CITY OF FIFE
SHORELINE MASTER PROGRAM UPDATE

INVENTORY AND CHARACTERIZATION

PREPARED FOR:

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1 All figures are located at the end of the document for easy reference. In some instances, some figures are also inserted into the body of document to provide further clarification of the text (e.g. the location of a reach). Page numbers are provided in this table for those figures that are incorporated into the body of the document.
INTRODUCTION

This report is intended to provide baseline information on the existing ecosystem processes and shoreline functions occurring within the City of Fife’s (City) shoreline jurisdiction (Figures 1, 1A and 1B) to provide a basis for the update of the City’s Shoreline Master Program (SMP). The City of Fife Urban Growth Areas (UGAs) are not included in this study as the City does not anticipate the annexation of these areas before the next shoreline master program update is scheduled to occur. City staff did confer with the adjacent jurisdiction, Pierce County, to ensure these areas were reviewed within the County Inventory and Analysis Document and that the results of that document corresponded to the findings as outlined in this document. This document utilizes the information resources identified in the Shoreline Inventory, submitted to the Washington State Department of Ecology (Ecology) in June 2010 as part of the SMP update. This document describes larger-scale (i.e., watershed) physical and biological processes occurring in the City’s shoreline jurisdiction as well as specific shoreline functions based on a shoreline reach analysis. Finally, this report analyzes opportunities for shoreline protection and restoration, as well as public access and shoreline uses, and provides information on specific data gaps or limitations that were identified during the analysis and characterization process as well as recommendations as to how those data gaps should be addressed.

1.1 STUDY AREA BOUNDARY

The City of Fife, which is 5.7 square miles in area, is located to the southeast of the City of Tacoma and to the west of the City of Milton and is located in the Puyallup River floodplain near the head of Commencement Bay in north Pierce County. Figure 2 shows an aerial view of the City and surrounding areas. The estimated 2009 population was 7,810. The shoreline within the City of Fife is approximately 6.13 miles long.

Two water bodies within the City are regulated under the State Shoreline Management Act (SMA). The Puyallup River is listed as such under the Washington State Administrative Code (WAC 173-18-310). Hylebos Creek is not on this list, but does meet the flow requirements for SMA regulation in the City as well as in the neighboring City of Milton.

This study focuses on the water bodies inside the City, including associated wetlands and the shore lands within 200 feet upland of the Puyallup River and Hylebos Creek. Consistent with the Shoreline Management Act, the study area includes the aquatic area, the edge of the water body as defined as the ordinary high water mark (OHWM) and shorelands within 200 feet upland of the OHWM (Figures 1, 1A, and 1B).

The Puyallup River waterward of the OHWM is under the sole jurisdictions of the Puyallup Tribe of Indians. Refer to Figure 7. In addition, the Sha Dadx wetland area and the hydrologic connection between the Oxbow wetland and the Puyallup River as well as the surrounding upland areas for both wetlands, are also under the jurisdiction of the Puyallup Tribe of Indians. Pursuant to RCW 37.12.060,

*Nothing in this chapter shall authorize the alienation, encumbrance, or taxation of any real or personal property, including water rights and tidelands, belonging to any Indian or any Indian tribe, band, or community that is held in trust by the United States.*
or is subject to a restriction against alienation imposed by the United States; or shall authorize regulation of the use of such property in a manner inconsistent with any federal treaty, agreement, or statute or with any regulation made pursuant thereto; or shall confer jurisdiction upon the state to adjudicate, in probate proceedings or otherwise, the ownership or right to possession of such property or any interest therein; or shall deprive any Indian or any Indian tribe, band, or community of any right, privilege, or immunity afforded under federal treaty, agreement, statute, or executive order with respect to Indian land grants, hunting, trapping, or fishing or the control, licensing, or regulation thereof.

The baseline analysis provided by this document includes all shorelines within City limits including those areas that are under the jurisdiction of the Puyallup Tribe of Indians. However further Shoreline Master Program Update tasks, including but not limited to policy and regulation development will be conducted in such a manner as to maintain compliance with both those laws and rules defining the Shoreline Management Update process as well as those laws and rules defining tribal jurisdiction.

1.2 METHODOLOGY

As noted in the introduction, the purpose of this document is to provide baseline information regarding City shorelines in order to inform the SMP update. It is intended to integrate information from a number of existing sources in order to address the requirements of the Shoreline Management Act (SMA) and to identify gaps for which existing information is not available. It relies heavily on adaptation of existing information and analyses of City shorelines. New data gathering and extensive re-analysis of existing data is not a requirement of the SMP update process and is therefore outside of the scope of the City’s SMP update.

This document addresses City shorelines at two different spatial scales: ecosystem/regional and reach. Regional information is largely in narrative form and comes from documents addressing conditions at Water Resource Inventory Area (WRIA), County, watershed, or basin level. All of the documents and other resources used for the characterization process are identified within the Inventory (Appendix A). Some of the sources from which regional-scale information were drawn include:

- *Salmon Habitat Limiting Factors Report for the Puyallup River Basin (Water Resource Inventory Area 10)* (Kerwin 1999)
- *City of Fife Draft Comprehensive Plan* (City of Fife 2005)
- *Draft City of Fife Shoreline Inventory* (Grette Associates 2004)

Reach scale information is largely based on review of geospatial data available in map format from the City and Pierce County. The geospatial data layers available to be utilized for reach review are summarized in the Shoreline Inventory (Appendix A). Additionally, aerial photos,
site visits, and institutional knowledge within the City all were used to supplement information at the reach scale.

In order to best use limited grant resources, this Inventory and Characterization is focused on reach-scale analysis of conditions and opportunities within the City shorelines. Regional information is presented within the context of City shorelines where it is available from the sources listed above, but will not be the sole source of information used by the City during the SMP update process. Pierce County completed an Inventory and Analysis of the jurisdictional shoreline area in 2009 as part of their SMP update process which was also used as a reference for this document. Additionally, Ecology is preparing analyses of watershed processes for Puget Sound shorelines that will become available in 2010. The City intends to supplement the regional information provided herein with County and Ecology information as it becomes available during the SMP update process.

