

Bertrand Watershed Improvement District  
Agriculture-Watershed Characterization and Mapping Report  
August 2016



Whatcom County Ag-Watershed Project



PROJECT PARTNERS



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## Abbreviations used in this document

AU	Assessment Unit/Analysis Unit (Puget Sound Watershed Characterization Project) <sup>1</sup>
AWCA	Agriculture-Watershed Characterization Area
CDID	Consolidated Drainage Improvement District
DID	Drainage Improvement District
DO	Dissolved oxygen
NRCS	Natural Resource Conservation Service
PDR	Purchase of Development Rights
PSWC	Puget Sound Watershed Characterization
RSA	Rural Study Area
USDA	United States Department of Agriculture
WCD	Whatcom Conservation District
WCPDS	Whatcom County Planning & Development Services
WCPW	Whatcom County Public Works
WDFW	Washington Department of Fish & Wildlife
WID	Watershed Improvement District
WRIA 1	Water Resource Inventory Area 1

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<sup>1</sup> In earlier pilot documents, AUs were also referred to as “Analysis Units”

# 1 Introduction

## 1.1 Background and purpose of agriculture-watershed characterization and mapping

Agricultural operations and watershed features have long been key components of Whatcom County's distinct landscape. Both are critical for our community's economy and health. While it may seem that agriculture and watershed functions are at odds with one another after decades of regulations and planning, there are in fact many locations where protection of agricultural lands and enhancement of watershed functions can result in mutual benefits.

Healthy watersheds provide a wide range of watershed ecosystem services. These include: surface and ground water supply and recharge; water storage and flood protection; production of food, fish, fiber and building materials; soil processes and sediments; cycling of nutrients, transport of pollutants; and protection against natural hazards such as floods, droughts and landslides. These many watershed services rely on processes involving water flow and storage, water quality, plants and animals.

Farming relies on watershed services as part of the "natural infrastructure" for production. Agricultural production requires enough water of suitable quality for irrigation, livestock and processing; healthy high-quality soils; drainage of fields and protection from flooding. In addition, agricultural systems require: a large enough land base to sustain a vibrant agricultural economy; access to labor, markets and additional "built infrastructure".

However, farms are also providers of watershed services, the most obvious being food production. The preservation of open space, wildlife corridors, protection of soils and flood water storage are other watershed services that can be provided on actively farmed

land. Landowners and farmers who participate in strategic actions to maintain, repair or protect larger-scale watershed processes can help to improve watershed health and enhance critical watershed services.

Definitions: for the purposes of the Ag-Watershed Project,

- *agricultural enhancement* entails maintaining the land base, soil, water, air, plants, animals, production capacity and natural infrastructure necessary to keep farmers farming over the long term as land uses and economic situations change over time. Thus "agricultural enhancement" and "agricultural protection" include but are not limited to agricultural land protection alone.
- *watershed enhancement* actions are those actions which improve the ability of the watershed to provide its natural benefits and services to communities. Watershed enhancement includes the idea of "repairing" major landscape processes related to hydrology and ecosystems, in order to maintain, protect or improve the delivery of watershed services.

The agriculture-watershed characterization maps and tables combine existing spatial data with field experience and farmers' local knowledge to identify agricultural priorities and needs in the lowland areas of Whatcom County and to bring those into the planning conversation with watershed priorities and needs. The results are intended to support integrated land and water planning at watershed scale, and to support the identification and prioritization of agricultural and watershed enhancement actions at farm and reach scale. These products will be provided to the Watershed Improvement Districts (WIDs) and Special Districts to inform and complement their current comprehensive planning work.

The characterization and mapping results presented in this report have been derived from multiple information sources. The information is provided for planning purposes only, is not for use in regulatory actions, and is intended to contribute to ongoing Whatcom County Planning and Development Services efforts to improve agricultural and watershed conditions.

## 1.2 About the Ag-Watershed Project

The Ag-Watershed Project is examining ways to reward the good things that farmers already do - those beneficial actions that go beyond existing regulation to maintain, repair or protect large-scale watershed processes, while also strengthening agriculture in Whatcom County.

The Ag-Watershed Project is a research and development project funded by a National Estuary Program Watershed Protection and Restoration Grant (June 2012 to June 2016) to Whatcom County Planning & Development Services, administered by the Washington Department of Commerce. Project partners include: Whatcom Farm Friends–Community Education, Whatcom Conservation District and Washington State Department of Fish & Wildlife.

Project fact sheets and links to all previous work, including technical reports and reference documents can be found at <http://whatcomcounty.us/2260/Agricultural-Watershed-Pilot-Project>

## 1.3 What is in this document

This document contains the reference information, work session information and results of the agriculture-watershed characterization and analysis conducted in 2016. The document is arranged into sections that allow easy access to specific categories of information. An overview of the document contents is also provided in the color-coded table in the front of this document.

Sections 1 and 2 provide background information about the Ag-Watershed Project, the characterization and mapping task, and the Bertrand Watershed Improvement District.

Section 3 is a summary of the overall methodology and results. It can be read as a stand-alone resource to obtain an overview of the process and the outcomes.

Section 4 contains a detailed description of the agricultural characterization methodology, and includes the agricultural prioritization maps and the detailed tables of information about agricultural priorities.

Section 5 contains a detailed description of the watershed characterization methodology, and includes the watershed prioritization maps and the detailed tables of information about watershed priorities.

Section 6 contains the set of agricultural and watershed reference maps that were used in generating the agriculture-watershed characterization results.

Sections 7 and 8 contain the bibliography and glossary of key terms. Sources of information cited in the text of the report are included in the bibliography but are also provided in footnotes for easy reference.

Appendices contain additional supporting information for future reference by the WID.

This document is one of a series of six reports. A customized report has been prepared for each of the Watershed Improvement Districts in Whatcom County. Reports for other Watershed Improvement Districts can be accessed through the WID websites<sup>2</sup> or through the Ag-Watershed Project page.<sup>3</sup> The results of the characterization and mapping have also been incorporated into an online story map at <http://arcg.is/29MYdYu><sup>4</sup>

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<sup>2</sup> Links to each WID website can be found at <http://www.agwaterboard.com/>

<sup>3</sup> See <http://www.co.whatcom.wa.us/2260/Agricultural-Watershed-Pilot-Project>

<sup>4</sup> Whatcom County Agriculture-Watershed Project (2016), Agriculture-Watershed Characterization & Mapping, Whatcom County. Story map prepared for the Whatcom County Agriculture-Watershed Pilot Project, Whatcom County Planning & Development Services, Bellingham, using ArcGIS® software by Esri. <http://arcg.is/29MYdYu>

## 2 Overview of the Bertrand Watershed Improvement District

The Nooksack River watershed and certain adjacent basins (including Lake Whatcom) which discharge to the marine waters of Georgia Strait and Puget Sound and to the Fraser River system in Canada are included in Water Resource Inventory Area 1 (WRIA 1), as designated by the State of Washington. The majority of Whatcom County is in WRIA 1 with a portion of the WRIA 1 extending into neighboring Skagit County (see Figure 1 and Figure 2).

Each Watershed Improvement District (WID) is a unique agricultural neighborhood in Whatcom County's broader farming community. Natural characteristics of the soil, locations of surface and ground waters and topography of the area help to delineate viable areas for the many types of agricultural production taking place. The boundaries of the WIDs have been selected not only to reflect the characteristics and interests of different agricultural neighborhoods, but also to align where possible with the geographic boundaries of water management areas used in mapping and planning of water resources by local and state governments and the agricultural land classifications used by local land use planners and agricultural specialists.

The Bertrand Watershed Improvement District (see Figure 3) is located in the north central lowland area of Whatcom County, adjacent to the main Nooksack River within WRIA 1. Land use in the local area is mixed, including agriculture and rural residential areas. Agriculture includes a mix of dairy hay, berry crops, and dairy corn. Several large agricultural production facilities, some supporting the regional agricultural community, are located in the WID area. The

closest city is Lynden (pop. 12,900) to the east. The City of Ferndale (pop. 12,700) is located to the south. A significant proportion of the soils in the Bertrand WID have been classified by the USDA Natural Resources Conservation Service as Prime or Prime if managed<sup>5</sup> (see Prime Soils reference map in Figure 19).

The Bertrand WID area encompasses 14,393 acres in total. The WID area includes Bertrand Creek and lower Fishtrap Creek, both of which originate in Canada, and Schneider Creek, all of which are included in Water Resource Inventory Area 1 (WRIA 1). Flow through Bertrand and Fishtrap Creeks is north to south, and flow through Schneider Creek is generally west to east. These tributaries contribute significant water flows to the mainstem Nooksack River.

The WID contains two other special purpose districts within its boundaries, whose primary purpose is to improve and maintain drainage of agricultural land within those portions of the WID. These are Consolidated Drainage Improvement District #1, and Drainage District #2 (see Special Districts reference map in Figure 22).

