BIRCH BAY WATERSHED CHARACTERIZATION AND WATERSHED PLANNING PILOT STUDY

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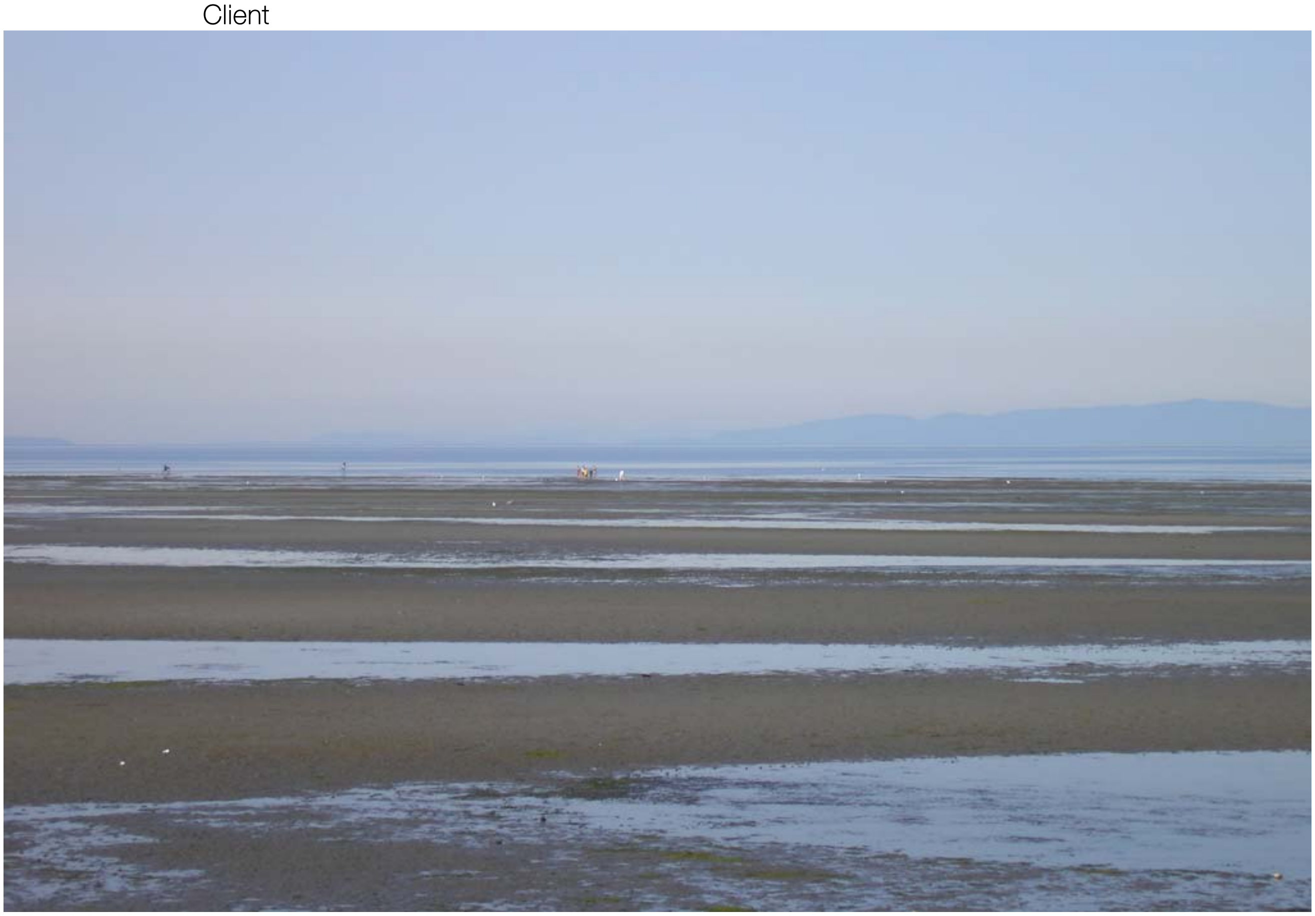
Prepared for:

October 2007

Whatcom County Planning
and Development Services
Client



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EXECUTIVE SUMMARY

The Birch Bay Watershed Characterization and Watershed Planning Pilot Study is the product of a collaborative effort by local, state, and federal agencies to create a comprehensive set of watershed management recommendations using integrated watershed characterization tools and techniques. This pilot study was initiated by a Multi-Agency Working Group (MAWG) and the Whatcom County Planning and Development Services (PDS) Department. The primary participants of the MAWG include the Environmental Protection Agency (EPA), the Washington Department of Ecology (Ecology), Washington Department of Fish and Wildlife (WDFW), and the Puget Sound Partnership (PSP, formerly Puget Sound Action Team).

In recent years, significant resources have been allocated towards gathering information and creating plans to guide development within the Birch Bay Watershed Management Unit (WMU). Many of the ongoing planning efforts share common goals for conscientiously managing stormwater to meet natural resource objectives for maintaining ecosystem health, recovering salmonid populations and improving nearshore habitat conditions. **This pilot study incorporates and builds upon these earlier planning efforts while further examining the potential vulnerability of specific areas in the watershed to future development pressures.** The study is not intended to supplant previous efforts, but provides further direction to evaluate recommendations, identify cost-effective management strategies and sources of funding, and implement collaborative, solutions-oriented land use practices.

This pilot study provides a preliminary recommendations for land use planning and resource management that will maintain–or preferably improve–the quality and condition of local wetland, stream, nearshore and terrestrial resources in the Birch Bay watershed. **The key findings and recommendations of the study are described in Chapter 7**. Chapters 1 through 6 provide the background, context and methods upon which the recommendations are based.

The study had the following main components:

Identifying Aquatic Resources and Basin Boundaries (**Chapter 3)** – The watershed was delineated into 32 drainage sub-basins based on surface water flows as shown in Figure 6. The sub-basins were grouped into 4 general Watershed Assessment Areas (WAAs) for purposes of identifying management recommendations (which are contained in Chapter 7).

Analyzing Future Development Patterns (Chapter 4) - A futures-based land use and development scenario was developed to understand potential development patterns within the basin based on current regulatory and zoning frameworks applicable in Birch Bay (see also Appendix C).

Evaluating Water Processes (Chapter 5) - Patterns of water, nitrogen and pathogen movement through the watershed were identified using an approach developed by the Department of Ecology to determine the relative importance of each basin for these processes (see also Appendix D).

Assessing Wildlife and Habitat Conditions (Chapter 6) - Wildlife use and available habitat conditions within the watershed were assessed to provide greater context for understanding overall ecological conditions and future management options (see also Appendix E).

Synthesizing information (Chapter 7) - A general framework was developed to depict the potential suitability of individual sub-basins for future development and determine management priorities and recommendations for each sub-basin based on current conditions and anticipated build-out scenarios.

Characterizing the ecological processes, habitat conditions, and potential development patterns within the Birch Bay study area is central to developing a successful **watershed-based plan** for land use, stormwater management, and natural resource protection/restoration. A comprehensive, process-based characterization provides the local community with critical information regarding ecologically sensitive areas, further identifying and prioritizing locations within the watershed for protection, restoration, and/or development.

Recommendations Summary

The results of this study depict the priority protection, restoration and development areas generally as shown in Figure ES-1 and more thoroughly described for each sub-basin in Table ES-1. These recommendations have not been adopted by Whatcom County. However, these results provide a framework for developing a comprehensive watershed management plan for Birch Bay.

<u>Terrell Creek WAA</u>

The highest priority would be to focus terrestrial and aquatic habitat rehabilitation efforts in the Terrell Creek WAA, primarily along the stream corridor and within and adjacent to Lake Terrell. This watershed has the greatest potential for sustaining existing aquatic ecosystems because it has areas of intact habitat and processes and a full range of connected habitats from the marine shoreline to the lake. Areas with the highest vulnerability within the WAA include Point Whitehorn Uplands, Terrell Creek Mainstem 2, Terrrell Creek Estuary Lake Terrell Tributary 1, and the Industrial Tributaries sub-basins.

<u>Central South WAA</u>

This WAA provides important wildlife habitat and includes extensive areas that are important to water flow, pathogen removal and dentrification processes. Although significant alterations have occurred (primarily ditching, stream channelization, and development along the shoreline), effective restoration can offset adverse effects. Future development should be concentrated within existing areas of development.

<u>Central North and Birch Point WAAs</u>

In these WAAs, the highest intensity development should be directed to sub-basins with lowest priority for restoration (red and pink) excluding Birch Point, Shintaffer, Rogers Slough, and Semiahmoo sub-basins. Higher density development within these sub-basins should be sited and designed using low impact development measures to minimize impacts to processes. Protect the processes of the Semiahmoo and Birch Point tributary sub-basins by minimizing forest clearing.

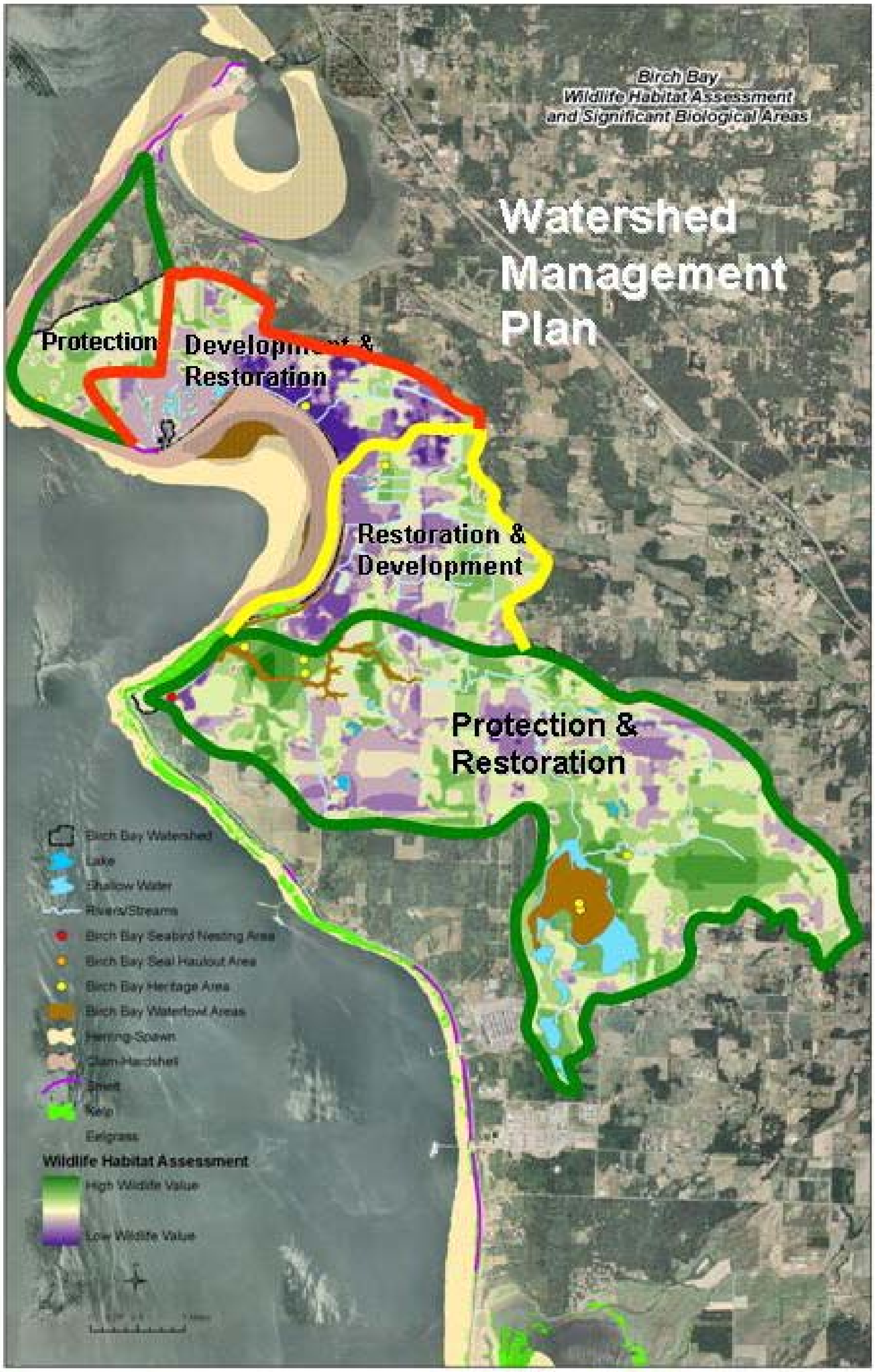


Figure Ex-1: Summary of study results showing relative suitability of areas for restoration, protection, and development in the Birch Bay Watershed

Table Ex-1. Management Category, Issue Summary, and Specific Recommended Actions for each sub-basin

WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
Terrell Creek	Lake Terrell East	Protection 2	Important waterfowl nesting habitat including habitat for common loon. Fewer wetlands than other subbasins in this WAA, so less important in terms of water processes, especially denitrification.	Implement standard CAO provisions placing special emphasis on projects that could directly or indirectly affect waterfowl habitat, especially near Northstar Road and Alderwood.
	Lake Terrell Trib 1	Protection 1	Key recharge area, so sub-basin is important for maintaining hydrology. Important amphibian habitat area.	Where feasible, maximize infiltration via LID-type measures and minimize impervious surface. Maintain exiting habitat mosaics with a mixture of vegetation types. Cluster development and locate developments closer to roads to minimize habitat fragmentation. Use farm plans to control pathogens. Implement Conservation Reserve Enhancement Programs (CREP) to improve riparian habitats. Provide bonus points for landowners applying for open space taxation for wetland properties.
	Lake Terrell Trib 2	Protection 1	Similar to Lake Terrell Trib 1. Highly permeable.	Maintain forest patches to promote infiltration and evapo-transpiration. Restore wetlands identified as having high restoration potential (see Figure 27)
	Lake Terrell	Protection 1	Not as much infiltration potential and fewer depressional wetlands than Lake Terrell Trib 1 and 2 sub-basins.	Consider improving flows out of the lake to improve downstream flow conditions in Terrell Creek.
	Terrell Creek Mainstem 3	Protection 2	Similar to other Terrell Creek sub-basins but slightly lower priority for Protection.	Same as above.
	Terrell Creek	Restoration 1	One of the highest priority Restoration areas in the	Re-establish woody cover to improve infiltration opportunities

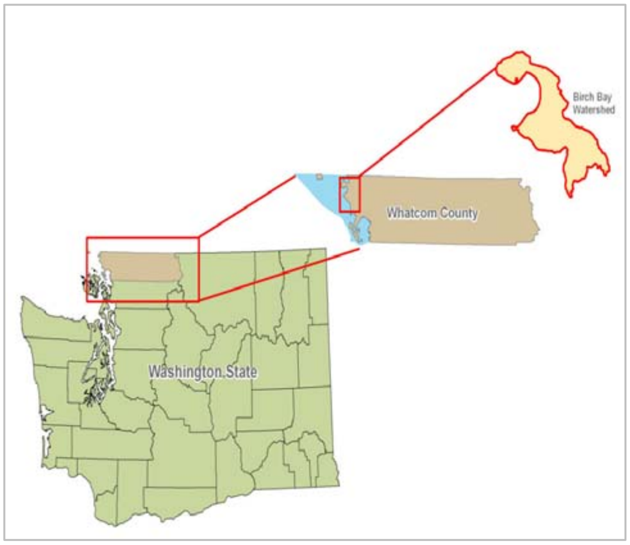
WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
	Mainstem 2		entire watershed. Key area for discharge, pathogen removal, and denitrification.	and slow runoff. Plug ditches to increase residence time and/or route water to depressional wetlands before discharging to creek. Redirect runoff from BP lands to lengthen discharge route to the Bay. Maintain mosaic of habitats for great blue herons and other species. Restore floodplain of Terrell Creek by improving in-stream structure. Prohibit expansion of the exiting UGA boundaries into this area to prevent future impacts.
	Terrell Creek Mainstem 1	Protection 2	Protection is the main priority similar to Terrell Creek Mainstem 3.	Protect wildlife. Implement LID and clustering.
	Fingalson	Restoration 2	High priority restoration area for water process and wildlife.	Create additional woody cover through planting to improve infiltrative capacity and enhance wildlife connectivity to areas outside the watershed. Re-vegetate riparian corridors (e.g., CREP).
	Industrial Tributary	Devel 2/Rest 2	Some opportunity to implement restoration compatible with ongoing industrial development in most areas. Not as important for pathogen and nitrogen removal as most other sub-basins in this WAA.	Restore forest habitats (and pocket wetlands) in southeastern part of the subbasin to provide nesting areas for herons. Develop a habitat management Plan for all species on ±1,000-acre BP properties.
	Point Whitehorn Uplands	Protection 2	No streams and few wetlands in this sub-basin, so lower priority for protection and restoration than P1 and R1 sub-basins. Entirely within UGA.	
	Point Whitehorn West	Development 2	Not an important area for water flow and water quality process, but important for habitat	Ensure that development minimizes impacts on nearshore resources and sediment processes.

WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
			because of proximity to nearshore resources. Important source of sediment for alongshore drift that maintains nearshore habitats. Development is appropriate consistent with CAO and SMP provisions.	
	Terrell Creek Upper Trib1	Devel2/Rest2	Development is appropriate consistent with CAO provisions.	Restore wetlands that have high restoration potential (Figure 27)
	Terrell Creek Upper Trib 2	Protection 1	Similar to Terrell Creek Lower Trib 1 E, but higher habitat value.	
	Terrell Ck. Estuarine Reach	Restoration 1	Important area at the lower end of the watershed, provides denitrification and pathogen removal. Important discharge zone.	Implement restoration recommendations contained in the SMP restoration Plan. Re-vegetate sparsely-treed riparian areas.
Central South	Terrell Ck. Lower Trib 2	Restoration 1	Similar to Estuary sub-basin, but also includes ditched wetlands that could be restored. Quality habitat in upper part of sub-basin.	Consider TDRs to move development out of this sub-basin. Consider relaxing CAO provisions in some areas to accommodate development and “banking” or storing” wetland functions in specific wetlands that have high restoration potential (see Figure 27), especially wetlands that can provide surface storage.
	Terrell Ck. Lower Trib 1 W	Restoration 2	Limited opportunities for restoration. Dense collection of septic systems immediately upstream.	Restore riparian areas and enhance wetlands to provide areas for pathogen removal.
	Terrell Ck. Lower Trib 1 E	Restoration 1	Similar to Fingalson sub-basin. Highly permeable.	Similar to Fingalson sub-basin.
	Bog Tributary	Restoration 2	Similar to Terrell Ck. Lower Trib 1 W.	

WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
	Central Uplands West	Restoration 2		Enhance wetlands in vicinity of the mobile home park. Use LID to control runoff and limit impervious surface.
	Central Uplands East	Restoration 2	Pathogen process mostly intact.	
Central North	Central Reaches	Development 1	Suitable for development.	
	Hillsdale	Development 2	Suitable for development.	
	Hillsdale North Trib	Restoration 2	Upper watershed is highly permeable. Numerous wetlands in this sub-basin.	Focus restoration on enhancing existing wetlands.
	Cottonwood South	Development 2	Suitable for development.	
	Cottonwood North	Development 2	Suitable for development.	
Birch Point	Shintaffer	Restoration 2/Dev 2	Extensive wetlands, including one large intact wetland.	Plug ditches.
	Rogers Slough	Restoration 2	Slough is highly modified from historic configuration.	Enhance slough in conjunction with beach restoration efforts.
	Rogers Slough Lower Trib	Development 2	Suitable for development	
	Rogers Slough Upper Trib	Development 2	Suitable for development, but moderate habitat value.	Ensure that impacts on wildlife are minimized.
	Birch Bay Marina	Development 1		
Birch Point	Semiahmoo Uplands	Protection 2	Extensive recent clearing. Highly permeable deposits in this area.	Protect existing wetlands and riparian areas.
	Birch Point South	Protection 2		

1.0 WHAT IS THE BIRCH BAY WATERSHED PILOT STUDY?

This pilot study represents a collaborative effort by local, state, and federal agencies to use watershed characterization techniques to guide future development in a manner that maintains–or preferably improves–the quality and condition of wetland, stream, nearshore and terrestrial resources in the Birch Bay watershed (Figure 1). A central purpose of this pilot effort is to take multiple recommendations from previous and ongoing studies and regulatory programs and integrate them into a comprehensive set of watershed management recommendations.



The results of this study can be used to:

- Identify the relative suitability of areas within the watershed for restoration, protection and/or development.
- Recommend mitigation strategies to offset the effects on development on aquatic resources and wildlife.
- Identify options for streamlining local development review and permitting.

Figure 1: Birch Bay Watershed, Whatcom County, Washington

The pilot study has an analytic component, which involves characterizing watershed processes, and a planning component, which consists of recommending solutions and actions needed to protect and restore ecosystem health. These are the first of several steps in a multi-step process to manage natural resources in the context of land use planning (Figure 2). The first two steps—analyzing (or characterizing) the landscape and its wetlands, streams and wildlife, and prescribing solutions—are addressed via this pilot study. The second two steps—taking actions and monitoring results[1]—are dependent upon formal adoption and implementation of a watershed plan by Whatcom County and the residents and stewards of the Birch Bay watershed. The Whatcom County Critical Areas ordinance (CAO)[2] allows local watershed-based management plans to substitute for standard critical areas regulations when certain criteria are met. Therefore, a locally adopted watershed plan in Birch Bay could tailor development regulations to watershed conditions to both streamline the regulatory process and provide increased resource protection.

[1] The implementation process is iterative and ongoing. If the monitoring data indicate that resources are not being adequately protected and cumulative impacts are occurring, adaptive management is required.

[2] Whatcom County Code (WCC) Title 16, Chapter 16.16., adopted September 2005.

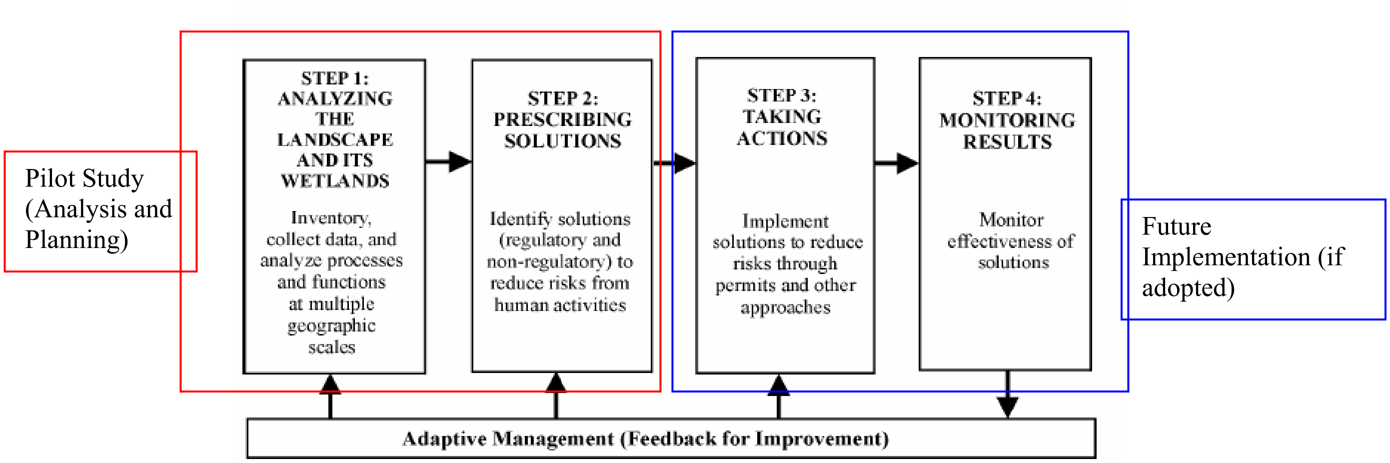


Figure 2: Four step process for using watershed characterization in land use planning

A central assumption of the *watershed characterization* component is that the ecological processes of a watershed are connected and that the health and sustainability of wetland, stream, nearshore and terrestrial resources are dependent upon interrelated and intact physical, chemical and biological processes. In the past, natural resources management has typically concentrated on the biological, physical, and chemical character of for example, an individual lake, wetland, stream reach, or estuary, without taking into consideration the ecological and physical relationships at the larger landscape or watershed scale, which control these characteristics. Recent scientific research has shown that landscape features and processes interact at variable scales and intensities over time to produce the structure and functions of aquatic (and terrestrial) ecosystems (Beechie and Bolton 1999). For example, rapid urbanization of upland areas within a watershed can have substantial impacts on hydrology, which can alter the structure of down-gradient stream systems.

> **Watershed characterization** is the process of describing and assessing the form, function, and relationships between physical and biological elements of the landscape to more thoroughly understand the character of the watershed. As used in this study the term refers to the analysis of processes related to the movement of water, sediment, nutrients, chemicals, energy or animals and plants at various scales (e.g., ecoregion, basin, sub-basin).

This research on watershed-scale processes concludes that ecological protection, management, and regulatory activities would be more successful at meeting goals and objectives if a comprehensive understanding of watershed processes were incorporated into management strategies (National Research Council 2001, Dale et al., 2000, Bedford and Preston 1988, Roni et al., 2002, Poiani et al., 1996, Gersib, 2001, Gove et al., 2001).

Whatcom County initiated the watershed characterization process as part of the County's Shoreline Management Plan (SMP) update Project. The County characterized key ecological processes related to the movement of water, sediment, heat/light, large woody debris (LWD), and nutrients in each of the 26 identified watershed management units (WMUs) including Birch Bay (Parametrix and ESA Adolfson, 2006).

This pilot study builds on the previous analysis using newly refined analytical tools developed by the Washington Department of Fish and Wildlife (WDFW) and Department of Ecology (Ecology) to:

1) Refine the analysis to the sub-basin scale within the Birch Bay WMU;

2) Improve the quality of data pertaining to the location and condition of wetlands and streams;

3) Rank three of the processes (water, nutrient, and pathogens) using analysis techniques developed and refined by Ecology. These techniques depict (in conjunction with information on the other watershed processes) the relative importance of each sub-basin for water quantity and quality processes;

4) Add a metrics-based fish and wildlife assessment for evaluating existing habitat conditions based on locally identified species of priority; and,

5) Incorporate a build-out scenario that examines potential land use patterns based on current zoning regulations.

A comprehensive, process-based characterization provides the local community with critical information regarding ecologically sensitive areas, further identifying and prioritizing locations within the watershed for protection, restoration, and/or development. The initial results of this characterization depict the priority protection, restoration and development areas generally as shown in Figure 3 and described in the subsequent sections of this report. These results provide a framework for developing a comprehensive watershed management plan for Birch Bay.

1.1 What are the specific goals of this project?

The intent of this pilot study is to create a comprehensive approach for guiding future land use planning efforts within the Birch Bay WMU. The overall goals of the project are to:

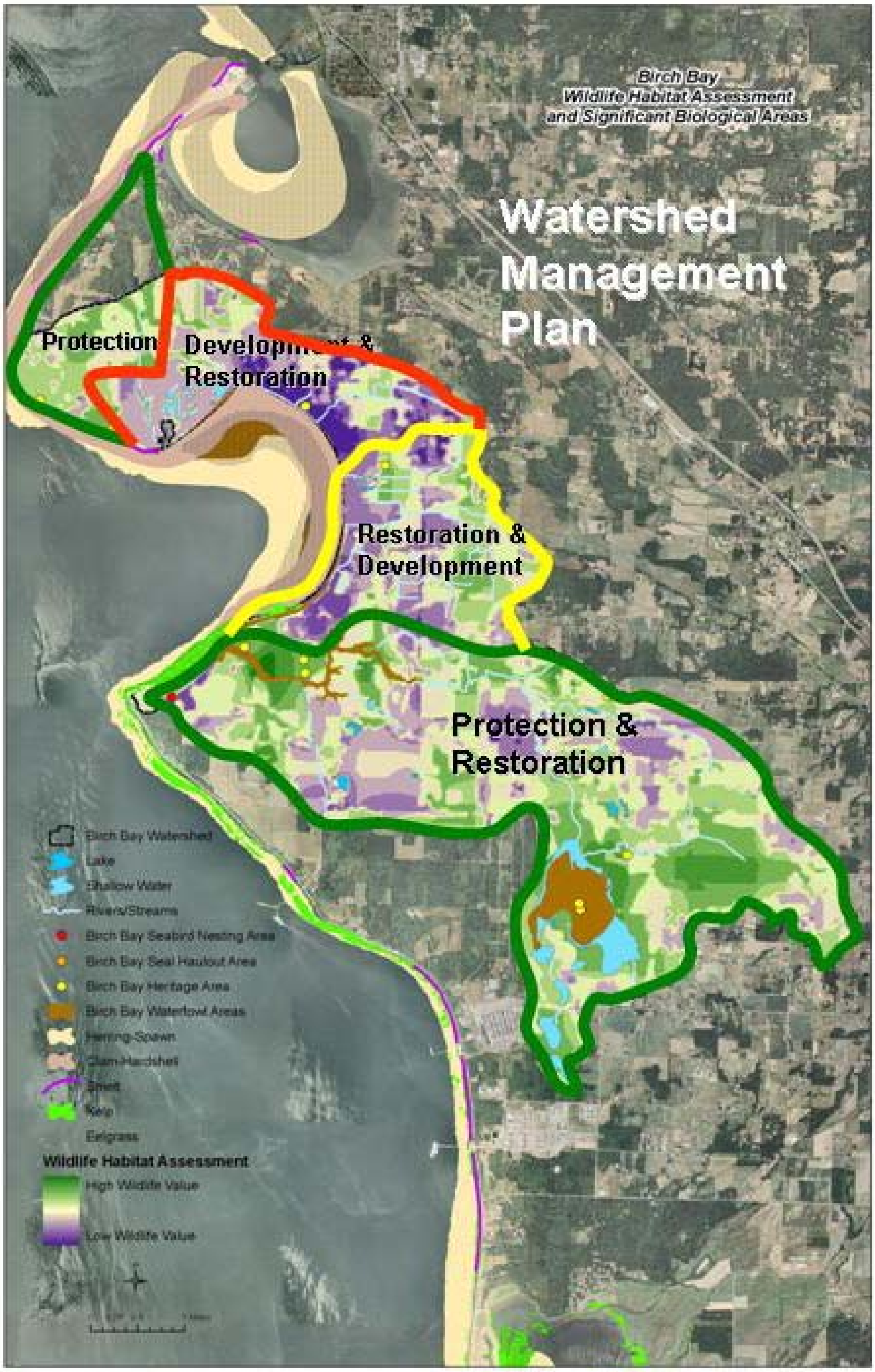
- Identify areas within Birch Bay for protection or restoration of ecosystem processes necessary for the long term functioning of marine and freshwater systems while also guiding the location and design of new development as described in the Birch Bay Sub Area (Community) Plan (Kask Consulting, 2004);

- Develop more effective and efficient decision making related to land use management issues at the local level; and,

- Demonstrate that science-based watershed characterization tools and methods can be used in other watersheds in the Puget Sound region.

Additionally, this study seeks to build upon and compliment the analysis described in the Birch Bay Comprehensive Stormwater Management Plan (BBCSWMP) (CH2M Hill, 2006) by providing additional information on areas within the watershed that are most at risk for ecological impacts associated with stormwater runoff and areas that could benefit most from effective stormwater management practices. The Puget Sound Partnership and EPA (two of the agencies that providing e funding for this study) are specifically interested in showing that watershed characterization, a component of stormwater management planning, can improve decision-making and maintain the health of local and regional ecosystems.

Figure 3: Summary of study results showing relative suitability of areas for restoration, protection, and development in the Birch Bay Watershed (See Sections 4-6 for details);



1.2 Who is involved in this effort?

This effort to integrate and synthesize current methods in watershed characterization and land use planning was initiated by a Multi-Agency Working Group (MAWG) and the Whatcom County Planning and Development Services (PDS) department. The MAWG consists of the following agencies and organizations:

- Washington Department of Ecology (Ecology)
- Puget Sound Partnership (PSP - formerly Puget Sound Action Team)
- U.S. Environmental Protection Agency (EPA)
- Washington Department of Fish and Wildlife (WDFW)
- U.S. Fish and Wildlife Service (FWS)
- Washington Department of Community Trade and Economic Development (CTED)
- Washington Department of Transportation (WSDOT)

Several local entities also provided essential information and support for this project. These entities include:

- Birch Bay Stormwater Steering Committee,
- Whatcom County Marine Resource Committee,
- Nooksack Tribe
- Nooksack Salmon Enhancement Association (NSEA) and
- Nakeeta Northwest (a Bellingham-based wildlife consulting firm)

The purpose of the MAWG is to work with local governments, through application of a pilot project, to demonstrate how to develop a watershed based plan using integrated methods for characterizing and analyzing environmental characteristics. The pilot project is designed to address multiple mandates, especially stormwater, salmon recovery, critical area protection, and water quantity.

The EPA, Ecology, and PSP provided the funding for this study.

1.3 Why was the Birch Bay watershed selected?

The MAWG interviewed several western Washington counties about their willingness to participate in a watershed planning pilot study, results of which could be used as a model statewide. Ecology selected Whatcom County and Birch Bay based on the following criteria: watersheds with high value natural resources and less than 10-percent effective impervious cover for the majority of the watershed; an adopted stormwater plan; and, adopted regulations that allow for the use of innovative watershed based measures such as offsite mitigation and low impact development measures. The Birch Bay watershed has an extensive amount of available data regarding current development conditions and ecosystem processes already compiled for the watershed, and because Whatcom County has been actively seeking opportunities to test new watershed-based planning tools to streamline development review and improve resource management protocols in rapidly developing areas of the County. This is in keeping with Whatcom County's CAO, which includes provisions that allow watershed plans to substitute for some critical area regulations and other land use restrictions. It is important to note that no new regulations or changes to existing regulations are being proposed at this time. However, this study makes recommendations for regulatory and/or other land use program changes that the County and residents of the watershed can consider in the future if desired.

1.4 How does this study relate to other planning efforts in Birch Bay?

In recent years, significant resources have been allocated towards gathering information and creating plans to guide development within the Birch Bay WMU. Many of the ongoing planning efforts share common goals for conscientiously managing stormwater to meet natural resource objectives for maintaining ecosystem health, recovering salmonid populations and improving nearshore habitat conditions. This pilot study incorporates and builds upon these earlier planning efforts while further examining the potential vulnerability of specific areas in the watershed to future development pressures. The study is by no means intended to supplant previous efforts, but provides further direction to evaluate recommendations, identify cost-effective management strategies and additional sources of funding, and implement collaborative, solution-oriented land use practices and resource management actions.

As a precursor to this pilot project, PSP and EPA funded a detailed review of relevant land use plans and technical documents that establish frameworks for setting goals, establishing development guidelines, and meeting stormwater and natural resource management objectives within the Birch Bay watershed, and more broadly, Whatcom County (Appendix A). The review analyzed seven (7) plans; listed in Table 1-1, identifying programmatic, regulatory, management, and structural recommendations related to land use and natural resource management both specific to the Birch Bay watershed and more generally applied to Whatcom County. This pilot study reviews those recommendations in light of the characterization results.

Collectively, the documents respond to a wide range of development and natural resource concerns and issues that arise when planning for future growth. However, no single document evaluated in the review uses a comprehensive ecosystem-based approach for evaluating the relationships between land use and watershed processes specific to the Birch Bay WMU. This lack of comprehensive watershed oversight reveals the explicit need to incorporate an ecosystems-based approach for developing plans and policies that promote development while also protecting and restoring ecosystem processes.

Although all the documents address the need to incorporate educational and stewardship opportunities, the primary non-structural and structural recommendations from each of these documents focus on the need to improve the water quality conditions within the Birch Bay watershed, to not only reduce potential impacts to human health, but also to improve the conditions for fish and wildlife. Thus, improvements to water quality conditions form the basis of the recommendations for this Birch Bay watershed management plan.

Table 1-1: Recent Planning Efforts with Recommendations Applicable to the Birch Bay Watershed

Plan/Document	Year	Description
Whatcom County Comprehensive Plan (WCCP)	2005	The WCCP is designed to meet the requirements stated in the Washington State Growth Management Act (GMA) by establishing a jurisdictional framework that coordinates Whatcom County's rural area growth policies with the urban growth policies of its incorporated cities.
Whatcom County Comprehensive Water Resources Plan (CWRP)	2001	The goal of the CWRP is to address current and future needs regarding water resources within Whatcom County. The plan provides water resource management objectives and provides guidance.
Birch Bay Community Plan (BBCP)	2004	The BBCP addresses population growth and development actions from a community perspective.
Birch Bay Comprehensive Stormwater Plan (BBCSWP)	2006	Stormwater issues related to potential development and growth within the Birch Bay watershed are examined and managed through this plan. Programmatic, regulatory, management and structural recommendations are made.
The WRIA 1 Salmonid Recovery Plan (SRP)	2005	The WRIA 1 SRP applies a landscape scale assessment for the recovery of endangered salmonids in WRIA 1 through specific programmatic, management, and structural recommendations. Although a comprehensive analysis of the entire WRIA unit, recommendations are focused on the Nooksack river system.
The Salmonid Habitat Restoration Strategy (the Strategy)	2005	The Strategy outlines a course of action for applying the recommendations generated in the SRP. Also focused on the Nooksack system, the Strategy applies a prioritization methodology for structural and management recommendations for species recovery.
The Shoreline Inventory and Characterization Report (ShICR)	2006	The ShICR compliments Whatcom County's Shoreline Management Plan (SMP) by characterizing all shoreline areas within the County. The report also assesses both current and potential shoreline functions, which in turn derive a set of regulatory, programmatic, and structural recommendations for shoreline management within the County.
The Shoreline Restoration Plan (ShRP)	2006	The ShRP outlines a course of action for prioritizing and applying the recommendations generated in the ShICR.