1.3 REPORT ORGANIZATION

This report is organized to correlate with requirements of Shoreline Management Act (SMA), Revised Code of Washington (RCW) 90.58, and its implementing guidelines in Washington Administrative Code (WAC) 173-26. It is intended to review large-scale information, and scale down sequentially to smaller reaches (reaches defined below in Section 1.4). This approach combines the requirement outlined in WAC 173-26-201(3)(d), Ecology’s draft SMP Handbook Chapter 7 Shoreline Inventory and Characterization (Ecology 2009), and Ecology’s guidance document Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes (Stanley et al. 2005).

1.4 SHORELINE REACHES

During the inventory process, the City of Fife divided the shoreline into a number of lineal segments according to environmental characteristics (e.g., significant wetlands, undeveloped habitat) and land use (e.g., zoning, existing and planned future land use) (Table 1, Figures 2, 2A and 2B). In some instances, study segments can also be identified according to the City of Fife street systems (e.g., from 4th Street East to 12th Street East along the Hylebos). However the street systems were only utilized in instances where a change in environmental characteristics, land use, or zoning was also present. For example, it was not possible to correlate a segment break to the street system for Puyallup Reach 2 (P2), which is primarily comprised of remnant oxbow of the Puyallup River that now functions as a large, wetland complex with a hydrologic connection to the River but also contains a smaller restored wetland habitat area identified as Sha Dadx (formerly the “Frank Albert Road Wetland”) (Section 4.2).
Table 1. Shoreline inventory reaches in the City of Fife.

<table>
<thead>
<tr>
<th>Study Segment (Reach)</th>
<th>Location</th>
<th>Description</th>
<th>Approx. Length (ft)</th>
<th>River Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Puyallup</td>
<td>1-5 Bridge (West City Limit) upstream to the hydrological connection to the Oxbow wetland upstream of 54th Ave</td>
<td>13,150</td>
<td>2.4 - 4.9</td>
</tr>
<tr>
<td>P2</td>
<td>Puyallup</td>
<td>Oxbow wetland, hydrological connection to Oxbow wetland, Sha Dadx wetland</td>
<td>Associated wetland (63 acres)</td>
<td>4.9</td>
</tr>
<tr>
<td>P3</td>
<td>Puyallup</td>
<td>Upstream edge of the hydrological connection to the Oxbow wetland to Freeman Rd (southeast city limit)</td>
<td>9,840</td>
<td>4.9-6.8</td>
</tr>
<tr>
<td>H1</td>
<td>Hylebos</td>
<td>Fife City limit (north, co-terminus of 57th and 55th Ave E) upstream to 4th St E, both banks</td>
<td>1,650</td>
<td>0.3-0.6</td>
</tr>
<tr>
<td>H2</td>
<td>Hylebos</td>
<td>4th St E upstream to 12th St E; both banks</td>
<td>3,335</td>
<td>0.6-1.3</td>
</tr>
<tr>
<td>H3</td>
<td>Hylebos</td>
<td>12th St E upstream to 70th; both banks,</td>
<td>4,380</td>
<td>1.3-2.1</td>
</tr>
</tbody>
</table>
FIGURE 2B
Study Segments - Puyallup Segment
Fife Shoreline Master Plan
Fife, WA
Note: Text within this Characterization, specifically for those reaches associated with Hylebos Creek, refers to left and right stream banks. This refers to bank orientation when facing upstream.

Diagram 1. Left and Right bank designations for various flow scenarios.
2 ECOSYSTEM CONTEXT

The City of Fife is located in the Puyallup River floodplain near the head of Commencement Bay in north Pierce County and is bordered by the Puyallup River to the south. The land was historically used by the Puyallup Indian Tribe and was included in its Reservation Lands within the 1856 amendments to the Medicine Creek Treaty. Just over a century later, in 1957, the City of Fife was incorporated and has been expanded periodically since that time. However, a significant portion of the City is still owned by the Tribe (Figure 7). The City’s present corporate limits and urban growth area are shown in Figure 1.

As noted in the introductory text of this document, the City of Fife contains two water bodies that are regulated under the State Shoreline Management Act. These two water bodies are the Puyallup River and Hylebos Creek. In order to place the jurisdictional riparian shorelines of the City of Fife within an ecosystem context, the following subsections describe the natural and development characteristics of the larger watershed.

2.1 WATERSHED NATURAL CHARACTERISTICS

The City of Fife is located entirely within the within the Puyallup Water Resource Inventory Area (WRIA 10). WRIA 10 is approximately 1,065 square miles (673,133 acres) in size and contains over 728 miles of rivers and streams that flow over 1,287 linear miles. WRIA 10 is located in both King and Pierce County jurisdictions. However, the majority of the WRIA is located within Pierce County jurisdiction. As such, the densest areas of population within this WRIA are located in Pierce County and include cities of Tacoma, Puyallup and Fife. The Puyallup River basin was one of the first watersheds in the Puget Sound to experience the full impacts of industrial, urban, and agricultural development (Kerwin 1999). As such, habitat and other watershed characteristics within WRIA 10 have been negatively impacted.

The major water systems within WRIA 10 include the White, Carbon and Puyallup Rivers. The Puyallup River is the largest drainage in WRIA 10. Pursuant to WAC 173-18-310, the Puyallup River is a shoreline of statewide significance. The Puyallup River is approximately 45 miles long. Its headwaters are the glaciers located on the western side of Mount Rainier and its mouth is at Commencement Bay. The Carbon and White Rivers flow into the Puyallup River upstream of the City of Fife. The City of Fife is located along River Miles 2.4 and 6.8 of the Puyallup River.

