

SHORELINE MASTER PROGRAM SHORELINE INVENTORY AND CHARACTERIZATION REPORT LYNDEN, WASHINGTON

prepared for:

City of Lynden
300 4th Street
Lynden, Washington 98264

November 17, 2010



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1.0 INTRODUCTION

This report has been prepared to support the City of Lynden’s (the City) Shoreline Master Program (SMP) update. The City’s SMP, also known as Chapter 16.08 of the Lynden Municipal Code, is being updated to comply with the Washington State Shoreline Management Act (SMA) requirements (RCW 90.58), and the state’s shoreline guidelines (Washington Administrative Code [WAC] 173-26, Part III), which were updated and adopted in 2003.

This work was funded in part through a grant from the Washington State Department of Ecology (Grant #G1000046).

1.1 REPORT PURPOSE

The purpose of this report is to document existing shoreline conditions in the City and present a baseline inventory and characterization of ecosystem-wide processes (also referred to as landscape processes) and shoreline ecological functions in accordance with the state shoreline guidelines in Chapters 173-26-201(3)(c) and 173-26-201(3)(d) of the Washington Administrative Code (WAC).

1.2 REGULATORY OVERVIEW

The City originally adopted its SMP in 1974. The SMA requires local jurisdictions to develop master programs governing shoreline use and development. The SMA establishes policies and regulations that give preference to shoreline uses that:

1. Protect the quality of water and the natural environment,
2. Depend on proximity to the shoreline (water-dependent uses), and
3. Preserve and enhance public access or increase recreational opportunities for the public along shorelines.

1.2.1 Shoreline Jurisdiction

Through the SMA, the City of Lynden regulates “shorelines of the state” including all “shorelines” and “shorelines of statewide significance” as defined in RCW 90.58.030. “Shorelines” means all of the water areas of the state, including reservoirs, and their associated “shorelands”, together with the lands underlying them; except:

1. Shorelines on segments of streams upstream of a point where the mean annual flow is twenty cubic feet per second (cfs) or less and the wetlands associated with such upstream segments; and

2. Shorelines on lakes less than twenty acres in size and the wetlands associated with such small lakes.

“Shorelands” or “shoreland areas” mean those lands extending landward for two hundred feet in all directions as measured on a horizontal plane from the ordinary high water mark (OHWM); floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all wetlands and river deltas associated with such streams, lakes, and tidal waters.

In the City, the following areas are to be considered to be within shoreline jurisdiction:

- The geomorphic floodway of the Nooksack River, plus 200 feet landward of the floodway within the geomorphic floodplain; (Upland areas within 200 feet of the geomorphic floodway, but outside of the floodplain are not included.)

- All lands within 200 feet of the OHWM of Fishtrap Creek;

- All “associated” wetlands; meaning wetlands that are in proximity to shorelines or that influence or are influenced by waters subject to the SMA (WAC 173-22-030 (1)). These typically include wetlands that physically extend into the shoreline jurisdiction, and wetlands that are functionally related to the shoreline jurisdiction through a hydrologic connection and/or other factors.

Within the geographic boundaries of the City of Lynden there are approximately 4.61 miles of freshwater shoreline located in or adjacent to the City. The City shorelines of statewide significance include the Nooksack River. The Fishtrap Creek accounts for 4.57 miles and the Nooksack River accounts for 0.04 miles. Portions of the Nooksack River near Lynden are separated from the city limits by Whatcom County jurisdictional lands. Properties which are

located in the City may be considered shorelands even though the property is separated from the Nooksack River or if the City Limits do not extend to the river. The total length of the Nooksack River which influences shoreland jurisdiction in Lynden is 1.9 miles. A map of the City of Lynden and the surrounding area is included as Figure 1.

1.2.2 **Relationship to Critical Areas Ordinance**

The Lynden Municipal Code Chapter 16.16 regulates development in and adjacent to designated critical areas as defined by the Washington State Growth Management Act (GMA) (RCW 36.70A). Although critical areas in shoreline jurisdiction are to be identified and designated under the GMA, they must also be protected under the SMA. The Washington State Legislature and the Growth Management Hearings Board have determined that local governments must adopt master programs that protect critical areas within shorelines at a level that is “at least equal” to the level of protection provided by the local critical areas ordinance (CAO) (ESHB 1933 Sec. 3(4); Sec. 5(4)).

The Legislature clarified that although Washington’s shorelines may contain critical areas, the shorelines themselves are not critical areas by default as defined by GMA.

2.0 METHODS

This chapter describes the methods used to determine shoreline jurisdiction, characterize ecosystem processes, and inventory shoreline conditions and functions.

2.1 DETERMINING SHORELINE JURISDICTION LIMITS

Prior to conducting a detailed analysis of ecosystem process and shoreline conditions, areas subject to, or areas potentially subject to shoreline jurisdiction were identified and mapped (per the criteria described in Section 1.2.1). The goals of this shoreline identification were to:

- Determine what portion of the floodplain would be subject to shoreline jurisdiction
- Verify the upstream extent of shoreline jurisdiction for rivers and streams (upstream extent of the 20 cfs mean annual flow)

The SMP floodplain for the Fishtrap Creek is based on the Federal Emergency Management Agency maps (FEMA 2004). The SMP floodplain for the Nooksack River is referred to as the geomorphic floodplain. Sources include the Nooksack River Historic Migration Zone Mapping, (Collins and Sheikh 2004a) and FEMA 2004.

The floodway, referred to as the geomorphic floodway, includes Whatcom County Flood division draft river management hazard mapping on the Nooksack River. This floodway layer was edited to fall within the floodplain (per SMP guidance). The shoreline jurisdiction includes this floodway plus 200 feet within the geomorphic floodplain. This was used to denote the effective floodway consistent with the SMA.

The Ordinary High Water Mark (OHWM) was determined using FEMA mapping and maps generated by the City of Lynden.

Associated wetlands were mapped as part of the City of Lynden Critical Areas survey conducted in the year 2000.

The shoreline jurisdiction map is included as Figure 2. Both the Fishtrap Creek and the Nooksack River exceed the 20 cfs requirement throughout the City of Lynden.

2.2 **SHORELINE ANALYSIS**

The shoreline characterization approach is based in part on the watershed process assessment guidance developed by Stephen Stanley, Susan Grigsby, and Jenny Brown of the Washington Department of Ecology (Ecology 2005). Some wording is taken directly from the Ecology guidance (Publication #05-06-027). In addition, the Whatcom County Shoreline Inventory and Characterization Report (Whatcom County 2006) was utilized to assist with developing the framework and providing specific information related to shorelines and watershed process in the Lynden area.

This watershed process assessment uses Geographic Information Systems (GIS) methods to examine areas of the landscape that are important for maintaining watershed processes and to assess how these areas have been altered by human activity. These processes include the movement of water, sediment, nutrients, pathogens, toxins, and wood as they enter into, pass through, and eventually leave the watershed.

The approach to characterizing watershed processes consisted of several steps, which are described below (per Ecology guidance).

2.2.1 **Step 1 – Identify Purpose for Understanding Watershed Processes**

For this report, the watershed processes are important to understand in order to characterize the ecosystem-wide processes. Once the ecosystem-wide processes are understood, they can be used to:

- ❖ Assist in identifying areas for restoration and protection
- ❖ Assist in identifying land use designations that protect ecosystem-wide processes
- ❖ Assist in establishing and meeting “no net loss” requirements

2.2.2 **Step 2 – Map the Analysis Area**

Project analysts identified and mapped aquatic resources in the City of Lynden including rivers, streams, and wetlands (existing and historic wetlands) using available GIS data from various sources:

- Rivers, streams and other water bodies - WDNR hydrography data, Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP; WDFW 2004),
- Wetlands - National Wetland Inventory (NWI), WDFW Priority Habitats and Species (PHS), Critical Areas Map for the City of Lynden.

A complete listing of GIS data sources is provided in Appendix A.

2.2.3 **Step 3 – Map Key Areas for Watershed Processes**

Processes occurring in the watershed maintain aquatic resources to varying degrees. This analysis focuses on key processes that are fundamental to the integrity of the ecosystem and can be managed within the context of the available land use plans and regulations (Ecology 2005). The following key processes that are critical to sustaining the aquatic resources and likely to be altered by human activity were identified:

- ❖ Hydrology (water delivery, movement, and loss)
- ❖ Sediment delivery, movement, and loss
- ❖ Phosphorus and toxins delivery, movement, and loss
- ❖ Nitrogen delivery, movement, and loss
- ❖ Pathogen delivery, movement, and loss
- ❖ Large woody debris delivery, movement, and loss

For this step, analysts used available GIS data to identify and map areas within the City that support ecosystem processes. The geographic location of these specific features (e.g., depressional wetlands, permeable surficial deposits, or steep gradients) was used to identify key areas for watershed processes. Because of their inherent characteristics, the key areas that

are identified have a greater influence on aquatic resource structure and function than other areas and therefore may be more important for protection and/or restoration (Ecology 2005).

2.2.4 **Step 4 – Map Process Alterations**

This step determines where land uses and/or actions associated with land use have altered naturally occurring processes. Knowing where and how processes have been altered provides insight into the various management approaches that may be appropriate for the City. Altered areas may provide opportunities for restoration, while unaltered areas may have potential for conservation or similar protection.

