velocity in the Narrows is recorded to be greater than five feet per second in the channel, with greater than 12 feet per second around flow obstructions such as bridge pilings (Polasik, 2005). Flow velocities drop off toward the shoreline, but are still a significant factor in determining shoreline morphology. The marine shoreline is relatively abrupt and homogenous through the Narrows. The bathymetry of the area drops off relatively rapidly moving away from the shoreline, reaching depths of greater than 140 ft at the eastern footings for the Tacoma Narrows Bridge (Shannon & Wilson, 2000).

Within Commencement Bay, tidal flux is not constrained, and therefore flow velocities are generally lower than those measured in the Narrows. Commencement Bay is deep compared to

the Narrows at greater than 450 feet deep. Circulation within the surface layer of Commencement Bay is typically driven by tides, wind-driven waves, and fluvial input from the Puyallup River and Hybelos Creek. Prevailing winds during storms are typically from the south, resulting in weak counterclockwise circulation in the bay as Puyallup River flows are directed to the north, then west along the Marine View Drive reach (Ebbesmeyer et al., 1986 in EVS, 1995). This pattern appears to be confirmed with observations of the development of the 'neo-delta' along the northern portion of the bay.

Circulation within the deeper, denser, saline portion of the bay is connected to patterns within the main basin of Puget Sound. However, several researchers note that the exact circulation patterns within Commencement Bay are complex and not well understood. Circulation within the deeper layer appears to be relative stable and clockwise (Ebbesmeyer et al., 1986 in EVS, 1995). Ongoing monitoring efforts by faculty and students at UW-Tacoma appear to confirm these general trends (accessed via the web at http://courses.washington.edu/uwtoce05/index.html).

Wind-driven waves in Puget Sound are typically associated with storm events and can determine surface layer direction and velocity. Waves have the potential to induce water velocities that are sufficient to mobilize and transport sand to cobble sized particles. Waves have the potential to both: (1) build accretionary landforms (e.g., beaches, berms), and/or (2) erode existing landforms (e.g., beaches, bluffs). The magnitude and direction of wind-driven waves is determined by climatic processes that can vary by season, and by local conditions including length of fetch and presence of local flow constraints. In general, surface circulation patterns, including waves, are more important in Commencement Bay than in the Narrows.

Since Tacoma's marine shorelines are located within the relatively protected waters of Puget Sound, currents are generally less important to the morphology and ecological functioning of the shoreline. Marine currents do provide a significant influx of marine nutrients and biota at the Straight of Juan de Fuca, which are then carried southward. The timing and extent of this flux is generally dependant on both climatic conditions (e.g., years of high or low runoff) and oceanic conditions (e.g., El-Nino Southern Oscillation variations).

Both tidal flux and wind driven waves can result in sediment transport within littoral cells (sections of coastal systems that include a sediment source and sink). Many coastal landforms represent dynamic equilibrium between upland sediment sources, net coastal circulation patterns, and depositional areas. If any part of the system is modified (e.g., installation of a bulkhead that reduces sediment source), then other elements of the system will adjust.

3.3.2 Coastal Bluffs and Hillslopes

Coastal bluffs and hillslopes that line much of Tacoma's shoreline are a key factor in the development of coastal morphology and ecosystem functioning. The geology, stratigraphy, and surface and groundwater patterns within the coastal bluffs typically determine the slope and potential for sediment delivery to the coastline (Shipman, 1999). The prevalence of bluffs comprised of glacially overridden soils and protective gravel beaches combine to result in relatively slow rates of bluff retreat within Puget Sound. However, large-scale failures do occur, often during high rainfall years, which can deliver significant volumes of sediment to the shoreline (Shipman, 2004; Zelo et al., 2000).

As discussed in the geology and soils section above, coastal bluffs within the City of Tacoma are typically composed of materials deposited during several glacial and interglacial episodes. Variable stratigraphic layering of successive glacial and nonglacial deposits can result in different sediment delivery dynamics. For example, a bluff composed entirely of till will generally retreat at a slower rate than a similar bluff that includes a layer of coarser outwash materials. The coarser outwash materials tend to be less resistant to erosion, and have lower strength, resulting in faster rates of bluff retreat. Bluffs that naturally contribute sediments and materials to the coastal zone, thereby supporting coastal processes and intertidal habitats, are referred to as feeder bluffs.

The movement of water through the hillslope also influences the potential for mass-wasting. The presence of a relatively impermeable layer (e.g. proglacial lake sediment) under a relatively permeable layer (e.g., recessional outwash) can increase hydrostatic pressures and focus the lateral flow of groundwater to the bluff face, resulting in instability at the interface between the two layers. This pattern often results in the stair-stepped bluff patterns observed within Puget Sound (Shipman, 2004). Precipitation is especially important in mass wasting processes in the Puget Sound, as large mass wasting events, both shallow and deep-seated, are correlated with above-average rainfall years (e.g., the winter of 1997-8).

Wave action can also result in mass wasting of hillsides. Wave action can erode the toe of the slope, thereby destabilizing the upper portion of the slope via loss of toe support. This process results in episodic bluff retreat that can threaten structures on or above the slope. This process also serves to deliver significant volumes of fine and coarse sediment to the shoreline, thereby influencing the type and extent of landforms and habitats.

The Puget Sound is an active tectonic region, with the potential for both Cascadia Subduction Zone and intraplate (e.g., Tacoma Fault) movements. Tectonic activity, can both: (1) result in rapid uplift or subsidence of portions of the shoreline, and (2) destabilize hillsides by seismicity (Atwater, 1990; NOAA, 2003). The significant 1949 slope failure in the Narrows was likely at least partially due to a 7.1 magnitude earthquake three days prior to the failure. More recently, the 2001 slope failure on the bluffs above the community of Salmon Beach was attributed to the 6.8 magnitude Nisqually earthquake.

3.3.3 Water Quality

Water quality within the marine shoreline of Tacoma is influenced by both broader Puget Sound circulation patterns and upland surface and groundwater runoff. The marine shoreline along the City of Tacoma is located within the larger “main basin” of Puget Sound (EVS, 1995; Gustafson et al., 2000). The main basin extends from a shallow (120 foot deep) sill at Whidbey Island south to the shallow sill (140 feet deep) at the southern end of the Tacoma Narrows. Flow within this main basin typically varies between well mixed in the colder months to stratified during the warmer months. Water quality varies significantly between the stratified and non-stratified times of the year.

The broader pattern of seasonal stratification appears to be modified near the City of Tacoma. Within the Narrows, the flow constriction from the sill results in longer term mixing in the vertical than is observed in broader portions of the sound. Within Commencement Bay, the

lower speed of tidal flux and potentially significant freshwater input contribute to persistently stratified conditions (Ecology, 1998; Ecology, 2002).

These differences in stratification and tidal flow result in measurable differences in salinity and dissolved oxygen between the Narrows and Commencement Bay. The lower limit for dissolved oxygen in marine water is 6 mg/L under the Washington State Water Quality Standards (State of Washington, 1997). A sampling location in the Narrows recorded dissolved oxygen levels at greater than the water quality standard, while a Commencement Bay sampling location recorded dissolved oxygen levels below the state water quality standard (Ecology, 1998).

Water temperatures in the southern portion of the main basin are typically between 8 and 12°C (46 and 54°F). Salinity is typically around 28 to 30 parts per thousand (ppt), but can occasionally be reduced to around 25 ppt in the surface layer during high runoff periods (Kerwin, 1999; Gustafson et al., 2000).

Fecal coliform bacteria are typically derived from upland sources and transported to the marine environment via surface flow. Fecal coliform bacteria have a relatively short lifespan in saline waters. High levels of fecal coliform bacteria have been measured at the core water quality monitoring stations within Commencement Bay. These counts are likely indicative of freshwater input from the Puyallup River and the other smaller tributaries.

The presence of industrial land uses on and near the Puyallup River delta has created the opportunity for the discharge of numerous pollutants to the surface, ground, and marine waters associated with the shorelines of Tacoma. As a result of these discharges, several units within Commencement Bay (where contaminant levels have been found to be at levels that are harmful to aquatic life) have been established as Superfund sites under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The CERCLA process is underway within Commencement Bay under the oversight of the Environmental Protection Agency (EPA).

3.3.4 Processes Affecting Riverine Shorelines

Riverine shorelines of the state within Tacoma include the Puyallup River and Hylebos Creek. These surface water channels serve as the linkage between their respective watersheds and the marine waters of Commencement Bay. Key ecosystem processes discussed for riverine shorelines include:

- Hydrology
- Sediment Generation and Transport
- Water Quality
- Organics, including Large Woody Debris

3.3.4.1 Hydrology

Water naturally enters a watershed through rain, snow, or movement of groundwater. Water moves within a watershed by surface water flow in rivers and streams, infiltrates and becomes groundwater, or is stored in wetlands, lakes, and floodplains. In a natural system, the movement

and storage of water is generally controlled by physical conditions such as climate (precipitation patterns and volumes), topography (gradient), land cover (vegetation) and the permeability or infiltration capacity of soils and the underlying surficial geology (Stanley et al., 2005).

Hydrologic processes often act to integrate different parts of the landscape, and thereby represent a nexus between the upland and aquatic environments. As such, hydrologic processes are an important element in all broad categories of ecosystem functions (Brinson, 1993).

Surface Water

The Puyallup River is the dominant source of surface water to Commencement Bay, draining approximately 950 square miles from the slopes of Mount Rainier west to Puget Sound. The drainage basin includes significant tributaries, the White and Carbon Rivers. In 1906, the White River, which had previously flowed north into the Green/Duwamish Rivers, changed course to flow entirely into the Puyallup River basin (King County, 1988). This change significantly increased flow and sediment transport through the lower Puyallup River.

A USGS gauge on the Puyallup River at the City of Puyallup (approximately 6 river miles upstream from the mouth) has recorded flows since 1914. Flows typically range from around 1500 cfs in September to over 3,500 cfs in the winter and spring. Snowmelt from the Cascades is a significant control on the timing of high flows through the Puyallup River system. High flows typically occur either in the early winter during periods of high precipitation or in the spring during snowmelt, particularly during rain-on-snow events. Figure 3-2 shows monthly mean discharges from the USGS gauge from 1914 to 2005.

Based on USGS gauge data, peak flows typically range from 10,000 to 40,000 cfs, with the highest recorded flow of 57,000 cfs occurring in December 1933.

Since that time, the construction of the Mud Mountain Dam on the White River and other flow modifications have reduced the magnitude and frequency of flood flows in the lower Puyallup.

The Puyallup River is tidal within the City of Tacoma. The extent of tidal influences varies with the amount of freshwater runoff, but generally extends past the I-5 bridge to RM 6.6. The exact upstream extent of the saltwater wedge is variable, and it not well-known at this time (Kerwin, 1999).

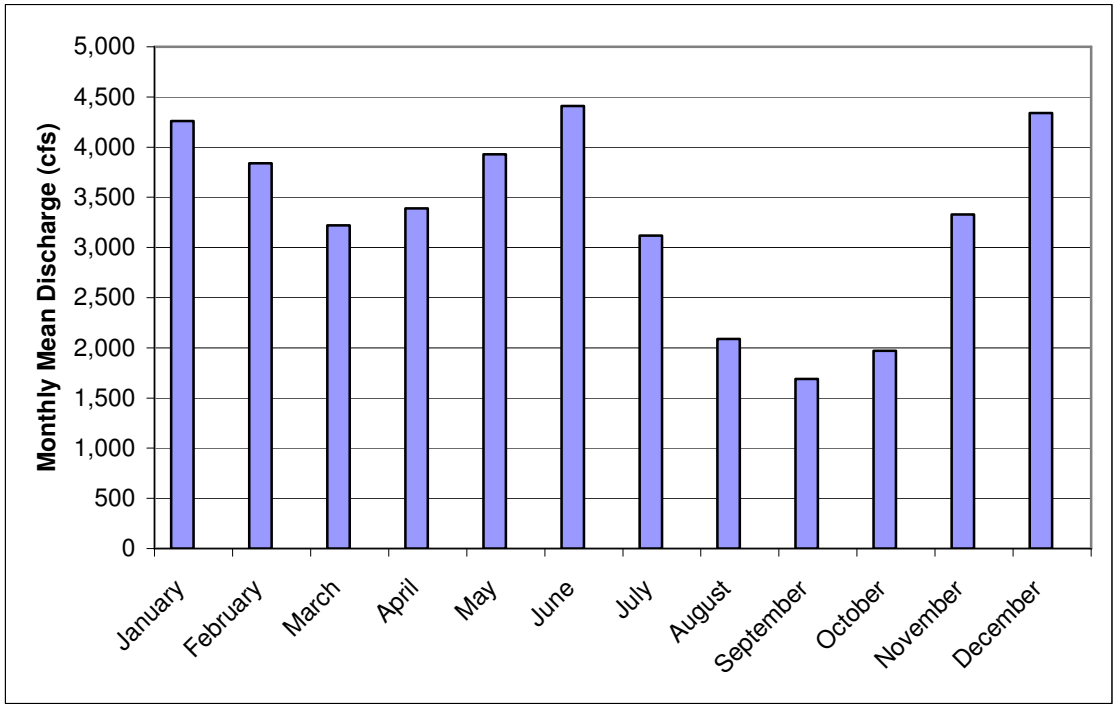

Figure 3-2. Monthly mean flows for the Puyallup River, measured at Puyallup from 1914 to 2005

The Washington State Department of Ecology has established instream flows within the Puyallup River (WAC 173-510-030). These flows range from a low of 1,000 cfs from September 15 to November 1, to 2,000 cfs from May 1 to July 1. A recent USGS study indicates that the lower instream flow value is not being met at times. The study also observed that the operation of the Lake Tapps diversion plays a significant role in the measured in-stream flows within the Puyallup River during low flow periods (Sumioka, 2004).

Hybelos Creek drains approximately 29 square miles of the lower Puyallup Valley and the Federal Way Highlands and is the second largest input of freshwater to Commencement Bay (Kerwin, 1999). Flows are recorded by the USGS at Highway 99 near Fife at a point with a drainage area of 16.8 square miles (USGS Gauge 12103020). Figure 3-3 shows monthly average flows from the period 1995 to 1999. USGS gauge data indicate that instantaneous peak flows range from 125 to 413 cfs from 1996 to 1999.

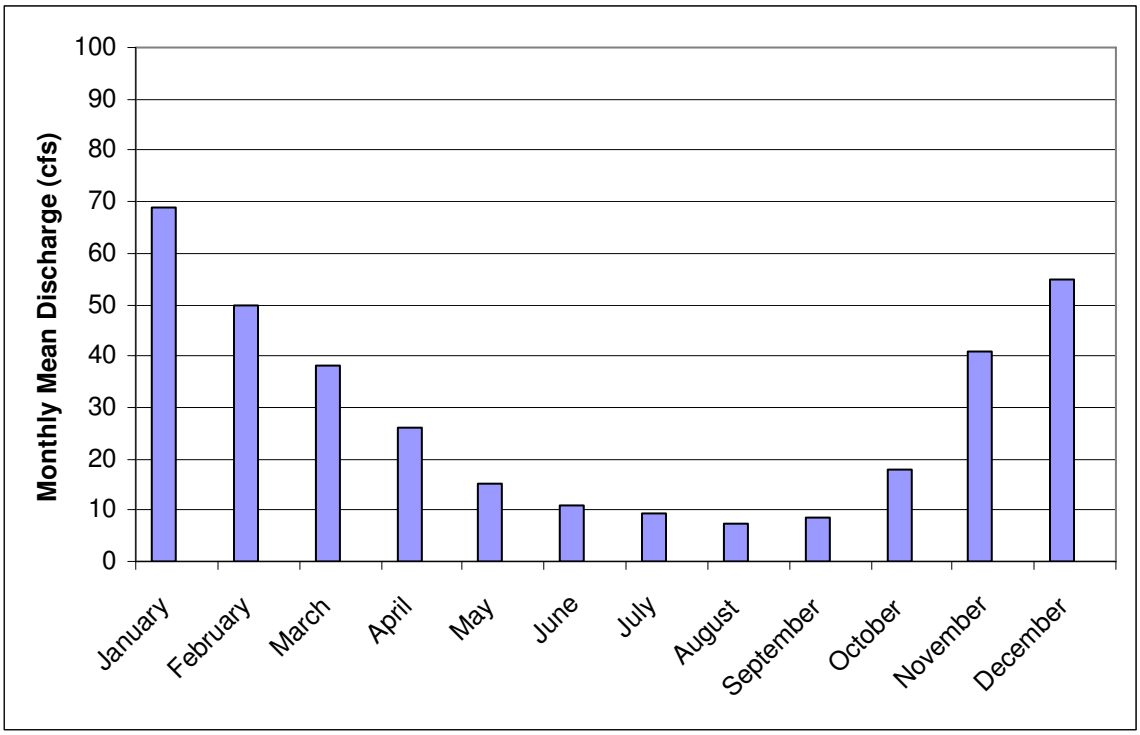

Figure 3-3. Monthly Mean Flows in Hylebos Creek

The Hybelos Creek channel has been highly altered via significant urbanization within its drainage basin, including the construction of Interstate 5. The west fork of Hybelos Creek results in frequent urban flooding within the City of Federal Way (Kerwin, 1999).

Ground Water

The glacial and alluvial materials that underlie portions of the City of Tacoma create a variable hydrogeologic system that provides important aquifer recharge functions in places. Critical aquifer recharge areas in this vicinity have been mapped by the City of Tacoma. Critical aquifer recharge areas are mapped along the alluvial Puyallup River Valley, and within the complex series of recessional outwash channels on the southern upland plain (GeoEngineers, 2004).

Water that infiltrates into the ground generally flows downward until impeded by less permeable soils and then flows laterally to a body of water or to a slope face where it may emerge as springs or seeps on the hillside. A portion of the groundwater, however, will percolate downward through lower-permeability soils, recharging underlying aquifers. Springs discharge along the steep slopes at the edge of the upland plateaus, including along the coastal bluffs, primarily from recessional outwash, which overlies the till; Vashon advance outwash, which underlies the Vashon till; and a deeper, pre-Vashon outwash (Woodward et al., 1995).

The Vashon and older glacial and nonglacial deposits in the vicinity of Tacoma form a sequence of sand and gravel layers separated by finer-grained layers of clay and silt, which are exposed in places along the steep slopes that lie between the upland plateau and the lowland floodplain and/or marine shoreline. The Vashon and older deposits comprise one or more aquifers and

aquitards (i.e., low permeability geologic strata that function to restrict groundwater movement). These interspersed permeable and relatively impermeable layers control subsurface water movement from the upland to the lowland.

Lodgment till and recessional outwash from the Vashon glaciation cover much of the upland area in the vicinity of Tacoma, but are generally absent from the steeper slopes at the edge of the upland and in the Puyallup River floodplain and delta. Lodgment till is an unsorted mixture of sand, gravel, silt, and clay deposited at the base of a glacier that has been compacted to a very dense state by the great weight of the overriding ice. This type of till has very low permeability and typically acts as an aquitard, restricting the downward flow of groundwater and reducing recharge of deeper aquifers. Recessional outwash was generally deposited in topographic lows on the till plain by meltwater streams emanating from the melting ice front. The outwash generally consists of sand and gravel and is relatively permeable. The distribution of till and outwash on the upland surface predominantly controls the infiltration of precipitation and aquifer recharge (Woodward et al., 1995).

Till occurs at or very near the ground surface over much of the southern and northern portions of Tacoma. Till areas are depicted in light brown on Map 3. In these areas, strong north- or northwest-trending ridges and swales left by the passage of glacial ice are common. Such features control surface drainage, such as Swan Creek, and the Clark/Chambers Creek systems, which drain the upland in the southern portion of the city. Shallow lakes and wetlands in localized topographic depressions provide storage of surface water runoff. Urban development in these areas decreases groundwater recharge and increases stormwater runoff by reducing vegetation, increasing impermeable surfaces, and decreasing areas of depressional wetlands.

Recessional outwash covers the till surface over significant areas of the upland in the southern portion of the city (Map 3). Recessional outwash occurs primarily in historical meltwater channels that drained the proglacial lake that filled the lower Puyallup Valley, including the South Tacoma Channel (USGS fact sheet). Please see the geology section above for more detail on these outwash channels. The layer of outwash covering the till allows infiltration of precipitation, effectively spreading precipitation events over longer periods of time and increasing residence time. These outwash deposits provide a vector for aquifer recharge due to their significantly greater permeability than the surrounding and underlying till deposits.

The greater permeability of these outwash deposits also increases the connectivity to surface land uses. Spills, leaking tanks, and build-up of pollutants can be infiltrated into shallow and deeper aquifers. A South Tacoma Groundwater Protection District has been formed by the joint Tacoma and Pierce County health department to address protection of the South Tacoma aquifer (TMC 13.09). The South Tacoma aquifer provides drinking water to meet peak demand (i.e., demand in excess of the supply from the Green River) within the City of Tacoma. Several areas of one-year time of travel from the surface to aquifers have been mapped within recessional outwash and younger alluvial materials within the City of Tacoma.

The highly variable glacial layering in this region can lead to complex shallow groundwater aquifers that have the potential to combine during periods of above average rainfall. When these shallow aquifers combine, the water table has the potential to exceed the surface elevation,

resulting in lowland flooding (USGS Fact Sheet). This process has the potential to impact the area of the South Tacoma Channel through the City of Tacoma.

Groundwater resources within the Puyallup alluvial valley/delta plain have been investigated to a limited extend as a part of the remedial investigations (EVS, 1995). The limited studies that have been performed indicate the presence of at least two shallow unconfined layers underlain by a deeper, confined aquifer. Net flow from these aquifers is typically toward Commencement Bay; however, gradients can reverse depending on tide stage (EVS, 1995).

3.3.4.2 Sediment Generation and Transport

The processes that govern the production, storage, and transport of sediment play a significant role in shaping the morphology and functioning of a riverine ecosystem. In natural river systems, sediment is delivered to the channel via overland flow, mass wasting (e.g., landslides, lahars), and channel migration (e.g., eroding the outside of a meander bend) (Stanley et al, 2005). The movement of sediment into, through, and out of the riverine ecosystem influences the form and functions of the riverine shorelines of Tacoma, including:

- Shoreline morphology;
- Hydrologic and hydraulic channel characteristics;
- Ability of surface and groundwater to interact; and
- Type and extent of aquatic habitat.

Sediment delivery processes function at a variety of scales. However, riverine ecosystems typically function to integrate processes over a large area. Therefore, sediment delivery processes are best understood and discussed at a watershed level.

Both the Puyallup River and Hybelos Creek are tidal riverine systems within the City of Tacoma's shoreline. Therefore, sediment dynamics are complicated by the interaction of freshwater flows and the ebb and flow of the tides within the delta environment. Sediment that is generated in the upper watershed of both fluvial systems is transported downstream to eventually form a delta at the mouth of each channel. Wash load and suspended sediment are flushed into Commencement Bay, while coarser materials (generally sand and larger particles) are retained within the delta.

The presence of Mount Rainier at the head of the mainstem Puyallup and the White and Carbon Rivers plays a significant role in the generation of sediment within the Puyallup River watershed. The steep, glaciated hillsides generate significant coarse and fine sediment that is available for downstream transport (Kerwin, 1999). The Puyallup transports significant sediment to Commencement Bay from glacial sources and yields an estimated 300,000 cubic yards of sediment per year (USGS, 1990). This sediment is primarily sand and finer material at the mouth of the Puyallup River (USGS, 1990).

The sediment dynamics of the lower Puyallup have been influenced by mining and river dredging activities. As part of Inter-County River Improvements and private-party mining operations, channel sediments were removed from the lower Puyallup River until the 1980s.

This approach maintained channel capacity. In-channel gravel mining has generally ceased or has been significantly reduced in recent years to preserve instream habitat. As a result, the channel bed of the lower Puyallup River has aggraded, thereby reducing flood carrying capacity (USGS, 1990; Kerwin, 1999).

Urbanization can increase sediment loading to aquatic systems via: (1) increasing peak flows resulting in channel scour, and (2) increasing the potential source of fine sediment to the system. As discussed above, the City of Tacoma is highly urbanized, which has the potential to increase fine sediment loading.

3.3.4.3 Water Quality

The quality of the water flowing through the Puyallup River and Hylebos Creek is the end result of the interaction of water with biota, soils, and urban and rural land use and infrastructure. Key ecosystem processes that impact the source, concentration, and transport of mineral and organic constituents are: biotic uptake, decomposition, adsorption, and dissolution. In general, elements cycle between dissolved and particulate forms in water to plants, animals, and soils, and back to the water column via decomposition.

Water quality processes influence the following shoreline functions:

- Elemental Cycling: including the delivery and storage of nitrogen, phosphorus, metals, toxins, and pathogens.
- Faunal Support/Habitat: biotic populations at all levels of food webs.

Processes that influence water quality occur over a variety of scales. As water moves through an ecosystem, it has the opportunity to deposit, entrain, and/or transport mineral and organic constituents that can affect water quality. The longer water is in contact with soil and vegetation, the more cycling will occur. Longer water contact times typically occur in low gradient areas in the landscape such as riverine and depressional wetland systems.

In general, the Puyallup River and Hybelos Creek have been disconnected from their respective floodplains, which reduces each system's potential to store and filter water before discharge to the marine system. In addition, both channels flow through a highly industrialized portion of the city, which has resulted in a degradation of water quality. Both channels are on the State of Washington's 303(d) list, and are included within the larger Commencement Bay Superfund sites.

3.3.4.4 Organics

Large wood (often referred to as Large Woody Debris [LWD]) significantly influences the geomorphic form and ecological functioning of riverine ecosystems in the Pacific Northwest (Maser et al, 1988; Nakamura and Swanson, 1992; Collins and Montgomery, 1993; Abbe and Montgomery, 1996; Collins et al., 2002; Montgomery et al., 2003a; Montgomery et al., 2003b). LWD consists of logs or trees that have fallen into a river or stream. In a natural system, LWD provides organic material to aquatic ecosystems and is considered a significant factor in forming stream structure and associated habitat characteristics (e.g., pools and riffles). Riparian

vegetation is the key source of LWD. LWD is primarily delivered to rivers, streams, or wetlands by mass wasting (landslide events that carry trees and vegetation as well as sediment), windthrow (trees blown over into a stream or river), or bank erosion (Stanley, et al., 2005). LWD is a more important factor affecting the functions of shorelines in smaller, narrower rivers in the upper part of the watershed than it is for larger rivers in the lower watershed. The wider the river is, from bank to bank, the less likely it is that LWD can create natural dams, pools, and riffles, or similarly affect the hydrology and in-stream habitat within the river. The importance of LWD in river reaches within the lower watershed is delivery of wood to the nearshore environment.

The presence, movement, storage, and decomposition of LWD influence the following shoreline functions:

- Delivery of wood and organics affects vegetation and habitat functions such as instream habitat structure (pools and riffles) and species diversity; and
- Riparian vegetation, especially LWD, provides habitat in the form of nesting, perching, and roosting as well as thermal protection, nutrients, and sources of food (terrestrial insects) to a variety of wildlife species.

The lack of LWD in the riparian zones of the Puyallup River and Hylebos Creek has been identified as a significant limiting factor in habitat extent and quality (Kerwin, 1999). Urban and industrial land use has resulted in the effective removal of the historical floodplain forest, and river management has focused on the removal of in-channel wood. Since the source of LWD in the lower watershed is gone, the process of delivery of large organics to the riverine ecosystem no longer functions in the lower Puyallup ecosystem.

3.3.5 Processes Affecting Lake Shorelines

Ecosystem-wide processes that affect lake shorelines include specific actions related to hydrologic processes, sediment delivery, water quality and organics. In Tacoma, unlike its river systems where water flow is affected by factors across a large watershed, Wapato Lake is located near the headwaters of its drainage basins and is influenced by a limited area draining to it. Lake processes are more easily altered by nearby land use modifications since they are directly tied to conditions in a smaller basin area.

Wapato Lake has formed within former glacial outwash channels on the upland plateau. The lake is in the headwaters of small tributary streams and is generally disconnected from larger-scale ecosystem-wide processes occurring within the river basin or coastal processes.

3.3.5.1 Hydrology

Hydrologic processes influence the following shoreline functions:

- Lake hydroperiod (e.g., timing and extent of inundation within the lake);
- Surface water storage – the volume of surface storage in the lake can impact downstream receiving waters; and
- Type and extent of lacustrine and lacustrine fringe habitat.