The Salmon Habitat Limiting Factors Report for the Puyallup River Basin (WRIA 10) separates the basin into six subbasins as follows: (1) Commencement Bay and Puget Sound Nearshore, (2) Lower Puyallup (RM 0.0 to 41.7), (3) Upper Puyallup (RM 41.7 to headwaters), (4) Carbon River, (5) White River, (6) Independent Tributaries to Puget Sound (including Hylebos Creek) (Kerwin 1999). Of those six subbasins, the City of Fife contains portions of both the Lower Puyallup River subbasin and the Hylebos Creek subbasin².

² The Pierce County Surface Water Management website refers to Lower Puyallup River and Hylebos Creek Watersheds. Although a map overlay analysis was not completed as part of this report, the area identified as...
Lower Puyallup subbasin

The Lower Puyallup subbasin is comprised of the downstream portion of the Puyallup River and begins below the confluence of the White River adjacent to the City of Puyallup (RM 0.0 to 41.7).

The Puyallup River channel within this subbasin has been modified utilizing dikes, revetments, and levees along both banks downstream of RM 28.6 to Commencement Bay. The placement of these water flow modifications has straightened and confined the river to an active channel width of approximately 130 feet and the resulting habitat is simplified throughout the subbasin (Kerwin 1999).

Hylebos Creek subbasin

The Hylebos Creek subbasin is comprised of the extent of the Hylebos Creek and drains approximately 18,300 acres and is connected to 25 miles of streams, 11 named lakes, and wetlands (Kerwin 1999). The Creek originates from Lake Geneva and Lake Killarney about four miles north and east of the City of Milton. The City of Fife is located along River Miles 0.3 and 2.1 of Hylebos Creek.

Hylebos Creek is thought to have been one of the most productive small stream systems in southern Puget Sound. However, due to the altered state of the creek, salmonid production is greatly reduced (Kerwin 1999). Alteration for this subbasin includes residential development, areas of channelization, modification/reduction/removal of adjacent wetlands, erosion and frequent flooding.

The City’s location near the terminus of the subbasin for both the Puyallup River and Hylebos Creek makes its shorelines susceptible to influence from conditions and practices in the rest of the basin. The level of development in both subbasins, particularly in the Hylebos basin, has resulted in very high road density as well as other impervious areas (e.g., parking lots, buildings). In addition to development, forestry and hydrology management (dams, diversions, and other forms of flood control) have also impacted the condition of watershed functions and processes for both subbasins.

2.1.1 Precipitation

WRIA and Pierce County based climate and precipitation information is discussed in a number of documents (Kerwin 1999, ESA Adolphson 2007). As is general for Western Washington area, Pierce County and the City of Fife typically experience a relatively long, mild wet season spanning fall to spring and a short, cool, dry season during the summer. In this area, the majority of rainfall occurs from November through April.
Average City temperatures are in the 60’s in the summer and in the 40’s during the winter. The warmest month of the year for the City is August with an average maximum temperature of 78.40 degrees Fahrenheit. The coldest month of the year for the City is January with an average minimum temperature of 32.90 degrees Fahrenheit.

The annual average precipitation at Fife is between 35 to 55 inches per year (City of Fife 2002). Winter months tend to be wetter than summer months. November is generally the wettest month of the year, with an average rainfall of 6.11 inches.

2.1.2 Vegetation

The primary source of information regarding vegetation within WRIA 10 is the Salmon Habitat Limiting Factors Report for the Puyallup River Basin (Kerwin 1999). This document indicates that vegetation within this WRIA is generally subject to vegetation-related stressors including urbanization, agricultural uses, riparian fragmentation, floodplain modifications, and increased amounts of impervious surface. General information on the vegetation within the Lower Puyallup River and Hylebos Creek subbasins is summarized from the Limiting factors report in the following text:

Lower Puyallup River subbasin

Historic records of the Puyallup River indicate that coniferous riparian habitat was present along the lower mainstem of the River. However, the construction of revetments and levees along the lower river has resulted in substantial modification to riparian vegetation including the elimination of connectivity to side and off channel habitat. Maintenance of the levees often eliminates adjacent vegetation and eliminates sources of LWD (See also Section 3.6 of this document). Remaining habitat is fragmented and only 5% of the mainstem of the Puyallup contains high quality habitat (Kerwin 1999). No areas of high quality habitat directly adjacent to the OHWM of the Puyallup River are located within the City. Development of the levee, roads, residences, parks, commercial and industrial uses have all altered shoreline vegetation presence and cover. Invasive species, including Himalayan blackberry (Rubus armeniacus) and Reed Canary Grass (Phalaris arundinacea) are present in many disturbed areas.

Hylebos Creek subbasin

Historic land use surveys of the Hylebos subbasin depict the area as containing coniferous forests interspersed with frequent disturbance (burning). Recent growth in this area has resulted in the replacement of habitat areas with urban, residential and industrial areas. Pierce County estimates that the range of impervious surface within the Hylebos Creek basin ranges from 2 to 53 percent. Degradation of aquatic processes and functions is observable when impervious surfaces reach 10 percent (Booth 1997). However, further studies indicate that impervious surfaces should not exceed 5% if high quality ecosystems associate with Puget Sound lowland streams are to be retained.
2.1.3 Surficial Geology and Soils

Soils information was primarily derived from the Soil Survey of Pierce County Area, Washington (Zulauf 1979). The soils of Pierce County formed mainly in glacial drift deposited by the most recent several continent-sized glacial ice sheets. This 3,000-foot thick glacier, emanating from Canada, formed most of the topography and waterways of the area between 13,000 and 15,000 years ago. The predominant deposit, and therefore parent soil material, is glacial till. It generally consists of compact basal till covered by a thin discontinuous layer of ablation till that was deposited during glacial retreat.

