

Puget Sound Watershed Characterization

Introduction to the Water Flow Assessment for Puget Sound

A Guide for Local Planners

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Introduction

Local governments need to develop land use plans, designations, regulations, and development standards based on watershed information. The Puget Sound watershed characterization project provides this information for planners in Puget Sound.

Watershed characterization establishes a framework to identify “informed solutions” and actions that address watershed problems. One method for conducting this characterization is outlined in *Puget Sound Watershed Characterization Project: Description of Methods, Models, and Analysis* (in review). It is available under Guidance Documents at www.ecy.wa.gov/mitigation/landscapeplan.html.

The Puget Sound watershed characterization will combine information from three assessments: water flow, water quality, and fish & wildlife processes. This Introduction addresses only the assessment of the *water flow* process in all Puget Sound watersheds.

The goal of this water flow assessment is to identify areas within each watershed that are more suitable for:

- restoration actions,
- protection, and
- higher intensity development.

This assessment produces a “watershed management” map showing where protection (green) and restoration (yellow) actions are more likely to succeed and will most benefit the water flow processes of the watershed (Figure 1).

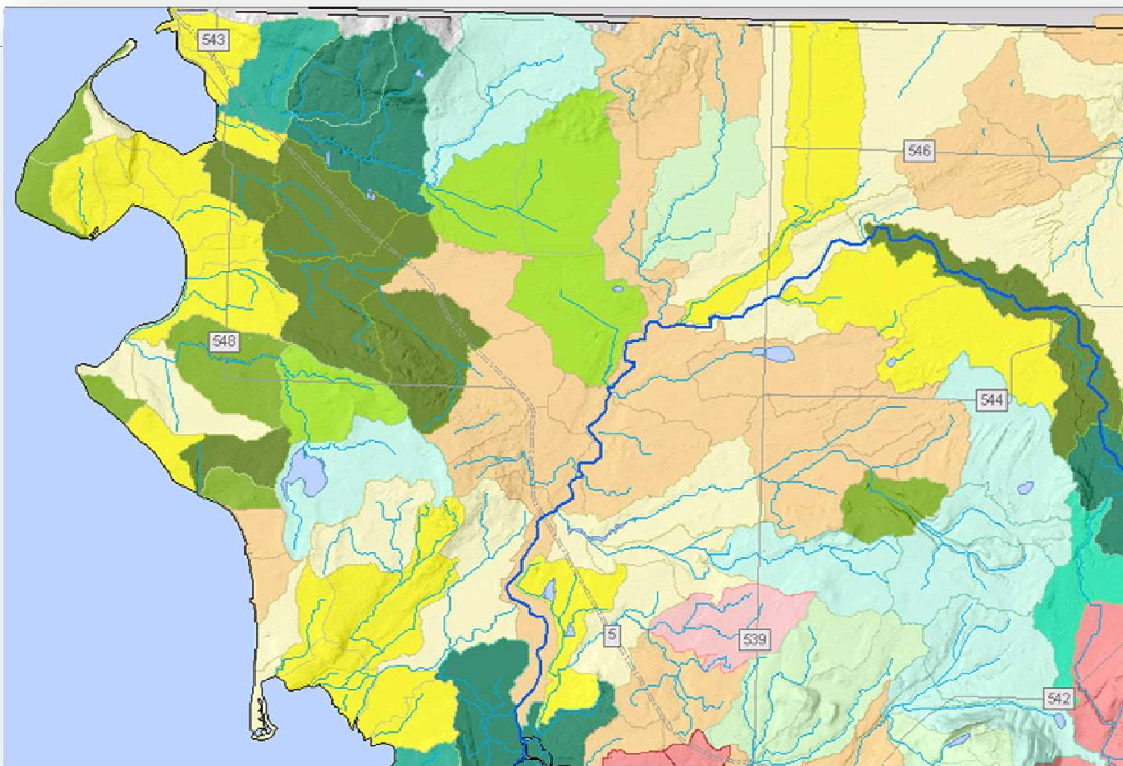


Figure 1: Watershed Management Map - Example of Potential Management Approaches for the Water Flow Process in Whatcom County (see legend detail in Figure 4)

The water flow process includes the ways water enters, moves through, and leaves the watershed.