2.0 WHAT ARE THE EXISTING CONDITIONS IN THE BIRCH BAY WATERSHED?

Birch Bay is part of a coastal watershed encompassing 31 square miles between Drayton Harbor and Lummi Bay (see Figure 1). Located approximately twenty miles north of Bellingham, Washington, the Bay includes the marine shoreline from Birch Point south to Point Whitehorn, including Birch Bay State Park. Of the approximately 12 lineal miles of marine shoreline within the Bay, roughly one and a half miles within the 194-acre Birch Bay State Park is publicly accessible.

Birch Bay and parts of the surrounding watershed are designated as unincorporated UGAs and investigations into the possibility of incorporation are ongoing. According to the Whatcom County Comprehensive Plan, Birch Bay is one of the fastest growing communities within the County. The 1990 U.S. Census showed Birch Bay with 2,656 persons and the 2000 census showed 4,961 persons, an increase of 87 percent (Kremen, 2005). Birch Bay has been and is experiencing rapid growth and as of 2006 is estimated to have approximately 7,000 persons. While the Birch Bay Community Plan calls for a year 2022 population of 9,619 persons, there is potential to attain that population level by 2010 (Kremen, 2005). Such rapid growth has the potential to adversely affect the ecological processes and natural resources that have historically attracted people to the watershed.

Named by botanist Archibald Menzies, aboard the 1772 *Vancouver* expedition of the Puget Sound, for an abundance of birch trees along its shores, archaeological evidence suggests that the Birch Bay area was originally inhabited by several Native American tribes including the Semiahmoo, Lummi and Nooksack prior to European settlement. However, by the end of the 1800s, Native American presence in the area had diminished.

Like much of the Puget Sound Region, early explorers and settlers were attracted to Birch Bay and the surrounding areas by the abundance of natural resources. In the 1870s, homesteading brought a second influx of settlers to the small but growing community at the northern terminus for the Union Pacific Railway. By the early 20th century, much of the timber resources in the area had been depleted and new regulations banning the use of fish traps served to further dissolve the local natural resource-based economy. By the 1920s, local entrepreneurs in the Birch Bay area were focusing their efforts on an international recreational and resort community serving Canadian and U. S. residents.

The opening of the Blaine Air Force Base in 1951 and the subsequent industrial development at Cherry Point including the Mobil Oil refinery in 1954, Intalco Aluminum in 1966, and the ARCO refinery in 1971 brought economic vitality to the area. By the late 1970s, Birch Bay had become a destination resort community, which continues to grow. Residents and visitors continue to value the natural resources of the Bay and surrounding lands and residents recognize the importance of careful planning to prevent the types of ecological impacts that would have adverse consequences on the quality of life, tourism, recreation, and cultural sustenance, and aesthetics.

2.1 General Characteristics

The topography of the Birch Bay area is a result of a diverse geologic and glacial history (Table 2-1). The most recent glacial event, ending approximately 11,300 - 13,500 years ago, generated an ice sheet more than one-mile thick over the Birch Bay area. The sheer weight of the ice compacted underlying sediments creating a hard-packed material called glacial till. This glacial till has low permeability, resulting in relatively poor infiltration rates and a high potential for surface water inundation and the creation of wetland habitats throughout much of the watershed. However, near the Bay and north, east, and south of Lake Terrell, coarse-grained outwash was deposited over the glaciomarine drift creating areas of higher permeability.

The underlying geology of the marine shores is also glaciomarine drift. This geologic unit is characterized by moderately to well-sorted gravel, sand, silt and clay (Lapen 2000). Emergence (beach) deposits, largely consisting of reworked Everson glaciomarine drift, are found in the vicinity of Point Whitehorn (Lapen 2000). This geologic unit is comprised of loose, moderately to well-sorted gravel and sand and local boulders and fine to medium sand. Quaternary beach deposits are found throughout much of the low elevation shores within Birch Bay. These modern beach deposits typically consist of moderately to well-sorted coarse sand and gravel and sand, silt and clay in tidal-flat deposits.

The northern and southern extents of the watershed at Birch Point and Point Whitehorn are the highest points in the watershed, approximately 350 and 150 feet above mean sea level, respectively. Steep bluffs that are susceptible to erosion from wave action and stormwater runoff exist along the shoreline of Birch Point and Point Whitehorn. The central inland portions of the watershed are relatively flat.

Table 2-1: Characteristics of Birch Bay

Feature	Characteristics
Climate	Maritime characterization with precipitation levels averaging roughly 35 inches per year. Daily average temperatures in Birch Bay vary from 62°F in July and August to 30°F in December and January.
Surficial Geology	Predominately comprised of fine grained glaciomarine drift (Bellingham Drift) deposited from floating glaciers onto a submerged marine terrace 11,300 to 13,500 years ago. This deposit has low permeability and covers the majority of the WMU except for areas near the Bay and to the north, west and south of Lake Terrell. Course grained outwash, with higher permeability, was deposited in these areas over the fine-grained glaciomarine drift.
Topography	This coastal watershed is relatively narrow, ranging from 2 to 5 miles wide and forms a gentle crescent that generally conforms to the shoreline. The central portion of the WMU forms a trough that was formed by large glacial outflows from the Sumas Glacier Overall, this is a low elevation terrace which slopes gradually towards Birch Bay. Elevations range from sea level to 350 ft.
Tidal Patterns	Birch Bay experiences diurnal tidal changes. The tide range is 9.15

Feature	Characteristics
	feet between mean higher high tide and mean lower low tide. This significant difference between high tide and low tide yields large areas of tidal flats that stretch up to a mile out into the bay depending on tidal changes.
Surface Water Flow Patterns	Due to the narrow watershed, most surface water flow consists of relatively short stream drainages that flow directly to Birch Bay, creating a "spoke like" pattern.
Groundwater flow	The USGS has not developed a complete groundwater flow map for this WMU. However, groundwater flow contours from the USGS are available for the central and southern WAAs. It is assumed that groundwater flow for the Central North and Birch Point WAAs is generally towards Birch Bay except for Birch Bay North and the northern portion of Birch Point South where groundwater flow is likely towards the west.
Wildlife/biodiversity	Highly diverse and productive with many unique resources and species including a major heron rookery, location along the pacific flyway.

Well water level data collected by the U.S. Geological Survey (USGS) (Vacarro et al., 1998) show that groundwater moves to the north, south, east and west parts of the watershed from a large central area in the mid to upper watershed of Terrell Creek. The mapped USGS groundwater flow contour is at 50 feet above sea level, and it is assumed that the groundwater elevation decreases outside of the central area delineated by this contour. Where the land surface intersects the groundwater elevation, discharge of groundwater to the surface (typically streams and wetlands) can occur. In the Birch Bay watershed, this could be in areas that approach sea level and have surficial deposits with higher permeability such as outwash or alluvium. Figure 4 shows such lower elevation areas with higher permeability as being near the lower reaches of Terrell Creek and near Point Whitehorn. Groundwater discharge may converge in Terrell Creek Mainstem 2 sub-basin at the creek drainage and provide support for stream flows. Groundwater discharge also may be occurring in the Bog and Terrell Creek Lower Tributary sub-basins.

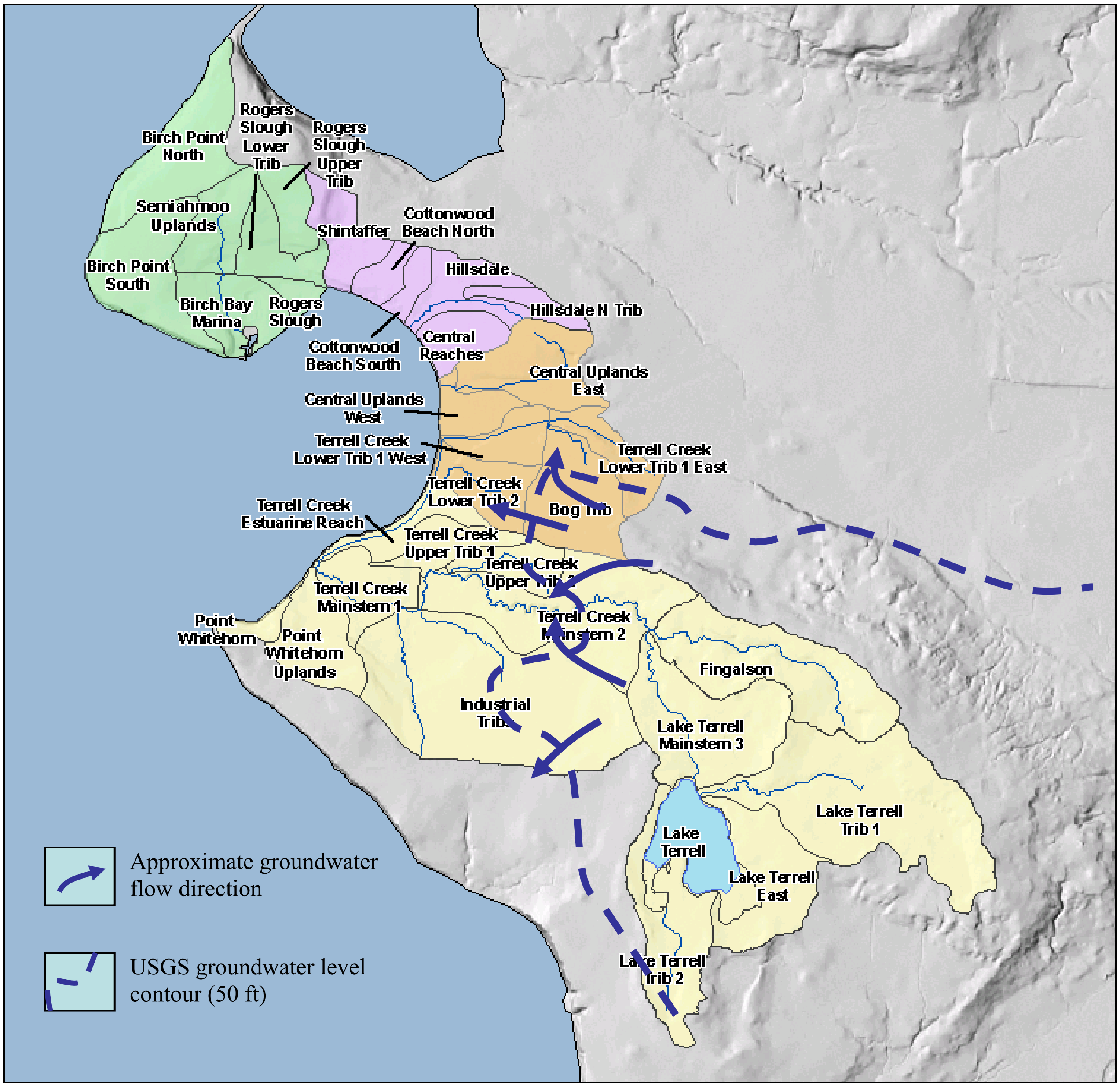


Figure 4: Estimated general groundwater flow patterns across sub-basins of the Birch Bay watershed based on data from the USGS

The Birch Bay marine shore includes shallow water bays and no-bank beaches with extensive intertidal and shallow subtidal flats. These high light environments support extensive eelgrass beds and tidal flat algal production, with their associated food webs. As a result, these shallow areas provide an early spring source of prey items for migrating salmonid fry at a time when deeper habitats are not as productive.

The beach in Birch Bay is a very popular recreation area with extensive shellfish beds and opportunities for recreational shellfish harvesting. The marine shorelines in Birch Bay from Birch Point to Point Whitehorn are deemed shorelines of statewide significance (RCW

90.58.310) and support significant fish, wildlife, and shellfish populations. The second largest active heron rookery in Washington is located on Birch Bay (Eissenger, 2006).

The Birch Bay WMU extends inland to the City of Ferndale, and includes Lake Terrell and Terrell Creek. Other water resources include Fingalson Creek and numerous small streams that drain directly to Birch Bay. Wetlands are widespread and extensive in the Birch Bay watershed, covering approximately 25 percent of the entire basin. Much of these wetland environments are associated with Terrell Creek and Lake Terrell located in the southern portion of the watershed. The upland environment near the Birch Bay shoreline once consisted of old growth coniferous forest, primarily Douglas fir and Western red cedar. Today, much of the forest within the basin has given way to residential, agricultural, and industrial land uses.

Birch Bay and its watershed supports exceptional biological diversity, due to the varied marine, freshwater, and upland terrestrial habitats that provide many niches for a rich array of fish and wildlife species. As one of the most rapidly growing areas in Western Washington, the intensity of development across the watershed will increase in the coming years, potentially impacting the amount and quality of habitat available for the rich biological resources found within the area. Some species will continue to thrive, but other, more sensitive species will only be retained if the landscape is responsibly managed to maintain a diversity of open grasslands and forest patches, broad and functional riparian corridors, and connections between varied seasonal and permanent habitats. The information on wildlife and habitat conditions developed from this assessment should make it possible for local decision-makers to address factors for retaining and enhancing biodiversity as the human population continues to grow.

2.2 Environmental Concerns

The wetland, stream, and wildlife resources of the Birch Bay watershed are susceptible to impacts associated with increases in stormwater runoff and other development-related impacts. This study focuses primarily on impacts related to water quality, water quantity and habitat loss/fragmentation caused by changing land use and increased impervious surface. Concerns related to sea level rise, air quality, climate change, invasive species and other issues are not addressed in this study.

Birch Bay is susceptible to elevated nutrient and pathogen levels caused by polluted runoff from the adjacent lands. Shellfish harvesting in Birch Bay, as well as other sheltered bays in the area (such as Drayton Harbor) has been periodically prohibited due to water quality problems caused by bacteria. In July of 2003, Birch Bay was added to the Washington State Department of Health's (WDOH) list of 'threatened' shellfish harvesting areas (CH2M Hill, 2006). This threatened status indicates a downward trend in local water quality conditions.

In general, potential sources of fecal coliform bacteria (pathogen) in Birch Bay include on-site sewage systems such as septic systems, broken sewage conveyance pipes, waste discharge from boat tanks, runoff from agricultural fields, and wildlife/domestic pet waste (CH2M Hill, 2006). The wastewater treatment plant outfall for the area discharges in deep water (deeper than Birch Bay) in an area with strong currents that rapidly disperse and dilute the discharge water. Thus, the outfall is unlikely to be a significant source of bacteria in Birch Bay (CH2M Hill, 2006). Marine waters are generally well mixed due to the exposure of the shoreline to tidal fluctuations, even within the relatively low energy and semi-enclosed waters of Birch Bay. The areas of weakest circulation occur in the southeastern corner of Birch Bay near the state park; this area is more susceptible to stormwater inputs with elevated nutrient/pathogen levels than other locations within this watershed. The stormwater outfall near the mouth of Terrell Creek and marine areas surrounding the Birch Bay Village Marina located along the Bay's northern shore are potential 'hot spots' for bacteria contamination (CH2M Hill, 2006). The characterization of pathogen processes (see Appendix D, figure 26) also suggests that the upper portion of the Terrell Creek watershed is a significant source of pathogens relative to other sub-basins.

In addition to declining water quality in Birch Bay, several other types of surface water problems exist in the area. Localized drainage issues, including flooding and erosion/sedimentation, occur in several parts of the watershed (CH2M Hill 2006). These issues are affecting the quality of freshwater systems within the watershed, and are believed to have contributed to a loss of aquatic and riparian habitat. The WRIA 1 Salmonid Recovery Plan (Nooksack Natural Resources et al., 2005) estimates and this study confirms that approximately 19 percent of the Terrell Creek drainage is covered by impervious surfaces such as roads, parking lots, and roof tops. Impervious surfaces, as an important environmental indicator for ecosystem quality, are described more thoroughly in Section 4.1.

Development near Birch Bay Village occurs in areas that are conducive to infiltration because of the underlying geology; however, high impervious surface coverage in this area potentially alters the natural hydrologic processes of groundwater recharge/discharge. In addition, many former wetland areas in the watershed appear to have been affected by development, including former wetlands near the Birch Bay Village golf course and marina. Loss of wetland habitat also appears to be extensive in portions of the watershed (Parametrix and ESA Adolfson, 2007).

Studies conducted by the Nooksack Salmon Enhancement Association (NSEA) found that Terrell Creek, the primary freshwater drainage within the Birch Bay WMU supports a variety of native fish species such as cutthroat trout and Coho salmon. However native fish population numbers within this 17-square mile drainage have declined significantly in the past 50 years. This decline is attributed to habitat degradation (primarily within the lower portion of the watershed) including loss of riparian habitat, barriers to fish passage, and extreme low flow rates during dry periods of the year (CH2M HILL, 2006). Fifty-eight percent of the Terrell Creek riparian zone has been converted to non-forest cover (Smith, 2002). Most of the remaining cover is scrub-shrub, deciduous, and mixed forest stands. No large conifer stands remain along the stream. The declines in the quality of surface water conditions in the creek (e.g., fecal coliform and temperature) can be associated with past and present land use practices resulting from the previously mentioned increases in human population within the watershed over the last two decades.

2.3 Zoning

Zoning regulations contained in WCC Title 20 for the Birch Bay watershed generally allow medium to high intensity residential use and a variety of high intensity resort-oriented commercial and lodging uses in the UGA and lower density rural residential use outside the UGA. Table 2-2 and Figure 5 depict zoning districts found within the Birch Bay watershed.

Table 2-2: Zoning districts in the Birch Bay watershed

Zoning District	Allowable Uses / Density Regulations	Location within Birch Bay Watershed
Urban Residential (UR)	This district allows 4 dwelling units per acre, with an 8,000 square foot minimum lot size in conventional subdivisions, 6,000 square foot lots in cluster subdivisions lots. Planned unit developments may include multifamily dwellings with a density increase of up to 35%. Maximum building coverage is 35% with no maximum impervious surface standard.	Areas of UR4 zoning include much of the northerly and westerly portion of the UGA in the Central South, Central North and Birch Point WAAs.
Urban Residential – Medium Density (URM)	URM-6 zoning which allows 6 dwelling units per acre, with a single family minimum lot size of 7,200 square feet and multifamily density at six units per acre URM 24 has a maximum density of 24 units per acre. A variety of design standards apply including a maximum 35 percent building coverage and 80 percent impervious surfaces.	This district applies over much of the central portion of the UGA as well as portions of the Birch Bay Waterfront from Shintaffer Road to the north boundary of the Resort Commercial zoning north of Harbor View Road in the northerly portion of the bay and from Broadway to and including Birch Bay State Park. Most of the district is URM-6. An area of URM-24 zoning surrounds the commercial area Alderson Road and SR 548
Resort Commercial (RC)	This district allows a variety of tourist oriented uses including multiple family dwellings, hotels and a variety of retail. Multi-family units are allowed at up to 22 units per acre, hotels and motels are allowed at a Floor Area Ratio (FAR) - overall floor area to lot area - of up to 0.56.	This district applies over the central part of the Birch Bay waterfront and extends inland up to a half-mile.
General Commercial (GC)	This district allows a variety of retail uses, hotels and motels at a FAR of 0.60 and multi-family dwellings at a density of 18 units per acre. Building coverage is a maximum 30% with a 10% open space requirements (an effective 90% impervious surface allowance).	This district is allowed at the intersection of Birch Bay-Lynden Road and SR 548 and at the intersection of Alderson Road and SR 548 in the Central North and Central South WAAs.
Rural Residential (RR)	This district allows a variety of residential densities. R5A allows 1 dwelling unit per 5	The district comprises the largest area in the watershed outside of the UGA.

Zoning District	Allowable Uses / Density Regulations	Location within Birch Bay Watershed
	acres R10A allows 1 dwelling unit per 10 acres	R5A is primarily located in the Terrell Creek WAA south of Bay Rd. and east to Ferndale. R10A is located north of Bay Rd., outside the Birch Bay UGA in the Terrell Creek Lower Tributary 2, Bog Tributary, and Terrell Creek Lower Tributary 1 East sub-basins.
(Impact) Industrial (II)	Light impact industrial (LII) uses are primarily related to services, and distribution, manufacture and assembly of finished products. Heavy impact industrial (HII) uses are primarily related to producing, distributing and changing the form of raw materials.	The district is allowed in the Cherry Point UGA comprising a large portion of the Terrell Creek WAA in the Industrial Tributaries, Point Whitehorn Uplands, and Lake Terrell Tributary 2 sub-basins.

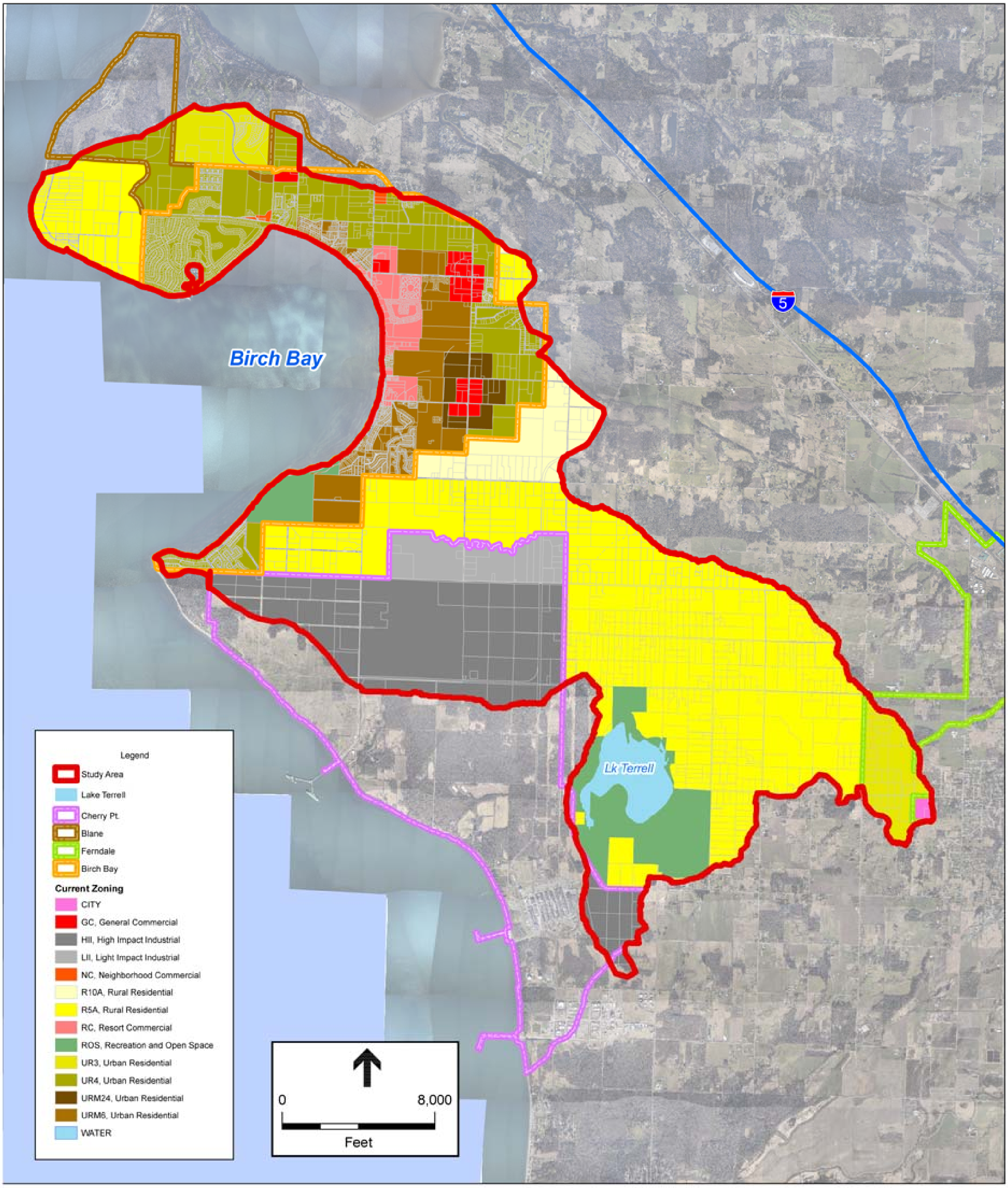


Figure 5: Zoning districts in the Birch Bay watershed

Whatcom County has two sets of stormwater development standards, one that applies countywide and a more stringent set of requirements (WCC 20.80.636) for Stormwater Special Districts, such as Birch Bay. The Stormwater Special District designation applies stormwater management requirements to all development on lots less than 5 acres and remodeling efforts that increase impervious surfaces more than 500 square feet. Requirements include providing both water quality and detention for all impervious areas on the site. These stormwater facilities are required to be in accordance with existing Whatcom County Development Standards, which are based on the 1992 Ecology Stormwater Management Manual for Western Washington (updated in 2001 and 2005).

However, the stormwater special district requirements do not specifically require the use of Low Impact Development (LID) techniques. The special district provisions require implementation of permanent stormwater BMPs, which could result in management measures that qualify as LID techniques, but there is no mandate to maximize LID techniques. Development and adoption of an LID ordinance, as recommended by the BBCSWP should be considered. Whatcom County may wish to use Ecology's NPDES Phase II permit Minimum Requirement #5 as a means for evaluating LID techniques and performance. In addition, care should be taken to apply LID techniques appropriate for the project location (CH2MHILL, 2006). For instance, infiltration along coastal bluffs may not be appropriate due to concerns regarding slope stability and/or erosion.

The Birch Bay watershed also has a water resource special district designation (WCC 20.80.735) which restricts the amount and phasing of clearing as well as requiring tree canopy retention. Requirements include:

- Temporary erosion and sedimentation control measures;
- Phased clearing to limit the amount of exposed soil on-site at any one time; and,
- Soil stabilization in cleared areas.

The CAO also regulates development patterns and densities within the Birch Bay. The CAO applies to geologically hazardous areas, frequently flooded areas, critical aquifer recharge areas, wetlands, and fish and wildlife habitat conservation areas (which includes streams and marine shores). Protecting and managing critical areas helps maintain ecological processes and functions and preserves public health, safety and welfare of our community.

3.0 WHAT DOES THIS PILOT STUDY ENTAIL?

The pilot study has 5 main components, which are summarized below and described in Sections 4 through 7 of this report. Components 1 through 4 refer to Step 1 of the four-step process for using watershed characterization techniques in land use planning (see Figure 2). Component 5 refers to Step 2. Refer to Appendices B through E for detailed information on the methods associated with each component.

1. **Identifying Aquatic Resources and Basin Boundaries** - The watershed was delineated into 32 drainage sub-basins based on surface water flows as shown in Figure 6. The sub-basins were grouped into 4 general Watershed Assessment Areas (WAAs) for purposes of identifying management recommendations. Investigators then identified and mapped wetlands and streams, as shown in Figure 7, using high resolution aerial photograph stereo pairs and Light Detection and Ranging (LIDAR) data. Each wetland/stream polygon was assessed in terms of its general condition, level of alteration, size, and hydrogeomorphic type (Appendix B).

2. **Analyzing Future Development Patterns** - A futures-based land use and development scenario was developed to understand potential development patterns within the basin based on current regulatory and zoning frameworks applicable in Birch Bay (Appendix C).

3. **Evaluating Water Processes** - Patterns of water, nitrogen and pathogen movement through the watershed were identified using an approach developed by the Department of Ecology to determine the relative importance of each basin for these processes (Appendix D).

4. **Assessing Wildlife and Habitat Conditions** - Wildlife use and available habitat conditions within the watershed were assessed to provide greater context for understanding overall ecological conditions and future management options (Appendix E).

5. **Synthesizing information** - A general framework was developed to depict the potential suitability of individual sub-basins for future development and determine management priorities and recommendations for each sub-basin based on current conditions and anticipated build-out scenarios.

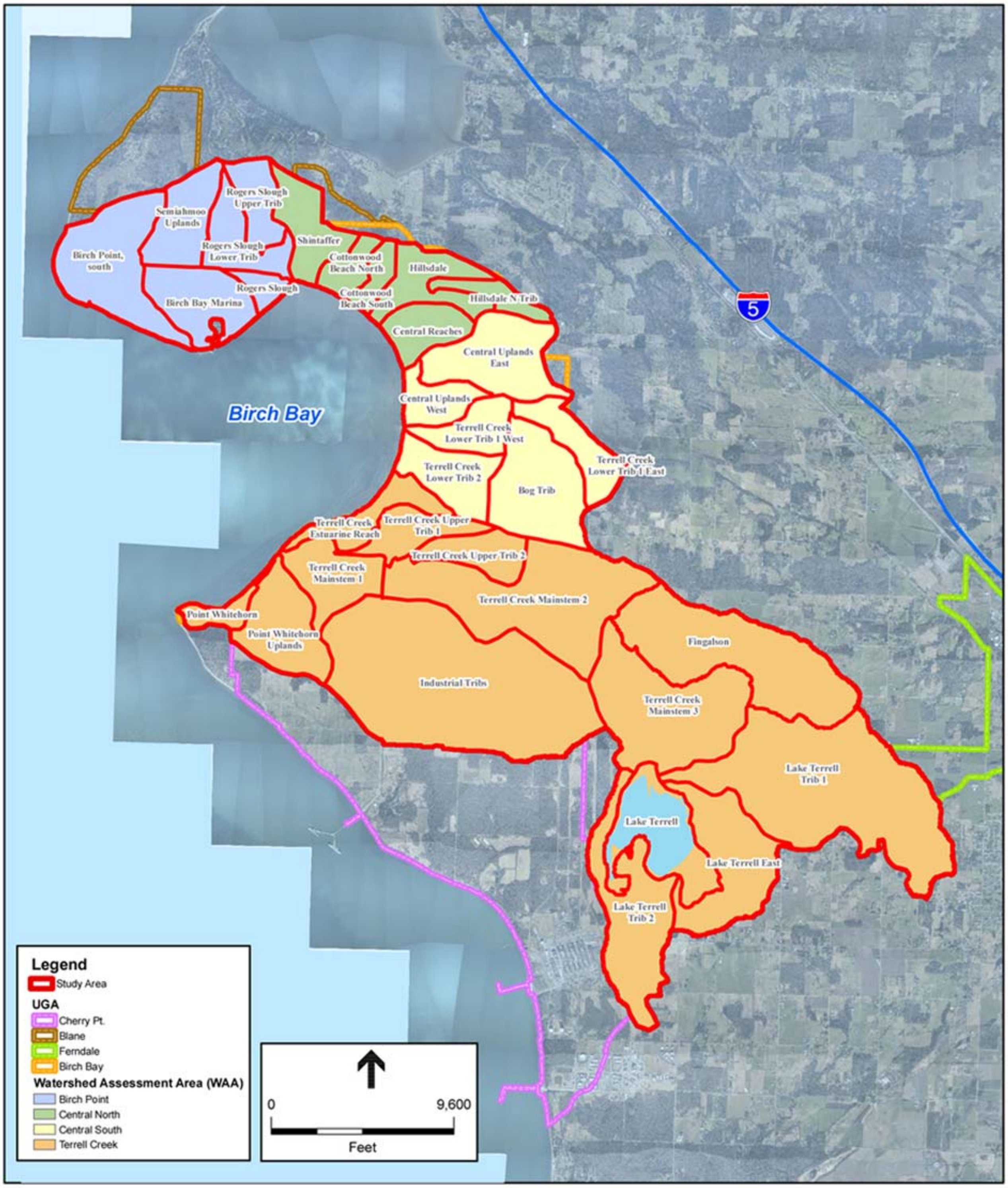


Figure 6: The Birch Bay watershed showing 32 sub-basins and 4 Watershed Assessment Areas

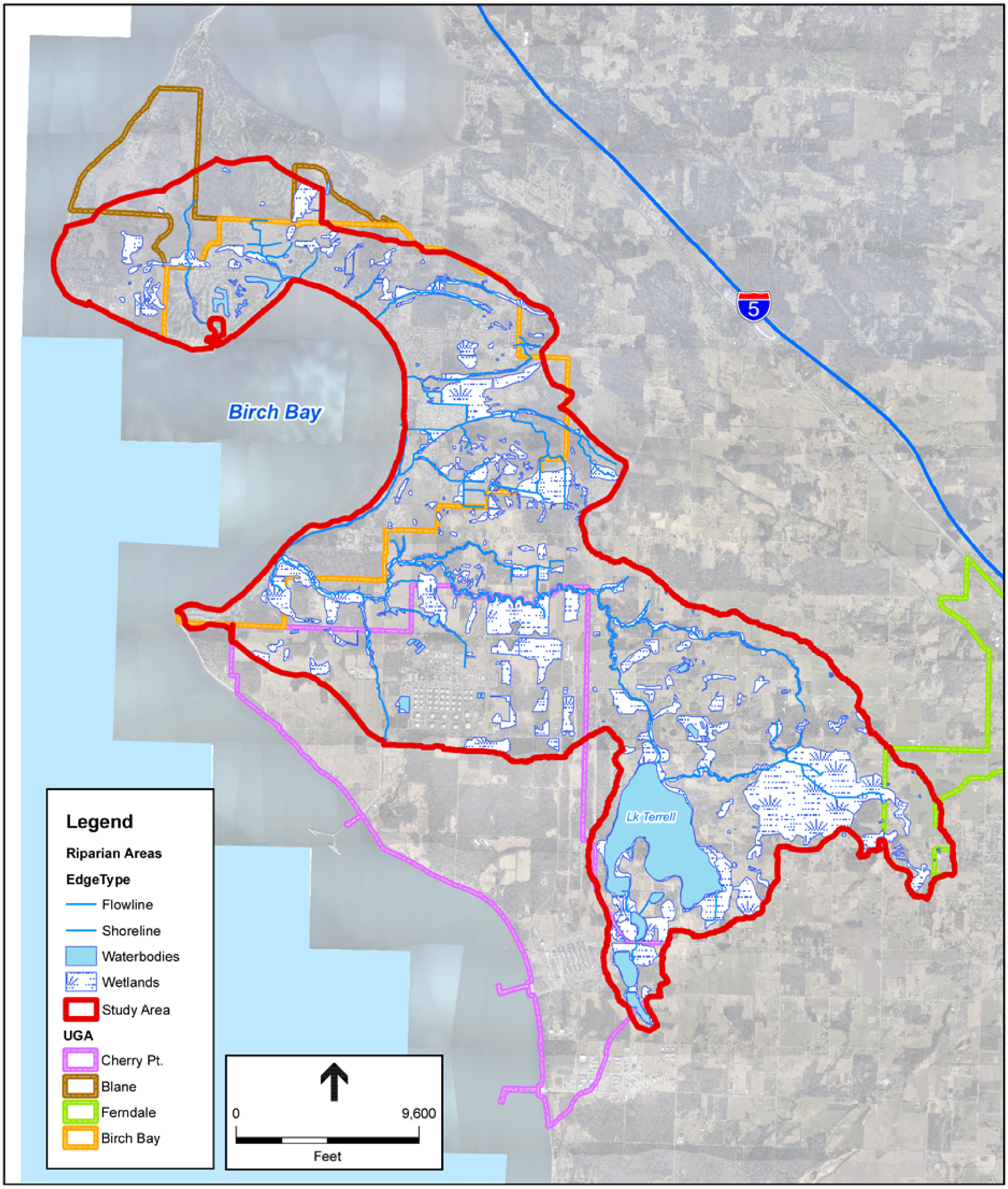


Figure 7: Wetland and stream resources in the Birch Bay watershed

4.0 HOW WERE FUTURE DEVELOPMENT PATTERNS ANALYZED?

Future development patterns were analyzed using a *futures scenario planning* framework. In general, futures scenario planning is an analysis technique designed to assess the relationships between human development actions and the impacts of these actions on natural processes and patterns (Hulse et al., 2000). A zoning-based, full-buildout, futures scenario plan (Planned Trend Scenario), used for this pilot study, analyzes the expected location of future development within a defined area, and estimates the number of new dwelling units (residential units) when all land available for development is developed at the highest intensities possible, per current zoning regulations. The build-out is correlated with future changes in impervious surface coverage to anticipate development impacts based on available scientific literature. Although this analysis technique does not predict when build-out will occur, it is useful in long-term planning efforts as a way to understand the potential for future growth and the impacts of such growth on natural resource processes in a specified area such as the Birch Bay watershed.