The surface and groundwater hydrology of Wapato Lake are tightly linked. Wapato Lake has formed within a narrow trough of Vashon Recessional Outwash (Qvr) and Steilacoom Gravels (Qvs) that were likely deposited as the proglacial Lake Puyallup drained to the south via the South Tacoma Channel. The relatively permeable Qvr and Qvs materials allow for rapid movement of surface waters from the basin area to the lake. Therefore, water levels within the lake are highly dependant on climatic conditions and land use within the contributing basin. Further, the input of groundwater to the lake is limited, as the lake bottom does not intersect a significant aquifer beyond the surface-driven aquifer.

Precipitation that falls within the receiving basin is transmitted to the upper wetlands relatively rapidly via surface, piped, or shallow subsurface flow. The speed of water flow to these wetlands has increased due to urbanization within the drainage area. This urbanization has resulted in an increase in impervious surfaces that transmit rainfall quickly through the storm drainage system to the wetlands .

Wapato Lake forms part of a surface water holding system at the headwaters of the Flett Creek and Chambers Creek system. A managed overflow at the south side of the middle waterbody of the lake allows water from Wapato Lake to flow south for discharge into Ward's Lake.

3.3.5.2 Sediment Generation and Transport

Sediment generation and transport processes influence the following shoreline functions:

- Surface water storage; the volume of surface storage in the lake can impact downstream receiving waters;
- Water Quality; some pollutants can be transported along with sediment; and
- Type and extent of lacustrine and lacustrine fringe habitat.

There are two primary sediment generation and transport processes within the Wapato Lake basin: (1) sediment build up and wash off from developed areas, and (2) shoreline erosion during storms. Urbanization results in soil disturbance, and vehicle traffic results in deposition of fine sediment on roadways. This sediment is washed into the storm drain system during precipitation events. The shoreline of Wapato Lake is unvegetated, and appears to be prone to erosion from foot traffic, surface runoff, and small wind-driven waves (Photo 3-1).

Photo 3-1. Eroding shoreline along Wapato Lake.

3.3.5.3 Water Quality

Water quality processes influence the following shoreline functions:

- Type and extent of lacustrine and lacustrine fringe habitat.

The hydrology of Wapato Lake is driven by precipitation within the drainage basin, which provides significant opportunity for the entrainment and transport of excess nutrients, metals, bacteria, and other potential pollutants in the stormwater that flows into the wetlands. Alterations to the lake over time have resulted in increased volumes of stormwater runoff into the wetlands and may have caused decreases in natural groundwater sources into the lake. The lake is currently closed to swimming and fishing due to extensive water quality problems. Metro Parks is currently investigating the issues related to water quality in the lake.

3.3.5.4 Organics

The presence, movement, storage, and decomposition of LWD influence the following shoreline function:

- Habitat functions such as lakeshore habitat structure and species diversity;

Lakes may deliver woody debris to stream outlets, but this is not an important function of the lakes in an urban setting. Delivery of LWD provides habitat function within the lakes themselves along the lakeshore supporting both inwater and riparian habitats. Some management plans of lakes and private property have excluded or minimized LWD.

4.0 NEARSHORE MARINE SHORELINE PLANNING AREA

This section provides reach-scale information for the City of Tacoma's marine shorelines, consistent with state guidelines. Elements identified in WAC 173-26-201(3)(c), "Inventory shoreline conditions," are described at the shoreline planning area scale, which approximates the limits of regulatory jurisdiction under the SMA. This section is organized generally into two sections, Natural Environment and Built Environment. Elements of the natural environment include a description of natural process modifications, aquatic resources, habitat, and regulated critical areas. Elements of the built environment include existing and planned land use patterns, infrastructure and shoreline modifications, public access areas, cultural resources, and other areas of special interest.

4.1 Nearshore Marine Reaches

For purposes of the shoreline inventory and characterization, the nearshore marine shoreline planning area was divided into five reaches totaling 33.6 miles. Reach divisions were made based on general land use characteristics and shoreline processes. The Narrows reach (Reach 1) is approximately 4.5 miles long, and extends from the city limits near Days Island to just north of the community of Salmon Beach. The Point Defiance reach (Reach 2) encompasses a majority of Point Defiance Park, extending nearly 2.5 miles from Fort Nisqually along the Tacoma Narrows to Owen Beach along Puget Sound/Outer Commencement Bay. The Ruston Way reach (Reach 3) extends 5.4 miles from Owen Beach along the Ruston Way and Schuster Parkway shoreline to the outer limits of the Thea Foss Waterway. The Waterways Reach (Reach 4) encompasses all of the waterways, including Thea Foss, Middle, Milwaukee, Sitcum, Blair, and Hylebos, but excludes the Puyallup River. The Puyallup River (Reach 5), Hylebos Creek (Reach 6), and Wapato Lake (Reach 8) are addressed in subsequent sections of this report. The Waterways Reach is the longest shoreline segment measuring 19.8 miles total. Reach 7, the Marine View Drive reach, extends 1.5 miles north around Commencement Bay from the Hylebos Waterway to the northern city limits (Table 4-1; Map 1).

In some ways the Thea Foss Waterway merits consideration as a separate reach, because its uses, development patterns, and treatment in the City's shoreline program are different from the other waterways at the head of Commencement Bay. While it is included with the other waterways for purposes of this inventory report, the City has detailed inventory information on the Thea Foss that is readily available, and where appropriate in this report (for example in the discussion in Table 4-8 below) the Thea Foss is discussed separately.

Two other marine areas are described generally at the end of this chapter. Reach 9, Browns Point-Dash Point UGA, is included in this inventory and characterization in anticipation that areas within this reach may become part of the City's shoreline jurisdiction through annexation in the future. The marine deep water area represents the offshore limits of the City's jurisdiction in the Tacoma Narrows and Commencement Bay (Table 4-1; Map 1).

Table 4-1. City of Tacoma Nearshore Marine Planning Area

Shoreline segment	Reach number	Length (mi)	Area (acres)
Narrows	1	4.5	419.5
Point Defiance	2	2.5	178.5
Ruston Way	3	5.4	468.0
Waterways	4	19.8	1,823.6
Marine View Drive	7	1.5	131.0
Total		**33.6**	**3,020.6**
Other Marine Areas			
Browns Pt.-Dash Pt. UGA	9	3.0	
Deep Water Areas	10	N/a	

4.2 Natural Environment

4.2.1 Modifications to Coastal/Nearshore Processes

In general, modifications to coastal/nearshore processes are more substantial within Commencement Bay than in the Tacoma Narrows. Modifications to coastal/nearshore processes can be discussed in terms of physical or structural modifications that affect natural sediment generation and transport processes to the marine nearshore environment.

Physical modifications along the marine shoreline of Tacoma are associated with development along the shoreline. Development often includes the placement of riprap armoring, construction of wood or concrete bulkheads, construction of boat ramps, installation of piers, and installation of docks (Photo 4-1).

Photo 4-1 Examples of shoreline modifications near Titlow Park

To provide an overview of the extent of physical or structural modification to the marine shoreline, the length of armored shorelines in each reach is summarized in Table 4-2, below. This includes vertical and angled bulkheads of various materials (wood, concrete, etc.) and riprap armored shorelines. Information in Table 4-2 is based on previous inventory work by GeoEngineers (2004). Text following Table 4-2 also describes in-water and over-water structures in each reach, such as piers, docks, and marinas.

Table 4-2. Shoreline Armoring by Reach

Reach	Length (mi) /Percent of Reach with Armoring	Notes
1 - Narrows	4.4 mi / 76%	Primarily vertical wood bulkheads with and without riprap. Includes five docks.
2 - Point Defiance	0.5 mi / 18%	Primarily bulkheads. Area has also been modified by mass-wasting (i.e., landslides).
3 - Ruston Way	6.5 mi / 97%	Includes nine docks. Five of the bulkheads are described as “poor condition”
4 - Waterways	15.8 mi / 71%	Significant structural alterations with Port of Tacoma industrial waterways development.
7- Marine View Drive	0.2 mi / 12%	Includes 159 docks, generally associated with marinas.

Three general levels of disturbance or alteration to natural processes are apparent from the information shown above in Table 4-2. The level of disturbance generally varies from low along Point Defiance to medium along the Narrows, and high within Commencement Bay.

The level of alteration is generally low along the Point Defiance Reach, which is almost entirely used as a park. Previous inventory work recorded four bulkheads within Reach 2, with informal riprap dumped at one of the bulkheads (GeoEngineers, 2004). Paved paths are present above the highwater line for much of the shoreline.

At least eight bulkheads and five docks exist within the Narrows Reach (1) to support marina, residential, and parkland uses (GeoEngineers, 2004). The docks are focused along the southern portion of the reach, in the wider portion of the Sound. In the northern end of Reach 1, bulkheads are associated with development in the Salmon Beach community. This community consists of approximately 3,500 feet of shoreline that is covered by single-family residential houses and cabins and is one of three such overwater residential communities located in the city. These houses are typically built at the base of the slope on piers over the water. Another overwater community, Wilton Road community, is located south of Titlow Beach. A rail line follows the shoreline for approximately 90 percent of the entire Reach 1 before entering a tunnel just south of the Salmon Beach community.

The Ruston Way Reach (Reach 3) includes 29 bulkheads, five of which have been described as being in "poor condition" (GeoEngineers, 2004). There are nine mapped piers/docks, associated with the Point Defiance Ferry Terminal and historic industrial activities. Ruston Way is a main arterial located adjacent to the shoreline, generally within 200-feet of the shoreline.

Modifications to the Waterways Reach (Reach 4) are extensive throughout this shoreline area, and are associated with the intense industrial and port land uses which characterize the Waterways built environment. Small areas of restoration activity have occurred within Reach 4 – most frequently as part of mitigation work for impacts to the shoreline environment. In these areas, mudflat and inter-tidal habitat does exist. Outside of these areas, however, the Waterways shorelines are highly modified with concrete and wooden bulkheads, as well as over-water structures that are supported by piers.

The Marine View Drive Reach (7) is the shortest of the inventory reaches, but includes a high density of piers and docks. These piers and docks are associated with log rafting operations and existing marinas. An overwater residential community is located north of East 11th Street. Marine View Drive is a main arterial street located adjacent to the shoreline, generally within 200-feet of the shoreline.

Artificial structures modify natural coastal sediment generation, storage, and transport processes. Bulkheads are generally intended to protect upland development from shoreline erosion. However, bulkheads are typically ineffective at preventing large mass wasting or landslide events that are triggered by significant rainfall and/or tectonic events. As a bulkhead armors the toe of a slope: (1) wave energy is being increased, and (2) the upland sediment source is being partially or temporarily blocked. The level of disturbance to these coastal processes within the shoreline of Tacoma is generally tied to the intensity of development.

Nearshore vegetation and habitats are also impacted by the presence of artificial shoreline structures. Shoreline armoring increases wave energy that can mobilize fine substrates that would otherwise be available for colonization by eelgrass (*Zostera* spp.) or nearshore algal colonies. Docks and log rafts also result in physical impacts in shallow areas and mudflats, which can result in removal of typical nearshore vegetation. Bulkheads can result in disconnection of upland sediment sources that would provide the materials to build mudflats, which in turn would provide the substrate for nearshore vegetation and algal environments.

4.2.2 Geologic Hazards

4.2.2.1 Erosion Hazard Areas

Erosion hazard areas are defined in Section 13.11.720.1 of the Tacoma Municipal Code as areas where the combination of slope and soil type makes the area susceptible to erosion by water flow, either by precipitation or by surface runoff. Erosion hazard areas include:

- Areas with a high probability of rapid stream incision, stream bank erosion or coastal erosion, or channel migration.
- Areas defined by the Washington Department of Ecology Coastal Zone Atlas shoreline slope stability mapping as one of the following areas (refer to Table 4-3 below): Class U (Unstable) includes severe erosion hazards and rapid surface runoff areas, Class Uos (Unstable old slides) includes areas having severe limitations due to slope, Class Urs (Unstable recent slides), and Class I (Intermediate).
- Any area characterized by slopes greater than 15%; and the following types of geologic units as defined by draft geologic USGS maps: m (modified land), Af (artificial fill), Qal (alluvium), Qw (wetland deposits), Qb (beach deposits), Qtf (tide-flat deposits), Qls (landslide deposits), Qmw (mass-wastage deposits), Qf (fan deposits), Qvr and Qvs series of geologic material types (Vashon recessional outwash and Steilacoom Gravel), and Qvi (Ice-contact deposits).
- Slopes steeper than 25% and a vertical relief of 10 or more feet

On the basis of slope classification in the Tacoma area, erosion hazard areas are present in all of the nearshore marine reaches except the Waterways. In the Narrows (Reach 1), slopes are classified by the Washington Coastal Atlas shoreline slope stability mapping as being intermediate to unstable, or as having areas of unstable old slides. At Point Defiance (Reach 2), slopes are unstable or consist of unstable old slides. Along the Ruston Way (Reach 3), slopes are generally characterized as unstable. Slopes along the Marine View Drive (Reach 7) are primarily characterized as intermediate.

Table 4-3. Ecology Slope Stability Map Designations

Slope Stability Designation	Definition
Stable (S)	Generally rise less than 15 percent in grade, except in areas of low groundwater concentration or competent bedrock. Include rolling uplands and lowlands underlain by stable material (i.e., unweathered till and/or peat deposits) with no significant slope.
Intermediate (I)	Generally steeper than 15 percent except in areas where weaker material and/or abundant material exist. These areas include slopes of sand and gravel, till, or thin soils over bedrock with no known failures.
Unstable (U)	Slopes that are considered unstable due to geology, groundwater, slope, and/or erosional factors which include areas of landslide and talus too small or obscure to be mapped.
Unstable Recent Landslide (Urs)	Recent or historically active landslide areas (based on surveys conducted in the late 1970s).
Unstable Old Landslide (Uro)	Post-glacial but prehistoric landslide areas.
Modified	Slopes that are highly modified by human activity and include areas of significant excavation or filling. Response of the slope to a combination of human activity and natural processes may be unpredictable.

4.2.2.2 Landslide Hazard Areas and Shoreline Slope Stability

Landslide hazard areas are defined in Chapter 13.11.720 of the Tacoma Municipal Code as areas that, due to a combination of geologic, topographic, and hydrologic factors, are susceptible to landsliding. They are identified as any area with the following three characteristics:

- Slopes steeper than 25% and a vertical relief of 10 feet or more.
- Hillsides intersecting geologic contacts that contain impermeable soils (typically silt and clay) frequently interbedded with permeable granular soils (predominantly sand and gravel, or impermeable soils overlain with permeable soils.
- Springs or groundwater seepage.

In addition, landslide hazard areas are identified as any area with one of the following characteristics: a) any area which has exhibited movement during the Holocene epoch (from 10,000 years ago to present), b) any area potentially unstable due to rapid stream incision, stream bank erosion, or undercutting by wave action, c) any area located on an alluvial fan presently subjected to inundation by debris flows or deposition by stream-transported sediments, d) any area where the slope is greater than the angle of repose of the soil, and e) any shoreline designated or mapped as Class U, Uos, Urs, or I by the Washington Department of Ecology Coastal Zone Atlas.

The Department of Ecology Coastal Zone Atlas (Ecology, 1979) characterizes the slope stability of the entire shoreline along Puget Sound. This mapping should not be considered comprehensive and does not include landslides that have occurred since the late 1970s. In the

Coastal Zone Atlas, slope stability is defined in terms of six separate categories as described in Table 4-3.

Landslide hazard areas occur in all of the reaches associated with the nearshore marine environment in Tacoma except the Waterways. Many areas are characterized by steep coastal bluffs that are commonly susceptible to failure. Landslides have been well documented in Tacoma along the Narrows (Shannon and Wilson, 2000; Edwards, 2006) (see Photo 4-2). Areas along Marine View Drive experience active slumping and slope failure in the winter storm season. The city's bluffs were probably formed by coastal erosion following retreat of the ice sheet and regional drop in relative sea level (Shipman, 2004). Over time, the bluffs become oversteepened due to wave erosion at the base of the cliffs. Landsliding and mass wasting ensue, resulting in episodic retreat of the shoreline.

Photo 4-2 Recent landslide remediation area above the Salmon Beach community in Reach 1 (The Narrows)

4.2.2.3 Seismic Hazard Areas

Seismic hazard areas are defined in Chapter 13.11.720 of the Tacoma Municipal Code as areas that are subject to severe risk of damage as a result of seismic induced settlement, shaking, lateral spreading, surface faulting, slope failure, or soil liquefaction. These conditions occur in areas underlain by noncohesive soils of low density, usually in association with a shallow groundwater table.

Areas susceptible to liquefaction are identified along the Narrows, Point Defiance, and Ruston Way reaches. Along the Narrows and Point Defiance reaches, liquefaction susceptibility is considered to be moderate. Much of the surficial sediment in these areas is mapped as alluvial, landslide, and beach deposits, as well as artificial fill. Artificial fill lines much of the shoreline along the Ruston Way reach, and thus is considered to have high susceptibility to liquefaction. As noted in Map 3 in Appendix A, the Waterways reach contains substantial artificial fill and is also likely to be susceptible to liquefaction.

4.2.3 Stream Mouths and Associated Wetlands

In the nearshore marine shoreline, the Puyallup River is the dominant feature contributing sediments and creating deltas at the river mouth. The mouth of the Puyallup is described in Section 5 of this report. In addition to the Puyallup and Hylebos, there are numerous short (e.g., less than 1,500 feet from the headwaters to the water) drainages that connect the upland till plain to the marine shoreline. These channels are typically very steep, and many have been previously classified as "gulches," likely indicating intermittent or seasonal flow (Tacoma, 2000). Inventoried drainages are listed below in Table 4-4, organized by Reach. Streams and wetlands in Tacoma are shown on Map 2.

Table 4-4. Tributary Drainages to the Marine Shoreline in Tacoma (Tacoma, 2000)

Reach Number	Drainage	Discharge Point
1	Crystal Springs	Titlow Pond/Estuary
	Titlow Park Gulch	Titlow Pond/Estuary
	Pedestrian Bridge Gulch	Puget Sound
	Tacoma Outboarder Association Gulch	Puget Sound
	Narrows Creek	Puget Sound
	War Memorial Gulch	Puget Sound
	Jason's Gulch	Puget Sound
	Chinese Mining Gulch	Puget Sound
	Creek Beside Ditch	Puget Sound
	Deer Haven Gulch	Puget Sound
	Stormwater Pipe Alley Gulch	Puget Sound
	South of Gold Creek Gulch	Puget Sound
	Gold Creek Gulch	Puget Sound
	Marinera Gulch	Puget Sound
	Double Drain Gulch	Puget Sound
	Tunnel Gulch	Puget Sound
	Salmon Beach (ground water seeps)	Puget Sound
3	Mason Gulch	Commencement Bay
	Puget Creek Gulch/Procter Gulch	Commencement Bay
	Buckley Gulch	Commencement Bay
4	Wapato Creek	Blair Waterway
	McMurray Gulch	Hylebos Waterway
	Coski Gulch	Hylebos Waterway
	Julia's Gulch	Hylebos Waterway
	Metal Gulch	Hylebos Waterway
	McBridge Gulch	Hylebos Waterway
	Manke Gulch	Hylebos Waterway
7	Agnes Road Gulch	Puget Sound (out of city limits)
	Dry Gulch	Puget Sound (out of city limits)
	Harbor Ridge Line	Commencement Bay
	Marine View Drive 1	Commencement Bay
	Marine View Drive 2	Commencement Bay
	Charlie's Gulch	Commencement Bay
	Ole's Gulch	Commencement Bay
	Loma Court Gulch	Commencement Bay

Wetlands associated with the nearshore marine shoreline are limited in the urban waterfront of Tacoma. The types of wetland typically located in the nearshore shoreline environments of western Washington include lagoons, saltwater marshes, and freshwater/brackish wetlands near the mouth of streams or rivers. In Tacoma, associated wetlands along the coastal shoreline are found in limited locations as tidal fringe habitats. Many of the areas locally designated as intertidal wetlands are considered special aquatic habitats, including non-vegetated mudflats, but are not classified as wetlands according to the state definition (Washington State Department of Ecology, 1997). Intertidal areas, rocky beaches and mudflats lacking prevalent wetland vegetation do not meet the definition of wetlands. These areas are still important marine habitats for anadromous fish, waterfowl, marine mammals and other marine aquatic species.

The City, the Port of Tacoma, and the NRDA Trustees, as part of Commencement Bay cleanup, have undertaken several intertidal wetland restoration projects. These projects involve planting within the intertidal areas to restore tidal marshes in and around Commencement Bay. Examples of these areas include the Mowitch site, Middle Waterway and tidal fringe wetlands near Squally Beach.

Wetland resources have been mapped along the courses of many of the small streams and gulches along the marine shoreline within the shoreline jurisdiction (GeoEngineers, 2004). However, many of these resources have not been confirmed in the field.

4.2.4 Coastal Flood Hazard Areas

Flood hazard areas are defined in Chapter 13.11.600 of the Tacoma Municipal Code as areas considered at risk for flooding delineated by the Federal Insurance Administration and on the most recent "flood insurance rate map," or "FIRM." Where the flood insurance map does not provide information, the City, through its Public Works Department, will consider and interpret information produced by the Army Corp of Engineers, Natural Resource Conservation Service, Department of Housing and Urban Development, or any other qualified person or agency to determine the location of Flood Hazard Areas and Coastal High Hazard Areas.

The Federal Emergency Management Agency (FEMA) has prepared Flood Insurance Rate Maps (FIRMs) that cover Tacoma's marine shorelines. These maps were adopted on December 1, 1983 (Community Mapping Series 530148). These maps indicate that an elevation of 9.0 (feet NGVD 29) has been established for coastal flooding. In general, this elevation does not intrude inland, typically staying waterward of the railroad grade on the Narrows side, Ruston Way, and Marine View Drive. The same elevation is also used within the waterways.

The marine shorelines of Tacoma are also subject to periodic flooding from tsunamis. Tsunamis can result from tectonic forces (e.g., earthquakes along the Cascadia Subduction Zone, Tacoma fault, Seattle fault) or mass-wasting events. In 1948, an earthquake along the Tacoma fault resulted in a large subaerial (upland) landslide that entered the Narrows, resulting in reflecting waves along the coastline. There have also been submarine failures of the Puyallup River delta in 1894 and 1943 that resulted in tsunamis (NOAA, 2003).

4.2.5 Critical or Priority Habitat and Species Use

Tacoma Municipal Code (Section 13.11.510) classifies fish and wildlife habitat conservation areas as being of critical importance to the maintenance of fish and wildlife species. Critical fish and wildlife habitat areas defined by code and summarized as follows:

- Fish and Wildlife habitat areas may include: lands containing priority habitats and species; all public and private tidelands or bedlands suitable for shellfish harvest; kelp and eelgrass beds and herring and smelt spawning areas; natural ponds under 20 acres and their submerged aquatic beds that provide critical fish or wildlife habitat; Waters of the State, which are defined in WAC Title 222, Forest Practices Rules and Regulations; lakes, ponds, streams and rivers planted with game fish and waters which support priority fish species as identified by the WDFW; and State natural area preserves and natural resource conservation areas, which are defined, established, and managed by the Washington Department of Natural Resources (DNR).

Critical fish and wildlife habitats in the City's marine shoreline jurisdiction are characterized throughout the following sections describing the shoreline and nearshore biological areas.

The Washington Department of Fish and Wildlife (WDFW) maintains priority habitat and species information for Washington State, including the status of species as threatened or endangered. The City of Tacoma is located in WDFW Region 6. Priority habitats within Region 6 include consolidated marine/estuarine shorelines, cliffs, caves, snags, riparian areas, old-growth/mature forests, and urban open spaces. Priority Habitats identified on WDFW maps along Tacoma's marine shorelines include cliffs/bluffs in Reaches 1-3 7; 1-UGA, and 2-UGA; urban natural open space in Reaches 1-4; lagoons in Reach 1; estuarine zones in Reaches 3, 4, and 7; and wetlands in Reaches 4 and 7 (WDFW, 2006). Cliffs and bluffs are greater than 7.6 meters (25 feet) high and provide significant wildlife breeding habitat. Urban Natural Open Space may provide habitat for priority species and use it for breeding and or foraging, it may function as a corridor connecting other priority habitats, or it may be an isolated remnant of natural habitat larger than 10 acres and is surrounded by urban development. Lagoons and estuaries are tidal habitats and adjacent tidal wetlands, usually semi-enclosed by land but with open, partly obstructed or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land. The salinity may be periodically increased above that of the open ocean by evaporation. Lagoons include Titlow Lagoon and Days Lagoon. In addition to these critical and priority habitats, the Titlow Beach Marine Preserve, established in March 1994, is also found along the Tacoma Narrows (Reach 1) shoreline.

Priority species found along the marine shoreline include purple martin (*Progne subis*) in Reaches 1 and 7, nesting bald eagles (*Haliaeetus leucocephalus*) in Reach 2, and a seabird colony near Old Town in Reach 3. Within Reach 4, priority species include nesting peregrine falcons on the 11th Street Bridge, a western pond turtle (*Clemmys marmorata*) within the Thea Foss Waterway, alcid seabird colonies near the mouths of Middle and Milwaukee Waterways, and a great blue heron (*Ardea herodias*) colony along the Hylebos Waterway. A seabird colony (no alcids or cormorants) was also identified in Reach 7 (WDFW, 2006).

The following sections discuss in more detail some of the priority species and species of local importance that occur within the City's shoreline jurisdiction.

4.2.5.1 Shellfish

Documented shellfish resources in the Tacoma shorelines include crabs and geoducks clams (*Panopea generosa*). Crab resources are found throughout inner Commencement Bay, in Reaches 3, 4, and 7, as well as the deep waters off of the Puyallup River delta. Commencement Bay is part of WDFW's Marine Catch Area (MCA) 11, which includes the waters north of the Tacoma Narrows Bridge and south of a line that extends from Point Southward to Brace Point. The recreational harvest of Dungeness crab in MCA 11 was 54,575 pounds during the 2004-2005 season and 37,465 pounds during the 2005-2006 season (Cain, personal communication, 2006). Two geoducks beds are documented in subtidal areas adjacent to the shoreline in Reach 1, south of the Tacoma Narrows Bridge. A scallop bed is reported to be located near the upper end of the Arsarco slag peninsula (Citizens For A Healthy Bay, 2006).

The Washington State Department of Health has closed all of the Commencement Bay shoreline from the King-Pierce County line to the Tacoma Narrows for shellfish harvesting due to a combination of marine biotoxins and pollution. The majority of marine biotoxin closures are centered near Point Defiance (Reach 2) and the westernmost portion of Ruston Way (Reach 3). Harvest advisories are in place for areas southeast of the Narrows due to pollution and the potential presence of biotoxins in particular shellfish species in these locations. The Department of Health conducts an ongoing assessment of pollution and conditions related to shellfish harvesting. The latest update was in March 2006, which maintained the closure of Commencement Bay to shellfish harvesting (Washington Department of Health, 2006).

While the Tacoma – Pierce County Health Department has warned against regularly consuming fish, shellfish, and crabs caught in nearshore Commencement Bay, a low level of recreational harvesting of many of these species does occur, primarily within the Thea Foss Waterway and along the Ruston-Pt. Defiance Shoreline (USEPA, 2004). Despite closures in place at the mouth of the River and throughout Commencement Bay to protect human health, recreational harvest of crab at the mouth of the Puyallup River and adjacent areas continues to occur.

4.2.5.2 Salmonids

The lower Puyallup River provides migration and rearing habitat for Chinook, pink, chum, and coho salmon, steelhead and bull trout. Adult salmonids are typically found in Commencement Bay between August and November, except spring Chinook and steelhead, which are present during winter and spring (Parametrix, 1985a). The White River spring run Chinook is the only native spring run Chinook in south Puget Sound (Citizens For A Healthy Bay, 2006).

Nearshore habitat is an important environment for juvenile salmonids, where the shallow water depth obstructs the presence of larger predator species. Juvenile Chinook salmon use the areas of Commencement Bay within 500 to 1,000 feet of the shoreline and in the Waterways, particularly after the releases of hatchery fish in mid to late May (Kerwin, 1999). All shoreline segments within the City's shoreline jurisdiction are known or expected to contain juvenile salmonids including bull trout, cutthroat, Chinook, chum, coho, pink, and sockeye salmon.