Planners can also evaluate known problems in the watershed within the context of the watershed management map. This evaluation helps identify specific land use and development practices to address those problems.

In combination with other available data, this information provides an ecosystem perspective of the water flow processes to support watershed-level planning and land use policies and decisions.

Below is a general description of the water flow assessment and how it can be used. Additional detail on assessment methods is available in the appendices for the Puget Sound Characterization Project, available under Guidance Documents at www.ecy.wa.gov/mitigation/landscapeplan.html.

Who should use the water flow assessment information?

Information from the water flow assessment should be used by local planners, resource managers, and land use and planning consultants. The information should be evaluated and applied to local plans with the assistance of technical experts familiar with watershed analysis. The experts should include a geomorphologist, landscape ecologist, and a wildlife and fisheries biologist.



What planning processes can the water flow assessment support?

Applications include comprehensive plans, Shoreline Master Program (SMP) updates, and Critical Areas Ordinances (CAOs). Additionally, they can be helpful in structuring regulatory or policy approaches at the sub-watershed scale.

For example, a planner might use the protection areas on the watershed management map to support the need to protect critical areas. Protection could occur through updates to Critical Areas Ordinances, public outreach and education, or incentive programs.

How does the water flow assessment work?

The water flow assessment is a *relative comparison* of areas within a watershed that are better suited for certain management actions to support water flow processes.

We call the individual areas for comparison “analysis units”. They range in size from one to ten square miles, smaller ones near the marine shoreline and larger ones in mountainous uplands. The analysis units were created by grouping smaller catchments from the Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP).

SSHIAP units reflect the processes that form and maintain stream segments. They are based primarily on gradient and confinement, and secondarily on habitat types. They were developed by the Northwest Indian Fisheries Commission.

The water flow assessment uses **two models** to

compare both the *importance* and *degradation* of water flow processes among the analysis units within a watershed

The *importance model* evaluates the watershed in its “unaltered” state. In the importance model, water delivery is evaluated by the quantity and type of precipitation including “rain-on-snow” zones, which affect the timing of water movement.

Surface storage is estimated by the amount of potential depressional wetlands, lakes, and stream floodplains, using data on soil types, topography, and stream confinement.

Water movement below the surface, which is important for understanding recharge and discharge, is evaluated using data on precipitation, coarse and fine grained deposits, slope wetlands, and alluvial floodplains.

Loss of water through evapotranspiration is considered relatively uniform across a watershed in an unaltered state, thus it is not included in the importance model.

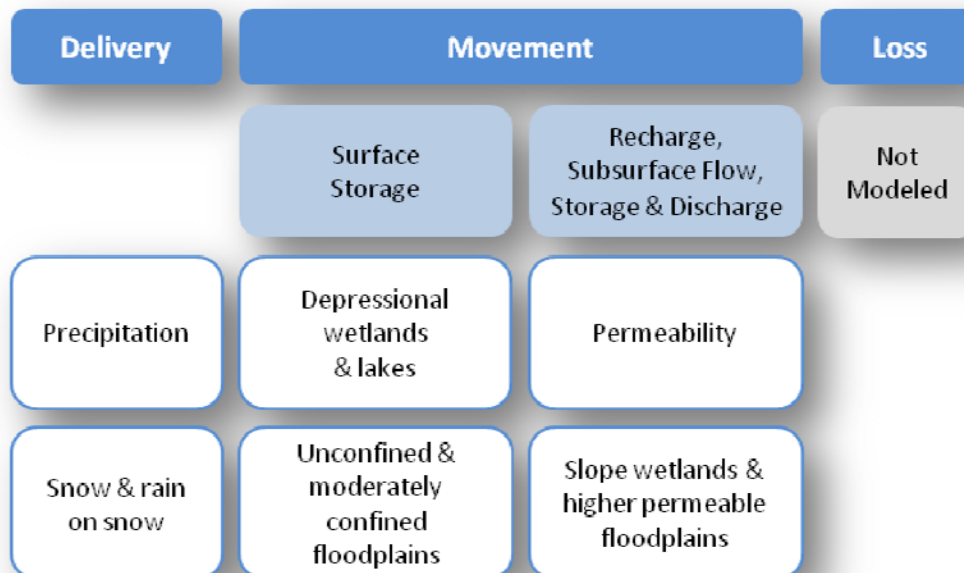


Figure 2: Modeling the Importance of Analysis Units to the Water Flow Process

The *degradation model* evaluates the watershed in its “altered” state. This model considers the impact of human actions to water flow processes.