> **Futures Scenario Planning** is a technique designed to assess the relationships between human development actions and the impacts to natural processes and patterns (Hulse, 2000).

Zoning-based futures scenario planning for full build-out has several potential drawbacks. The first is that full build-out scenarios tend to over-estimate actual growth and associated impacts for a given study area (Nelson and Graham, 2003). For example, full build-out analysis makes the assumption that all areas will develop to the highest density allowed by the current zoning regulations, and then multiplies each zoned area by the average impervious cover for its associated zoned land use. However, full build-out rarely occurs at the densities that zoning allows. Consequently, much of the potential development based on zoning regulations may not occur due to local economic conditions or a lack of available infrastructure. Thus, zoning-based build-out scenarios can represent a worst-case scenario for development impacts to ecological processes and habitat conditions (Zielinski, 2002).

The second limitation is that this type of land use scenario development only takes into context residential zoning districts. Zoning districts with commercial or industrial classifications have minimal potential residential dwelling unit capabilities and are thus considered outside of the scope of the information generated for the scenario. For this analysis, all commercial and residential zoning districts are assumed to have the potential to develop to full capacity, and are thus integrated into the evaluations of impervious surface, but are not included in the density calculations.

For the purposes of this pilot study, four steps were taken to evaluate current development patterns within the watershed as well as the Planned Trend Scenario (Table 4-1). The explicit methods used to create the Planned Trend Scenario are described in detail in Appendix C.

Table 4-1: Steps for Conducting a Build-Out Analysis

Step 1 – Assess Current Development Patterns (Residential Location & Density)

Step 2 – Identify Buildable Areas per Whatcom County Regulations

Step 3 – Assess Future Development Patterns (Location & Density)

Step 4 – Evaluate Changes to Impervious Coverage

The first step includes identifying current residential development patterns and densities within the watershed using parcel and zoning district data provided by Whatcom County. To do this, each parcel is assigned a potential development characterization code (Table 4-2) depending on current development intensities and the amount of remaining parcel area for development.

Table 4-2: Potential Development Characterization Codes

Development Code	Definition
Fully Developed Lot	Any legal lot of record, which cannot be subdivided and already has a dwelling unit or some other structure.
Undeveloped Parcel	Any vacant parcel, which may be subdivided or developed with more than one dwelling unit.
Underdeveloped Parcel	Any parcel, which currently contains one or more dwelling units and that may be subdivided or developed with additional dwelling units.
Vacant Lot	Any legal lot of record, which meets the minimum size requirement of the zone, but cannot be subdivided, and is vacant.
Non-Conforming Vacant Lot	A legal lot of record that does not meet the minimum size requirement of the zone but is vacant.

The second step is to determine the amount of buildable land remaining within the watershed. Coupled with the initial step, the buildable land estimate guides the determination of future land uses within the Birch Bay WMU. In an effort to identify remaining buildable lands, protected open space and land that is undevelopable for reasons such as the presence of wetlands, streams (or other habitat conservation areas), geologically hazardous areas, or critical aquifer recharge areas as defined by the CAO (WCC 16.16) are excluded from this category. As part of this analysis, wetland buffers were based on assumed categories of quality. Due to the lack of specific data regarding the condition of the identified wetland habitats, minimum buffer areas were applied as defined by WCC 16.16. Stream buffers were assigned based on the stream type as defined in WCC 16.16. The remaining land located outside of critical areas and buffers is assumed to be available for future development.

Building from steps one and two, the third step is to assess locations and patterns of potential future development within the watershed. Aggregated to the sub-basin scale this analysis depicts the *vulnerability* of sub-basins within the Birch Bay WMU to potential future residential development. Appendix C provides specific information regarding the methodology used and steps taken to derive the potential residential development densities within the watershed.

Vulnerability, as used in this pilot study, is a measure of the potential increase in development intensity (as indicated by increased dwelling unit density) and in impervious surface cover. When these attributes increase due to build-out, ecological resources are at greater risk of degradation or impact.

The fourth and final step is to calculate and assess the total area of *impervious surface* within the watershed sub-basins. This step is done concurrently with steps two and three to contribute to understanding the vulnerability of each sub-basin to potential development and to aid in the impact assessment of current development patterns on ecosystem health.

To assess current impervious conditions, impervious surface coefficients for each zoning classification are developed through a spatially derived data merger between the Whatcom County parcel data and data developed by the National Oceanic and Atmospheric Administration (NOAA) through the Coastal Change Analysis Program (C-CAP) (Table 4-3). Following a qualitative comparison of other impervious surface analyses performed per land use types for relative accuracy (Nelson and Graham, 2003 and May et al., 1997), the coefficients for each land use are then aggregated to the sub-basin scale to assess current land use intensities for each WAA within the watershed.

Impervious surfaces are surfaces that cannot be effectively penetrated by water, thereby resulting in surface runoff. Watersheds with high amounts of impervious surface area are at risk for stream and wetland degradation, flooding and other impacts.

Table 4-3: Average Impervious Surface Percentage per Parcel for Each Zoning Type

Zoning Type*	Average Impervious %	Parcel Count
Heavy Industrial	65.6	11
General Commercial	48.7	28
Light Industrial	27.3	3
Neighborhood Commercial	47.1	10
Rural Residential (10 AC)	19.3	33
Rural Residential (5 AC)	22.4	400
Recreational Commercial	40.9	271
Urban Residential (3/AC)**	38.5	18
Urban Residential (4/AC)	41.6	1684

Zoning Type*	Average Impervious %	Parcel Count
Urban Residential, Medium Density (6/AC)	40.5	1152
Recreational Open Space	12.9	7

*Zoning district URM24 is not represented in high enough densities to generate average impervious areas.

** UR3 Zoning District is applied to land within City of Blaine jurisdiction based on growth projections and developable area available (City of Blaine, 2006)

To develop the potential change in impervious surface densities within the Birch Bay watershed the potential dwelling unit density data is combined with the data describing the percentage of impervious surface for each land use. The outcome provides information regarding which sub-basins are at greatest risk for ecological impact due to increased development (e.g., the most vulnerable sub-basins within the watershed).

4.1 Why use impervious surface coverage as a predictor of environmental impact?

Impervious surfaces are any surface that cannot be effectively penetrated by water, thereby resulting in stormwater runoff. In other words, the water that is produced during a rain event cannot soak into the ground creating surface flow. Impervious surfaces are generally extensive in urbanizing areas. Some examples include buildings, driveways/roadways, parking lots, sidewalks, and compacted soils.

In the Puget Sound region, significant research has been conducted over the past two decades on the negative relationship between increasing amounts of impervious surfaces within a drainage basin and ecological parameters such as water quality and flow conditions in streams (Alberti et al., 2007; Booth and Jackson, 1997; May et al., 1997; Booth et al., 1996; Horner et al., 1996; Luchetti and Fuersteburg, 1993). Impervious surface coverage has become a key issue in watershed planning and characterization due to the impact these surfaces have on ecological health (Table 4-4) (Arnold and Gibbons, 1996).

Table 4-4: Characteristics of Impervious Surfaces (adapted from Arnold and Gibbons, 1996)

1	Impervious surfaces are a functional characteristic of urbanization
2	Impervious surfaces prevent infiltration of precipitation to groundwater
3	Impervious surface ratios are correlated to hydrologic alterations in the urban environment
4	Impervious surfaces degrade water quality conditions through the conveyance of pollutants

From a planning perspective, it is important to quantify impacts of imperviousness on ecological health and identify thresholds at which definitive changes in ecosystem condition occur. Although researchers have identified trends that generally support the identification of such thresholds, from a hydrological perspective the level of impact appears to be continuous rather than threshold pattern (May et al., 1997; Booth and Jackson, 1997). Figure 8[3] shows that as the level of imperviousness increases, stream quality transitions from "sensitive" to "impacted" to "non-supporting" (meaning that the stream is not capable of supporting basic ecological functions).

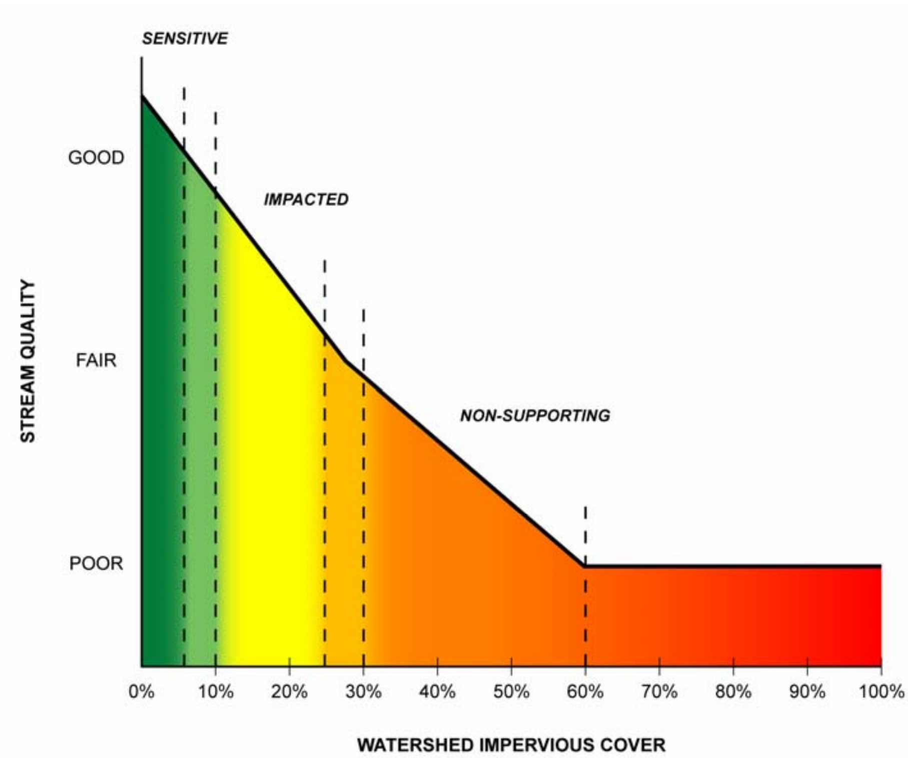


Figure 8: Relationship between impervious cover and impacts to stream quality.

[3] **Figure 8 highlights transitional response zones between sensitive, high quality stream conditions (6-10% impervious cover) and impacted, non-supporting conditions (25-30% impervious cover) (Adapted from Center for Watershed Protection (www.cwp.org)).**

4.2 What are the findings of the future development analysis?

4.2.1 Impervious surfaces

One of the most telling findings from the analysis of the Planned Trend Scenario is that although there is an expected increase in the intensity of development, the signatures of this development have relatively little impact to impervious levels at the sub-basin scale. Based on the categories for impacts to stream quality shown in Figure 8, the majority of sub-basins remain within the same category of “sensitive”, “impacted”, or “non- supporting.” The anomalies to this trend include the Industrial Tributaries and Point Whitehorn Uplands sub-basins in the Terrell Creek WAA where an assumption was applied in the analysis that all non residential land uses had potential for full build-out increasing the impervious percentages to those shown in Table 4-3 for each non-residential zoning district. The Cottonwood Beach South sub-basin, located in the Central North WAA, is situated almost entirely within the UGA boundaries and has a moderate potential for future development. Within this framework, the sub-basin will move from “sensitive” to “impacted.” Figure 9 and 10 show the current impervious surface levels and potential for changes (increases) in impervious surface per sub-basin under build-out conditions.

4.2.2 Development intensity

Figure 11 shows the buildable areas (at the parcel scale) within the watershed that are currently undeveloped, underdeveloped or vacant. These areas are likely to experience the greatest increase in development intensity over time as residential build-out occurs. Collectively, the sub-basins in the Terrell Creek WAA have the lowest potential for increased development intensity. This is primarily due to the relatively rural zoning district, R5A that dominates much of the upper watershed around the lake. Development intensities will likely increase on the industrial lands owned by BP within the Cherry Point UGA and within the very upper portion of the Lake Terrell Tributary 1 sub-basin in which includes the City of Ferndale UGA. In general, like the rest of the watershed residential development intensities increase within the UGA, closer to the Bay.

The Central South WAA has the highest potential for increased development intensity within the Birch Bay watershed. Primarily located within the densely zoned UGA, the potential areas of highest development intensity are located within a half-mile of the Bay. The upper sub-basins, Terrell Creek Lower Tributary 1 East and the Bog Tributary, located outside the Birch Bay UGA, contain rural zoning districts such as R5A and R10A with many parcels already meeting the allowable development densities. This results in a lower potential for future development than the other basins within the Central South WAA.

The Central North WAA is also primarily contained within the Birch Bay UGA and currently contains the highest intensity of development levels within the watershed. An exception to this generality is the Cottonwood South sub-basin. This sub-basin is currently only developed in the lower portions of the sub-basin, but based on the UR4 zoning district given to the upper watershed has the potential for an appreciable increase in development intensity.

The Birch Point WAA contains the greatest amount of variability of all the WAAs within the watershed. Although current impervious levels are relatively low within many of the sub-basins, including Birch Point, Semiahmoo Uplands and Lower and Upper Rogers Slough Tributary, the potential for increased residential development intensities within these areas is moderate to high. The Birch Bay Marina and Rogers Slough sub-basins located within the UGA are already relatively densely developed, but will accommodate moderate amounts of future growth based on current zoning regulations.

4.2.3 Vulnerability

Figure 12 shows the areas of the watershed that are most vulnerable to ecological impacts as a result of increased development. As stated previously, vulnerability is a measure of the potential increase in development intensity (as indicated by increased dwelling unit density) and in impervious surface cover. When these attributes increase due to build-out, ecological resources are at greater risk of degradation or impact. As would be expected, the higher the potential residential density in a zoning district, the greater the potential change to impervious surface coverage, and the more likely ecological resources will be impacted. The results of the land use assessment are summarized generally in Table 4-5. The table provides a summary of findings related to the vulnerability of sub-basins and WAAs to potential future development pressure.

Table 4-5: Potential Development Change of Sub-basins and Watershed Assessment Areas (WAA)

WAA	Sub-basin	Current Impervious Surface Levels	Potential Increase to Impervious Surface Levels[1]	Potential Development Intensity[2]	Sub-basin Vulnerability[3]	WAA Vulnerability[3]
Terrell Creek	Lake Terrell East	Low to Mod.	Low	Low	Low	Low to Moderate
	Lake Terrell Trib 1	Low to Mod.	Moderate	Low to Mod	Low to Mod.	
	Lake Terrell Trib 2	Low to Mod.	Low	Low	Low	
	Lake Terrell	Low	Low	Low	Low	
	Terrell Creek Mainstem 3	Low to Mod.	Low	Low	Low	
	Terrell Creek Mainstem 2*	Moderate	Moderate	Low to Mod	Moderate	
	Terrell Creek Mainstem 1	Low to Mod.	Low	Moderate	Moderate	
	Fingalson	Low	Moderate	Low	Low to Mod.	
	Industrial Tributary*	Mod. to High	High	High	High	
	Point Whitehorn Uplands*	Low to Mod	High	High	Mod. to High	
	Point Whitehorn	Moderate	Low	Moderate	Low to Mod.	
	Terrell Creek Upper Trib. 1	Moderate	Moderate	Low to Mod	Moderate	
	Terrell Creek Upper Trib. 2	Low to Mod.	Low	Low	Low	

WAA	Sub-basin	Current Impervious Surface Levels	Potential Increase to Impervious Surface Levels[1]	Potential Development Intensity[2]	Sub-basin Vulnerability[3]	WAA Vulnerability[3]
	Terrell Ck. Estuary	Moderate	High	Mod to High	Mod. to High	
Central South	Terrell Ck. Lower Trib. 2	Moderate	High	Mod to High	Mod. to High	Moderate to High
	Terrell Ck. Lower Trib. 1 West	Mod. to High	High	High	High	
	Terrell Ck. Lower Trib. 1 East	Low to Mod.	Low	Low to Mod	Low to Mod.	
	Bog Tributary	Low to Mod.	Low	Low to Mod	Moderate	
	Central Uplands West	High	High	High	High	
	Central Uplands East	Moderate	High	Mod to High	Mod. to High	
Central North	Central Reaches	High	High	Mod to High	Mod. to High	Moderate
	Hillsdale	Moderate	High	Moderate	Mod. to High	
	Hillsdale N	Low to Mod.	Low	Moderate	Moderate	
	Cottonwood Beach South	Low	Moderate	Moderate	Moderate	
	Cottonwood Beach North	Moderate	High	Moderate	Moderate	
Birch Point	Shintaffer	Low to Mod.	Moderate	Moderate	Moderate	Moderate
	Rogers Slough	High	Low	Mod to High	Moderate	
	Rogers Slough Lower Trib	Moderate	High	Mod to High	Mod. to High	
	Rogers Slough Upper Trib	Low to Mod.	Moderate.	Moderate	Moderate	
	Birch Bay Marina	High	High	Moderate	Moderate	
	Semiahmoo Uplands	Low to Mod.	Moderate	Moderate	Moderate	
	Birch Point South	Low	Moderate	Low	Low to Mod.	

[1] Represents the degree to which impervious surface cover has the potential to increase in each sub-basin, based on impervious cover coefficients per land use district and potential dwelling densities.

[2] Categories based on the potential development of residential units per sub-basin, based on the aggregation of potential dwelling densities at the parcel scale.

[3] Vulnerability of Sub-basin / WAA to increased levels of residential development, based on a qualitative assessment of potential change in development intensity and potential increase to impervious surface levels

*Note: Sub-basins with industrial land zone districts are assumed to have a high vulnerability to potential change caused by development.

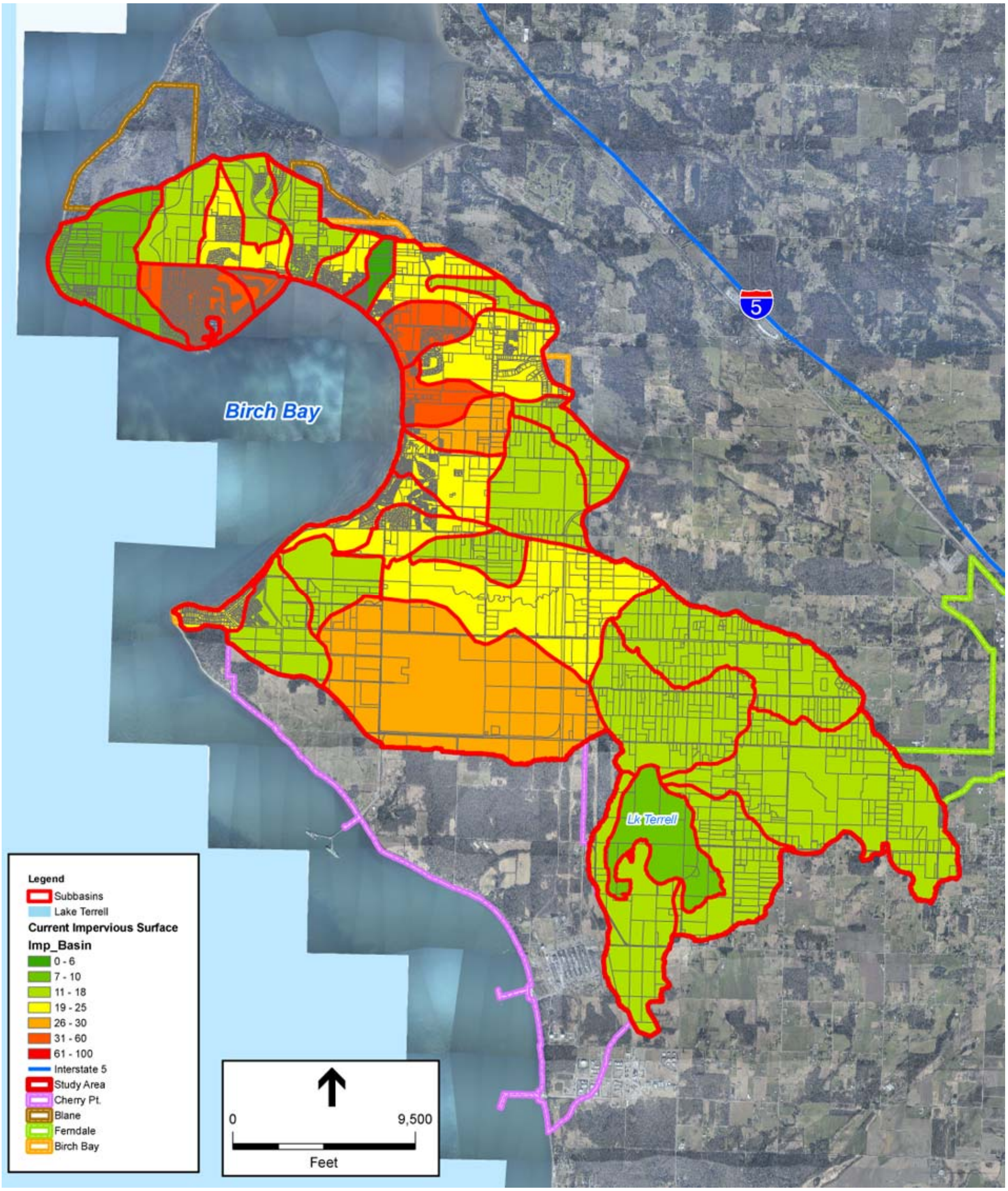


Figure 9: Current levels of impervious surface throughout the watershed

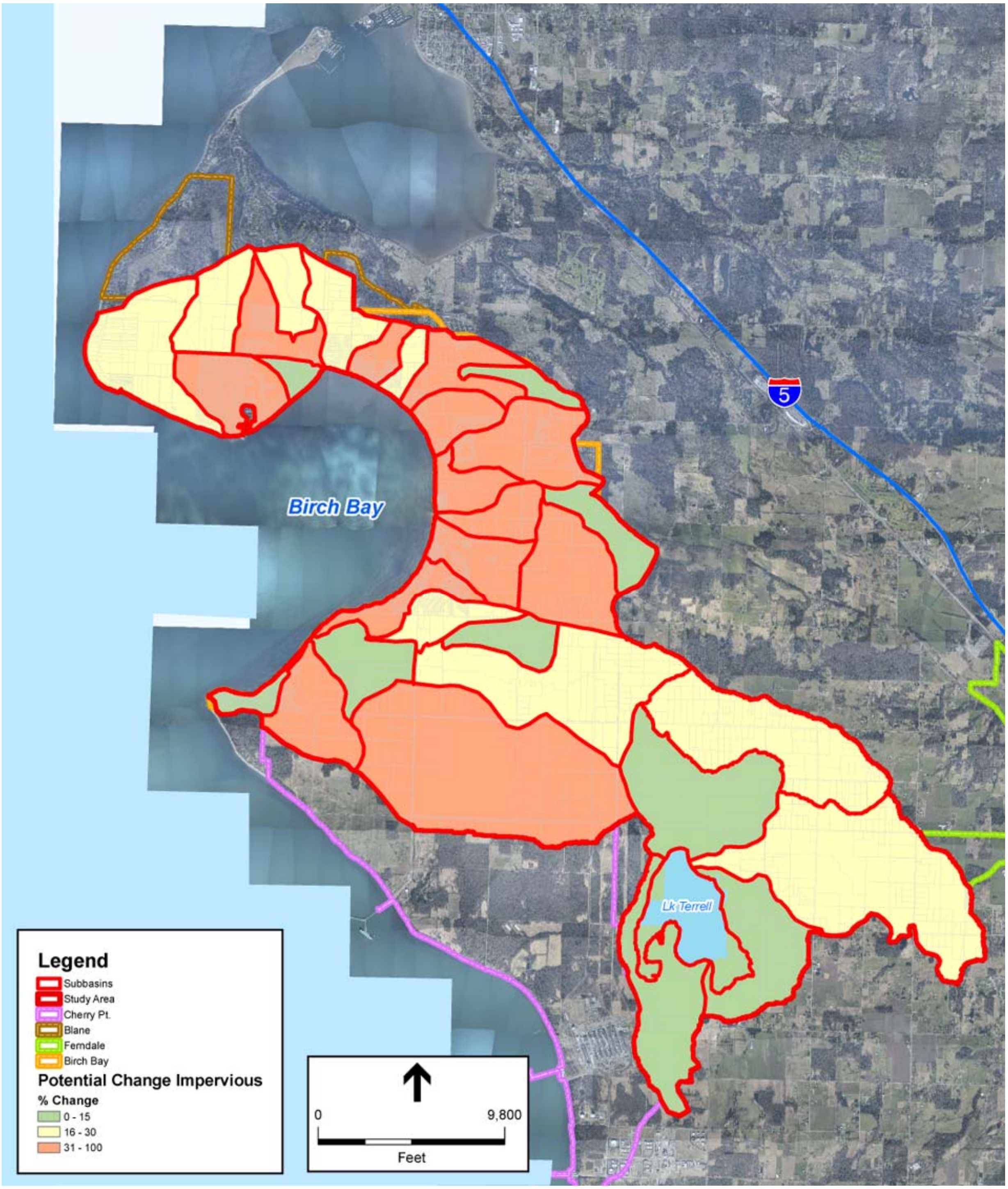


Figure 10: Estimate of percent change in impervious surface based on build-out conditions per sub-basin

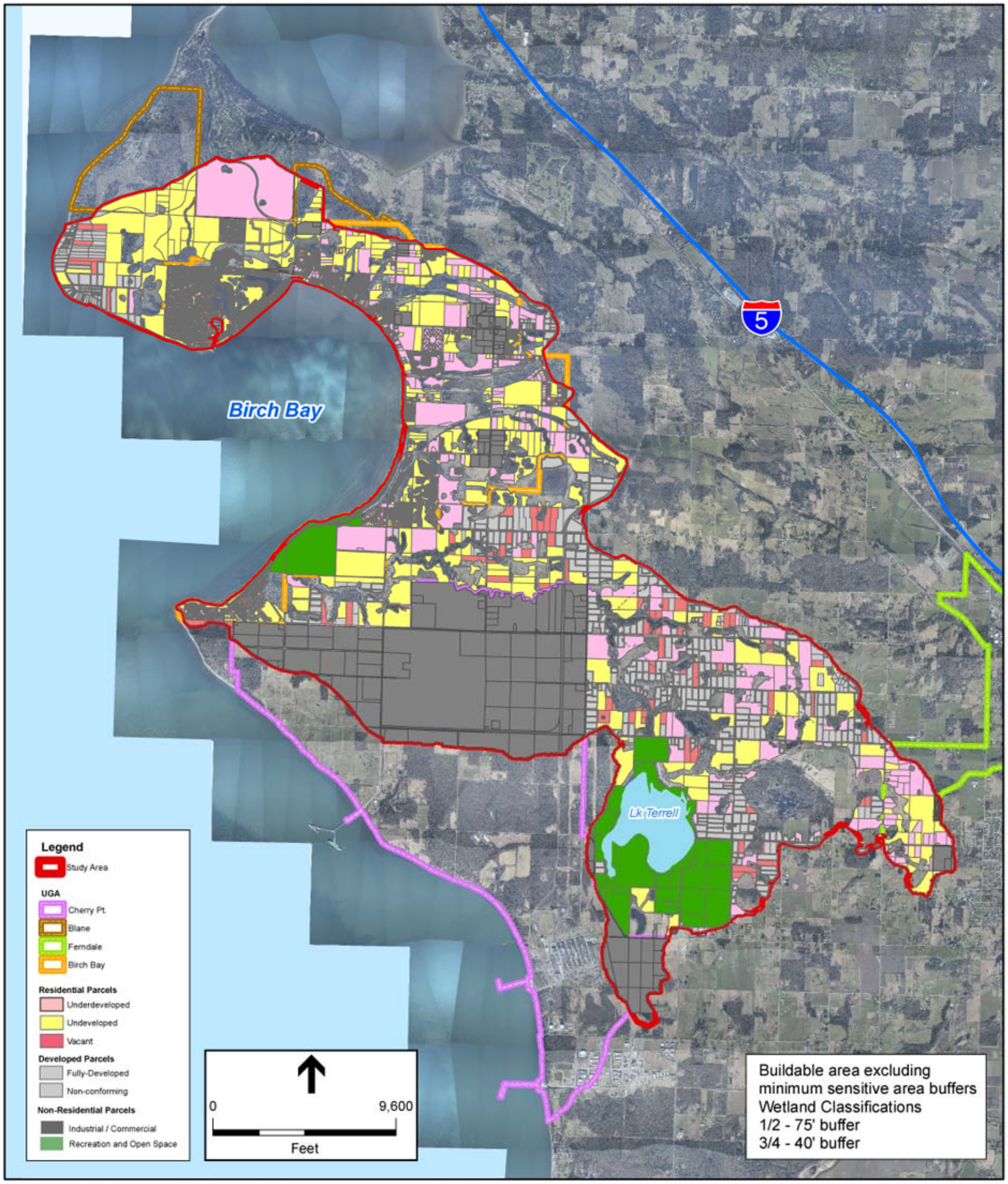


Figure 11: Potentially buildable areas that are currently undeveloped, underdeveloped, or vacant.

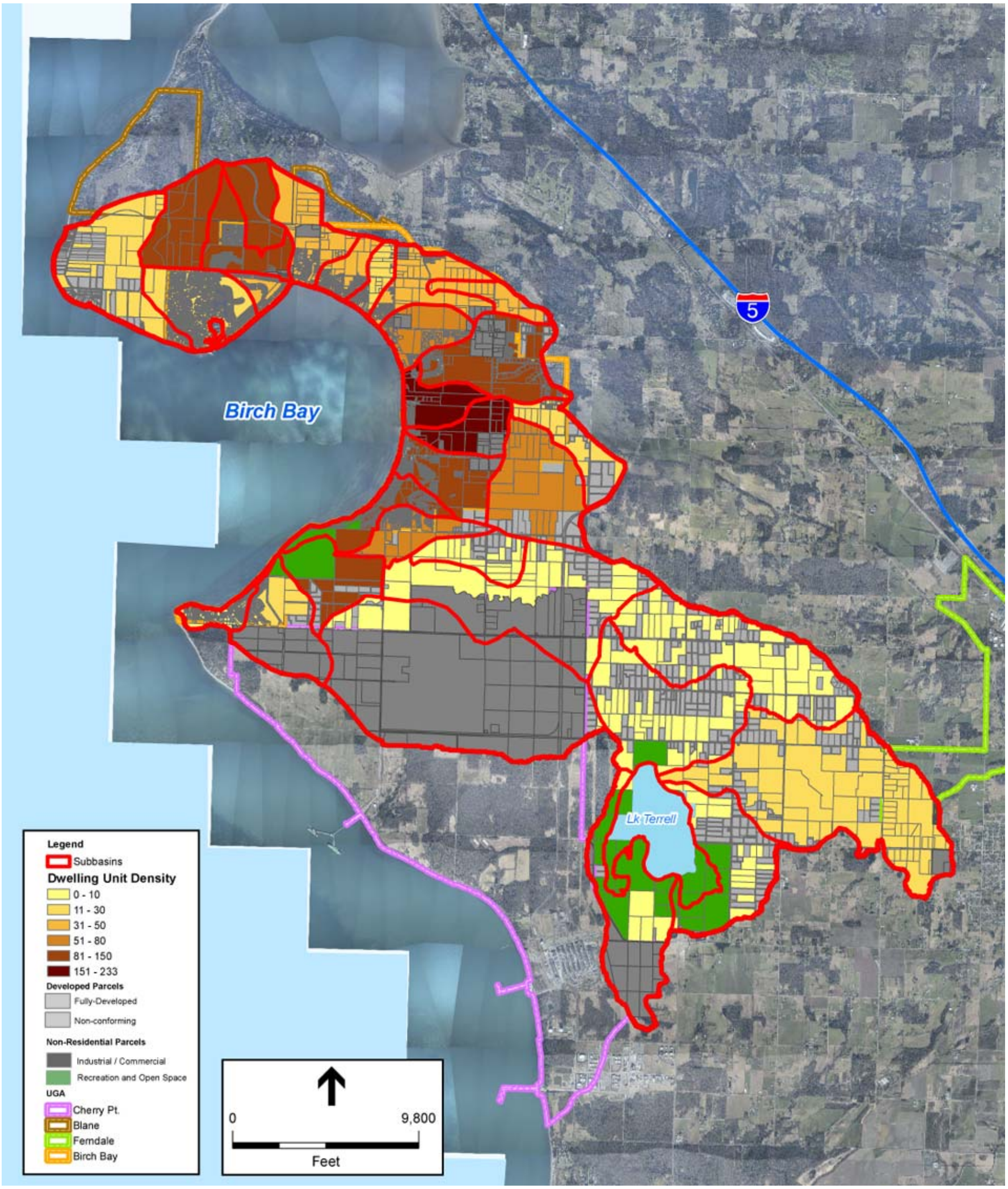


Figure 12: Relative vulnerability of areas to ecological impact due to increased development at build-out.

5.0 HOW WERE WATER PROCESSES CHARACTERIZED?

The tools and methods applied in this pilot study to characterize the hydrological and ecological water processes are thoroughly described in Ecology Publication #05-06-027, *Protecting Aquatic Ecosystems: Volume 1, A Guide for Puget Sound Planners to Understand Watershed Processes* and *Volume 2, Models for Understanding Watershed Processes* (Stanley et al., 2005). This approach assesses how water moves through the landscape and identifies areas within the watershed that are most important–on a relative scale–to maintaining a healthy hydrologic cycle (Figure 13). A detailed description of how this method was applied in the Birch Bay watershed is provided in Appendix D.

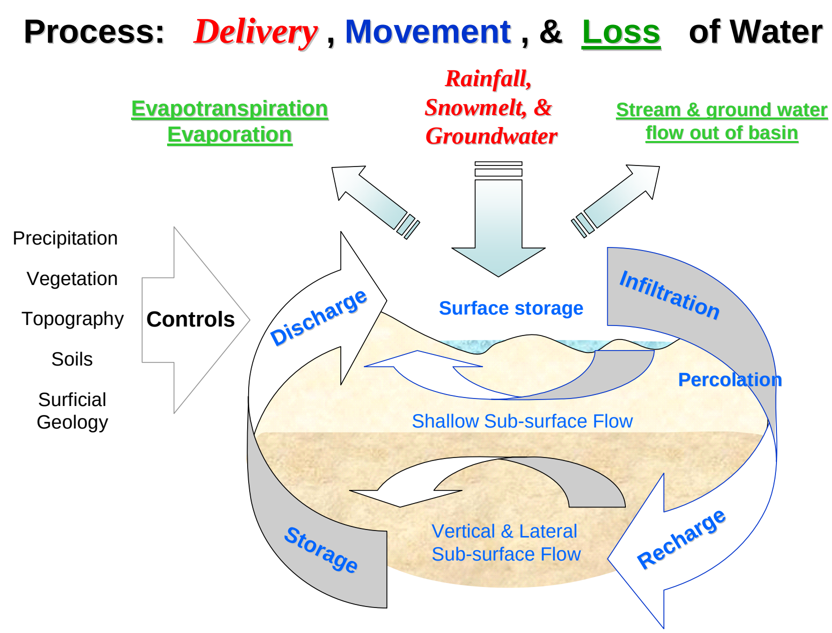


Figure 13: The hydrologic cycle showing water movement through the landscape (Source: Stanley et al., 2005)

The method focuses on five essential steps for understanding watershed processes (Table 5-1). The five steps use existing environmental data and land use information. The method is designed to apply a simple, rapid, and inexpensive approach using readily available data. In addition, the method is adaptable to localized watershed conditions like Birch Bay.

Table 5-1: Five Steps for Understanding Watershed Processes (Stanley et al., 2005)

1	Identify the purpose for analyzing watershed processes
2	Map the area for analysis
3	Map key areas for watershed processes
4	Map areas where watershed processes have been altered
5	Identify sub-basins for potential restoration and protection actions

This pilot study focuses on three watershed processes that play a key role in structuring and maintaining aquatic ecosystems within the Puget Sound Region (Naiman et al., 1992; Beechie and Bolton, 1999; Beechie et al., 2003). These processes are the movement of:

- Water
- Nitrogen, and
- Pathogens (fecal coliform)

These processes were chosen, because:

1. Changes in the hydrologic regime can cause erosion, increased rates and severity of flood events, loss of groundwater recharge, and decreased low flow volumes, which can adversely affect humans, fish, and wildlife.
2. Excess nitrogen can cause anaerobic conditions in lakes, wetlands, and bays, which are commonly, associated with fish kills around the Puget Sound region.
3. High concentrations of pathogens within surface water can be toxic to both humans and wildlife species.

Areas of importance is a term used in this study to identify areas that because of their inherent characteristics of soil, geology, or landscape position play a relatively greater role in the performance of beneficial process such as infiltration, discharge, denitrification and pathogen removal.