2.3 **SHORELINE REACH INVENTORY**

The Fishtrap Creek and Nooksack River (the jurisdictional shorelines in the City) were divided into reaches to facilitate the inventory of shoreline conditions. The reach identification procedure generally followed the Whatcom County Inventory and Characterization methodology. This methodology identified stream reaches based on biophysical criteria, tributary confluence, geomorphology, land cover, and riparian condition. Features such as fish habitat type, gradient, and stream confinement also influenced reach breaks.

2.4 **RESTORATION OPPORTUNITIES**

Potential restoration opportunities were identified through the synthesis of the landscape process characterization and the reach scale inventory and assessment.

3.0 OVERVIEW OF LANDSCAPE PROCESSES AND ALTERATIONS

The City of Lynden is located in the northwestern corner of Washington State in Whatcom County (Figure 1). The city is bordered on the north, west, and east by agricultural areas and on the south by the Nooksack River. The Fishtrap Creek meanders through the center of the city. A map identifying the shoreline jurisdiction and aerial photograph are included as Figure 2.

The City of Lynden lies within Water Resource Inventory Area (WRIA) 1, which includes the Nooksack River system, independent Puget Sound tributaries; and the southern portion of certain Fraser River drainages.

3.1 GEOGRAPHIC CONTEXT

In order to understand the landscape processes, a description of the geology, topography, and climate is necessary. An understanding of these geographic features is vital in characterizing the shorelines in the Lynden Area.

3.1.1 Geology

The Ice Age of the Pleistocene scoured the entire Lynden area flat as ice sheets advanced south. It is estimated that the ice may have been one mile thick above Lynden at its greatest extent. Tons of outwash sediments were deposited in that ancient sediment basin by the melt water that flowed from both the advancing and retreating ice sheets. The sediments accumulated in the area of Lynden to a thickness of approximately 600 feet (USGS, 98-4195). Great outwash channels were eroded into these unconsolidated sediments and they were eventually occupied by newer, more modest rivers and streams.

Currently, within the last 10,000 years, the dominating geomorphic process that has been shaping the Lynden area has been erosion. Chemical reactions, water, and gravity act in conjunction to break down high spots and fill in low ones. Rivers and streams carry and redistribute the sediments to places miles from their source. Occasional volcanic eruptions input new material into the sediment system through aerial deposition of ash and massive lahars.

3.1.2 **Topography**

The topography in the City of Lynden generally slopes from north to south- toward the Nooksack River as shown on Figure 3. The elevation along the banks of the Nooksack River in Lynden is approximately 45 feet above sea level. The highest point, located in the northeast portion of the City along Badger Road, is approximately 125 feet above sea level.

Prominent topographic features in the City include the steep bluff located in the southern portion of the city where the topography changes from the Lynden terrace to the Nooksack floodplain and Fishtrap Creek which is incised in the Lynden Terrace especially in the southern part of the City.

In general, the north part of the City is level with a very minimal slope to the south. This area was historically used as farmland and ditches along the Double Ditch, Benson, Depot, and Bender Roads are indicative of efforts to provide adequate drainage for the farmland.

3.1.3 **Climate**

The Lynden climate can be described as mild. The lowest monthly average temperature is 32.1°F and the highest monthly average temperature is 75.8 °F. The average annual precipitation is 45.3 inches (Northwest Economic Council 2004).

3.2 **LANDSCAPE PROCESSES**

The following provides a description of landscape processes and the mechanisms through which they operate based on historic or unaltered conditions.

3.2.1 **Water Delivery, Movement, and Loss**

The City of Lynden receives an average of 45.3 inches of precipitation annually. Due to the size of the City, the precipitation pattern is consistent through-out the City. Runoff is rainfall-driven, and peak stream flows tend to occur from November to February. In general, water moves from the north to south (toward the Nooksack River) in the Lynden area. The seasonal water table is relatively shallow in the north parts of Lynden and is considerable deeper near the edge of the terrace overlooking the Nooksack River Valley.

Figure 4 shows the upper and lower soil permeability in the City. In general, the upper soil displays moderate permeability in the north part of the City and rapid permeability in the southern part of the City. The lower soil has rapid permeability throughout the City. The Nooksack floodplain generally has moderate permeability in the upper and lower soils.

Due to their permeability, soils in the north part of the City are more likely to become seasonally saturated. When the soils are saturated during rain events, overland flow may result. Wetlands may also form on these soils due to their relatively low permeability. Other areas of the City which may form wetlands due to lower soil permeability include the lower portion of the Fishtrap Creek and the Nooksack floodplain.

The floodplains associated with the Fishtrap Creek and the Nooksack River in the City are shown on Figure 5. Wetlands associated with the Fishtrap Creek and the Nooksack River are shown on Figure 6.

Figure 7 shows the geologic deposit underlying the City. The geologic unit below the City consists almost entirely of outwash sand and gravel from the Sumas Stade. The outwash is deep and provides for storage of groundwater. This aquifer is known as the Abbotsford-Sumas Aquifer. The aquifer is predominately unconfined with a thickness of typically 50-75 feet but can range from 15-230 feet. The mean hydraulic conductivity is 270 feet per day (Cox and Kahle 1999). The outwash provides a high yield aquifer that supplies water for both residential and irrigation use. Water levels typically fluctuate about 5 feet or less during the year (Stasney 2000).

Recharge to the aquifer is primarily by precipitation. Because of the permeable soils and coarse-grained aquifer material, recharge is on the order of 60% of the annual precipitation (Cox and Kahle 1999). Groundwater recharge and discharge are important mechanisms for maintaining stream base flows in the City of Lynden. A 2005 piezometer study conducted by USGS (Cox 2005) installed nine in-stream piezometers in Fishtrap Creek (five within the City of Lynden). In general, the piezometers indicated upward flow (groundwater discharging to surface water) except for one location in the City of Lynden (the authors of the study postulated that this result may be related to the surrounding geography around the piezometer). Gradients on all piezometers varied seasonally and were lowest (or reversed flow) in late summer and were highest in early spring.

The piezometer study confirmed the importance of groundwater flow in maintaining stream base flows.

The slope break (where the Lynden Terrace meets the Nooksack Lowlands) can result in the return of groundwater to the surface. The presence of the Pangborn Muck as shown on Figure 8 indicates that groundwater may be emerging at the slope break.

3.2.2 **Sediment**

Under natural conditions, sediment movement occurs through surface erosion, mass wasting events, and in-channel erosion. Sediment may be deposited and stored in areas where the water has low velocity (Stanley 2005).

Fishtrap Creek has only isolated areas in which erosion naturally occurs at high rates, including transitions from plateaus to terraces and ravines formed by the stream. The stream banks do provide a limited sediment source.

3.2.3 **Phosphorus and Toxins**

Key areas which support storage and uptake of both phosphorus and toxins include wetlands and clay soils. Phosphorus may also be stored and removed from ecosystems through sedimentation (Stanley 2005). Areas with more clay like soils include the mapped wetlands and muck soils and the silt loams mapped in the north part of the City and near the Nooksack. These areas may be important for the storage and uptake of phosphorus and toxins.

3.2.4 **Nitrogen**

Wetland areas are important features for nitrogen storage, cycling and removal. In wetlands, volatilization of nitrogen compounds occurs as bacteria process decaying organic matter and denitrification occurs as a by-product of microbial respiration in anaerobic conditions.

Riparian areas are also important for removal of nitrogen through denitrification. Nitrate dissolves easily and travels through the soil column to the groundwater if not assimilated by plants. The nitrate remains in groundwater unless utilized by denitrifying microbes (Cox 2005). Denitrification likely takes place in the sediments and riparian areas surrounding the streambed, where reducing conditions are more common (Puckett 2004).

Key areas in the City include the streambeds and riparian areas along the Fishtrap Creek and its tributaries as well as those along the Nooksack River. Additional key areas include wetland areas.

3.2.5 Pathogens

Under natural conditions, pathogen delivery to watersheds results from fecal matter deposited by wildlife. The movement of pathogens consists of overland flow, surface flow (ditches and other waterways), and to a limited extent subsurface flow. However, a study performed in 2005 on ground water/surface water interactions in the Nooksack Basin (Cox 2005) indicated that groundwater discharging into surface water rarely contained fecal bacteria *Escherichia Coli* or nitrate and that most fecal bacteria and nitrate were transported by surface water. The low rate of fecal bacteria transported by groundwater may be the result of die-off and filtration within the pore spaces as water flows through the vadose zone and aquifer.

Pathogens are removed from the watershed when they die. Wetlands play a key role in removing sediments and pathogens due to low water velocity, high residence times, filtering vegetation, and soils suitable for adsorption (Stanley 2005).

3.2.6 Large Woody Debris

Large Woody Debris (LWD) is a principal factor in structuring habitat characteristics in many Puget Sound ecosystems (Naiman 1992). LWD is delivered by mass wasting, windthrow, and bank erosion. Mass wasting events on forested slopes provide a significant amount of wood for streams. Windthrow or the individual treefall near a stream can be an important source of LWD in lower gradient channels. In western Washington trees within 100 feet of streams are likely to reach the channel if they fall (WFPB 1997). In unconfined channels, the amount of LWD increases as the stream migrates to areas of erodible soils (May 2003).