It uses land cover data to estimate changes from forest loss and impervious surfaces, as well as the presence of dams to evaluate the degree to which water delivery has changed.

Degradation to surface storage is estimated from data on the degree of urban and rural development and its impact to wetland and stream storage.

Changes to recharge are estimated from land cover and its reduction in area for infiltration. Road density evaluates areas for impacts to shallow subsurface flow.

Reduction in discharge is estimated by well density and the effect of land cover alteration to floodplains and slope wetlands.

Water loss is evaluated by looking at the change to evaporation and transpiration as represented by the total amount of impervious cover in the watershed.

Each model provides a ranking, from low to high, for how important and how degraded each analysis unit is relative to all units in the watershed.

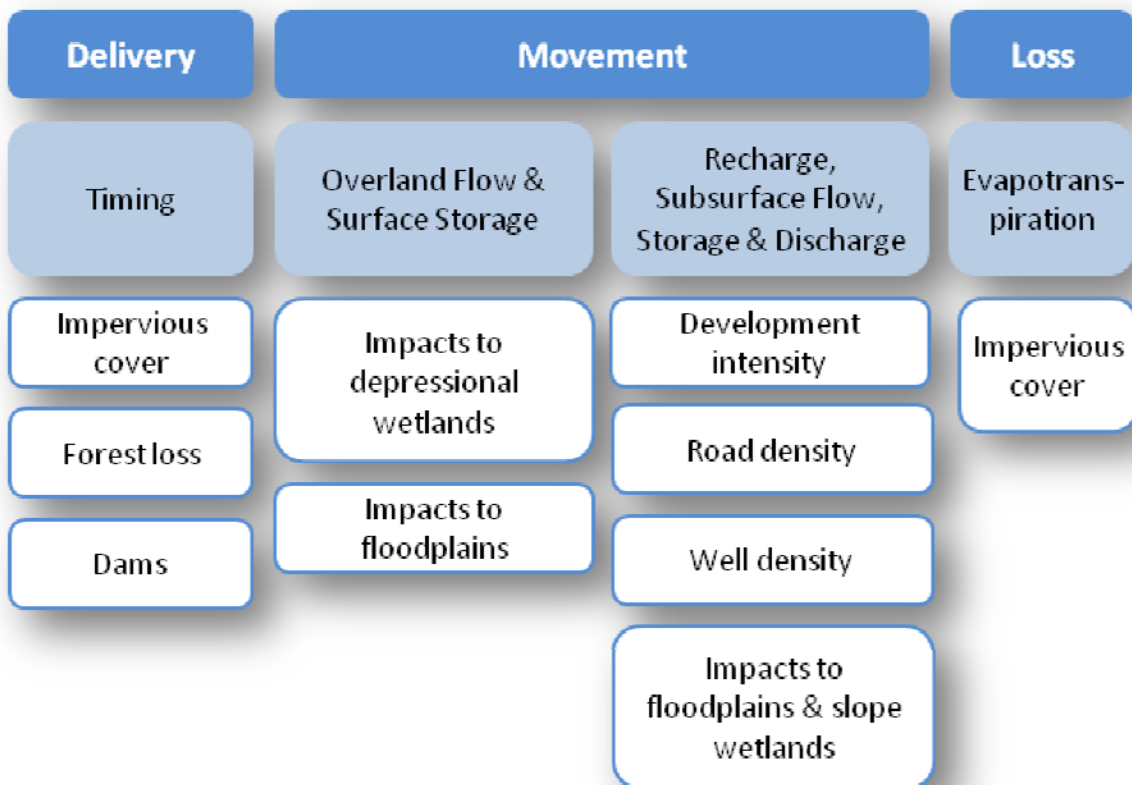


Figure 3: Modeling the Degradation of Analysis Units to the Water Flow Process

How can planners use the results to make land use policy?

The water flow assessment produces a database and GIS maps that planners can use to develop a watershed based management framework. Actions identified in the framework should support ongoing watershed management goals.

GIS maps show results for the importance model in shades of blue, with darker shaded units ranking higher in importance for the water process. Results for degradation are in shades of pink, with darker shaded units ranking more degraded.