After the glacial retreat, the Puget Sound waters extended into the Puyallup and Lower White River valleys and layers of silt and clay accumulated in the associated estuaries. The present location of the Puget Sound in relation to the general location of the Puyallup and White rivers within the ecosystem results from a combination of Mount Rainier lahars and fluvial deposition.

The predominant soils in Fife are the Sultan, Briscot, Puyallup, and Pilchuck series. Each of these series is formed in alluvium and is likely to have resulted from the lahars and fluvial deposition described above. These soils range from poorly drained to moderately well drained (Zulauf 1979).

2.1.4 Topography

The City of Fife lies within an abandoned floodplain from the Puyallup River that is located on top of a previous mudflow from Mount Rainier. The amount of gradient (vertical drop) from one end of the City to the other is only a few feet (City of Fife 2002).

2.2 Land Use

2.2.1 Historic

Historically, the area north of Interstate 5 was emergent tidal marsh land, while the area south was a combination of freshwater wetlands and uplands. During the late 1800s much of the area was used for agriculture, requiring ditching and draining of both tidal and freshwater wetlands. In 1874, the first railroad was constructed across the head of Commencement Bay, waterward of the area that is now Fife, thereby initiating the conversion of the Bay’s tideflats to a highly urbanized seaport. This conversion, in combination with flood control efforts made in the wake of the 1906 diversion of the White River into the Puyallup (made permanent by the Corps in 1914), resulted in channel hardening at the mouths of both the Puyallup and the Hylebos. Levees were constructed along much of the lower Puyallup, including the reach that defines the south edge of the City.

During the early and mid 20th century, agriculture continued to be a primary land use in the area that is now Fife. However as the Port of Tacoma facilities expanded during the mid and late part of the century, land use began to shift toward industry and commercial uses. These have included regionally significant trade and commerce, and also commercial uses that benefit from visibility on the Interstate 5 corridor. The City’s Comprehensive Plan (2005) recognizes the ultimate
conversion of agricultural lands to other urban uses by designating them with traditional urban designations (e.g., residential, commercial, industrial, etc.).

The City has a limited series of historic aerial photos that are more than twenty years old. There is a single image of the City with limits taken in 1984 (print, color, 1:4,800), images of different parts within the City from 1978 that include some of the Puyallup River and all of Hylebos Creek within the City (print, black and white, 1:4,800), and some undated images taken as a single series including some of the Puyallup River (print, black and white, 1:2,400). The undated series pre-dates 1978.

These aerial photos clearly demonstrate the development of commercial, industrial, and residential areas in the City. Even in 1984, there remained large tracts of agriculture in areas that have since been developed. However, changes in shoreline areas have been significantly lower in magnitude that those along the Interstate 5 corridor. In some cases, access has been restricted since the beginning of the photographic record. The north end of Levee Road was at one time open to all vehicle traffic, and there were two active roads, Berens and Ferguson Roads, where road beds still exist.

The same is true on Hylebos Creek, where there was greater vehicular access and activity on the left bank between 4th and 8th Streets East from an old gravel mine, and included clearing within the shoreline area. With the exception of some commercial and industrial development (e.g., near Frank Albert Road East and 70th Avenue East on the Puyallup River, and near Pacific Highway on the Hylebos), shoreline land use has either remained relatively constant or been reduced according to the photographic record.

2.2.2 Current

Existing land use designations in the City include residential, commercial/service, education, public facilities, industrial, utilities, open space/recreation, resource land and vacant. Developable vacant land comprises a considerable portion of the area within the City. Commercial and industrial uses are also common in the City.

Existing land use practices on these shorelines were observed using aerial photos, field visits, and review of City GIS data. On the Puyallup River, waterward of Levee Road, the entire shoreline is comprised of the Puyallup River Levee, which is not developable. There are some areas of trees or shrubby vegetation, but not enough to characterize it as forested. Shoreline jurisdiction extends landward of the levee, and includes Levee Road and a narrow strip of adjacent land.

Most of the shore lands downstream of Frank Albert Road are vacant and have been cleared or otherwise used for agriculture. There are scattered residences with access from the road whose property extends into the shoreline jurisdiction. Upstream of Frank Albert Road to 70th Avenue East most of the land has been cleared and much of it has been subdivided into single-family residential properties. At 56th Avenue East there is a small group of houses with frontage on Levee Road whose properties extend into the shoreline jurisdiction. Land use in the area immediately adjacent to 70th Avenue East includes commercial (dumpster storage) and medium-
density residential (mobile homes and single family). The remainder of the Puyallup River shoreline along Levee Road is being utilized for agriculture. However, current and future zoning designations for the City have zoned this land for residential and commercial uses.

Approximately one-quarter mile southeast of 54th Avenue East is the hydrological connection between the Puyallup River and the Oxbow Wetland. Because of this connection, the wetland is included in the shoreline jurisdiction. The Puyallup Tribe of Indians has a considerable interest in biological and cultural integrity of the Oxbow Wetland. Most of the area adjacent to the wetland was cleared and used for agriculture in the recent past. Multiple residential subdivisions now surround this wetland.

Along the Hylebos, most of the land is developed as single family residential dwelling units or is vacant, undeveloped land. A wetland mitigation area (Milgard Nature Area) is on the right bank between 4th and 8th Streets East in an area that is in industrial use. The left bank of the Hylebos, across from the Milgard site, contains another restoration site (Hylebos Estuary Wetlands Project). There is a small area on the south side of Pacific Highway within the shoreline jurisdiction that is designated for multiple uses (high-density residential, commercial) and has scattered homes.
3 WATERSHED PROCESSES

Ecology’s Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes guidance (Stanley et al. 2005, referenced hereafter as Protecting Aquatic Ecosystems) provides a framework for assessing important watershed processes. The six processes addressed by this guidance are the delivery, movement, and loss of water, sediment, phosphorus and toxins, nitrogen, pathogen, and large woody debris within a watershed. This guidance has been recommended by Ecology to fulfill the regional-scale analysis of shoreline process and function during the SMP update process.