More information about the Bertrand WID can be found at the website <http://www.bertrandwid.com/>

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<sup>5</sup> U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI.  
[http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2\\_054242](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054242)



Figure 1. Regional map showing general location of Whatcom County and Water Resource Inventory Area 1 (red boundary)

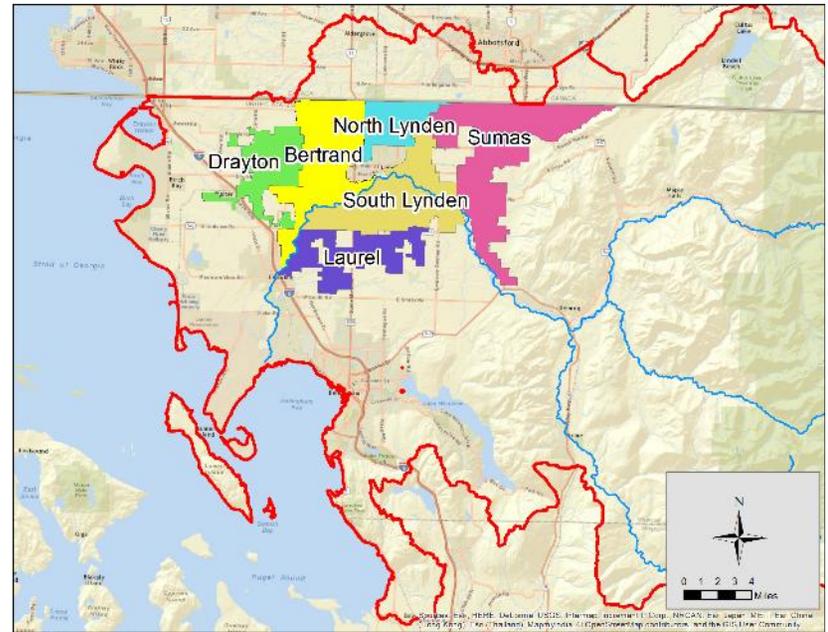


Figure 2. Map showing Water Resource Inventory Area 1 and the Watershed Improvement Districts

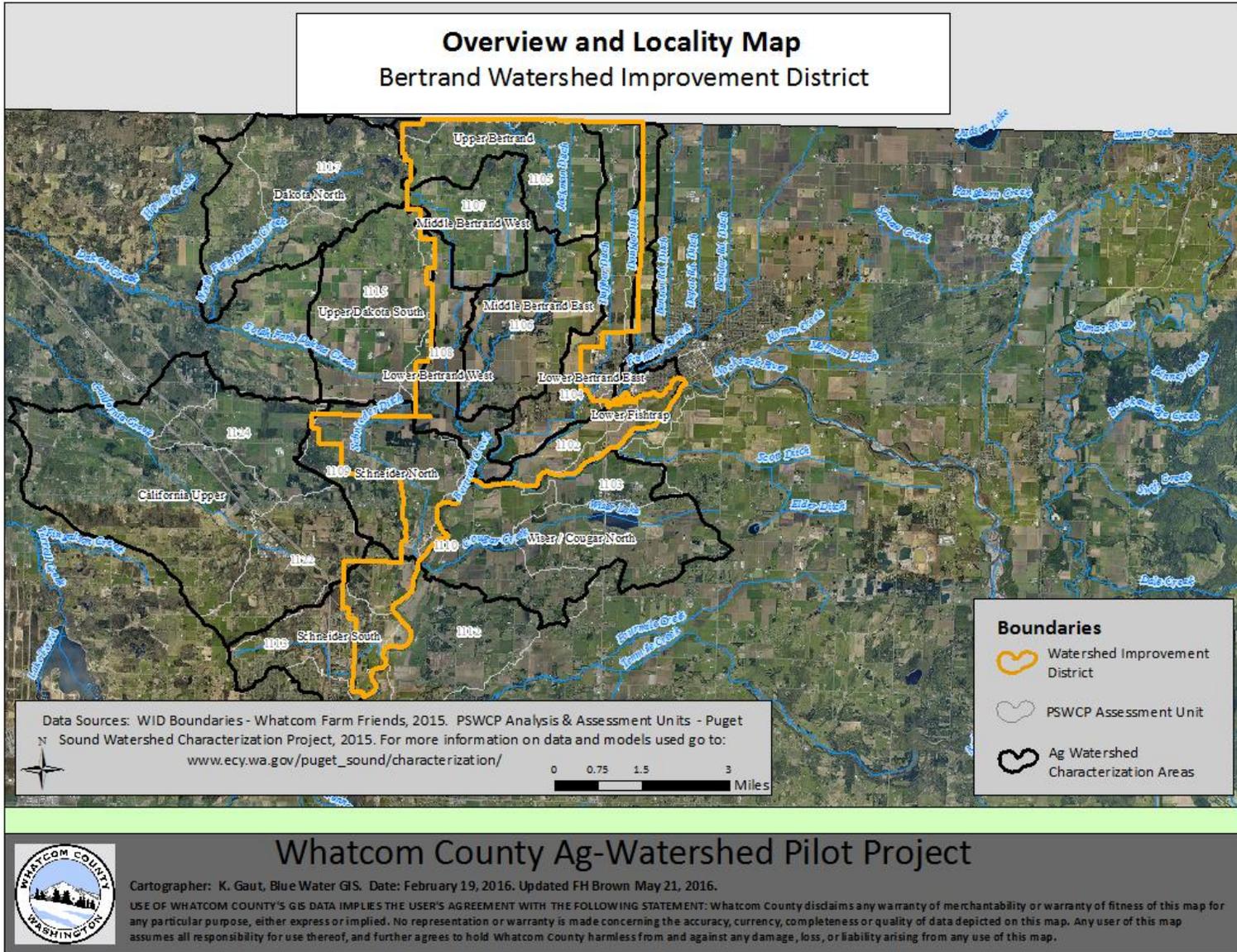


Figure 3. Bertrand WID: Overview and locality map

### 3 Summary results and approach used for agriculture-watershed characterization

#### 3.1 Pilot characterization and mapping (2012)

The methodology for agriculture-watershed characterization and mapping was developed and pilot-tested during Phase 1 of the Ag-Watershed Project. The pilot focus area covered the Bertrand, Fishtrap and Kamm watersheds. The pilot results are reported in the Phase 1 report on mapping and characterization (Gill, 2013).<sup>6</sup> Project Fact Sheet 2 provides additional background information on the agriculture-watershed characterization and mapping process.<sup>7</sup>

Information that was gathered during the pilot study in 2012 was reviewed and updated and has been incorporated into the 2016 agriculture-watershed characterization reports for the Bertrand, North Lynden and South Lynden Watershed Improvement Districts.

#### 3.2 Brief description: Methodology used for the 2016 WID characterization and mapping

Areas within the Bertrand Watershed Improvement District (WID) have been prioritized for both watershed and agricultural enhancement. This work has used an approach of structured combination and integration of local field knowledge and experience with a series of reference maps and tables, all of which draw on existing information and data.

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<sup>6</sup> Gill, P. (2013), *Agriculture-Watershed Characterization and Mapping Report for the North Lynden watersheds*. Prepared for the Whatcom County Agriculture-Watershed Pilot Project, Whatcom County Planning & Development Services, Bellingham. <http://www.co.whatcom.wa.us/2260/Agricultural-Watershed-Pilot-Project>

<sup>7</sup> Ag-Watershed Project fact sheets can be downloaded from <http://whatcomcounty.us/2260/Agricultural-Watershed-Pilot-Project>

A work session was held with Bertrand WID members and technical staff of local agencies in January 2016, during which participants used maps to identify and prioritize the type and location of agricultural and watershed services that could potentially be enhanced on agricultural land where there is potential for mutual benefit to both agricultural and watershed systems.

#### 3.2.1 Watershed analysis

The results of the watershed characterization and mapping for the Bertrand WID include tables and summary maps which describe the watershed services that are most needed for a healthy watershed (including the restoration of salmon populations) and where they could be enhanced in the watershed.

In order to generate these tables and summary maps for the Bertrand WID, the information contained in the watershed reference maps (see section 6.2 of this report) was combined with the results of watershed characterization<sup>8</sup> (water flow assessments for WRIA 1, provided by the Department of Ecology in a series of maps showing the areas which are most in need of either restoration or protection of larger-scale water flow processes). The work session participants reviewed this information, provided additional local field knowledge on site-specific watershed priorities, and identified potential actions or projects that could help to achieve watershed priorities.

A more detailed description of the watershed characterization methodology is provided in section 5.1 of this report.

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<sup>8</sup> Watershed 'characterization' is a set of water and habitat assessments that compare areas within a watershed for restoration and protection value. It is a coarse-scale tool that supports decisions regarding where on the landscape should efforts be focused first, and what types of actions are most appropriate to that place. See [http://www.ecy.wa.gov/puget\\_sound/characterization/index.html](http://www.ecy.wa.gov/puget_sound/characterization/index.html)

### 3.2.2 Agricultural analysis

The results of the agricultural characterization and mapping for the Bertrand WID include tables and summary maps which describe the agricultural services that are most needed for the long term success of agriculture, and where they could be enhanced in the watershed. The primary focus was on the “natural infrastructure” for agriculture: soils, water, adequate drainage and flood protection, and long-term protection of the agricultural land base.

Methods used to prioritize agricultural needs are based on a combination of: information from (i) existing agricultural protection programs in Whatcom County, (ii) available GIS data presented in the agricultural reference maps (see section 6.1 of this report) and (iii) local knowledge provided at the WID work session.

At the WID work session, participants assisted the project team to collate and evaluate information on agricultural system needs and priorities in the WID area, and to locate the different agricultural system needs and priorities on base maps of the WID area.

A more detailed description of the agricultural characterization methodology is provided in section 4.1 of this report.

### 3.3 Application: How to use the results of the agriculture-watershed characterization and mapping

The WID can use the characterization maps and tables of agricultural and watershed priorities to support their land and water planning, management, and project funding.

The characterization maps and tables should help the WID to identify, prioritize and strategically locate practical beneficial

projects and actions at the farm or reach-scale, and to enhance agricultural operations and watershed functions in the WID area.

The characterization maps and tables should also help the WID identify project opportunities that enhance watershed processes while strengthening agriculture where agricultural and watershed priorities are complementary, and to find acceptable trade-offs where they compete.

These results, which incorporate local knowledge and farmer insights, may also be used to communicate the WIDs’ priority enhancement needs to planners for consideration in broad scale planning such as Whatcom County’s Comprehensive Planning Process. More information on how to use these results in planning can be found in the Ag-Watershed Project Fact Sheet 5, included as Appendix D of this report.

### 3.4 Summarized results for the Bertrand Watershed Improvement District

The summary table below (Table 1) and the summary maps in Figure 4 highlight the most significant watershed and agricultural enhancement opportunities within the Bertrand WID area. Check marks in Table 1 indicate where a specific enhancement priority was identified during the characterization and mapping process. Detailed descriptions of priorities, the sources of data or information on priorities, and descriptions of opportunities for enhancement through specific actions can be found in Table 3 and Table 5 in this report.