3.3 LANDSCAPE PROCESS ALTERATIONS

The increasing urbanization of the City of Lynden since the 1950s has had a profound effect on the landscape processes affecting the Fishtrap Creek and the Nooksack River.

3.3.1 **Water Delivery, Movement, and Loss**

The City of Lynden is located directly over an area with high infiltration/recharge potential, and extensive wetlands in the Fishtrap drainage have been filled or drained. This is particularly true where wetlands are drained by ditches, as indicated by extensive straight-line hydrography in areas north of the City of Lynden. In general, urbanization reduces the amount of precipitation that can infiltrate and loss of wetlands further increases peak flows.

Of particular concern is the potential for flooding along the Fishtrap Creek. Development in Lynden, Whatcom County, and British Columbia has increased peak flows during storm events in Fishtrap Creek. The Canadian portion of the Fishtrap Creek watershed is approximately 13,762 acres (the total Fishtrap Creek water shed is 23,655 acres). A management plan prepared for the North Lynden Watershed Improvement District (NLWID) studied the Fishtrap Creek water shed and estimated that 82% of the Fishtrap Creek flow at the Badger Road was generated in Canada. It is anticipated that peak flows will continue to increase as development, especially in British Columbia, continues (NLWID 2009). This will increase the flooding potential along Fishtrap Creek in Lynden.

Levees have disconnected the Nooksack River from its floodplain, decreasing surface water storage during peak runoff events. Such conditions typically limit storage potential both in the channel and in the associated riparian and hyporheic zones, and increase transport by decreasing channel roughness and shortening stream length.

Water withdrawals are also a major issue in the surrounding area and contribute to reduced stream flow during the summer low period. Groundwater consumption for irrigation increased 380 percent between 1950 and the 1980s (WCD 1986). Most water is consumed during summer months for agricultural purposes.

Due to a lack of long-term stream gage data for the City of Lynden, changes in peak flow frequency and duration are difficult to document. Land use in the Lynden Area appears to have affected base flows. Fishtrap Creek is currently failing to meet legally established flow minimums in the summer months (Ecology 303d List and Water Quality Assessment Program).

3.3.2 **Sediment Alterations**

The three primary factors governing surface erosion include gradient, erodibility of soils, and vegetative cover (WFPB 1997). Loss of vegetative cover in the Lynden area is the result of construction activities and urbanization. Land disturbance due to construction in the City is

likely a source of increased sediment supply in Fishtrap Creek. The road densities within 200 feet of Fishtrap Creek indicate increased potential for sediment transport via ditches and storm sewers.

The channelization of the Fishtrap Creek due to hard armoring of banks is a significant factor in altering the sediment delivery process in Fishtrap. Urbanization in Lynden also results in large peak flows during storm events which also alters the channel erosion patterns in Fishtrap Creek. The NLWID evaluation of the 2005 water year hydrograph indicated that the response to precipitation in the Fishtrap Creek drainage tends to be “flashy” or quick (NLWID 2009). This type of response is typical of urban streams.

Typically, wetlands promote the settling and filtration of suspended solids and fine sediment. The urbanization around the Fishtrap Creek has resulted in the loss of wetlands which have reduced the natural removal of fine sediment. In addition, the ditch network in the northern part of the City is indicative of the loss of wetlands and the increased movement of sediment.

3.3.3 Phosphorus and Toxins Alterations

Fishtrap Creek and its tributaries do not contain soils conducive to extensive hyporheic storage, but there are large areas of organic soil and potential wetlands in the Fishtrap Creek area that may be important for the adsorption of phosphorus and/or toxins.

The Nooksack River near Lynden is extensively diked, and has experienced wetland loss. Phosphorus and toxins retention processes are concentrated in the Nooksack floodplain. Process-intensive areas for groundwater phosphorus removal are also concentrated in the Nooksack floodplain.

Depressional wetlands and areas with high infiltration potential are prevalent along the Nooksack floodplain and along Fishtrap Creek in the City. These areas tend to support phosphorus and toxins retention processes, which can improve the quality of downstream waters.

Areas important for phosphorus uptake and storage have been impaired throughout the City. Stream channelization, development adjacent to the Fishtrap Creek, and construction of levees along the Nooksack (which disconnect the river from its adjacent floodplain) are indicators that hyporheic functions are impaired. Other signs of impairment include loss of wetlands important for phosphorus uptake and storage on the Nooksack floodplain.

Land uses that can contribute excess phosphorus to streams are widespread in the Lynden area. Till agriculture and dairy farming are the most prevalent land use in the surrounding area, while residential land use is common in the City of Lynden. These land uses extend in similar proportions into the upper watershed that lies in Canada.

Utah State University (2002) also identifies pesticide contamination in groundwater in the Lynden area. Ethylene dibromide has exceeded EPA standards in the lower Bertrand Creek and the Meadowdale area in and west of Lynden. Fishtrap Creek has increased concentrations of ethylene dibromide. Existing concentrations are a result of pre-1988 applications. Consequently, USU (2002) identified Bertrand and Fishtrap Creeks as the top priority in WRIA 1 for managing groundwater quality.

3.3.4 Nitrogen Alterations

Similar to the discussion of phosphorus, nitrogen retention, uptake, storage, and nutrient cycling processes are concentrated in the Nooksack floodplain and areas of organic soil and potential wetlands in the Fishtrap Creek area.

Depressional wetlands and areas with high infiltration potential are prevalent along the Nooksack floodplain and along Fishtrap Creek in the City of Lynden. These areas tend to support nutrient retention and denitrification processes, which can improve the quality of downstream waters.

Areas important for nutrient uptake, storage, and cycling have been impaired throughout the City. Stream channelization, development adjacent to the Nooksack tributaries, and construction of levees (which disconnect the river from its adjacent floodplain) are indicators that hyporheic functions are impaired. Although data confirming hyporheic alterations are difficult to obtain, a 2005 USGS study showed that riparian areas along Bertrand and Fishtrap Creeks were extremely effective in removing nitrogen and fecal coliform bacteria (Cox 2005). Ditching and tile draining in agricultural areas greatly reduces the effectiveness of these removal areas by creating a bypass network for delivery of bacteria and nutrient to streams.

Other signs of impairment include loss of wetlands important for nutrient and contaminant uptake and storage on the Nooksack floodplain.

Land uses that can contribute excess nitrogen to streams are widespread in the Lynden area. Till agriculture and dairy farming are the most prevalent land use in the area, while

residential land use is common in the City of Lynden. These land uses extend in similar proportions into the upper watershed that lies in Canada.

3.3.5 Pathogen Alterations

Source areas for fecal matter and associated pathogens are also widespread in the Lynden area. A large number of dairies surround Lynden.

Water quality alterations have been documented throughout the Lynden area, and high fecal coliform levels are a primary concern. In Fishtrap Creek, as shown on Figure 9, water quality impairment due to fecal coliform occurs mostly upstream of the City of Lynden. Particular sites include Double Ditch (east and west) and the ditches along Benson Road, Bender Road, Depot Road and Assink Road. This is consistent with water quality data that suggest the largest fecal coliform contributions appear to occur upstream of Pangborn Road and between Bender Road and Lynden’s Main Street (USU 2001; Ecology WQA 2008).

TMDL monitoring in 2004-5 shows that Fishtrap Creek failed to meet established standards for 90th percentile and median fecal coliform concentrations (Ecology WQA 2008). Fishtrap Creek also violated standards for dissolved oxygen in the most recent monitoring (Ecology WQA 2008).

Ecology Water Quality Assessment (WQA) also reports general trends this decade in relative fecal coliform loading in the Nooksack system. The relative contribution from Fishtrap Creek and Kamm Slough is decreasing, while relative fecal coliform loading in Bertrand Creek is increasing. The likely cause of such a trend is improved management in Fishtrap Creek and Kamm Slough or the reduction of agricultural land use.

3.3.6 Large Woody Debris Alterations

In the Lynden area, streams and rivers historically recruited LWD from the areas adjacent to stream channels via tree throw and bank erosion/channel migration. Fluvial redistribution of wood from upstream is also a very important source on the Nooksack River.

An assessment performed by the Nooksack Indian Tribe Natural Resources Department (Coe 2001) analyzed the LWD recruitment potential and stream shading hazard along the Nooksack River and its tributaries. The Fishtrap Creek was nearly entirely (98.6%) rated as low recruitment potential with the remainder being listed as moderate. No portions of Fishtrap Creek

rated high for LWD recruitment potential. Similarly, 78.9% of Fishtrap Creek was given a high stream shading hazard classification with the remainder being classified as a moderate hazard.

The lack of forest cover in the Lynden area indicates that organic input processes are impaired. The ability of the Fishtrap to recruit LWD is low because of the lack of intact riparian vegetation and straight-line hydrography.

Straight-line hydrography is correlated to low recruitment potential in Fishtrap Creek drainages areas with at least limited recruitment potential occurring on the mainstem Fishtrap Creek in and upstream of the City of Lynden, although riparian areas there are somewhat disturbed.

3.4 **ALTERATIONS SUMMARY**

The alterations to shoreline function found in Lynden are typical of urban environments. The urbanization causes higher peak flows and lower dry weather flows due to the amount of impervious surface in the watershed. In addition, the sediment processes are changed due to channelization and hard armoring. These have a negative impact on nutrient (nitrate and phosphorus) uptake in the riparian zone. In addition, removal of vegetation has a detrimental impact on LWD recruitment.