The raw scores for the individual elements of each model (e.g. water delivery, storage, recharge, and discharge) for every analysis unit is provided in the data tables attached to the GIS shape files for the assessment.

By combining the results from the importance and degradation models, planners can see how each analysis unit ranks relative to all the other units, which ones are more important for various elements of the water processes and which ones are least and most impaired. A simple matrix (Figure 4) is used to combine the results and suggest what types of watershed management actions might be most appropriate for different areas in the watershed.

For example, areas with relatively high importance and relatively low degradation (upper left corner of Figure 4) are more suitable for **protection actions**. Areas with high importance and high degradation (upper right corner) should be considered for **restoration actions**. Areas with low importance and high degradation (lower right corner) are **more suitable for development**, since land use changes will have the least impact on water flow processes in these areas.

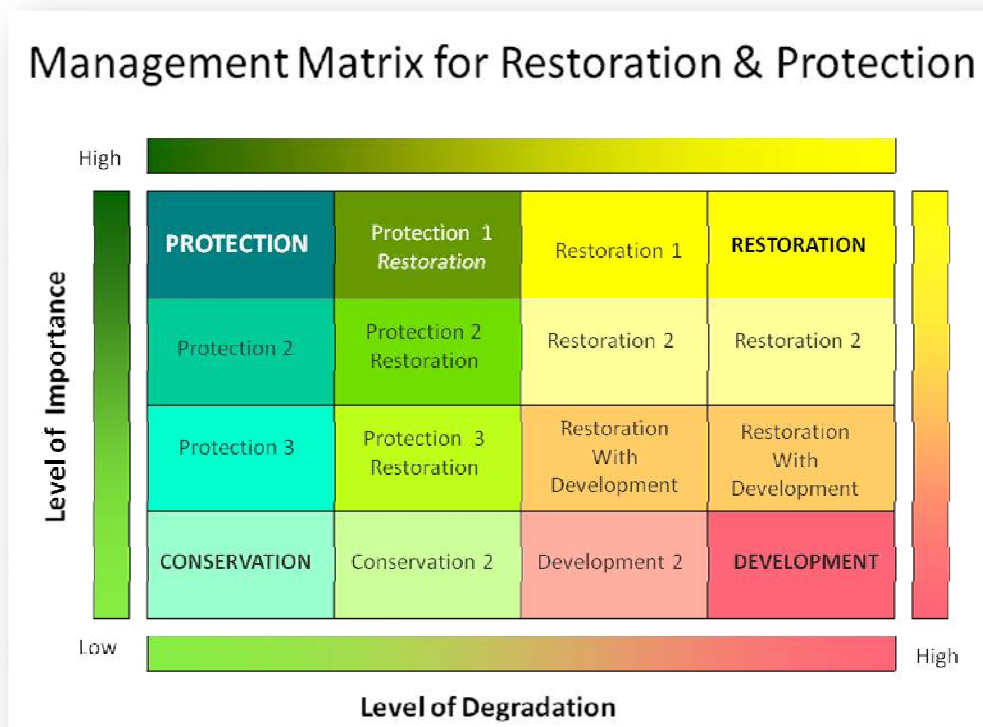


Figure 4: Matrix Showing How Results of the Importance and Impairment Models Can Be Combined to Point to Potential Watershed Management Approaches