Table 1. Summary results of agriculture-watershed characterization and mapping for the Bertrand WID  
(See locality map in Figure 3 for locations of agriculture-watershed characterization areas)

Agriculture-Watershed Characterization Area:	Upper Bertrand	Middle Bertrand East	Middle Bertrand West	Lower Bertrand East	Lower Bertrand West	Lower Fishtrap	Schneider North	Schneider South
Agricultural Enhancement Priority (See Table 3 for details)								
Prime agricultural soils	√	√	√	√	√	√	√	√
Water quality for crops and livestock	√ (Fe, nitrate)	√	√	-	-	√	√	-
Water quantity for agricultural activities	√	√	√	√	√	√	√	√
Agricultural drainage	√	-	-	√	-	√	-	√
Flood protection	-	-	-	√	-	√	√	√
Agricultural land base:								
Important agricultural land	√	√	√	√	√	√	√	√
Protection from development pressure	-	√	-	√	-	-	√	√
Other:								
Pollination	√	√	√	√	√	√	√	√
Watershed Enhancement Priority (See Table 5 for details)								
Water Quality								
Nutrients, Ammonia-N	-	-	-	√ (Amm-N)	-	-	-	-
Bacteria	√	√	-	√	√	√	√	-
Temperature	-	-	-	-	-	√	-	-
Dissolved oxygen	√	√		√	√	√	√	-
Other:	-	-	-	-	-	-	-	-
Habitat								
Salmon spawning (documented, current)	√	-	-	-	√	√	-	-
Anadromous fish	√	√	√	√	√	√	√	-
Wildlife	√	-	-	√	-	√	√	-
Wetland	√	√	√	√	√	√	√	√
Water Flow Processes <sup>9</sup>								
Delivery	√	-	√	-	-	-	-	-
Discharge	-	-	√	√	√	√	-	√
Recharge	√	√	√	√	√	√	-	-
Storage	√	-	√	√	-	√	-	-
Other	-	-	-	-	-	-	-	-

<sup>9</sup> Check marks are shown in the summary table if the recommendation for any water flow process is indicated as highest restoration/restoration/highest protection/protection.

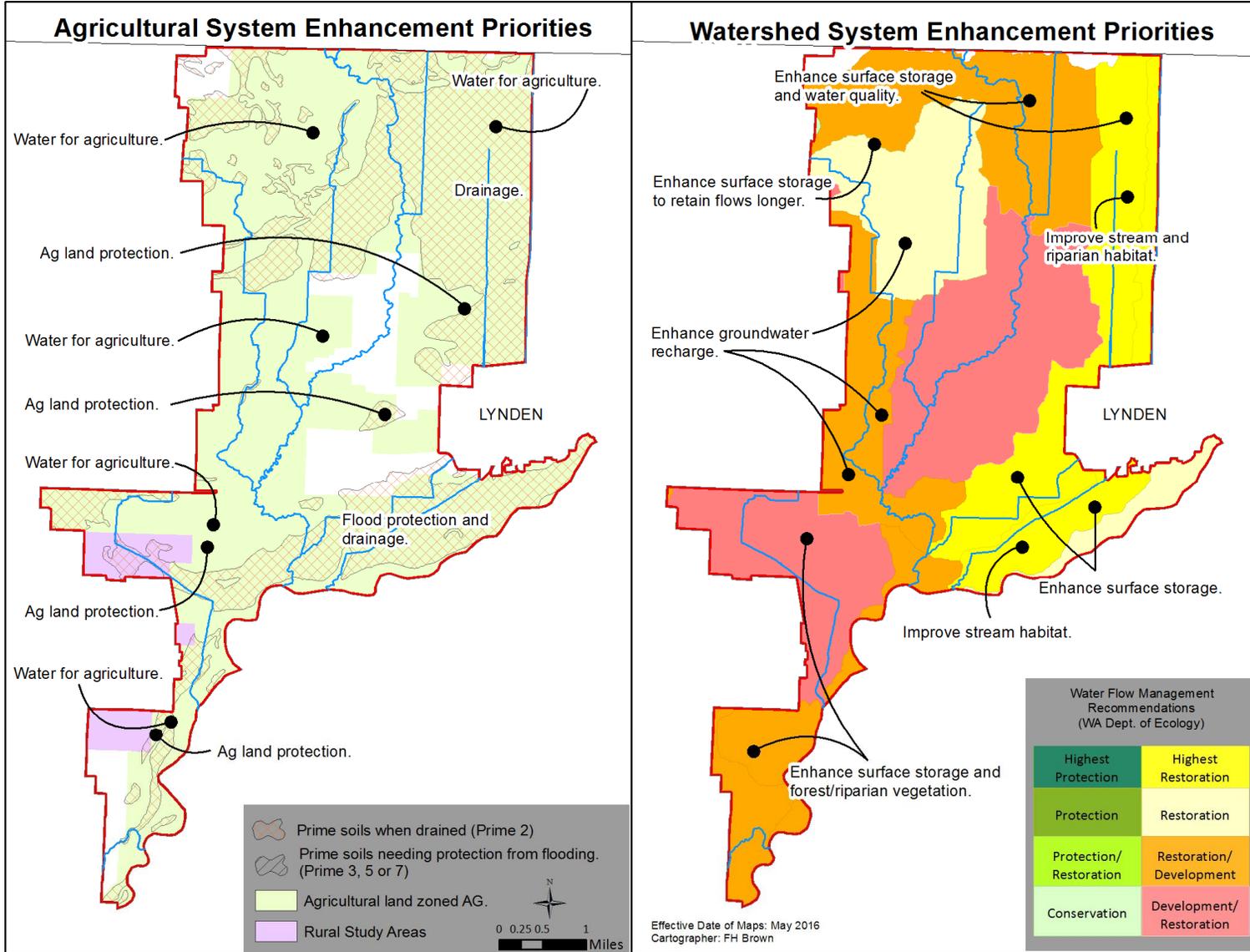


Figure 4. Bertrand WID: Summary maps of agricultural and watershed enhancement priorities

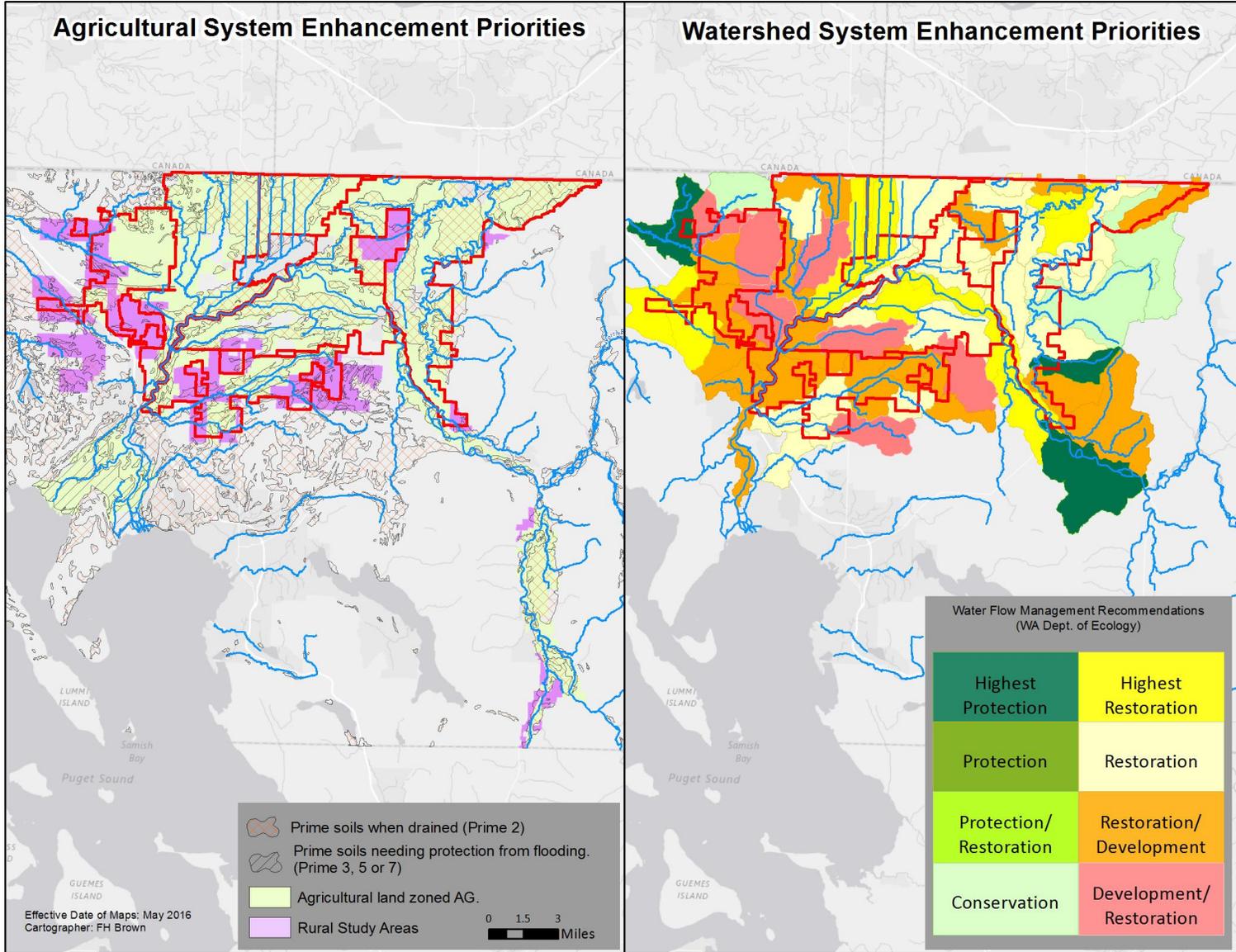


Figure 5. General agricultural and watershed enhancement priorities for the lowland areas of Whatcom County

### 3.5 Possible future challenges and priorities

Future challenges (1-10 years) may include issues listed below. See Table 1 for the full summary results of agriculture-watershed characterization and mapping for the Bertrand WID.

- **Water quantity:** Access to legal irrigation water is a key priority (58 new applications have been filed in the WID area). Bertrand Creek, and Fishtrap Creek are closed year-round to further appropriations unless mitigated. Restrictions on irrigation from creeks, tributaries, and other surface water sources are in place until instream flow levels are met during critical periods for fish per the existing Nooksack Instream Flow Rule.<sup>10</sup> There is limited access to water rights in some areas of the WID, and major Group A public suppliers do not have adequate water rights in suitable locations to meet projected future demand.<sup>11</sup>
- **Protection of agricultural land from development pressure:** All sub-basins within the Bertrand WID area contain prime agricultural soils, agricultural lands of importance and prime if drained soils. Additional residential growth on these prime soils is projected in some areas of the WID.
- **Water quality:** Sections of surface waters reported with high levels of fecal bacteria and low dissolved oxygen concentrations, and groundwater contamination has been reported over large areas of the Sumas-Blaine Aquifer which underlies the Bertrand WID.
- **Drainage & flood management:** Soils in the Bertrand WID require drainage in some areas, and flood protection in others. These are seasonal issues: drainage is needed in spring, and

seasonal flood protection is needed during critical times in the growing and harvesting seasons, with some crops being able to tolerate only limited periods of inundation.