Critical Habitat, as defined by the Endangered Species Act, "is the specific areas within the geographical area occupied by a species…on which are found those physical or biological features essential to the conservation of the species and that may require special management considerations or protection"; and "specific areas outside the geographical area occupied by a species at the time it is listed… that are essential for the conservation of the species." Critical Habitat has been designated for Pacific salmon and steelhead in Washington, Oregon, and Idaho, including the Puget Sound Evolutionarily Significant Unit (ESU) Chinook salmon. Designated Chinook Critical Habitat in Tacoma includes nearshore marine areas of both Commencement Bay and the Tacoma Narrows from the extreme high tide line to a depth of 30 meters relative to Mean Lower Low Water (MLLW) (Federal Register, 2005a). Critical Habitat has also been designated for bull trout, which may be present in the nearshore areas of Tacoma. Designated Critical Habitat for bull trout includes marine waters of Commencement Bay and the Tacoma Narrows to a depth of 33 feet (10 meters) relative to MLLW (Federal Register, 2005b).

Nearshore modifications of shorelines by armoring, overwater structures and loss of riparian vegetation can affect salmonid habitat (Redman et al., 2005) in the following ways:

- Loss and/or simplification of deltas and delta wetlands;
- Alteration of flows through major rivers;
- Contamination of nearshore and marine resources;
- Alteration of biological populations and communities;
- Transformation of land cover and hydrologic function of small marine discharges via urbanization; and
- Transformation of habitat types and features via colonization by invasive plants.

4.2.5.3 Forage Fish

Forage fish include species that as adults breed prolifically and are small enough to be prey for larger species. They are often non-game fish. The three forage fish species most likely to occur in the City's shoreline jurisdiction include surf smelt, sand lance, and Pacific herring. Different species utilize different parts of the intertidal and subtidal zones, with sand lance and surf smelt spawning primarily in the substrate of the upper intertidal zone, and Pacific herring spawning primarily on intertidal or subtidal vegetation (Lemberg et al., 1997). Information on the potential forage fish species within the City's jurisdiction is summarized in Table 4-5.

Table 4-5 Forage Fish Species

Species	Documented Presence	Spawning Timing	Preferred Spawning Substrate	Spawning Location
Pacific herring	Puget Creek nearshore, anecdotally (PCRS, 2006).	Quartermaster Harbor stock spawn January through mid-April	Eelgrass	Upper high tide limits to depths of 40 feet (typically between 0 and –10 tidal elevation)
Sand lance	Yes, Titlow, Point Defiance to Owen Beach, in pockets along Reach 3, Brown's Point (WDFW PHS); Puget Creek nearshore, anecdotally (PCRS, 2006)	November 1 to February 15	Fine sand, mixed sand and gravel, or gravel up to 3cm	From + 5 tidal elevation to higher high water line (from bays and inlets to current-swept beaches)
Surf smelt	Yes, Brown's Point (WDFW PHS)	South Puget Sound stocks are fall-winter spawners (September to March)	Mix of coarse sand and fine gravel (1-7mm)	Upper intertidal

Information on documented forage fish spawning activity was available from the WDFW PHS data (2006). No Pacific herring spawning areas are currently documented in the shoreline inventory area (WDFW, 2006). Anecdotal information indicates that herring spawning may occur at the Puget Creek nearshore (PCRS, 2006). The areas offshore of Point Defiance are mapped as a holding area prior to spawning in Quartermaster Harbor. It is likely that they utilize the nearshore areas of Reaches 1-3 for feeding and migration.

WDFW (2006) documents sand lance spawning areas in Reach 1 near Titlow, along the eastern shore of Reach 2 from the tip of Point Defiance to Owen Beach, and in small pocket beaches along Reach 3. An additional sand lance spawning area has been identified on the north shore of Browns Point, in the Tacoma UGA, and there is anecdotal information related to sand lance spawning at the Puget Creek nearshore (PCRS, 2006). Surf smelt spawning areas have been documented only in a small stretch on the north/northwest shore of Browns Point in Tacoma's UGA (WDFW, 2006). Based on anecdotal information, forage fish spawning of an unidentified species may occur within Reach 7 at the mouth of the Hylebos Waterway, but has not been verified by WDFW (CHB, 2006).

Sand lance and surf smelt spawn in the upper intertidal zone of protected sand-gravel beaches throughout the increasingly populated Puget Sound basin, making these species vulnerable to the cumulative effects of various types of shoreline development. "No net loss" regulations for protection of known spawning sites of forage fish species are included in the Washington Administrative Code Hydraulic Code Rules (WAC 220-110), which are applied during permitting of in-water construction activities.

Nearshore modifications affect forage fish habitat in the following ways:

- Development impacts the shoreline, particularly marinas and boat ramps, which bury spawning habitat, introduce the potential for repeated disturbance, and potentially alter nearshore hydrology;
- Sewer outfalls introduce pollutants and nutrients to the nearshore;
- Overwater structures shade intertidal vegetation and may alter nearshore hydrology;
- Riprap revetments and bulkheads impound sediment in bluffs such that fine-grained spawning beach sediment is not replenished (ongoing net-shore drift decreases spawning habitat); and
- Riprap revetments and vertical bulkheads alter nearshore hydrology and may increase wave energy on intertidal areas.

4.2.5.4 Marine Mammals

Marine mammals that are found within Puget Sound include the killer whale (*Orcinus orca*), Pacific harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), gray whale (*Eschrichtius robustus*), Dall's porpoise (*Phocoenoides dalli*), and harbor porpoise (*Phocoena phocoena*). Steller sea lions (*Eumetopias jubatus*) and humpback whales (*Megaptera novaeangliae*) may also occur in Puget Sound, though they are infrequent visitors. The harbor seal is the most common marine mammal in Puget Sound, and California sea lions are a common resident and seasonal migrant in Puget Sound. Seals and sea lions use specific shoreline areas, known as haul-outs, to haul-out of the water and rest, dry out, interact and regulate body their temperature. In addition to resting, harbor seals give birth to and nurse their pups at certain haul-out locations, and undergo an annual molt of their pelage or fur. Haul-outs can include beaches, rocky areas, log booms and floats. Some haul-outs are used regularly, while others may be used seasonally or occasionally. Seal and sea lion haul-outs have been documented along Tacoma's marine shoreline on buoys, floats, and logbooms in northeast Commencement Bay (Jeffries et al., 2000). Based on anecdotal information, a small number of harbor seals use the rafts held in the in-water log storage site at the mouth of the Hylebos Waterway as a pupping area (CHB, 2006). The closest documented pupping ground is on Gertrude Island, south of the Tacoma Narrows. It is not known whether seals pupping on Gertrude Island use Commencement Bay (EVS, 1995).

Dall's porpoise and harbor porpoise live year-round in Puget Sound, but are unlikely to use the nearshore marine habitats in the planning area due to shipping traffic. Southern Resident and transient killer whales may occur in southern Puget Sound, particularly during winter months. From late spring to fall, most whales can be found in the inland waters around the San Juan Islands, including Haro Strait, Boundary Passage, and the eastern portion of the Strait of Juan de Fuca; winter movements and distribution are poorly understood for the population (Wiles, 2004). Critical Habitat has been proposed for killer whales, including Puget Sound marine waters deeper than 20 feet (6.1 meters) (Federal Register, 2006).

4.2.5.5 Shorebirds and Upland Birds

Adjacent to the open waters of Puget Sound, the nearshore marine shoreline environment provides habitat for birds and their prey. A variety of shorebirds utilize the nearshore environment for wintering and breeding. A total of 203 bird species have been recorded in the Commencement Bay area. Of these species, 162 are found regularly, and 36 breed within the area (Table 4-6) (EVS, 1995).

Table 4-6. Bird Species Regularly Found in Commencement Bay Summarized by Major Group

Order	Common Name	Species Regularly Occurring	Occurring Species That Breed In Commencement Bay
Gaviformes/ Podicipediformes	Loons and grebes	8	1
Pelecaniformes	Cormorants	3	0
Ciconiiformes	Herons	2	2
Anseriformes	Ducks and geese		
	Dabbling	13	2
	Diving	10	0
	Fish-eating	4	0
Falconiformes	Raptors	9	1
Galliformes	Quail	2	2
Gruiformes	Rails	3	0
Charadriiformes	Shorebirds	15	2
Charadriiformes	Gulls, terns, and alcids	14	2
Columbiformes	Pigeons	2	1
Strigiformes	Owls	2	0
Caprimulgiformes Apodiformes	Nighthawks, swifts	2	0
Covaciiformes	Kingfisher	1	1
Piciformes	Woodpecker	2	1
Passeriformes	Swallows and flycatchers	7	4
	Crows, jays, and shrikes	15	6
	Wrens, warblers, and sparrows	16	11
Total Species		**130**	**36**

4.2.6 Marine Riparian and Intertidal Habitats

Riparian areas are transitional zones between terrestrial and aquatic ecosystems. Riparian habitats include those portions of terrestrial ecosystems that significantly influence exchanges of

energy and matter with aquatic ecosystems (Brennan and Culverwell, 2004). Marine riparian vegetation is defined as vegetation overhanging the intertidal zone (KCDNR, 2001). Marine riparian zones function by protecting water quality; providing wildlife habitat; regulating microclimate; providing shade, nutrient and sources of food; stabilizing banks; and providing large woody debris (Anchor Environmental and People for Puget Sound, 2002).

Historically, tidal marshes formed the dominant habitat type in Commencement Bay. Comprised of salt (low), brackish (medium) and freshwater (high) marsh habitats they formed a complex mosaic of dendritic channels and plant communities. By 1988 only approximately 57 acres (Shapiro and Associates, 1992), or approximately one (1) percent, of the original tidal marshes remained. Much of these remaining lands are probably not original habitat but the result of intentional filling (Kerwin, 1999).

4.2.6.1 Marine Riparian Vegetation

Riparian vegetation in Reach 1 (the Narrows) is largely mixed shrubs and grasses. Much of the shoreline habitat has been compromised by fill associated with the historic construction of the Burlington Northern Railroad. The steep slopes are largely vegetated with deciduous trees and shrubs; however, this riparian zone is separated from the shoreline by the railroad. In addition, residential development and its associated armoring (bulkheads/ riprap) along the shoreline in the Salmon Beach community has resulted in the loss of marine riparian vegetation and has further limited the association between upland vegetation and nearshore areas. Scattered areas of overhanging riparian vegetation can be observed, however, particularly around Titlow Park.

Riparian vegetation in Reach 2 (Point Defiance) is characterized by trees along the high steep bluffs, and mixed trees and shrubs along Commencement Bay. No bulkhead has been mapped for a majority of this shoreline segment, although an angled riprap bulkhead segment and vertical concrete bulkhead have been mapped in the vicinity of Owens Beach. Downed Large Woody Debris (LWD) and/or drift logs were mapped along a majority of this shoreline segment (GeoEngineers, 2004).

Mixed trees and shrubs dominate the riparian vegetation in the northern portion of Reach 3 (Ruston Way), within Point Defiance Park. South of the ferry terminal, where it is present, riparian vegetation is largely composed of grasses. Scattered shrubs and trees line Ruston Way. However, the vegetated bluffs are separated from the shoreline by both Ruston Way and railroad tracks. Shoreline armoring is extensive along this reach, and LWD has been mapped in scattered areas (GeoEngineers, 2004).

Riparian vegetation in the Waterways (Reach 5) is largely concentrated near restoration sites such as Middle Waterway, Milwaukee Waterway, Fairliner, and Squally Beach. Middle Waterway restoration sites include a 1.85-acre intertidal marsh and riparian buffer restoration project on the southwest shore of Middle Waterway (City) and a 3.3-acre marsh and riparian restoration project located at the southeast end of the waterway (Simpson). At the Simpson site, riparian vegetation was dominated by Scouler's willow, colonial bentgrass, kinnikinnick, and rose. Native trees such as black cottonwood, Douglas fir, and western hemlock occur on the site, but were most prevalent in the northern portion of the site (Ridolfi and Adolfson, 2003). Milwaukee Waterway riparian vegetation consists largely of native shrubs and grasses on a berm

surrounding the restoration site. The Fairliner habitat area along the west shore of Blair Waterway just south of East 11th Street has riparian plantings of kinnikinnick, salal, Oregon grape, wild strawberry, and several indigenous tree species (Port of Tacoma, 2000). The Squally Beach restoration site is a 0.66-acre site located near the middle of the Hylebos Waterway on the east bank. Riparian plants at Squally Beach include red alder, paper birch, black cottonwood, Douglas fir, red osier dogwood, Oregon grape, Pacific ninebark, nootka rose, Hooker's willow, Scouler's willow, and snowberry. Otherwise, riparian vegetation is largely lacking within the Waterways. The shorelines are armored almost entirely by urban and port industrial sites.

Mixed riparian vegetation can be found along the steep bluffs of Reach 7 (Marine View Drive). However, this riparian zone is separated from the shoreline by Marine View Drive (Photo 4-3). Log rafts, homes, and docks and piers along the shoreline also limit vegetation, but where it is present, it is generally composed of grasses and shrubs. Woody debris accumulations are mapped along a majority of the shoreline segment (GeoEngineers, 2003).

Photo 4-3 Vegetated slope along Marine View Drive.

Shoreline activities that may negatively affect marine riparian areas (Brennan and Culverwell, 2004) include:

- Fecal and chemical contamination from failing septic systems, lawn chemicals, and stormwater;

- Loss of vegetation from shoreline armoring, clearing and grading activities, or tree removal for view corridors; and
- Wildlife habitat infringement due to increased ambient light levels at night, fragmentation from road crossings, noise from human activity, and domestic pets.

4.2.6.2 Marine Intertidal Habitats

Throughout the planning area, the dominant intertidal habitats include flats, eelgrass beds, backshore lagoons, saltmarsh, sand and gravel beaches, and kelp beds . Flats generally include gently sloping (less than 5° slope) sandy or muddy intertidal or shallow subtidal areas (KCDNR, 2001), and are used by juvenile salmonids, shorebirds, and shellfish, among other species. Flats are generally located at the mouths of streams where sediment transported downstream is deposited, and in areas of low wave and current energy where longshore waves and currents deposit sediment (KCDNR, 2001).

The nearshore areas of Commencement Bay typically are characterized by narrow intertidal and shallow subtidal margins around a relatively deep urban bay. These margins are important migratory routes for salmon, waterfowl, and shorebirds, and serve as rearing areas for juvenile to adult salmonids and their prey, as spawning areas for forage fish, and for intertidal and subtidal shellfish and algae production.

As of the late 1990's, the marine shoreline of Commencement Bay consisted of approximately 440 acres of intertidal habitat (+11.8 ft to –4 ft MLLW) and shallow subtidal habitat (-4 ft to –10 ft MLLW), and approximately 510 acres of open water habitat in the waterways. The number of acres of intertidal and shallow subtidal habitat has increased since 1990 due to the completion of habitat restoration projects and remedial actions.

Commencement Bay contains approximately 25 miles of marine shoreline (including the shoreline from Brown's Point to Ruston). Emergent marsh and riparian vegetation is essentially absent from this area. Along the Ruston Way reach, the narrow intertidal and subtidal habitats contain relatively steep riprapped shorelines, bulkheads, and abandoned or derelict over-water structures (CBNRT, 1997). Along Reach 7, the intertidal habitats are broken up by commercial marinas and log storage facilities, although habitat is relatively intact in the northern reaches, including vegetated shallows south of Brown's Point (CBNRT, 1997).

It has been estimated that of the original 2,100 acres of historical intertidal mudflat, approximately 180 acres remain today. Extensive anthropogenic activity such as dredging and filling is responsible for the decline of these habitats. The majority of the remaining mudflat habitat lies within the Hylebos, Middle, and Wheeler-Osgood Waterways and near the mouth of the Puyallup River (Kerwin, 1999).

Development projects since the mid-1980's have included mitigation and restoration actions focused on conversion of subtidal and upland habitat into intertidal and shallow subtidal habitat. These mitigation actions have resulted in the construction of approximately 50 acres of intertidal and shallow subtidal habitat. Intertidal habitat restoration projects in Reach 4 include Olympic View, Slip 5, and Rhone-Poulenc. The Olympic View site, located along Commencement Bay between the Thea Foss and Middle Waterways, was restored in 2002 to provide intertidal habitat

and allow the reestablishment of a productive community of tidal species. While eelgrass and marsh species were not observed at the site during a recent site visit (Adolfson, 2006), eelgrass may be present, but may not be visible without a dive survey or boating over. Slip 5, located on the western side of the mouth of Blair Waterway, is a 6.67-acre gravel beach, which provides an ideal habitat for marine invertebrates that are eaten by salmon. Rhone-Poulenc, a 0.6-acre restoration site on the western side of the Blair Waterway, provides high-quality salt marsh and mudflat habitat (Port of Tacoma, 2000). The Milwaukee Waterway provides possibly the most extensive intertidal habitat within City shorelines. Approximately 18.0 acres of the 22.3-acre site falls between –4 ft and +12 ft MLLW, with substrates composed of unvegetated gravel, cobble, and sand/mudflat (Grette Associates, 2004).

Titlow Beach Marine Preserve, in Reach 1, is closed to harvest of most species. The 55.6-acre preserve is approximately one mile long, and extends approximately 1,000 ft offshore. The site includes the remains of a pier offshore. Away from the pier, the bottom is 95% shallow open sandy flat. Marine plants at the Preserve include red, brown, and green algae, and minimal eelgrass (*Zostera marina*) (Murray and Ferguson, 1998).

Shoreline activities that may impact tidal flats (KCDNR, 2001) include:

- Unnatural erosion or deposition of sediment;
- Harvesting of shellfish and other marine life;
- Fecal and chemical contamination from on-site septic systems, lawn chemicals, and stormwater;
- Physical disturbances from shoreline armoring, marina construction, and upland development practices;
- Shading from overwater structures; and
- Loss of emergent and riparian vegetation.

Eelgrass beds are found in shallow subtidal areas and provide feeding and rearing habitat for a large number of marine organisms. Eelgrass beds are reported within shallow subtidal habitats along the Ruston shoreline, most notably at the Puget Creek nearshore area, approximately 1.5 km south of the ASARCO facility (EVS, 1995; GeoEngineers, 2004; PCRS, 2006). Eelgrass beds have also been reported at Point Defiance and north of Brown's Point (EVS, 1995). More recent eelgrass data indicates patchy eelgrass within Reach 1 south of the Narrows bridge, in Reach 3 from just south of the ASARCO facility to just south of Puget Gulch, at the Olympic View restoration site in Reach 4, and north of Browns Point in the UGA (WDNR, 2001) Puget Creek Restoration Society and Metro Parks are working on a project to replace mooring buoys along Ruston Way and the Narrows for boaters to tie up to instead of dropping anchors, which can impact eelgrass.

Fine-scale wood debris can negatively impact the aquatic environment as it decomposes. Commencement Bay has a history of milling activities along Ruston Way, which has contributed to large quantities of decomposing fine-scale wood debris. Estimates place up to 30 acres of the nearshore areas as potentially impacted by fine-scale wood debris (DNR, 2006). Removal of fine-scale wood debris might encourage expansion of existing eelgrass populations.

Shoreline activities that may impact eelgrass include:

- Clam hydraulic harvesting;
- Mussel and flatfish dragging;
- Rafts that shade seagrass;
- Pens - shade seagrass and the effluent changes sediment biogeochemistry;
- Crab and lobster traps that are dragged through seagrass beds;
- Ghost traps – water scours vegetation from around trap;
- Propeller scour and wash;
- Moorings and anchors;
- Discharges– nutrient loading (grey water, black water) and contaminants oil;
- Physical disturbances from shoreline armoring;
- Contaminated sediments and high levels of wood waste;
- Low oxygen conditions;
- Shading from overwater structures; and
- Physical disturbances from dredging and filling.

Kelp provides habitat for many fish species, including rockfish and salmonids, potential spawning substrate for herring, and act to buffer the shoreline from waves and currents, among other functions. Kelp is the major source of primary production in the benthic zone – providing direct food, detritus and dissolved organic material. Kelp distribution is largely dependent upon the type of substrate, generally attaching to rocky substrates. In areas where there is a coarsening of substrate in the low intertidal and shallow subtidal zones, there is a more likely occurrence of kelp. Kelp beds can form three different types of canopies: 1) surface (floating) canopy in the bull kelp, *Nereocystis* (shown as floating kelp in ShoreZone, WDNR 2001), 2) stipitate kelps (short stipes holding the blades off the bottom) such as the subtidal genus *Ptygophora*, found in high current areas in the Narrows, and 3) prostrate species with short stipes that create a canopy near the bottom, creating cover for a complex understory community of shade-loving, dessication-intolerant species (examples include *Agarum* spp., *Costaria costata*, *Saccharina subsessile*). Prostrate species are abundant in the lower intertidal and shallow subtidal in areas of moderate to strong currents and gravel and cobble substrate and are shown as non-floating kelp in ShoreZone (WDNR, 2001).

These kelp beds were previously reported only in a small area of the Ruston shoreline immediately below the ASARCO facility (Evans Hamilton and D.R. Systems, 1987 in EVS, 1995). Based on recent anecdotal information, kelp has been more recently reported in and around the eelgrass beds in the Puget Creek nearshore area (PCRS, 2006). WDNR ShoreZone Inventory data documents continuous kelp or patchy floating kelp (bull kelp, *Nereocystis*) and non-floating kelp (*Laminaria*) for most of Reach 1. . Within Reach 2, continuous floating and non-floating (prostrate) kelp beds are found on Point Defiance. Patchy non-floating (prostrate)

kelp is also found in Reach 3 from the north end of the reach to Mason Gulch, and a small segment near Old Town dock, as well as on the north side of Browns Point in the UGA (WDNR, 2001).

Shoreline activities that may impact kelp densities (KCDNR, 2001) include:

- Physical disturbances from shoreline armoring, marina construction, and harvesting;
- Shading from overwater structures;
- Beach nourishment; and
- Nutrient loading.
- Harvest
- Damage from boat propeller cutting
- Sedimentation

Water Quality (Marine areas including Commencement Bay, Tacoma Narrows, and the Waterways)

As with many transitional zones between water and land, nearshore shorelines provide important habitat for both aquatic and terrestrial animals and plants. This habitat is not only influenced directly by nearshore development, but it can also be influenced by changes in water quality. The surrounding watersheds affect the water quality of the marine nearshore, by transporting pollutants from upstream sources. Pollutants, sediment, and debris washed from watersheds are deposited in a stream or lake and may be transported further via an outflow to a coastal shoreline.

The City of Tacoma marine nearshore water quality is influenced by nearly all aspects of land use including rural and urban residential development, commercial/businesses, industrial development, forest practices, public infrastructure (roads/sewer), and agriculture both currently and historically. The Puyallup River watershed is the largest freshwater system in Water Resource Inventory Area 10 (WRIA 10) draining an area approximately 1,065 square miles in size (Kerwin, 1999) and ultimately discharges to Commencement Bay in the City of Tacoma. The water quality of the Puyallup River (Reach 5) and its major tributaries are influenced by their surrounding land uses and includes several large municipalities other than Tacoma including Fife, Puyallup, Sumner, and Auburn, which in turn influences the water quality within the marine nearshore areas of Commencement Bay. In addition, Tacoma's heavily industrialized area west of the I-5 corridor including the Port of Tacoma (Reach 4) and the ASARCO smelter site located on the south shore of Commencement (Reach 3) have and continue to contribute to degraded water quality conditions within the marine nearshore surrounding the City.

Ecology's 2002/2004 Water Quality Assessment identifies and reports on tested waterbody segments as they relate to state water quality standards for a variety of parameters, including temperature, pH, dissolved oxygen, metals, etc. Waterbody segments are classified as Category 1, 2, 4, or 5. Category 5 waters are polluted waters that require a TMDL. In November 2005 the U.S. Environmental Protection Agency approved the list of Category 5 waters, which represents the state's 303(d) list of impaired waters. Category 4 waters are polluted but do not require a TMDL (because a TMDL or pollution control plan is already in place or the waterbody is

impaired by a non-pollutant such as low streamflow, dams, etc.). Category 2 waters are considered "waters of concern", where pollution is present but may not violate state water quality standards. Category 1 waters meet tested standards for clean waters, but may not be free of all pollutants.

Table 2 shows the marine waterbodies within the City that are listed on the 2004 303(d) list, as well as the water quality parameters that exceeded standards for the class of water tested. Waters that are listed on the 303(d) (Category 5) list are required to develop a Total Maximum Daily Load (TMDL) or Water Cleanup Plan to address the pollutants of concern and set acceptable loading limits, usually in pounds per day, for the constituent of concern within the affected waterbody. For the constituents listed below in Table 4-7, a TMDL is required. For Commencement Bay waters, an approved TMDL was developed in 1992 to address dioxins. Although the Tacoma Narrows is listed in the Table as occurring on the 303(d) list, the listed reach occurs outside the City of Tacoma in WRIA 15.

Table 4-7 303(d) Listed Marine Water Quality Impairments in Tacoma, WA

Waterbody Name	Exceeded Water Quality Parameter	Medium	Within City
Commencement Bay	**Dieldrin**	Tissue	✓
	Total PCBs	Tissue	✓
	Dissolved Oxygen	Water	✓
	Fecal Coliform	Water	✓
	Bis(2-ethylhexyl) phthalate	Tissue	
Tacoma Narrows	**Total PCBs**	Tissue	
Hylebos Waterway	**Chlorinated Pesticides**	Tissue	✓
	DDT	Tissue	✓
	PAHs	Tissue	✓
	Total PCBs	Tissue	✓

Source: Washington State Department of Ecology, 2005

In general, impairments to water quality within the marine waters of the City of Tacoma have a variety of point and non-point sources. Many of these sources may also result from land uses and activities upstream of the City's jurisdictional boundaries. Property development and use of fertilizers can result in excessive nutrients (nitrogen and phosphorous) entering surface and groundwater, which promote algae growth and too much organic waste in the water; both reduce dissolved oxygen needed by fish. Dieldrin, DDT, and other chlorinated pesticides are used in agricultural practices and often find their way into aquatic systems via stormwater runoff. Failing septic systems and excessive waterfowl are the typical sources of fecal coliform bacteria in urban

areas, which can indicate a risk to human health. PCBs are tied primarily tied to industrial waste and is a common contaminant in most industrial waterways.

PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances, such as tobacco and charbroiled meat. There are more than 100 different PAHs. PAHs generally occur as complex mixtures (for example, as part of combustion products such as soot), not as single compounds. PAHs usually occur naturally, but they can be manufactured as individual compounds for research purposes. As pure chemicals, PAHs generally exist as colorless, white, or pale yellow-green solids. They can have a faint, pleasant odor. A few PAHs are used in medicines and to make dyes, plastics, and pesticides. Others are contained in asphalt used in road construction. They can also be found in substances such as crude oil, coal, coal tar pitch, creosote, and roofing tar (ATSDR, 1995).

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects (ATSDR, 2001). This is a common pollutant found in industrialized waterways such as Commencement Bay.

4.3 Built Environment

4.3.1 Existing and Future Land and Shoreline Use

The Tacoma Narrows (Reach 1) marine shoreline land use is primarily composed of Titlow Park, which has approximately 56 acres of shoreline and adjacent upland property. South of 6th Avenue the development includes a mix of commercial and residential development. There are also two marinas located along the southern extent near Day Island. North of Titlow Park and south of Point Defiance Park is the Salmon Beach Community, which consists of privately owned, overwater single-family structures constructed on pilings at the high waterline (Tacoma, 1996). Similar overwater single-family homes are also present at the Wilton Road residential community located in the Titlow Beach area. An active railroad bed is located along the entire extent of the Tacoma Narrows (Reach 1) south of Salmon Beach, where it enters Bennett Tunnel. Reach 1 has been modified throughout by bulkheads and armoring for the railroad and pilings for the homes located at Salmon Beach and the Titlow Beach area. According to Tacoma's land use intensity map, which illustrates the city's future land uses, Reach 1 is designated for low intensity development. Low Intensity designation includes single-family homes, duplexes and triplexes, parks, schools, libraries and neighborhood commercial uses.

The city's land use pattern near Point Defiance (Reach 2) is park and open space, and the shoreline has not been significantly altered. Owen Beach, a public beach and picnic area, is located along the northern side of Point Defiance Park. The area includes concrete bulkheads and roadway development. A pedestrian walkway connects Owen Beach with commercial development to the south. Future land use in Reach 2 is designated as low intensity.