Watershed-scale (regional) analysis has been limited to what can be reasonably inferred from the documents and information gathered during the Inventory phase of the SMP update. The City will be able to supplement this information with pertinent regional analyses conducted as part of the Pierce County SMP update and Ecology’s analysis of watershed processes in Puget Sound.

Because Fife’s shorelines are almost entirely riverine, with the exception of a few associated wetlands, the six watershed processes have variable degrees of influence on shoreline function. Additionally, the majority of the Lower Puyallup River and Hylebos subbasins are outside of City jurisdiction, shoreline or otherwise. For each process addressed below, relative importance of each watershed process for influencing Fife’s shorelines is assessed. This is followed by a brief discussion of delivery, movement, and loss of each process component within the watershed. Finally, potential alterations of those processes are assessed as much as possible based on inventory information. This assessment has been completed using modified tables describing indications of alteration based on Protecting Aquatic Ecosystems appendices. This approach is intended to ensure that all six watershed processes have been considered despite the limited nature of the assessment.

Information in this section is largely drawn from the Salmon Habitat Limiting Factors Report (Kerwin 1999), with other documents referenced as noted.

3.1 WATER

Within the City shorelines, water movement is primarily controlled by freshwater flow, as opposed to tidal flow movement related to marine processes. However, there may be some tidal influences near the mouths of the Puyallup River and Hylebos Creek that affects water movement within the City. As the majority of water movement is related to freshwater flow, the larger watershed process (e.g. precipitation) is important for informing shoreline function within the City. Delivery, movement, and loss of water within larger watershed are described briefly below on best available information. However, a complete analysis of water processes within the Lower Puyallup River and Hylebos subbasins is beyond the scope of this Inventory and Characterization document.

Freshwater delivery into the City from precipitation is described in Section 2.1.1. The majority of rainfall occurs from the third week of October through the month of June, and average annual rainfall varies from 35-55 inches. Only a small portion of this precipitation falls as snow.
As noted in Section 2.1, water transport within the Lower Puyallup River subbasin has been significantly modified from its historic condition. This includes the construction of hydroelectric dam(s), logging of forest lands and the construction of logging roads, significant development in the lower basin, extensive agricultural practices in the floodplain, and a major flood control effort that has resulted in straightening and channel hardening of much of river below approximately river mile 28 to the mouth at Commencement Bay, including the installation of a complex system of levees, revetments, and dikes on both sides of the River.

The Hylebos Creek subbasin is also highly modified as a result of rapid growth in south King County, Federal Way, Milton, as well as northeast Tacoma and Pierce County. Kerwin (1999) characterized the Hylebos Creek basin as “one of the most heavily urbanized subbasins in the State”. The conversion of lowland forests to highly developed urban area has resulted in a significantly flashier creek with overall lower flows and seriously degraded water quality.

The City shorelines adjacent to the Puyallup River contain a levee that extends the entire length of the City’s jurisdiction. This levee protects adjacent land use but also modifies water flow and removes connectivity to floodplain as well as off and side channel habitat. The City shorelines adjacent to Hylebos Creek are less modified than those adjacent to the Puyallup River and may provide a relatively larger capacity for surface water storage than the Puyallup River shorelines. However, water flows within Hylebos Creek are substantially smaller than those of the Puyallup River and as such the need for surface water storage along the Hylebos is unlikely to be as necessary as it is along the Puyallup. Most of the developed shoreline more likely runs off into the Puyallup or Hylebos either overland or by way of the City’s storm drain system.

Within the Lower Puyallup and Hylebos subbasins, some amount of water loss would be expected from evaporation and transpiration; however the majority of surface water loss is more likely due to drainage to Commencement Bay from the Puyallup River and Hylebos Creek. Once water has drained to marine areas, tidal processes become the dominant mechanism in its movement, including export outside of Commencement Bay towards the Puget Sound. At the City scale, it is anticipated that drainage would be far be the dominant form of water loss.

A number of the causes of change and indicators of alteration described in Table B-3 of Protecting Aquatic Ecosystems are present in the Lower Puyallup River and Hylebos subbasins, in particular those related to development along stream and wetland corridors. These indicate that water movement, particularly surface and shallow sub-surface movement, has been altered in this system. As stated previously, water movement within the Puyallup River shoreline areas is primarily controlled by levees and revetments along the Puyallup River rather than watershed-processes. As such, up-stream watershed-scale alterations to water transport (excluding flood events) are unlikely to result in significant affect to existing shoreline conditions. However, water movement within Hylebos Creek is not a restricted as it is along the Puyallup. As such, up-stream watershed-scale alterations are more likely to result in an affect to shoreline conditions.
<table>
<thead>
<tr>
<th>Component of Process</th>
<th>Sub-Component</th>
<th>Indicators of Alteration</th>
<th>Present in the Lower Puyallup River/Hylebos subbasins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery</td>
<td>Climate</td>
<td>(none included in Protecting Aquatic Ecosystems Table B-3)</td>
<td>Not evaluated¹</td>
</tr>
<tr>
<td></td>
<td>Precipitation</td>
<td>Non-forested vegetation in rain-on-snow zones</td>
<td>No</td>
</tr>
<tr>
<td>Movement</td>
<td>Surface, overland flow</td>
<td>Watershed imperviousness Stormwater discharge pipes Drainage ditches in seasonally saturated areas Loss of seasonally saturated areas</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Surface, storage</td>
<td>Loss of depressional wetlands Straight-line hydrography in depressional wetlands Straight-line hydrography of stream reaches with floodplains Dikes and levees on stream reaches with floodplains Dams</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Below surface, shallow subsurface flow</td>
<td>New construction Land uses with impervious cover on geologic deposits of low permeability Non-forested vegetation on geologic deposits of low permeability</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Below surface, recharge</td>
<td>Non-forested vegetation on geologic deposits of high permeability Land uses with impervious cover on areas of high permeability Utility lines Septic systems Unlined irrigation canals</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Below surface, vertical and lateral subsurface flow</td>
<td>Drawdown patterns Baseflow trends</td>
<td>Not evaluated²</td>
</tr>
<tr>
<td></td>
<td>Below surface, subsurface storage</td>
<td>Constantly wet road ditches</td>
<td>Not evaluated²</td>
</tr>
<tr>
<td></td>
<td>Return to surface, discharge</td>
<td>Well locations pumping rates and volumes</td>
<td>Not evaluated²</td>
</tr>
<tr>
<td>Loss</td>
<td>Evaporation</td>
<td>(none included in Table B-3)</td>
<td>Not evaluated¹</td>
</tr>
<tr>
<td></td>
<td>Transpiration</td>
<td>Land cover</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Streamflow out of basin</td>
<td>Diversion structures</td>
<td>Not evaluated²</td>
</tr>
<tr>
<td></td>
<td>Groundwater flow out of basin</td>
<td>Baseflow trends Well locations, pumping volumes</td>
<td>Not evaluated²</td>
</tr>
</tbody>
</table>