Poor water quality, as documented by Ecology (high amounts of fecal coliform and low dissolved oxygen) is present in portions of the Fishtrap Creek. The source of these problems is not due to any single factor but to watershed alterations both in and outside Lynden.

4.0 SHORELINE GENERAL CONDITIONS

In order to more accurately characterize the shorelines in the City of Lynden, the Fishtrap Creek was divided into four reaches. The Nooksack River shorelands in the City of Lynden are considered a single reach. In total, there are five shoreline reaches in Lynden. A detailed discussion of each reach is included in Section 5.0. A discussion of the general conditions of all shoreline reaches is included in the following section.

4.1 LAND USE

A zoning map for the City of Lynden is provided as Figure 10. The zoning along the Fishtrap Creek is a mixture of single family residential, multi-family residential, commercial, and public lands. A discussion of the zoning along each reach is included in Section 5.0.

The City of Lynden, typical of small towns, has a considerable percentage of its land area as impervious surfaces. These impervious surfaces include roads, parking areas, houses, other buildings, and driveways. A thorough review and calculation for the amount of impervious surface in the shoreline area has not been conducted. The estimate based on a 2008 aerial photograph is 25% impervious surface. An estimate of impervious area based on a 1950 aerial photograph was 2%.

Shoreline modifications are common along the Fishtrap Creek in Lynden. These modifications include bridges and other structures along with riprap and other hard armoring along residential properties and in the City Park. The Nooksack River is diked along the City of Lynden. A review of aerial photographs and site reconnaissance did not reveal any docks, piers, or other in-water structures in the Fishtrap Creek and Nooksack River in Lynden.

4.2 CRITICAL AREAS

Critical Areas as defined by the State of Washington Growth Management Act (RCW 30.70.170) were also identified for the SMP update project. Critical areas include wetlands, fish and wildlife conservation areas, critical aquifer recharge areas, and geologically hazardous areas.

4.2.1 **Wetlands**

Wetlands mapped in the City of Lynden are shown on Figure 6. Wetlands are located in the shoreline jurisdiction area in the southern and northern portions of the Fishtrap Creek in Lynden. There are other wetlands located outside the shoreline jurisdiction that may impact water quality in the Fishtrap Creek and Nooksack River.

4.2.2 **Fish and Wildlife Habitat Conservation Areas**

Habitat Conservation Areas within the City of Lynden are shown on Figure 11. The Washington Department of Fish and Wildlife (WDFW) Salmon and Steelhead Stock Inventory (SASSI) reports that Chinook, chum, Coho, steelhead, and cutthroat trout have been documented in Fishtrap Creek up to the Canadian border (Streamnet 2005). Chinook spawn primarily within the shoreline and the majority have ocean-type life history, spending little time rearing in the stream as juveniles (Anchor 2003). A smaller proportion of fall-run Chinook exhibit stream-type life history and utilize stream habitat for rearing. Coho are the most widely distributed species and chum use primarily the mainstem for spawning. (Anchor 2003). Use of tributaries is limited, although Double Ditch may provide habitat for various salmonid species (Streamnet 2005). Steelhead redds have also been noted in Double Ditch (Seymour 2010). Steelhead have been recently listed as threatened under the Endangered Species Act.

4.2.3 **Critical Aquifer Recharge Areas**

Critical aquifer recharge areas have not been mapped for the City of Lynden. Aquifer recharge has been determined to be important for sustaining dry weather flows in the Fishtrap Creek. The City of Lynden is located directly over an area with high infiltration/recharge potential. In addition, areas north of the City of Lynden are important for recharging the Abbotsford-Sumas aquifer.

4.2.4 **Geologically Hazardous Areas**

Areas with steep slopes and earthquake sensitive areas as mapped by the City of Lynden are shown on Figure 12. Areas with steep slopes are located along the lower portions of the Fishtrap Creek in Lynden and along the Nooksack Floodplain bluff. These areas may be more susceptible to erosion, sloughing, and minor landslides.

Areas that are considered earthquake sensitive are located on “soft soils” where earthquake damage is more pronounced. In general, areas with stiff soils undergo less shaking during an earthquake.

4.3 **FLOODPLAINS AND CHANNEL MIGRATION ZONES**

The 100-year floodplain for the Fishtrap Creek and the Nooksack River is shown on Figure 5. The NLWID management plan and anecdotal reports for residents indicate the flooding along the Fishtrap Creek both in Lynden and Whatcom County has been increasing. The source of the increased flooding potential is not entirely understood but the NLWID plan notes that climate patterns and continued development in the Canadian portion of the Fishtrap Creek watershed may be to blame.

Fishtrap Creek is largely incised through the City of Lynden and has limited migration potential with the exception of a few flat broad areas. The Nooksack River was known to migrate throughout the floodplain before the lower portion of the river was extensively diked. Due to the construction of the dikes, the river is largely confined to the current channel.

4.4 **DEGRADED AREAS**

The Fishtrap Creek shoreline jurisdiction within the City of Lynden has been extensively developed- especially in the central portion of Lynden. Mitigation and restoration efforts have been performed in the northern portion and southern portion of Fishtrap Creek in the City. Bank armoring with rock or broken concrete is common in the central portion of the City. In addition, numerous bridges (both vehicle and pedestrian) have been constructed over the creek.

Landowner education and implementation of alternative armoring methods and landscaping will improve the degraded areas throughout the City. In addition, proper mitigation and preservation should be implemented on those portions of the creek which have not been developed.

4.5 **EXISTING AND POTENTIAL PUBLIC ACCESS SITES**

The Lynden public has access to the Fishtrap Creek in the City Park and along the Jim Kaemingk trail system which runs north from the City Park to the Bender Fields Park. In

addition, there are pedestrian bridges at Bender Road, 8th Street, and Kok Road which allow the public to view the creek.

An opportunity to increase public access would be to extend the existing trail complex to the south.

There are no access sites to the Nooksack River within the limited portion of the City's jurisdiction. There are nearby access sites at the Hannegan and Guide Meridian bridge crossings. The Guide Meridian bridge crossing includes a parking area for fishermen, canoeists, and other river users.

4.6 **HISTORICAL OR ARCHAEOLOGICAL SITES**

There are no known historical or archeological sites within the City of Lynden shoreline jurisdiction. It is possible that historical or archeological sites may be encountered due to the use of the creek for tribal fisheries.

5.0 SHORELINE REACH-SCALE INVENTORY

The jurisdictional shorelines in the City of Lynden include the Fishtrap Creek and the Nooksack River. The Fishtrap Creek was divided into four reaches and the Nooksack River was considered a single reach. The reaches are shown on Figure 10.

The jurisdictional extent of Fishtrap Creek includes the entire stream within the City of Lynden and its UGA. This encompasses approximately 4.57 miles. The jurisdictional extent of the Nooksack River (adjacent to City lands) includes approximately 0.04 miles. Approximately 1.9 miles of the Nooksack River affect the Lynden shoreline jurisdiction (the Lynden shoreline jurisdiction is separated from the Nooksack River by Whatcom County lands).

Fishtrap Creek flows through the center of the City in a northeast to southwest direction. The creek has a mean annual flow of about 38 cubic feet per second (cfs). The creek derived its name from the first settlers. The settlers observed a large fish trap and dry house located at a Native American settlement near the mouth of Fishtrap Creek where the tribe caught and dried the salmon that ran up the creek. Today the creek supports chum, Coho and Chinook salmon, as well as steelhead, and cutthroat trout.

Fishtrap Creek originates in Canada and drains portions of the southern slopes of the Boundary Uplands. The Boundary Uplands are the uplands that lie along the U.S.-Canadian Border and separate the Fraser River Valley to the north from the Nooksack River Lowlands to the south. On its way to the Nooksack River, the stream runs through the Lynden Terrace. The Lynden Terrace is an outwash plain created during the Fraser Glaciation. It extends from the Boundary Uplands south to the flood plain of the Nooksack River south of Lynden. The City of Lynden is located just above the floodplain on the edge of the Terrace.

Fishtrap Creek is a low gradient stream from the U.S.-Canadian Border through most of the City of Lynden. At the border the stream elevation is about 140 feet and at Lynden 90 feet. This means the stream drops, on the average, about 10 feet vertically for every mile traversed. The reach between Lynden and the Nooksack floodplain has a somewhat steeper gradient as the creek drops to the floodplain of the Nooksack River.

The stream corridor through the City is composed of a flat meander belt of varying width rimmed by uplands. The most pronounced transitions are found in the down stream

reach of Fishtrap Creek. At this location, the stream channel cuts through the leading edge of the Lynden Terrace outwash plain and drops to the Nooksack River floodplain. The least pronounced transitions are found at the upstream end south of Badger Road, and on the Nooksack River floodplain as the stream enters and crosses the floodplain in the City's Urban Growth Area. In between, the width of the meander belt and the transition from meander belt to uplands varies with the topography.

Trees line the stream channel along many sections of the stream and grasses and shrubs are also present. The meander belt and adjoining transition areas are for the most part free of buildings structures and other improvements. The steeply sloping banks along parts of the channel make it difficult to access and develop the shoreline areas adjacent to the stream channel.