The Ruston Way marine shoreline (Reach 3) has been modified along its entire length (Tacoma, 1996). West of the Town of Ruston, development includes a large yacht club, public boating facilities, roadway development, ferry terminal, and concrete bulkheads. East of the Town of Ruston, development includes commercial water-related activities, parks, and the railroad. The

commercial development is located on filled land and/or pilings. Several areas along Ruston Way are owned by Tacoma Metro Parks and include public open space and public shoreline access, including public access docks and a pedestrian/bicycle path along Ruston Way. Down shore and southeast of Ruston Way, the area lies entirely on fill and includes the railroad line, surface streets, and shipping facilities. The remediation and redevelopment of the former ASARCO smelter site is ongoing and will be a mix of residential, commercial, and public open space.

Future land use designations in Reach 3 include a mix of low to high intensity uses. From the border with Reach 2 to the city limits of Ruston, the shoreline is designated as low intensity. From the city limits of Ruston, along Ruston Way approximately one-half mile, the land use intensity is designated High. High Intensity areas include heavy industrial, high-rise and regional commercial uses. Continuing along Ruston Way the land use intensity is designated as Low to Medium. Medium Intensity includes light industrial, community commercial and apartments. The remainder of the reach, up to Thea Foss Waterway, is designated as High Intensity.

The Waterways (Reach 4) have been heavily modified for industrial use as a port terminal. Recently, the Thea Foss Waterway has been redeveloped as a premier mixed-use waterfront neighborhood. Some developments include museums, office, retail, pedestrian walkways and marinas (Tacoma Economic Development Department, 2005). North of Thea Foss Waterway is the Port of Tacoma's terminal port facilities used by the Port of Tacoma. The Port of Tacoma is a public municipal corporation established in 1918 by the citizens of Pierce County. The Port operates in an area over 2,500 acres. Of this, all of Reach 4 is included in an area designated as a Manufacturing/ Industrial Center in its comprehensive plan by the Puget Sound Regional Council and the Port's Comprehensive Scheme of Harbor Improvements (CSHI) (Port of Tacoma, 2006). This industrial area is primarily shipping terminals, but includes a mix of heavy and light industrial and water related commercial uses as well. The Port's CSHI establishes that the Manufacturing and Industrial Center area is intended for future property development for maritime terminal development, industrial development, and environmental mitigation and restoration (Port of Tacoma, 2006). Future land use in Reach 4 is designated High Intensity by the City of Tacoma. The City's Comprehensive Plan calls for the manufacturing/industrial center to be developed with a mix of industrial uses that are well served by rail, roads, and transit.

Land and shoreline use in Reach 7 (Marine View Drive) consists of floating log storage and several marinas with mostly small watercraft (Photo 4-4). Along the waterfront toward the eastern extent of the reach are a number of single-family residential structures, many of which are on pilings. Adjacent to the marinas and residential development, Marine View Drive parallels the shoreline and is bordered on the upland side by largely undeveloped steep slopes. Reach 7 future land use designation is Low Intensity with the exception of the marina areas, which are designated Medium Intensity.

Photo 4-4 Commencement Bay beach front in Reach 7 (Marine View Drive). Floating logs, marinas, and vegetated steep bluffs adjacent to Marine View Drive are shown.

4.3.2 Shoreline Districts, Shoreline Environment Designations, and Zoning

As described in Chapter 2, the City plans for and regulates land and shoreline use in the shoreline planning areas through the current Shoreline Master Program, codified in Chapter 13.10 of the Tacoma Municipal Code. Shoreline districts function similarly to zoning designations. Each district has a specified intent or policy basis for desired uses in that area, as well as development standards and use regulations. Each district is assigned a shoreline environment designation, supporting the overall goal for the district. Finally, zoning designations (TMC, Chapter 13.06) are applied to the shoreline districts and adjacent upland areas. The shoreline district and zoning designations are shown on Map 5. Table 4-8 identifies the shoreline districts, their policy intent, and shoreline environment designations for each nearshore marine reach.

Table 4-8 Shoreline Districts and Environment Designations

Reach	Shoreline District and Policy Intent	Shoreline Environment Designation
1. Tacoma Narrows	S-1, Western Slope South: to retain the existing character of the area and prohibit development of uses which will have significant adverse impact on existing housing. S-2, Western Slope Central: to encourage recreational development within the area; retain the natural beach areas for their educational, scientific and scenic value; and retain the natural steep slopes as a buffer between the railroad and residential areas. S-3, Western Slope North: to generally conserve the entire area in its natural state, which will allow the continuation of the residential community of Salmon Beach as a historic area of the City. The area of steep slope above the railroad shall be retained in vegetative cover to reduce siltation of the beach areas and to serve as a noise reducer between the railroad and housing areas.	S-1: Urban S-2: Conservancy S-3: Conservancy
2. Point Defiance	S-4, Point Defiance - Natural: to protect the existing natural environment of the area, provide for perpetual utilization for park purposes, and permit the creation and improvement of view areas and trail systems. S-5 (portion), Point Defiance - Conservation: to provide for perpetual utilization for park and recreational uses and permit the creation and enhancement of view areas and trail systems and allow development of marinas, boat launch facilities, and other water-oriented commercial uses.	S-4: Natural S-5 (portion): Conservancy
3. Ruston Way	S-5 (portion), Point Defiance - Conservation:: to provide for perpetual utilization for park and recreational uses and permit the creation and enhancement of view areas and trail systems and allow development of marinas, boat launch facilities, and other water-oriented commercial uses. S-6, Ruston Way: to encourage development of a coordinated plan of mixed public and private water-oriented use activities, including commercial, recreational, and open space development, which will prohibit development of new industrial use activities. S-7, Schuster Parkway: to allow development of deep water terminal and light industrial facilities, but to preserve the character and quality of life in adjoining residential areas, school and park properties.	S-5 (portion): Conservancy S-6: Urban S-7: Urban

Reach	Shoreline District and Policy Intent	Shoreline Environment Designation
4. Industrial Waterways	S-8, Thea Foss Waterway: to improve the environmental quality of Thea Foss Waterway; provide continuous public access to the Waterway; encourage the reuse and redevelopment of the area for mixed-use pedestrian-oriented development, cultural facilities, marinas and related facilities, water-oriented commercial uses, maritime activities, water-oriented public parks and public facilities, residential development, and waterborne transportation; and to encourage existing industrial and terminal uses to continue their current operations and leases to industrial tenants.	S-8: Urban
	S-10, Port Industrial: to allow the continued development of the Port Industrial Area, with an increase in the intensity of development and a greater emphasis on terminal facilities within the City.	S-10: Urban
	S-11, Marine View Drive South: to permit the development of water-related parks, open space, and recreation facilities, and to allow development of marinas and related facilities, water-oriented commercial uses, and residential uses.	S-11: Urban
	S-12 (portion), Marine View Drive North: to permit the development of water-related parks, open space, and recreation facilities, and allow development of marinas and related facilities, water-oriented commercial uses, and residential uses.	S-12 (portion): Urban
7. Marine View Drive	S-12 (portion), Marine View Drive North: to permit the development of water-related parks, open space, and recreation facilities, and allow development of marinas and related facilities, water -oriented commercial uses, and residential uses.	S-12 (portion): Urban

4.3.3 Existing and Proposed Public Access Sites

A primary goal of the Shoreline Master Plan is to provide for public access to shorelines. The City's 2000 *Recreation and Open Space Plan* (City of Tacoma, 2000) describes the parks, open spaces, and trails (existing and proposed) in the City's shoreline planning area. The City of Tacoma's Shoreline Trails Plan, a component of the Comprehensive Plan, identifies additional existing shoreline public access areas (Tacoma, 1989). All existing public access opportunities are described by reach area below.

4.3.3.1 Existing Public Access

The City of Tacoma has a diversity of parks, open space, and public facilities, many of which provide shoreline access. Several City parks and open space areas offer access to the nearshore marine shoreline. Approximately 7 percent of the nearshore marine shoreline planning area is developed as park and/or designated open space.

Along the city's Tacoma Narrows marine shoreline (Reach 1), Titlow Park provides public access to the marine shoreline. The entirety of Reach 2 and small portions of Reach 1 and 3, along the northern most portion of Point Defiance, are included in Point Defiance Park. The 702-acre regional park provides public access to marine beaches and the nearshore forested areas. In the western portion of Point Defiance Park is the The Boathouse Marina, located in the western portion of Point Defiance Park, provides fishing and pleasure boating supplies and rentals. Southeast of Point Defiance along Ruston Way (Reach 3), a series of parks is interconnected by a shoreline public trail. Parks providing shoreline public access along this corridor are Jack Hyde Park, Hamilton Park, Dickman Mill Park, Marine Park, and Cummings Park. The Old Town Dock extends from Dickman Mill Park and the Les Davis Pier extends from Marine Park. These resources provide a variety of passive and active recreational uses along the marine shoreline in the city. Pierce County Parks and Recreation currently owns a 90,000 square foot section of Puget Creek Beach.

No parks exist within the remaining Marine Reaches (4 and 7). Parks providing public access in Reach 1-UGA include Brown's Point Lighthouse Park and Dash Point Park. Across Interstate 705 from the marine shoreline, Firemans Park provides views of the marine shoreline; however, it is outside of the Reach 4 planning area. Along both the west and east shorelines of the Thea Foss Waterway (the western most portion of Reach 4), concrete board walks and public plazas provide public access to the shoreline. On the east side of Port of Tacoma Road, a public viewing area is provided at the site of an intertidal mitigation site on Commencement Bay. Plaza areas are most prevalent around The Museum of Glass, accessible from downtown Tacoma via the Bridge of Glass, and the surrounding marinas.

The City has designated open space within the planning area of much of the City's non-park marine shorelines. Open space designation areas are set back from the shoreline boundaries and include steep slope areas and gulches. The Narrows planning area (Reach 1) includes the Westridge Open Space to the south of the Tacoma Narrows Bridge and the West Slope Open Space to the north of the bridge. As noted above, all of the Reach 2 shoreline is in Point Defiance Park. The Ruston Way planning area (Reach 3) includes four segments of the Ruston/Schuster Slope Open Space. Slope segments along this planning area are divided by Mason, Puget, Buckley, and Garfield Gulch Natural Areas (also designated open space), all extending out from the Reach 3 planning area to the south. The southern most extent of the Ruston/Schuster Slope Open Space extends into the Waterways planning area (Reach 4) near the west shoreline of the Thea Foss Waterway. Additional Reach 4 designated open space exists along the northeast extent of the planning area. Southeast of the Marine View Drive – Norpoint Way intersection, small areas of the Marine View Drive Slope (MVDS) Open Space overlay the Hylebos Waterway planning area along the northeast shoreline. Northwest of this intersection, a large area of the MVDS overlays the Hylebos Waterway planning area, also along the northeast shoreline.

4.3.3.2 Proposed Public Access

Tacoma's park system provides significant access to the marine shoreline. The City's Recreation and Open Space Plan (City of Tacoma, 2000) calls for enhancements to existing parks and open space properties to enhance active and passive recreational opportunities. Specifically, the plan proposes that the City continue to secure open space areas from private ownership, building on

the existing network of corridors within the city. An example of the existing trail system which utilizes shoreline areas, connecting Garfield Gulch to Garfield Park and the Old Town Dock, is highlighted as an example for future systems. Pierce County, DNR, and Puget Creek Restoration Society are developing an access/restoration plan for the Puget Creek Beach area.

Twenty-nine saltwater wetland areas, ranging in size from less than 1 acre to 37 acres, have been identified along the marine shorelines of Commencement Bay and associated waterways (Rose, 2005). As identified in the policies of the Recreation and Open Space Plan, the City should examine the wetlands for possible procurement and limited development to make public access The ASARCO Redevelopment Area is located in the Ruston Way Reach (Reach 3). Future plans for this area include a park, pedestrian promenade, play area and boat launch facilities.

4.3.4 Historic and Cultural Resources

The existing Tacoma Shoreline Master Program provides a general goal to identify, restore and preserve those features of historical/cultural, scientific, and educational value for use by the public (City of Tacoma, 1996). The City of Tacoma Comprehensive Plan also addresses historic preservation in the Parks and Open Spaces and Generalized Land Use Elements. The plan establishes a goal to maintain, preserve, and enhance the city's historic, cultural, and archeological resources to provide a sense of local identity and history to the community. Policies in the Comprehensive Plan direct the City to preserve and protect historic and archeological sites from incompatible land uses.

The Washington State Department of Archeology and Historic Preservation (DAHP) maintains a database of sites listed on Washington's Historic register and the national register. A search of the database for sites within the City's shoreline planning area revealed a series of sites within the City's marine shoreline planning area. Near the location of the existing Tacoma Narrows Bridge (State Highway 16), in the Narrows (Reach 1) planning area, ruins from the historic Tacoma Narrows Bridge have been classified as a historic site on both Washington State and National Registers. The collapse of the historic bridge, described as the 'Galloping Gertie', is an important historical event in both local and civil engineering history.

North of the existing bridge, and extending to the beginning of the Point Defiance planning area (Reach 2), the nearshore area has been designated as the Salmon Beach Historic District. The Salmon Beach Community is characterized by a series of vernacular style detached residential dwellings originally constructed between 1910 and 1917. Many of the structures maintain the similar 'home-built' characters of original construction, with building materials made up of found / scrap lumber. Historical use of the Salmon Beach area peaked during the Depression Era, a period in which the residences were used by 'hard-luck' families relying on fishing and other subsistence living practices. At least one cabin ('Cabin No. 37') within the Salmon Beach Historic District is listed on the National Register of Historic Places (Edwards, 2006).

Within Point Defiance Park, in close proximity to the Reach 2 planning area, are the Fort Nisqually Restoration and Camp Six historic areas. Fort Nisqually Restoration, a reconstruction of the historical Fort Nisqually from historic records and ruins, is classified as a site of military significance on the Washington Heritage Register. Camp Six, a logging museum created "in

1964 to recreate the look and feel of a typical logging operation" (OAHP, 1973), contains a number of historic elements and is classified as a district by both National and State Registers.

Two sites included on State and/or National Registers are mapped within the Ruston Way Planning Area (Reach 3). Fireboat No. 1, one of few pre-WWII era fireboats remaining in the United States, is docked at the City's Marine Park as a monument / museum and is protected as a National Historic Landmark. Directly SE of Hamilton Park, the Dickman Lumber Company Saw Head (dating from 1929) is listed as an object on the Washington Heritage Register.

A portion of Tacoma's City Center lies within close proximity to the west shoreline of the Thea Foss Waterway. Portions of the City Center are within the Waterway's planning area, although the majority is separated by Interstate-705. Included within the City Center are a number of buildings included on State and National Historic/Heritage Registers. The area of highest historic building concentration is included in the Old City Hall Historic District (listed on State and National registers). The Old City Hall Historic District stretches from S 4th Street to S 9th Street and is bordered to the east by Interstate-705. Outside of the City Center, three other historic sites are mapped along the Waterways Planning Area (Reach 4). Along the east shoreline of the Thea Foss Waterway, directly north of the S 11th Street Bridge, is City Fire Station No. 18. Built in 1929 as the Fireboat Station for the City (current use as well), the structure is listed on both State and National registers. Near the intersection of Taylor Way and E 11th Street between the Blair and Hylebos Waterways, is City Fire State No. 15. Built in 1929 in the Spanish Colonial Revival Style, the structure is listed on both State and National registers. Docked along the Hylebos Waterway at 1801 Taylor Way is the M.V. Kalakala, an Art Deco style ferry originally built in 1935. Used as a ferry in Puget Sound Waterways until 1967, the vessels storied history includes an extended period in Alaska where the vessel was used first for mobile crab-processing and later as a cannery by the fishing industry. The Kalakala is listed on both State and National registers. Brown's Point Lighthouse in the Brown's Point UGA Planning Area (Reach 2-UGA) is listed on the National Historic Register.

Native American use of waterbodies throughout western Washington has been well documented. Native peoples undoubtedly used the City's marine shoreline and associated tributaries for fishery resources. The shorelines could be considered a significant traditional cultural place. As such, there is a high probability of archaeological resources remaining near the marine shoreline. These resources, if existing in the City, may have been removed or destroyed during fill and development activities along the marine shorelines. The City evaluates archeological and historical resources on a parcel-by-parcel basis during development review.

The City's existing shoreline inventory (GeoEngineers, 2004) contains a mapping layer that indicates the presence of recorded archaeological resources . The mapping layer shows generalized locations of recorded archaeological resources located within the City's shorelines, based on information provided by DAHP. Resources have been documented in locations corresponding to Reaches 1 (the Narrows); 2 (Point Defiance); the north half of Reach 3 (Ruston Way); and portions of the Thea Foss and Blair Waterways in Reach 4 (GeoEngineers, 2004). Recent discoveries have included a Native American summer camp on the Thea Foss in Reach 4 and a Native American fishing weir near the Lincoln Avenue Bridge in Reach 5.

4.3.5 Impervious Areas

Measures of impervious area are typically used at a watershed, drainage basin, or stormwater collection basin to assess effects on hydrology (peak flow timing, flow rates, and quantities). Impervious area immediately adjacent to shorelines is more instructive in terms of assessing the lack of riparian vegetation.

Impervious area in the Narrows (Reach 1) shoreline planning area is low because of the parks, open space, steep bluffs and railroad right of way adjacent to the shoreline. However, some impervious area is created by the railroad along Reach 1, south of the Bennett Tunnel. In the southern extent of the reach, from the city limits to the Narrows Bridge, Titlow Beach Park limits the amount of impervious surface. North of the Narrows Bridge to Salmon Beach, the railroad bed is the only feature that contains impervious area. The single-family houses at Salmon Beach create limited impervious surfaces from rooftops.

Point Defiance Park (Reach 2) contains almost no impervious surface, with the exception of surface streets that intersect the shoreline planning area. The shoreline planning area is primarily composed of mixed vegetation leading to the shoreline, except on the north side where a large beach exists.

Ruston Way (Reach 3) has wide variability in impervious area. From Point Defiance Park to the Ruston city limits, open space extends from the park boundary to the Tacoma Yacht Club and Washington State ferry terminal. These and the adjacent land uses produce large areas of impervious area. From Ruston city limits to Thea Foss Waterway, impervious area is high to moderate. Impervious surfaces include the railroad bed, surface parking lots, docks, and small shipping facilities.

The Waterways (Reach 4) represent a high concentration of impervious area. The majority of the Thea Foss waterway is covered with either buildings or pavement. The Middle waterway has less pavement, but surfaces are assumed to be very consolidated and would provide little permeability. The marine shoreline planning area of the Milwaukee, Sitcum, and Blair Waterways are almost covered entirely by pavement. Like the Thea Foss, the Hylebos Waterway is covered primarily with impermeable surfaces but has intermittent undeveloped shoreline. The Hylebos Waterway has an associated wetland extending north, which is covered by thick vegetation above Marine View Drive.

Marine View Drive parallels the shoreline planning area in Reach 7. Other impervious areas include the marina facilities and single-family housing along the beach.

4.3.6 Roads and Bridges

State Route 16 crosses as the Tacoma Narrows bridge about mid-way through the Narrows (Reach 1). The density of roads along Reach 1 is very low due the steep slopes, parks, and railroad right of way throughout the reach. In Point Defiance (Reach 2) shoreline planning area, there are no bridges and only a few roads, which access the park and beach. Ruston Way Marine Shoreline (Reach 3) has a relative high density of roads but lacks any bridges. Abutting Point Defiance Park is North Waterfront Drive, which extends from Owens Beach in Point Defiance Park to the Tacoma Yacht Club. Ruston Way runs from the Ruston City limits to

Commencement Park. Schuster Parkway runs from Commencement Park to the Waterways (Reach 4). The Waterways (Reach 4) have a very high density of roads and several bridges. Bridges include; 11th Street bridges, which cross over the Thea Foss and Hylebos Waterways, and State Route 509, which crosses over the Thea Foss Waterway. A network of arterials and collector streets are located throughout the entire Waterway reach. Marine View Drive is the only major road located in Reach 7.

4.3.7 Utilities and Infrastructure

The City of Tacoma provides sanitary sewer service to 90,000 customers within the City. The city operates two wastewater treatment facilities, the Central and the North End Wastewater Treatment Plants. The Central Wastewater Treatment Plant, located on the tide flats along the Puyallup River, uses high purity oxygen and bacteria to remove organics from wastewater. The North End Treatment Plant, in Mason Gulch off Ruston Way, uses chemicals to remove the organics and a filter with bacteria to treat the wastewater before it enters Puget Sound.

The city has over 700 miles of sewer and storm drainage pipes. Sewer pipes direct effluent to one of two City central treatment facilities. Portions of the stormwater system have outfall locations entering the Puget Sound. In the Narrows (Reach 1) there are 16 outfall locations. Most of which are located on the southern extent of the reach. The Point Defiance (Reach 2) has 14 outfall locations. One of these outfalls serves the Point Defiance Park Aquarium and has its own NPDES permit. Ruston Way (Reach 3) has 23 outfall locations, most of which are located mid-way down Ruston Way. The Waterways (Reach 4) contains 90 outfall locations. Most are located on the landward side of the Thea Foss Waterway and the Hylebos Waterway. Marine View Drive (Reach 7) has no public outfall locations.

Additionally, a set of high voltage power lines crosses the Tacoma Narrows.

4.3.8 Areas of Special Interest

According to Ecology guidelines, areas of special interest to be inventoried include such things as priority habitats, eroding shorelines, developing or redeveloping harbors or waterfronts, dredge disposal sites, and toxic or hazardous waste clean-up sites (WAC, 173-26-201(3)(c)(iv)). Priority habitats are discussed above in Section 4.2. Eroding shorelines are described in the context of regulated geologic hazard areas for erosion and landslide hazards in Section 4.2 above. Other elements are described below.

The City's existing shoreline inventory includes mapping for "rapidly developing waterfronts" (GeoEngineers, 2004). The City's shoreline development was classified as "none," "minimal," or "rapidly" based on the number of building permits applied for in recent years. The majority of Reach 1 (the Narrows) is classified as minimal, with the exception of the Salmon Beach Community, which is classified as rapidly. Reach 2 (Point Defiance) is classified as none. Reach 3 (Ruston Way) is classified primarily as minimal Reach 4 (the Waterways) is classified primarily as rapidly. Reach 7 (Marine View Drive) is classified as minimal.

Specific locations of dredge disposal sites have not been identified. However, since the Port of Tacoma was formed in 1918, substantial dredge and fill activities in Commencement Bay associated with development of port terminal facilities and waterways have occurred.

The Department of Ecology maintains a statewide GIS database of facilities with suspected or confirmed contaminated sites, and facilities with the potential to introduce contaminants into the environment. The database was reviewed to identify any known sites within 200 feet of the City's marine shoreline planning area. All of the sites are listed as facilities that generate hazardous waste or store hazardous materials (unless otherwise noted). Three sites were identified within Reach 1, no sites were identified within Reach 2, and seven sites were identified within Reach 3. The sites in Reaches 1 and 3 are typically associated with either State clean-up sites, facilities that generate hazardous waste, or underground storage tanks. Within the Waterways shoreline planning area (Reach 4), a total of 92 sites are mapped. The majority of the sites in Reach 4 are associated with facilities that generate hazardous waste. Other sites include a Federal (Superfund) clean-up site (the Commencement Bay nearshore tideflats), other State and voluntary clean-up sites, facilities with underground storage tanks, and facilities with industrial stormwater discharge permits. Four sites were identified within Reach 7. None of the sites in Reach 7 were listed as contaminated or active clean-up sites.

4.4 Other Marine Areas

4.4.1 Browns Point-Dash Point UGA

The area depicted on Map 1 (and others in Appendix A) as Reach 9, Browns Point-Dash Point UGA, represents approximately 3 miles of marine shoreline in the City's Browns Point-Dash Point designated Urban Growth Area. This area was not included in the existing shoreline and critical areas inventory information compiled in 2004. Accordingly, reach scale information is lacking relative to other marine reaches in the city. However, state guidelines encourage local jurisdictions to consider shoreline areas that may be annexed in the near future. The Comprehensive Plan Land Use Element states that the Browns Point-Dash Point area should be considered for near term annexation (10 to 20 years). The City has already prepared an economic feasibility study as a first step at examining annexation of this area and small areas have already been annexed. Detailed land use planning for the Browns Point-Dash Point UGA has not yet been included in the City's comprehensive planning. Pre-designating shoreline or zoning designations will not likely occur until such detailed study is undertaken. Without pre-designations, regulated shorelines in areas annexed by the City would continue to be regulated under the provisions of the Pierce County Shoreline Management Regulations (Title 20 PCC) until the City's SMP is amended to specifically address annexed areas.

The Washington State Department of Ecology has mapped unstable slopes across portions of the Browns Point-Dash Point shoreline. Primary areas of instability, mapped as *unstable*, unstable old slide, and unstable recent slide, are located between Browns Point and Dash Point, and are more concentrated in areas to the southeast and north of Dash Point. These areas would qualify as erosion hazard areas are defined in Section 13.11.720.1 of the Tacoma Municipal Code. Generally, coastal topography throughout the Browns Point – Dash Point shoreline area is characterized by moderately steep vegetated slopes, the majority of which have been partially modified by development activity, as described below.

As documented in GeoEngineers, 2004, there are four drift cells mapped along the Browns Point – Dash Point shoreline area. Moving from northeast to southwest towards Browns Point, drift cells within this reach are identified as PI-1-1, PI-1-2, PI-1-3, and PI-1-4 within the report. PI-1-

1, which begins in King County to the south of Dumas Bay, terminates at Dash Point and is characterized by southwesterly shore drift. PI-1-2 originates in a zone of divergence approximately 0.6 km to the south of Dash Point and is characterized by northerly net shore-drift, towards Dash Point. PI-1-3 also originates 0.6 km to the south of Dash Point, and is characterized by southwesterly net shore-drift, terminating at Browns Point. High wave energy through this shoreline removes finer sediments from the foreshore (beach) and deposits them in deep water off of Browns Point. PI-1-4 orignates at a zone of divergence approximately 1.25 km southeast of Browns Point, and is characterized by a net shore-drift in the northeasterly direction, terminating at Browns Point.

The Browns Point – Dash Point near shore area is documented as containing patchy eelgrass beds. The shoreline area is identified as being used by several species of shellfish, although issues with biotoxins and pollution have led to closures on harvest of these resources. WDFW Priority Habitats within the Browns Point – Dash Point area include urban natural open space a areas. Additionally, the nearshore environment is known to provide habitat and spawning areas to forage fish, including sand lance and smelt (GeoEngineers, 2004) and habitat to numerous salmonid species, including Puyallup populations of Chinook salmon.

Land use near the Browns Point – Dash Point shoreline area is dominated by moderate density single family residential (R4 to R6), with all buildable parcels developed with primary residential structures and associated outbuildings (garages and beach front structures). There are two parks that provide public access to the Browns Point – Dash Point shoreline: Browns Point Lighthouse Park and Dash Point Park. Existing amenities at Browns Point Lighthouse Park, owned and operated by the City, include picnic areas and restroom facilities. Dash Point Park is also owned and operated by the City, and includes picnic areas and restroom facilities. Both parks provide beach access.

Shoreline modifications associated with residential and parkland uses are prevalent in the Browns Point – Dash Point shoreline area. Analysis of 2006 aerial photography shows that the majority of residences have concrete bulkheads along the shoreline side of their properties. Many of the residential parcels have developed the area immediately landward of their respective bulkheads with accessory structures, most likely used as cabanas.

4.4.2 Deep Water Areas

The area depicted on Map 1 (and others in Appendix A) as “Deep Water Areas” is intended to represent the offshore limits of the City’s regulatory shoreline jurisdiction in the Tacoma Narrows and Commencement Bay. The boundaries shown are approximate and are not based on any geographically defined legal boundaries. The area corresponds to the City’s Shoreline District 13 – Commencement Bay and Tacoma Narrows, which is described as “an area bounded by: the Outer Harbor Line of Commencement Bay and the Tacoma Narrows, or the Federal Pierhead Line in areas where the Outer Harbor Line is nonexistent; and the seaward City limit common to the City of Tacoma and Pierce County; except that area lying within the Town limits of the Town of Ruston” (TMC 13.10.160.B.).