¹Where climate is the major natural control, evaluation of these indicators is beyond the scope of regional analyses (Stanley et al. 2005).
Evaluation of these indicators is beyond the scope of the City’s Inventory and Characterization. The City will utilize Watershed Process analyses completed by Pierce County as part of their SMP update, and by Ecology, to inform water processes and indicators of alteration.

3.2 SEDIMENT

Delivery, movement, and loss of sediment within the Lower Puyallup and Hylebos subbasins are described briefly below based on best available information with a focus on the City shorelines of the Puyallup River and Hylebos Creek; a complete analysis of sediment processes within the Lower Puyallup River/Hylebos subbasins is beyond the scope of this Inventory and Characterization document.

Sediment delivery into the Puyallup River and Hylebos subbasins likely occurs through all three mechanisms described in Protecting Aquatic Ecosystems: surface erosion, mass wasting and in-channel erosion (Table 3). Large amounts of fine sediment load are found throughout the Lower Puyallup subbasin (Kerwin 1999); the majority of this sediment load is likely provided by the headwater glaciers as well as upstream watersheds. The development of the levee along the Puyallup River is likely to prevent the shorelines within the city from providing substantial contribution to the sediment load, with the exception of occasional levee failures. In addition, the levee also serves to reduce areas of off and side channel habitat and the straightening of the river also result in the ability of the shorelines to act as a storage area for sediment.

Due to the relative lack of shoreline armoring/levees, as compared to the Puyallup shorelines within the City, as well as the existing off and side channel habitat areas (both existing and created), it is anticipated that the shorelines adjacent to Hylebos Creek have the potential to contribute to and be modified by watershed sediment processes. In addition, the Limiting Factors Report finds that sediment problems will persist with increases in water flow (Kerwin 1999). However, no specific information regarding sediment transport within Hylebos Creek was identified during the inventory process.

Table 3. Indicators of altered sediment delivery, movement, and loss within the Lower Puyallup River/ Hylebos Subbasins

<table>
<thead>
<tr>
<th>Component of Process</th>
<th>Sub-Component</th>
<th>Indicators of Alteration</th>
<th>Present in the Lower Puyallup River/Hylebos Subbasins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery</td>
<td>Surface erosion</td>
<td>Non-forested land cover on highly erodible slopes adjacent to aquatic resources</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New construction draining to aquatic resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Row crops agriculture draining directly to aquatic resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Roads within 200 ft of aquatic resources</td>
<td></td>
</tr>
<tr>
<td>Mass wasting</td>
<td>Roads in high mass wasting hazard areas</td>
<td>Not evaluated¹</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-forested land cover on high mass wasting hazard areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-channel erosion</td>
<td>Straight-line hydrography in unconfined channels</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urban land cover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movement</td>
<td>Sedimentation</td>
<td>Loss of depressional wetlands</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Straight-line hydrography in depressional</td>
<td></td>
</tr>
</tbody>
</table>
3.3 PHOSPHORUS AND TOXINS

Because the City’s shorelines are located near the confluence of both the Puyallup River and Hylebos Creek into Commencement Bay, one of the primary concerns for the interaction between City Shorelines and watershed-scale phosphorus and toxins processes is how they affect delivery into Commencement Bay and ultimately Puget Sound, whether from the entire subbasins or areas within the City. However, no information sources have been identified during the SMP update that directly informs phosphorus and toxins movement within the subbasins and a complete analysis of the phosphorus and toxin transport processes within the Lower Puyallup River and Hylebos subbasins is beyond the scope of this Inventory and Characterization. As such, the analysis of the delivery, movement and loss of phosphorus and toxins within the City is limited to the information available via Ecology’s 303(d) listings as well as the information provided in the Limiting factors report.

Ecology’s 303(d) and Level 4 listings of the Puyallup River within the City include fecal coliform and mercury. Level 2 listings for the Puyallup River include dissolved oxygen. Phosphorus and specific toxins are not listed for the Puyallup River within the boundaries of the City.

Ecology’s 303(d) listings of Hylebos Creek within the City include fecal coliform. Level 2 listings include dissolved oxygen. The Limiting Factors Report indicates that Hylebos Creek has been found to contain elevated levels of phosphorus (Kerwin 1999); however this is not reflected within the information available on the Washington State Department of Ecology’s Water Quality Assessment website. Toxins were not listed on Ecology’s 303(d) list for the Hylebos within the City. In addition, monitoring by the Friends of the Hylebos also indicate that pH, dissolved oxygen, and nitrates, while acceptable now, may be worsening over time.