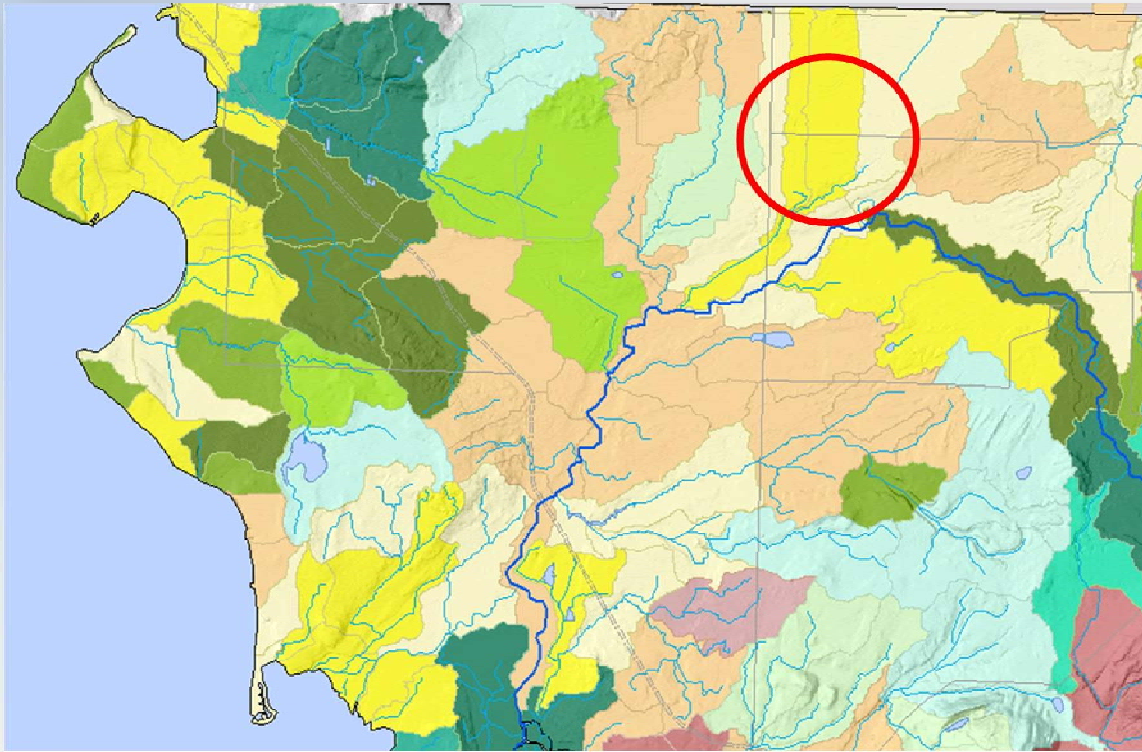


Figure 5: Watershed Management Map for Water Flow Processes (see legend detail in Figure 4). The analysis unit in the red circle (Fishtrap Creek) was ranked a high priority for restoration of water flow processes.

The water flow assessment results can also be used to help managers and planners better understand and suggest actions to resolve specific watershed problems (Figure 5).

Problem: Low Dissolved Oxygen in Streams	
Condition	Possible Actions
High degradation to storage and discharge areas in wetlands, and high nutrient loading	Restore water quality processes in key wetlands including denitrification which can help reduce biological oxygen demand.

Figure 6: Example of Potential Actions to Correct Water Quality Problem

For example, consider a watershed with a water quality problem of low dissolved oxygen levels in conjunction with nitrogen loading from agricultural land use. This may suggest restoration of depressional wetlands since they can provide substantial reduction of nitrogen through the denitrification process.



Figure 7: Example of Potential Restoration Area

Similarly, if a watershed had lowland flooding during rain on snow events, planners might focus on areas that are important for water delivery in the mountainous uplands. They also might look at areas that are important for storage in the lowland units, particularly those located downstream of water delivery areas.

Problem: Lowland Flooding During Rain or Snow Events	
Condition	Possible Actions
High degradation for delivery areas and low degradation for storage areas	Protect floodplain and depression areas in the upper and mid watershed and restore forest cover in the mountainous areas to slow delivery and increase storage.
Low degradation for delivery areas and high degradation for storage areas	Restore depression and wetland storage in the upper and mid watershed to increase storage capacity.

Figure 8: Example of Potential Actions to Correct Lowland Flooding during Rain on Snow Events

The water flow assessment contributes to the assessment of ecosystem-wide processes, required by the Shoreline Master Program

Guidelines. It can be used to identify areas appropriate for restoration and protection in the associated restoration plan. Because all of the watersheds around Puget Sound are being assessed, the results also can help regional planners understand how watersheds relate to one another and to create a better overall strategy for Puget Sound recovery and restoration.

What are the results not appropriate for?

The results are most appropriate for regional and watershed-level planning. The assessment uses coarse scale data that covers the entire Puget Sound, so the results do not provide the detail needed to make decisions about a specific site.

For example, while the results can help planners identify the best location for mitigation within a watershed, they might not be detailed enough to identify the specific amount and type of mitigation needed for a particular project.



How have results been used so far?

Initial water flow assessment results are being used by Clark County to support development of a county-wide aquatic mitigation framework. More information on the Clark County project is available at the County's web siteⁱ.