The analysis identifies *areas of importance* and *areas of alteration* for infiltration/discharge, denitrification and pathogen removal and recommends management strategies for each Sub-basin as described in Section 7.

Important areas are identified based on the presence of wetlands, floodplains, riparian areas and highly permeable geologic deposits. Areas of alteration are indicated by relatively high levels of impervious surface, areas of wetland loss, and areas with abundant sources of fecal coliform bacteria (see Appendix D for a complete explanation).

Areas of alteration are places where key processes are considered to be more noticeably impaired relative to other subbasins for the purposes of this study.

5.1 What are the findings of the process analysis?

The findings generated from the water process analysis are presented here for each analyzed process (hydrology, nitrogen and pathogens) along with a cumulative assessment of the process conditions within the Birch Bay watershed. For each process, the characterization reveals the relative level of importance and degree of alteration for each sub-basin. The assigned values of high, medium and low are not absolute and cannot be compared to sub-basins outside the watershed.

5.1.1 Hydrological processes

As stated previously, the Birch Bay watershed has been altered from natural conditions by human activity within the basin. However, the intensity of alteration in the form of forest clearing, degree of wetland filling, and amount of stream alteration varies significantly in the watershed. In areas of low development intensity such as in the upper sub-basins of the Terrell Creek WAA, hydrologic processes are still primarily intact and functioning. Common alterations in these low intensity areas include forest clearing and ditching of streams and wetlands for agricultural and residential land uses.

In areas where more extensive development alterations have taken place, such as the lower reaches of the Birch Point, Central North, and Central South WAAs, the potential that hydrological processes have been altered increases significantly. Higher intensity alterations include filling wetlands for development purposes, constructing formal drainage systems, and increases in the amount of impervious cover due to more urban development.

As Figure 14 shows, the highest-ranking (most important) areas for hydrological processes include the upper sub-basins of the Terrell Creek WAA (e.g., Fingalson) as well as several of the sub-basins in the South Central WAA including the estuarine reach of Terrell Creek (just above the mouth of Terrell Creek). Areas of less importance from a hydrological perspective include Birch Point and Point Whitehorn as well as several of the sub-basins within the North Central North WAA. Figure 15 shows the relative levels of alteration in each area.

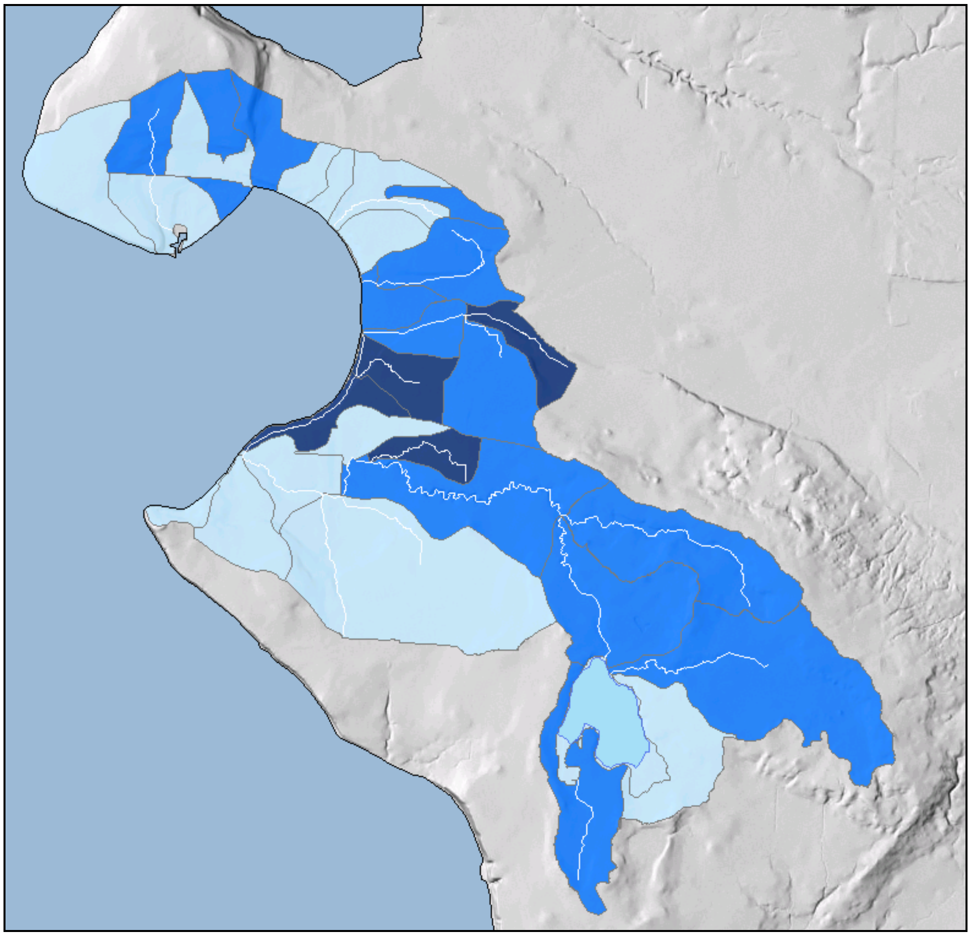


Figure 14: Areas of high, medium and low importance for hydrologic process (high = dark blue, med = medium blue, low = light blue)

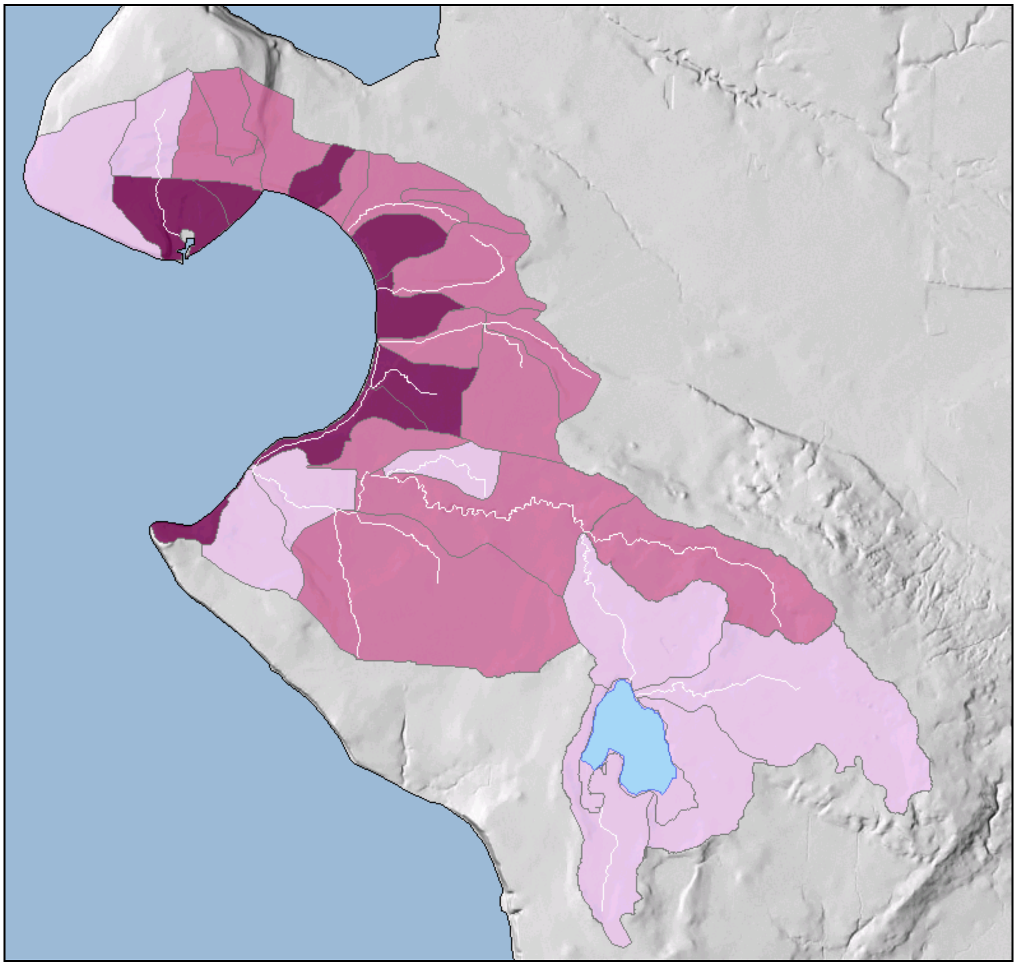


Figure 15: Areas of high, medium, and low alteration (high = dark pink, medium = medium pink, low = light pink)

5.1.2 Nitrogen processes

Denitrification is the process of reducing highly oxidized forms of nitrogen available for consumption by many groups of organisms into gaseous nitrogen. This process takes place under special (low oxygen) conditions found in some wetlands, lakes, and lowland riparian environments. The denitrification process is important in areas of increasing land use intensity because of these areas typically generate high nitrogen loads as a result of agricultural and urban land uses. It is also important that denitrification environments are located in lower areas of the watershed because denitrification efficiency increases in areas where there are higher levels of nitrogen inputs. Therefore, factors that affect the importance of a sub-basin for performing dentrification processes include total percentage of wetland and riparian areas relative to other sub-basins and the location of the wetlands and streams relative to nitrogen producing land uses.

Within the Birch Bay watershed, the sub-basins of highest denitrification importance are located in the Central South WAA, in Lake Terrell, and the upper sub-basins of the Terrell Creek WAA. These classifications are based on both the amount and location of wetland and riparian areas (Figure 16). However; alteration to denitrifying environments caused by the filling and draining of wetland environments in Birch Bay is extensive, encompassing most of the larger watershed (Figure 17).

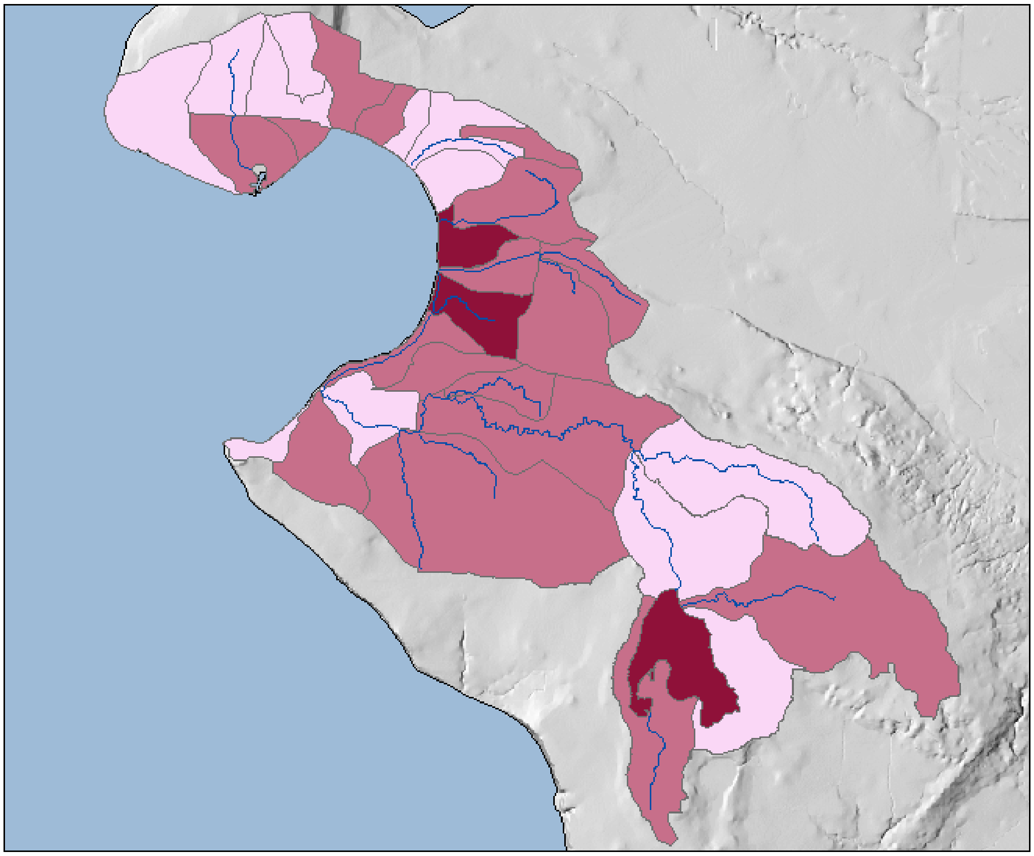


Figure 16: Areas of high, medium and low importance for denitrification (high = dark purple, medium = medium purple and low = light purple)

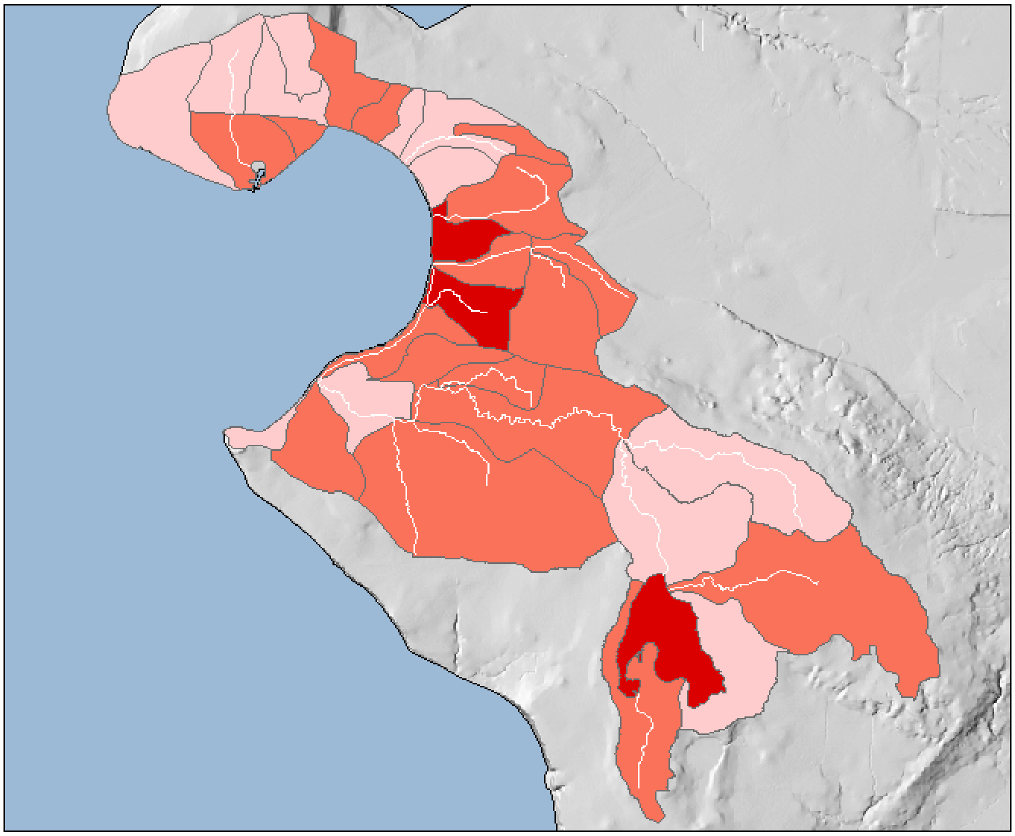


Figure 17: Areas of high, medium and low alteration for denitrification (high alteration = dark red, medium = orange and low = light red)

5.1.3 Pathogen processes

For the purposes of this pilot study, fecal coliform bacteria are used as the pathogen indicator for analysis. Fecal coliform bacteria are often present in high concentrations in aquatic environments near (downstream of) areas with high concentrations of septic systems, high levels of urbanization and ranching or dairy farming. Pathogens, such as fecal coliform bacteria, contribute to environmental problems when the rate of their transport through a watershed is increased due to channelization, paving, and filling/draining of wetlands or the presence of more sources.

Pathogens are removed from aquatic environments through sedimentation (includes adsorption), filtration by vegetation, movement through soils and loss through death of the organisms from environmental and biological factors (heat, UV radiation, predation). These processes work best in areas were surface waters are slowed (depressional wetlands and riparian areas) or infiltrated (permeable soils). Therefore, sub-basins with a high density of low-gradient streams and/or a high percentage of wetlands are not only effective at removing pathogens but can also provide a very effective network for the movement of pathogens if they are channelized and drained. This pattern is evident in the Birch Bay watershed. Areas that have a high stream density and high percentage of wetlands (i.e., Central South WAA and the upper sub-basins of the Terrell Creek WAA) not only have a high importance but a high level of alteration from development activities

(Figures 18 and 19). This includes the Terrell Creek Lower Tributary 1 East and Tributary 2, Terrell Creek Estuary, Bog Tributary, and Central Uplands West sub-basins.

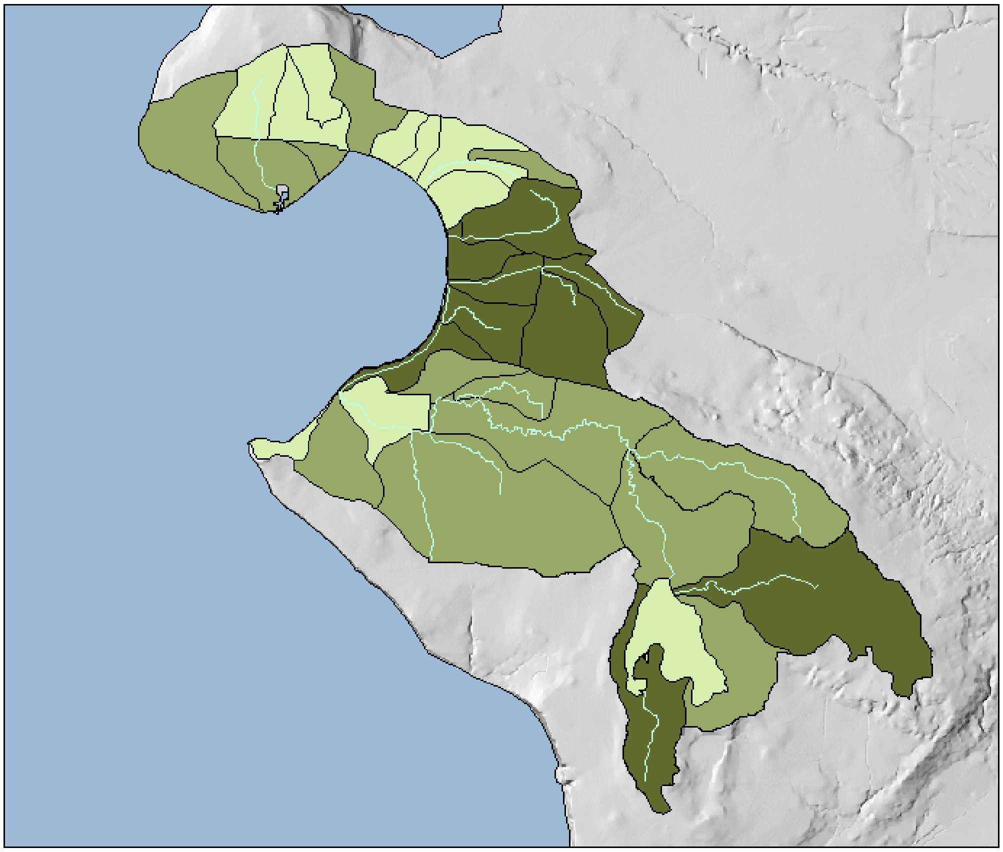


Figure 18: Areas of high, medium, and low importance for pathogen processes (high importance = dark green, medium = medium green, and low = light green)

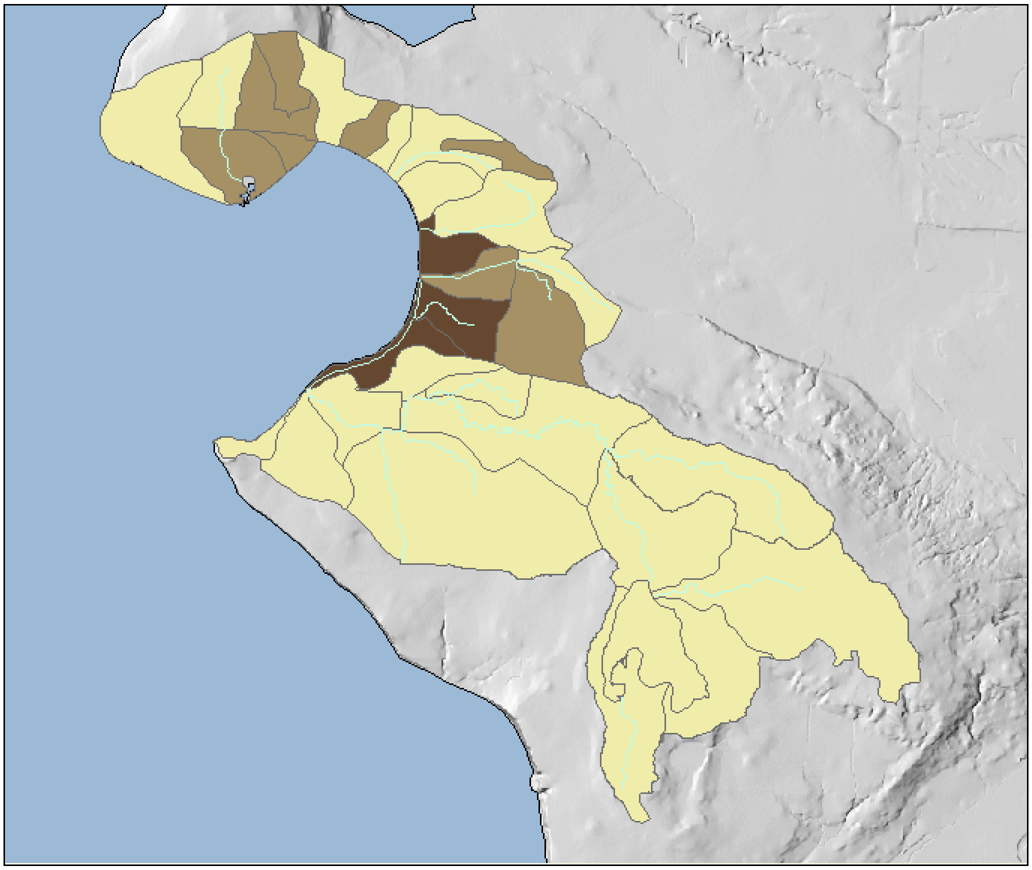


Figure 19: Areas of high, medium, and low alteration of pathogen processes (high alteration = dark brown, medium = brown, and low = tan)

6.0 HOW WERE HABITAT CONDITIONS ASSESSED?

For the purposes of this pilot study, WDFW analyzed current fish and wildlife habitat conditions at broad and mid-level scales using both countywide and watershed-based approaches, respectively. Figure 20 shows the broad scale analysis results are they pertain to Birch Bay. Also known as the Local Habitat Assessment Model (LHA), these scales of analysis provide an assessment of spatial patterns that indicate the relative suitability of the landscape to provide habitat for a select group of species listed in Table 6-1.[4] A detailed description of the wildlife assessment approaches and methodology is provided in Appendix E.

The mid-level scale, specific to the Birch Bay watershed, provides a higher level of detail than the countywide assessment approach. In this manner, land use constraints become more focused, and attention to individual species is more applicable to understanding the availability and quality of habitat conditions. There are limitations to this analysis however. The LHA model is developed as primarily a broad-scale analysis technique. Although results of the technique, when applied to the mid-level or sub-basin scale, are informative because they describe context, they are not a complete description of conditions. For example, there is an inherent bias in the model favoring forest species. This is appropriate at the county or broad scale, because historical losses of forest, and presumably the species that depend on large forest patches, predominate in terms of area. However; on a more localized scale other beneficial habitat types such as fallow fields, cleared areas that are not in pasture or production agricultural use that have been found to support the highest diversity of birds (Eissenger, 2007) than any other habitat type within the watershed, is scored lower in the LHA model because this habitat type cannot be distinguished from other non-wetland, open areas using the available land use/ land cover data sets.

To adjust for the limitations of the LHA model, local-scale assessments were conducted to identify indicators to habitat structure and wildlife conditions. The strongest indicator of high-quality habitat conditions is obviously confirmed reports of species presence in areas that meet the conditions for an important life need, such as breeding or concentrated foraging. More focused attention is provided to areas known to harbor a greater diversity of species, or greater populations of single species. To obtain confirmed reports of areas of high diversity and important populations, WDFW consulted with several local wildlife experts to compile a list of focal species present within the watershed. Representatives from the Nooksack Tribe, NSEA, Whatcom Marine Resources Committee, Whatcom County, locally based WDFW staff, and Nakeeta Northwest Wildlife Services provided valuable knowledge for this task and helped in generating a list of focal species for this analysis (Table 6-1).

[4] Pixel rankings in the underlying GIS data layers are rescaled for the watershed-based analysis, so the structure of the smaller scale assessment is internally consistent, but not quantitatively comparable to the countywide wildlife assessment and characterization.

Table 6-1: List of Focal Species for the Birch Bay Watershed.

Wildlife Response Groups	Species
Waterbirds	Common loon Great blue heron Waterfowl (multi-species)
Grassland/marsh birds	Short-eared owl Northern harrier Western meadowlark
Area-sensitive birds	Pileated woodpecker Song-birds (multi-species)
Mid-sized mammals	Bobcat[1]
Pond-breeding amphibians	Northern red-legged frog Western toad
Salmonids	Cutthroat trout Coho salmon
Nearshore spawning fish	Herring Sand lance Surf smelt
Shellfish	Various clam species

[1]Bobcats are believed to be present in the Lake Terrell Wildlife Area, and thus very likely in surrounding areas. Addressing their area and connectivity needs means many other mammals will be addressed as well.

From this list of species, categories of development-based stressors with the potential to impact habitat conditions, ecosystem processes, and interspecies relationships were developed to more fully understand the capacity and quality of habitat conditions available for the listed species and respective life stages. For a complete review refer to Appendix E.

In areas where species presence reports cannot be confirmed, the LHA model provides a structure to evaluate important landscape and habitat factors that determine the potential of an area to provide high-quality habitat. For example, one component of this analysis evaluates the type, extent, and connectivity of forest canopy connected to and within the Birch Bay watershed. The information for this type of landscape-scale assessment is generated from readily available Geographic Information System (GIS) data layers provided by ecoregional assessments, land use/land cover studies, road network descriptions and densities, and WDFW Priority Habitats and Species data.

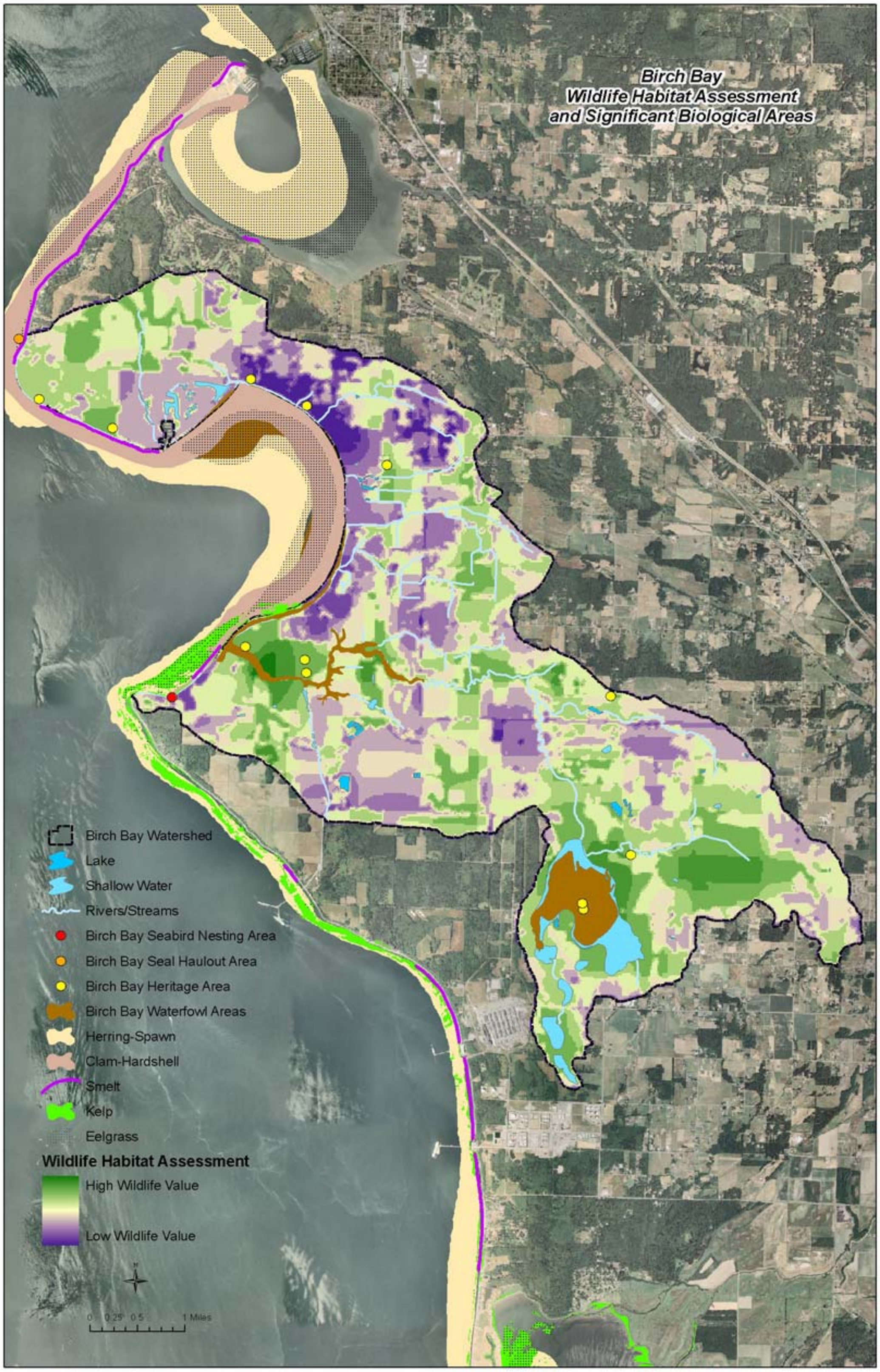


Figure 20: Broad-scale analysis indicating relative ranking for habitat value (green = high value, purple= lower value)

6.1 What are the findings of the habitat assessment?

The habitat assessment findings can be grouped according to 4 general habitat area overlays developed by WDFW as described below. The overlays are meant to identify specific geographic areas within the watershed where conservation activities can be focused.

1. Marine/Nearshore Conservation Overlay
2. Terrestrial Conservation Overlay
3. External and Internal Linkage Overlay
4. Watershed Areas Outside of the Wildlife Conservation Overlay

6.1.1 Marine/Nearshore Conservation Overlay

The marine riparian/nearshore component of the Birch Bay watershed extends from Birch Point to Point Whitehorn, encompassing the entire shoreline of Birch Bay, and includes a small estuary at the mouth of Terrell Creek, as well as pocket estuaries at the mouths of several unnamed drainages along the northern shore of the Bay. This component also includes both open water and fringe uplands. Although the most intense development in the watershed has occurred in the nearshore area, Birch Bay still supports a rich variety of wildlife that uses marine and nearshore habitat. For this analysis, WDFW the habitat requirements for waterbirds, forage fish, and shellfish were evaluated. These groups depend on broad habitat-forming processes, water quality processes, and a subtle intermixture of very specific habitat structures (Figure 20).

The broad processes that affect the persistence and biological integrity of these habitats are primarily the routing and delivery of sediments, nutrients/pathogens, contaminants, and, in the case of the Terrell Creek estuary, the routing and delivery of water. Primary sediment sources for long shore drift processes occur at Birch Point and Point Whitehorn. Nearshore developments, including bulkheads along Point Whitehorn and groins and jetties within Birch Bay have altered the natural supply and distribution of sediments. Sources and delivery of nutrients/pathogens to the marine system are controlled by upland activities and are delivered by surface runoff, drainage infrastructure, open channel streams, and Terrell Creek.

6.1.2 Terrestrial Conservation Overlay

The terrestrial conservation overlay highlights potential areas of critical terrestrial habitat located within sections of the Terrell Creek WAA and the headwater areas of the Central South WAA. Of critical importance for the diversity of species within these areas is the pattern or mosaic of diverse habitat types, e.g., forests, fields, fields associated with forest edges, streams, and wetlands. Birch Bay State Park, conservation lands along lower Terrell Creek, BP mitigation/conservation lands, and the WDFW Lake Terrell Wildlife Area lands are relatively protected conservation areas.

Within the Terrell Creek WAA there are two zones of critical importance: the Terrell Creek Core Zone, and the Amphibian/Wildlife Area Core Zone (Figure 21).

1. The Terrell Creek Core Zone is a broad area that encompasses the mainstem of Terrell Creek from the estuarine reaches, through the state park, to the vicinity of the main forks of the creek. This zone is of exceptionally rich fish and wildlife value, including important nesting, roosting, and staging areas for Great blue heron, amphibian use such as for Coastal giant salamander, and salmonids and other native fishes.

2. The Amphibian/Wildlife Area Core Zone is located in the SE corner of the Birch Bay watershed and is the primary headwaters area for Terrell Creek, including Lake Terrell (and the WDFW Wildlife Area lands). This zone is rich in wetland and stream resources, with relatively good connectivity, low traffic volumes (although two sides may have barrier traffic roads), and interspersed forested and open habitat. Dwelling densities are variable, but tend to be low. The combination of a core area of protected land at the WDFW wildlife area and the absence of major roads in this area provide the best opportunity in the watershed to focus on long-term conservation for amphibians such as the Northern red-legged frog, and Western toad (if extant). These species are very sensitive to development and traffic, and without focused measures would not be expected to persist in this watershed over time. This area additionally provides habitat for many more sensitive species of birds, mammals, and reptiles.

6.1.3 External and Internal Linkage Overlay

Because wildlife movement is not restricted by watershed boundaries, general areas along the watershed boundaries which can serve as connectivity zones into and out of the watershed for many species were identified as shown in Figure 21. To ensure that wildlife populations within the Birch Bay watershed do not become isolated, a functional level of connectivity should be maintained within these identified zones.

6.1.4 Areas Outside of the Fish and Wildlife Conservation Overlay

The Birch Point WAA, the Central North WAA, and the western portions of the Central South WAA, are not specifically included in the previous conservation overlay descriptions (with the exception of marine riparian, and flyways). These portions of the watershed include the most densely developed areas of Birch Bay. The intensity of development, higher traffic volumes, and lack of available habitat and habitat connectivity options means that development-sensitive species will have less opportunity to persist. This effect will intensify, as the human population within the watershed will continue to grow. However, some of the same habitat features (e.g., the mosaic of habitats, forested, and open) that exist within the terrestrial conservation overlay can be found here as well, and can be valuable for many species.

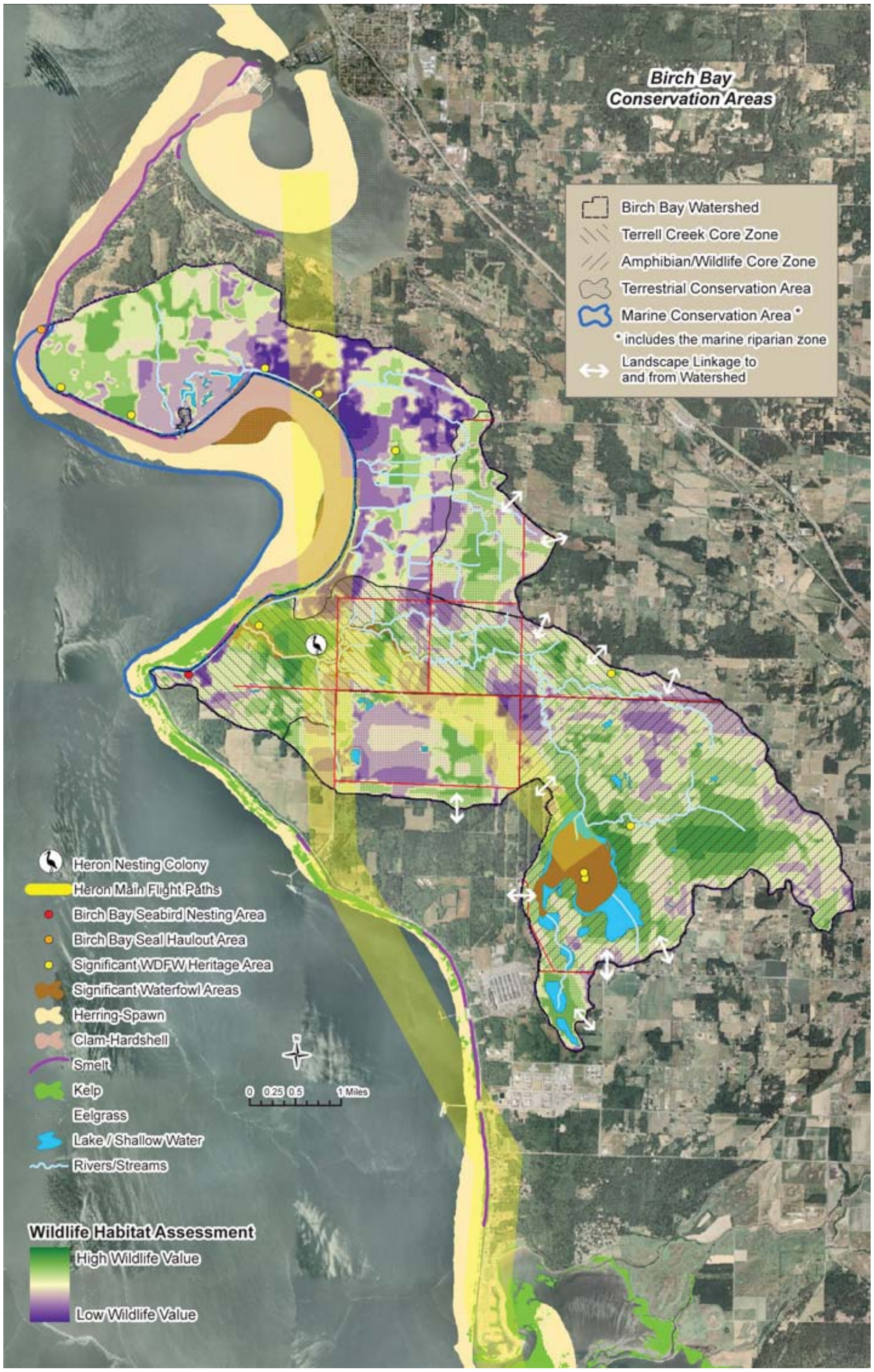


Figure 21: Wildlife core areas and connectivity to areas outside the watershed.