Other documents generally identify stormwater run off, sewer, and septic systems as concerns within the Lower Puyallup River and Hylebos subbasins, all of which may result in increased phosphorus and toxin loads within the City water bodies. Both urban and agricultural land use are prominent in the basin, which may indicate altered processes according to Protecting Aquatic Ecosystems Table D-2 (Table 4).
Table 4. Indicators of altered phosphorus and toxins delivery, movement, and loss within the Lower Puyallup River/Hylebos subbasins.

<table>
<thead>
<tr>
<th>Component of Process</th>
<th>Sub-Component</th>
<th>Indicators of Alteration</th>
<th>Present in the Lower Puyallup River/Hylebos Subbasins</th>
</tr>
</thead>
</table>
| Delivery             | Phosphorus sources | Urban land use  
Agricultural land use  
Agricultural land use adjacent to dairies | Yes                                                   |
| Toxin sources        | Urban land use  
Row crop land use |                                                     | Yes                                                   |
| Surface Erosion      | (Table 3 – Sediment Delivery, Movement, and Loss) |                                                     | Yes (see Table 3)                                     |
| Movement             | Biotic uptake and decomposition | (none included in Protecting Aquatic Ecosystems Table D-2) | Not evaluated¹                                     |
| Adsorption (P)       | Straight-line hydrography in depressional wetlands with mineral soils  
Loss of depressional wetlands with mineral soils  
Urban land cover in areas of clay soils adjacent to aquatic ecosystems | | Not evaluated¹                                     |
| Adsorption (T)       | Straight-line hydrography in wetlands with organic or clay soils  
Loss of wetlands with organic or clay soils |                                                                 | Not evaluated¹                                     |
| Sedimentation        | (Table 3 – Sediment Delivery, Movement, and Loss) |                                                     | Yes (see Table 3)                                     |
| Loss                 | (Table 2 – Water Delivery, Movement, and Loss) |                                                     | Yes (see Table 2)                                     |

¹ Evaluation of these indicators is beyond the scope of the City’s Inventory and Characterization. The City will utilize Watershed Process analyses completed by Pierce County as part of their SMP update, and by Ecology specifically for Puget Sound marine shorelines, to inform water processes and indicators of alteration.

3.4 NITROGEN

A complete analysis of the nitrogen process within the Lower Puyallup River and Hylebos subbasins is beyond the scope of this Inventory and Characterization. No information sources have been identified during the SMP update review process that directly informs nitrogen movement in the Lower Puyallup River or Hylebos subbasins.

Ecology’s Water Quality Assessment information for the Puyallup River and Hylebos Creek is discussed in Section 3.3 of this document. Nitrogen is not listed within the either subbasin as a Level 5 (303 d), Level 4, or Level 2 impairment for either of the waterbodies within the City. Ammonia meets testing standards in the Puyallup River within the City of Fife (Level 1) but is not listed for the Hylebos. The Limiting Factors Report indicates that Hylebos Creek has been found to contain elevated levels of nitrogen (Kerwin 1999); however this is not reflected within the information available on the Washington State Department of Ecology’s Water Quality Assessment website.
The potential for process alteration within the Puyallup River and Hylebos Creek based on the information provided in Protecting Aquatic Ecosystems Table E-2 is provided in Table 6.

**Table 5. Indicators of altered nitrogen delivery, movement, and loss within the Lower Puyallup River/Hylebos Subbasins**

<table>
<thead>
<tr>
<th>Component of Process</th>
<th>Sub-Component</th>
<th>Indicators of Alteration</th>
<th>Present in the Lower Puyallup River/Hylebos Subbasins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery</td>
<td>Nitrogen sources</td>
<td>Agricultural land use Rural residential land use</td>
<td>Yes</td>
</tr>
<tr>
<td>Movement</td>
<td>Biotic uptake and decomposition</td>
<td>Straight-line hydrography in headwater streams</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Nitrification</td>
<td>Straight-line hydrography in depressional wetlands Loss of depressional wetlands</td>
<td>Not evaluated¹</td>
</tr>
<tr>
<td></td>
<td>Adsorption</td>
<td>Straight-line hydrography in headwater streams</td>
<td>Yes</td>
</tr>
<tr>
<td>Loss</td>
<td>Denitrification</td>
<td>Straight-line hydrography in depressional wetlands Loss of depressional wetlands</td>
<td>Not evaluated¹</td>
</tr>
</tbody>
</table>

¹ Evaluation of these indicators is beyond the scope of the City’s Inventory and Characterization. The City will utilize Watershed Process analyses completed by Pierce County as part of their SMP update, and by Ecology to inform water processes and indicators of alteration.

### 3.5 Pathogens

Pathogens, specifically fecal coliform bacteria, are a significant concern for both the Puyallup River and Hylebos Creek within the City. Both waterbodies and a number of the associated tributaries have been included in Ecology’s 303(d) list in successive years.

Delivery, movement, and efforts to reduce levels of fecal coliform within both the Lower Puyallup River and Hylebos are described briefly below on best available information. As with the other watershed-scale processes, complete analysis of the pathogen process within the both the Lower Puyallup River and Hylebos subbasins is beyond the scope of this document.

In natural systems, delivery of fecal coliform and other pathogens is from wildlife fecal material. Some delivery from wildlife (terrestrial and aquatic) is pertinent within the Lower Puyallup River and Hylebos subbasins. However, in altered systems fecal coliform loads are more likely due to domestic animals (agricultural and residential) and failing septic systems. Portions of both the Lower Puyallup River and Hylebos subbasins have a large component of rural residential land use which may result in both mechanisms. This likely contributes to increased fecal coliform levels within both subbasins.