Natural processes such as tidal flux, flow velocities, and circulation patterns occurring in this area are described in Chapter 3 (Section 3.3.1, Processes Affecting Marine Shorelines). The

Narrows is a channel with depths up to 140-feet characterized by flow velocities greater than five feet per second. Commencement Bay is relatively deep (greater than 450 feet) with lower flow velocities than the Narrows. Circulation patterns within the surface layer of the Bay are typically driven by tides, wind-driven waves, and fluvial input from the Puyallup River and Hylebos Creek.

The deep water areas also generally correspond to those areas lying seaward from the line of extreme low tide, which are defined by the SMA as shorelines of statewide significance. As such, use of these areas should be informed by the statutory policy for preferred uses established in RCW 90.58.020. Tacoma's SMP notes that the intent of Shoreline District 13 is "to maintain these bodies in substantially their natural state for use by the public for navigation, commerce, and recreation purposes" (TMC 13.10.160.A.). The types of uses occurring in these areas that are regulated under the City's SMP include road and bridge construction, aquaculture, breakwaters, environmental remediation, habitat improvement, jetties and groins, log rafting for cargo-handling purposes, and underwater utilities.

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5.0 PUYALLUP RIVER SHORELINE PLANNING AREA

This section provides reach-scale information for the City of Tacoma's Puyallup River shorelines, consistent with state guidelines. Elements identified in WAC 173-26-201(3)(c), "Inventory shoreline conditions," are described at the shoreline planning area scale, which approximates the limits of regulatory jurisdiction under the SMA. This section is organized generally into two sections, Natural Environment and Built Environment. Elements of the natural environment include a description of natural process modifications, aquatic resources, habitat, and regulated critical areas. Elements of the built environment include existing and planned land use patterns, infrastructure and shoreline modifications, public access areas, cultural resources, and other areas of special interest.

5.1 Puyallup River Reach

The City of Tacoma includes the final approximately 14,000 feet (2.7 miles) of the Puyallup River before it flows into Commencement Bay (Reach 5 shown on Map 1). Including the 200-foot setback to either side of the river, the shoreline planning area in Reach 5 is approximately 340 acres.

This section of river is treated separately from the nearshore marine environmental because, while this section of river is tidally-influenced, the sediment and water load from the upper watershed typically dominate ecosystem functions. The reach of river has been straightened, channelized, and dredged in the past, and is now effectively disconnected from the significant delta that the river had formed historically at the head of Commencement Bay. The shoreline is heavily rip-rapped, leveed, or otherwise modified throughout this reach, with the exception of some recent restoration activities.

The reach is tidally-influenced throughout, with consistent width, depth, and slope characteristics due to past river management practices. Therefore, this section of the Puyallup River is treated as one reach for the purposes of this Inventory and Characterization report.

Photo 5-1. The Puyallup River (aspect northwest from the East 11th Street Bridge toward Commencement Bay)

5.2 Natural Environment

5.2.1 Riverine Process Modifications

The process modifications along the Puyallup River shoreline primarily consist of changes: (1) in the upper watershed, (2) in river management approaches, (3) in land use within the city and historical Puyallup delta, and (4) as a result of CERCLA/ MTCA remediation and restoration projects more recently.

5.2.1.1 Upper Watershed

Modifications to water and sediment delivery pathways have occurred within the upper watershed of the Puyallup River. These modifications change the amount, type, and timing of water and sediment delivery to the lower Puyallup. Key modifications include:

- Channel avulsion of the White River into the Puyallup River, potentially doubling flow and sediment load in the lower Puyallup (Kerwin, 1999, King County, 2006);
- Installation of the Mud Mountain Dam on the White River in 1962, which changes timing and volume of flows;
- Installation of the PSE diversion on the White River, which changes timing of flows;
- Installation of the Electron Dam on the Puyallup River in 1904, which changes timing of flows;
- Increased demands on groundwater, which has reduced summer low flows within the Puyallup (Kerwin, 1999);
- Changes in land use which has increased runoff volume and reduced time to peak flow; and
- Changes in land use which has resulted in increased fine sediment loading.

5.2.1.2 River Management

As discussed above, the river management actions that began with the Inter-County River Improvement District in the early 1900s have changed the location, morphology, and ecological functioning of the lower Puyallup River. Key process modifications include:

- Relocation of the main channel, resulting in an approximately 15% reduction in channel length between the mouth and confluence with the White River (Kerwin, 1999);
- Installation of levees that are maintained by Pierce County and the Corps of Engineers;
- Historic channel bed material removal; and
- Discharges from wastewater treatment plants (Pelletier, 1994).

5.2.1.3 Industrial Land Use within the Delta

The industrialization and construction of the waterways within the Puyallup River delta has modified the balance of fluvial and coastal processes in the lower Puyallup and Commencement Bay ecosystem. The channelization of the Puyallup River disconnected the river from the delta plain, significantly modifying morphology and processes occurring within the delta (Kerwin, 1999).

5.2.1.4 Remediation and Restoration Activities

More recently, significant attention has focused on the remediation and restoration of the ecosystems on the Puyallup delta and nearshore Commencement Bay that have been impacted by historical industrial land uses. Remediation and restoration activities are described further in Section 8.

5.2.2 Tributary Streams and Associated Wetlands

Tacoma has previously identified a Lower Puyallup Basin, which is the only portion of the city that drains directly to the Puyallup River (Tacoma, 2000). The Lower Puyallup Basin includes two primary drainages: Swan Creek and the "T" Street Gulch.

Swan Creek is the longest mapped tributary within the City of Tacoma at approximately 3 miles. Swan Creek flows north to the Pierce County border and joins Clear Creek, which eventually flows into the Puyallup River upstream of Interstate 5. Swan Creek supports salmon , and includes associated wetlands including the Haire Wetland (Tacoma, 2000).

The "T" Street Gulch runs south to north in a parallel valley west of Swan Creek, and includes areas that are surface and sub-surface (piped). Flow within the "T" Street Gulch is thought to be intermittent, and flow is piped from the upstream side of Interstate 5 to the Puyallup River (Tacoma, 2000).

Wapato Creek is located northeast of the Puyallup River within the Port of Tacoma. The Wapato Creek channel was likely a historical distributary channel within the Puyallup River delta (Kerwin, 1999). Wapato Creek is currently a highly modified urban channel. Wapato Creek flows into the head of the Blair Waterway via a piped outfall. Flood control efforts within the Wapato Creek drainage have resulted in flows being diverted into the Puyallup River (Kerwin, 1999).

Associated wetlands within the Lower Puyallup Basin have been mapped and/or preliminarily identified in several locations adjacent to the Puyallup River. Wetlands are identified along the alignments of Swan Creek and the "T" Street Gulch, along with small depressions on the till plain surface (GeoEngineers, 2004). Further, several recent wetland restoration projects (e.g., the Gog-le-hi-te wetlands) have been constructed along the Puyallup River mostly within Tribal lands. The Gog-le-hi-te wetlands include approximately 10 acres of restored wetlands. The site provides habitat for shorebirds, migratory waterfowl, and salmon (Port of Tacoma, 2006).

5.2.3 Geologic Hazards

5.2.3.1 Erosion Hazard Areas

Erosion hazard areas, as defined above in Section 4.2.2, are not present along the Puyallup reach. Although erosion hazard areas have not specifically been mapped for the Puyallup reach, erosion is most likely to occur in areas where steep slopes and landslide hazards are identified.

5.2.3.2 Landslide Hazard Areas

Landslide hazard areas, as defined above in Section 4.2.2, are largely absent from the Puyallup reach given the gentle topography of the area. However, adjacent hillsides in some areas are mapped as having slopes in excess of 40 percent and so are considered landslide hazard zones. These areas occur where the Puyallup River nears the southern portion of the Puyallup River Valley, in the vicinity of Interstate 5.

5.2.3.3 Seismic Hazard Areas

The entire valley bottom of the Puyallup River is considered a seismic hazard area because of its high susceptibility to liquefaction. Sediments in the area consist chiefly of highly saturated, unconsolidated artificial fill and sandy alluvium that lose strength easily when shaken (Palmer et al., 2003, in GeoEngineers, 2004).

5.2.4 Flood Hazard and Channel Migration Zones

FEMA is currently in the process of updating FIRMs for the lower Puyallup River, including the reach within the City of Tacoma (NHC, 2005). Updated mapping is being performed based on a U.S. Army Corps of Engineers decision to decertify the lower Puyallup River levee as a result of sediment build-up within the channel. This update will result in a significant increase in the projected area of flooding during the one percent chance flow compared to the area shown on maps adopted in 1983 and 1987. The increase in area is due in large part to the lack of freeboard (i.e., a depth above the predicted flood elevation that provides a factor of safety) provided by the existing levees along the Puyallup and the flooding than can result if they were overtopped or breached. Potential flooding is now shown as a broad portion of the flat alluvial valley including portions of the Port of Tacoma.

Historical channel migration of the Puyallup River likely encompassed the majority of the width of the lower valley, and included distributary channels throughout the delta. Therefore, the width of the past channel migration zone through the City of Tacoma could be assumed to be very wide. However, channelization, bank armoring, and the construction of levees, currently limit the potential for channel migration.

5.2.5 Critical or Priority Habitat and Species Use

The lower Puyallup River provides habitat for Chinook, pink, chum, and coho salmon, steelhead and bull trout. Fish species distribution maps (WDFW, 2006) indicate that rearing is the primary function of the lower Puyallup River within Tacoma for coho, and spring and fall run Chinook salmon. No spawning occurs below RM 10.2 (Williams et al., 1975). Sockeye salmon adults are

observed annually in the lower Puyallup River subbasin, but there is some question as to their origin and ability to be naturally sustaining (Kerwin, 1999).

The lower portion of the Puyallup River contains designated Critical Habitat for the Coastal-Puget Sound Distinct Population Segment of bull trout (*Salvelinus confluentus*) (70 Federal Register 185). The Puyallup River also contains designated Critical Habitat for Puget Sound ESU Chinook salmon (*Oncorhynchus tshawytscha*) (70 Federal Register170); however, the portion of the Puyallup River within the City of Tacoma is considered Puyallup Indian Tribe lands and is therefore excluded from the designation.

The Puyallup Tribe maintains a ceremonial and commercial salmon fishery in the lower Puyallup River. The Tribal salmon fishery targets salmon in the lower mainstem of the Puyallup River from the mouth to river mile (RM) 10.4 at the confluence of the White River. Most of the salmon fishery occurs on the lower 6 miles below Clarks Creek Bridge.

Other Priority Habitats within the lower Puyallup River include wetlands (Gog-le-hi-te) and estuarine zones. The estuarine zone, or salt wedge, generally extends less than 2.5 miles upstream from the river mouth during high tide; however, monitoring data indicate it sometimes reaches RM 2.9 (Ebbert, 2003).

The Swan Creek restoration project, located at 2717 Pioneer Way East, was completed in 2001 and included 12 acres of wetland preservation and enhancement. This restoration project reconnected the Haire wetland to Swan Creek by a 530-foot channel. This new channel provides salmonid access for rearing, refuge and feeding. This project was funded under the Thea Foss and Wheeler-Osgood Waterways National Resource Damage Assessment (NRDA) Consent Decree signed in 1997.

5.2.6 Instream and Riparian Habitats

The lower Puyallup River is constrained by a series of dikes, revetments and levees along both banks downstream of the Champion Bridge (RM 28.6) to the river mouth at Commencement Bay. These revetments and levees have eliminated connections with side- and off-channel aquatic habitats, precluded functioning riparian vegetation habitats, and precluded the recruitment of small and large wood from areas most likely to contribute this material. Channelization and levees have also reduced river processes that form pools, side channels and other habitat features used by salmonids (Kerwin, 1999).

Less than 5% of the lower Puyallup River has what can be considered high quality riparian habitat, and that habitat is fragmented into small segments often separated by distances of over a mile. The current Army Corps of Engineers levee vegetation management standards pertaining to levees from RM 0.0 to RM 3.0 call for the removal of all vegetation with a trunk diameter exceeding four inches diameter at breast height (dbh). Pierce County maintains the remainder of the levees along the lower Puyallup River and generally levee maintenance by the County is limited to the removal of wood debris only if it is detrimental to the flood control structure. Two mitigation sites along the Puyallup River shoreline planning area provide some off-channel and riparian habitat: Gog-le-hi-te and the Puyallup River Side Channel.

The Gog-le-hi-te wetlands are a constructed wetland complex consisting of approximately 10 acres. The Gog-le-hi-te wetland was originally constructed by the Port of Tacoma in 1986 to mitigate for habitat lost when the Sea-Land Terminal was built in 1984. The site currently provides habitat for a wide range of shorebirds, migratory birds, and salmon. Public use of the site includes waterfowl viewing (Port of Tacoma, 2006).

The Puyallup River Side Channel habitat was built by the City of Tacoma as mitigation for the Thea Foss and Wheeler-Osgood Waterways Superfund Remediation Project. It was designed to provide 4.17 acres of off-channel habitat intended for use by juvenile salmonids for rearing and refugia during outmigration to the estuary (USACE, 2005). The site, constructed in 2005, is crescent shaped, approximately 1,500 ft long and 240 ft wide at its widest point, with an approximate 120-ft wide opening to the Puyallup River. Riparian plantings are planned for elevations between +13.2 and +15 ft MLLW, and wetland grass species will be hydroseeded between +9 and +13.5 ft MLLW (Blaylock, 2006).

5.2.7 Water Quality

Water quality within the Puyallup River and the Puyallup River estuary has been well documented and is continuously monitored by several federal, state, tribal and local jurisdictions (USGS, 2003; Ecology, 2005). The Puyallup River has two 303(d) listings (Category 5 listings) for impaired water quality including fecal coliform bacteria and mercury; however the 303(d) listed reaches occur upstream and outside the city of Tacoma. The Puyallup River within the city contains one Category 2 listing for copper and 6 Category 1 listings for lead, zinc, chromium, mercury, pH, and temperature.

Impairments to water quality of the Puyallup River within the waters of the city have a variety of point and non-point sources. Many of these sources may also result from land uses and activities upstream of the city's jurisdictional boundaries. Agriculture, gardening practices, and property development can result in excessive nutrients (nitrogen and phosphorous) entering surface and groundwater, which promote algae growth and too much organic waste in the water. This reduces dissolved oxygen needed by fish. Failing septic systems and livestock are the typical sources of fecal coliform bacteria, which can indicate a risk to human health. Land development, roads, logging, and agriculture increase sediment in streams, cloud the water, and cover aquatic habitat. Although these activities may be concentrated upstream of the city, they affect water quality in the city's waterbodies.

Within the Puyallup River, fecal coliform likely comes from developed areas upstream in the watershed (from such sources as rural septic systems and livestock grazing). In addition, stormwater discharged to streams and the Puyallup River can contain contaminants such as heavy metals, oil, grease, and organic compounds.

In the early 1990s, Ecology conducted a TMDL study for the Puyallup River. The approved TMDL established criteria and loading parameters to address water quality issues in the Puyallup River with respect to Biological Oxygen Demand (BOD_5), ammonia, and residual chlorine (EPA, 1994). For point-source pollution, the TMDL is implemented through requirements for water quality of wastewater effluent discharges to the river. These are established as requirements for industrial National Pollutant Discharge Elimination System (NPDES) permits.

Following the TMDL study, the City of Tacoma determined that it needed significant upgrades to its wastewater treatment facility to comply with the new NPDES permit requirements. As a result, the City is currently in the process of upgrading its wastewater treatment plant. Improvements included increased capacity and improved treatment technology.

Currently, the Puyallup River is proposed as a priority for developing a Water Cleanup Plan addressing fecal coliform bacteria. It should also be noted that while established state surface water quality criteria apply for most of the Puyallup River, the Puyallup Tribe of Indians have developed their own EPA approved water quality standards for the lower Puyallup River, which includes those portions of the Puyallup River within the City of Tacoma. Water quality of the Puyallup River within the lower Puyallup River is under Tribal jurisdiction, including Usual and Accustomed waters. The EPA approved the Tribes water quality standards in 1994; however the Tribe is in the process of revising these standards and it is anticipated these standards will be approved in the Fall of 2006. The proposed standards are identified in *The Puyallup Tribe of Indians Water Quality Standards for Surface Waters of the Puyallup Tribe* (Ridolfi, 2005).

5.3 Built Environment

5.3.1 Existing and Future Land and Shoreline Use

The Puyallup River (Reach 5) is similar in land use to the surrounding Waterways (Reach 4) and is composed almost entirely of industrial uses. East of East 11th Street bridge the industrial uses become interspersed with vacant or under developed land. Reach 5 is designated High Intensity according to Tacoma's land use intensity map, which illustrates the city's future land uses. High Intensity areas include heavy industrial, high-rise and regional commercial uses.

5.3.2 Shoreline Districts, Shoreline Environment Designations, and Zoning

According to the City's zoning map, the Puyallup River between the upstream city limits near I-5 and the 11th Street bridge is in Shoreline District 9. Downstream portions of the river are in Shoreline District 10. Adjacent upland zoning designations include Light Industrial, Heavy Industrial, and Port Maritime Industrial (See Table 5-1).

Table 5-1. Shoreline Districts and Environment Designations

Reach	Shoreline District and Policy Intent	Shoreline Environment Designation
5 - Puyallup River	S-9, Puyallup River: to permit recreational development of the riverfront while allowing industrial development of adjacent upland areas, and to encourage continued preservation of Clear Creek, its associated wetlands, and related ecosystems.	S-9: Urban
	S-10, Port Industrial: to allow the continued development of the Port Industrial Area, with an increase in the intensity of development and a greater emphasis on terminal facilities within the City.	S-10: Urban

5.3.3 Existing and Proposed Public Access Sites

There are no parks or open spaces currently within or adjacent to the Puyallup River planning area (Reach 5). Along the east shoreline area of the Puyallup River, directly downstream of the East Ellis Street Bridge and the State Highway 509 crossing, the Gog-le-hi-te Restoration Site provides public access. This area and additional areas extending to the south of the Interstate 5 crossing would likely be appropriate for open space designation.

5.3.4 Historic and Cultural Resources

The Washington State Department of Archeology and Historic Preservation maintains a database of sites listed on Washington's Historic register and the national register. A search of the database for sites within the City's shoreline planning area revealed two sites within the Puyallup River shoreline planning area. South of the Washington State Highway 509 crossing, a railroad bridge has been designated as a Historic Bridge on the Washington Heritage Registry. At the south limits of the Puyallup River shoreline planning area near the intersection of E Bay Street and E 28th Street, an Indian Cemetery is listed as a Site of Ethnic Heritage on the Washington Heritage Registry. The City's mapping layer for Township Range Sections containing recorded archaeological resources includes most of the Puyallup River in the City (GeoEngineers, 2004).

5.3.5 Impervious Areas

The Puyallup River shoreline planning area (Reach 5) is predominantly composed of impervious area. The segment from the city limits to the bridge at Lincoln Avenue contains the largest amount of pervious area, based on aerial photo interpretation. This area appears to have a discontinuous buffer of vegetation along the shoreline planning area. From Lincoln Avenue west to East 11th Street the area is mostly impervious with concrete or hard packed gravel over most surfaces. Small patches of pervious area exist, mainly on the south bank. West of East 11th Street the surface is almost entirely paved or covered with buildings.

5.3.6 Roads and Bridges

Bridges in the Puyallup River Shoreline Area (Reach 5) from the mouth of Commencement Bay include the 11th Street Bridge, Lincoln Avenue Bridge, State Route 509, Pacific Highway 99, and Interstate 5. Several collector streets are located throughout the shoreline planning area as well.

5.3.7 Utilities and Infrastructure

The City of Tacoma provides sanitary sewer service to 90,000 customers. The City operates two wastewater treatment facilities, the Central and the North End Wastewater Treatment Plants. The Central Wastewater Treatment Plant, located on the tide flats along the Puyallup River, uses high purity oxygen and bacteria to remove organics from wastewater. The North End Treatment Plant, in Mason Gulch off Ruston Way, uses chemicals to remove the organics and a filter with bacteria to treat the wastewater before it enters Puget Sound.

The City has over 700 miles of storm drainage pipesPortions of the stormwater system have outfalls entering the Puget Sound. In the Puyallup River (Reach 5) there are four outfalls located mid-way between the East 11th Street crossing and the State Route 509 crossing.

5.3.8 Areas of Special Interest

The City's inventory mapping of "rapidly developing waterfronts" classifies the Puyallup River shorelines as developing "rapidly" (GeoEngineers, 2004).

The Department of Ecology maintains a statewide GIS database of facilities with suspected or confirmed contaminated sites, and facilities with the potential to introduce contaminants into the environment. The database was reviewed to identify any known sites within 200 feet of the City's marine shoreline planning area. Within the Puyallup River shoreline planning area (Reach 5), a total of nine sites are mapped. All of the sites are listed as facilities that generate hazardous waste or store hazardous materials.

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6.0 HYLEBOS CREEK SHORELINE PLANNING AREA

This section provides reach-scale information for the City of Tacoma's Hylebos Creek shorelines, consistent with state guidelines. Elements identified in WAC 173-26-201(3)(c), "Inventory shoreline conditions," are described at the shoreline planning area scale, which approximates the limits of regulatory jurisdiction under the SMA. This section is organized generally into two sections, Natural Environment and Built Environment. Elements of the natural environment include a description of natural process modifications, aquatic resources, habitat, and regulated critical areas. Elements of the built environment include existing and planned land use patterns, infrastructure and shoreline modifications, public access areas, cultural resources, and other areas of special interest.

6.1 Hylebos Creek Reach

The Hylebos Creek subbasin is approximately 18,361 acres in size containing 25 miles of streams, 11 named lakes, and numerous wetlands and is located in one of the most highly developed watersheds in the state. The majority of the watershed is located outside the City of Tacoma's Hylebos Creek planning area in the Cities of Federal Way and Milton. Approximately 0.5 river mile of Hylebos Creek is included in the City of Tacoma, from USGS River Mile (RM) 0.00 to approximately RM 0.5. The Hylebos Creek shoreline planning area in Tacoma is approximately 23.9 acres or approximately 0.13 percent of the entire watershed area.

The portion of the Hylebos Creek that flows through the City of Tacoma is addressed here as one reach (Reach 6) (Map 1). The reach is approximately 0.5-mile and extends from the upstream boundary with city limits downstream to the confluence with the Hylebos Waterway. The inventory and characterization of the Hylebos Waterway is included in Section 4 above, as part of Reach 4 (the Waterways).

6.2 Natural Environment

6.2.1 Riverine process modifications

Process modifications to Hylebos Creek have been extensive. Modifications are primarily associated with rapid and significant urbanization throughout the drainage basin and the conversion of the mouth of the Hylebos into the Hylebos Waterway (Kerwin, 1999). Key modifications to riverine processes within Hylebos Creek include:

- Significant increase in flow volume and decrease in time to peak of flows (i.e., precipitation is conveyed to channels more quickly) due to increases in impervious surface and decrease in wetland area;
- Removal of in-channel LWD;
- Removal of floodplain forest;
- Industrial land uses, including land fills have likely reduced water quality; and

- Filling of tide flats, restricting the estuarine portion of the system to within a constructed waterway.

6.2.2 Tributary Streams and associated wetlands

No tributary streams to Hylebos Creek have been identified within the short (0.5 mile) Reach 6.

Several potential wetlands have previously been identified within topographic depressions and a significant portion of the bluff above the Hylebos Creek and Waterway is mapped as wetland (GeoEngineers, 2004). Wetlands associated with the Hylebos include potential riparian wetlands along the stream channel south of Marine View Drive. Wetland restoration has occurred along the Hylebos immediately north of Marine View Drive at the Mowitch restoration site.

6.2.3 Geologic Hazards

Erosion and landslide hazard areas, as defined above in section 6.2.2, are not present along the Hylebos Creek reach.

Some of the areas along Hylebos Creek area are considered moderately susceptible to liquefaction during an earthquake. These seismic hazard areas occur where fine-grained Vashon recessional lacustrine deposits overlie the coarser, Vashon recessional outwash deposits (Map 3).

6.2.4 Flood hazard and channel migration zones

The Federal Emergency Management Agency (FEMA) has prepared Flood Insurance Rate Maps (FIRMs) that cover Hylebos Creek. These maps were adopted on December 1, 1983 (Community Mapping Series 530148). These maps indicate that an elevation of 9.0 (feet NGVD 29) has been established for flooding in the waterway, and in the portion of Hylebos Creek in the City of Tacoma. In general, this elevation does not extend outside the banks of the creek. The same elevation is also used within the waterways. However, in the revised FEMA maps currently being developed and reviewed, this reach of Hylebos Creek is included within the area with the one percent chance flow associated with the Puyallup River (NHC, 2005).

No channel migration zones have been established for Hylebos Creek (Photo 6-1). There is potential for channel migration within the recently completed Mowich Restoration site. The scale of potential migration appears to be limited to less than 5 times the channel width.

Photo 6-1. Hylebos Creek near low tide, looking upstream (aspect East) from Marine View Drive.

6.2.5 Critical or Priority Habitat and Species Use

Chinook salmon are documented as occurring throughout Hylebos Creek in the City (Williams et al., 1975; WDFW, 2006). Fish species distribution maps (SalmonScape) (WDFW, 2006) indicate that Hylebos Creek within Tacoma serves primarily as a migration corridor for fall run Chinook salmon. Spring run Chinook salmon do not inhabit the Hylebos Creek (WDFW, 2006).

NOAA Fisheries designated critical habitat for Chinook salmon (Federal Register, Vol. 70, No. 170) extending from the Hylebos creek outlet upstream to the endpoint in West Hylebos Creek, which would include the entire Hylebos Creek planning area within the City of Tacoma.

Other salmonids that use the Hylebos Creek reach include: sea-run cutthroat trout, coho salmon, fall chum salmon, and winter steelhead. The reach within the City's planning area serves primarily as a rearing and migration corridor for salmonids. Spawning habitat was not documented within the reach.

No other priority species were identified within the City's Hylebos Creek planning area (WDFW, 2004). Priority habitats documented within the City's Hylebos Creek planning area includes urban natural open spaces and riparian zones (Map 4).

6.2.6 Instream and Riparian Habitats

The two main factors influencing Hylebos Creek habitat within the City's shoreline planning area are channelization and the rapid rate of urbanization. The impacts of agricultural development, urbanization, and channel modifications have impaired the habitat ecological functions that Hylebos Creek provides. Overall, habitat conditions are severely degraded compared to historical conditions (Kerwin, 1999). This is in large part due to increased urbanization within the entire watershed, and historical and current flood control practices.

The following disturbances have had the most impact on habitat within the riverine aquatic system: construction of levees and revetments along significant portions of the reach through the City has reduced off-channel connections with side channel habitats and wetlands; highly developed shoreline areas with patchy riparian vegetation where present; lack of large woody debris and recruitment potential throughout the watershed; and channel straightening resulting in lack of habitat complexity (e.g., pool to riffle ratios, LWD, channel migration). Bank stability is good and erosion is minimal. However, this is due primarily to diking and other modifications described above. These modifications do not allow the stream to form natural meanders and they limit floodplain connections to adjacent wetlands and off-channel habitats. The Mowich restoration site within the City's Hylebos Creek shoreline planning area has removed portions of the levee and created off-channel habitat (Photo 6-2).

Photo 6-2 Hylebos Creek near low tide, looking downstream (aspect West) toward the Hylebos Waterway and Commencement Bay. The Mowich Restoration Project site is located on the right bank

6.2.7 Hylebos Creek Water Quality

Hylebos Creek is listed on Ecology's 2004-303(d) for fecal coliform bacteria: however the listed reaches are located upstream of the City in the jurisdiction of the municipalities of Federal Way and Milton. Hylebos Creek in the City of Tacoma has no other water quality listings with Ecology. For a description of water quality categories please refer to the water quality section of Chapter 4.

6.3 Built Environment

6.3.1 Existing and Future Land Use

Land use patterns along Hylebos Creek (Reach 6) can be grouped into two distinct areas, west and east of Marine View Drive. West of Marine View Drive land use resembles the Hylebos Waterway, characterized by parking lots associated with industrial land uses on either side of the creek. East of Marine View Drive land use is less intensely developed. Adjacent to the north bank of Hylebos Creek, outside of the shoreline planning area, is a large gravel operation.