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<sup>10</sup> [WAC 173-501](#) (1985), Instream Resources Protection Program – Nooksack Water Resource Inventory Area 1.

<sup>11</sup> *Whatcom County Coordinated Water System Plan Update* (2016), <http://www.whatcomcounty.us/1035/Coordinated-Water-System-Plan-Update>

## 4 Agricultural characterization and mapping for the Bertrand Watershed Improvement District

### 4.1 Methodology

#### 4.1.1 General approach

The general approach used in this work has been to identify and characterize

- what the priority agricultural needs are in the WID area, and why these are priorities for farming,
- where these are most needed in the WID area for the long term success of agriculture,
- what are the potential opportunities for agricultural enhancements that can address these needs, and
- which specific actions at reach-scale or farm-scale might be most effective in meeting agricultural enhancement needs in the WID.

The method used to characterize, prioritize, and map agricultural enhancement needs within the area of the Watershed Improvement District (WID) was developed and used in the pilot study,<sup>12</sup> and has since been adapted and refined as described here. The methodology relies on the structured combination of information derived from

- (i) existing agricultural land protection programs in Whatcom County,
- (ii) available GIS data used to prepare the agricultural reference maps, and
- (iii) local knowledge provided by participants in the WID work session.

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<sup>12</sup> Gill P (2013), *Agriculture-Watershed Characterization and Mapping Report for the North Lynden watersheds*. Prepared for the Whatcom County Agriculture-Watershed Pilot Project, Whatcom County Planning & Development Services, Bellingham. <http://www.co.whatcom.wa.us/2260/Agricultural-Watershed-Pilot-Project>

#### 4.1.2 What are the priorities for agriculture and why are these needed?

A viable agricultural system relies on three kinds of infrastructure:

- Natural infrastructure including available land, soils, water, air, plants and animals;
- Built infrastructure including product packing and processing facilities, livestock shelter and management facilities, transportation and water conveyance systems for irrigation, land drainage and flood protection;
- Supporting socio-cultural-economic infrastructure including research capacity, cultural value, knowledge and information transfer, labor, regulations and governance, business structures, access to markets.

The agricultural characterization has been focused on those aspects of agricultural infrastructure that are considered to be priorities for maintaining a viable agricultural industry in Whatcom County, and that are suited to mapping. These general priorities were initially identified in the pilot agricultural characterization and mapping workshop held in Lynden in October 2012<sup>13</sup> with farmers, agriculture professionals, planning and conservation agency staff:

- Availability of prime agricultural soils for all crop types and rotations;
- Water quantity for agricultural activities (irrigation, livestock and agricultural processing);
- Water quality for agriculture (livestock, crops, processing);
- Land drainage including timing of drainage for soil preparation, crop growth and harvesting;
- Protection of fields from flooding at critical times in the growing season;

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<sup>13</sup> Gill, P. (2013), *Ibid.*

- Protection of the agricultural land base from conversion for non-farming land uses;
- Protection from development pressure and agricultural-residential conflicts.

#### 4.1.3 Detailed description of process for characterizing and mapping agricultural enhancement priorities

Step 1: Delineation of Agriculture-Watershed Characterization Areas. The WID area was divided into several smaller “Agriculture-Watershed Characterization Areas” (AWCAs), based on a combination of the WRIA 1 water management areas<sup>14</sup> and the Puget Sound Watershed Characterization Project Assessment Units (see section 5 in this report for explanation of the assessment units). The AWCAs reflect hydrological and agricultural characteristics in the landscape, are recognizable for WID members, and are of a size that is practical for the WIDs to utilize in their planning processes. Importantly, the AWCAs represent common areas within which to characterize and map both agricultural and watershed enhancement priorities.

Step 2: Agriculture priority maps. The project team assembled a series of agriculture priority maps based on analysis of GIS data from Whatcom County’s existing Agriculture Program and other relevant sources. The agriculture priority maps included, for each agriculture-watershed characterization area (AWCA) associated with the WID:

- Proportion of prime soils (Figure 6);
- Drainage needs for agricultural land (Figure 7);
- Flood protection needs for agricultural land (Figure 8);

<sup>14</sup> *Surface Water Delineation Boundaries in WRIA 1* (November 2002), [http://wria1project.whatcomcounty.org/uploads/PDF/Maps/WRIA%201%20Water%20sheds%20&%20Streams%20V3\\_draftscreen.pdf](http://wria1project.whatcomcounty.org/uploads/PDF/Maps/WRIA%201%20Water%20sheds%20&%20Streams%20V3_draftscreen.pdf)

- Important agricultural land and needs for protection of the agricultural land base (Figure 9);
- Water quantity needs for agricultural activities (Figure 10).

Step 3: Agriculture reference maps. The project team prepared a series of agriculture reference maps to provide background information for the characterization and mapping process, using GIS data from Whatcom County and other relevant sources. The agriculture reference maps included:

- Agriculture priority areas identified in the County’s Agriculture program as important agricultural land,<sup>15</sup> including land within the Agriculture District (AG), land in the Rural Study Areas, and land on which agricultural conservation easements have been placed through the Purchase of Development Rights program (Figure 17);
- Agricultural land use inventory,<sup>16</sup> showing current land cover on agricultural lands in the WID (Figure 18);
- Location of Prime farmland soils as defined by the USDA (Figure 19);
- Potential residential development rights on agricultural land (Figure 20);
- Water right points of diversion – existing water rights and new applications (Figure 21);
- Special Districts that are wholly or partially within the WID area, including drainage, diking and flood control districts (Figure 22);
- Surface water quality impairments (Figure 27).

<sup>15</sup> *Whatcom County Agricultural Strategic Plan* (2011), Planning & Development Services Published May 17, 2011; Re-Published July 27, 2011 <http://www.whatcomcounty.us/DocumentCenter/View/3630>

<sup>16</sup> *Whatcom County Agricultural Land Cover Analysis* (2013), Whatcom County Planning & Development Services: Agricultural Program, May 2013 <http://www.co.whatcom.wa.us/DocumentCenter/View/3989>

Step 4: WID work session. The WID commissioners hosted a work session to bring together participants with local knowledge of agriculture in the WID area, including farmers and residents, agency staff and agriculture professionals. At the work session, participants gathered around several large printed maps of the WID area and discussed the agricultural and watershed priorities in the WID. Participants were provided with a set of the reference maps to use in the discussion as needed. Participants' inputs on agricultural priorities and specific actions were compiled by the project team as notes in a series of tables (see Table 3 in this report) and as notes on the large desk-top maps.

Step 5: Characterization and determination of agricultural enhancement priorities and specific actions. The project team added information from the agricultural priority maps and other reference documents to the detailed agricultural enhancement tables, along with the information provided by the work session participants (see Table 3). Agricultural priorities were determined for each Agriculture-Watershed Characterization Area (AWCA) by combining the reference information and the work session information as shown in Table 2 below. Where specific actions at specific locations were suggested by work session participants, these were included in the Agricultural Priority Actions Map (Figure 11).

Step 6: Mapping of agricultural enhancement priorities. A summary agricultural enhancement map was prepared (Figure 4) to show, as far as possible in a single map, the locations of agricultural priorities including prime farmland soils, important agricultural land, flood protection and agricultural drainage.

Table 2. Methodology for determination of agricultural enhancement priorities in the Bertrand WID.

1. Primary indicator of priority: Refer to the reference maps and reference documents for a substantiated agricultural priority in each agriculture-watershed characterization area according to the criteria below. If a criterion is met for indicating an agricultural priority, then add this in yellow highlight to the detailed agricultural characterization tables, and put a check mark in the summary table of agricultural and watershed enhancement priorities (Table 1).		
2. Modifiers: Refer to the work session participants' comments for this area to see whether their comments might modify the indicator of priority or would support a priority being added to the table, as explained below. Modify the agricultural priority indicators in summary Table 1 and detailed Table 3 as needed.		
3. Specific actions/opportunities: If the participants recommended specific actions to address priority needs, then record these in the "possible actions" column in the detailed agriculture characterization tables. Specific actions that can be tied to a specific location should be placed on the agricultural priority actions map. Specific actions that are more general can be listed in the possible actions column of the detailed agricultural characterization tables.		
Priority	Criteria for indicating priority	Modifiers
<i>Prime agricultural soils</i>	>50% of the area is Prime farmland (any prime soils category 1-10 according to USDA definitions for prime farmland)	-
<i>Water quality for crops and livestock</i>	Note WA Dept. of Ecology water quality impairments in category 5, 4a or 4b where these might affect use of the water for agricultural activities.	If work session participants noted a specific water quality issue that could affect the use of water for agricultural purposes (e.g. iron causes blockage of irrigation pipes; nitrate can be a problem for livestock), then indicate as "priority for agriculture" and crosscheck with reference documents or reference maps to substantiate if possible.
<i>Water quantity for agricultural activities</i>	More than 1 new application for water right in the area.	Refer to participants' comments and reference maps. If number of new applications is <3 and participants stated, with supporting evidence, that water quantity for agriculture is currently sufficient, then the priority indicator can be removed.
<i>Agricultural drainage</i>	>50% of the area contains Prime 2 soils (Prime if drained) Note presence of drainage district – not a modifier but indicates that drainage needs ongoing maintenance to remain effective.	Refer to participants' comments to see whether they consider drainage to be a priority (if they do not, that does not necessarily mean that drainage is not needed in the area, but probably means that if drainage infrastructure is present then it is adequately maintained). If specific actions were recommended at specific locations, then add those to the actions column.
<i>Flood protection</i>	Contains >5% soils that are Prime if protected from flooding, OR Contains 1 in 100-year flood area, OR Contains floodway	If only a small portion of the area contains one of the 3 criteria at left, then refer to participants' comments and if they did not consider flood protection to be a general need for the area, then the priority indicator can be removed.
<i>Agricultural land base:</i> · <i>Important agricultural land</i> · <i>Protection from development pressure</i>	>50% of the area is any combination of AG zoned, Rural Study Area or PDR easement.	-
	Reference maps: If a Rural Study Area is present (see ag priority areas reference map), OR If the area contains parcels with more than 2 potential additional dwelling units (development rights reference map)	Refer to participants' comments to see if they are experiencing residential-ag conflicts or pressure for conversion of agricultural land in the area and consider this to be a priority.
<i>Other:</i>	Refer to participants' comments. Crosscheck with reference documents or reference maps to substantiate if possible.	-

## 4.2 Agricultural characterization tables

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Table 3. Agriculture characterization tables for the Bertrand WID

NOTE: Possible actions include: Specific actions identified by WID Actions Map # location (e.g. BT8) and Assessment Unit (AU), and general actions which do not have locations specified. Some of these actions do not appear on the WID Priority Actions Map due to: (i) action is general in description no location is noted; (ii) action is specific in description but no location noted; (iii) action is general in description, located outside the WID area; (iv) action is specific in description, located outside the WID.