For the purposes of this pilot study, the LHA results were further aggregated at the sub-basin scale to determine the relative general importance of each area of the watershed for wildlife as depicted in Figure 22.

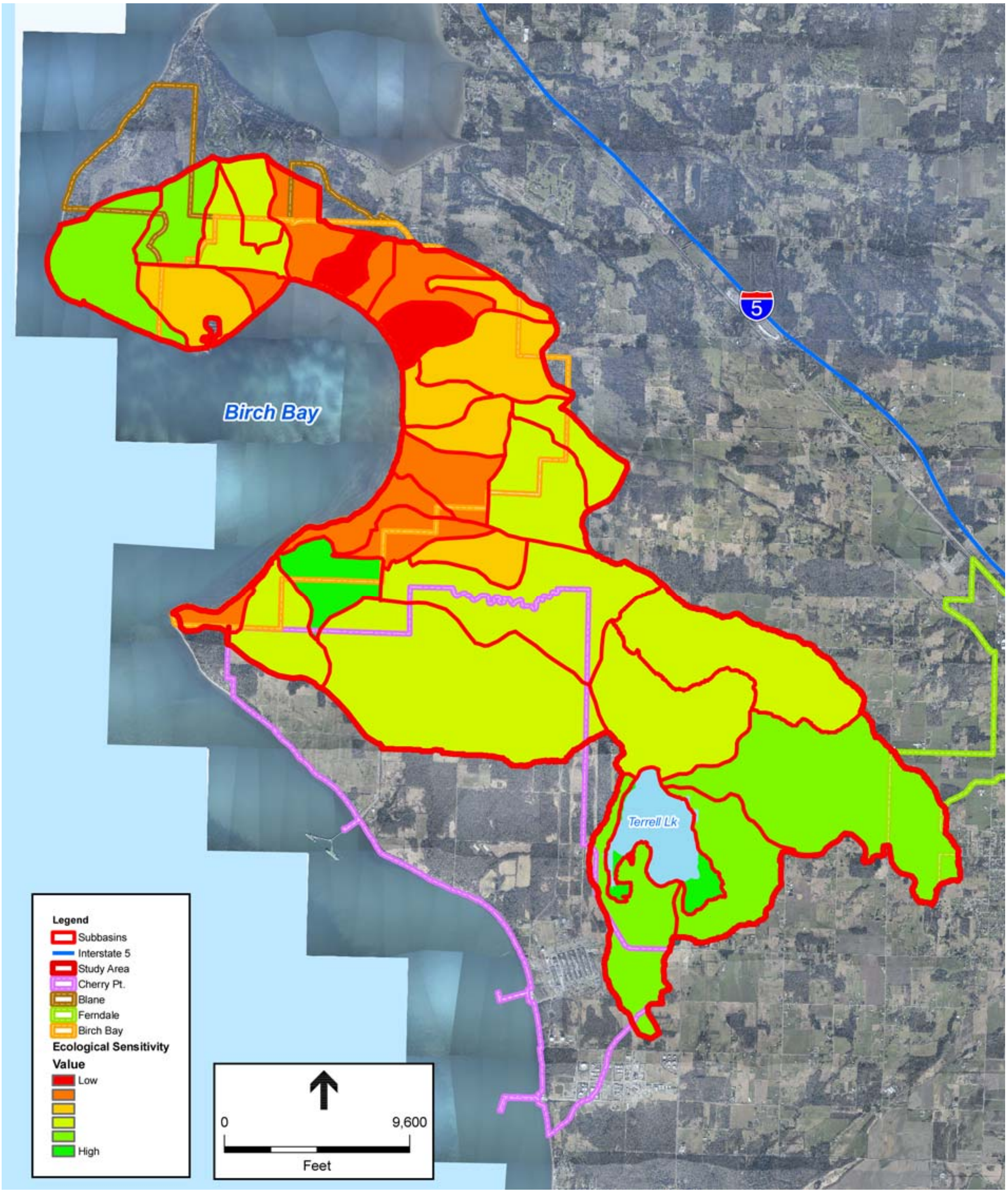


Figure 22: Coarse-scale depiction of general habitat value from low (red) to high (green).

7.0 WHAT MANAGEMENT ACTIONS DOES THIS STUDY RECOMMEND?

The results of the individual characterization components–future development (see Section 4), watershed processes (see Section 5) and habitat conditions (see Section 6)–can be used to develop a general watershed-based management framework for Birch Bay. Management recommendations are derived through a 4-step process, which is summarized as follows and explained in the subsections below:

1. Use data from the water processes characterization and habitat assessment to categorize individual sub-basins according to one of three general management categories:

    a. Protection,

    b. Restoration, and/or

    c. Development.

2. Recommend actions for each sub-basin that will help achieve the intent of the management goal;

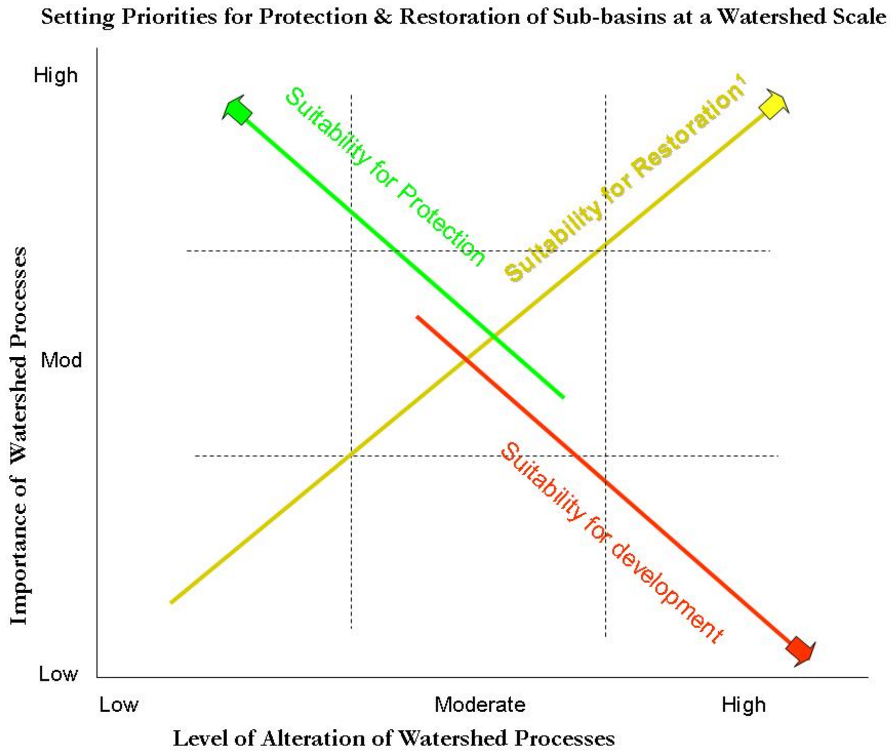
3. Evaluate categories and recommendations from Steps 1 and 2 in light of the vulnerability analysis to identify any conflict with anticipated future development; and

4. Refine management recommendations based on results of Step 3.

7.1 General management categories

7.1.1 Water processes

The recommended *management category* for each sub-basin is determined based on the relationship between the existing level of importance and the degree of alteration as shown in Figure 23.



1) Applies to areas where restoration is feasible. If the site proposed for restoration is in an existing developed urban area, or where processes are so altered (either within a sub-basin or in the upper watershed) that they cannot be adequately restored, then the site is more suitable for development and restoration should be shifted to other locations in the sub-basin that are rated high for both level of importance and level of alteration.

Figure 23: Approach for determining general management categories for individual sub-basins based on the relationship between level of importance and degree of alteration.

Each process (hydrology, denitrification and pathogen removal) is assigned into a general management category based on its overall location on the above graph and then a synthesis management category is assigned to the sub-basin based on the combination of categories for all 3 processes. Once all the sub-basins within a WAA are assigned to a category, an overall management goal for that WAA is determined.

> **Management categories** are used in this study to indicate where within the watershed different management approaches should be prioritized. This approach does not mean that "Development" should not be allowed in an area categorized as "Restoration" or vice versa. However, an area categorized as "Restoration" would be less appropriate for intense development and would need active measures (such as wetland enhancement) to maintain aquatic and/or wildlife resources - See Table 7-1 for definitions and examples of the three categories.

The 3 categories–Protection, Restoration and Development–are intended to help differentiate the general management priorities for each area of the basin. These categories could be used to help identify sending and receiving areas for new development via a transfer of development rights (TDR) program, or could possibly help in locating mitigation sites (including mitigation banks) for development projects that require wetland mitigation, for example.

The categories are not absolute or exclusionary, meaning that it is possible for Development to occur within a Protection area and for Restoration to occur in a Development area, and so forth, because within any sub-basin or WAA there may be areas of anomaly that do not match the overall management recommendation. It is also important to note that the categories are not discreet but occur along a continuum from Protection (highest value, least altered) to Development (lowest value, most altered) with each category consisting of 2 levels (e.g., P1, P2, R1, R2…).

This study assumes that some level of protection is being applied throughout the watershed via existing regulations and plans; however, an outcome of this study could be to modify how some of the existing protections are applied in various areas of the watershed. As an example, if a sub-basin is categorized as a Development 1, but there is a significant wetland community in that sub-basin, certain CAO provisions might be relaxed on some wetlands if the primary high-value wetland is fully protected or restored. Similarly, if the key issue in a Restoration sub-basin is related to pathogen processes, it might be feasible to relax stream buffers on some tributaries if appropriate measures are implemented to restore specific depressional wetlands and/or streams downstream of the primary pathogen sources. These are just a few examples; other scenarios are possible and could be evaluated in the future with input from the community. Table 7-1 explains the basic concepts underlying these management categories and lists some of the types of actions that would be associated with each category. Table 7-2 shows how the categories are assigned based on the score for each water process.

A limitation to this approach for characterizing hydrologic processes is that this model primarily addresses freshwater processes, and under values marine and nearshore processes. For example, the marine shoreline in the Point Whitehorn West sub-basin has been found to be important for the routing and delivery of sediment in the local marine system (Whatcom County, 2007). Due to the focus on freshwater processes the model prioritizes the area for development. If marine processes were included, the sub-basin would likely rank as Restoration 1 or 2 with the intention of both preserving and improving sediment delivery for nearshore habitats.

Table 7-1: Management category definitions and potential actions for Protection, Restoration and Development

Category	Definition	Examples of Potential Actions
Protection 1 (P1)	These are the highest quality, most valuable areas of the watershed in terms of water process and wildlife habitat. Existing processes and resources are largely intact. In areas identified as P1, protecting existing wetland, stream, nearshore and terrestrial wildlife resources from future development is of paramount importance, and should be the highest priority. Impacts to resources in P1 areas would potentially have serious consequences for the long-term	Enforce existing critical area, shoreline, stormwater and related regulations to the maximum extent possible. Prohibit filling of wetlands and direct impacts to streams unless this standard would put essential public services or facilities at risk or there is an overriding public health or safety issue. Require the maximum prescribed buffer on existing critical areas and/or increase buffers if necessary.

Category	Definition	Examples of Potential Actions
	sustainability of Birch Bay, Terrell Creek and/or other resources in the watershed.	Acquire /set aside valueable resource areas through conservation easements or purchase. Require all new development to employ Low Impact Development (LID) Techniques unless technically infeasible or undesirable because of geologic conditions. Revise zoning to reduce future development impacts. Prevent expansion of UGA into these areas.
Protection 2 (P2)	P2 areas are also priorities for protection, but to a slightly lesser degree than P1 areas. Processes in these areas are minimally impaired and habitats are mostly in tact. These areas require traditional forms of resource protection and will sometimes require special measures to design development in a way that allows the watershed process to continue with minimal impairment.	Enforce standard CAO-type protections. Acquire /set aside value resource areas through conservation easements or purchase. Require LID in some instances. Implement farm plans to control pathogen sources.
Restoration 1 (R1)	In these areas, restoring watershed processes is the top priority. This means improving upon the current conditions through active intervention for purposes of "lifting" the current level of ecosystem functioning. This does not necessarily mean restoring to a pre-development condition and would not involve "taking" of private lands for restoration purposes. The goal in these areas is to ensure that watershed processes associated with key areas are reinstated. This can involve restoring the natural condition of a specific site, but it can also include activities that restore the capacity of the important area to support the process.	Remove fill to restore former wetlands. Enhance wetlands and riparian areas through planting (includes CREP plantings). Establish vegetation mosaics to improve habitat values. Fix blocked culverts. Plug ditches to slow drainage in areas where flooding will not create safety hazards. Implement drainage modifications and/or alter channel conditions to summer stream flows. Expedite Planned Unit Development reviews when development includes restoration measures. Allow developers to "buy down" buffers through restoration above and beyond project mitigation.
Restoration (R2)	Restoration is also a priority in these areas, but to a somewhat lesser	Actions would be similar to those identified for R1 areas.

Category	Definition	Examples of Potential Actions
	degree than R1.	
Development 1 (D1)	From an ecological perspective, D1 areas are the most suitable areas in the watershed for new development. These areas can be expected to accommodate additional new development with relatively less impact to wetlands, streams, nearshore areas and habitats than other parts of the watershed.	"Send" development to these areas to spare other areas from development impacts. Modify density requirements to allow increased density.
Development 2 (D2)	D2 areas are also suitable for development. Development in these areas is expected to have less impact on natural resources and processes compared to other areas, except D1 areas.	Similar to D1.

Table 7-2: Synthesis of watershed process results and overall management categories (Colors represent overall recommendation for the Watershed Assessment Area)

D1 = Development (red); D2 = Development 2 (pink); R2 = Restoration 2 (light yellow); R1 = Restoration 1 (dark yellow); P2 = Protection 2 (light green); P1 = Protection 1 (dark green). The Synthesis Rating is based on rules: If two or more ratings are similar select that rating – hydro rating should provide lead rating (e.g. P1 and P2 = P1). If two ratings are similar and third rating is "D" consider decreasing lead rating (e.g. R1, R1 and D1 = R2). If two ratings are similar and third rating is "P" consider increasing lead rating by one (e.g. D1 and D2 and P1 = D2). If three ratings are dissimilar, select hydro rating or combination.

WAA	Sub-basin	Hydro Process	De-nitrification Process	Pathogen Process	Synthesis Rating	Overall Management Category
Terrell Creek	Lake Terrell East	P2	D2	P1	P2	Protection 2
	Lake Terrell Trib 1	P1	R2	P1	P1	Protection 1
	Lake Terrell Trib 2	P1	R2	P1	P1	Protection 1
	Lake Terrell	P1	P1	P2	P1	Protection 1
	Terrell Creek Mainstem 3	P1	D1	P1	P1	Protection 2
	Terrell Creek Mainstem 2	R2	R2	P1	R1	Restoration 1
	Terrell Creek Mainstem 1	P2	P2	P2	P2	Protection 2
	Fingalson	R2	D2	P1	R2	Restoration 2
	Industrial Tributary	D2	R2	P1	D2/R2	Dev 2/Rest 2
	Point Whitehorn Uplands	P2	R2	P1	P2	Protection 2

WAA	Sub-basin	Hydro Process	De-nitrification Process	Pathogen Process	Synthesis Rating	Overall Management Category
D1 = Development (red); D2 = Development 2 (pink); R2 = Restoration 2 (light yellow); R1 = Restoration 1 (dark yellow); P2 = Protection 2 (light green); P1 = Protection 1 (dark green). The Synthesis Rating is based on rules: If two or more ratings are similar select that rating – hydro rating should provide lead rating (e.g. P1 and P2 = P1). If two ratings are similar and third rating is "D" consider decreasing lead rating (e.g. R1, R1 and D1 = R2). If two ratings are similar and third rating is "P" consider increasing lead rating by one (e.g. D1 and D2 and P1 = D2). If three ratings are dissimilar, select hydro rating or combination.						
	Point Whitehorn West	D1	D1	P2	D1	Development 2
	Terrell Creek Upper Trib1	D2	R2	P1	D 2/R 2	Dev2/Rest2
	Terrell Creek Upper Trib 2	P1	R2	P1	P1	Protection 1
	Terrell Ck. Estuarine Reach	R1	R2	R1	R1	Restoration 1
Central South	Terrell Ck. Lower Trib 2	R1	R1	R1	R1	Restoration 1
Central South	Terrell Ck. Lower Trib 1 W	R2	R2	R1	R2	Restoration 2
Central South	Terrell Ck. Lower Trib 1 E	R1	R2	P1	R1	Restoration 1
Central South	Bog Tributary	R2	R2	R1	R2	Restoration 2
Central South	Central Uplands West	R2	R1	R1	R1	Restoration 2
Central South	Central Uplands East	R2	R2	P1	R2	Restoration 2
Central North	Central Reaches	D1	D1	P2	D1	Development 1
Central North	Hillsdale	D2	D2	P2	D2	Development 2
Central North	Hillsdale North Trib	R2	R2	R2	R2	Restoration 2
Central North	Cottonwood South	D2	D2	P2	D2	Development 2
Central North	Cottonwood North	D1	R2	D2	D2	Development 2
Birch Point	Shintaffer	R2	R2	P1	R2	Restoration 2/Dev 2
Birch Point	Rogers Slough	R2	R2	R2	R2	Restoration 2
Birch Point	Rogers Slough Lower Trib	D2	D1	D2	D2	Development 2
Birch Point	Rogers Slough Upper Trib	R2	D2	D2	D2	Development 2
Birch Point	Birch Bay Marina	D1	D1	R2	D1	Development 1
Birch Point	Semiahmoo Uplands	P1	P2	P2	P2	Protection 2

WAA	Sub-basin	Hydro Process	De-nitrification Process	Pathogen Process	Synthesis Rating	Overall Management Category
D1 = Development (red); D2 = Development 2 (pink); R2 = Restoration 2 (light yellow); R1 = Restoration 1 (dark yellow); P2 = Protection 2 (light green); P1 = Protection 1 (dark green). The Synthesis Rating is based on rules: If two or more ratings are similar select that rating – hydro rating should provide lead rating (e.g. P1 and P2 = P1). If two ratings are similar and third rating is "D" consider decreasing lead rating (e.g. R1, R1 and D1 = R2). If two ratings are similar and third rating is "P" consider increasing lead rating by one (e.g. D1 and D2 and P1 = D2). If three ratings are dissimilar, select hydro rating or combination.						
	Birch Point South	P2	P2	P1	P2	Protection 2

Green areas have high levels of importance for watershed processes and limited alteration and should be considered for the highest priorities for protection. Some development may be suitable in these areas but extra care should be taken, especially in dark green areas, to establish land use patterns (i.e. land use types, activities, development policies, standards and regulations) that protect and maintain watershed processes. Lighter green areas may have a lower level of importance but may play an important role in sustaining downgradient aquatic resources.

Yellow areas have a high level of importance for watershed processes and a high level of alteration and should be considered for restoration unless watershed processes are permanently altered by urban development. Restoration in "dark yellow" areas will have the most significant benefit, relative to other sub-basins, in restoring watershed processes and aiding in sustaining downgradient aquatic resources. Again, care should be taken in establishing land use patterns that protect and maintain areas for important watershed processes.

Orange to red areas have lower levels of importance for watershed processes and higher levels of alteration and should be considered more suitable for development. Because orange areas represent a transition from restoration areas, planning measures employing both restoration and appropriately sited development should be considered.

Based on the analysis of alteration and current conditions of watershed processes within Birch Bay the results indicate that large tracts of the watershed meet appropriate criteria for restoration activities. The Terrell Creek WAA and Central South WAA show the most promise for restoration, however; the Shintaffer sub-basin in the Central North WAA also has a high potential for restoration. Areas that are downstream of high loading areas for nutrients and pathogens are also priorities for restoration. For example, the upper portions of the Terrell Creek watershed show high levels of fecal coliform and nitrogen loading (Figures 25 and26) making the middle watershed (e.g., Terrell Creek Mainstem 2 sub basin) a target area for restoring wetlands and riparian zones that can provide denitrification and pathogen removal and hence improve the quality of water entering the Bay.

The Terrell Creek WAA also contains several areas along the Birch Bay shoreline and farther up in the watershed near Lake Terrell that should be protected from intense development pressures. Birch Point South and the Semiahmoo Uplands sub-basins in the Birch Point WAA are also identified as potential areas for protection. However, residential development activities within the Semiahmoo Uplands will likely impact, and thus decrease the protection potential for this sub-basin.

The recommendation for development based on the current conditions and degree of current watershed process alterations is primarily concentrated in the sub-basins that comprise the Central North WAA. This is the location where the majority of high intensity development occurs within the watershed. The findings also recommend further development within the Birch Bay Marina and Rogers Slough sub-basins.

Figures 24, 25 and 26 depict the management recommendations shown in Table 7-2 above.

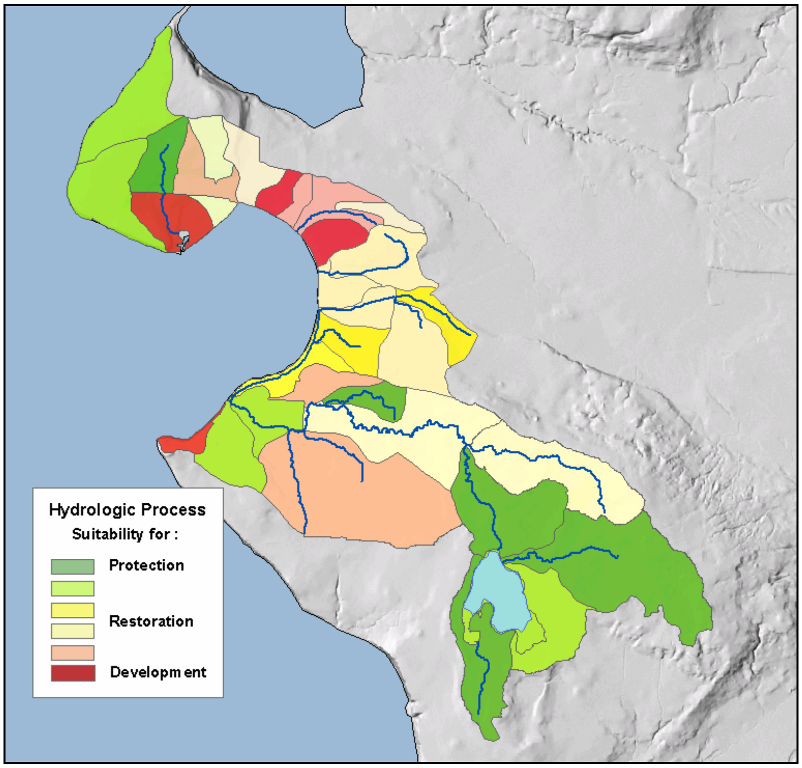


Figure 24: Management recommendations based on hydrologic processes.

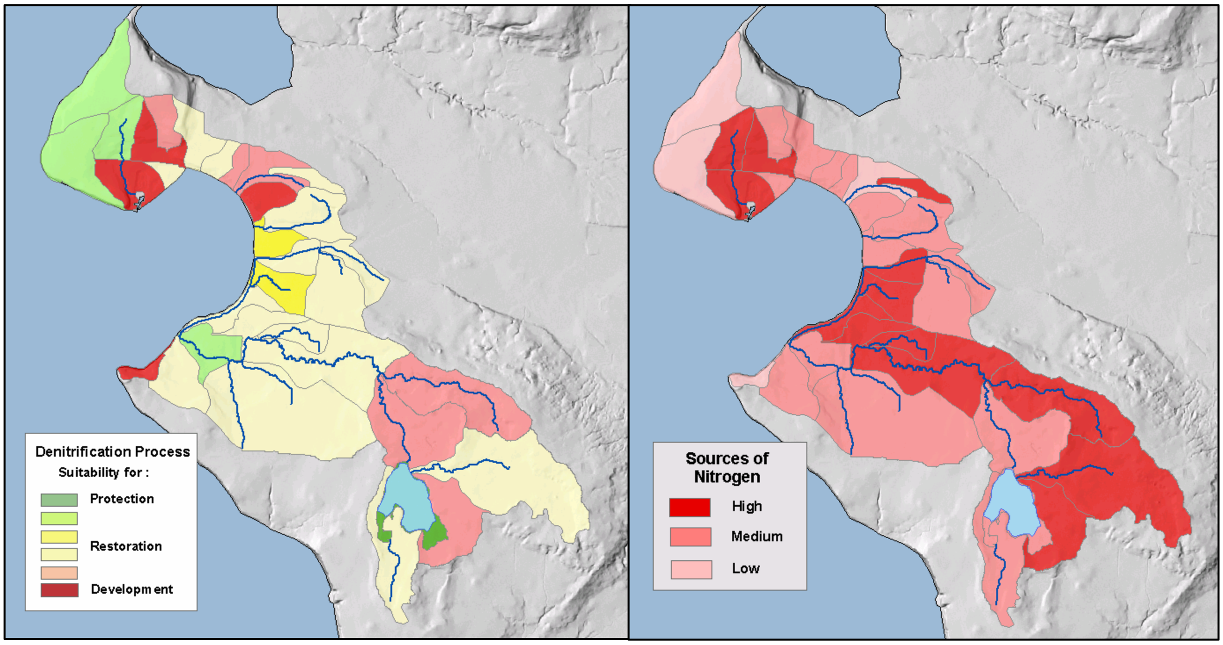


Figure 25: Management recommendations based on denitrification processes.

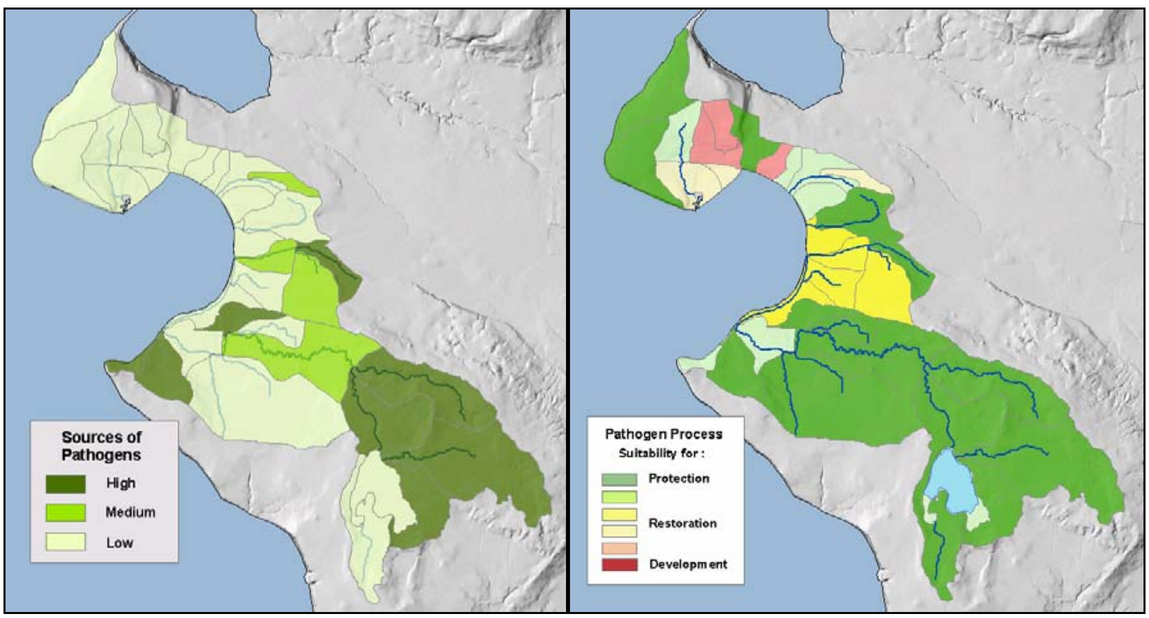


Figure 26: Management recommendations based on pathogen processes.

7.1.2 Wildlife habitat

Each sub-basin can also be assigned to a general management category of High, Moderate or Low based on the overall habitat value for wildlife. The habitat assessment results can then be paired with the water process characterization results above to better understand management recommendations in the watershed as shown in Table 7-3.

Table 7-3: Wildlife habitat value ratings paired with water process results from Table 7-2.

WAA	Sub-basin	Management Category for Water Processes from Table 7-1	General Wildlife Value	Consistency with Water Processes?
Terrell Creek	Lake Terrell East	Protection 2	High	Yes
	Lake Terrell Trib 1	Protection 1	High	Yes
	Lake Terrell Trib 2	Protection 1	High	Yes
	Lake Terrell	Protection 1	High	Yes
	Terrell Creek Mainstem 3	Protection 2	Mod to High	Yes
	Terrell Creek Mainstem 2	Restoration 1	Moderate	Yes
	Terrell Creek Mainstem 1	Protection 2	High	Yes
	Fingalson	Restoration 2	Low to Mod	Yes
	Industrial Tributary	Devel 2/Rest 2	Low to Mod	Yes
	Point Whitehorn Uplands	Protection 2	Moderate	Yes
	Point Whitehorn West	Development 2	High	No
	Terrell Creek Upper Trib1	Devel2/Rest2	Mod to High	No
	Terrell Creek Upper Trib 2	Protection 1	Moderate	Yes
	Terrell Ck. Estuarine Reach	Restoration 1	Mod to High	Yes
Central South	Terrell Ck. Lower Trib 2	Restoration 1	Low	Yes
	Terrell Ck. Lower Trib 1 W	Restoration 2	Low	Yes
	Terrell Ck. Lower Trib 1 E	Restoration 1	Mod to High	Yes
	Bog Tributary	Restoration 2	Mod to High	Yes
	Central Uplands West	Restoration 2	Low	Yes
	Central Uplands East	Restoration 2	Low	Yes
Central North	Central Reaches	Development 1	Low	Yes
	Hillsdale	Development 2	Low to Mod	Yes
	Hillsdale North Trib	Restoration 2	Low	Yes
	Cottonwood South	Development 2	Low	Yes

WAA	Sub-basin	Management Category for Water Processes from Table 7-1	General Wildlife Value	Consistency with Water Processes?
	Cottonwood North	Development 2	Low	Yes
Birch Point	Shintaffer	Restoration 2/Dev 2	Low	Yes
	Rogers Slough	Restoration 2	Low	Yes
	Rogers Slough Lower Trib	Development 2	Low to Mod	Yes
	Rogers Slough Upper Trib	Development 2	Moderate	No
	Birch Bay Marina	Development 1	Low	Yes
Birch Point	Semiahmoo Uplands	Protection 2	Mod to High	Yes
	Birch Point South	Protection 2	High	Yes

7.2 Actions for achieving general management goals

With an understanding of the hydrologic, water quality and wildlife habitat conditions in each subbasin, some specific management recommendations can be identified for each area. These recommendations highlight some of the actions that could be taken in specific areas. If no specific actions are listed, refer to the general menu of recommended measures for each category shown in Table 7-1.

Table 7-4: Issue summary and specific management recommendations per sub-basin.

WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
Terrell Creek	Lake Terrell East	Protection 2	Important waterfowl nesting habitat including habitat for common loon. Fewer wetlands than other subbasins in this WAA, so less important in terms of water processes, especially denitrification.	Implement standard CAO provisions placing special emphasis on projects that could directly or indirectly affect waterfowl habitat, especially near Northstar Road and Alderwood.
	Lake Terrell Trib 1	Protection 1	Key recharge area, so sub-basin is important for maintaining hydrology. Important amphibian habitat area.	Where feasible, maximize infiltration via LID-type measures and minimize impervious surface. Maintain exiting habitat mosaics with a mixture of vegetation types.

WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
				Cluster development and locate developments closer to roads to minimize habitat fragmentation. Use farm plans to control pathogens. Implement Conservation Reserve Enhancement Programs (CREP) to improve riparian habitats. Provide bonus points for landowners applying for open space taxation for wetland properties.
	Lake Terrell Trib 2	Protection 1	Similar to Lake Terrell Trib 1. Highly permeable.	Maintain forest patches to promote infiltration and evapo-transpiration. Restore wetlands identified as having high restoration potential (see Figure 28)
	Lake Terrell	Protection 1	Not as much infiltration potential and fewer depressional wetlands than Lake Terrell Trib 1 and 2 sub-basins.	Consider improving flows out of the lake to improve downstream flow conditions in Terrell Creek.
	Terrell Creek Mainstem 3	Protection 2	Similar to other Terrell Creek sub-basins but slightly lower priority for Protection.	Same as above.
	Terrell Creek Mainstem 2	Restoration 1	One of the highest priority Restoration areas in the entire watershed. Key area for discharge, pathogen removal, and denitrification.	Re-establish woody cover to improve infiltration opportunities and slow runoff. Plug ditches to increase residence time and/or route water to depressional wetlands before discharging to creek. Redirect runoff from BP lands to lengthen discharge route to the Bay. Maintain mosaic of habitats for great blue herons and other species. Restore floodplain of Terrell Creek by improving in-stream structure. Prohibit expansion of the exiting UGA boundaries into this area to prevent future impacts.
	Terrell Creek	Protection 2	Protection is the main priority similar to Terrell	Protect wildlife.

WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
	Mainstem 1		Creek Mainstem 3.	Implement LID and clustering.
	Fingalson	Restoration 2	High priority restoration area for water process and wildlife.	Create additional woody cover through planting to improve infiltrative capacity and enhance wildlife connectivity to areas outside the watershed. Re-vegetate riparian corridors (e.g., CREP).
	Industrial Tributary	Devel 2/Rest 2	Some opportunity to implement restoration compatible with ongoing industrial development in most areas. Not as important for pathogen and nitrogen removal as most other sub-basins in this WAA.	Restore forest habitats (and pocket wetlands) in southeastern part of the subbasin to provide nesting areas for herons. Develop a habitat management Plan for all species on ± 1,000-acre BP properties.
	Point Whitehorn Uplands	Protection 2	No streams and few wetlands in this sub-basin, so lower priority for protection and restoration than P1 and R1 sub-basins. Entirely within UGA.	
	Point Whitehorn West	Development 2	Not an important area for water flow and water quality process, but important for habitat because of proximity to nearshore resources. Important source of sediment for alongshore drift that maintains nearshore habitats. Development is appropriate consistent with CAO and SMP provisions.	Ensure that development minimizes impacts on nearshore resources and sediment processes.
	Terrell Creek Upper Trib1	Devel2/Rest2	Development is appropriate consistent with CAO provisions.	Restore wetlands that have high restoration potential (Figure 27)
	Terrell Creek Upper Trib 2	Protection 1	Similar to Terrell Creek Lower Trib 1 E, but higher habitat value.	
	Terrell Ck. Estuarine	Restoration 1	Important area at the lower end of the watershed, provides	Implement restoration recommendations contained in the SMP restoration Plan.

WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
	Reach		denitrification and pathogen removal. Important discharge zone.	Re-vegetate sparsely-treed riparian areas.
Central South	Terrell Ck. Lower Trib 2	Restoration 1	Similar to Estuary sub-basin, but also includes ditched wetlands that could be restored. Quality habitat in upper part of sub-basin.	Consider TDRs to move development out of this sub-basin. Consider relaxing CAO provisions in some areas to accommodate development and "banking" or storing" wetland functions in specific wetlands that have high restoration potential (see Figure 27), especially wetlands that can provide surface storage.
Central South	Terrell Ck. Lower Trib 1 W	Restoration 2	Limited opportunities for restoration. Dense collection of septic systems immediately upstream.	Restore riparian areas and enhance wetlands to provide areas for pathogen removal.
Central South	Terrell Ck. Lower Trib 1 E	Restoration 1	Similar to Fingalson sub-basin. Highly permeable.	Similar to Fingalson sub-basin.
Central South	Bog Tributary	Restoration 2	Similar to Terrell Ck. Lower Trib 1 W.	
Central South	Central Uplands West	Restoration 2		Enhance wetlands in vicinity of the mobile home park. Use LID to control runoff and limit impervious surface.
Central South	Central Uplands East	Restoration 2	Pathogen process mostly intact.	
Central North	Central Reaches	Development 1	Suitable for development.	
Central North	Hillsdale	Development 2	Suitable for development.	
Central North	Hillsdale North Trib	Restoration 2	Upper watershed is highly permeable. Numerous wetlands in this sub-basin.	Focus restoration on enhancing existing wetlands.
Central North	Cottonwood South	Development 2	Suitable for development.	
Central North	Cottonwood	Development 2	Suitable for development.	

WAA	Sub-basin	Management Category	Issue Summary	Specific Recommended Actions
	North			
Birch Point	Shintaffer	Restoration 2/Dev 2	Extensive wetlands, including one large intact wetland.	Plug ditches.
	Rogers Slough	Restoration 2	Slough is highly modified from historic configuration.	Enhance slough in conjunction with beach restoration efforts.
	Rogers Slough Lower Trib	Development 2	Suitable for development	
	Rogers Slough Upper Trib	Development 2	Suitable for development, but moderate habitat value.	Ensure that impacts on wildlife are minimzed.
	Birch Bay Marina	Development 1		
Birch Point	Semiahmoo Uplands	Protection 2	Extensive recent clearing. Highly permeable deposits in this area.	Protect existing wetlands and riparian areas.
	Birch Point South	Protection 2		

Wetlands with potential for restoration and/or enhancement are identified in Figure 27. These would be priority areas for restoring hydrologic processes.

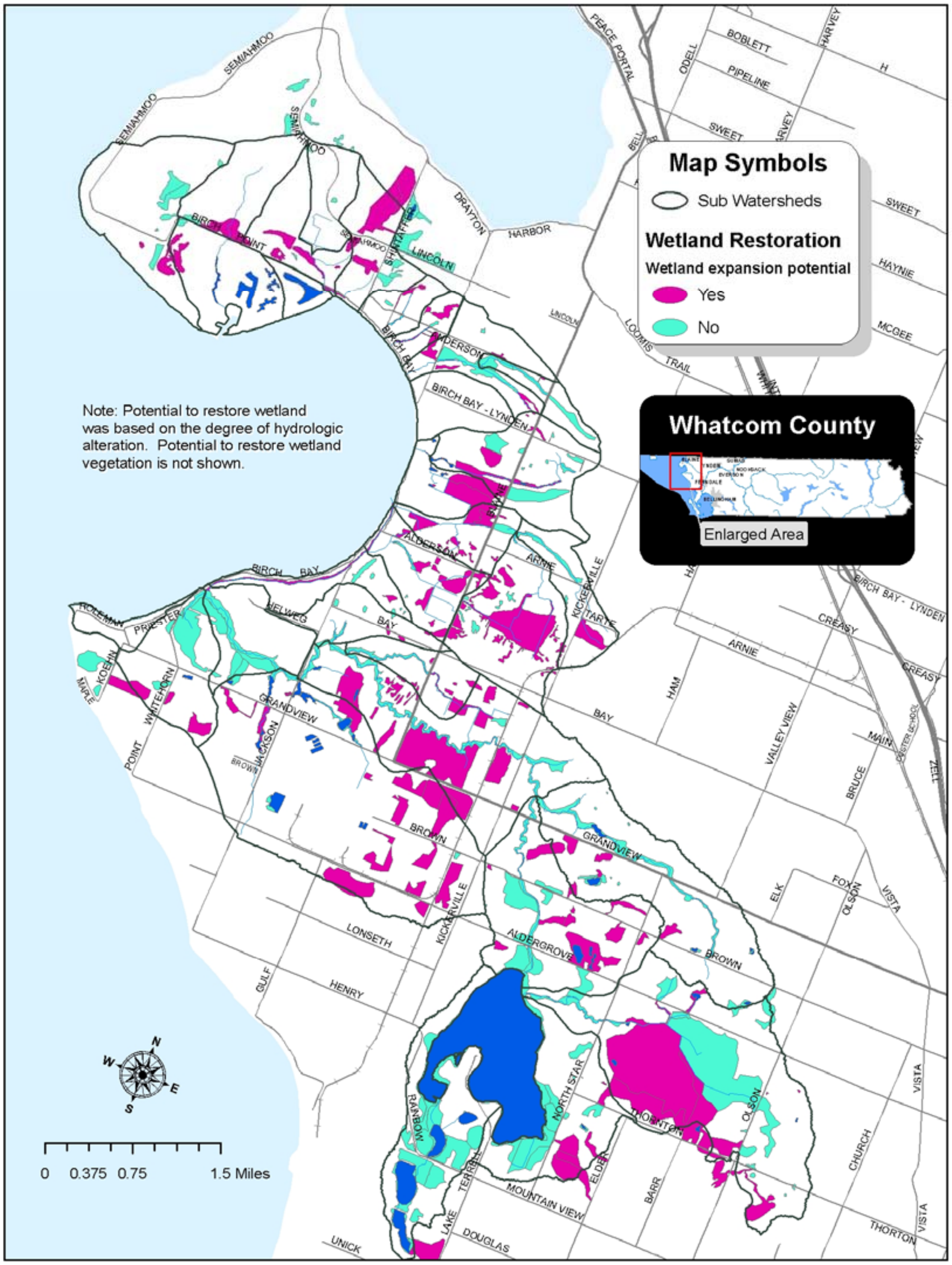


Figure 27: Wetlands with good restoration potential.

In addition to the management recommendations outlined above for each sub-basin, WDFW developed additional recommendations for each of the 4 wildlife overlay zones as described in Table 7-5.

Table 7-5: Washington Department of Fish and Wildlife Overlay Recommendations

Feature	Recommendation/Action	Purpose
Marine/Nearshore Recommendations		
Delivery & routing of sediments	Remove bulkheads from the feeder bluffs at Point Whitehorn. Remove groins obstructing long shore drift within Birch Bay. Where applicable, allow natural backshore processes to reestablish.	Reestablishing backshore structure is important for maintaining appropriate substrates for the extensive eelgrass beds within the bay, for surf smelt spawning in upper intertidal areas, and for native clam beds.
Delivery & routing of nutrients & pathogens	Reduce nutrient and pathogen loading into surface waters in the terrestrial portions of the watershed.	Excess nutrients may be partially responsible for low dissolved oxygen events in the Terrell Creek estuary. Pathogen delivery to Birch Bay increases the risk that shellfish beds may be impacted.
Delivery & routing of water	Enhance infiltration capacity within the basin to increase low flows.	Low flows in surface waters may contribute to low dissolved oxygen events and fish kills in the Bay and associated estuary of Terrell Creek.
Great Blue Heron habitat structures	Minimize roost tree removal and disturbance at Great blue heron roost sites near major foraging areas of Birch Bay.	Protect and enhance Great blue heron habitat conditions.
Waterfowl habitat	Minimize disturbance of mixed boulder/large cobble substrate beaches (primarily Birch Point).	These areas are used by brant during feeding and for resting.
Terrestrial Recommendations		
Dwelling densities	Seek to maintain dwelling densities of ≤1 du/10 acres within broad areas of the Terrestrial Conservation Overlay, and ≤1 du/20 acres in and near the Terrell Creek Core Zone and the Amphibian/Wildlife Area Core Zone.	Focus on broad open estuary, grasslands, agriculture, and fallow field areas to better meet the dwelling density sensitivity of sensitive species in the watershed. Lesser densities in and around the Lake Terrell sub-basin would benefit great blue heron and other waterfowl.

Feature	Recommendation/Action	Purpose
Mosaic of habitats	Within the Terrestrial Conservation Overlay, retaining a variety of field and forest habitats is especially important. This rich assemblage of habitats is needed by the array of sensitive species that depend on this watershed for habitat (e.g., the herons, grassland birds, forest birds, amphibians, and other species).	Maintaining a variety of habitat patches, ranging from ≥ 12 acres up to500 or more acres, and linking these patches together, will benefit the persistence of a wide variety of sensitive species. The Stellar's Jay and Cooper's Hawk rely on smaller patch sizes, while larger habitat patches are important for species such as the Pileated woodpecker, Short-eared owl, bobcat, Western meadowlark, and spotted skunk.
Roads and traffic	Pay special attention to roads and traffic within the Amphibian/Wildlife Area Core Zone: Use traffic softening methods (e.g., lower speed limits) within this zone to discourage straight-through use. Minimize the building of new roads. Sign important areas where wildlife, including amphibians, cross roads. Consider narrow roads with inviting bike trails or walking paths to encourage less car traffic. Terrell Creek Core Zone: Make high traffic roads friendlier to wildlife, including amphibians, using repair and reconstruction opportunities to redesign stream crossings. Minimize the building of new roads, and route traffic most directly onto busier roads.	A traffic routing plan that allows important wildlife areas to maintain low traffic levels will be important for the long-term persistence of many species. Amphibians, reptiles, and large animals are all be vulnerable to traffic mortality (i.e. road kill)
External and Internal Linkage Recommendations		
Connective linkages to external areas	Seek to maintain linkages with ≥80% natural or open habitat.	Linkages with external habitat provide corridor connections for

Feature	Recommendation/Action	Purpose
	Give special attention to road crossings that may be in linkage areas: Preserve forest/undeveloped habitat on both sides of road Route traffic away from linkages Sign for wildlife crossing and lower speed limits.	wildlife dwelling in and migrating through the area. It is important to consider both a mosaic of large, connected patches as well as a network of smaller, stepping-stone-like patches linked across a landscape, as these support the survival of different sensitive species.
Fly zones	Seek to maintain flyway areas of approximately 0.5 mile width, with >= 80% natural or open habitat Keep lighting minimized, e.g., use outside fixtures that meet 'dark-sky' performance standards. Locate tall buildings and communication towers away from flyways Maintain air flights, including helicopters above 500 feet.	Provides protection for the existing Great Blue heron colony near Birch Bay State park. From the nest site, the birds follow consistent paths to reach foraging areas in Drayton harbor, Birch Bay, Lummi Bay, and Lake Terrell. Waterfowl, such as swans and loons, also commonly follow these paths.
Areas Outside Conservation Concentrations		
Patches of forest and/or open habitat	Maintain interspersed patches of habitat to support native birds such as Western Tanager, Sharp-shinned Hawk, Willow Flycatcher, Bewick's Wren, Song Sparrow, and American Goldfinch.	These patches will also benefit other wildlife species such as coyote and the Pacific chorus frog (where breeding ponds may be nearby).
Bald eagles	Protection will be based on site-specific WDFW management regulations.	Bald eagle management guidelines provide a visual buffer and protect vegetation to allow for alternative nest sites within the area.
Riparian and wetland areas	Maintain intact riparian vegetation to protect water quality, and provide habitat for fish and wildlife.	These areas are used year-round by great blue herons, serving in part as roost sites and juvenal dispersal areas.
Roads and traffic	These should be managed as part of an overall plan for the Birch Bay watershed that supports routing traffic away from important wildlife areas.	Roads have a high impact on wildlife and create linear disruptions on vegetation and habitat patches. Low traffic levels will contribute to the persistence of more sensitive species.

7.3 Management goals based on sub-basin vulnerability

The management categories that were assigned based on the water process and habitat assessment take into account the existing conditions of each sub-basin in terms of level of importance and degree of alteration, however, they do not take into account planned development scenarios. Thus, the initial results and recommendations must be reviewed in light of the anticipated future development impacts for the watershed as indicated by the future development analysis (see Section 4).

Ideally, new development would be concentrated in areas that are already experiencing high levels of alteration and low watershed process and habitat conditions. However, if Restoration is identified as the priority management objective for a specific area and that area is determined to be highly vulnerable to future development (meaning a high rate of increase in development intensity and impervious surface), the chances of achieving the full spectrum of restoration measures is likely to be more challenging.

Table 7-6 identifies which sub-basins have a potential conflict between the recommended management goal (Protection, Restoration, or Development) and the expected level of additional development (dwelling density and impervious surface. The vulnerability level does not substantially change the overall management recommendations for the 4 WAAs, and for the most part, the recommended management strategies seem achievable given the expected level of development. However, a few potential problem areas are identified including the Point Whitehorn and Point Whitehorn Uplands sub-basins, the Terrell Creek Estuary sub-basin, Lower Terrell Creek Tributary 1 West and Lower Terrell Creek Tributary 2 sub-basins, and the Central Uplands East and West sub-basins. The Terrell Creek Estuary sub-basin is one of the top priorities for restoration, yet it is expected to experience moderate to high development pressure so implementing restoration may be a challenge. The Point Whitehorn Uplands is a high priority area for Protection, but development intensity is expected to increase, suggesting that special care may be needed to ensure that resources and processes are maintained.

Table 7-6: Sub-basin vulnerability in relation to the recommended management categories.

WAA	Sub-basin	Sub-basin Vulnerability	Recommended Management Category	Consistent with Sub-basin Management Recommendation
Terrell Creek	Lake Terrell East	Low	Protection 2	Yes
	Lake Terrell Trib 1	Low to Mod.	Protection 1	Yes
	Lake Terrell Trib 2	Low	Protection 1	Yes
	Lake Terrell	Low	Protection 1	Yes
	Terrell Creek Mainstem 3	Low	Protection 2	Yes
	Terrell Creek Mainstem 2	Moderate	Restoration 1	Yes
	Terrell Creek Mainstem 1	Moderate	Protection 2	Yes
	Fingalson	Low to Mod.	Restoration 2	Yes
	Industrial Tributary	High	Dev. 2 / Rest. 2	Yes
	Point Whitehorn Uplands	Mod. to High	Protection 2	No, may be difficult to achieve protection with anticipated development
	Point Whitehorn	Low to Mod.	Development 2	No, could be a sending area for development to take on more development than planned.
	Terrell Creek Upper Trib1	Moderate	Dev. 2 / Rest. 2	Yes
	Terrell Creek Upper Trib 2	Low	Restoration 1	Yes
	Terrell Ck. Estuary	Mod. to High	Restoration 1	No, may be difficult to restore with anticipated development
Central South	Terrell Ck. Lower Trib 2	Mod. to High	Restoration 1	No, may be difficult to restore with anticipated development
	Terrell Ck. Lower Trib 1 W	High	Restoration 2	No, may be difficult to restore with anticipated development
	Terrell Ck. Lower Trib 1 E	Low to Mod.	Restoration 1	Yes
	Bog Tributary	Moderate	Restoration 2	Yes
	Central Uplands West	High	Restoration 2	No, may be difficult to restore with anticipated

WAA	Sub-basin	Sub-basin Vulnerability	Recommended Management Category	Consistent with Sub-basin Management Recommendation
				development
	Central Uplands East	Mod. to High	Restoration 2	No, may be difficult to restore with anticipated development
Central North	Central Reaches	Mod. to High	Development 1	Yes
	Hillsdale	Mod. to High	Development 2	Yes
	Hillsdale N	Moderate	Restoration 2	Yes
	Cottonwood South	Moderate	Development 2	Yes
	Cottonwood North	Moderate	Development 2	Yes
Birch Point	Shintaffer	Moderate	Dev. 2 / Rest. 2	Yes
	Rogers Slough	Moderate	Restoration 2	Yes
	Rogers Slough Lower Trib	Mod to High	Development 2	Yes
	Rogers Slough Upper Trib	Moderate	Development 2	Yes
	Birch Bay Marina	Moderate	Development 1	Yes
	Semiahmoo Uplands	Moderate	Protection 2	Yes
	Birch Point South	Low to Mod.	Protection 2	Yes

7.4 Final Synthesis and Recommendations

This section summarizes overall results and recommendations for the 4 WAAs. It also describes and recommends specific management tools that can be used to achieve the overall goals for each area.

7.4.1 Terrell Creek WAA

Based on a development approach that conscientiously strives to protect and restore the ecological conditions of the Birch Bay watershed, the highest priority for these actions would be to focus terrestrial and aquatic habitat rehabilitation efforts in the Terrell Creek WAA, primarily along the stream corridor and within and adjacent to Lake Terrell. This watershed has the greatest potential for sustaining existing aquatic ecosystems given the presence of areas of intact habitat and processes and a full range of connected aquatic habitat from the marine shoreline to upland lake habitat. Areas with the highest vulnerability within the WAA include Point Whitehorn Uplands, Terrell Creek Mainstem 2, Terrrell Creek Estuary Lake Terrell Tributary 1, and the Industrial Tributaries sub-basins.

7.4.2 Central South WAA

Because a high percentage of the area is comprised of areas important to all three watershed processes and habitat conditions, this WAA has the highest priority for restoration. Though significant alteration to watershed processes have occurred (primarily from ditching, channelization of creeks, and development along the shoreline) the alteration is not permanent. Future development should be concentrated within existing areas of development.

7.4.3 Central North and Birch Point WAAs

Focus highest intensity development in sub-basins with lowest priority for restoration (red and pink) excluding Birch Point, Shintaffer, Rogers Slough and Semiahmoo sub-basins. Development within these sub-basins may be of a higher density but should be sited and designed, using low impact development measures, to minimize impacts to processes. Protect the processes of the Semiahmoo and Birch Point tributary sub-basins by minimizing forest clearing.

7.4.4 Additional Information on Recommended Programmatic Actions

This section provides information on implementing some of the programmatic recommendations described in the previous sections.

7.4.4.1 Comprehensive Plan Urban Growth Area Boundary Revisions:

Revisions to designated urban growth areas (UGA) may be considered for the specific areas currently targeted for high density urban growth that have moderate to high quality watershed process and habitat values based on additional information contained in this study not available when the UGA boundaries were last considered. Potential areas for consideration include the Bog Tributary and Terrell Creek Lower Tributary 1, East sub-basins in the Central South WAA, and the Terrell Creek upper Tributary 2 and Point Whitehorn Uplands sub-basins in the Terrell Creek WAA.

In evaluating potential changes in UGAs, consideration is limited to areas in the margins of the UGA, since the development patterns in the interior of the UGA tend to have higher current development densities and are part of current development patterns that cannot readily be changed. Any proposal for revision of UGA boundaries to exclude these areas would need to also include revision in other areas with less sensitive resource value that would provide sufficient area to serve future growth as well as meet criteria for logical service boundaries and an avoidance of isolated UGA pockets or abnormally irregular boundaries.

7.4.4.2 Transfer of Development Rights:

Clustering allows transfer within a project site of development from more sensitive lands to lands more suitable for intensive development. Transfer of Development rights is a mechanism to provide a similar mechanism between lands that are not under the same ownership or control.

Transfer of development rights is provided for in the Whatcom County zoning code (WCC 20.89) for designated "sending areas" and designated "receiving areas". Already existing "sending areas" within the Birch Bay watershed include locations within the Point Whitehorn and Birch Point South sub-basins, as well as in the Terrell Creek Mainstem 2 sub-basin along Terrell Creek. A receiving area is designated in the General Commercial (GC) and Urban Residential – Medium 24 zoning district at the intersection of Alderson Road and SR 548 in the Terrell Creek Lower Tributary 1 and Terrell Creek Lower Tributary 2 sub-basins.

In addition the Birch Bay Community Plan (Kask Consulting, 2004) contains policies addressing transfer of development rights in Policy LU-1h that would require land owners who obtain increased density through UGA expansion to purchase or transfer development rights; in Policy SL-2e that would designate important shoreline areas in Birch Bay as "sending areas" and in Policy CA-1d that would designate critical areas and buffers in Birch Bay as "sending areas."

Expanding the "sending areas" within the Birch Bay watershed to those areas identified in this study as area with high ecological functions such as lands near Lake Terrell would facilitate use of transfer of development rights to achieve protection from alteration and development of these areas.

Reliance on transfer of development rights may not be a substantial factor in the short term. A 2006 study for Skagit County concluded that the "market" is not ready for TDR. Builders are generally willing to pay only about a quarter of the current value of a rural development rights and new development will not absorb the higher density without making it mandatory. (Ag Prospects, 2006)

Generally speaking, the success of TDR programs nationwide has been limited. TDR programs have been promoted as a market-based solution to growth or preservation challenges without appreciation for the complexity of the market forces involved. It is possible that changing market conditions may make TDR programs effective in the future, but they are unlikely to make a substantial contribution under existing market conditions.

7.4.4.3 Low-Impact Development Standards:

Low impact development (LID) covers a wide variety of practices intended to mimic natural hydrologic patterns and therefore reduce the negative impacts development has on hydrology and water quality. The key to effective LID implementation is determining the desired functions to be maintained or restored. LID generally includes three main components, all of which could be employed as components to development standards in all or portions of the Birch Bay watershed (Table 7-7)

Table 7-7: General LID Components and Applicability within Birch Bay

LID Components	Application within Birch Bay	Strategies
Maintenance (or restoration) of native forest cover	Applicable in varying degrees across the entirety of the Birch Bay watershed.	Focus on expanding existing forest patches. Reforest impacted riparian and wetland buffer locations along Terrell Creek Plant street trees within the highest density areas of Birch Bay UGA Establish ‘tree area canopy retention’ program
Control total runoff volumes	Applicable in areas with permeable soils	Utilize Detention / Retention / Dispersal LID strategies such as open swales. Require the addition of 8 – 12 inches of soil in disturbed and mitigated areas Use low impact building techniques such as permeable paving, vegetated roofs, and roof rainwater collection systems
Manage water quality through treatment	Applicable through out Birch Bay watershed	At minimum, manage stormwater to 2005 Stormwater Standards for Western Washington In areas with direct connection or short transference zones to Bay (sub-basins along Birch Bay shoreline) increase water quality treatment requirements.

The application of LID techniques can offer a number of advantages over traditional, engineered stormwater drainage approaches, including:

Addresses stormwater at its source: LID practices seek to manage rainfall where it falls, reducing or eliminating the need for regional detention ponds and flood controls.

More protective of headwater streams: Because LID practices infiltrate rainfall and prevent runoff, they reduce pollutant loads as well as streambank erosion associated with peak flows.

Promotes groundwater recharge: Many LID techniques infiltrate stormwater, recharging groundwater aquifers and providing baseflow to streams during dry weather. These infiltration practices also reduce stream temperature because surface runoff is warmer than groundwater.

Allows for more flexible site layouts: The small-scale, dispersed nature of LID practices means that designers can include stormwater management in a variety of open spaces and landscaped areas—traditional stormwater management required large set-asides for ponds and wetlands that consumed valuable real estate.

Enhanced aesthetics and public access/use: Well-designed, vegetated practices can provide a visual amenity, particularly when compared to hardened drainage infrastructure such as pipes, curbs, gutters, and concrete-lined channels. Some practices can double as park space, offering recreational amenities.

Cost savings: A common misunderstanding is that LID costs more than traditional stormwater management, but case studies have shown the opposite to be true (see Table 7-8). Typically, cost savings arise from a reduction in the size and extent of pipes and other infrastructure needed to handle runoff. Savings can also arise from the ability to build additional units that would not have been feasible using traditional stormwater management approaches.

Table 7-8: Cost Benefits of Low Impact Development Designs

Project Name and Location	Description	Cost Benefit
Poplar Street Apartments 1 Aberdeen, NC	270-unit apartment complex Most of the curb-and-gutter systems were eliminated Stormwater managed with a variety of LID BMPs	$175,000 in savings over conventional stormwater costs
Somerset 1 Prince George's County, MD	Residential subdivision Most of the site was designed with swales and rain gardens Curbs and gutters were eliminated	Conventional: $2,456,843 LID Design: $1,671,461 Savings: $785,382 Able to develop 6 additional lots Decreased cost per lot by $4,000
Gap Creek 1 Sherwood, AR	Residential subdivision Drainage areas preserved Greenbelts created for drainage area protection and recreation Streets designed to follow land contour	$2.2 million in additional profit Lots sold for $3,000 more than competitors' lots Able to develop 17 additional lots Decreased cost per lot by $4,800
Kensington Estates 1 Pierce County, WA	103-lot residential development Decreased roadway width Porous paving Cul-de-sacs with vegetated depressions	Estimated cost savings of 20% of conventional construction costs

Project Name and Location	Description	Cost Benefit
	in the center	
Circle C Ranch 1 Austin, TX	Residential subdivision Stormwater directed as sheet flow to a stream buffer Four bioretention areas	Conventional: $250,000 LID Design: $65,000 Savings: $185,000 Additional savings from reduced storm drain pipe size and trenching depth
Green Roof Density Bonus 2 Portland, OR	Portland offers a density bonus of 5,000 ft2 for installation of a green roof on a commercial property	An estimated $225 million in additional economic development generated since inception
Laurel Springs 3 Jackson, WI	Residential subdivision Developed using a clustered design Open space preserved Grading and paving reduced	Conventional: $3,200,081 Conservation: $2,570,555 Savings: $629,526

Sources: U.S. Environmental Protection Agency, 2005; Liptan, 2007; Winer-Skonovd et al., 2006.

Appendix D of the Birch Bay Comprehensive Stormwater Plan (CH2M HILL, 2006) reviews the effectiveness and feasibility of applying LID techniques and practices in the Birch Bay watershed. In general, the findings of the analysis confirm that the hydrologic processes in portions of the Birch Bay watershed would benefit from the application of LID techniques and strategies. However, there are some notable limitations to the application of LID in portions of the watershed.

LID BMPs would be most useful in areas with a deep groundwater table and soils with good infiltration capacity. Areas in the watershed with high groundwater levels would not benefit to the same degree from the application of these practices. This is primarily a concern in the downtown business district, where high groundwater and high tidal elevations limit storage and infiltration. Therefore, LID BMPs with the intent to reduce runoff may not be the most cost-effective solution to the local drainage problems in downtown Birch Bay or for improving the overall health of Birch Bay. Furthermore, implementation of LID BMPs is most applicable in urban/suburban areas and does not fully address changes in the hydrologic regime related to agricultural/pastoral land uses, which contribute to the problems in the Birch Bay watershed.

A resource for LID implementation is contained in the Low Impact Development Technical Guidance Manual for Puget Sound (PSAT, 2005). This manual provides detailed descriptions of low impact development BMPs and their applications. It also provides guidance on how to give developers credit for reduced runoff to make stormwater facilities smaller. Use of this manual for site layout and design is optional and not required by Whatcom County.

Site Planning and Layout Options

Site planning and layout using LID guidelines minimizes clearing to preserve native vegetation and soils, stream crossings, and grading. A critical goal of site planning is to preserve the natural topography and vegetation of the site, prevent/minimize direct impacts to critical areas like streams and wetlands, and decrease the amount of new total impervious surface (TIA). A variety of methods have been developed for residential development to achieve these goals.

- Reduce road and driveway lengths (Schueler 1995).
- Narrow lot frontages to reduce overall road length per home (Schueler 1995).
- Reduce road widths and turn around areas in residential developments, construct parking on one side of the street, use permeable pavers in non-drive lanes.
- Reduce front yard setbacks to reduce driveway length.
- Provide trail system to connect services and reduce use of vehicles, which in turn reduces the overall pollutant load.

The general strategies provided above for minimizing the impact of new development to site conditions should be applied to the majority of future development within the Birch Bay watershed, however it is most important where future densities are anticipated to be the highest such as within UGA boundaries.

Clustering with Additional Lot Size or Building Type Flexibility

Achieving additional open space or forested area for LID implementation, for wildlife habitat, or to preserve wildlife movement corridors to reduce habitat fragmentation within single family residential development is constrained to some extent by the lot size allowed for clustering without the more complex Planned Unit Development (PUD) review and approval procedures.

Within the UR4 Urban Residential (UR) District with an 8,000 square foot minimum lot size in conventional subdivisions and a 6,000 square foot lot allowance in cluster subdivisions the clustering provisions can achieve about a 25% component of open space within a development, assuming about 20 percent of land area is devoted to infrastructure. A reduction in the minimum lot size for clustering to 5,000 square feet would allow about 38% open space within a development. A 4,000 square foot lot would yield up to 50% open space.

Planned unit developments (PUD) may be employed under existing codes to include multifamily dwellings in a cluster development. The more extensive procedural requirements of the PUD, the additional processing time, and the uncertainty involved in meeting approval criteria often discourages use of the process by developers. An alternative process that addresses community concerns on compatibility of building types with a process that would allow development by right might specify a narrower range of building types, such as duplexes or townhomes instead of the full range of multi-family building types, might include specific design standards, or might allow greater flexibility in cases where open space provides a buffer between existing residents and the new development.

7.4.4.4 Revisions to Critical Areas Codes

The current Whatcom County CAO (WCC 16.16) offers some innovative approaches for regulating critical areas including allowing mitigation banking, off-site mitigation, and alternative mitigation approaches. The results of this study could be used to take adavanatge of these approaches.

Wetlands

Regulations for wetlands in the current CAO use a rating system and development standards that can generally be regarded as reflecting the current ecological functions. The landscape analysis performed for this study identifies a number of degraded or displaced wetland systems that have the potential to provide substantial ecological functions if restored or rehabilitated. Regulations could be revised to provide reference to studies such as this to provide a level of protection consistent with their restoration potential.

The County also could broaden the provision in 16.16.260.E to allow management plans for specific sub-basins within the Birch Bay area to satisfy the requirements of CAO regulations and provide relief and/or deviation as appropriate from the specific standards and requirements in the code. Under the current code, this option is limited to a plan sponsored by a Watershed Improvement District or other special purpose district, a mitigation plan for a major development, or a Planned Unit Development (RCW 36.70B.170 - .210). Additional flexibility may be appropriate where detailed studies are completed on the subbasin level to identify development, protection, and restoration areas.

The code currently allows off-site mitigation when it can be shown to provide equal or greater benefits than on-site mitigation. This is important in light of study results which indicate that some areas of the watershed are more suitable for restoration than others. Directing mitigation activities to these areas may help to improve the effectiveness and success of wetland mitigation projects compared to traditional on-site mitigation approaches that are not informed by watershed characterization.

Streams

Regulations for streams in the current CAO uses a classification system based on the Washington Department of Natural Resources water classification system developed for the implementation of the state forest practices act. This system classifies streams based on legal status of inclusion as a “shoreline” under the Shoreline Management Act, or by the presence of anadromous or resident fish.

This system has the advantage of clarity, simplicity and statewide understanding. Its disadvantages are that it does not account for differences in productivity of different water bodies for different lifecycle functions of aquatic species.

An alternative classification and buffer system could be employed for streams in Birch Bay that differentiates for high intensity and low intensity uses and/or inner and outer buffers, based on the results of this study, tailoring protection and buffer standards to the specific resources present.

Terrestrial Wildlife

Regulations in the current CAO identify critical areas for terrestrial wildlife largely by species. Except for habitat provided incidentally by riparian corridor or wetland buffer areas, no terrestrial habitat is specifically designated in the Birch Bay area, except areas coincident with nesting areas for eagles and other endangered, threatened or state priority species.

The general lack of specific provision for general wildlife habitat protection in the Birch Bay area represents an approach to preserving wildlife habitat functions that focuses largely on individual species, historically the dominant paradigm for wildlife management approaches. (Musgrave, 1993)

WDFW provides information on important upland wildlife habitat areas through its Priority habitats and Species (PHS) program, http://wdfw.wa.gov/hab/phspage.htm. In addition, Washington's Comprehensive Wildlife Conservation Strategy (CWCS) calls for the conservation of species and habitats with the greatest conservation need. The CWCS recognizes the importance of keeping common species plentiful and building conservation partnerships with other agencies, tribes, local governments, and non-governmental organizations to protect habitat (WDFW, 2005).

A regulatory approach that focuses on habitat rather than species may have several features different from the species-specific approach, including the following:

- Characterize habitat in a manner that emphasizes the ability of ecological systems to provide a range of ecosystem functions including those beyond the provision of potential habitat for plant and animal species. These additional services include recreation and aesthetics, watershed protection, buffering natural systems from invasive species and infectious disease, carbon sequestration, and, in many instances, sustained commercial harvest of natural resources.
- Characterize habitat in a manner that emphasizes the scale and relationship functions including minimum areas required for functions, fragmentation of habitat blocks, connections between habitat patches, facilitating wildlife movement through the area and characterization of different species abilities to move between patches based on the character of connections.
- Protecting wildlife from the negative impacts of development, including not only negative impacts to the habitat itself, but also to animal behavior and life cycle activities using the characterization of ecological functions, scale and relationships to establish a regulatory context in which human activities and habitat needs are considered on a system basis rather than through site-by-site assessment and mitigation.

Wildlife habitat functions may be provided in conjunction with human use at a variety of intensities. The intensity of human use tends to be correlated with the amount of alteration of vegetation from that typical of native vegetation communities used by wildlife. For example, the habitat conservation strategy for low-intensity agricultural areas, including less intensively used pasturelands, may provide habitat for a range of species adapted to the specific vegetation provided. Urban areas tend to provide an even more limited variety of habitat niches that are generally suitable for human-tolerant species in yards, parks, and even urban street trees. (Hanson et al., 2005)

A strategy for land use regulation in the Birch Bay area that would include a component of wildlife habitat protection based on providing a range of ecosystem functions might include:

- Develop specific land use regulations in an overlay, which would preserve those features that would allow ecological functions to continue within the larger interconnected system. The basis of such a system would be effective connections between different habitat patches allowing species to move from one to the other for various lifecycle functions. (Toms River, 2004);
- Forest cover preservation and restoration requirements;
- Minimum patch size preservation requirements;
- Standards to prevent roads and other linear features from producing barriers to movement. In some cases these can be combined with riparian corridor, but in many cases will require measures to provide overland movement across roads where stream or other corridors are not available.

The potential for such strategies to be included within the Birch Bay watershed would concentrate efforts in the Terrell Creek WAA to preserve existing conditions and retain and enhance conditions between habitat patches both within and outside the watershed.

7.4.4.5 Other Potential Programmatic Actions

It is noted here that the BBCSWP recommends development of a Sub Flood Control Zone District to provide revenues for managing surface water in the Birch Bay watershed (CH2M Hill, 2006). The details of such a proposal are still being investigated, but essentially the district would charge fees to property owners based on the type of land use and/or the amount of impervious surface. The collected funds would be used to implement surface water management actions throughout the watershed. Although the flood control zone district recommendation is outside the scope of this study, information from this pilot study could be used to inform the establishment of a sub flood control zone district, if desired by the County and area residents. For example:

- Property owners could be eligible for reduced fees for implementing recommended restoration measures or using alternative development techniques designed to address specific issues in each sub-basin.
- Fees could be assessed geographically in proportion to the specific conditions and perceived benefits in each sub-basin as indicated by this analysis.

In addition, the following recommendation should be considered for Birch Bay:

Establish Birch Bay as a Shellfish Protection District: Whatcom County has currently two designated Shellfish Protection Districts, in Drayton Harbor and Portage Bay. Building from the recommendations found in the Birch Bay Comprehensive Stormwater Plan (CH2M HILL, 2006), establishment of a shellfish protection district in Birch Bay would create a forum to address point and non-point sources of pollution that may be affecting water quality over the shellfish beds, with the intent of developing strategies to help restore the areas for shellfish harvesting. An advisory committee, consisting of nine members, is comprised of local citizens and local governments with an interest in helping to improve the water quality of the harbor and the entire shellfish district. The ultimate goal of the committee is to make improvements to the water quality of the shellfish district to enable the shellfish beds to be re-classified to an approved status.

More information on the shellfish protection districts can be found at the WSU Cooperative Extension website at http://whatcomshellfish.wsu.edu/ as well as at Whatcom County's web-site at http://www.whatcomcounty.us under the Water Resources Division of the Public Works Department.

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APPENDIX A

Comprehensive Management Strategy for Stormwater and Natural Resources

BIRCH BAY, WASHINGTON

COMPREHENSIVE STORMWATER MANAGEMENT STRATEGY PROJECT

PHASE 1

Prepared by ESA Adolfson

Prepared for: October 2007

State of Washington, Puget Sound Partnership (formerly Puget Sound Action Team)

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1.0 PURPOSE

The Puget Sound Partnership (PSP), in cooperation with the U.S. Environmental Protection Agency (EPA) and Whatcom County, is developing a Comprehensive Stormwater Management Strategy (CSMS) for the Birch Bay watershed. This plan is not intended to supplant the extensive stormwater planning efforts already underway in the Birch Bay watershed management unit (WMU) [1] and adjacent watersheds in the Water Resource Inventory Area No. 1 (WRIA 1), but build upon these efforts in an attempt to identify cost-effective solutions, additional sources of funding, and other collaborative practices that will aid the local community in characterizing and implementing effective stormwater practices and resource management actions.