Stream crossings over Fishtrap include several roadways as well as pedestrian bridges. In addition to surface crossings, at some locations along the stream sanitary sewer lines are installed in casings bored beneath the stream channel.

Data from the Whatcom County Inventory and Characterization of Fishtrap Creek (Whatcom County 2006) was used to assist in the characterization of Fishtrap Creek and the Nooksack River. The data was used in the characterization and inventory of ecosystem-wide processes and ecological function for each individual reach.

5.1 **FISHTRAP CREEK REACH 1**

Reach 1 of the Fishtrap Creek extends from the southern Lynden UGA boundary (the Fishtrap Creek crosses under the Guide Meridian Road at this point) to the confluence of Double Ditch with Fishtrap Creek as shown on Figure 13. The lower (southern) portion of Reach 1 has been channelized using dikes. The stream takes on a more natural character near the Kok Road Bridge. Restoration efforts have been undertaken in the area between the dikes and the Kok Road Bridge. Placement of LWD along the channel banks, elimination of reed canary grass and blackberries, and re-vegetation with suitable trees and shrubs was noted.

Upstream of the Kok Road bridge, the stream follows a natural meander. This natural meander is influenced by the local topography. In some locations, the stream channel is confined by steep banks (near the Front Street Bridge). The stream meander belt widens near the Double Ditch confluence.

Land use in Reach 1 consists of 10 commercial properties, 11 single family residences, six multi-family residences, the Northwest Washington Fair Grounds, agricultural land to the south, and large amounts of undeveloped land adjacent to the creek.

5.1.1 **Land Use Patterns**

The predominant land uses along Reach 1 are commercial and single family residential with a small amount of agricultural land along the lower portion of Reach 1. The Northwest Washington Fairgrounds also abuts the stream channel in the central portion of Reach 1. The Lynden zoning map (included as Figure 13) indicates that land use within the city limits in this reach will remain similar to current conditions.

A portion of the reach is located in the Lynden Urban Growth Area. These properties are zoned multifamily residential, general commercial, and agriculture which is generally in line with their current usage. The exception is that the multifamily zoned properties are currently utilized as single family dwellings.

5.1.2 **Transportation**

The Guide Meridian-Fishtrap bridge is the southern boundary of Reach 1. Therefore, a portion of the Guide Meridian Road (State Route 539) exists in Reach 1. The Guide Meridian Road was recently widened by Washington State Department of Transportation and a new bridge over Fishtrap Creek was installed.

Other transportation structures in Reach 1 include the Kok Road Bridge in the central portion of Reach 1 and the Front Street Bridge in the northern portion of Reach 1.

5.1.3 **Utilities**

Properties in Reach 1 are served with a sanitary sewer system with the exception of properties in the Lynden UGA which may have septic tanks. There are utility crossings over the creek at Kok Road and Front Street. A City of Lynden sewer pump station is located near the Kok Road Bridge.

5.1.4 **Shoreline Modifications**

With the exception of the Kok Road and Front Street Bridge, there was only minor evidence of armoring or landowner alteration of riparian areas. In the southern portion of Reach 1, restoration efforts have been undertaken and planted trees and shrubs are beginning to become established. Some effort will be required to control and remove non-native vegetation in these areas.

Modifications to the hydrologic cycle include the Front Street and Kok Road Bridges as well as extensive diking in the southern portion of Reach 1. These modifications along the Fishtrap Creek also negatively affect the movement of sediment by confining the stream channel. The modifications also affect the LWD recruitment potential and limit the amount of shading the Fishtrap Creek receives. There are no significant sources of nitrogen or phosphorus in Reach 4. The road crossings and subsequent stormwater runoff may be a source of toxins in the Fishtrap Creek.

5.1.5 **Existing and Potential Access Areas**

Current public access areas include a pedestrian bridge just north of the Kok Road Bridge. Due to steep slopes, there is no public access along the Front Street Bridge. Public lands along Reach 1 include the Northwest Washington Fairgrounds but there is no established or maintained public access point on the Fairgrounds property. Due to the presence of public property and the broad meander belt in portions of Reach 1, there are public access opportunities in this reach.

5.1.6 **Critical Areas**

Wetlands. Wetlands are present throughout Reach 1 with the exception of the southern portion which is extensively diked. The City of Lynden Inventory of Critical Areas list three wetlands in Reach 1 (Wetland ID 10, 11, and 12). The wetlands are shown on Figure 6. In particular, the wetlands west of the Fairgrounds property have high revegetation potential. The wetlands at the Double Ditch-Fishtrap Confluence are particularly important to both water bodies. This wetland offers good salmonid habitat for spawning, good shade, and adequate wood.

Geologically Hazardous Areas. Soils in Reach 1 consist of Briscot Silt Loam, Lynwood Silt Loam, and Lynden Sandy Loam as shown on Figure 8. There are steep slopes along Reach 1 as shown on Figure 12. The steep slopes are present north of Kok Road to the northern boundary of Reach 1. Due to the type of soil present, the slopes are easily erodible. The slopes should continue to be protected to prevent damage to structures and property due to bank erosion or channel migration.

Fish and Wildlife Habitat. The stream banks along the lower end of the reach are vegetated with trees, grasses and shrubs. The middle portion of the reach is more heavily vegetated with shrubs and mixed stands of trees. Evidence of re-vegetation restoration efforts were found along the east side of 19th Street between Kok Road and Front Street. Himalayan Blackberry and Reed Canary Grass are common on the eastern bank (Northwest Washington Fair Grounds). Moving north from the Front Street Bridge, the tree canopy thickens on the upper portions of the reach.

Frequently Flooded Areas. Large portion of the shoreline jurisdiction along the southern part of Reach 1 are in the 100 year floodplain as shown on Figure 5.

5.1.7 Shoreline Ecological Function

With the exception of road crossings, diking, and the presence of some residential and commercial development, the shoreline ecological function along Reach 1 is mostly intact. The majority of the reach has riparian buffers and wetland areas are common. Restoration efforts have been undertaken in the southern and central portions of Reach 1 which have helped restore ecological function. Water delivery and movement has been altered by some impervious area including roads. Alterations to sediment processes in Reach 1 are minimal. Similarly, alterations to nutrient (nitrogen and phosphorus) and toxins (including pathogens) processes have been minimal. With the exception of the southern portion of Reach 1, there is some LWD available for recruitment. Fishtrap Creek is generally rated as low or moderate for LWD recruitment potential

The segments of Reach 1 which are lower functioning include the road crossings and the southern portion of Reach 1 which is diked.

5.1.8 **Opportunity Areas**

In general, Reach 1 is affected by nearby development but functioning well. Preservation of the current state is important. Two areas for enhancement include:

- The Fairgrounds property could be enhanced to increase the ecological function along this portion of Reach 1. Wetland construction and revegetation are options in this area.
- The southern portion of Reach 1 is heavily diked. This area is bounded on the south by agricultural land which may provide an opportunity to increase the meander belt of the creek.

5.2 **FISHTRAP CREEK REACH 2**

Reach 2 of the Fishtrap Creek extends from the confluence of Fishtrap and Double Ditch to the confluence of Fishtrap and Benson Road Ditch as shown on Figure 14. The predominant land uses along Reach 2 include single family residential, multi-family residential, and public land use (Fisher Elementary School and Lynden Middle School).

The stream channel in the lower (southern) portion of Reach 2 is broad and surrounded by steep high banks. The stream channel in the upper portion of Reach 2 is surrounded by more gently sloping uplands. In general, the meander belt of the stream in Reach 2 is broad at the southern end, narrows in the middle of the reach, and broadens again in the upper part of the reach.

5.2.1 **Land Use Patterns**

Land use along Reach 2 is almost entirely residential. A small amount of commercial property is located on 18th Street. A large apartment complex and other multi-family housing units are located on the north side of Liberty Street. Upstream of the Double Ditch-Fishtrap confluence the residential properties encroach on the creek riparian area to a greater extent than was evident in Reach 1.

Two schools, Fisher Elementary School and Lynden Middle School, are located in the Reach 2 shoreline jurisdiction. The bus garage at Fisher School is located within the shoreline jurisdiction. In addition, one church property is located north of the 14th Street Bridge. Large amounts of undeveloped property are located at the Double Ditch-Fishtrap confluence and

pastureland north of Main Street. Based on the Zoning Map (included on Figure 14), the land use along Reach 2 will likely remain similar to current conditions.

5.2.2 **Transportation**

There are three roadways crossing the Fishtrap Creek in Reach 2. The crossings include: The 17th Street Bridge, the 14th Street Bridge which was recently replaced, and the Main Street Bridge which is due for replacement in 2011. The 17th Street Bridge will likely handle more traffic flow once the connector to Main Street is constructed. Main street serves as a major east/west arterial for the city.

The 17th Street bridge is listed in the Whatcom County Fish Passage Barrier Inventory Report as a triple culvert that is 67% passable (WCPW 2006).

Each bridge has sidewalks for pedestrian traffic. A pedestrian only bridge is also present north of 8th Street. This is a steel bridge used by bikers and walkers. Numerous side streets also fall into the shoreline jurisdiction in Reach 2.