3A. Agricultural enhancement priorities: Upper Bertrand							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
Upper Bertrand AU1105  Notes from reference maps and other documents	1-10 new applications for water rights in Upper Bertrand (>3). See Ag Priorities Map: Water Quantity	Sections of Bertrand Creek in Upper Bertrand are in category 5 for DO, and category 4a for bacteria. <sup>17</sup>  Nitrate contamination is reported in groundwater over large areas of the Sumas-Blaine Aquifer. <sup>18</sup>  Concentrations of iron greater than or equal to 3,000 micrograms/liter in some Bertrand wells tapping Sumas aquifer. <sup>19</sup>  <b>Ag water quality priority</b>	>50% of soil in Upper Bertrand is prime if drained. See, Ag Priorities map: Drainage  <b>Ag drainage priority</b>	<5% of soil in Upper Bertrand is prime if protected from flooding.  Main Bertrand Creek is within 1:100-year flood zone, but this is confined to an area close to the channel. See Ag Priorities map: Flooding.	>80% of land in Upper Bertrand is in AG Zoning. See Ag Priorities: Ag Land Base map. <b>Ag land base priority</b>  89% of the area in Upper Bertrand is Prime soil. See Ag Priorities map: Prime Soils, and Ag reference map: Prime soils. <b>Ag prime soils priority</b>  No parcels with >2 potential dwelling units. See Ag reference map: Potential development rights.		
Upper Bertrand AU1105  Notes from work sessions in October 2012 and January 2016.	Irrigation water needed. Ground water is not limited, but: low stream flows coming from Canada [BT10]; Bertrand stream flow gets very low in late summer, at a time when irrigation water is also needed.  <b>Ag water quantity priority</b>	High iron concentrations in groundwater (natural origin) – clogs irrigation lines but not otherwise a significant problem for ag. Poor water quality from Canada. Nitrates in water taken from wells can be a problem for livestock & for drinking water. Fecal coliform counts can be high in Bertrand: potential sources include livestock, waterbirds, septic tanks, Canada runoff.	Drainage maintenance is an issue. Spring is a critical time for drainage. Poor drainage near the border on the western side of this area. Problems with drainage along Jackman Ditch. H Street ditch maintenance needed in north east part of this area, to move spring water out of the fields.	Not a problem for the most part on Bertrand – may be a localized problem on Jackman Road. Some localized flooding near the border. Mostly a problem in spring.	Good soils for corn, grass, berries (along creek).  Upper watershed is parcelized.	Pollination indicated as a generic service need. Locations not specified.	General: -Augmentation of late summer surface flows from groundwater.(i) -Opportunities for surface water storage to be enhanced.(i)  Specific: [BT8] AU1105: Change riparian area management practices to reduce hosts for berry crop pests such as fruitfly (e.g. blackberry and some native plants)

<sup>17</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>18</sup> Ecology (2012) *Sumas-Blaine Aquifer Nitrate Contamination Summary*. Pub #12-03-026. <https://fortress.wa.gov/ecy/publications/documents/1203026.pdf>

<sup>19</sup> Cox, S. E., and Kahle, S. C. (1999) Hydrogeology, Ground-Water Quality, and Sources of Nitrate in Lowland Glacial Aquifers of Whatcom County, Washington, and British Columbia, Canada; Water-Resources Investigations Report 98-4195. USGS. <http://pubs.usgs.gov/wri/1998/4195/report.pdf> (last accessed 4/4/2016).

3B. Agricultural enhancement priorities: Middle Bertrand (East)							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
<p>Middle Bertrand East AU1106</p> <p>Notes from reference maps and other documents</p>	<p>&gt;25 new applications for water rights in Middle Bertrand East. See Ag Priorities map: Water Quantity</p> <p>Ag water quantity priority</p>	<p>A small section of Bertrand Creek in Middle Bertrand East is in category 5 for DO, and category 4a for bacteria.<sup>20</sup></p> <p>Nitrate contamination is reported in groundwater over large areas of the Sumas-Blaine Aquifer.<sup>21</sup></p> <p>Concentrations of iron greater than or equal to 3,000 micrograms/liter in some Bertrand wells tapping Sumas aquifer.<sup>22</sup></p> <p>Ag water quality priority</p>	<p>&lt;25% of the soil in this area is Prime 2 (prime if drained). See Ag Priorities map: Drainage.</p>	<p>&lt;5% of soil in Upper Bertrand is prime if protected from flooding. Main Bertrand Creek is within 1:100-year flood zone, but this is confined to an area close to the channel.</p> <p>See Ag Priorities map: Flooding.</p>	<p>68% of land in Middle Bertrand East is in AG Zoning. See Ag Priorities: Ag Land Base map.</p> <p>Ag land base priority</p> <p>100% of the soils in this area are Prime. See Ag Priorities map: Prime Soils</p> <p>Ag prime soils priority</p>		
<p>Middle Bertrand East AU1106</p> <p>Notes from work sessions in October 2012 and January 2016.</p>	<p>Irrigation water is needed for berry &amp; potato farming. Water rights are limited. Ag competes with instream low flow requirements between July and October. -Many farmers would prefer to have groundwater rights. Groundwater is cleaner and better for berries – need to keep bacteria off berries.</p>	<p>High iron concentrations are a challenge – water needs filtering for use in drip lines but otherwise ok for farming. High nitrates problematic for potable water.</p>	<p>Pretty well drained. Water table is lower here – not such a great need for drainage.</p>	<p>Good capacity to move water out of this area. Sheet flows off the land due to clay soils &amp; soil compaction.</p>	<p>Heart of berry soils. Good soils, but need organic matter. Some parcelization &amp; residential development. Some residential conflicts – noise and spraying.</p> <p>Protection from development pressure is an ag priority.</p>	<p>Pollination indicated as a generic service need. Locations not specified.</p>	<p>General: Work with higher ground and natural elevations to allow the Nooksack overflow to move out of funneled area near Bertrand/Nooksack confluence.(ii)</p>

<sup>20</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>21</sup> Ecology (2012), *Sumas-Blaine Aquifer Nitrate Contamination Summary*. Pub #12-03-026. <https://fortress.wa.gov/ecy/publications/documents/1203026.pdf>

<sup>22</sup> Cox, S. E., and Kahle, S. C. (1999), *Hydrogeology, Ground-Water Quality, and Sources of Nitrate in Lowland Glacial Aquifers of Whatcom County, Washington, and British Columbia, Canada*; Water-Resources Investigations Report 98-4195. USGS. <http://pubs.usgs.gov/wri/1998/4195/report.pdf> (last accessed 4/4/2016)

3C. Agricultural enhancement priorities: Middle Bertrand (West)							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
<p>Middle Bertrand West AU1107</p> <p>Notes from reference maps and other documents</p>	<p>1-10 new applications for water rights in Middle Bertrand West. See Ag Priorities map: Water Quantity (map shows 2 new applications)</p>	<p>Elevated iron likely comes from iron-manganese nodules known to exist in peat in the region. <sup>23</sup></p>	<p>&lt;50% of the soils are prime if drained. See Ag Priorities map: Drainage.</p>	<p>&lt;5% of soil is prime if protected from flooding in Middle Bertrand West. See Ag Priorities: Flooding map.</p>	<p>&gt;80% of land in Middle Bertrand West is in AG Zoning. See Ag Priorities: Ag Land Base map. <b>Ag land base priority</b></p> <p>85% of this area is Prime soil. See Ag Priorities: Prime Soils map <b>Prime soils priority</b></p>		
<p>Middle Bertrand West AU1107</p> <p>Notes from work sessions in October 2012 and January 2016.</p>	<p>Irrigation water is needed for berry &amp; potato farming. Water rights are limited. Ag competes with instream low flow requirements between July and October. -Many farmers would prefer to have groundwater rights. Groundwater is cleaner and better for berries – need to keep bacteria off of berries. <b>Ag water quantity priority</b></p>	<p>High iron concentrations (localized) are a challenge – water needs filtering for use in drip lines but otherwise ok for farming. High nitrates problematic for potable water. <b>Ag water quality priority</b></p>	<p>Improve drainage on ag land as it is unknown how much impact will occur from additional stormwater over time.</p>	<p>Some crops cannot withstand holding flood water, e.g., grass pastures at certain times of year.</p> <p>Berry ground runoff adds debris and silt to neighboring fields</p>	<p>Good soils, but need organic matter.</p> <p>Some adjacent residential conflicts. Some parcelization &amp; residential development, but still limited.</p>	<p>Pollination indicated as a generic service need. Locations not specified.</p>	<p>Specific: [BT2] AU1107: Fish barriers and fish habitat functions in area west of Barnhart Rd could be improved, as fishway practices have changed. Conservation District could assist landowners.</p>

<sup>23</sup> Mitchell, R. J., et al (2005), *Water Quality: Abbotsford-Sumas Final Report*. Western Washington University