Future land use intensity maps designate Reach 6 as High Intensity. High Intensity areas include heavy industrial, high-rise and regional commercial uses.

6.3.2 Shoreline Districts, Shoreline Environment Designations, and Zoning

According to the City's zoning map, portions of Hylebos Creek upstream of the Hylebos Industrial Waterway are in Shoreline District 10. Between Marine View Drive and the Waterway, the creek is not in a shoreline district. In this area, the creek is in the Port Maritime Industrial (PMI) zoning designation. Upstream of Marine View Drive, the Creek is in District 10 (Table 6-1).

Table 6-1. Shoreline Districts and Environment Designations

Reach	Shoreline District and Policy Intent	Shoreline Environment Designation
6. Hylebos Creek	S-10, Port Industrial: to allow the continued development of the Port Industrial Area, with an increase in the intensity of development and a greater emphasis on terminal facilities within the City.	S-10: Urban

6.3.3 Existing and Proposed Public Access Sites

There are no parks or designated open spaces currently in or adjacent to the Hylebos Creek planning area (Reach 6). A series of nearshore restoration projects are located or planned within the Hylebos Creek planning area. The Lower Hylebos Marsh Restoration Project was designed to restore ecological function to the restoration area and create off channel habitat (Friends of the Hylebos Wetlands, 2006). This project and others will provide increasing passive recreation opportunities as native flora and fauna utilize the areas.

6.3.4 Historic and Cultural Resources

A search of the Washington State Department of Archeology and Historic Preservation database revealed no recorded or mapped historic or archaeological sites within the Hylebos Creek shoreline planning area. However, Native American use of waterbodies throughout western Washington has been well documented. Native peoples undoubtedly used the Hylebos Creek shoreline for fishery and other natural resources. As such, there is a moderate probability of archaeological resources remaining near the Creek's shoreline. These resources, if existing in the City, may have been removed or destroyed during fill and development activities along the shorelines.

6.3.5 Impervious Areas

Impervious area along Hylebos Creek (Reach 6) reflects the land use pattern described above. West of Marine View Drive the planning area contains parking lots on either side of the creek. East of Marine View Drive the area is largely undeveloped and with the exception of a few buildings has relatively little impervious surface.

6.3.6 Roads and Bridges

Marine View Drive is the only bridge crossing over the creek in the City.

6.3.7 Utilities and Infrastructure

In the Hylebos Creek (Reach 6) there are three outfall pipes located near the Marine View Drive Bridge that crosses Hylebos Creek. Other utilities crossing the stream include overhead powerlines and a natural gas pipeline attached to the bridge.

6.3.8 Areas of Special Interest

The City's inventory of rapidly developing waterfronts classifies the portion of Hylebos Creek in Reach 6 as "none" (GeoEngineers, 2004). According to Ecology's Facility Site database, one site is mapped within the Hylebos Creek shoreline planning area. The site is classified as a facility that generates hazardous waste.

7.0 WAPATO LAKE SHORELINE PLANNING AREA

This section provides reach-scale information for the City of Tacoma's Wapato Lake shorelines, consistent with state guidelines. Elements identified in WAC 173-26-201(3)(c), "Inventory shoreline conditions," are described at the shoreline planning area scale, which approximates the limits of regulatory jurisdiction under the SMA. This section is organized generally into two sections, Natural Environment and Built Environment. Elements of the natural environment include a description of natural process modifications, aquatic resources, habitat, and regulated critical areas. Elements of the built environment include existing and planned land use patterns, infrastructure and shoreline modifications, public access areas, cultural resources, and other areas of special interest.

7.1 Wapato Lake Reach

Wapato Lake is made up of three hydrologically connected waterbodies. The northernmost waterbody is essentially a large wetland complex with an open water portion. The upper waterbody opens up into a larger middle waterbody with wetlands surrounding the fringe. The lower waterbody constitutes the main lake area and contains the majority of development, which is primarily restricted to Wapato Park and its amenities. For purposes of this report, the area surrounding all three waterbodies and associated wetlands is treated as one reach (Reach 8; Map 1).

A stormwater bypass exists at the southwestern end of the middle waterbody. This bypass routes the stormwater flows around the main lake to Ward's Lake and then to the Flett Holding Basins. A dike was constructed in 1981 when the lake was dredged and "restored." The dike was designed to keep sediments in the stormwater from entering the land reaching the main portion of Wapato Lake.

7.2 Natural Environment

7.2.1 Lake Processes and Bank Modifications

Land use and development surrounding Wapato Lake have resulted in shoreline modifications including the placement of bulkheads, overwater structures, and removal of forested vegetation and other alterations as described below.

Wapato Lake is a 34-acre lake and is included within the greater Wapato Park (Photo 7-1). With much of the area surrounding Wapato Lake being designated as a City-Metro park, development other than that for the park has been limited. Urban residential and commercial development and a major transportation facilities (including I-5) surround Wapato Lake Park on all sides, which effectively isolates Wapato Lake from other natural areas.

The lowest and largest section of Wapato Lake is separated from the upper two lakes by a section of fill (causeway), which supports a paved trail that surrounds the lake. A small bridge (box culvert) serves as the connection between the upper lakes and the lower lake. Additional shoreline modifications along the lower lake include; riprap armoring of adjacent to the boathouse, a residential property at the south end of the lake, two overwater structures (fishing

piers), tree removal along the shoreline perimeter, and a small concrete boat ramp. Other areas along the lower lake banks, which have little or no armoring are experiencing significant erosion. Several houses on the west side of the lower lake were purchased and removed by Metro Parks for improvements to the park.

Modifications to the shoreline of the upper two lakes are limited to residential bulkheading on the east side of the upper most lake, an elevated foot bridge between the upper and middle lakes, and riprap armoring along the causeway between the lower and middle lakes. The upper two lakes are primarily surrounded by wetlands and have a mixture of forested, emergent, and scrub/shrub components, which provide good cover and habitat. The lower lake, where the majority of park amenities are located, contains some native trees and shrubs. However, most of the area is covered by open grassy areas and offers little benefit to the shoreline by providing soil stability, cover, and habitat.

Photo 7-1. An area of active bank erosion on Wapato Lake in Wapato Lake Park.

7.2.2 Drainage Basin, Tributary Streams and Associated Wetlands

Wapato Lake (Reach 8) is located in the Flett Creek sub-basin in the southern part of Tacoma, which is the second largest drainage basin within the City. Streams within the basin generally flow southwest and west into the Chambers Creek watershed, which empties into Chambers Bay and eventually the Tacoma Narrows. Wapato Lake has no freshwater input or outlet via streams.

Wapato Lake is situated on top of low-permeability till, which suggests that it likely receives most of its water from surface runoff from the adjacent uplands rather than from groundwater seepage. However, Wapato Lake is divided into three separate sections with the upper two open-water portions of the lake being surrounded by wetlands containing scrub-shrub, forested, and emergent wetland vegetation types and likely contribute some groundwater recharge to Wapato Lake during the dry summer months. The upper two portions of Wapato Lake serve primarily as stormwater retention and filtration areas.

The middle waterbody and the wetlands receive most of their water from two storm drain inlets at the north end of the lake, which drains portions of the I-5 corridor as well as local streets north of the park (City of Tacoma, 2005). This water is bypassed around the main lake, although during periods of high flow, some stormwater may be discharged to the main lake. An outflow structure exists at the very south end of the lower lake, which directs stormwater runoff to the City's storm drainage system and eventually discharges to Ward's Lake in Lakewood, Washington.

All of Wapato Lake itself is mapped as wetland, and each of the wetland habitats adjacent to the lake are considered associated wetlands under the SMA. The lower lake comprises an open-water wetland and the middle and upper lakes contain a mixture of palustrine forested, palustrine emergent, and palustrine scrub/shrub components. A large connected wetland area exists to the east of the middle lake, which is primarily palustrine forested wetland. Three other small wetlands occur within the Wapato Lake shoreline planning area to the north of the park and contain both palustrine forested and emergent components (GeoEngineers, 2004)(Map 2). Wapato Lake is considered a Wetland of Local Significance in the Critical Areas Preservation Ordinance, and as such is given higher priority in wetland protection and preservation.

7.2.3 Geologic Hazards

Erosion hazard areas, as defined above in Section 4.2.2, are not present in the Wapato Lake reach. However, as noted above, erosion along portions of the lower lake banks is evident (Photo 1).

Scattered slopes in the Wapato Lake reach and along the perimeter of the lake are considered landslide hazard areas, as defined above in Section 4.2.2. These areas are characterized by relatively steep slopes (as seen on topographic maps), and a sedimentary sequence generally represented by Vashon recessional outwash deposits underlain by Vashon Till.

Seismic hazard areas, as defined above in section 4.2.2, are not present in the Wapato Lake reach.

7.2.4 Critical Wildlife Habitat and Species

According to the WDFW PHS database, Wapato Lake does not contain any documented use by federally or state listed species, but does contain fish, and a very large concentration of waterfowl , which are important to many species as a food source including the bald eagle (WDFW, 2006). Wapato Lake priority habitats include wetlands and urban natural open space. Wetlands are transitional areas between terrestrial and aquatic environments that have the potential to have a comparatively high fish and wildlife density, high fish and wildlife diversity, provide important fish and wildlife breeding habitat, and provide important fish and wildlife seasonal ranges. Preservation of these areas is highly important due to their limited availability and their vulnerability to habitat alterations. The urban natural open space designation, in the case of Wapato Lake, is given to any remnant of natural habitat larger than 10 acres and is surrounded by urban development.

Although there has been no documented use of the area by bald eagles, Wapato Lake likely provides a foraging area for eagles due to the presence of waterfowl concentrations and other

fish species (rainbow trout). Osprey, a current state monitor species, has been observed foraging over Wapato Lake. Also, the lake likely provides habitat conducive to supporting western pond turtles, a state endangered and federal candidate species, although none have been documented there.

7.2.5 Lake and Riparian Habitats

Lakeside vegetation provides valuable wildlife habitat, reduces erosion, contributes to improved water quality, and contributes large woody debris to provide cover and habitat for a range of fish species. Vegetation surrounding the park is largely native in origin, dominated by Douglas fir and Oregon ash; however, around the lower portion of the lake (developed portion), vegetation is primarily lawn grasses and a mixture of native and ornamental trees and shrubs landward of the paved trail. Vegetation around the perimeter of the lower lake is sparse with the exception of lawn grasses. Some willows, immature cottonwood, and Himalayan blackberry can be found in places. Aquatic and wetland species including lilly pads and cattail are found along wetted portions of the northernmost extent of the lower lake and are generally associated with shallow fringe areas of the lake. The southernmost extent of the lower lake adjacent to 72nd street is primarily lawn grasses and ornamental trees and shrubs. The middle portion of the lake is more heavily vegetated with cottonwoods, willow being the dominant tree along the middle lakes outer edge and reverting to more upland species (primarily Douglas fir) as you move away from the water. Lilly pads and cattail dominate the nearshore vegetation of the middle lake. Vegetation, other than lawn grasses of adjacent residential development, of the upper lake is dominated by wetland species including several species of willow, Douglas spirea, red alder, cottonwood, cattail, and reed canary grass. The upper lake has many snags, which can provide valuable nesting areas for many bird and mammal species, feeding areas, perching areas, and roosting platforms.

7.2.6 Water Quality

A lake's trophic status is evaluated to summarize water quality lake conditions. Trophic status refers to the combination of clarity, nutrient concentrations and algae levels that are often used to determine a lake's productivity. In the case of a lake, productivity is often undesirable because it leads to increases in plant and algae growth. The three major divisions of trophic status are: oligotrophic (refers to lakes of low productivity; clear water and few plants and algae), mesotrophic (moderate productivity with some plants and algae) and eutrophic (highly productive, algae and/or plant rich systems).

Lake flushing is a critical aspect of determining how vulnerable a lake may be to pollution. Lakes with higher flushing rates are less vulnerable to the effects of pollutants because they have a shorter residence time. This means that pollutants entering the lake via the stormwater outfalls can move through the lake and exit through the outflow. Increases in impervious surfaces in the upland environment can also affect subsurface groundwater flow into the lake leading to changes in water quality.

Wapato Lake is one of the largest urban natural open spaces in the southern portion of the City. Wapato Park covers approximately 87.5 acres, which includes 34 acres of open water habitat. Land use in the surrounding area has altered the hydrology of Wapato Lake. The largest contributor to altered hydrology and degraded water quality is the conversion of natural areas to that of impervious surfaces (roads/rooftops). The wetlands receive most of their water from stormwater that discharges from two large outfalls into the north end of the wetlands. The stormwater carries stormwater runoff from the adjacent I-5 corridor and surrounding commercial and residential areas to the lake. This stormwater is bypassed around the main lake. The lower and largest portion of Wapato Lake is very shallow.. Water quality has been an issue for Wapato Lake throughout its history with a lake closure occurring as early as 1942 and extending through 1948. In 1981, Wapato Lake was completely drained and dredged and treated with aluminum sulfate to control phosphorus . At this time, the dike was built at the northern end of the main lake to improve water quality by collecting sediment from the stormwater runoff. The lake has seen more recent closures due to toxic algae (1997) and fecal coliform (1998). The Lake was closed to swimming and fishing in March of 2006 by the Tacoma-Pierce County Health Department due to toxic algae blooms. The lake has had fish, bird and turtle kills over the past year. The Washington Department of Fish and Wildlife has removed most rainbow trout from the lake in response to the algal blooms and moved them to nearby Spanaway Lake.

Currently, the shallow nature of the system and high nutrient loading has accelerated the eutrophication process for the system. Other than the stormwater inlets and outlets , there is no natural outlet or inlet to Wapato Lake. The shallow depth, poor circulation, and high phosphorous loading has encouraged excessive vegetative plant growth and algal blooms, which as they grow and decompose, oxygen is used up resulting in low dissolved oxygen levels resulting in fish kills. Algal blooms can also cause problems because they release toxins, which can kill fish and other aquatic life including waterfowl. Human health may also be at risk to exposure to affected waters. In addition, the concentration of waterfowl, particularly Canada geese, has contributed to elevated fecal coliform levels within the lake. Wapato Lake is currently listed on the Washington State Department of Ecology (Ecology) 303(d) list of impaired surface waters for fecal coliform bacteria. A Total Maximum Daily Load (TMDL) will need to be prepared for Wapato Lake addressing the fecal coliform issue. A TMDL was approved in 1993 under the Clean Lakes project, not because of a 303(d) listing, for total phosphorus loading within Wapato Lake, which addressed concerns over excessive algal growth within the lake.

The Tacoma-Pierce County Health Depatment (TPCHD) and Metro Parks are currently undertaking a water quality and sediment monitoring study of Wapato Lake. Based on the results of the study, the City anticipates establishing recommendations for addressing water quality problems in the lake.

The City's Wapato Lake Master Plan (City of Tacoma, 2005) has identified several enhancement options that are focused on improving water quality, reducing the amount of sediment entering the system, and increasing dissolved oxygen levels to that which will support aquatic life. These options include: 1) installation of an aerating fountain and bubblers throughout the lake, 2) establishment of a vegetative edge along the north and west sides of the lake to control soil erosion, increase nutrient removal, and increase shade; 3) public access and shoreline erosion prevention measures; 4) increasing the amount of water entering the lake by pumping in fresh

water from the Green River conduit at the north end of the lake; 5) control of the waterfowl population; and 6) development of a lake management plan in cooperation with State and local agencies (City of Tacoma, 2005). These options are subject to the findings and recommendations of the water quality study currently being conducted by TPCHD and Metro Parks.

7.3 Built Environment

7.3.1 Existing and Future Land Use

Land use within the shoreline planning area is predominantly park and open space. Wapato Park is approximately 87.5 acres in size and includes Wapato Lake and associated wetlands. The shoreline planning area includes several dozen single-family residences abutting the park boundary. Future land use intensity maps designate the area as Low to Medium Intensity. Low Intensity designation includes single-family homes, duplexes and triplexes, parks, schools, libraries and neighborhood commercial uses. Medium Intensity includes light industrial, community commercial and apartments.

7.3.2 Shoreline Districts, Shoreline Environment Designations, and Zoning

According to the City's zoning map, Wapato Lake is located in Shoreline District 14. The Shoreline District 14 policy intent is to "encourage continued preservation of the lake, marsh, wetlands, and related ecosystems and to provide for perpetual utilization for park, recreational, and open space uses. No activity shall be permitted which will reduce, destroy, or in any way adversely affect the public shoreline and the Wapato marsh" (TMC, 13.10.170.A). The Shoreline Environment Designation is Conservancy. Adjacent zoning designations are primarily R-2, Single-Family Residential. An area near the lake is designated Commercial, between S. Alaska Street and I-5 (Map 5).

7.3.3 Existing and Proposed Public Access Sites

The majority of the Reach 8, around Wapato Lake, exists within Wapato Park. Passive and active recreation recreational opportunities within Wapato Park include walking trails, scenic lake overlooks, play structures and fields, and a boathouse. There are no other designated open space areas within Reach 8.

As the majority of the planning area currently is owned by the City and maintained as Wapato Park, there is no need to increase public access to the lake planning area. As such, no measures are proposed to create new public access space beyond Wapato Park. The City's Recreation and Open Space Plan (City of Tacoma, 2000) does call for improvements to existing facilities where determined to be necessary. Improvements within Wapato Park would enhance the existing public access opportunities.

7.3.4 Historic and Cultural Resources

There are no recorded archaeological or historic sites near Wapato Lake identified in the Washington State Department of Archeology and Historic Preservation database (WDAHP, 2006).

7.3.5 Impervious Areas

Impervious area in Wapato Lake (Reach 8) is limited within Wapato Park. Exceptions include surface streets, parking lots, paved trails and walkways, park buildings, bridges, and docks. Outside the park but within the shoreline planning area, impervious area is associated with single-family residences, which are connected by paved surface streets and driveways.

7.3.6 Roads and Bridges

Roads in the Wapato Lake Shoreline Planning Area (Reach 8) include Wapato Lake Drive, which runs through Wapato Lake Park on the east side of the lake. On the west side the lake is bordered by Alaska Street.

7.3.7 Utilities and Infrastructure

As described above, the northern portion of Wapato Lake functions as part of the stormwater system, receiving most of its water from storm drain inlets at the north end of the lake, bypassing the main lake and discharging to the stormwater system at Ward's Lake .

7.3.8 Areas of Special Interest

Wapato Lake was not included in the City's previous inventory of rapidly developing waterfronts (GeoEngineers, 2004). However, since the majority of the lake is within a developed park, additional development potential would be considered minimal to none. No sites in the Wapato Lake shoreline planning area are mapped in the Department of Ecology database of facilities with suspected or confirmed contaminated sites, or facilities with the potential to introduce contaminants into the environment. Portions of the lower lake exhibit eroding shorelines as noted above.

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8.0 ASSESSMENT OF SHORELINE FUNCTIONS AND OPPORTUNITY AREAS

Tacoma's location at the head of Commencement Bay and the mouth of the Puyallup River has long made it an important location in the functioning of southern Puget Sound. Past restoration work by the City of Tacoma has been closely coordinated with private, regional, and federal entities, resulting in several successful restoration and enhancement projects. Through the development of this *Inventory and Characterization* report, ecosystem processes have been identified and discussed in light of significant changes in land use in the city and the upper watershed, in an effort to use a watershed approach to support the planning for the next iteration of Tacoma's Shoreline Master Program. In this way, Tacoma can continue to build upon past progress to improve the ecological functioning and viability of its shoreline.

Applying this watershed approach, key ecological functions have been identified that would benefit from special focus under Tacoma's Shoreline Master Program. These functions are summarized in tables below, along with discussion of the overall level of historical alteration when compared to the pre-disturbance condition. General restoration opportunities to address the current impairment of shoreline functions, and the relative potential for restoration success, are also described.

Along with these summary tables, both programmatic and specific restoration actions are identified. In general, these actions have been developed as part of other regional planning efforts, specifically through the Natural Resource Damage Assessment process for cleanup in Commencement Bay. These potential actions can be considered in the context of conditions and opportunities within individual shoreline reaches in the City. Shoreline reach summaries are provided, which identify key shoreline management issues and restoration potential. The specific restoration approach for Tacoma's shorelines will be more fully developed in later phases of the SMP revision process.

The City is actively engaged in developing additional habitat restoration plans. In 2007, the City embarked on a project to evaluate all open spaces and undeveloped habitat areas within city limits. The purpose of this study is to determine the habitat potential and restoration opportunities for undeveloped lands within the city, including those within the shoreline area. Over 100 sites were identified as open spaces and prioritized for potential habitat restoration. Sites identified included undeveloped road right of ways, park lands, steep slopes, wetlands, streams and their buffers. Data regarding existing habitat conditions, tree cover, species present and restoration potential were collected at each site. This information is currently being summarized in a technical report. Data collected using global positioning units has been incorporated into the GIS system and information will be illustrated on city-wide maps.

8.1 Nearshore / Marine Environment

The following table (Table 8-1) summarizes the status of the Nearshore / Marine Planning Area and describes the shoreline functions, the level of alteration compared to historical condition, and the restoration opportunities to improve shoreline functions within the City. This section addresses functions pertains to five shoreline planning areas: 1) Tacoma Narrows, 2) Point Defiance, 3) Ruston Way, 4) Commencement Bay Waterways, and 5) Marine View Drive.

8.1.1 Status of Shoreline Functions Summary Table

Table 8-1. Assessment of Nearshore Functions within Tacoma

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Habitat: Estuarine habitat; subtidal and intertidal mudflats and salt marshes provide transition habitat between fresh and salt water environments	**High** Physical modifications to the Puyallup delta have changed the spatial mixing of fresh and salt water. The installation of roads, docks, and bulkheads has tended to disconnect freshwater seeps and wetlands from marine waters.	**Low** The extent of physical modifications to the system has been substantial enough to preclude straightforward restoration measures to achieve pre-disturbance levels of ecosystem functioning. There is the potential to better connect freshwater seeps and wetlands to the marine shoreline, as part of shoreline rehabilitation projects. Inclusion of provisions in the updated shoreline program to provide such connections where seeps or wetlands are present will improve the habitat function as redevelopment occurs over time.

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Hydrology: Attenuation of wave energy	**High** The general trend toward a 'harder' shoreline (e.g., bulkheads, revetments, docks, etc.) has resulted in less overall wave attenuation than in the pre-disturbance condition.	**Moderate** Encouraging the use of soft-armoring techniques and support of estuarine wetland restoration efforts can improve wave energy attenuation within the City's nearshore over time. Inclusion of a preference for soft-armoring in the updated shoreline program will encourage this transition.
Sediment Generation and Transport: Sediment delivery from coastal bluffs and streams	**Moderate** Bluff erosion processes have been modified as structures (e.g. roads, railroads, piers and docks, bulkheads) at the toe have reduced the frequency of tidal and wave interaction with the bluff. The lack of interaction at the toe has likely reduced smaller-scale erosion throughout the city. However, larger-scale erosion events (e.g., landslides due to seismic events) still have the potential to contribute significant quantities of sediment to the nearshore.	**Moderate** Maintenance of existing connections between bluffs and the nearshore, for example along the extensive unarmored shoreline of Point Defiance, is a high priority. Maintenance of the existing connections between stream mouths and the nearshore, for sediment delivery and other habitat benefits, is also a high priority. Reconnection of feeder bluff function to support nearshore processes is more difficult and expensive where the existing infrastructure protects public and private property, or where the existing infrastructure itself disconnects the bluffs from the nearshore (for example, railroad tracks and highways). The Restoration Plan may consider identifying and prioritizing individual projects to reconnect feeder bluffs to the nearshore.

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Water Quality: Wetland removal of pollutants through sedimentation and adsorption	**Moderate** Reduction in wetland area has reduced contact time of water with soil. This lowers the potential for filtering and cycling of pollutants, which adhere to soil particles.	**Moderate** Long term restoration of estuarine and freshwater wetlands in Commencement Bay has restored some of this function. Continued efforts, in conjunction with the Tacoma Open Space and Habitat Plan and in cooperation with the Port of Tacoma, will build on previous success.
Water Quality: Delivery, movement, and loss or removal of nutrients, pathogens, and toxicants; storage of phosphorus and removal of nitrogen and toxins through sedimentation and adsorption.	**High** The delivery, transport, and disposition of nutrients, pathogens, and toxins have been significantly altered from the pre-disturbance condition. Upland sources of these pollutants have increased significantly as a result of urban and industrial land uses within and near the shoreline. Potential storage has decreased through wetland loss and installation of impervious surfaces.	**Moderate** Significant source control and remediation efforts are currently underway to remove and avoid pollutant discharge to the nearshore. These efforts should continue and be expanded. Use of low impact development and other water quality improvement techniques, both within the shoreline area and upland, will decrease pollutant loading over time.
Habitat: Shoreline habitat for wildlife; vegetation provides structure for invertebrates, birds, amphibians, reptiles, and mammals.	**Moderate** While plant communities along the shoreline have been subjected to several phases of disturbance, they have recovered along the many steep bluffs, ravines, and in the protected portions Point Defiance.	**Low** The presence of significant infrastructure such as roads and railroads limits the potential to recover this function. Opportunities include the inclusion of new measures in the updates shoreline program to include habitat features as redevelopment projects occur, and inclusion in the Restoration Plan of a process to identify and prioritize individual projects to expand shoreline habitat.

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Habitat: Source and delivery of LWD	**High** Removal of mature trees from riparian areas, and from surrounding bluffs has significantly reduced the source of LWD to the nearshore system.	**Moderate** The source of LWD exists, however, restoring the connectivity between the bluff/forest system and the nearshore would require significant removal or modification to existing infrastructure (e.g., roads, railroads).

8.1.1.1 Tacoma Narrows Shoreline Planning Area

Summary of Reach

The Tacoma Narrows Planning area or reach includes regulated shoreline districts S-1 (Western Slope South), S-2 (Western Slope Central), and S-3 (Western Slope North) along the Tacoma Narrows. Reach scale maps showing existing land use patterns and aerial photography are included in Appendix B. The constraint of the tidal flux through Tacoma Narrows creates strong currents that affect shoreline morphology in this reach. The nearshore environment in the Narrows Shoreline Planning Area is characterized by steep slopes and coastal bluffs fronted by a narrow beach, much of which is moderately disturbed by development. Seventeen drainages flow into the Puget Sound along this reach, all of which drain steep gulches along the shoreline.

Land and shoreline use in this reach is predominantly single-family residential, concentrated in over-water residential communities (Salmon Beach and Titlow Beach). Public access and shoreline recreational use is provided at the marina at Day Island and at Titlow Beach Park. Shoreline modifications in this reach include bulkheads and docks, which support marina, residential, and parkland uses (GeoEngineers, 2004). The BNSF railroad is located along the shoreline throughout much of this reach, disrupting sediment source/transport processes and connectivity between beaches and bluffs. Docks are focused along the southern portion of the reach, in the wider portion of the Sound. In the northern end of Reach 1, bulkheads as well as piers are associated with development in the Salmon Beach and Titlow Beach overwater residential communities.

Despite moderate levels of disturbance, the area contains documented kelp and eelgrass beds, as well as wild geoduck beds. The area is identified as being used by purple martins, which are documented as a priority species by WDFW. WDFW Priority Habitats within the Narrows Shoreline Planning Area include cliffs/bluffs, urban natural open space, and lagoons. Additionally, the nearshore environment provides significant habitat to forage fish and numerous salmonids, including Puyallup and Nisqually populations of Chinook salmon. Titlow Beach itself has been designated a Marine Protected Area (MPA) and is protected by state law (WAC 220-16-460). This area is rich in marine life and is managed jointly by the Washington Department of Fish and Wildlife and Metropolitan Parks as a marine preserve.

Reach Issues

Key management issues within the Narrows Shoreline Planning Area include the following:

- Bluff erosion processes have been modified as the railroad and other structures at the toe have limited the potential for tidal and wave interaction with the bluff. The lack of interaction at the toe has likely reduced smaller-scale erosion throughout this shoreline area. However, larger-scale erosion events (e.g., landslides due to seismic events) do still have the potential to contribute significant quantities of sediment to the nearshore.

- Over-water residential communities, particularly Salmon Beach, pose regulatory challenges. Salmon Beach is a designated historic district, with individual cabins recognized on the National Register of Historic Places. Redevelopment of homes is generally allowed, while landslide hazards remain a concern.