5.2.3 **Utilities**

Utilities are present at all crossings including the pedestrian bridge. The utilities include sewer, water, electrical, natural gas, cable, and other utilities. All properties along Reach 2 are served by sanitary sewer systems. Stormwater systems on roads, houses, and parking lots also drain to the Fishtrap Creek along Reach 2. Newer construction (such as the 14th Street Bridge) includes stormwater management and detention facilities.

5.2.4 **Shoreline Modifications**

In the steeper areas adjacent to Fishtrap Creek, deciduous and evergreen trees and shrubs are common. The steep banks are substantially vegetated. The tree canopy is intermittent with patches of significant canopy. The more gently sloping banks have less canopy due to the presence of lawns and other areas maintained by property owners. These areas also frequently use rockery type bulkheads or other armoring methods for bank stabilization.

Riparian vegetation diminishes upstream of 17th Street. Portions of Reach 2 have little vegetation, LWD, and limited shade. Bank armoring will confine the stream channel and

impact the movement of sediment in the watershed. Nitrogen and phosphorus may be entering the Fishtrap Creek along Reach 2 due to excess fertilizer use in lawn and landscaping adjacent to the creek. Sources of toxins may include stormwater run-off.

5.2.5 Existing and Potential Access Areas

Public access along Reach 2 is limited. Steep slopes on the downstream portion (for example near Fisher School) limit public access opportunities. In the upstream portion, residences encroach on the creek and limit the access opportunities. Other than views from the three traffic bridges and the pedestrian bridge, there are no other public access areas.

Some level of public access may be obtained in the property near the Double Ditch-Fishtrap confluence or in the pastureland north of Main Street but this would require the purchase of property or easements.

5.2.6 Critical Areas

Wetlands. Wetlands are present in the southern (downstream) portion of Reach 2 as shown on Figure 6. The wetland at the Double Ditch-Fishtrap confluence was discussed in the prior section. Wetlands identified in Reach 2 are classified as Type II wetlands which means the wetlands are a significant resource based on functional value and diversity. The wetlands in Reach 2 are primarily associated with the riparian zone along Fishtrap. The wetlands are identified as ID 13, 16, 17, and 18 in the City of Lynden Inventory of Critical Areas.

Geologically Hazardous Areas. Soils in Reach 1 consist of Lynwood Silt Loam, Laxton Loam, Hale Silt Loam and Lynden Urban Land Complex as shown on Figure 8. There are steep slopes along the downstream portion of Reach 2 as shown on Figure 12. The steep slopes are present from the downstream boundary of Reach 2 (Double Ditch-Fishtrap confluence) to Main Street. Due to the type of soil present, the slopes are easily erodible.

Fish and Wildlife Habitat. The stream banks along the lower end of the reach are vegetated with trees, grasses and shrubs. The amount of riparian vegetation diminishes upstream of the 17th Street Bridge. Reach 2 is designated as a Class B Stream Habitat as shown on Figure 11. Bank armoring is most prevalent in the area near the 17th Street Bridge. Houses and apartment buildings encroach on the north bank of the Fishtrap Creek and limit the channel migration. Residences near the 8th Street Pedestrian Bridge also encroach on the Creek and

some homeowners have reported flooding of homes in this area. North of the Main Street Bridge, as the meander belt broadens, the vegetation in the riparian area changes from trees and shrubs to grasses. A small portion of the shoreline area is used as pasture land for beef cattle.

Frequently Flooded Areas. Other than the stream channel, there are no portions of Reach 2 that are in the FEMA 100 year floodplain as shown on Figure 5. A homeowner with a residence near the 8th Street Pedestrian Bridge was interviewed and reported that his yard frequently floods and has nearly flooded his daylight basement so it is possible that the FEMA mapping is not sufficient to identify frequently flooded area.

5.2.7 **Shoreline Ecological Function**

The ecological function in Reach 2 is affected by the development along the Fishtrap Creek. With the exception of the Double Ditch-Fishtrap confluence and the pasture north of Main Street, the reach is fully developed. Homes or other structures are located in the Shoreline Jurisdiction throughout Reach 2. Some of the results of the development along Reach 2 include:

- Removal of shoreline vegetation has reduced the shading of the creek and the LWD recruitment potential.
- Lawns and other owner maintained areas near the creek may be contributing excess nitrogen and phosphorus to the creek.
- Stormwater flows to the creek may increase the peak flows and lead to undesired stream bank erosion.
- Construction of armored bulkheads along the creek reduces riparian function, sediment movement, and channel migration.

5.2.8 **Opportunity Areas**

In general, Reach 2 is impaired due to development along portions of the shoreline. Preservation and enhancement of the current state in less impaired areas is important. Two areas for enhancement include:

- The forested wetland area at the confluence of Double Ditch and Fishtrap should be preserved in the current state.
- Consider acquiring the pasture land north of Main Street for riparian restoration and public access. Consider connecting the city trail system.
- Remove fish passage barrier at the 17th Street Bridge.
- Enhance the area near the 8th Street Pedestrian Bridge with additional public viewing areas.

5.3 **FISHTRAP CREEK REACH 3**

Reach 3 of the Fishtrap Creek extends from the confluence of Fishtrap and Benson Road Ditch to the Bender Road Bridge as shown on Figure 15. Depot Road Ditch discharges to the Fishtrap Creek in the central portion of Reach 3.

5.3.1 **Land Use Patterns**

Predominant land use along Reach 3 consists of single family residences, park area (Lynden City Park), schools (Lynden Middle School and Lynden Christian School) and a small area of industrial land use (near Depot Road). Other than the schools, where the playground and ball fields are in the jurisdiction while most buildings are out of the jurisdiction, there is little vacant land in Reach 3. The shorelands along Reach 3 are nearly completely built-out. Based on the Zoning Map (included on Figure 14), the land use along Reach 3 will likely remain similar to current conditions.

5.3.2 **Transportation**

Major road stream crossings exist at Depot Road and Bender Road. Both Depot and Bender Road serve as major north/south arterials for Lynden. There is one private driveway bridge crossing Fishtrap Creek at the end of Cedar Drive. The City Park has two pedestrian bridges and the city trail system has another pedestrian crossing over Fishtrap Creek at the end of Brookfield Court. There are numerous side streets in the Reach 3 shoreline jurisdiction including Park Place, Parkside Court, South Park Street, Van Loo Lane, Cedar Drive, and Brookfield Drive.

5.3.3 Utilities

Utility crossings are present at the Depot and Bender Road Bridges. Sewer pump stations are also located near each crossing. All properties along Reach 3 are served by sanitary sewer systems. Stormwater systems on roads, houses, and parking lots also drain to the Fishtrap Creek along Reach 3. Newer construction (such as the Homestead Golf Course development) includes stormwater management and retention facilities.

5.3.4 Shoreline Modifications

Development within 200 feet of Fishtrap is common in Reach 3. The presence of houses, driveways, and roads affects the hydrologic and sediment processes along Fishtrap Creek. Hard armoring of stream banks is common along Reach 3. In addition, property owners maintain lawns and other landscaping to the stream edge. Portions of Reach 3 have little riparian vegetation and the vegetation that is present is immediately adjacent to the creek. Public access to the creek is excellent along the upstream segment (Depot Road to Bender Road) of Reach 3.

Nitrogen and phosphorus may be entering the Fishtrap Creek along Reach 3 due to excess fertilizer use in lawn and landscaping adjacent to the creek. Sources of toxins may include stormwater run-off. LWD recruitment potential is limited in Reach 3 due to the small amount of riparian vegetation along the reach.

5.3.5 Existing and Potential Access Areas

There is public access to Fishtrap Creek in the Lynden City Park. In the summer, wading and fishing (Fishtrap is a juvenile only fishing water per WDFW) are common in this area. In addition, a trail system which follows Fishtrap Creek begins in the City Park and extends upstream along the Fishtrap Creek past the Bender Fields Park. The trail is set outside a narrow vegetated area adjacent to the Creek but does allow access to Fishtrap Creek at various locations. Included in the trail system are sitting benches which allow excellent views of the Fishtrap Creek.

A small salmon hatchery operated by the Lynden Christian Biology Department is located along Reach 3 north of Lynden Christian School. The hatchery raises approximately 50,000 Coho fry on an annual basis to supplement the natural stocks in the Fishtrap Creek. The hatchery provides an excellent opportunity to educate students on the salmon lifecycle and

the importance of habitat preservation and restoration. Biology students at Lynden Christian High School assist in salmon rearing, preservation, and restoration work through-out the school year.

5.3.6 **Critical Areas**

Wetlands. There are no mapped wetlands located in Reach 3.

Geologically Hazardous Areas. Soils in Reach 1 consist of Lynwood Silt Loam, Laxton Loam, Tromp Loam and Lynden Urban Land Complex as shown on Figure 8. There are no mapped steep slopes or other geologically hazardous areas along Reach 3 as shown on Figure 12.

Fish and Wildlife Habitat. The lower portion of Reach 3 has a mixture of gently sloping stream banks and steep slopes (near Depot Road). East of the Depot Road Bridge, the stream is characterized by low banks. Due to the large amount of developed residential property along Reach 3, armoring of the stream bank is common. The most common armoring materials consist of broken concrete pieces and large rock. The stream banks along Reach 3 are generally vegetated with trees, shrubs, and grasses. Some areas may have a narrow line of trees along the stream bank which separates the creek from open fields (Lynden Middle School) or creek side trails. In shoreline areas where single family residential properties abut the Fishtrap Creek, it is common to find homeowners with lawns or other landscape features that extend to the stream banks. These areas are largely devoid of tree canopy or large shrubs. In areas not maintained by homeowners, trees are common as well as Himalayan Blackberry and other invasive plants.