3D. Agricultural enhancement priorities: Lower Bertrand (East)							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
<p>Lower Bertrand East AU1104</p> <p>Notes from reference maps and other documents</p>	<p>1-10 new applications for water rights in Lower Bertrand East. See Ag Priorities: Water Quantity map (6 applications)</p> <p>Ag water quantity priority</p>	<p>A section of Bertrand Creek is in category 5 for ammonia, and sections of Duffner Ditch in Lower Bertrand East are in category 5 for DO, and category 4a for bacteria.<sup>24</sup></p>	<p>&gt;50% of soil in Lower Bertrand East is prime if drained. See Ag Priorities: Drainage map.</p> <p>Consolidated Drainage District #1 is located within the Lower Bertrand East sub-basin.<sup>25</sup></p> <p>Ag drainage priority</p>	<p>&lt;5% of soil is prime if protected from flooding and the southern area of Lower Bertrand East lies in 1:100-year flood zone. See Ag Priorities: Flooding map.</p> <p>Protection from flooding is an ag priority.</p>	<p>64% of land in Lower Bertrand East is in AG Zoning. See Ag Priorities: Ag Land Base map.</p> <p>Ag land base priority</p> <p>96% of soils are Prime in Lower Bertrand East. See Ag Priorities: Prime Soils map</p> <p>Prime soils priority</p> <p>Lynden UGA and West Main Street developments are adding pressure for conversion of land. See Ag reference map: Agriculture Priority Areas</p> <p>Ag land protection priority</p>		
<p>Lower Bertrand East AU1104</p> <p>Notes from work sessions in October 2012 and January 2016.</p>	<p>Limited irrigation needs here. Plenty of water, but not water rights. Efficient drip irrigation for berries is already in place. Potatoes/berries grown</p>	<p>Some nitrogen problems in groundwater, in areas of highly permeable soils. Water quality for ag generally is acceptable, iron concentrations not problematic for ag. Urban stormwater could potentially add to water quality degradation in future.</p>	<p>Wet marshy ground in some areas. Limited options for drainage since the land is low-lying.</p>	<p>[BT6] AU1104: some problems with intermittent flooding north of Badger Road.</p> <p>Stormwater from Lynden is a problem in the southern part of this area and in the floodplain, affecting Duffner Ditch and lower Bertrand Creek. Duffner and Bertrand Creek (drainage from W. Main St. new light industrial development).</p>	<p>Adjacent residential conflicts. Development pressure from Lynden expanding to the west of the city.</p>	<p>Pollination indicated as a generic service need. Locations not specified.</p>	<p>General: Work with City of Lynden: -secure stormwater detention and infiltration on upland. (ii) -don't allow conveyance of additional flow from development to be discharged onto lower elevation ag land. (ii) -design stormwater discharge to not exceed pre-development rates. (ii)</p> <p>Specific: [BT4] Duffner Ditch needs a new self-regulating flood gate.</p>

<sup>24</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>25</sup> WCD (2014), *Agricultural Drainage for Drainage Districts*. <http://www.whatcomcd.org/ag-drainage-districts>

3E. Agricultural enhancement priorities: Lower Bertrand (West)							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
<p>Lower Bertrand West AU1108</p> <p>Notes from reference maps and other documents</p>	<p>1-10 new applications for water rights in Lower Bertrand West – See Ag Priorities: Water Quantity map (6 applications shown on map)</p> <p>Ag water quantity priority</p>	<p>A section of Bertrand Creek in Lower Bertrand West is in category 5 for DO, and category 4a for bacteria, and category 4c for habitat.<sup>26</sup></p> <p>Nitrate contamination is reported in groundwater over large areas of the Sumas-Blaine Aquifer.<sup>27</sup></p> <p>Elevated iron likely comes from iron-manganese nodules known to exist in peat in the region.<sup>28</sup></p>	<p>&lt;25% of soils in this area are Prime if drained.</p>	<p>&lt;5% of soil is prime if protected from flooding. Bertrand Creek is within 1:100-year flood zone, but this is confined to an area close to the channel, except for the southern portion of this area near the Nooksack/Bertrand confluence. The southern portion of Lower Bertrand West is in floodway and 1:100-year flood zone. See Ag Priorities: Flooding map.</p>	<p>&gt;80% of land in Lower Bertrand West is in AG Zoning. See Ag Priorities: Ag Land Base map.</p> <p>Ag land base priority</p> <p>99% of soils in in Lower Bertrand West are Prime. See Ag Priorities: Prime Soils map</p> <p>Prime soils priority</p>		
<p>Lower Bertrand West AU1108</p> <p>Notes from work sessions in October 2012 and January 2016.</p>	<p>Limited irrigation needs here. Plenty of water, but not water rights. Efficient drip irrigation for berries is already in place.</p>	<p>Some nitrogen problems in groundwater, in areas of highly permeable soils. Water quality for ag generally is acceptable, iron concentrations not problematic for ag. Urban stormwater could potentially add to water quality degradation in future.</p>	<p>Bertrand here can handle drainage water.</p>			<p>Pollination indicated as a generic service need. Locations not specified.</p>	<p>Specific: [BT8] AU1108: Drainage ditch contains debris from trees, needs maintenance for better flow.</p>

<sup>26</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>27</sup> Ecology (2012), *Sumas-Blaine Aquifer Nitrate Contamination Summary*. Pub #12-03-026. <https://fortress.wa.gov/ecy/publications/documents/1203026.pdf>

<sup>28</sup> Mitchell, R. J., et al (2005), *Water Quality: Abbotsford-Sumas Final Report*. Western Washington University

3F. Agricultural enhancement priorities: Lower Fishtrap							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
Lower Fishtrap AU1102  Notes from reference maps and other documents	1-10 new applications for water rights in Lower Fishtrap. See Ag Priorities: Water Quantity map	Sections of Fishtrap Creek in Lower Fishtrap are in category 5 for temperature and DO, and category 4a for bacteria. <sup>29</sup>	>50% of soil in Lower Fishtrap is prime if drained. See Ag Priorities: Drainage map.  Consolidated Drainage District #1 is located within the Lower Fishtrap sub-basin. <sup>30</sup>  <b>Ag drainage priority</b>	<5% of soil is prime if protected from flooding and the southern area of Lower Fishtrap lies in floodway and the 1:100-year flood zone. See Ag Priorities: Flooding map.  <b>Ag flood protection priority</b>	70% of land in Lower Fishtrap is in Ag Zoning. See Ag Priorities: Ag Land Base map. <b>Ag land base priority</b>  90% of soils in this area are Prime. See Ag Priorities: Prime Soils map <b>Prime soils priority</b>		
Lower Fishtrap AU1102  Notes from work sessions in October 2012 and January 2016.	More irrigation water needed – water rights. <b>Ag water quantity priority</b>	High fecal coliform counts in runoff from Lynden <sup>31</sup> and Canada. Many geese on the Lynden stormwater detention pond. Need more retention of stormwater, especially in the N Lynden Business Park area of W Main Street. High iron levels in groundwater (natural origin) can be a problem for berry growers. <b>Ag water quality priority</b>	Drainage is a significant problem in this area. Runoff from Lynden brings sediment and erosion problems in the lower Fishtrap Creek. Drainage may require leveling, storage or removal of sediment - need to be able to address changes in grade occurring overtime creating standing water in some ditches. Beavers are dropping trees into the creeks and ditches.	Downstream of Lynden needs flood protection in spring from Nooksack River flooding – backflooding into Fishtrap & Bertrand Creeks added to increase storm runoff from Lynden. Used to be mostly a winter/spring flooding problem but with increased impervious surface in Lynden, now a 1-inch rainfall in summer can lead to flooding. Lynden used to pay farmers for maintenance. If the levee at Fishtrap is lowered we might lose ag field protection in spring/summer. What happens at the Duffner X Bertrand flood-gate if changes are made elsewhere in sub-basin? Floodgates on Duffner ditch don't work well due to armoring. Too much maintenance required.	Limited pressure for development in the floodplain: development rights are available, but the ground is too wet to develop. Berry production is increasing. Area is best for “row crops” potatoes, corn, grass, hay.	Decline in pollinators, possibly due to diseases.	Specific: [BT1] AU1102 Drainage: culvert plugged  [BT4] AU1110 and AU1102: Flood Flows: have had August water on these fields which is harmful to ag. Duffner Ditch has grown in size and is over-capacity because of high runoff from Lynden. Backs up during flood flows – needs a new self-regulating floodgate.  [BT13] AU1102: Need more flood gates on south side of Fishtrap Creek. Repair & replace existing gates.

<sup>29</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>30</sup> WCD (2014), *Agricultural Drainage for Drainage Districts*. <http://www.whatcomcd.org/ag-drainage-districts>

<sup>31</sup> Whatcom County (2015), *Fishtrap Watershed Water Quality Status. Fecal Coliform Bacteria- November 2015* <http://www.whatcomcounty.us/DocumentCenter/View/13883>

3G. Agricultural enhancement priorities: Schneider Ditch (North)							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
<p>Schneider North AU1109 &amp; small portion of AU1110</p> <p>Notes from reference maps and other documents</p>	<p>1-10 new applications for water rights in Schneider North. See Ag Priorities: Water Quantity map (5 applications shown on map)</p>	<p>Sections of Keefe Lake Outlet in Schneider North are in category 5<sup>32</sup> for DO, and category 4a<sup>33</sup> for bacteria.<sup>34</sup></p> <p>Elevated iron likely comes from iron-manganese nodules known to exist in peat in the region.<sup>35</sup></p>	<p>&lt;50% of soils in this area are prime if drained.</p> <p>Drainage District #2 is located within the Schneider North subbasin.<sup>36</sup></p>	<p>&lt;5% of soil is prime if protected from flooding but much of Schneider Ditch in Schneider North lies in floodway and 1:100-year flood zone. See Ag Priorities: Flooding map.</p> <p><b>Flood protection priority for ag</b></p>	<p>&gt;80% of land in Schneider North is in Ag Zoning &amp; RSAs. An RSA occupies a portion of this sub-basin. See Ag Priorities: Ag Land Base map.</p> <p><b>Ag land base priority</b></p> <p>Parcelization and parcels with &gt;2 potential additional dwelling units. See Ag reference map: Potential development rights.</p> <p><b>Protection from development pressure is an ag priority.</b></p> <p>97% of soils score in Schneider North are Prime. See Ag Priorities: Prime Soils map</p> <p><b>Prime soils priority</b></p>		
<p>Schneider North</p> <p>Notes from work session in January 2016.</p>	<p>Irrigation for potatoes and corn. Access to groundwater is needed to reduce surface water users. AU1109</p> <p>Water Quantity: Irrigation water needed</p> <p><b>Ag water quantity priority</b></p>	<p>High iron in groundwater. Stormwater quality has potential impact on ag land and soil quality.</p> <p><b>Ag water quality priority</b></p>		<p>Blueberry farms get flooded in this area. [BT5] AU1109: flooding on fields May-Oct from Schneider Ditch, which creates problems for farmers. Beaver problem along Enterprise Road. Jail crews remove beaver dams. Dike washout area.</p>	<p>Parcelization at top end of Schneider and south end of Bertrand on R5/R10 lands above the flood plain. Ag land is marginal in this area.</p>	<p>Use of both natural pollinators and honeybees in this area. Decline in bee populations is of concern.</p>	<p>General: Some of this area is the best corridor for flood management of the Nooksack River.(i) Need to relook at CAO, beaver management and drainage maintenance regulation conflicts.(ii) Specific: [BT3] AU1109. Good opportunities for riparian restoration; address barriers on pond, culverts and ladders.</p>