The CSMS is part of the initial step in a multi-agency-sponsored pilot project to develop methods for utilizing established watershed characterization tools in the development of watershed-based land use management plans focused on preserving and restoring ecosystem processes, while concurrently planning for and accommodating projected population growth and economic development. More specifically, the pilot project seeks to facilitate protection and restoration of ecosystem processes necessary for the long term functioning of marine, freshwater, and terrestrial systems in and adjacent to the Birch Bay watershed. The pilot project will also provide recommendations for developing more effective and efficient tools to facilitate the decision making process for land use management at the local level.

The Birch Bay watershed was chosen as the pilot case because Whatcom County has been actively seeking opportunities to use watershed-based planning tools to streamline development review and improve natural resource management. Currently Whatcom County recommends the use of low impact development strategies and techniques in its protection of Critical Areas such as wetlands and stream systems.

As an example, Whatcom County's Critical Area Ordinance (CAO) includes provisions that allow watershed plans to "substitute" for some critical area regulations and other land use restrictions. The CAO also includes detailed standards and procedures for mitigation banking based on and consistent with State banking standards.

The effort to develop the CSMS for the Birch Bay WMU is divided into the three phases described below:

1. Review plans and technical documents collecting and evaluating planning, stormwater, and resource management recommendations for the Birch Bay WMU.

2. Develop and / orrefine existing watershed characterization tools[2] and analysis methods that are relevant statewide to test the applicability of the recommendations on a local scale.

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[1] For the purposes of this pilot project the Birch Bay watershed is characterized by the WMU boundaries as defined by the WRIA 1 Salmonid Recovery Plan.

[2] Watershed characterization refers to the analysis of ecosystem processes related to the movement of water, sediment, nutrients, chemicals, energy or animals and plants at various scales (basin, subbasin, watershed). This is a Geographic Information Systems-based approach to manage, analyze, display and monitor ecological data and results. The results can be used to make informed decisions related to land protection, restoration, planning and permitting.

3. Demonstrate how integrating watershed characterization into local land use planning can improve decision-making, increase predictability during development review, reduce workload and cost, and improve the health of local and regional ecosystems.

This draft report is a summary of the Phase I findings. In recent years, significant resources have been allocated towards gathering and analyzing available information, as well as creating plans to guide development and manage resources within the Birch Bay WMU. Many of the ongoing planning efforts share common goals for managing stormwater and meeting natural resource objectives for maintaining ecosystem health, recovering salmonid populations and improving nearshore habitat conditions.

As described above, the intent of this initial phase of the CSMS is to review and synthesize the programmatic, regulatory, management, funding, and physical improvement recommendations of the pertinent reports and technical documents prepared for Whatcom County as they relate to development guidelines, stormwater, and natural resource management objectives that have been developed for the Birch Bay watershed and surrounding areas. In this manner, the pertinent recommendations summarized in this document are categorized based on the intent and function of the recommendation to improve conditions and clarify the management objectives for land use and ecosystem processes within the Birch Bay basin.

2.0 BACKGROUND

Birch Bay, Washington is an unincorporated urban growth area (UGA) along the shores of the Strait of Georgia in Whatcom County. Located approximately 20 miles north of the City of Bellingham, and 50 miles south of Vancouver, British Columbia this small but growing residential and resort community is concentrated around the protected coastal bay for which the community is named.

Birch Bay is the receiving water of a coastal watershed encompassing 31 square miles located between Semiahmoo Bay to the north and Lummi Bay to the south (Figure 1). The Bay includes the marine shoreline from the Semiahmoo Peninsula and Birch Point, south to Point Whitehorn including Birch Bay State Park. The watershed extends inland to the City of Ferndale, and includes Lake Terrell and Terrell Creek. Other water resources within the watershed include Fingalson Creek and numerous small streams that drain directly to Birch Bay. Wetlands are widespread and extensive in the Birch Bay watershed, currently covering approximately 25 percent of the basin area.

According to the U.S. census (2000) approximately 5,000 people resided within the Birch Bay census designated place (CDP). Since 1990, the population of the Birch Bay watershed has increased by 87 percent, and it is projected that by 2022 the population will again double to nearly 10,000 (Census). Development of the primarily residential and recreational community is currently concentrated along the shorelines of the bay. The primary land use in the upper portions of the Birch Bay watershed consists of agricultural areas and pasture lands.

The marine and freshwater resources within the Birch Bay watershed provide the ecological foundation for supporting both human and non-human use within the watershed. As an example, the approximately twelve lineal miles of marine shoreline in Birch Bay from Birch Point to Point Whitehorn are deemed shorelines of statewide significance (RCW 90.58.310) and support significant fish, wildlife, and shellfish populations. Nearly two miles of the marine shoreline area located within the 194-acre Birch Bay State Park is publicly accessible. This area is a popular recreational area with extensive shellfish beds providing opportunities for recreational shellfish harvesting.

However, the water resources of the Birch Bay watershed and its associated fish and wildlife populations are susceptible to elevated nutrient and pathogen levels caused by pollution from human sources. Shellfish harvesting in Birch Bay has been periodically prohibited due to water quality problems. In July of 2003, Birch Bay was added to the Washington State Department of Health's (WDOH) list of 'threatened' shellfish harvesting areas because portions of the bay exceeded water quality standards for fecal coliform. This status indicates a downward trend in local water quality conditions, which could lead to expanding and/or extending harvesting prohibitions by the WDOH in an effort to ensure public health conditions and safety (CH2MHill, 2006).

In general, sources of fecal coliform bacteria in Birch Bay may include sewage treatment outfalls, on-site sewage systems such as septic systems, broken sewage conveyance pipes, waste discharge from boat tanks, runoff from agricultural fields, and wildlife/domestic pet waste (CH2MHill, 2006). Although marine waters are generally well mixed in Birch Bay due to the exposure of the shoreline, areas of relatively low energy do occur, primarily in the southeastern corner of Birch Bay near the state park. These low energy areas are potentially more susceptible to elevated nutrient/pathogen levels than other locations within the Bay.

Two other areas of concern for poor water quality conditions within Birch Bay include the outfall near the mouth of Terrell Creek and the mouth of the Birch Bay Village Marina in the northeast corner of the Bay. However, the local wastewater treatment plant outfall for the area discharges in deep water (deeper than Birch Bay) in an area with strong currents that rapidly disperse and dilute the discharge water. Thus, the outfall is unlikely to be a significant source of bacteria and contaminants in Birch Bay (CH2MHill, 2006).

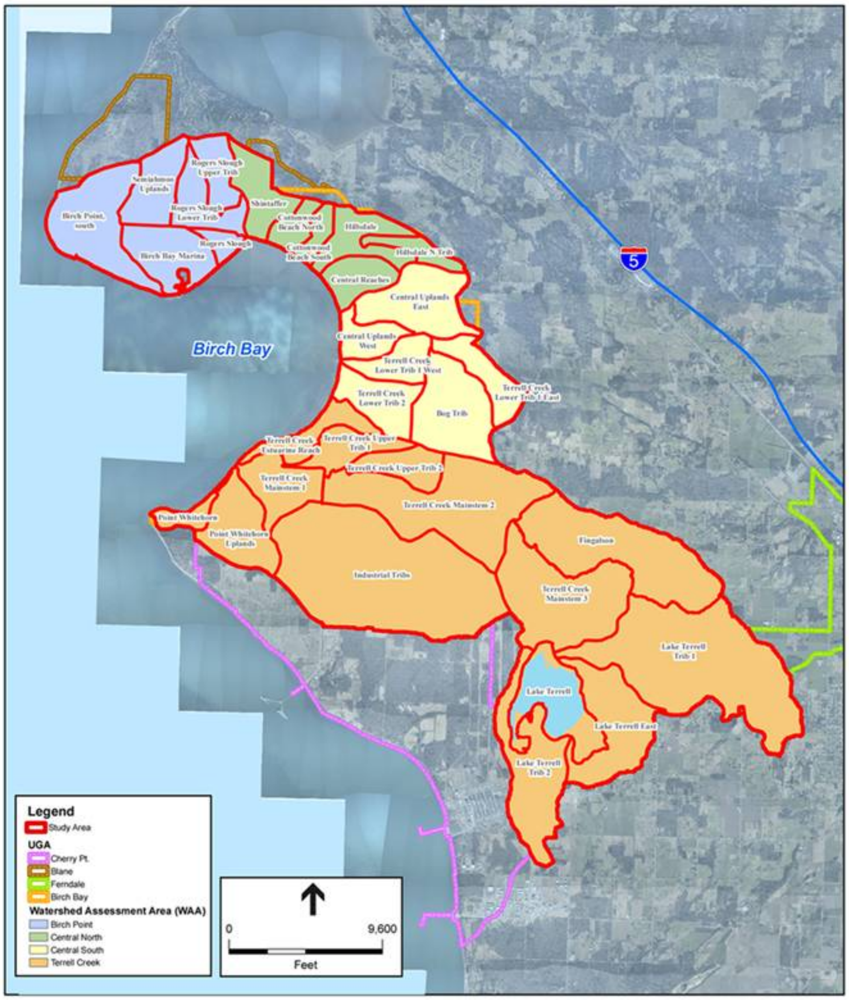

Figure 1. Birch Bay Watershed, Whatcom County (Source ESA Adolfson, 2007)

In addition to declining water quality in Birch Bay, several other types of surface water problems exist in the area. Localized drainage issues, including flooding and erosion/sedimentation, occur in several parts of the watershed (CH2MHill, 2006). Also, many areas of historical wetlands appear to have been affected by development, including former wetlands near the Birch Bay Village golf course and marina. Loss of historical wetland areas also appears to be extensive in the Cherry Point drainage (Gersib, 2001). These issues are affecting the quality of freshwater systems within the watershed, and have contributed to the degradation of available aquatic, wetland, and riparian habitat.

Research conducted by the Nooksack Salmon Enhancement Association (NSEA) found that Terrell Creek, the primary freshwater drainage within the Birch Bay WMU supports a variety of native fish species such as cutthroat trout and Coho salmon. However native fish population numbers within this 17 square mile drainage have declined significantly in the past 50 years. The causes of this decline are attributed to past and present land use practices, causing habitat degradation (primarily within the lower portion of the watershed) including loss of riparian habitat, barriers to fish passage, and extreme low flow rates during dry periods of the year. It is estimated that fifty-eight percent of the Terrell Creek riparian zone has been converted to non-forest cover with no significant conifer stands remaining along the stream corridor (Smith 2002). Much of the remaining riparian cover along Terrell Creek is comprised of less than ideal scrub-shrub, deciduous, and immature mixed forest stands.

The WRIA 1 Salmonid Recovery Plan (2005) estimates that 19.4 percent of the Terrell Creek drainage is covered by impervious surfaces. According to recent findings, a general threshold of six to ten-percent impervious area in any given watershed within the Puget Sound Region creates a situation in which hydrological processes are significantly impacted and recovery becomes unlikely (Booth and Jackson, 1997; May et al., 1997).

The two areas of most intense development are along the marine shoreline and in the Terrell Creek drainage above Lake Terrell. Efforts are currently underway at local, county, state, and federal levels to manage this population growth and development within the watershed to more effectively protect and restore the quality and conditions of the hydrologic processes within the watershed. For example, on February 22, 2005 the Whatcom County Council decreed by local ordinance (2005-030) that the Birch Bay WMU become a Stormwater Special District and a Water Resource Special Management Area, required to regulate and protect water quality by managing the quantity and quality of stormwater generated by development actions. This declaration places additional regulatory provisions on residential development within the basin that requires on-site stormwater facilities and the implementation of erosion and sediment control (ESC) measures to prevent soil and sediment-laden runoff from leaving construction sites. After construction, sites must be re-vegetated or permanent ESC measures must be installed.

Development and other human activities have affected the quality and structure of nearshore habitats as well. The Birch Bay watershed has a total of thirty-five groins alongshore in Birch Bay, two jetties at the Birch Bay Village Marina entrance, and the three industrial piers at Cherry Point. Field surveys performed by Coastal Geologic Services in 2005 documented bulkheading, or sediment impoundment, along 7.2 percent (6,944 feet) of the Birch Bay shoreline (not counting bulkheads along the large accretion shoreform beach within Birch Bay). Obstructions to sediment transport, such as groins and jetties, commonly exacerbate erosion down-drift and cause wave refraction where sediment transport is blocked by the structure. The loss of beach sediment and focusing of wave energy can lead to beach lowering and sediment coarsening, thus leading to habitat degradation. Adjacent beaches can also be affected by bulkheads that cause wave refraction, and can result in erosion hot spots.

The Birch Bay marine shore includes many areas of shallow water and no-bank beaches with extensive intertidal and shallow subtidal flats. These high light environments have historically supported extensive eelgrass beds and tidal flat algal production, with their associated food webs. These shallow areas also provide an early spring source of prey items for migrating salmonid fry at a time when deeper habitats are not as productive. However, residential and commercial development along the marine shorelines, have displaced much of the marine riparian vegetation within Birch Bay.

3.0 METHODS OF ANALYSIS

3.1 Comparative Document Review

Each of the documents analyzed in this initial phase of the CSMS are compared and evaluated qualitatively, identifying and categorizing recommendations as they pertain to objectives for guiding development and managing stormwater and natural resources in the Birch Bay watershed. In this manner, the pertinent recommendations presented in each document are categorized based on the intent and function of the recommendation to improve natural resource conditions and clarify the management objectives for land use and ecosystem processes within the Birch Bay basin.

Each of the plans compared and evaluated, though all tied to water resources, have differing mandates and authority. For example, the Birch Bay Comprehensive Stormwater Plan (BBCSWP) specifically recommends structural solutions to stormwater quality and quantity, while only touching on wetland solutions knowing the Critical Area Ordinance (CAO) update and shoreline inventory covered that area more specifically. In addition, during the BBCSWP process the citizens of Birch Bay set the prioritization of projects with specific quantifiable criteria, while many of the other plans had only general comments from the public.

To facilitate the evaluation of the plans, recommendations are divided into two categories: non-structural and structural. The non-structural category includes programmatic, regulatory, and funding recommendations, while the structural category is comprised of physical recommendations and alternatives for actively improving the hydrological and ecological conditions of the watershed.

3.2 Evaluating and Synthesizing Recommendations

The processes and mechanisms shown in Figure 2 provide the conceptual, ecosystem-based framework through which this Phase I CSMS review qualitatively analyzes the intent and function of the structural and non-structural recommendations provided in the documents reviewed. This framework is used to identify and consider potential gaps in the current collection of documents and reports that provide land use management recommendations for the Birch Bay area. The recommendations reviewed range in scope from broadly stated recommendations intended to generally improve hydrological conditions to more specific recommendations designed to enhance ecosystem mechanisms and processes operating within the Birch Bay watershed.

Ecological System	Process	Mechanism
Freshwater Streams, Lakes, and Wetlands		
	Hydrology	
		Infiltration/Recharge
		Surface Water Storage
		Runoff and Peak Flows
		Groundwater
	Sediment	
		Delivery and Storage
	Water Quality	
		Nitrogen Delivery / Removal
		Pathogen Delivery / Removal
	Organic Materials	
		Riparian Conditons
		Large-Woody Debris Recruitment
	Heat/Light	
		Canopy Cover
Marine /Nearshore Environments		
	Circulation	
		Oxygen Levels
		Temperature
	Sediment	
		Delivery and Storage
	Water Quality	
		Nitrogen Delivery / Removal
		Phosphorus Delivery / Removal
		Pathogen Delivery / Removal
	Nutrient Dynamics	
		Intertidal and Littoral Vegetation
	Heat/Light	
		Nearshore Canopy Cover

Figure 2. Ecosystem mechanisms and processes used to evaluate document and plan recommendations

4.0 DOCUMENT SUMMARIES

Several State and County land use oriented plans and documents have been adopted or updated within the past two years, including the Whatcom County Comprehensive Plan, the Birch Bay

Community Plan (also known as the Birch Bay Sub Area Plan), and the Birch Bay Comprehensive Stormwater Plan. These plans and documents have been created to guide land use decisions and protect, and in some cases restore, ecosystem processes within the Birch Bay UGA and surrounding watershed[3]. Other, more ecosystem process-based plans have also been adopted in the past year including the WRIA 1 Salmonid Recovery Plan and the Whatcom County Shoreline Management Program update. The objectives of these documents are focused on managing hydrologic conditions and stormwater, maintaining salmonid populations, and improving the conditions of the highly valued shellfish resources along the marine shores of the watershed. These documents along with local ordinances and established development standards control growth and protect the existing environmental (natural, social, economic) conditions of the Birch Bay watershed. The intent and overall objectives of the plans reviewed in this evaluation are summarized below:

4.1.1.1.1 Whatcom County Comprehensive Plan (Kremen, 1997, Updated 2005)

Based on the requirements stipulated in the Washington State Growth Management Act (GMA; RCW 36.70A) Whatcom County's Comprehensive Plan (WCCP) is intended to guide and coordinate growth in unincorporated sections of the County in conjunction with the new urban growth plans of its incorporated cities. The fundamental purpose of the WCCP is to establish a framework, through inter-jurisdictional cooperation, to coordinate goals, policies and action items for the growth planning and implementation actions that are occurring in designated urban growth areas and in the county's rural areas.

The WCCP provides an overarching framework for land use management in unincorporated Whatcom County that includes policy guidance and action items related to stormwater and natural resource management, including fish and wildlife habitat protection/restoration, wetlands preservation, etc. Additionally, the WCCP supports protection of the County's natural resources through a comprehensive environmental management program that includes coordination, regulation, restoration, mitigation, and public education. As part of the adoption of the WCCP, the Whatcom County Council, in conjunction with all local cities, adopted a set of Countywide Planning Policies. The framework provided by these adopted planning policies ensures that local planning efforts will be consistent with one another and supportive of regional goals.

4.1.1.1.2 Whatcom County Comprehensive Water Resources Plan (Kremen, 1999, Updated 2001)

Originally written in 1999 and updated in 2001, the purpose of the Whatcom County Comprehensive Water Resources Plan (CWRP) is to identify the short and long-term water resource needs within Whatcom County, and to further clarify and provide guidance for establishing water resource management goals. The plan lists several long-term goals for managing the water resources within Whatcom County, including:

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[3] The document review focuses on key countywide and locally sponsored planning documents. It does not include additional planning efforts by Tribal agencies, nongovernmental organizations, academic institutions and the like which may be ongoing in this region.

- maintaining a reliable and sustainable water supply that supports existing needs, and provides for growth;
- protecting and contributing to the enhancement of fisheries, restoring shellfish populations, and satisfying Endangered Species Act requirements;
- developing a coordinated land use and habitat management plan that provides recreational opportunities while restoring and sustaining natural systems;
- protecting and promoting areas of groundwater recharge; and
- providing an effective water management structure that performs comprehensive planning and coordinates efforts that support the diverse needs and users while promoting the efficient use of available resources.

4.1.1.1.3 Birch Bay Community Plan (Kask Consulting, Inc., 2004)

The Birch Bay Community Plan (BBCP) was adopted as a sub-area of the Whatcom County Comprehensive Plan in 2004. Prepared under the direction of a citizen-based steering committee in context with the requirements stipulated by the GMA, the Shoreline Management Act (RCW 90.58), the State Environmental Policy Act (RCW 43.21C), and the Whatcom Countywide Planning Policies, the plan represents the community's vision for accommodating future growth in the area while also preserving and nurturing the natural systems and aesthetics that are valued in the community today. This adopted vision recognizes that a dynamic accord must be struck between future development actions and the preservation/restoration of natural system processes to maintain the quality of life so highly appreciated by residents within the Birch Bay community.

While working to establish the aforementioned vision, the plan is designed to provide both structural and non-structural recommendations in an attempt to guide practical, development-based actions for the community in making zoning decisions, subdivision actions, capital improvements decisions, shoreline development and other actions that shape the local community. It also recommends specific actions to rehabilitate and enhance portions of the beach along Birch Bay Drive to achieve ecological, aesthetic, recreational and public safety objectives.

4.1.1.1.4 Birch Bay Comprehensive Stormwater Plan (CH2MHill, 2006)

The Birch Bay Comprehensive Stormwater Plan (BBCSWP) was developed to examine the current surface water issues within the Birch Bay watershed and propose solutions to more adeptly manage those issues in accordance with the BBSAP goals and objectives for future growth and development within the basin. The BBCSWP provides both structural and programmatic recommendations for addressing the impacts of stormwater on both built and ecological systems, and also examines funding opportunities for the outlined solutions. The plan further discusses issues of regulatory compliance with potential Endangered Species Act (ESA), Clean Water Act, and National Pollutant Discharge Elimination System (NPDES) requirements.

4.1.1.1.5 The WRIA 1 Salmonid Recovery Plan (Nooksack Natural Resources et al. 2005)

The WRIA 1 Salmonid Recovery Plan (SRP) outlines a local strategy of projects, programs and timelines to recover salmonid populations, with a particular focus on Puget Sound populations of Chinook salmon and bull trout, listed as 'threatened' under the ESA. The WRIA 1 SRP includes a comprehensive look at the scientific data collected on salmonids and their habitat over the last several decades, explains the factors inhibiting salmonid populations, and describes strategies and actions needed to recover salmonids to self-sustaining numbers. Central to the plan are eight actions to be taken in WRIA 1 over the next ten years that will jump-start early Chinook recovery. Many of the actions proposed in the recovery plan focus on preserving and/or restoring aquatic habitat and riparian conditions, which is under management control of both public and private landowners.

4.1.1.1.6 The Salmonid Habitat Restoration Strategy (City of Bellingham et al., 2005)

The purpose of the WRIA 1 Salmonid Habitat Restoration Strategy (SHRS) is to provide greater detail and direction to the WRIA SRP. The strategy identifies and prioritizes specific projects to protect and restore the habitats and landscape processes essential to the recovery of ESA-listed Chinook salmon and bull trout, along with other salmonids native to WRIA 1.

The Strategy constitutes an important component of the SRP, which incorporates recommendations for four key factors that determine salmonid population health, known as the 4 "H's" (habitat, harvest, hatchery, and hydropower) and, in addition to voluntary measures, also covers regulatory and incentive-based actions. Developed as a cooperative approach, the Strategy also supports and manages other active efforts from separate funding sources to restore and protect aquatic species in the WRIA 1, regarding all efforts as beneficial to the protection and restoration of ecological functions and landscape processes.

4.1.1.1.7 The Shoreline Inventory and Characterization Report (Parametrix and ESA Adolfson, 2007)

The Draft Shoreline Inventory and Characterization Report (ShICR) supports Whatcom County's Shoreline Management Program (SMP)[4] by documenting the existing shoreline conditions throughout Whatcom County. The report presents a baseline inventory and characterization of landscape processes and shoreline ecological functions in accordance with state shoreline guidelines. Specifically, the ShICR reports on the areas important for performing ecosystem processes at the watershed scale and describes ecological functions that influence the shorelines of Whatcom County; assesses the relationship between landscape processes and ecological function to identify current conditions; and, identifies specific opportunities and measures to protect and/or restore these functions and processes.

4.1.1.1.8 The Shoreline Restoration Plan (Parametrix and ESA Adolfson, 2007)

The Draft Shoreline Restoration Plan (ShRP) builds on the shoreline inventory and characterization document, supporting Whatcom County's SMP. The plan is not intended to

[4] The SMP is a component of the County's Comprehensive Plan.

supplant other salmon recovery planning efforts or watershed planning under RCW 90.82, but to provide a complimentary and coordinated approach for restoration planning and practice. The ShRP creates a framework for fostering shoreline restoration through coordinated planning efforts and voluntary cooperative and non-regulatory implementation. The plan identifies degraded areas and sites with potential for restoration, establishes overall goals and priorities for the restoration of these degraded areas; identifies and incorporates ongoing projects and programs currently being implemented; identifies additional projects and programs needed to achieve local restoration goals; identifies timelines and benchmarks for implementing restorative measures; and finally, provides mechanisms or strategies to ensure that restoration projects and programs will be implemented according to plans. The ShRP further ensures that projects will be appropriately monitored to determine the effectiveness of project techniques to inform future projects and programs.

4.2 Document Reviews

The plans reviewed in this report have two primary foci: guiding development decisions, and managing ecosystem processes through preservation, enhancement, and restoration activities. The intent and scope at which these plans are developed and applied is what in many ways forms the distinction between plans. For example, the WCCP provides a range of programmatic and regulatory recommendations that are applicable to both the broader, countywide scale and the Birch Bay watershed, while the BBCSWP focuses more specifically on developing management and performance measures specific to the Birch Bay watershed. The BBCSWP provides programmatic, regulatory, and capital improvement recommendations to address drainage, flooding, and water quality issues at a higher spatial resolution.

The WRIA SRP and SHRS provide an ecosystem approach for managing ESA-listed Chinook salmon and bull trout, focusing recommendations most specifically on the Nooksack watershed, outside of the Birch Bay area. However, general programmatic recommendations provided in the WRIA SRP and the SHRS for the proliferation of salmonids and the improvement of habitat conditions have been incorporated into this review. The ShICR and ShRP also use an ecosystem-based approach specifically analyzing the conditions of the shorelines in Whatcom County. The ShRP makes specific programmatic and capital improvement recommendations for enhancing and restoring the functional ecosystem processes and habitat conditions of the Birch Bay shoreline and Terrell Creek.

The CWRP and the BBCP examine both development and ecosystem management issues within the Birch Bay watershed, and provide programmatic, regulatory, and capital improvement recommendations to address these issues. These documents provide a watershed specific, localized perspective for guiding future urban development patterns while also supporting natural resource conditions within the Birch Bay watershed.

4.3 Information Gaps

The documents evaluated for this report provide an overview of the complex ecosystem conditions and land use issues in the Birch Bay watershed and offer a plethora of non-structural, programmatic and regulatory recommendations for protecting ecosystem processes and guiding development patterns. However, aside from the recommendations provided in the BBCWSP, there are comparably few structural improvement projects recommended. What is missing in many of these documents is the place-based (site-specific) best available scientific information needed for determining how ecological conditions can guide future land use decisions within the Birch Bay watershed.

This limitation is in part due to the small sample of documents evaluated in this initial recommendation review. Further iterations of this document review will benefit from a more broadly scoped analysis of recommendations generated in documents of, for example, management plans for specific areas within the Birch Bay watershed such as the Lake Terrell Management Plan, and reports generated by the Nooksack Salmon Enhancement Association (NSEA). The more finely scaled, structural recommendations, provided in these reports will provide more explicit information on the physical and biological conditions of the natural resources specific to the Birch Bay watershed.

5.0 RECOMMENDATION SUMMARIES

5.1 General Management Recommendations

The general management objectives from each of the plans are broadly categorized into: 1) watershed processes (see Figure 2), 2) critical areas[5] and habitat structure, 3) biological concerns, and 4) social concerns. Figure 3 shows the categorical distribution of recommendations from each of the reviewed documents and plans.

However, making specific ecosystem process and mechanism based recommendations is often difficult because of potential impacts to the larger watershed ecosystem. For example, a recommendation to control discharge from Lake Terrell to manage lake water levels may be beneficial for the local lacustrine conditions, but may also have negative impacts on the larger watershed ecosystem by reducing baseflows within Terrell Creek potentially overriding groundwater influence to the stream. For this reason, planned management and restoration actions should be reviewed for consistency with both local plans like the Lake Terrell Management Plan as well as larger, watershed-wide management plans.

The recommendations generated in the reviewed documents for the watershed processes category focus primarily on water quality and quantity issues. Water quality is identified in all of the documents evaluated as a primary management objective, and forms the nexus through which the evaluated documents provide similar structural and non-structural recommendations. A decrease in water quality conditions is often a direct result of human influences on the landscape from both point and non-point pollution sources. Water quality also heavily impacts the biological conditions of the instream, lake, wetland, and nearshore environments.

From a water quantity perspective, infiltration rates in much of the Birch Bay watershed appear to be currently intact, a redistribution of water quantities from increased development can have serious impacts to critical areas such as streams and wetlands as well as their associated habitat structure. Impacts to habitat structure, in turn, influence, often negatively, responses from the biological resources within the watershed.

[5] This includes critical areas as defined by the Growth Management Act and as designated by Whatcom County in the Title 16 WCC.

Closely related to physical processes is habitat structure. The functional processes of the ecosystem have a direct connection to the structure and availability of habitat within stream, wetland, and nearshore areas. Each of the documents under review recommends the preservation, conservation, and/or restoration of both terrestrial and aquatic habitat in critical resource areas.

For example, the loss of historical wetlands in Birch Bay as a result of direct anthropogenic influences such as filling and development often provide clear opportunities for restoration. Restoring these areas could improve water quality processes, which may have a positive effect on nearshore areas. Existing wetlands offer opportunities for habitat improvements via enhancement of existing vegetation communities, especially riparian wetlands within the Birch Bay and Fingalson Creek drainages which have many existing wetlands worthy of protection and/or enhancement.

Biological response is often the indicator used for determining the condition or quality of an ecosystem. A specific focus on preserving and enhancing salmonid populations within the Birch Bay WMU was only included in the SRP and SHRS, however, improving shellfish conditions was a primary objective for both ecosystem and planning-based reports. The July 2003 listing of Birch Bay by the WDOH as a 'threatened' shellfish harvesting area has motivated residents, planners, and natural resource managers to focus efforts on improving the shellfish conditions within the basin.

The primary social concerns are summarized as public education and outreach programs, issues of public safety, and land use designations. Each of the planning-oriented reports examined, including the WCCP, the CWRP, the BBSAP, and the BBCSWP, contend that development and urban growth strategies need to protect critical areas and incorporate an enhanced open space network that provides better access to recreation sites. In general, these plans contend that education and stewardship activities associated with open space sites will encourage the community to become more closely involved in managing the local environment.

Figure 3. Management Recommendations

	WATERSHED PROCESSES				CRITICAL AREAS / HABITAT			BIOLOGICAL CONCERNS		SOCIAL ISSUES		
Document	Water Quality	Flood Control	Groundwater Recharge	Erosion / Sediment Control	Stream / Riparian	Shoreline	Wetland	Salmonids	Shellfish	Education/ Outreach	Public Safety	Land Use
WCCP	X	X	X		X	X	X	X	X	X	X	X
CWRP	X	X	X		X			X	X	X	X	X
BBCP	X	X			X	X	X		X	X	X	X
BBCSWP	X	X		X	X					X	X	X
ShICR	X				X	X	X	X	X			
ShRP	X		X		X	X	X	X	X			
WRIA SRP	X	X		X	X	X		X		X		
SHRS	X	X		X	X	X		X		X		

WCCP = Whatcom County Comprehensive Plan
CWRP = Whatcom County Comprehensive Water Resources Plan
BBCP = Birch Bay Community Plan
BBCSWP = Birch Bay Comprehensive Stormwater Plan
ShICR = Shoreline Inventory and Characterization Report
ShRP = Shoreline Restoration Plan
WRIA SRP = WRIA 1 Salmonid Recovery Plan
SHRS (Strategy) = The Salmonid Habitat Restoration Strategy

5.2 Programmatic (non-structural) Recommendations

Although the documents and plans evaluated in this analysis vary in scope and intent they all contain programmatic recommendations for protecting, conserving, and in some cases restoring functional ecological processes to the Birch Bay watershed. Figure 4 provides a list of seven programmatic recommendations that represent a summary of those offered in the plans and technical documents evaluated. Categorically similar to the general management recommendations described previously, these programmatic recommendations focus on developing programs that commit to comprehensive ecosystem-based management approaches, actively identify and pursue potential funding sources, and foster communication within and between management agency and citizen-based groups.

Figure 4. Key Programmatic (non-structural) Recommendations

Commit to an adaptive ecosystem-based approach for managing the natural resources of the watershed including all waterbodies, freshwater and marine, shorelines, riparian areas, and wetlands;
Identify, protect, and/or restore both marine and freshwater processes and areas critical to the proliferation of salmonids and shellfish;
Provide a more complete assessment of the actual and potential environmental impacts of land use and development activities, including stormwater infrastructure, and options for preventing or minimizing these impacts at the watershed scale;
Commit to developing and implementing land use and zoning plans that respect our scientific understanding of ecological functions, processes, and conditions, and are representative of sustainable and low-impact development strategies;
Identify and assess potential funding sources that provide an alternative to increased drainage and utility rates. These alternative sources of funding will increase the ability of local governments and communities to manage stormwater to the necessary level to achieve established water quality standards and associated environmental outcomes;
Foster volunteer and stewardship efforts to improve the general community's understanding related to ecological functions and processes, as well as understanding of potential impacts associated with stormwater quantity and quality; and
Promote cooperative interagency and community partnerships that work to improve jurisdictional coordination and effectiveness while developing plans and implementation strategies that meet or at least address all stakeholder issues.

5.3 Regulatory (non-structural) Recommendations

The primary regulatory recommendations generated in the evaluated documents promote the strict regulation of development standards within Whatcom County and, more specifically, the Birch Bay watershed. The focus of several of these recommendations is to protect, preserve, and restore the ecosystem processes for the protection and enhancement of terrestrial and aquatic habitat. Other regulatory recommendations proposed developmental restrictions in high quality and transitional habitat zones such as along shorelines and within riparian areas. In synthesis, the primary regulatory recommendation from the evaluated documents was for County agencies and citizen groups to develop and coordinate a clear set of goals, policies, and actions that establish a basis for defining development regulations and protecting critical areas and ecosystem processes.

A summary of regulatory recommendations from each of the evaluated plans and technical documents are described in Figure 5. Many of the recommendations shown in Figure 5 have already been implemented by Whatcom County, and reveal the active adoption of recommendations by the County into current land management policy.

Figure 5. Key Regulatory (non-structural) Recommendations

Develop and adopt a low-impact development ordinance implementing standards for narrower streets, limitations on impervious surfaces, tree retention policies, and stormwater techniques focused on retention and infiltration;
Improve inspection, compliance, and enforcement measures;
Administer stormwater management standards as developed by the Washington Department of Ecology (2005);
Enforce HB 1458 requiring health authorities to identify and correct failing septic systems;
Develop and apply regulations preserving access to public lands and protecting viewsheds;
Develop more strict land use restrictions to protect critical areas such as shorelines from intensive development; and
Pursue adoption and implementation of ground and/or surface water management plans and protection efforts.

5.4 Funding (non-structural) Recommendations

Potential sources for generating funds to support the recommendations proposed in these reports are diverse, but not extensive (Figure 6). The majority of available funding programs identified are public sources for improving drainage infrastructure conditions and enhancing ecological conditions for salmonids and shellfish. The WRIA SHRS does recommend an on-line, searchable database for watershed restoration funding in the Pacific Northwest (http://ssrc.boisestate.edu).

Figure 6. Potential Funding Sources

Private Sources
Nessett Foundation (Parks)
Public Sources
Public Works Trust Fund (Infrastructure) Local Dedicated Funding Salmon Recovery Funding Board (potential) Aquatic Lands Enhancement Account (ALEA) (potential) Department of Ecology (Instream flow) PUD Ecology Phase 4 (potential)
Grants
Federal Appropriation
Bonds
General Obligation and Revenue Bonds
Taxes
Levys for protection districts County General Fund
Resources
http://ssrc.boisestate.edu (funding database for restoration)

5.5 Physical Improvement (structural) Recommendations

As described in the previous sections, the documents evaluated in this report primarily provide broad programmatic and regulatory recommendations for guiding land use development and protecting critical areas and ecosystem processes. However, several of the documents, including the BBCP, BBCSWP, and ShRP developed specific physical improvement recommendations for the Birch Bay WMU. For example, the ShRP recommends measures to offset past alterations to nearshore processes in the Birch Bay WMU, which are largely related to anthropogenic structures that impede movement of sediment and negatively affect adjacent beaches and sediment impoundment by bulkheads. These structures are primarily located in the Birch Bay and Cherry Point reaches. Full restoration of these processes is only possible by removing the structures. Where removal is not an option, efforts to reduce impacts or perform compensatory mitigation may be partially effective alternatives.

As seen in Figure 7 these recommendations are presented here in three categories: Ecological Systems, Stormwater, and Land Acquisition.

Figure 7. Structural Recommendations

Ecological Systems	Recommendation	Source(s)
Marine Shoreline	Remove bulkheads between Point Whitehorn and Birch Point	ShRP
	Protect sediment sources that supply large accretionary beaches and marshes in Birch Bay	ShRP
	Restore and conserve shoreline sediment sources near Cherry Point and Point Whitehorn	ShRP
	Enhance riparian conditions	ShRP
	Restore Marsh along Public Shorelines	ShRP
Stream (Terrell Creek)	Replace culvert on Terrell Creek at Grandview Road	BBCSWP
	Enhance riparian conditions along Terrell and Fingalson Creeks	BBCSWP
	Restore Instream Conditions of Terrell Creek	ShRP; WRIA SRP; BBCSWP
	Protect / Restore Lake Terrell	ShRP
Stormwater System	Watershed-wide Stormwater System	BBCSWP; BBCP
	Spot Drainage Improvements	BBCSWP
Public	Acquire Available Open Space	WCCP; BBCP

5.5.1 Prioritizing Capital Programs and Structural Project Recommendations

Currently, a local strategy for prioritizing capital programs and structural project recommendations is presented in the BBCP (Figure 8). This prioritization strategy is based on the financial and physical impact of a proposed project or program to the Birch Bay Community, but does not incorporate the evaluation of potential impacts at the ecosystem scale. The information generated in the CSMS will enable an ecosystem-based evaluator to be incorporated into the BBCP project prioritization strategy. Adding such an evaluator to the prioritization strategy will further enable the Birch Bay community to address its vision for "achiev[ing] harmony between [the] natural and man-made environment," and "to reach a mutually supportive balance within the [complex system of relationships between living things]" (BBCP, 2004; 5-4).