Frequently Flooded Areas. There are no portions of Reach 3, other than the stream channel, that are in the FEMA are in the 100 year floodplain as shown on Figure 5. Anecdotal evidence indicates that the FEMA mapping may not reflect the true nature of the flooding potential along portions of Fishtrap Creek.

5.3.7 **Shoreline Ecological Function**

The ecological function in Reach 3 is affected by the development along the Fishtrap Creek. With the exception of school ball fields and playgrounds, the reach is fully developed. Homes or other structures are located in the shoreline jurisdiction throughout Reach 3. Some of the results of the development along Reach 3 include:

- Removal of shoreline vegetation has reduced the shading of the creek and the LWD recruitment potential.
- Lawns and other owner maintained areas near the creek may be contributing excess nitrogen and phosphorus to the creek.
- Stormwater flows to the creek may increase the peak flows and lead to undesired stream bank erosion.
- Construction of armored bulkheads along the creek reduces riparian function, sediment movement, and channel migration.

5.3.8 **Opportunity Areas**

In general, Reach 3 is heavily impaired. Preservation of existing riparian areas and enhancement of degraded areas is important. Two areas for enhancement include:

- The City Park provides excellent public access to the creek. An education element could be added discussing the importance of protecting the stream, salmon life cycle, etc.
- Areas along the city trail could be enhanced with vegetation and additional public access sites.

5.4 **FISHTRAP CREEK REACH 4**

Reach 4 of the Fishtrap Creek extends from the Bender Road Bridge to the Badger Road Bridge at the north city limits as shown on Figure 16. In general, Reach 4 is located in residential areas. The upstream portion of Reach 4 was agricultural until 10-15 years ago when the area began to be developed. This segment of Reach 4 has a lack of mature vegetation which is likely the result of past agricultural clearing practices.

5.4.1 **Land Use Patterns**

The predominant land uses along Reach 4 are single family housing, multifamily housing, and public land (Bender Field Park). Other than Bender Field Park, there is some vacant land along East Badger Road and east of Bender Park Boulevard. Based on the Zoning Map (included on Figure 14), the land use along Reach 4 will likely remain similar to current

conditions. The Reach is likely completely built out with only a few buildable lots remaining in the jurisdiction. The vacant land along East Badger Road and east of Bender Park Boulevard is not likely to be developed due to access limitations.

5.4.2 **Transportation**

Major road stream crossings exist at Bender Road, Aaron Drive, and East Badger Road (State Route 546). Bender Road serves as major north/south arterial for Lynden. Aaron Drive is a major east/west arterial for Lynden. East Badger Road serves as a major route through north Whatcom County connecting Lynden with Everson, Nooksack, Sumas, and the Canadian Border. There is one private driveway bridge crossing Fishtrap Creek on North Bridgeview Drive. The city trail system has pedestrian crossings over Fishtrap Creek at Bender Road and near Brook Court. There are numerous side streets in the Reach 4 shoreline jurisdiction including Edgewater Lane, Brook Court, West Cascade Lane, North Cascade Way, Bridgeview Drive, North Bridgeview Drive, Willow Street, and James Circle.

5.4.3 **Utilities**

Utility crossings are present at the Bender Road Bridge. All properties along Reach 4 are served by sanitary sewer systems. Stormwater systems on roads, houses, and parking lots also drain to the Fishtrap Creek along Reach 4. Newer construction includes stormwater management and retention facilities.

5.4.4 **Shoreline Modifications**

Development within 200 feet of Fishtrap Creek is common in Reach 4. The presence of houses, driveways, and roads affects the hydrologic and sediment processes along Fishtrap Creek. Hard armoring, which negatively impacts the movement of sediment, of stream banks is also common along the downstream segments of Reach 4. Newer development in the northern (upstream) segment of the reach is set back from the creek to a greater extent than the older development.

In the older developed areas, property owners are more likely to maintain lawns and other landscaping to the stream edge which may be sources of nitrogen and phosphorus. Portions of Reach 4 have little riparian vegetation and the vegetation that is present is immediately adjacent to the creek. There is little LWD present in the northern (upstream) segment of the reach though restoration efforts have been undertaken and LWD needs many

years to develop. Stormwater detention facilities are common in the area draining to Reach 4 but toxins remaining in the treated stormwater may still be impacting the reach.

5.4.5 **Existing and Potential Access Areas**

Good public access exists along the southern (downstream) portion of Reach 4. This is due to the city trail which exists along the south side of Bender Field Park. There is a pedestrian crossing at the end of the trail near Brook Court. A small trail also exists in Reach 4 near the Aaron Drive bridge. This trail follows the edge of Fishtrap Creek for 350 feet and then merges with the sidewalk along Willow Street.

5.4.6 **Critical Areas**

Wetlands. There are small mapped wetlands in Reach 4 as shown on Figure 6. The wetlands are associated with the stream riparian zone. The wetlands are ID #23 and 24 in the 2002 City of Lynden Inventory of Critical Areas. The inventory document notes that the wetlands could use a buffer gain where acceptable. Wetland areas north of Aaron Drive have been restored and enhanced and a backwater channel was excavated.

Geologically Hazardous Areas. Soils in Reach 4 consist of Hale Silt Loam, Laxton Loam, Tromp Loam and Lynden Urban Land Complex as shown on Figure 8. There are no mapped steep slopes or other geologically hazardous areas along Reach 4 as shown on Figure 12.

Fish and Wildlife Habitat. The stream character in Reach 4 is similar to Reach 3. Low stream banks and a tightly meandering stream channel are typical. Hard armoring on residential parcels is common. Vegetation along Reach 4 consists of trees and shrubs confined to the area immediately adjacent to the stream channel. Restoration efforts consisting of side channel construction, riparian planting, and stormwater detention facilities have been under taken in the upper part of Reach 4. Non-native vegetation including Himalayan Blackberry is common in areas not maintained by homeowners.

Frequently Flooded Areas. There are no portions of Reach 4, other than the stream channel, that are in the FEMA 100 year floodplain as shown on Figure 5. Recent flooding triggered by 10 year storm events reported by homeowners indicates that the FEMA mapping may not adequately reflect the flooding potential along Fishtrap Creek.

5.4.7 **Shoreline Ecological Function**

The ecological function in Reach 4 is affected by the development along the Fishtrap Creek but less so than Reach 3. With the exception of school ball fields and playgrounds, the reach is fully developed. Homes or other structures are located in the shoreline jurisdiction throughout Reach 4. Newer developments along Reach 4 have been set back from the creek and restoration efforts have been undertaken in the upstream Reach 4 segment. Some of the results of the development along Reach 4 include:

- Past agricultural activities in Reach 4 have removed mature riparian vegetation along the creek. Restoration efforts have been undertaken in Reach 4 but will not provide mature LWD in the near term. Shading conditions have improved due to the restoration efforts.
- Lawns and other owner maintained areas near the creek may be contributing excess nitrogen and phosphorus to the creek.
- Unmitigated stormwater flows to the creek may increase the peak flows and lead to undesired stream bank erosion.
- Construction of armored bulkheads along the creek reduces riparian function, sediment movement, and channel migration.

5.4.8 **Opportunity Areas**

In general, Reach 4 is impaired. Preservation and enhancement of the current state is important. Two areas for enhancement include:

- Areas along the city trail could be enhanced with more vegetation and additional public access sites.
- Vacant land east of Bender Park Boulevard could be purchased to provide additional area for wetland/riparian enhancement.

5.5 **NOOKSACK RIVER**

A complete discussion of the Lower Mainstem of the Nooksack River is found in Section 8 of the Whatcom County Inventory and Characterization Report (Whatcom County 2006). Only 0.04 miles of the Nooksack River are located adjacent to the City of Lynden however, approximately 1.9 miles of the river affect the City of Lynden Shoreline Jurisdiction.

A complete characterization and inventory of the Nooksack River was not conducted for this report. Rather, using the Whatcom County Inventory and Characterization, general conditions of the Lower Mainstem Nooksack River are provided in this report. Reach Designations listed in the sections below are taken from the Whatcom County document. The City of Lynden Jurisdiction is located within Reach 12 of the Whatcom County document.

Due to their proximity, a small amount of properties in southern Lynden are located the shoreline jurisdiction because they are located in the floodway or within 200 feet of the floodway even though Whatcom County land (non-Lynden jurisdictional shorelands) lies between the subject properties and the Nooksack River.

5.5.1 **Land Use Patterns**

Existing land cover and land use patterns along the Lower Mainstem Nooksack River are predominantly associated with agriculture (a mix of dairy, livestock, and row crops). The Lower Mainstem land cover in all reaches is dominated by a combination of cultivated land and wetlands.

Major utilities along the Lower Mainstem Nooksack include the City of Lynden's sewer treatment plant and outfall. The City of Lynden Shoreline Jurisdiction along the Nooksack River is based largely on the sewer treatment plant property. This portion of the Nooksack River is heavily diked and armored.