<sup>32</sup> Category 5 - Polluted waters that require a TMDL (total maximum daily load) or other WQI (water quality Improvement) project: the traditional list of impaired water bodies traditionally known as the 303(d) list. Starting with the 2008 Water Quality Assessment, Washington's 303(d) list of polluted waters were placed under Category 5 in the approved assessment. Placement in this category means that Ecology has data showing that the water quality standards have been violated for one or more pollutants, and there is no TMDL or pollution control plan. WA Department of Ecology, 2015. *Water Quality Assessment Categories*. <http://www.ecy.wa.gov/programs/wq/303d/WQAssessmentCats.html> (Accessed March 28, 2016)

<sup>33</sup> Category 4a - has a TMDL: water bodies that have an approved TMDL in place and are actively being implemented. WA Department of Ecology, 2015. *Water Quality Assessment Categories*. <http://www.ecy.wa.gov/programs/wq/303d/WQAssessmentCats.html> (Accessed March 28, 2016)

<sup>34</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>35</sup> Mitchell, R. J., et al (2005), *Water Quality: Abbotsford-Sumas Final Report*. Western Washington University

<sup>36</sup> WCD (2014), *Agricultural Drainage for Drainage Districts*. <http://www.whatcomcd.org/ag-drainage-districts>

3H. Agricultural enhancement priorities: Schneider Ditch (South)							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
<p>Schneider South AU1112</p> <p>Notes from reference maps and other documents</p>	<p>1-10 new applications for water rights in Schneider South. See Ag Priorities: Water Quantity map (2 applications shown on map)</p>	<p>Elevated iron likely comes from iron-manganese nodules known to exist in peat in the region.<sup>37</sup></p>	<p>&lt;25% of the soils are prime if drained.</p>	<p>&lt;5% of soil is prime if protected from flooding but the eastern area of Schneider South lies in floodway and 1:100-year flood zone. See Ag Priorities: Flooding map.</p> <p><b>Flood protection priority for ag</b></p>	<p>32% of land in Schneider South is in Ag Zoning and RSA, but the area that is within the WID is almost all AG zoning and RSA. See Ag Priorities map: Ag Land Base map and Ag Reference map (Agriculture Priority Areas).</p> <p><b>Ag land base priority</b></p> <p>83% of soils in the area are Prime. See Ag Priorities: Prime Soils map.</p> <p><b>Prime soils priority</b></p> <p>Land parcelization, parcels with &gt;2 potential additional dwelling units. See Ag reference map: Potential development rights.</p> <p><b>Protection from development pressure is an ag priority.</b></p>		
<p>Schneider South AU1112</p> <p>Notes from work session in January 2016.</p>	<p>Irrigation for potatoes and corn.</p> <p>Access to groundwater needed to reduce surface water use.</p> <p><b>Ag water quantity priority</b></p>	<p>High iron in water (natural origin).</p>	<p>Beaver issues along Dewilds on Enterprise Road. Trees in area attract more beaver, which affects drainage efficiency. Housing development on west side of Schneider area now causes flooding due to runoff. AU1112: unmaintained ditch below Alfred's dike.</p> <p><b>Ag drainage priority</b></p>	<p>See break in area along Whiskey and Schneider Creek from 2014 storms, permit timeline and repair failure in 2015. Aug 2015 – overtopped here. Schneider Creek downstream of River Road has floodflow (water on ag fields). Problematic if May-Oct.</p>	<p>Residential and ag is mostly potatoes, corn and grass</p> <p>AU1109 – Parcelization &amp; development</p>	<p>The PUD#1 is part of Bertrand WID. Be sure to consult them about water service and pumping station access needs.</p>	

<sup>37</sup> Mitchell, R. J., et al (2005), *Water Quality: Abbotsford-Sumas Final Report*. Western Washington University

31. Agricultural enhancement priorities: General in Bertrand WID area (no location specified)							
	Water quantity: Irrigation, stock and processing	Water quality	Drainage	Flood protection	Land	Other	Possible actions
Bertrand WID general comments at January 2016 work session			Willow species planted in hedgerows are problematic for field drainage: difficult to clean the ditches although they do shade out the canary grass well. Conservation District no longer plants willows along ditches.	Need timely work on flood gates. Delays in permit can put off a fix for up to 2 years if you miss the fish window e.g., Whiskey X Schneider Creeks' failed repair.  Cutting of trees on some dikes is required by Army Corp Engineers, but then Whatcom Co requires landowner payment for permits to remove the trees – needs resolution.		Naming drained land as degraded does not accurately reflect ag land improvements.  Land leveling needed for some crop types.	General: Relook at regulations for moving more than 50 yards of soil and timeliness of permitting agencies to respond to ag permit requests.(ii)

### 4.3 Agricultural priorities: Summary maps

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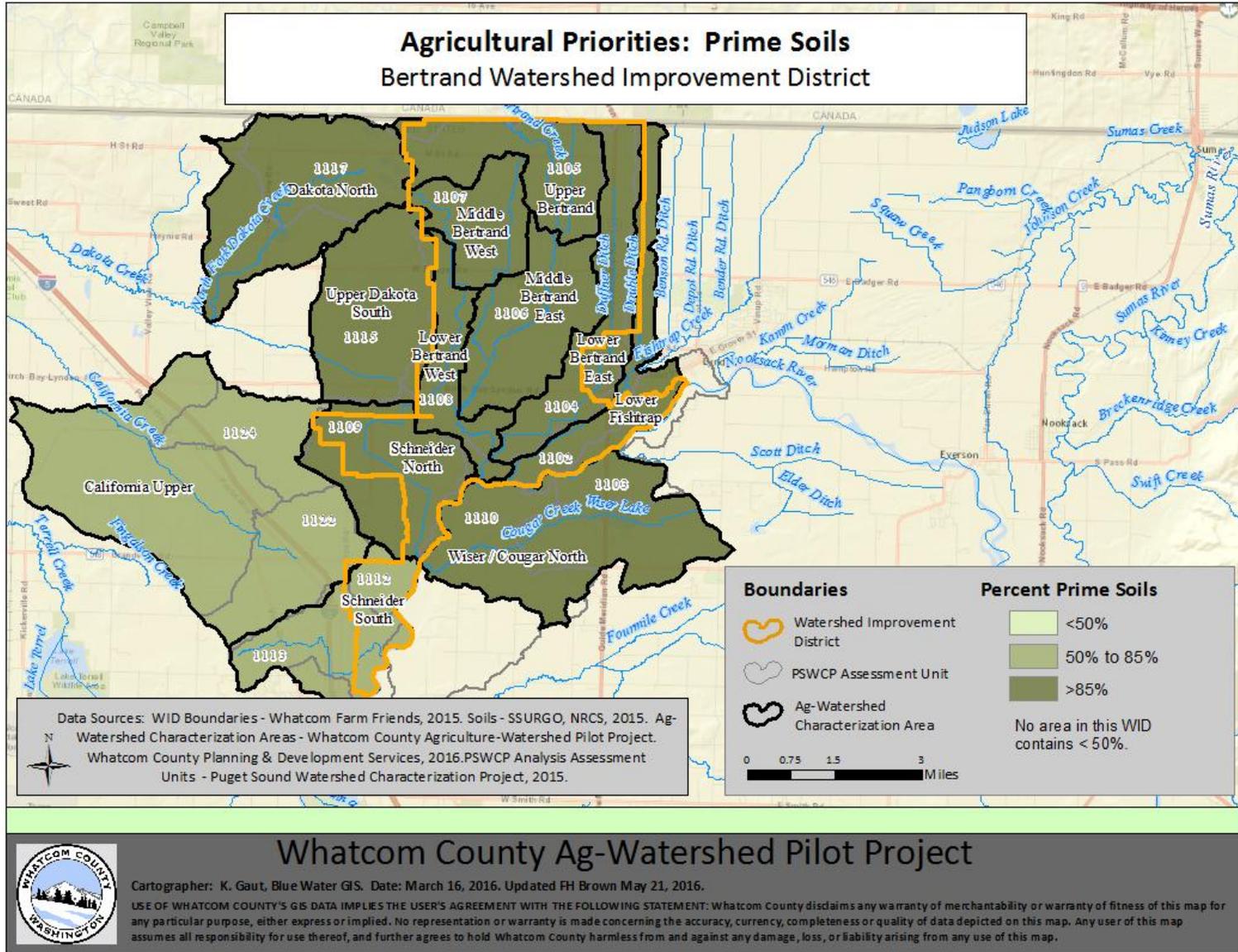


Figure 6. Bertrand WID agricultural priorities: Proportion of prime soils. Data from reference map of prime soils