Increased fecal coliform delivery is likely exacerbated by alterations in its movement through the watershed. Specifically, alterations described in Table F-2 of Protecting Aquatic Ecosystems have reduced the watershed’s ability to slow downstream transport, which has in turn reduced sedimentation potential (Table 7). Both the Puyallup and Hylebos contain segments that have been channelized (Kerwin 1999). Ultimately, this results in less fecal coliform being retained within the watershed, or it being retained for a shorter period of time. This affects the ability for
natural predation by other microbes to remove it from the system. Therefore, not only is more fecal coliform being delivered, but the system is less able to remove it. Within both subbasins as well as within City shorelines, it is likely that increased impervious surface has likely increased the rate of fecal coliform transport, similarly reducing opportunity for sedimentation and eventual predation. Increased impervious surface in developed areas outside of City shorelines are also likely to contribute to increased fecal coliform impairments in the creeks and Bay.

Table 6. Indicators of altered pathogen delivery, movement, and loss within the Lower Puyallup River/Hylebos Subbasins.

<table>
<thead>
<tr>
<th>Component of Process</th>
<th>Sub-Component</th>
<th>Indicators of Alteration</th>
<th>Present in the Lower Puyallup River/Hylebos Subbasins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery</td>
<td>Fecal inputs</td>
<td>Rural residential land use</td>
<td>Yes</td>
</tr>
<tr>
<td>Movement</td>
<td>Transport (overland, surface, and subsurface flow; recharge)</td>
<td>Straight-line hydrography Urban land cover and/or impervious cover Ditching on geologic deposits of low permeability</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adsorption Loss of depressional wetlands Straight-line hydrography in all depressional wetlands</td>
<td>Not evaluated¹</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sedimentation (Table 3 – Sediment Delivery, Movement, and Loss)</td>
<td>Yes (see table 3)</td>
</tr>
<tr>
<td></td>
<td>Loss</td>
<td>Death Loss of depressional wetlands</td>
<td>Yes</td>
</tr>
</tbody>
</table>

¹Evaluation of these indicators is beyond the scope of the City’s Inventory and Characterization. The City will utilize Watershed Process analyses completed by Pierce County as part of their SMP update, and by Ecology to inform water processes and indicators of alteration.

### 3.6 LARGE WOODY DEBRIS

Large woody debris (LWD) has been increasingly identified as an important habitat component for channel morphology and salmonids in river systems. LWD within a stream system can result in the formation of an upstream pool as well as a downstream plunge pool as water flows around the wood. The pools provide deeper water habitats that allow for hiding and resting areas and are also important during low streamflow periods. These pools can also provide cover habitat for juvenile fish. LWD can also modify the velocity of waterflow within a stream, especially behind large rootwads. These areas of reduced velocity provide areas for the fish to rest. In larger streams and rivers, LWD can also serve to trap and accumulate smaller pieces of wood, branches, leaves and other organic materials that provide complexity and diversity to in-stream habitat.

LWD can be recruited to a stream or river from bankside vegetation in the immediate area including side and off channel habitats and from upstream sources. The most common recruitment process for LWD into a stream system is primarily streambank erosion and windthrow. However, the construction of levees, dikes and revetments has separated the main channel from contributing side and off-channel aquatic habitats.
The delivery, movement, and loss of LWD within the larger watershed are described briefly below and is based on best available information the remainder of the section text is focused on the jurisdictional shorelines of the Puyallup River and Hylebos Creek. A complete analysis of LWD processes within the Lower Puyallup River and Hylebos subbasins is beyond the scope of this Inventory and Characterization.

LWD in the Lower Puyallup subbasin has been described as “virtually absent” (Kerwin 1999).

Along the Puyallup shoreline, the river is completely disconnected from vegetation across Levee Road, with the exception of the Oxbow wetland. Vegetation from the levee itself is the only potential source of LWD. However, practices of the US Corps of Engineers (between RM 0 and RM 3) and the Pierce County River Improvement District (upstream of RM 3) generally dictate the removal of trees greater than six inches in diameter at breast height (Kerwin 1999), thereby eliminating the capacity for the shoreline to function as a source for LWD.

Much of shoreline on the Hylebos has been developed and cleared of large woody vegetation up to the Creek banks. However, since there are large reaches where forested habitat extends to the shoreline, including most of the left bank, there is capacity for LWD recruitment. No quantitative data exist on LWD frequency in these two shoreline areas, but based on field observations it is very low in both areas. This is consistent with Kerwin’s (1999) assessment that LWD is a limiting factor for salmonids in both the Puyallup and the Hylebos.

A number of the indicators of alterations described in Protecting Aquatic Ecosystems Table G-2 are present within the subbasins (Table 8). In addition reach specific LWD information is provided in section 4 of this document.

Table 7. Indicators of altered large woody debris delivery, movement, and loss within the Lower Puyallup/Hylebos Subbasins.

<table>
<thead>
<tr>
<th>Component of Process</th>
<th>Sub-Component</th>
<th>Indicators of Alteration</th>
<th>Present in the Lower Puyallup River/Hylebos Subbasins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery</td>
<td>Streambank erosion</td>
<td>Dikes and levees&lt;br&gt;Straight-line hydrography in floodplains&lt;br&gt;Non-forested land cover within 100 ft of stream in a floodplain</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Mass wasting</td>
<td>Non-forested land cover on high mass wasting hazard areas</td>
<td>Not evaluated¹</td>
</tr>
<tr>
<td></td>
<td>Windthrow</td>
<td>Non-forested land cover within 100 ft of streams</td>
<td>Yes</td>
</tr>
<tr>
<td>Movement</td>
<td>Storage</td>
<td>Dikes and levees&lt;br&gt;Straight-line hydrography in floodplains</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Loss</td>
<td>Breakage/Decomposition&lt;br&gt;(not included in Protecting Aquatic Ecosystems Table G-2)</td>
<td>--</td>
</tr>
</tbody>
</table>

¹Evaluation of these indicators is beyond the scope of the City’s Inventory and Characterization. The City will utilize Watershed Process analyses completed by Pierce County as part of their SMP update, and by Ecology to inform water processes and indicators of alteration.