Other properties in the City Shoreline Jurisdiction are zoned residential and commercial. There is a significant amount of undeveloped land located in the southern portion of the City commercial zone. Full build-out of these properties is unlikely due to their inclusion in the Nooksack River floodway.

5.5.2 **Transportation**

City of Lynden transportation facilities located in the Nooksack River Shoreline Jurisdiction include South 6th Street (which leads to the sewer treatment plant), South 7th Street, and small segments of Front Street.

5.5.3 **Utilities**

Utilities present in the Nooksack River Reach are primarily associated with the sewer treatment plant. Sanitary sewer, water, electrical, and other utilities are present.

5.5.4 **Shoreline Modifications**

With the exception of a small riparian zone, the sewer treatment plant occupies all the City property adjacent to the river. This is heavily developed property. North of the sewer treatment plant some vacant land exists.

5.5.5 **Existing and Potential Access Areas**

There are no public access areas to the Nooksack River in the City Jurisdiction. Nearby access areas are located at the Guide Meridian and Hannegan Bridges.

There is potential for a public access to the Nooksack River west of the sewer treatment plant.

5.5.6 **Critical Areas**

Wetlands. There are mapped wetlands in the Nooksack River Jurisdiction as shown on Figure 6. The wetlands are ID# 28, 29, 30, 32, and 33 in the 2002 City of Lynden Inventory of Critical Areas. Of particular importance is the forested wetland located west of the sewer treatment plant and the large spring fed wetland at the base of Front Street. As described in the Whatcom County Inventory and Characterization report, wetlands play an important role in the hydrology and ecology of the Nooksack River floodplain.

Geologically Hazardous Areas. As shown on Figure 12, portions of the Nooksack River Jurisdiction lie in earthquake sensitive areas. In addition, steep slopes are present along Front Street.

Fish and Wildlife Habitat. The Lower Mainstem Nooksack River riparian corridor is consistently disturbed in all reaches as a result of agricultural conversion (Coe 2001). A narrow band of small to medium-sized hardwoods borders the river almost continuously, but is generally less than 50 feet wide. Pastures and agricultural fields occupy the remaining portions of the riparian zone.

The reaches of the lower mainstem Nooksack River are used by all anadromous salmonids (Chinook, chum, Coho, pink, and sockeye salmon, bull trout, steelhead, and sea-run cutthroat trout).

There are two early-timed, native origin Chinook stocks in the Nooksack River Basin (Smith 2002). Both are described as critical stocks. One stock spawns in the North and Middle Forks (and tributaries) of the Nooksack River. This stock is also supplemented by a hatchery program designed to rebuild the population (Smith 2002). The other stock spawns in the South Fork of the Nooksack River. These stocks are part of the Puget Sound Chinook Evolutionary Significant Unit (ESU) that is listed as threatened under the Endangered Species Act (Meyers 1998).

Fall Chinook also spawn in the mainstem of the Nooksack River and tributaries (Smith 2002). A stock of non-native hatchery fall Chinook has been released in large numbers throughout the North Fork, South Fork and mainstem of the Nooksack River for many years. In addition, hatchery fall Chinook have been released from the Lummi Sea Ponds in Lummi Bay.

There are two stocks of Chum Salmon that have been identified in the Nooksack River Basin (Smith 2002). One stock spawns in the mainstem and South Fork- this stock is described as a native stock with wild production. Another stock of Chum Salmon spawns in the North Fork of the Nooksack River. This stock has been supplemented by hatchery releases and is considered healthy.

One Coho Salmon stock is distributed throughout the Nooksack Basin (Smith 2002). Large quantities of Coho Salmon from various stocks have been released at the Kendall Creek hatchery and Skookum Creek hatchery as well as the Lummi Sea Ponds.

There are two stocks of Pink Salmon indentified in the Nooksack River Basin (Smith 2002). One stock is known to spawn in the North and Middle Forks and the second stock spawns in the South Fork. Both stocks have wild production as no hatchery supplementation has occurred. Pink Salmon are also known to spawn in the mainstem of the Nooksack River (Smith 2002).

There is evidence of small numbers of river spawning Sockeye Salmon in the Nooksack River (Smith 2002). These Sockeye leave the river as yearlings and are similar to other river-sea populations in the Skagit River, Canada, and Alaska.

Bull trout are known to use the mainstem Nooksack River for migration and foraging. Anadromous adults typically overwinter in the mainstem before moving out to forage in the estuary and migrating upstream to spawn. Anadromous sub-adults overwinter in the mainstem before returning to marine areas to forage, while fluvial sub-adults forage and overwinter in the mainstem Nooksack (Nooksack Natural Resources et al. 2005).

There are four steelhead trout stocks in the Nooksack River region. Three are winter steelhead and one is summer run stock (Smith 2002). All are native origin with wild production. Steelhead were recently listed as threatened under the Endangered Species Act.

Frequently Flooded Areas. Nearly all portions of the Nooksack River Jurisdiction lie within the 100 year floodplain as shown on Figure 5.

5.5.7 **Shoreline Ecological Function**

The sewer treatment plant located on the bank of the Nooksack River undoubtedly affects the shoreline function along the stretch of the Nooksack River in Lynden. Construction of the sewer treatment plant filled part of the floodway causing flood rise and other impacts.

In general though, the impacts on the Nooksack River from development in the City are minor compared to the county-wide impacts discussed in the Whatcom County Inventory and Characterization Report. The Nooksack River in Lynden is diked which affects the hydrologic cycle and the movement of sediment.

The loss of wetlands in the Nooksack floodplain also negatively affects the hydrologic cycle, the movement of sediment, the movement and destruction of nitrogen and phosphorus, and the movement of toxins. There are several wetlands present in the City Shoreline Jurisdiction which should be preserved or enhanced.

5.5.8 **Opportunity Areas**

Due to the limited extent of the Nooksack River in Lynden, there are few opportunities. Opportunities to consider include:

- Preserve and enhance wetlands in the shorelands of the Nooksack River
- Work with Whatcom County, WRIA 1, and other groups to restore ecological function on a larger scale.

6.0 INFORMATION GAPS

Gaps in existing information or areas beyond the scope of work for this report are identified below. Information described below would be helpful in guiding the development of shorelands in the City.

- Flooding along the Fishtrap Creek is a risk as development continues in the Abbotsford, British Columbia area which is the headwaters of the creek. Anecdotal evidence indicates that flows in the Fishtrap Creek are increasing during rain events due to increased impervious area and construction activities in the Abbotsford area. A complete hydrologic/hydraulic study of the Fishtrap Creek watershed would be helpful in determining if peak flows in the Fishtrap Creek have been and will continue to increase. Due to the amount of armoring along the Fishtrap Creek, higher peak flows could significantly affect the movement of sediment and may further increase bank erosion in areas that are not armored.
- Based on conversations with local residents, the flooding potential along the Fishtrap Creek may not be accurately reflected in the FEMA floodplain mapping. Additional study of the flooding potential along the Fishtrap Creek in Lynden may be necessary.
- A calculation of the impervious area in the City was beyond the scope of this report. An estimate was performed using a sampling approach. A more complete calculation would assist in planning development along the shorelines in the City.
- Wetland delineation reports were not available for many wetlands in the City. This report relied on a 2002 Study of Critical Areas to evaluate wetlands in the shoreline reaches. Before planning restoration or enhancement activities or when planning new development near wetlands, a more complete delineation should be performed.

7.0 RECOMMENDATIONS

7.1 FISHTRAP CREEK

Fishtrap Creek reaches in the City of Lynden are channelized and armored to protect development from channel migration and flooding. Educating homeowners to reduce the amount of armoring, planting appropriate vegetation in shorelands, and limiting fertilizer and pesticide use may help on a site by site level.

Restoration including removal of invasive vegetation and re-vegetation using “stream-friendly” vegetation may be possible on public lands (such as the Northwest Washington Fairgrounds and the City Park properties) or on private lands if easements can be obtained. The effectiveness of these activities is likely limited but would provide improvement on a site level.

Mitigation or restoration efforts along Fishtrap should focus on providing riparian vegetation and construction of wetland features including side channels and channel migration zones.

Other activities which may be undertaken with Whatcom County or Department of Fish and Wildlife include removal or relocation of levees along the Fishtrap Creek south of Lynden (possibly extending into the Lynden UGA). This would provide a more natural stream channel and improved riparian conditions.

Of particular concern in Lynden is the increasing potential for flooding due to increasing peak flows. Working with Whatcom County to perform hydraulic modeling of Fishtrap Creek and lower Double Ditch and find ways to increase water storage as well as locating new residences out of the flood hazard area would be beneficial.

Efforts to begin this the hydraulic modeling have been initiated at the EPA. The goals of the modeling proposal and the recommendations in this report are similar. This project would be beneficial for Lynden and the surrounding area.

7.2 **NOOKSACK RIVER**

Due to the small amount of property located adjacent to the Nooksack River, Lynden has virtually no ability to perform any restoration on the Nooksack River. Preserving and enhancing wetlands in the Nooksack floodplain would be beneficial. Lynden, as a Nooksack River stakeholder, can also participate in larger Nooksack River restoration and conservation efforts led by Whatcom County or other organizations.

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