A potential ecosystem-scale evaluation strategy to be developed and incorporated into the current prioritization model could be based on whether or not the action or project would have beneficial impacts to multiple ecosystem processes as listed in Figure 2. For example, restoring the instream conditions of Terrell Creek not only addresses the need to improve habitat conditions and access within the system, but also addresses issues of water quality, flood abatement, and in an indirect way, groundwater recharge. Thus, such a recommendation would be given a higher ranking than a project that addressed a single ecosystem process.

Figure 8. Strategy for Prioritizing Capital Programs and Structural Project Recommendations (BBCP, 2004; 17-4)

1. Projects mandated by law, as well as by state and federal regulations, will receive priority consideration.
2. Projects necessary to correct existing deficiencies will receive priority consideration.
3. Projects previously initiated will be completed in subsequent phases and will receive priority consideration.
4. Projects providing for the renovation of existing facilities resulting in preservation of the community's prior investment or reducing maintenance and operating costs will receive priority consideration.
5. Projects whose construction or acquisition results in new or substantially increased operating costs will be considered after an evaluation of needs and operating costs have been identified.

5.5.2 Relative Costs for Physical Improvement Recommendations

The relative costs associated with the physical improvement projects are rough, planning-level estimates for design and implementation based on scope and technical difficulty of the recommendations (Figure 9). The specific recommendations are categorized into stormwater, Terrell Lake and Creek, Birch Bay shoreline, and open space. The cumulative costs for each of the categories is estimated to be high, however individual projects located beneath the categorical header range in relative cost from low to high depending on the recommendation.

Figure 9. Relative Costs for Recommended Capital Improvement Projects

H	***Stormwater***
H	Develop Regional Stormwater System
M/L	Spot Drainage Improvements
H	***Terrell Creek and Lake Terrell***
	Protect / Restore ecological functions of Terrell Creek and Lake Terrell
L	Enhance riparian conditions
M	Acquire / Restore mouth/delta Terrell Creek
M	Enhance instream conditions along Terrell Creek
M	Replace Terrell Creek culvert at Grandview Road
H	***Birch Bay Shoreline***
	Restore nearshore processes in Birch Bay
M	Restore nearshore marsh habitat
L	Enhance riparian conditions
M	Restore shoreline sediment sources near Cherry Point
M	Remove bulkheads between Birch Bay State Park and Point Whitehorn
H	***Open Space / Recreation***
	Increase quantity and quality of available open space
L	Coast Millennium Trail Connections
H	Acquire available open space

H = High; M = Moderate; L = Low

6.0 SUMMARY

Over the past several years, significant resources have been allocated for developing the documents evaluated in this recommendation review. Each of the documents provide recommendations for managing growth while protecting natural resources to maintain salmonid populations and improve the conditions of the highly valued shellfish resources within and adjacent to the Birch Bay watershed. All of the plans evaluated in this report provide pertinent information towards these ends, specifically focusing on individual components for managing land use and/or ecosystem processes.

Since 2005, Whatcom County has completed several activities developed from recommendations offered by these plans for managing growth and protecting natural resources, including the adoption of the Critical Areas Ordinance (CAO) and the Shoreline Management Program, and the update of the countywide planning policies. The documents and plans analyzed in this report, as well as the codes, ordinances, and standards that have been developed and adopted from their recommendations, provide policies that will impact both the long and short-term land use patterns within the watershed by controlling development and providing potential protection of the existing Birch Bay environment (natural, social, economic.)

Collectively, the documents evaluated respond to a wide range of development and natural resource concerns and issues that arise when cultivating plans for managing future growth in a watershed based on ecosystem processes. However, no single document evaluated in this review utilizes a comprehensive ecosystem-based approach for evaluating the relationships between land use and watershed processes specific to the Birch Bay WMU. This lack of comprehensive watershed oversight reveals the explicit need to incorporate an ecosystems-based approach for developing plans and policies that promote development while also protecting and restoring ecosystem processes.

The non-structural programmatic, regulatory, and funding recommendations from each of the documents are repetitive and often relatively vague. In all the documents but the BBCP and the BBCSWP, the non-structural recommendations are offered on a relatively high level without supplying specifics for how adopting these recommended regulatory or programmatic actions would impact specific locations and actions within the Birch Bay watershed. Recommended sources for funding both programs and specific projects were also non-specific.

Several of the documents, most specifically those developed for the Birch Bay UGA or WMU, such as the BBCP and the BBCSWP, provide capital or structural project recommendations for improving both present and future conditions within the watershed. The ShRP also provides several specific structural recommendations for improving the nearshore habitat within Birch Bay.

Although all the documents address the need to incorporate educational and stewardship opportunities, the primary non-structural and structural recommendations from each of these documents focused on the need to improve the water quality conditions within the Birch Bay WMU, to not only reduce potential impacts to human health, but also to improve the conditions for fish and wildlife. Thus, from this evaluation, water quality forms the nexus on which all of the structural and non-structural recommendations from the evaluated documents relate, and provides a starting point for developing an ecosystem-based approach for managing land use and stormwater within the basin.

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APPENDIX B

Wetland and Riparian Inventory: Methodology and Limitations

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Appendix B

SUBJECT: **Wetland and Riparian Inventory: Methodology and Limitations Birch Bay, Washington**

This memorandum provides the methodology utilized for refining the inventory of existing wetlands within the Birch Bay WMU[1] per Task #1 of the agreed upon scope of work between Parametrix/ ESA Adolfson and the Multi-agency Watershed Group (MAWG)[2]. The wetland inventory qualitatively identifies wetland areas and evaluates the relative importance (function and value) of these wetlands using rapid assessment techniques, remote sensing, high-resolution aerial photos (Pictometry), and other available data sets, with limited field reconnaissance. The methodology used for a similar inventory of riparian areas within the Birch Bay watershed is also included within this memorandum.

The wetland identification and riparian data generated during the course of this study are saved in a .shp (ESRI) file format titled BB_WETLAND_ID.shp and BbayRiparianBuffers.shp, respectively. The data files have been made available to members of the MAWG as part of the requested deliverables under Task #1 of the aforementioned scope of work.

PURPOSE

The scope and intent of this work is to develop an integrated approach that incorporates methods used in watershed characterization to provide guidance for future land use planning efforts. The overall goals of the project are to:

- use watershed science-based strategies for guiding future development;
- outline comprehensive mitigation and restoration strategies to offset anticipated development impacts; and
- identify options for streamlining local development review.

More specifically, this project seeks to facilitate protection and restoration of ecosystem processes necessary for the long term functioning of marine, freshwater, and terrestrial systems in and adjacent to the Birch Bay watershed while achieving more effective and efficient decision making related to land use management at the local level.

BACKGROUND

As part of the SMP update process Whatcom County conducted a landscape-scale characterization of ecosystem processes using the methods developed by Stanley et al. (2005). The landscape characterization examined key

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[1] For purposes of this task, the Pt. Whitehorn and the industrially zoned areas of the upper Terrell Creek drainage subbasins would be excluded. However, these areas are to be included in the overall characterization of ecosystem processes.

[2] The MAWG includes: the Washington Department of Ecology, the Puget Sound Action Team (PSAT), the U.S. Environmental Protection Agency (EPA), Washington Department of Fish and Wildlife (WDFW), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (FWS), Washington Department of Community Trade and Economic Development (CTED), Cascade Land Conservancy, Washington Department of Transportation (WSDOT), and the Washington Association of Counties.

processes related to the movement of water, sediment, heat/light, LWD, and nutrients in each of the 26 identified watershed management units (WMUs) in the County. The characterization:

- Identified key processes within the landscape that shape and influence the health of aquatic systems including wetlands, streams, estuaries, and marine waters;
- Mapped areas on the landscape that are important to the operation and maintenance of these processes,
- Assessed how these processes have been altered by human activity, and
- Determined protection, restoration and management needs for each WMU, including Birch Bay, based on existing conditions.

This pilot project builds on this existing work by: 1) refining certain aspects of the characterization (e.g., improved wetland characterization); 2) numerically scoring two of the processes (water and nutrients) using new tools developed by Stanley et al. to depict (in conjunction with information on the other processes) the relative importance of each sub-watershed for water and denitrification processes; and 3) adding a metrics-based fish and wildlife assessment.

This pilot project is part of a larger effort by the MAWG to develop an integrated set of tools that use watershed science in a land use planning context. The Birch Bay watershed was chosen as the pilot case, because Whatcom County has been actively seeking opportunities to use watershed-based planning tools to streamline development review and improve natural resource management. As an example, Whatcom County's Critical Area Ordinance (CAO) includes provisions that allow watershed plans to "substitute" for some critical area regulations and other land use restrictions. The CAO also includes detailed standards and procedures for mitigation banking based on and consistent with State banking standards.

WETLAND INVENTORY

Wetland Identification Methodology

On February 14, 2007 a subcommittee of the MAWG, several Whatcom County employees, and members of the ESA Adolfson team joined in a working meeting to discuss scope, methodological details, and provide training for "remote" wetland identification. During the course of this meeting the basic parameters for study were determined and the specific area of interest was identified.

Data Sources

Numerous data sources were used during this inventory refinement (Table 1). All of the sources provided pertinent information regarding wetland signatures, however the aerial imagery from different seasons proved to be the most useful for quickly identifying wetland signatures on a year-round basis. The LiDAR also proved to be beneficial by revealing landscape position and surface slopes of possible wetland locations. The NRCS data, although relatively course in scale, also guided decisions based on the permeability of surrounding soils.

The previous wetland surveys were also beneficial. These include the National Wetlands Inventory, NOAA Coastal Change Analysis remote sensing data, and a reconnaissance level wetlands inventory conducted by Jim Wiggins, Aquaterra Systems Inc. and Randall Perry, Department of Ecology in 2001. Most useful was the 2001 inventory by Ecology as it received ground truthing that the other datasets did not. These reference inventories provided a starting point for the stereophoto interpretation.

Table 1: Data Sources utilized for the identification of wetlands and riparian corridors.

Name	Date	Source	Description
LiDAR	Summer 2006	US Geological Survey	The LiDAR data presented in hillshade provided information on landscape position and relief

Stereo Photos	2001/2006	WA Department of Transportation (DOT)	The stereo photos provided aerial perspective of research area. The September 2006 photos did not cover the area south of Point Whitehorn, this area was supplanted by 2001 photos purchased from the DOT photo lab. The photos were not ortho-rectified or geo-referenced. Whatcom County printed stereopairs of the 2006 photos at 1:12000 scale. A stereoscope was used to pick up vegetation signatures that indicated a high likelihood wetland vegetation.
Ortho and Oblique imagery	Winter 2004	Pictometry International Inc.	Another source of aerial imagery for project area, taken in February of 2004. This provided a wet view of the landscape contrasting more recent dry season photos from DOT. High resolution (6 inch) oblique images provide a detailed look at hard to see areas on the summer aerial photos.
NRCS – Soil Data	2001	SSURGO soils NRCS	Provided general locations of soil composition and drainage classification
BB-Wetland	2001	Department of Ecology via Aquaterra Systems Inc.	Previous wetland survey that covered approximately 40% of the project area. Represented the most reliable wetland inventory due to levels of field reconnaissance
Whatcom County, Critical Area Ordinance Wetlands (WCC 16.16)	1997, updated 2006	National Wetlands Inventory, WA Department of Fish and Wildlife, NOAA National Landcover Dataset	Provided general locations of potential wetland areas. Primarily based on remote sensing from 1980s and 2000.
Historical Wetlands	2001	Gersib, R.	Based primarily on 1990s photos and soils

Wetland Identification Parameters

The wetland identification parameters described below were determined to provide an adequate level of site specific information to meet project goals and objectives while not moving beyond the limitations presented by the available data and the remote assessment methodology developed.

Wetland Class

The wetland classes are from the Hydrogeomorphic Method (HGM) for classifying wetlands (Brinson, 1993) as defined in the *Washington State Wetland Rating System for Western Washington* (2004). A score was given for both current class and potential class. Potential refers to the class the wetland may have been prior to disturbance, and what it could possibly be again.

Table 2: Wetland Classifications

1	Depressional
2	Riverine
3	Lake-Fringe
4	Slope
5	Flats
6	Freshwater Tidal
7	Estuarine
8	Upland*

*Only used in Potential category, typically referring to stock or stormwater ponds.

Special

The special category was recorded only if the wetland areas were identified as ecosystems of special concern, afforded higher regulatory restrictions than other wetland environments. The classes in the special category were a subset of the special wetland types as identified in the *Washington State Wetland Rating System for Western Washington* (2004).

Table 3: Special Wetland Categories

0	Not Special
1	Bog
2	Lagoon
3	Estuary

Vegetation Alteration

This category was subjectively determined based on the degree of observed vegetation alteration and degree of recovery. Based on regional characteristics, it was assumed in this analysis that the majority of the Birch Bay watershed had been extensively forested prior to Euro-American settlement in the immediate area and had been logged at least once since the settlement period. If the majority (>80%) of the identified wetland polygon was forested it was determined that the alteration of vegetation structure is low.

Table 4: Vegetation Alteration

1	Low (<20% altered)
2	Partial (20 – 80 % altered)
3	High (>80% altered)

Buffer Size

The values for this category were derived from the Veg_Alt, Hydro_Alt, and HGM_Now classes through a system of if, then statements described below. Buffer sizes were established as the minimum required buffer width for Class 1 and 2 wetlands (75-feet) and Class 3 and 4 wetlands (40-feet) (per the Whatcom County Critical Area Ordinance, WCC 16.16). Since it is challenging to classify wetlands using remote analysis, we generated a system for making conservative assumptions about buffer width as follows:

If Veg_Alt = 3 (High Alteration), then Buffer_Size = 2 (40-feet)

If Veg_Alt = 1 (Low Alteration), then Buffer_Size = 1 (75-feet)

If Veg_Alt = 2 and HGM_Now = 2 (riverine), 3 (lake fringe), or 7 (estuarine), then Buffer Size = 1 (75-feet)

If Veg_Alt = 2, HGM_Now = 1 (depressional), and Hydro_Alt = 1 (Low Alteration) or 2 (Moderate Alteration), then Buffer Size = 1 (75 feet)

If Veg_Alt = 2, HGM_Now = 1 (depressional), and Hydro_Alt = 3 (High Alteration), then Buffer Size = 2 (40 feet)

Hydrological Alteration

This category was subjectively determined based on the degree of observed hydrological alteration within the identified wetland polygon. The level of hydrological alteration was determined based on the degree to which water flow paths had been modified (e.g. drained and/or channelized into drainage ditches) or the presence of infrastructure such as roads was located within the identified wetland polygon. In some rare cases development (predominantly housing plots) was located within these wetland polygons and was included in the assumptions of hydrological alteration. If greater than 80% of the identified wetland polygon was determined to contain 'natural' surface hydrology conditions it was determined that the degree of hydrological alteration is low.

Table 5: Hydrological Alteration

1	Low (<20% altered)
2	Partial (20 – 80 % altered)
3	High (>80% altered)

Confidence Level

Confidence level was determined qualitatively based on several characteristics. The first was the number of data sources that confirmed the potential for wetland presence within the examined area. If only one source revealed this potential, then confidence level remained low. If more than one source identified wetland potential, then confidence level was considered either moderate or high depending on surrounding landscape and hydrological conditions. Our best professional judgment, supported by a QA/QC approach for validating wetland characteristics also played heavily into determining the degree of confidence for each identified wetland polygon.

Table 6: Confidence Level

1	Low
2	Moderate
3	High

Wetland Potential

This category was defined as the potential for an identified wetland polygon to expand. Closely related to hydrological alteration, wetland potential in this instance is synonymous with restoration potential. The binary (yes/no) category was qualitatively determined based on the degree and type of hydrological alteration within the identified wetland polygon. However, highway infrastructure and development were considered semi-permanent and decreased the potential for a wetland area to expand. In some instances, the identified wetland polygons appeared to cover the maximum amount of area possible based on surrounding landscape characteristics.

Table 7: Wetland Potential

1	Yes
2	No

Source
This category was filled in based on the number and type of sources used to identify the wetland polygon. The data sources are listed above.

Notes
This category was provided to supply anecdotal information about the identified wetland polygon that would not be captured by the other categories.

Field Check
This simple binary (yes/no) category was developed to record whether or not the identified wetland polygon was included in the limited field reconnaissance conducted to confirm site conditions.

Table 8: Field Check

1	Yes
2	No

Research Team
To maintain the integrity and consistency of the data collected and evaluation conducted, a 4-member team of wetland scientists and watershed ecologists from ESA Adolfson performed the study. Each member was trained in the methodology, understood the scope of available resources, and had been provided with an overview of the landscape conditions within the watershed. Teams of two worked systematically across the watershed applying the methodology. Team members cycled out periodically, allowing for all members of the larger team to work with one another in an effort to ensure consistency of data collection and evaluation.

Assumptions
During the course of this 'remote' wetland identification study several assumptions were made concerning the confidence of findings at varying scales and across land uses with differing types and densities of vegetative cover. These assumptions are listed below.

- Although no minimum size for identifying potential wetlands was clarified, visual wetland signatures in any area smaller than 1,000 to 3,000 square feet was difficult to discern, unless the area was open water.

- For consistency, open water, such as stock and stormwater ponds and lakes were digitized as wetland polygons. However, these areas were consistently not afforded the wetland potential parameter.

- Any identified wetland polygons that extended beyond the boundaries of the study area were included in their entirety.

- Linear ditches were often included in the delineation of the wetland polygon to provide visual cues to the general movement of water through a complex of wetland areas.

- Agricultural fields and full-canopied forests often displayed the most difficult visual cues to discern remotely, described in more detail below in the Limitations section. The extent of wetland polygons was limited in these landcover types to areas that could be visually discerned with at minimum low confidence, and were supported by landscape position and soil data.

Field Reconnaissance
On March 10, 2007 several ESA Adolfson wetland biologists and Whatcom County employee Peter Gill conducted field reconnaissance on more than 40% of the identified wetland polygons. The field reconnaissance

was a windshield survey that was performed using major roadways. Some limited site walks were performed, however, the overall intent was to observe conditions throughout the watershed. Approximately 10% of the identified polygons were altered by field reconnaissance findings.

The areas examined in the field represented the general land use and environmental conditions observed throughout the Birch Bay watershed. These conditions included active agricultural fields with subtle swale/depression complexes, second growth conifer forest, and alder forests. In general, the remotely identified boundaries were confirmed, however, there were some instances where the actual wetland observed in the field was either much smaller (e.g. the intersection of Semiahmoo and Shintaffer roads) or much larger (e.g. the intersection of Point Whitehorn and Grandview) than the polygons identified in the office. Remote identification was more successful in cleared areas than in areas with dense forest cover.

Limitations

Wetlands are not always easy to identify, much less categorize, when in the field. When using remote sensing techniques these environments become even more difficult to discern. The most limiting factor for such analysis is the quality of the data being examined. Even using high quality aerial imagery from different times of the year and LiDAR technology it was often difficult to discern wetland characteristics in areas of several landcover types. The most difficult areas to discern was forested landscapes. Canopy cover inhibits the analysis of surface conditions, and although the LiDAR technology provides a fairly accurate representation of the ground plane beneath the canopy, inconsistencies and errors in the data maintained a low confidence level. For forested areas, we relied heavily on previously collected information from a variety of previous wetland surveys conducted within the watershed.

Another landcover type from which it was difficult to discern wetland characteristics was active agricultural or pasturelands. Although, the ground plane is easily discernable using aerial imagery and many of the lands in these land use categories were either distinctly wetland or not, a lot of the areas showed marginal wetland conditions and thus became one of the focuses for field survey.

Although the use of this remote wetland identification methodology proved to be useful for identifying general locations and characteristics of wetland areas within a landscape context, it is near impossible to determine with any accuracy the extent of wetland conditions in these areas. Thus, the data generated from this study merely provides information regarding general wetland locations and characteristics within a landscape scale context. No empirical evaluations of wetland area can be developed from the information generated.

RIPARIAN INVENTORY

Riparian Area Characterization Methodology

Developed during the same February 14, 2007 meeting that defined the basic parameters for wetland identification; the riparian characterization was designed to be a coarse evaluation of riparian conditions within the Birch Bay watershed using remote sensing techniques and a rapid assessment methodology. The riparian assessment methodology was developed from the WDFW Draft Landscape PHS Riparian Metrics (Figure 1). These metrics provide a rating system for channel stability and stream habitat based on two primary characteristics within the riparian corridor: (1) the percentage of natural vegetation within the corridor, and (2) the number of riparian corridor breaks per mile of stream habitat.

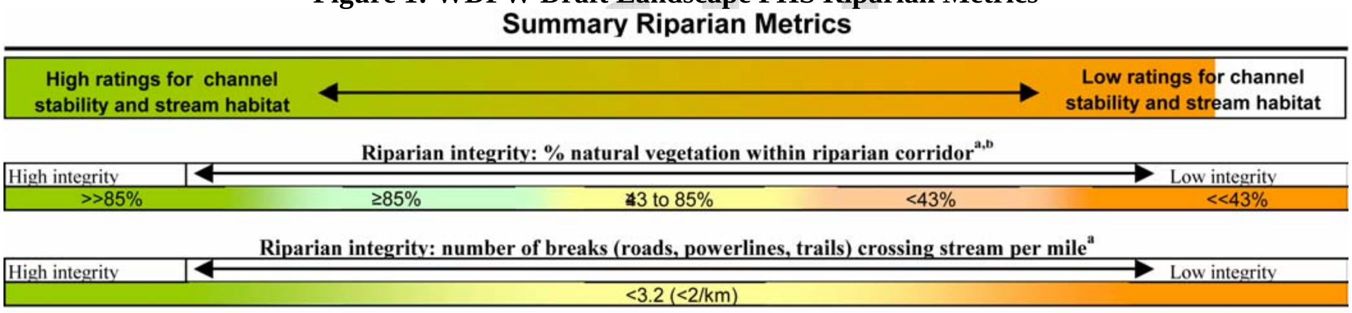
Defining the Riparian Corridor

For the purposes of this study, the riparian corridors for each watercourse were determined by regulatory guidelines stipulated in the Whatcom County Critical Area Ordinance (WCC 16.16.720.H.3). According to the code, Type 1 streams regulated by the shoreline management program (Terrell Creek) require a 150 ft buffer, all rivers and streams that are salmon-bearing are afforded a 100-ft buffer from the ordinary high water mark of each bank. Other watercourses such as non salmon-bearing streams and ditches are given a 50-foot buffer width. Lakes (under 20 acres) and ponds were also given a 50-foot riparian width in accordance with the WCC 16.16.

In an attempt to provide a more accurate assessment of riparian conditions, study reaches were broken at all tributary confluences. In some instances, in-line lakes were also used as study reach breaks. Although reaches were not of uniform length, breaking the reaches at tributary confluences represented the most logical course of action due to the short, dendritic patterns of the majority of streams in the Birch Bay watershed.

Data Sources
Whatcom County digtitized the location of streams and lakes using 2004 Pictometry images and 2006 LiDAR data. The streams were broken into segments at confluences and buffer according to the Whatcom County Critical Areas Ordinance requirements. Using the buffers as riparian areas, ESA Adolfson used the same 2004 aerial photography to determine both percent of natural vegetation and corridor breaks for this inventory.

Figure 1: WDFW Draft Landscape PHS Riparian Metrics



Riparian Evaluation Parameters
The riparian evaluation parameters were developed from the WDFW Draft Landscape PHS Riparian Metrics (Figure 1). These parameters were determined to provide an adequate level of site specific information to meet project goals and objectives while not moving beyond the limitations presented by the available data and the remote assessment methodology developed.

Crossings
Determined per stream or lake reach, the crossings were broken into three categorical headings: roads, utility lines, and other. More than 90% of the riparian breaks identified within the study area were roads with only a single utility line instance.

Natural Vegetation
This qualitatively determined category is based on the percent of canopy or shrub vegetation present within a study reach. The percentage for both the left and right banks was calculated independently. The percentage categories were based on those described in Figure 1.

Table 9: Riparian Vegetation Categories

1	<5%
2	5 – 44%
3	44 – 85%
4	85 – 95%
5	> 95%

Research Team

To maintain the integrity and consistency of the data collected and evaluation conducted, ESA Adolfson scientist Steve Winter collected all riparian data. Steve worked systematically through the water systems identifying and categorizing riparian characteristics based on the previously described parameters. QA/QC was conducted independently on all data collected.

Limitations

Similar to the limitations described in the wetland methodology, the most limiting factor for any remote sensing approach to landscape characterization is the quality of the data available. Although the aerial imagery used in this analysis was current (2004) and of high quality, discerning vegetation types using aerial imagery is difficult. This limitation resulted in data that merely provides information regarding the presence or absence of riparian vegetation. It does not provide any insight into the type or composition of vegetation present within the riparian corridor.

APPENDIX C

Land Use Assessment: Methodology and Limitations

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Appendix C

SUBJECT: **Land Use Assessment: Methodology and Limitations**
Birch Bay, Washington

This memorandum provides the methodology utilized for assessing current and potential land use conditions within the Birch Bay watershed per Task #4 of the agreed upon scope of work between Parametrix/ ESA Adolfson and the Multi-agency Watershed Group (MAWG)[1]. The methodology described here refines already developed land use assessment tools for integration with other tools designed to characterize ecosystem process and habitat conditions. Based on a 4-step process, the methodology described below is used to generate information regarding the vulnerability and intensity of individual sub-basins within the Birch Bay watershed to potential development based on current zoning patterns designated by Whatcom County (2005).

PURPOSE

The scope and intent of this pilot project is to develop an integrated approach that incorporates multiple methods used in watershed characterization to provide guidance for future land use planning efforts. The overall goals of the project are to:

- use watershed science-based strategies for guiding future development;
- outline comprehensive mitigation and restoration strategies to offset anticipated development impacts; and,
- identify options for streamlining local development review.

More specifically, this project seeks to facilitate protection and restoration of ecosystem processes necessary for the long term functioning of marine, freshwater, and terrestrial systems in and adjacent to the Birch Bay watershed while achieving more effective and efficient decision making related to land use management at the local level.

BACKGROUND

As part of the SMP update process Whatcom County conducted a landscape-scale characterization of ecosystem processes using the methods developed by Stanley et al. (2005). The landscape characterization examined key processes related to the movement of water, sediment, heat/light, LWD, and nutrients in each of the 26 identified watershed management units (WMUs) in the County. The characterization:

- Identified key processes within the landscape that shape and influence the health of aquatic systems including wetlands, streams, estuaries, and marine waters;
- Mapped areas on the landscape that are important to the operation and maintenance of these processes,
- Assessed how these processes have been altered by human activity, and

[1] The MAWG includes: the Washington Department of Ecology, the Puget Sound Action Team (PSAT), the U.S. Environmental Protection Agency (EPA), Washington Department of Fish and Wildlife (WDFW), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (FWS), Washington Department of Community Trade and Economic Development (CTED), Cascade Land Conservancy, Washington Department of Transportation (WSDOT), and the Washington Association of Counties.

- Determined protection, restoration and management needs for each WMU, including Birch Bay, based on existing conditions.

This pilot project builds on this existing work by: 1) refining certain aspects of the characterization (e.g., improved wetland characterization); 2) numerically scoring two of the processes (water and nutrients) using new tools developed by Stanley et al. to depict (in conjunction with information on the other processes) the relative importance of each sub-watershed for water and denitrification processes; and 3) adding a metrics-based fish and wildlife assessment.

This pilot project is part of a larger effort by the MAWG to develop an integrated set of tools that use watershed science in a land use planning context. The Birch Bay watershed was chosen as the pilot case, because Whatcom County has been actively seeking opportunities to use watershed-based planning tools to streamline development review and improve natural resource management. As an example, Whatcom County's Critical Area Ordinance (CAO) includes provisions that allow watershed plans to "substitute" for some critical area regulations and other land use restrictions. The CAO also includes detailed standards and procedures for mitigation banking based on and consistent with State banking standards.

The approach(es) developed in the following document is/ are based on the categories and conditions outlined in the description of Task 4, below:

This task involves assessing existing development patterns and estimating future build out based on current zoning and other existing development standards. As with Task 1, the analysis will focus on non-industrial zoned areas of the watershed. We will document the impacts of projected development patterns on wetlands, land cover changes, and increased impervious surface, and further relate these impacts to water quality degradation, flooding and habitat loss using available literature. We will also develop recommendations for alternative development scenarios that incorporate 'green infrastructure' concepts, Low Impact Development techniques, transfer of development rights and/or other strategies and compare the impacts of these scenarios with the conventional development approach. This task will also include review of current development standards and permit procedures. Products of this task include a list of mitigation/restoration measures that would be needed to offset development impacts and promote a watershed-based approach for guiding development patterns and managing aquatic resources.

METHODS

Introduction

Future land use patterns are assessed using a futures scenario-planning framework. In general, futures scenario planning is an analysis technique designed to assess the relationships between human development actions and the impacts of these actions on natural processes and patterns (Hulse et al., 2000). A zoning-based, full-buildout, futures scenario plan (Planned Trend Scenario), used for the purposes of this pilot study, analyzes the expected location of future development within a defined area, and estimates the number of new dwelling units (residential land uses) when all land available for development is developed at the highest intensities possible, per current zoning regulations. The build out is correlated with future changes in impervious surface coverage to anticipate development impacts based on available scientific literature. Although this analysis technique does not project when build-out will occur, it is useful in long-term planning efforts as a way to understand the potential for future growth and the impacts of such growth on natural resource processes in a specified area such as the Birch Bay watershed.

Limitations

Zoning-based futures scenario planning for full build-out has several potential drawbacks. The first is that full build-out scenarios tend to over-estimate actual growth and associated impacts for a given study area (Nelson and Graham, 2003). For example, full build-out analysis makes the assumption that all areas will develop to the highest density allowed by the current zoning regulations, and then multiplies each zoned area by the average impervious cover for its associated zoned land use. However, full build-out rarely occurs at the densities that zoning allows. Consequently, much of the potential development based on zoning regulations may not occur due to local economic conditions or a lack of available infrastructure. Thus, zoning-based build-out scenarios can represent a worst-case scenario for development impacts to ecological processes and habitat conditions (Zielinski, 2002).

The second limitation is that this type of land use scenario development only takes into context residential zoning districts. Zoning districts with commercial or industrial classifications have minimal potential residential dwelling unit capabilities and are thus considered outside of the scope of the information generated for the scenario. For this analysis, all commercial and residential zoning districts are assumed to have the potential to develop to full capacity, and are thus integrated into the evaluations of impervious surface, but are not included in the density calculations.

Planned Trend Scenario Model

There are four (4) steps to developing a planned trend scenario model that examines the potential impact of anticipated build-out conditions on natural resource processes in Birch Bay such as surface water hydrology and water quality (Figure 1).

Figure 1: Steps for Developing a Planned Trend Scenario Model for Birch Bay, Washington.

Step 1 – Assess Current Development Patterns (Residential Location & Density)

Step 2 – Identify Buildable Areas per Whatcom County Regulations

Step 3 – Assess Future Development Patterns (Location & Density)

Step 4 – Evaluate Changes to Impervious Coverage

Step 1 – Assess Current Residential Development Patterns (Location & Density)

The first step includes identifying current residential development patterns and densities within the watershed using parcel and zoning district data provided by Whatcom County. To do this, each parcel is assigned a potential development characterization code (Figure 2) depending on current development intensities and the amount of remaining of parcel area for development.

Figure 2: Potential Development Characterization Codes

Parcel Characterization	Definition
Fully Developed	Any legal lot of record, which cannot be subdivided and already has a dwelling unit or some other structure.
Undeveloped	Any vacant parcel, which may be subdivided or developed with more than one dwelling unit.
Underdeveloped	Any parcel, which currently contains one or more dwelling units and that may be subdivided or developed with additional dwelling units.
Vacant	Any legal lot of record, which meets the minimum size requirement of the zone, but cannot be

	subdivided, and is vacant.
Non-Conforming Vacant	A legal lot of record that does not meet the minimum size requirement of the zone but is vacant.

Current development intensities are determined by examining the value of built structures on each parcel from the Whatcom County Assessors database. If the building value is greater than $3,000 an assumption is made that the parcel contains a single dwelling unit, or if zoned for multi-family meets the maximum density of multi-family units for the zoning classification. Potential development characterizations are then generated for each parcel based on the size of the parcel and the residential density requirement for the zoning district in which the parcel is located (Figure 3).

Figure 3. Residential Zoning and Density Requirements in the Birch Bay Watershed

Zoning District	Residential Density Requirement
R10A	1 du* / 10 ac
R5A	1 du / 5 ac
RC	1 du / 0.5 ac
UR3	1 du / 0.333 ac
UR4	1 du / 0.25 ac
URM24	1 du / 0.0416 ac
URM6	1 du / 0.166 ac

Step 2 – Identify Buildable Areas per Whatcom County Regulations
The second step determines the amount of remaining buildable area within each sub-basin. Coupled with the initial step, the buildable land estimate guides the determination of future land uses within the Birch Bay watershed.

In an effort to identify remaining buildable lands, protected open space and land that is undevelopable for environmental reasons such as the presence of wetlands, streams (or other habitat conservation areas), geologically hazardous areas, or critical aquifer recharge areas as defined by the Whatcom County Code (WCC 16.16 – Critical Areas) are excluded from this category. As part of this analysis buffers were applied to the wetland and riparian areas based on assumed categories of quality. Due to the lack of specific data regarding the condition of the identified wetland habitats, minimum buffer areas were applied as defined by WCC 16.16. Review Appendix B of this report for a detailed description for how wetland and riparian buffer areas were generated for this analysis. The remaining land located outside of critical areas and buffers is assumed to be available for development.

Step 3 – Assess Future Development Patterns (Location & Density)
Building from steps one and two, the third step is to assess locations and patterns of potential residential development within the watershed. This is completed by selecting all parcels with a characterization code that can accommodate future residential growth (Vacant, Undeveloped, Underdeveloped). The potential dwelling unit density for each parcel is then calculated from the buildable areas analysis. The result of these steps is a potential dwelling unit density calculation for each parcel within the watershed. For the purposes of this analysis, these density calculations per parcel are aggregated to the sub-basin scale to determine the potential vulnerability of that sub-basin to potential residential development pressure.

Step 4 – Evaluate changes to Impervious Cover
The fourth and final step for the land use-planning component is to calculate and assess the total impervious areas within the watershed sub-basins. This step is done concurrently with steps two and three to contribute to

understanding the vulnerability of each sub-basin to potential development and to aid in the impact assessment of current development patterns on ecosystem health within the watershed.

For an assessment of current impervious conditions, impervious surface coefficients for each zoning district classification are developed through a spatially derived data merger between the Whatcom County parcel data and data developed by the National Oceanic and Atmospheric Administration (NOAA) through the Coastal Change Analysis Program (C-CAP) (Figure 4). Following a qualitative comparison of other impervious surface analyses performed per land use types for relative accuracy (Nelson and Graham, 2003 and May et al., 1997), the coefficients for each land use are then aggregated to the sub-basin scale to assess current land use intensities for each WAA within the watershed. To develop a potential change in impervious surface density model for the Birch Bay watershed the potential dwelling unit density data is combined with the impervious surface data derived for each land use.

Figure 4: Average Impervious Percentage per Parcel for Each Zoning Type.

Zoning Type*	Average Impervious %	Parcel Count
Heavy Industrial	65.6	11
General Commercial	48.7	28
Light Industrial	27.3	3
Neighborhood Commercial	47.1	10
Rural Residential (10 AC)	19.3	33
Rural Residential (5 AC)	22.4	400
Recreational Commercial	40.9	271
Urban Residential (3/AC)**	38.5	18
Urban Residential (4/AC)	41.6	1684
Urban Residential, Medium Density (6/AC)	40.5	1152
Recreational Open Space	12.9	7

*Zoning district URM24 is not represented in high enough densities to generate average impervious areas.
** UR3 Zoning District is applied to land within City of Blaine jurisdiction based on growth projections and developable area available (City of Blaine, 2006)

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APPENDIX D

Watershed Characterization of Birch Bay

APPENDIX E

Birch Bay Fish and Wildlife,

Current Conditions Landscape Assessment