- Removal of mature trees from riparian areas and from surrounding bluffs has reduced the source and pathways of LWD to the nearshore system. However, portions of this reach do retain mature vegetation on the waterward side of the railroad grade.

- Alterations to the shoreline have reduced the extent of kelp and eelgrass beds in the intertidal area, although eelgrass beds are still mapped in this reach. Kelp and eelgrass beds provide important habitat to forage fish and numerous salmonids, including Puyallup and Nisqually populations of Chinook salmon.

- Continued protection and preservation of the Titlow Beach Marine Preserve Area. Park management goals include maintaining and protecting the park environment and providing public education and outreach regarding marine life.

8.1.1.2 Point Defiance Shoreline Planning Area

Summary of Reach

This reach includes regulated shoreline district S-4 (Point Defiance – Natural), and a portion of S-5 (Point Defiance – Conservation) along Point Defiance shorelines. Reach scale maps showing existing land use patterns and aerial photography are included in Appendix B. The constraint of the tidal flux through Tacoma Narrows creates strong currents that effect shoreline morphology. The portion of this shoreline planning area forming a portion of the Commencement Bay shoreline is more significantly influenced by wave action. The nearshore environment in the Point Defiance Shoreline Planning Area is characterized by steep slopes and active feeder bluffs fronted by a narrow beach, much of which is minimally to moderately altered by development.

Disturbances, as detailed within Chapter 4, include bulkheads that support the predominantly parkland use (GeoEngineers, 2004). The Point Defiance Shoreline Planning Area is almost entirely within Point Defiance State Park. As such, minimal upland development has occurred within or upland of the planning area. Existing bulkheads within this reach are primarily associated with shoreline roadways and trails.

The area contains documented kelp and eelgrass beds. The shoreline area is used by bald eagles, which are considered a priority species by WDFW. WDFW Priority Habitats within the Narrows Shoreline Planning Area include cliffs/bluffs and urban natural open space. Additionally, the nearshore environment provides significant habitat to forage fish (including spawning habitat for sand lance) and numerous salmonids, including Puyallup and Nisqually populations of Chinook salmon.

Reach Issues

Key management issues within the Point Defiance Shoreline Planning Area include the following:

- Active feeder bluff erosion processes are generally intact and should be protected. Future park and recreational development should avoid or limit the need for artificial shoreline stabilization measures that may disrupt natural sediment source and transport processes.

- Existing conditions include native forested habitat located near the shoreline, which should be protected. Point Defiance Park currently contains mature forest within 100 to 200 feet of the marine ordinary high water mark. Preservation of forested habitat will maintain shade, provide habitat for wildlife, and allow for large woody debris input to the shoreline areas.

- Pollution and biotoxins have affected populations of shellfish within the nearshore environment. Although significant point pollution sources are not documented as entering the shoreline environment within the Point Defiance Shoreline Planning Area, pollution occurring to and in nearby shorelines is affecting resources within this area.

8.1.1.3 Ruston Way Shoreline Planning Area

Summary of Reach

The Ruston Way Shoreline Planning area or reach includes a portion of regulated shoreline district S-5 (Point Defiance – Conservation), and districts S-6 (Ruston Way) and S-7 (Schuster Parkway) along the Commencement Bay shoreline. Reach scale maps showing existing land use patterns and aerial photography are included in Appendix B. Tides and wind-driven waves are the primary coastal circulation processes that occur in this reach. The nearshore environment in the Ruston Way Shoreline Planning Area is highly altered with existing development and infrastructure, with remaining vegetated areas consisting primarily of landscaped park spaces (ornamental shrubs, trees, and lawn areas). Several vegetated ravines or gulches containing perennial streams (such as Puget Creek and Mason Gulch) drain from adjacent uplands and discharge into Commencement Bay in this reach. Although the lower portions of these streams are altered as they pass under the railroad and Ruston Way, some support pocket beaches or small estuaries associated with the stream mouths.

Land and shoreline use in this reach is primarily a mixture of recreational and water-oriented commercial and industrial uses. Public access is abundant, with waterfront parks connected by public trails. Key waterfront features include portions of Point Defiance State Park, the Point Defiance Ferry Terminal, the Tacoma Yacht Club, and public marina and boat launch facilities in Shoreline District S-5. Commercial development and parks and open space are predominant in Shoreline District S-6, while deep water terminal and light industrial facilities are located waterward of the railroad in Shoreline District S-7. The former Asarco site is located in this reach near the Town of Ruston. This site is a large formerly industrial site that is undergoing remediation and planning for redevelopment as a marina and other uses. The North End

Wastewater Treatment Plant is located upland of the railroad in Mason Gulch. Its associated effluent outfall is located in this reach.

The shoreline of the Ruston Way Shoreline Planning Area is moderately to highly modified throughout. Shoreline modifications include docks and bulkheads, which support water-oriented commercial, industrial, and recreational uses (GeoEngineers, 2004). Several of the docks and bulkheads are failing and/or derelict. Ruston Way (a major arterial) and the BNSF railroad tracks are adjacent to the shoreline throughout this reach, thereby reducing natural shoreline riparian vegetation and limiting connectivity between the beach and adjacent uplands.

Despite disturbance, the area contains documented kelp and eelgrass beds. The shoreline area is identified as being used by several species of shellfish, although issues with biotoxins and pollution have led to closures on harvest of these resources. WDFW Priority Habitats within the Ruston Way Shoreline Planning Area include cliffs/bluffs, urban natural open space, wetlands, and estuarine areas. Documented wetlands and natural habitats are highly fragmented, and are associated with the three pocket estuaries located within the shoreline area. Additionally, the nearshore environment is known to provide habitat to forage fish (sand lance spawning associated with the pocket beaches) and numerous salmonids, including Puyallup populations of Chinook salmon.

Reach Issues

Key management issues within the Ruston Way Shoreline Planning Area include the following:

- Bluff erosion processes have been modified as roads, railways, bulkheads, and other structures at the toe of the slope have reduced the frequency of tidal and wave interaction with the bluff. The existing infrastructure (road and railroad tracks in particular) limit the opportunity to restablish these connections in the future. However, protection and site-specific restoration actions could focus on the stream mouths and associated pocket beach/estuaries.

- Pollution and biotoxins have affected populations of shellfish within the nearshore environment. Although significant point pollution sources are not documented as entering the shoreline environment within the Ruston Way Planning Area, pollution occurring to and in nearby shorelines is affecting resources within this area.

- Water quality issues relate to changes in the equation for excess nutrients, pathogens, and toxins. Sources of these pollutants have increased significantly as a result of urban and industrial land uses near the shoreline. Storage, filtering, and cycling of pollutants has been reduced through wetland loss and installation of impervious surfaces.

- Alterations to the shoreline have reduced the extent of kelp and eelgrass beds in the intertidal and shallow subtidal area, although discontinuous (patchy) kelp and eelgrass beds are documented in this reach. Kelp and eelgrass beds provide important habitat to forage fish and numerous salmonids, including Puyallup and Nisqually populations of Chinook salmon.

- As redevelopment occurs along the waterward side of Ruston Way, opportunities should be explored to decrease or remove impervious areas (e.g., parking lots), limit new over-water structures, and restore or enhance shoreline vegetation. Although many lots waterward of the road are limited by their depth (50 to 100 feet), site configuration should be explored to eliminate the need for bulkheads or other traditional "hard" shoreline armoring. Alternative bank stabilization ("soft shore" armoring) should be encouraged during redevelopment.

- Ruston Way area currently provides abundant public access through public beaches, parks and trails. Maintaining and improving the public access in this reach will be important to reach Citywide shoreline access goals.

8.1.1.4 Commencement Bay Waterways Shoreline Planning Area

Summary of Reach

This planning area includes regulated shoreline districts S-8 (Thea Foss Waterway), S-10 (Port Industrial), S-11 (Marine View Drive South), and a portion of S-12 (Marine View Drive North) along the Commencement Bay shoreline. Reach scale maps showing existing land use patterns and aerial photography are included in Appendix B. The nearshore environment in the Waterways Shoreline Planning Area is intensely developed and highly altered, with minimal vegetated areas remaining.

Land and shoreline use in this reach is dominated by water-dependent port and maritime industrial uses and associated facilities. Shoreline District 10 includes the Port of Tacoma industrial waterfront area where commercial shipping, as well as timber related industries are dominant land uses. Other key use areas include the Thea Foss Waterway, which continues to undergo reuse and redevelopment focused on water-oriented public access and recreational uses, water-oriented commercial development, mixed-use residential and pedestrian oriented development, marinas and waterborne transportation. A similar mixture of uses, but less intensely developed; characterize the Marine View Drive portion of the Waterways reach, including water-related parks and open space, marinas, water-oriented commercial uses, and residential development.

The shoreline of the Waterways Shoreline Planning Area is highly modified from its natural condition throughout. Shoreline modifications include numerous docks and bulkhead structures, as well as large overwater piers and structures that are supported by pilings. Modifications have occurred in order to support water-dependent commercial, industrial, and recreational uses (GeoEngineers, 2004). Several of the docks and bulkheads arefailing and/or derelict.

Extensive mudflat and shallow subtidal areas dominated the historic environment of the Commencement Bay nearshore. The historic condition of the Bay also included a well-developed river delta with numerous distributary channels, extensive emergent marsh, and a wide estuarine transition zone between upland and marine habitats. Despite the extensive level of alteration that has minimized remaining areas of inter- and subtidal habitat, recent mitigation and restoration activity has recreated and restored some mudflat and transitional areas along the Waterways shoreline. The shoreline area is used by several species of shellfish, although issues

with biotoxins and pollution have led to closures on harvest of these resources. WDFW Priority Habitats within the Waterways Shoreline Planning Area include urban natural open space and estuarine areas. Documented wetlands are highly fragmented, and are largely associated with areas that have been recently restored. Juvenile salmonids, including Chinook, chum and rarely coho, continue to use the shallow water areas and restoration sites within Commencement Bay for rearing and passage (Simenstad, 2000).

Reach Issues

Key management issues within the Waterways Shoreline Planning Area include the following:

- Pollution and biotoxins have effected populations of shellfish within the nearshore environment.
- Reduction in wetland area has reduced water contact time of water with soil. This lowers the potential for filtering, cycling, and removal of pollutants.
- The equation for excess nutrients, pathogens, and toxins is significantly altered from the pre-disturbance condition. Sources of these pollutants have increased significantly as a result of urban and industrial land uses near the shoreline. Potential pollutant storage has decreased through wetland loss and installation of impervious surfaces. Water quality should be maintained through on-site treatment and detention systems.
- The general trend toward a 'harder' shoreline (e.g., bulkheads, revetments, docks, etc.) has resulted in less overall wave attenuation than in the pre-disturbance condition.
- Port industrial development is expected and encouraged to continue and intensify. Redevelopment along the Thea Foss Waterways is ongoing and expected to continue. As redevelopment occurs, increasing public access and recreational uses should be encouraged, and shoreline mitigation and restoration should be informed by a comprehensive restoration-planning framework for Commencement Bay.

8.1.1.5 Marine View Drive Shoreline Planning Area

Summary of Reach

The Marine View Drive Shoreline Planning area or reach includes the majority of the regulated shoreline district S-12 (Marine View Drive North) along the Commencement Bay shoreline. Reach scale maps showing existing land use patterns and aerial photography are included in Appendix B. The nearshore environment in the Marine View Drive Shoreline Planning Area is characterized by steep slopes and bluffs fronted by a narrow beach. A few stream gulches drain the upland and discharge to Commencement Bay in this reach as well. Marine View Drive separates the beach from adjacent upland bluffs, disrupting natural erosion and sediment transport processes. While the upland bluffs are well vegetated with mature forest cover, the roadway has resulted in with a reduction in vegetated areas remaining waterward of the road in certain areas.

Shoreline uses in this reach are primarily water-oriented commercial and recreational (e.g., marinas, open space areas). Shoreline modifications include numerous docks and some bulkhead structures. Modifications have occurred in order to support water-oriented commercial and recreational uses (GeoEngineers, 2004), and many of the docks are associated with marinas within the shoreline area.

Despite moderate levels of disturbance, the area contains documented kelp and eelgrass beds. WDFW Priority Habitats within the Marine View Drive Shoreline Planning Area include cliffs/bluffs, wetlands, and estuarine areas. Documented wetlands are highly fragmented, and are associated with the three pocket estuaries located within the shoreline area. Additionally, the nearshore environment is known to provide habitat to forage fish and numerous salmonids, including Puyallup populations of Chinook salmon. Several estuarine restoration projects along Marine View Drive have been established and provide enhanced habitat to waterfowl and marine species.

Reach Issues

Key management issues within the Marine View Drive Shoreline Planning Area include the following:

- Bluff erosion processes have been modified as the roadway and other structures at the toe (bulkheads, docks, piers, breakwaters associated with marinas) have reduced the frequency of tidal and wave interaction with the bluff. The lack of interaction at the toe has likely reduced smaller-scale erosion throughout this shoreline area. However, larger-scale erosion events (e.g., landslides due to seismic events) do still have the potential to contribute significant quantities of sediment to the nearshore.

- Pollution and biotoxins have affected populations of shellfish within the nearshore environment. Although significant point pollution sources are not documented as entering the shoreline environment within the Marine View Drive Shoreline Planning Area, pollution occurring to and in nearby shorelines is affecting resources within this area.

8.1.2 Programmatic Restoration Opportunities

This section describes ongoing shoreline restoration work in Tacoma and discusses the overall restoration framework established for the nearshore / marine environment by the Natural Resource Damage Assessment (NRDA) program, the City and its partners. The restoration strategy in Commencement Bay is based on landscape analysis principles and was developed in the Commencement Bay Cumulative Impact Study – Restoration and Mitigation Goals (US Army Corps of Engineers, 1993) and the Commencement Bay Conceptual Restoration Plan (Commencement Bay Natural Resource Trustees, 1997). In the context of the SMP update, additional technical analysis and planning for restoration in Tacoma's shorelines will occur in later phases of the SMP update, consistent with WAC 173-26-201(2)(f).

The City of Tacoma has an active and well-established history in nearshore and intertidal restoration, particularly in Commencement Bay. Restoration in the nearshore marine

environment of Commencement Bay has occurred over the past 15 to 20 years through cleanup and remediation efforts under the Commencement Bay Natural Resource Damage Assessment (CB/NRDA) program. These efforts are part of the implementation of the Commencement Bay Conceptual Restoration Plan (Commencement Bay Natural Resource Trustees, 1997), which details the restoration components outlined in the preferred alternative – the Integrated Approach – as described in the programmatic Environmental Impact Statement (EIS) prepared for the Commencement Bay cleanup plan. Restoration options for Commencement Bay cleanup were outlined in detail in Volume II - Restoration Options, Commencement Bay Cumulative Impact Study (Shapiro and Associates, June 1993). The Integrated Approach outlined in the EIS includes the implementation of a combination of restoration projects that are designed to maximize the benefits to the damaged natural resources in Commencement Bay, and meet the goals and objectives of the Commencement Bay Natural Resource Trustees.

The 1997 Restoration Plan focuses on the 25 square miles of Commencement Bay as its primary restoration area, including the mouths of the Hylebos Creek, Wapato Creek and the Puyallup River. Identified as the primary area where natural resources have been damaged by past releases of hazardous substances, this area is where remediation efforts are focused and ongoing. The 1997 Restoration plan describes the NRDA restoration goals and objectives, including a restoration framework for the Commencement Bay area. The NRDA Trustees have evaluated a number of potential restoration sites in conjunction with the potentially responsible cleanup parties, environmental groups and the public. Broad-based action groups such as Citizens for a Healthy Bay (CHB) and the Commencement Bay Cleanup Action Committee (CBCAC), along with the City of Tacoma and other partners, have developed visions for the Commencement Bay restoration framework and activities. Site screening and selection criteria were developed through this process and over 100 potential restoration sites were evaluated. All SMP restoration activities proposed within the Commencement Bay area should be conducted in coordination with this restoration plan and its framework.

The four main objectives of the CB/NRDA Restoration plan are:

- Provide a functioning and sustainable ecosystem where selected habitats and species of injured fish and wildlife will be enhanced to provide a net gain in habitat function beyond existing conditions;
- Integrate restoration strategies to increase the likelihood of success;
- Coordinate restoration efforts with other planning and regulatory activities to maximize habitat restoration; and
- Involve the public in restoration planning and implementation.

Six specific habitat areas were selected as the areas of focus for the Restoration Plan (NRDA Trustees, 1997). These habitat areas are all within the City of Tacoma's shoreline jurisdiction and include the following:

1. Puyallup River wetlands and riparian corridor;
2. Heads of waterways and river delta;
3. The Hylebos Waterway;
4. The eastern shoreline of Commencement Bay;
5. The western shoreline of Commencement Bay; and
6. Hylebos and Wapato creeks wetlands and riparian corridors.

The Salmon Habitat Protection and Restoration Strategy for WRIA 10 and WRIA 12 also supports efforts that protect and restore intertidal and shallow subtidal habitat throughout Commencement Bay. There are several general protection and restoration measures that can be applied to all of the coastal/nearshore shorelines in Tacoma. These include the following:

- Reduce and minimize shoreline armoring wherever feasible and unnecessary to support water-dependant uses.
- Control point and non-point sources of contamination.
- Restore, enhance, or protect viable habitat that provides connective corridors between riverine and estuarine habitats and between estuarine and open water.
- Allow LWD to remain in the shoreline to provide structure for refuge
- Limit additional bulkheads; promote development of natural shorelines and habitats
- Include the use of shoreline setbacks for new construction and promote shoreline vegetation buffers
- Maintain public access to the shoreline
- Conserve or restore stream mouths
- Protect and restore intertidal and shallow subtidal habitat throughout Commencement Bay to provide rearing habitat for salmonids

In addition to Commencement Bay cleanup and remediation, the City is currently engaged in an Open Space and Habitat Assessment project to evaluate the remaining open spaces and habitat linkages within the city limits as part of the first step in developing a 20-year open space habitat plan. The development of the plan will include the following four goals:

1. Analysis of open space/natural areas,
2. Identification of wetland / habitat mitigation sites,
3. Assessment of agency and community stewardship capacity, and
4. Development of a public-private partnership to implement the plan

In 2007, the City began to evaluate publicly owned open spaces, easements, corridors and other undeveloped habitats for prioritization in a citywide restoration program. The Open Space and Habitat Assessment project is investigating areas both within the shoreline jurisdiction of the City and beyond that jurisdiction in undeveloped upland areas. Tacoma Green Partnership, a public-private partnership between the City of Tacoma, Cascade Land Conservancy, Metro Parks, Tahoma Audubon Society, and numerous organizations, businesses and citizens, is a major participant in the Open Space evaluation. The Partnership is currently conducting fieldwork to evaluate the overall conditions of publicly owned areas of open space. The results of this project will be available in 2008 for inclusion in the Restoration planning element of the City's SMP update.

8.1.3 Site-Specific Conservation and Restoration Opportunities

Based upon the approximately 100 potential restoration sites identified in the 1997 Restoration Plan described above, the City of Tacoma and Citizens for a Healthy Bay developed a comprehensive table of restoration projects in Commencement Bay in 2006 (see Table 8.2 below). This table summarizes completed, on going, and proposed restoration projects within the nearshore and riverine habitats associated with Commencement Bay. The location of the restoration sites is illustrated on Map 8, Appendix A. In addition to the CB NRDA Trustees several agencies and or public entities have undertaken or plan to undertake these restoration activities:

- City of Tacoma
- Foss Waterway Cleanup
- Port of Tacoma
- Puyallup Tribe
- Simpson Tacoma Kraft
- Metro Parks
- Foss Maritime
- Washington State Department of Natural Resources
- Washington State Department of Transportation

- Head of Hylebos Cleanup Group
- Puget Creek Restoration Society
- Asarco
- US Oil

Table 8-2 Commencement Bay Sensitive Habitat Sites (City of Tacoma, October 2006)

Map # (see Map 8)	Name	Size (acres)	Notes
A	**City of Tacoma**		
A.1	Middle Waterway	1.85	NRDA
A.2	Olympic View (includes tidelands)	12.4	NRDA
A.3	Swan Creek	12	NRDA
A.4	Tahoma Salt Marsh	1.95	NRDA
A.5	Hylebos Marsh Alternative Site (future)**	unknown	NRDA - Result of agreements from the Port of Tacoma and NRDA Trustees
A.6	Consumer Central Heating (pocket beach) next to 1147 Dock St.	< 1	Foss Waterway Cleanup
A.7	Esplanade Riparian Area	< 2	Foss Waterway Cleanup
A.8	Berg Scaffolding (pocket beach)	< 1	Foss Waterway Cleanup
A.9	Johnny's Dock (pocket beach)	< 1	Foss Waterway Cleanup
A.10	Puyallup River Side Channel	8.22	Foss Waterway Cleanup
A.11	Bunker Aquatic Habitat	12.12	Foss Waterway Cleanup
A.12	Middle Waterway Tideflat	9.52	Foss Waterway Cleanup
A.13	North Beach Habitat		Foss Waterway Cleanup
A.14	Chinese Reconciliation Park	4.26	City of Tacoma Economic Development effort
A.15	Neo Delta Augmentation		
B	**Port of Tacoma**		
B.1	Clear Creek	11.5	Mitigation
B.2	Fairliner	3	Mitigation
B.3	Gog-le-hi-te	9.5	Mitigation

Map # (see Map 8)	Name	Size (acres)	Notes
B.4	Gog-le-hi-te expansion (2007)	6.22	Mitigation
B.5	Milwaukee	25	Mitigation
B.6	Rhone Poulenc	1.25	Mitigation
B.7	Slip 5	9.37	Mitigation
B.8	Salt Chuck**		Mitigation
B.9	Pioneer Way Prop. By hatchery		Mitigation
C	**NRDA Trustees**		
C.1	Mowitch	3.1	NRDA
C.2	Squally Beach	0.66	NRDA
C.3	Yowkwala	15	NRDA
C.4	Skookum Wulge	1.19	NRDA
C.5	Jordan	15.3	NRDA
C.6	Sha Dadx (future)**	7	NRDA
D	**Puyallup Tribe**		
D.1	Inner Hylebos Mudflats Conservation Site	est. 30	Mitigation
D.2	Hylebos Mouth Mitigation Site	est. 3	Mitigation
E	**Metro Parks**		
E.1	Dickman Mill		Mitigation
E.2	Titlow Pond		
E.3	Thea's Park		
F	**Foss Maritime**		
F.1	Olympic View - Foss	est. .2	GOH
G	**Simpson Tacoma Kraft**		
G.1	St Paul Cap	est. 12	
G.2	Middle Waterway		
H	**Department of Natural Resources**		
H.1	DNR Aquatic Lands-South		
H.2	DNR Aquatic Lands-Middle		
H.3	DNR Aquatic Lands-North		

Map # (see Map 8)	Name	Size (acres)	Notes
H.4	OVRA Triangle restoration**		
I	**Head of Hylebos Cleanup Group**		
I.1	Schnitzer Steel		Mitigation
I.2	J&G Marina		
I.3	Arkema (Atofina)*		
I.4	Dunlop		
I.5	WeyCo.-Kaiser Beach		
J	**WA DOT - Hylebos Creek**		
K	**Milgard - Hylebos Creek**		
L	**Mini (Middle Waterway Action Comm.)**		
M	**Puget Creek Restoration Society**		
M.1	Wood Waste/Eelgrass seeding study		
M.2	Fish ladder to creek		
N	**American Construction**		on Hylebos waterway
O	**US Oil**		near Lincoln Ditch
P	**Asarco**		

* Road access point and may not reflect shoreline/waterside

**Future Site

Restoration sites built and planned are to be developed and maintained in accordance with the restoration framework established by the CB NRDA. Efforts include those activities triggered by remediation, mitigation requirements, and voluntary restoration. Future restoration planning for shorelines within the City will need to be conducted in coordination with the NRDA framework and on-going strategies. The Restoration Plan element of the Shoreline Master Program will be the step within the SMP update process whereby the goals and objectives of future shoreline restoration projects are coordinated with the existing framework.

The City has already completed several restoration actions within the overall NRDA framework. Under the Thea Foss and Wheeler-Osgood Waterways National Resource Damage Assessment (NRDA) Consent Decree signed in 1997, the City committed to construct five restoration sites; each of the five sites is monitored for a respective five-year period. Four of these sites are located in the Nearshore Planning Area and are described below:

- Middle Waterway – 1701 E. F Street (1.85 acres of salt marsh and upland habitat) Restoration was completed in 2000.

- Olympic View – 202 East F Street (12.4 acres of restored shoreline and upland habitat). Restoration was completed in 2002. More than 600 piling, two derelict vessels, and old warehouse, and 11 tons of contaminated soils were removed to create habitat-friendly slopes on the beach. An eelgrass bed just off shore is now protected within the restoration site boundary.

- Tahoma Salt Marsh – 1741 North Schuster Parkway (1.95 acres of salt marsh and upland habitat). Restoration was completed in 2004. Located along the Ruston Way shoreline, these new salt marsh and riparian areas provide salmonid habitat along Commencement Bay's western shoreline.

- The City has completed all of the in-water remediation work (dredging, capping) in the Thea Foss Waterway and has filled the St. Paul Waterway with clean cap material. The other major components of the Thea Foss remediation site package are the Bunker Aquatic Habitat, a 12-acre site; North Beach Habitat, a 7-acre site; Middle Waterway Tideflat Habitat, a 9.4-acre site; Puyallup River Side Channel, a 6-acre site; and the Esplanade Riparian Enhancement and Foss Pocket Beach areas.

The 1997 Commencement Bay restoration plan also identifies the following conservation and restoration opportunities that could be applied at various sites within the marine nearshore:

Waterways

- Remove artificial debris

- Incorporate LWD and rootwads

- Regrade slopes to allow for mudflat and salt marsh establishment

- Restore riparian buffers

- Replace creosote-treated pilings with alternative construction materials

- Use steel grids on decking to minimize shading impacts

- Encourage the use of soft shoreline armoring

Shoreline approaches (Reaches 3 and 7)

- Protect and enhance nearshore margins, including creek cleanup activities

- Place nest boxes

- Reestablish fringing marshes

- Reestablish/establish eelgrass beds

- Reestablish/establish kelp beds
- Enhance intertidal spawning substrate
- Remove derelict creosote pilings along Ruston Way
- Remove fine-scale wood debris from Commencement Bay

Other restoration opportunities in Tacoma's marine shorelines have been identified through the WRIA planning process. One proposed restoration project is the "Outer Hylebos" project, located between the mouth of Hylebos Waterway and Browns Point. The proposed action includes the placement of clean dredged material over an area of approximately 40 acres of DNR bedlands to convert subtidal habitat to intertidal and shallow subtidal habitat. The "Outer Hylebos" project ranked among the top ten most effective actions for recovering Puyallup Chinook, Lower White Chinook, and Upper White Chinook (WRIA 10/12).

WRIA 12 nearshore habitat protection and/or restoration are also a priority because both Nisqually and Puyallup River Chinook and other stocks use this nearshore habitat (Runge et al., 2003). A nearshore habitat assessment for WRIAs 11 and 12 (not including Commencement Bay) has been funded by the Salmon Recovery Funding Board is currently underway, and is anticipated to be complete in 2007.

8.2 Puyallup River

8.2.1 Status of Lower Puyallup River Functions Summary Table

This section summarizes the status of the Lower Puyallup River Planning Area based upon the inventory information, and describes the shoreline functions, the level of alteration compared to historical condition, and the restoration opportunities to improve shoreline conditions (see Table 8-3).

Table 8-3. Assessment of Puyallup River Shoreline Functions within Tacoma

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Habitat: Estuarine habitat; subtidal and intertidal mudflats and salt marshes provide transition habitat between fresh and salt water environments	**High** Physical modifications to the Puyallup delta have changed the spatial mixing of fresh and salt water. The installation of levees and revetments along the Puyallup River has focused the flow of freshwater into Commencement Bay. Changes in flow regime due to upstream diversion and regulation, and changing land uses have modified timing and quantities of freshwater flows.	**Low** The scope of the physical modifications to the system is significant enough to preclude straightforward restoration measures within in the city. Restoration projects, such as Gog-le-hi-te wetlands, have the potential to increase the area over which the fresh to salt water transition occurs. Levee setbacks, wherever feasible, should be considered during preparation of the Restoration Plan.
Hydrology: Channel and floodplain connection	**High** The installation of levees and revetments along the main channel has significantly reduced connections between the channel and the floodplain within the city.	**Low** The City's position at the lowest part of the watershed and the presence of the Port of Tacoma combine to limit the potential for significant re-connection of channel and floodplain in this location.