In Birch Bay, Whatcom County, the water flow assessment results are being used along with some more detailed information, including a wetland inventory and habitat/species use, to create a watershed based sub-area plan.

This sub-area assessment of water flow processes was conducted relative to those analysis units within the Birch Bay watershed. The results were used to establish a protection zone (green) for the mainstem Terrell Creek, a restoration zone (yellow) for the central portion of the watershed, and a more intense development zone (red) for the northern portion of the watershed (Figure 9).

For more information on the Birch Bay effort, go to www.whatcomcounty.us and search on "Birch Bay Watershed Action Plan."ⁱⁱⁱ

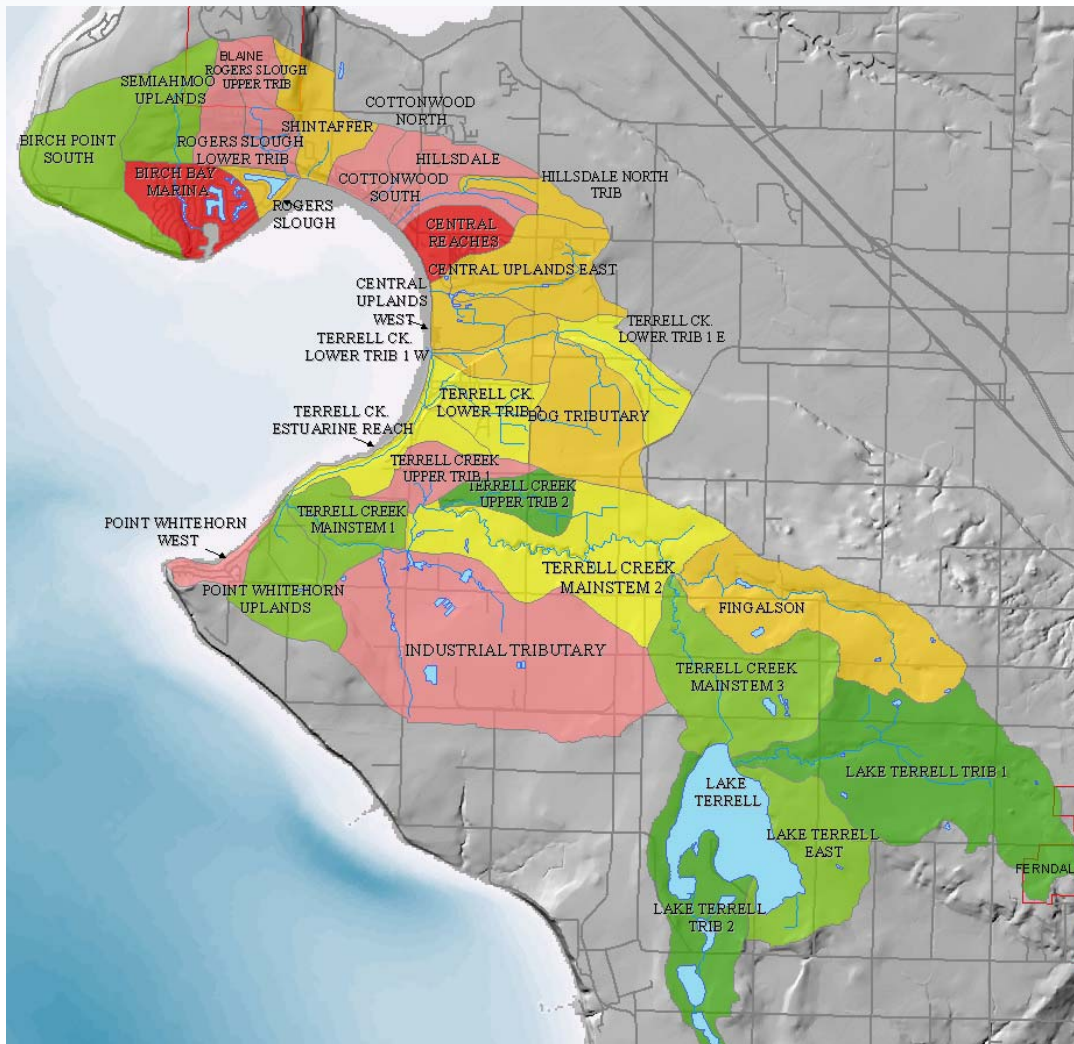


Figure 9: Birch Bay Watershed Management Plan

Where can I see results for my watershed?

The water flow assessment results will be displayed on the Coastal Atlas by early 2011ⁱⁱⁱ. In the fall of 2010, results for Puget Sound watersheds will be available for download. Please contact Susan Grigsby at susan.grigsby@ecy.wa.gov, or 360-407-7546 to request results for your planning area.

What data sets are used in the water flow assessment?

The water flow assessment uses existing, readily available data that covers Puget Sound. Geology, topography, precipitation, and rain-on-snow areas are from the Washington State Department of Natural Resources. Soils data is from the US Department of Agriculture Soil Survey Geographic (SSURGO) database, stream confinement from the Salmon and Steelhead Habitat Inventory Assessment Program, and land cover from the National Oceanic and Atmospheric Agency Coastal Change Analysis Program (C-CAP).

Where can I get information on processes not evaluated by the water flow assessment?

There are numerous sources of additional information including the following.

- The Puget Sound Nearshore Partnership has data at several scales on the types of changes to the nearshore environment, available at www.pugetsoundnearshore.org.

- The Washington Department of Fish and Wildlife EcoRegional Assessments provide systematic analysis of habitat and species information combined with data on human impacts within an ecoregion. These can help planners identify relatively intact habitats that, if conserved, will help to sustain the ecoregion's biodiversity into the future. EcoRegional assessments are available at www.biodiversity.wa.gov/ecoregions.
- The SSHIAP SalmonScape interface provides data layers on hydrography, fish distribution, Salmonid Stock Inventory, barriers to fish passage, habitat characteristics such as stream gradient, and Ecosystem Diagnosis and Treatment model output. They are available at www.wdfw.wa.gov—search on “SSHIAP.”^{iv}
- Ecology maintains listings of impaired waters and related information on plans to restore and recovery water bodies at www.ecy.wa.gov—search on “water quality assessments.”^v
- Ecology provides a clearing house of WRIA resource and planning documents including ambient monitoring stations and results at www.ecy.wa.gov—search on “my watershed.”^{vi}
- Slide prone area data. The Department of Natural Resources maintains data on landslides and areas that may be prone to landslides. Two data sets are available, landslides at a 1:24000 scale and the DNR Forest Practices Landslide Inventory. Go to www.dnr.wa.gov and search on “landslide” or “forest practices landslide inventory.”^{vii}

How do I get help interpreting and applying the water flow assessment?

Specialists on water flow assessment and Ecology's watershed characterization project have been meeting with county and local governments to talk about the results of the water flow assessment and how those results can be used during ongoing Shoreline Master Program updates.

If you would like additional information on how your planning area might use the Puget Sound watershed characterization project, or to arrange a meeting, please contact Stephen Stanley at Ecology's Northwest Regional Office, (425) 649-4210 or stephen.stanley@ecy.wa.gov.

Next Steps: More to Come

The water flow assessment is the first part of an effort that will produce full watershed characterizations for all Puget Sound watersheds.

The second part of the effort will begin in the fall of 2010. It will include work to integrate and synthesize the water flow assessment with assessments of the marine nearshore (based on the Puget Sound Nearshore Ecosystem Restoration Program work), water quality, and habitat/wildlife (based on the EcoRegional Assessment but will include salmon and shellfish). This synthesis will result in a final characterization for Puget Sound watersheds.

The Washington State Department of Ecology and the Puget Sound Partnership received funding from EPA for this effort.



Endnotes

Additional web addresses for cited documents:

ⁱ www.cityofvancouver.us/shorelineupdate/documents.html

ⁱⁱ www.whatcomcounty.us/pds/naturalresources/specialprojects/birchbaywatershed-actionplan.jsp

ⁱⁱⁱ www.ecy.wa.gov/programs/sea/sma/atlas_home.html

^{iv} wdfw.wa.gov/mapping/salmonscape/sshiap/

^v www.ecy.wa.gov/programs/wq/links/wq_assessments.html

^{vi} www.ecy.wa.gov/apps/watersheds/wriapages/

^{vii} www.dnr.wa.gov/Publications/ger_data_landslides_24k.htm