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Hydrology: Summer low flows	**High** Upstream water diversion and use has resulted in less water flowing through the channel during the summer low-flow period. Ecology has established instream flows for the Puyallup River, with a minimum of 1,000 cfs from September 15 to November 1 (WAC 173-510-030). The recent USGS study found that minimum instream flows are not always achieved, especially during dry years.	**Moderate** The City's position at the lowest part of the watershed limits the potential for modifying summer low flows. The City could partner with regional and/or upstream entities to address minimum instream flows on the Puyallup.
Hydrology: Flood flow retention	**Moderate** As noted above, channel-floodplain interaction is significantly modified, which has the potential to reduce flood flow retention. However, it is unlikely that this landscape position provided significant flood storage in the pre-disturbance condition, given its proximity to Commencement Bay.	**Low** The City's position at the lowest part of the Puyallup watershed limits the potential to provide significant flood storage. The City could partner with regional watershed entities and Pierce County to address the flood storage issue.
Sediment Generation and Transport: Upland sediment generation	**Moderate** Fine sediment loading to the Puyallup River has increased due to build-up and wash-off from urban and industrial land uses.	**Moderate** Implementation and retrofit of water quality BMPs to the existing stormwater system can reduce fine sediment loading.

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Water Quality: Wetland removal of pollutants through sedimentation and adsorption	**High** Reduction in wetland area and channel-floodplain connection has reduced water contact time of water with soil. This lowers the potential for filtering and cycling of pollutants.	**Moderate** Encouraging the restoration of riverine and other wetlands within the contributing basin can increase water contact time with soil.
Water Quality: Delivery, movement, and loss or removal of nutrients, pathogens, and toxicants; storage of phosphorus and removal of nitrogen and toxins through sedimentation and adsorption.	**High** The delivery, transport, and disposition of nutrients, pathogens, and toxins have been significantly altered from the pre-disturbance condition. Upland sources of these pollutants have increased significantly as a result of urban and industrial land uses within and near the shoreline. Potential storage has decreased through wetland loss and installation of impervious surfaces. The development of the TDML for the Lower Puyallup has highlighted potential sources of point-source pollution and flow reduction.	**Moderate** Significant source control and remediation efforts are currently underway to remove and avoid pollutant discharge to the riverine environment. Restoration of riverine/estuarine wetlands can improve the system's ability to provide long-term storage of these pollutants.
Habitat: Shoreline habitat for wildlife; vegetation provides structure for invertebrates, birds, amphibians, reptiles, and mammals.	**High** Most native riparian vegetation has been removed during past river management projects.	**Low** Levee vegetation management standards will generally preclude the restoration of native riparian vegetation communities. However, use of native shrubs may provide limited restoration opportunities.

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Habitat: Source and delivery of LWD	**High** Removal of mature trees from riparian areas, and removal from upstream bridges has significantly reduced the source of LWD to Puyallup River.	**Moderate** The potential to re-introduce LWD, either through planting or placement exists. However, both methods would have to be carefully designed to work within the current river setting and within the existing levee management standards controlled by others (e.g., USACOE).

8.2.1.1 Puyallup River Shoreline Planning Area

Summary of Reach

The Puyallup River Shoreline Planning area or reach includes the regulated Shoreline District S-9 (Puyallup River) and a portion of District S-10 (Port Industrial). Reach scale maps showing existing land use patterns and aerial photography are included in Appendix B. The Puyallup Rive shoreline in Tacoma is highly modified due to a long history of river management practices and intensive shoreline use. The nearshore environment in the Puyallup River Shoreline Planning Area is highly altered, with minimal vegetated areas remaining.

Land use along the Puyallup River shorelines in Tacoma is predominantly port/maritime related industrial. Ownership along the river includes a mix of federal (USACOE), tribal (Puyallup Tribe), and City of Tacoma property. The shoreline of the Puyallup River Shoreline Planning Area is modified throughout. Shoreline modifications include levees throughout as well as large overwater piers and structures that are supported by pilings. Modifications have occurred in order to support water-oriented commercial, industrial, and recreational uses (GeoEngineers, 2004). The long history of intensive industrial and port facility shoreline land use has heavily polluted sediments within the Puyallup River. Significant attention has been focused on remediation and cleanup of pollution within the river.

Extensive mudflat/wetland estuarine areas dominated the historic environment of the Puyallup River delta. The historic river delta was completely reorganized during the creation of the waterways and Port development, thus changing the habitats and processes at the mouth. Despite the extensive level of alteration that has minimized remaining areas of inter- and subtidal habitat, recent mitigation and restoration activity has created some wetland areas along the Puyallup River shoreline. Restoration work has provided habitat, which is available for use by shorebirds, migratory waterfowl, and salmon, all of which are associated with the Puyallup River delta. Documented salmonid use of the Puyallup Delta is extensive, with all of the northwest anadromous species using the area for migratory passage. WDFW Priority Habitats within the Puyallup Shoreline Planning Area include wetland and estuarine areas. Documented wetlands are highly fragmented, and are largely associated with areas that have been recently restored.

Reach Issues

Key management issues within the Puyallup River Shoreline Planning Area include the following:

- The installation of levees and revetments along the Puyallup River have focused the flow of freshwater into Commencement Bay. Levee management standards and practices constrain opportunities for significant replacement or restoration of mature riparian vegetation. Opportunities for levee setback/off-channel habitat and wetland restoration (such as the City's Puyallup River Side Channel Project) should be explored, encouraged, and expanded.

- The Puyallup River provides rearing habitat for Chinook salmon and other salmonids and is designated by the City as a "stream of local significance," with 150-foot buffers established by the City's Critical Areas Preservation Ordinance.

- Existing conditions include a lack of trees and native riparian vegetation along the Puyallup River due to the levees. Native forested habitat should be restored wherever possible behind the levees to improve shading function, provide habitat for wildlife, and allow for large woody debris input to the shoreline areas.

- Reduction in wetland area has reduced water contact time of water with soil. This lowers the potential for filtering and cycling of pollutants.

- The equation for excess nutrients, pathogens, and toxins is significantly altered from the pre-disturbance condition. Sources of these pollutants has increased significantly as a result of urban and industrial land uses near the shoreline. Potential storage has decreased through wetland loss and installation of impervious surfaces.

- Alterations to the shoreline have reduced the extent of wetland and mudflat habitat associated with the Puyallup delta. Wetlands provide important habitat to numerous salmonids, including Puyallup populations of Chinook salmon, as well as shorebirds and migratory waterfowl.

- Fine sediment loading to the Puyallup River has increased due to build-up and wash-off from urban and industrial land uses.

8.2.2 Programmatic Restoration Opportunities

Programmatic restoration opportunities within the mouth of the Lower Puyallup River are discussed in part in the earlier section 8.1.3 as part of the overall Commencement Bay NRDA project. Restoration opportunities specific to the Puyallup River focus on four general topics:

- upland stormwater management and source control;

- addressing water diversion from the White River;

- focusing wetland and stream restoration and enhancement projects, and

- addressing the newly-decertified levees.

Urbanization throughout the Puyallup River's watershed has resulted in increased point and non-point source pollution and changes to the rainfall to runoff characteristics of the system. These changes have resulted in alterations and impairments to hydrologic, sediment generation and transport, water quality, and riparian and in-channel habitat ecosystem functions throughout the Puyallup River ecosystem. Therefore, the first primary programmatic restoration opportunity is to target restoration and enhancement of ecosystem processes throughout the urbanized watershed. In general, these opportunities include the application of Low Impact Development

techniques, retrofitting of BMPs to existing stormwater systems, and bringing attention to the importance of source control.

Low flows within the Lower Puyallup River during the summer months have the potential to negatively impact water quality and in-channel habitat conditions. It appears that the management of water diversions, especially Lake Tapps, plays a significant role to influence flow volumes during the summer. Since the future management of the PSE diversion and Lake Tapps system is uncertain, summer low flows within the White River and Lower Puyallup River should be a consideration during the decision-making process.

The existing CERCLA and NRDA processes within Commencement Bay are resulting in significant resources being focused on the restoration and enhancement of the Puyallup Delta. This presents a significant opportunity for the City of Tacoma to work with other stakeholders to pursue watershed, reach, and site-specific restoration opportunities. Several projects have already been completed, some over five years ago (e.g., Middle Waterway Shore Restoration Project). These existing projects provide an opportunity to learn from past experience and refine restoration techniques.

The decertification of the levees along the lower Puyallup River provides an opportunity to revisit the way that the lower Puyallup River is managed. For the majority of the 20th century, the Puyallup River was managed in a way that resulted in significant alteration to ecological functioning, due in large part to channelization and installation of levees for flood control and land reclamation. As alternatives are sought and investigated to address the decertification of levees, the consideration of watershed and reach scale geomorphic and ecological processes would be beneficial to finding long term solutions that can work with, rather than against, the river.

8.2.3 Site-Specific Conservation and Restoration Opportunities

Limited site-specific conservation and restoration opportunities that are not part of the CERCLA process or within the Puyallup Nation planning process have been identified to date within the Lower Puyallup River. The acquisition and restoration of off-channel estuarine habitat has been identified as a long-term priority within WRIA 10 (Pierce County, 2005).

Previous inventory work has identified several potential restoration sites along the Lower Puyallup (GeoEngineers, 2004). These locations typically focus on undeveloped land along the river corridor. The City of Tacoma has previously teamed with other agencies to restore wetlands and streams along Swan Creek, in the lower Puyallup Watershed. Other site-specific projects underway include the Puyallup River Side Channel and Neo Delta Augmentation projects (Map 8). Conserving and building on these projects should be a priority action.

A study by Simenstad from the Wetland Ecosystem Team (2000) indicates that protection of the “neodelta” forming at the mouth of the Puyallup is an important link to enhancing rearing habitat, especially for juvenile salmonids. The new delta includes mud and sand flats forming offshore near the Simpson Mill area. Restoration options at the mouth of the Puyallup River should include expansion of off-channel restoration areas and connectivity to the “neodelta” for the benefit and recovery of salmonids (Simenstad, 2000).

8.3 Hylebos Creek

This section summarizes the status of the Hylebos Creek Planning Area and describes the shoreline functions, the level of alteration compared to historical condition, and opportunities to restore functions. Table 8-4 summarizes the assessment for the Hylebos.

8.3.1 Status of Hylebos Creek Functions Summary Table

Table 8-4. Assessment of Hylebos Creek Shoreline Functions within Tacoma

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Habitat: Estuarine habitat; subtidal and intertidal mudflats and salt marshes provide transition habitat between fresh and salt water environments.	**High** Physical modifications to mouth of Hylebos Creek have changed spatial mixing patterns of fresh and salt water, generally reducing the area to within the river banks, downstream of Marine View Drive.	**Moderate** As past restoration efforts have shown, the potential exists within a limited area to increase the wetted area of the tidally-influenced portion of Hylebos Creek.
Hydrology: Channel and floodplain connection	**High** The installation of levees and revetments along the main channel has significantly reduced connections between the channel and the floodplain within the City.	**Moderate** The City's position at the lowest part of the Hylebos system and the presence of the Port of Tacoma combine to limit the potential for significant re-connection of channel and floodplain in this location. Where possible, levee setbacks can provide greater wetted width within the City.
Hydrology: Summer low flows	**Moderate** Upstream land use has resulted in less water flowing through the channel during the summer low-flow period.	**Moderate** The City's position at the lowest part of the watershed limits the potential for modifying summer low flows. The City could partner with regional and/or upstream entities to address minimum instream flows.

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Hydrology: Flood flow retention	**Moderate** As noted above, channel-floodplain interaction is significantly modified, which has the potential to reduce flood flow retention. However, it is unlikely that this landscape position provided significant flood storage, given its proximity to the Hylebos Waterway.	**Low** The City's position at the lowest part of the Hylebos system limits the potential to provide significant flood storage.
Sediment Generation and Transport: Upland sediment generation	**Moderate** Fine sediment loading to Hylebos Creek has increased due to build-up and wash-off from urban and industrial land uses.	**Moderate** Implementation and retrofit of water quality BMPs to the existing stormwater system can reduce fine sediment loading. Stormwater quality measures are proposed in the Hylebos basin plan.
Water Quality: Wetland removal of pollutants through sedimentation and adsorption	**High** Reduction in wetland area and channel-floodplain connection has reduced water contact time of water with soil. This lowers the potential for filtering and cycling of pollutants.	**Moderate** Encouraging the restoration of riverine and other wetlands within the contributing basin can increase water contact time with soil.

Process: Function	Level of Alteration	Potential Protection and Restoration Measures and Opportunities
Water Quality: Delivery, movement, and loss or removal of nutrients, pathogens, and toxicants; storage of phosphorus and removal of nitrogen and toxins through sedimentation and adsorption.	**High** The delivery, transport, and disposition of nutrients, pathogens, and toxins have been significantly altered from the pre-disturbance condition. Upland sources of these pollutants have increased significantly as a result of urban and industrial land uses within and near the shoreline. Potential storage has decreased through wetland loss and installation of impervious surfaces. Hylebos Creek is listed as impaired on the 303(d) list for fecal coliform.	**Moderate** Significant source control and remediation efforts are currently underway to remove and avoid pollutant discharge to the riverine environment. Restoration of riverine/estuarine wetlands can improve the system's ability to provide long term storage of these pollutants.
Habitat: Shoreline habitat for wildlife; vegetation provides structure for invertebrates, birds, amphibians, reptiles, and mammals.	**Moderate** Most native riparian vegetation has been removed during past river management projects. Steeper portions of the stream have provided some area for riparian vegetation.	**High** Re-establishment of native riparian plant communities can occur within the City along Hylebos Creek.
Habitat: Source and delivery of LWD	**High** Removal of mature trees from riparian areas has reduced the source of LWD to the lower Hylebos.	**High** The potential exists to add long-term LWD source by re-establishing native riparian forest communities along Hylebos Creek.

8.3.1.1 Hylebos Creek Shoreline Planning Area

Summary of Reach

This reach is located within a portion of District S-10 (Port Industrial). Reach scale maps showing existing land use patterns and aerial photography are included in Appendix B. Process modifications to Hylebos Creek have been extensive. Modifications are primarily associated with rapid and significant urbanization throughout the drainage basin and the conversion of the mouth of the Hylebos into the Hylebos Waterway. Key modifications to riverine processes within Hylebos Creek include:

- Significant increase in flow volume and decrease in time to peak of flows (i.e., precipitation is conveyed to channels more quickly) due to increases in impervious surface and decrease in wetland area;
- Removal of in-channel LWD;
- Removal of floodplain forest and associated wetlands;
- Industrial land uses, including land fills have likely reduced water quality; and
- Filling of tide flats, restricting the estuarine portion of the system to within a constructed waterway.

Extensive mudflat/wetland estuarine areas dominated the historic environment of the Hylebos Creek delta. Despite the extensive level of alteration that has minimized remaining areas of inter- and subtidal habitat, recent mitigation and restoration activity has created some wetland areas along the Hylebos Creek shoreline. Restoration work has provided habitat, which is available for use by shorebirds, migratory waterfowl, and salmon. WDFW Priority Habitats within the Hylebos Creek Shoreline Planning Area include wetland and estuarine areas. Documented wetlands are highly fragmented, and are largely associated with areas that have been recently restored (as documented in Chapter 6).

Reach Issues

Key management issues in the Hylebos Creek Shoreline Planning Area include the following:

- Reduction in wetland area has reduced water contact time of water with soil. This lowers the potential for filtering and cycling of pollutants. Off-channel wetland restoration should be explored and encouraged wherever possible.

- Hylebos Creek provides rearing habitat for Chinook salmon and other salmonids and is designated by the City as a “stream of local significance,” with 150-foot buffers established by the City’s Critical Areas Preservation Ordinance.

- The equation for excess nutrients, pathogens, and toxins is significantly altered from the pre-disturbance condition. Sources of these pollutants have increased significantly as a result of urban and industrial land uses near the shoreline. Potential storage has decreased through wetland loss and installation of impervious surfaces.

- Most native riparian vegetation has been removed during past river management projects. Steeper portions of the stream have retained some riparian vegetation. Restoration and enhancement of riparian vegetation should be encouraged, particularly upstream of the industrial waterways.

8.3.2 Programmatic Restoration Opportunities

Programmatic Restoration Opportunities for Hylebos Creek can be synthesized from the Salmon Limiting Factors Report for WRIA 10:

- Target re-establishment and restoration of riverine wetlands and river-floodplain connections;
- Update stormwater management techniques to buffer the impact of urbanization;
- Enhance riparian habitat;
- Address point and non-point source sources of pollutants; and
- Address sediment loading, especially within the East Fork (Kerwin, 1999).

8.3.3 Site-Specific Conservation and Restoration Opportunities

Numerous restoration and enhancement projects have been accomplished throughout the Hylebos Creek watershed under the auspices of the CERCLA process, and due to the efforts of local watershed restoration groups (e.g., Friends of the Hylebos) and municipalities.

Previous inventory work has identified three potential restoration opportunities within the portion of Hylebos Creek within the City (GeoEngineers, 2004). These areas typically focus on undeveloped land along the creek. Significant restoration work that has been completed includes the Mowitch off-channel/wetland restoration project, located downstream of Marine View Drive. The Hylebos Marsh Alternative Site, upstream of Marine View Drive, has been identified by the City as a future project (Map 8). This project will create and preserve aquatic habitat and wetlands for local Coho, Chinook, and chum salmon. Other restoration activities will include removing non-native, invasive species and replanting with native vegetation. Restoration is expected to be completed in 2007.

8.4 Wapato Lake

This section summarizes the status of the Wapato Lake Planning Area and describes the shoreline functions, the level of alteration compared to historical condition, and opportunities for restoration. Table 8-5 summarizes the functional assessment for Wapato Lake.

8.4.1 Status of Wapato Lake Functions Summary Table

Table 8-5. Assessment of Wapato Lake Shoreline Functions within Tacoma

Process: Function	Level of Alteration	Restoration Potential/Opportunities
Hydrology: Water storage	**Moderate** Modifications to the Lake have resulted in additional runoff being directed toward the lake. An artificial outlet has been added, leading to Ward's Lake and the Flett Creek holding ponds. In the predisturbance condition, the Lake would have likely provided storage of water from large runoff events, allowing for infiltration into the shallow aquifer. Artificial connections have changed the way the lake functions during significant runoff.	**Moderate** The changes to the hydrology of the Lake may also provide future restoration potential. Hydrology of the lake system could be managed as part of a basin plan to continue to provide important water storage functioning. Management could include installation of additional controls and/or structures to achieve a lake hydroperiod that functions within the current land use setting.
Sediment Generation and Transport: Sediment Sink	**Low** While sediment loading to the Lake has increased, the lack of an outlet stream allows the lake to continue to function to retain sediment. Some suspended sediment may be routed to Ward's Lake and Flett Holding Ponds, but the lake has been reconfigured to retain most sediment in the upper portion.	**Moderate** Implementation and retrofit of water quality BMPs to the existing stormwater system can reduce sediment loading to the lake.

Process: Function	Level of Alteration	Restoration Potential/Opportunities
Water Quality: Maintain trophic level	**High** Increases in sediment, nutrient, pathogen, and other pollutants have accelerated eutrophication and changed the tropic level of Wapato Lake. This change is reflected in the closure of the lake to swimming; and limitations on fishing.	**Moderate** Restoration of water quality of Wapato Lake will require some source control and treatment throughout the contributing basin. Implementation and retrofit of water quality BMPs to the existing stormwater system can reduce pollutant loading to the lake. Target the restoration of wetlands in the drainage paths from upland land uses to the lake.
Habitat: Shoreline habitat for wildlife; vegetation provides structure for invertebrates, birds, amphibians, reptiles, and mammals.	**High** Native vegetation from around the lake has been removed during the development of the park and other elements surrounding the lake.	**Moderate** Re-establishment of native plant communities can occur around Wapato Lake. This effort will have to be coordinated and balanced with the continued Public Access to the lake via the park.
Habitat: Source and delivery of LWD	**High** Removal of mature trees from around the lake has reduced the source of LWD.	**High** The potential exists to add long-term LWD source by re-establishing native forest communities around the lake.
Habitat: Connection between upland and aquatic habitats	**Moderate** Development of the park and the contributing basin has reduced the quality of the connection between Wapato Lake and its surrounding uplands. Primary disruptions include: artificial bank hardening, vegetation removal, installation of impervious surfaces, and buildings	**Low** The restoration potential for connecting the lake to surrounding habitats is limited by the surrounding development. There may be areas were corridors may be preserved and/or enhanced.

8.4.1.1 Wapato Lake Shoreline Planning Area

Summary of Reach

Wapato Lake is in the regulated Shoreline District S-14. Wapato Lake is made up of three hydrologically connected waterbodies. The northernmost waterbody is essentially a large wetland complex with an open water portion. The upper waterbody opens up into a larger middle waterbody with wetlands surrounding the fringe. The lower waterbody constitutes the main lake area and contains the majority of development, which is primarily restricted to Wapato Park and its amenities.

Land use and development surrounding Wapato Lake have resulted in shoreline modifications including the placement of bulkheads, overwater structures, and removal of forested vegetation and other alterations. With much of the area surrounding Wapato Lake being designated as a City-Metro park, development other than that for the park has been limited. Urban residential and commercial development and a major transportation facilities (including I-5) surround Wapato Lake on all sides, which effectively isolate Wapato Lake from other natural areas.

The lake does not contain any WDFW noted Priority Habitats, however does support resident fishes and a large concentration of waterfowl. Wapato Lake is considered a "wetland of local importance" under the City's Critical Areas Preservation Ordinance.

Reach Issues

Key management issues within the Wapato Lake Shoreline Planning Area include the following:

- Modifications to the Lake have resulted in additional runoff being directed toward the lake. An artificial outlet has been added, leading to Ward's Lake and the Flett Creek holding ponds.

- While sediment loading to the Lake has increased, the lack of an outlet stream allows the lake to continue to function to retain sediment.

- Increases in sediment, nutrient, pathogen, and other pollutants have accelerated eutrophication and changed the tropic level of Wapato Lake. This change has resulted in degradation of the lake's water quality, which is reflected in the closure of the lake to swimming, and limitations on fishing.

- Development of the park and the contributing basin has reduced the quality of the connection between Wapato Lake and its surrounding uplands. Primary disruptions include: artificial bank hardening, vegetation removal, installation of impervious surfaces, and buildings

- Metropolitan Parks is currently engaged in a study of Wapato Lake to improve water quality and overall habitat. Recommendations from this study should be integrated into the City's shoreline restoration plan.

8.4.2 Programmatic Restoration Opportunities

There are several general protection and restoration measures that can be applied to all of the impairments discussed above. These include the following:

8.4.2.1 Protection Opportunities

- Protect and maintain existing wetlands and riparian vegetation
- Protect existing forested areas in the park and along the shoreline
- Minimize encroachment on functional riparian and wetland habitat
- Educate property owners on the importance of the nearshore zone and general lakeside stewardship practices
- Promote development of in-water structure such as downed trees
- Limit shoreline modifications
- Limit additional bulkheads; promote development of natural shorelines and habitats
- Include the use of shoreline setbacks for new construction and promote shoreline vegetation buffers

Maintain public access to the lakes, but restrict water access to centralized locations to prevent further shoreline erosion.

8.4.2.2 Restoration Opportunities

- Restore in-water habitats and improve water quality by improving the quality of surface waters draining to the lake
- Restore nearshore structure or develop buffer zones where possible
- Expand buffer zones or improve buffer quality around wetlands where possible
- Highlight locations for effective stormwater retrofitting

8.4.3 Wapato Lake Site-Specific Restoration Opportunities

As described in Chapter 7, Tacoma-Pierce County Health Department (TPCHD) and Metro Parks are currently undertaking a comprehensive water quality study of Wapato Lake. It is expected that restoration opportunities related to lake water quality will be developed based on the results of this study. Preliminary results presented to Metro Parks indicate that treatment with alum may be required to improve water quality without disturbing lake sediments.

The lake enhancement recommendations presented in the Wapato Park Master Plan should be supported with some modifications. Existing bulkheads could be replaced with bioengineered shore protection and bioengineered shore protection could be used instead of riprap to protect areas along the south and western edges of the lake that are experiencing excessive erosion.

Although the park is large for this size lake, little nearshore vegetation remains in the lower section of the lake. Sections could be restored and used as educational demonstrations for other property owners. Habitat complexity could be improved by providing large woody debris into the lake.

An aeration fountain could be used to increase circulation and dissolved oxygen levels as discussed in the Wapato Park Master Plan; however, the placement of this structure should be adequate enough to provide benefits to the entire portion of the lower lake.

It is not yet known what is causing the majority of the water quality problems within Wapato Lake, but the shallowness of the lake exacerbates these problems by encouraging plant and algal growth. Although cost-prohibitive, dredging out the lake (in places) to an appropriate depth and periodically providing maintenance dredging would reduce sediment buildup and aquatic vegetation growth within the lake. Recent news indicates that sewage from the Tacoma Mall may have accidentally been directed through the stormwater system to Wapato Lake, and the faulty connection has now been fixed (The News Tribune, June 16, 2007).

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9.0 DATA GAPS

This section describes specific data gaps or limitations identified during development of the shoreline inventory and characterization as required by Ecology's guidelines (WAC 173-26-201(3)(c)(viii)). This list should not be considered exhaustive. As additional information is developed, it may be instructive as the City considers future updates and amendments to its Shoreline Master Program.

Urban Growth Areas: The City's existing shoreline and critical areas inventory and mapping work (GeoEngineers, 2004) did not include shorelines of the state in Tacoma's designated Urban Growth Areas (UGAs). The City has indicated that annexations over the next ten to twenty years would likely be focused in the Browns Point-Dash Point UGA. This area includes approximately 3 miles of marine shoreline in Commencement Bay and Puget Sound. This area has been addressed in this draft, but does not have the same level of background available data as other marine shoreline reaches.

Floodplain Mapping: Accurate mapping of flood hazard areas is important to minimize potential harm to human life and protect property. Since the location of the floodplain is integral to the definition of the City's shoreline management jurisdiction and planning area, accurate mapping is also critical to the City's SMP. FEMA is remapping flood hazard areas for the Puyallup River in the City's shoreline planning area (NHC, 2005). This mapping has been incorporated in this report (Map 2), but has not yet been adopted or approved by FEMA for flood insurance purposes. Coordinating with FEMA and Pierce County to understand how flood hazard areas may have changed since the last published FIRM mapping would enhance the City's understanding of baseline conditions as it continues to update its SMP.

Archaeological Resources: This inventory references data on file with the Washington Department of Archaeology and Historic Preservation for recorded archaeological sites and for properties listed on state or national historic registers. This inventory does not include development of a "probability model" for assessing potential archaeological resources in the shoreline. However, the State Department of Archaeology and Historic Preservation recently completed a GIS-based predictive model for archaeological resources in the Hood Canal region. The model covers much of the Puget Lowlands in south Puget Sound, including all of the City of Tacoma. Use of this resource may assist with permitting and development review during administration of the City's SMP and other land use regulations.

Stormwater Planning: This inventory does not describe whether the City has a comprehensive approach or planning objectives for long-term capital improvements to stormwater management and treatment.

Shoreline and Nearshore Ecological Habitat Evaluation: The South Puget Sound Salmon Enhancement Group is in the process of conducting a field based (by boat) nearshore habitat assessment of shorelines in Pierce County and Tacoma with funding assistance from the Salmon Recovery Funding Board. This nearshore habitat assessment data should be available sometime in 2007. Similar information related to nearshore habitat assessments of Commencement Bay is not available for WRIA 10.

Geology Mapping: The USGS and University of Washington are in the process of updating quadrangle mapping of geology at 1:24,000 scale in the Puget Sound region. The geology mapping shown on Map 3 is a draft work product of this effort, and is currently in review at USGS. Final mapping should be incorporated when available.

Restoration and Remediation: A great deal of work has been done and is ongoing related to habitat restoration and toxic hazard remediation in Commencement Bay and the lower Puyallup River. Some of these efforts are documented in this report but an integrated assessment of activities to date and potential opportunities would be best accomplished during Phase 2 work, with development of a Shoreline Restoration Planning Element of the SMP.

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