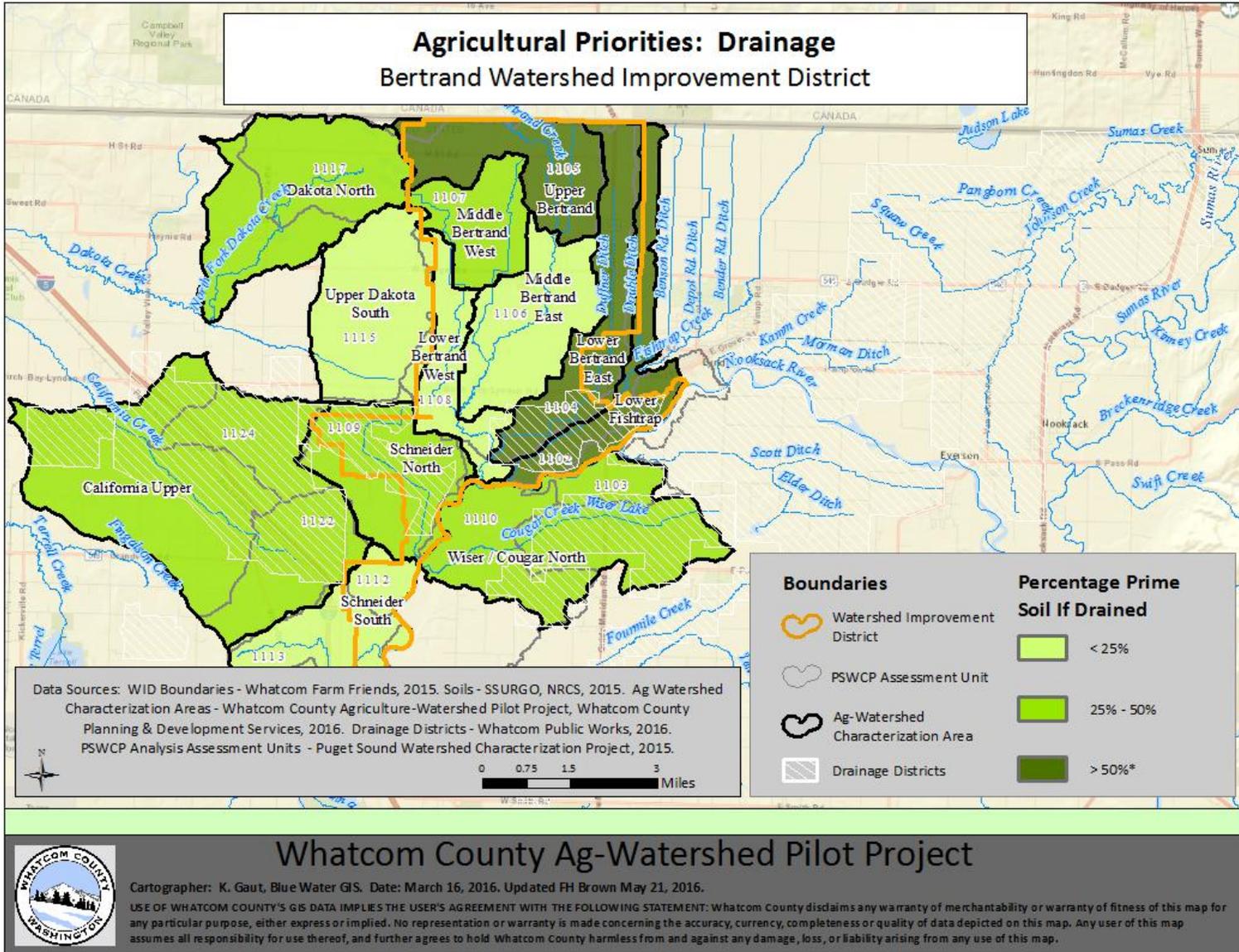


Figure 7. Bertrand WID agricultural priorities: Drainage of agricultural land. Data from reference maps of prime soils and special districts

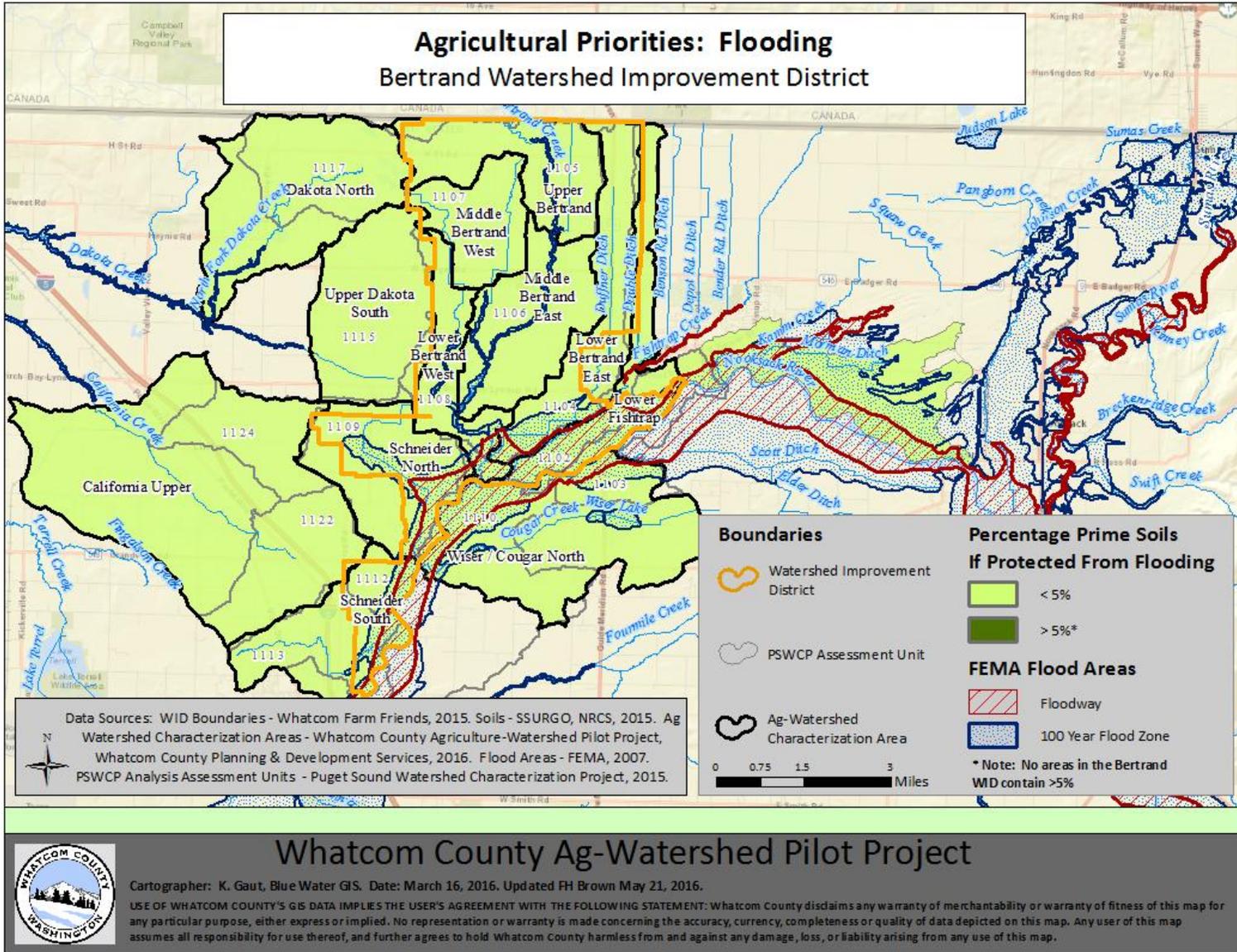


Figure 8. Bertrand WID agricultural priorities: Protection from flooding. Data from reference maps on prime soils and special districts.

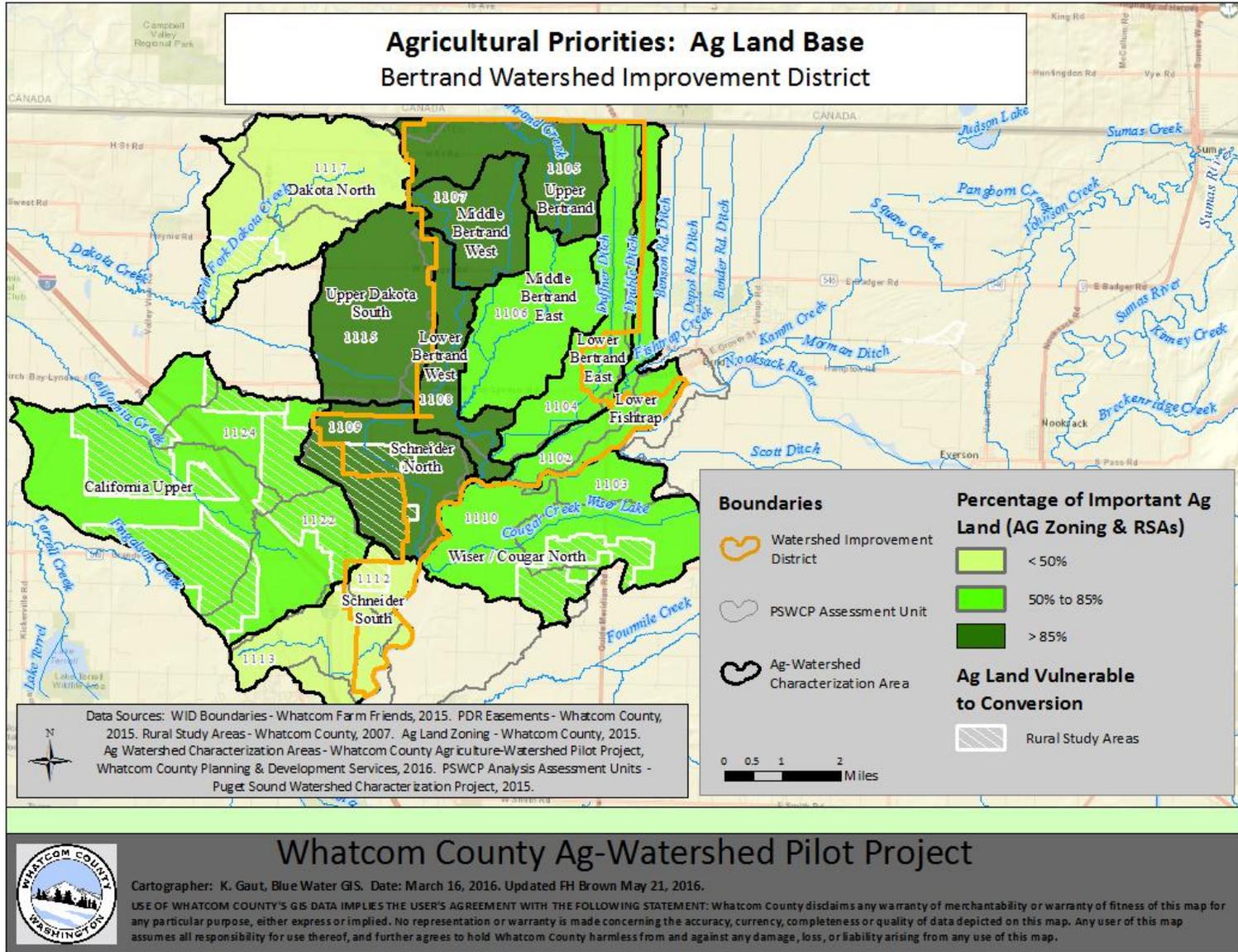


Figure 9. Bertrand WID agricultural priorities: Protection of the agricultural land base. Data from reference map of agricultural priority areas

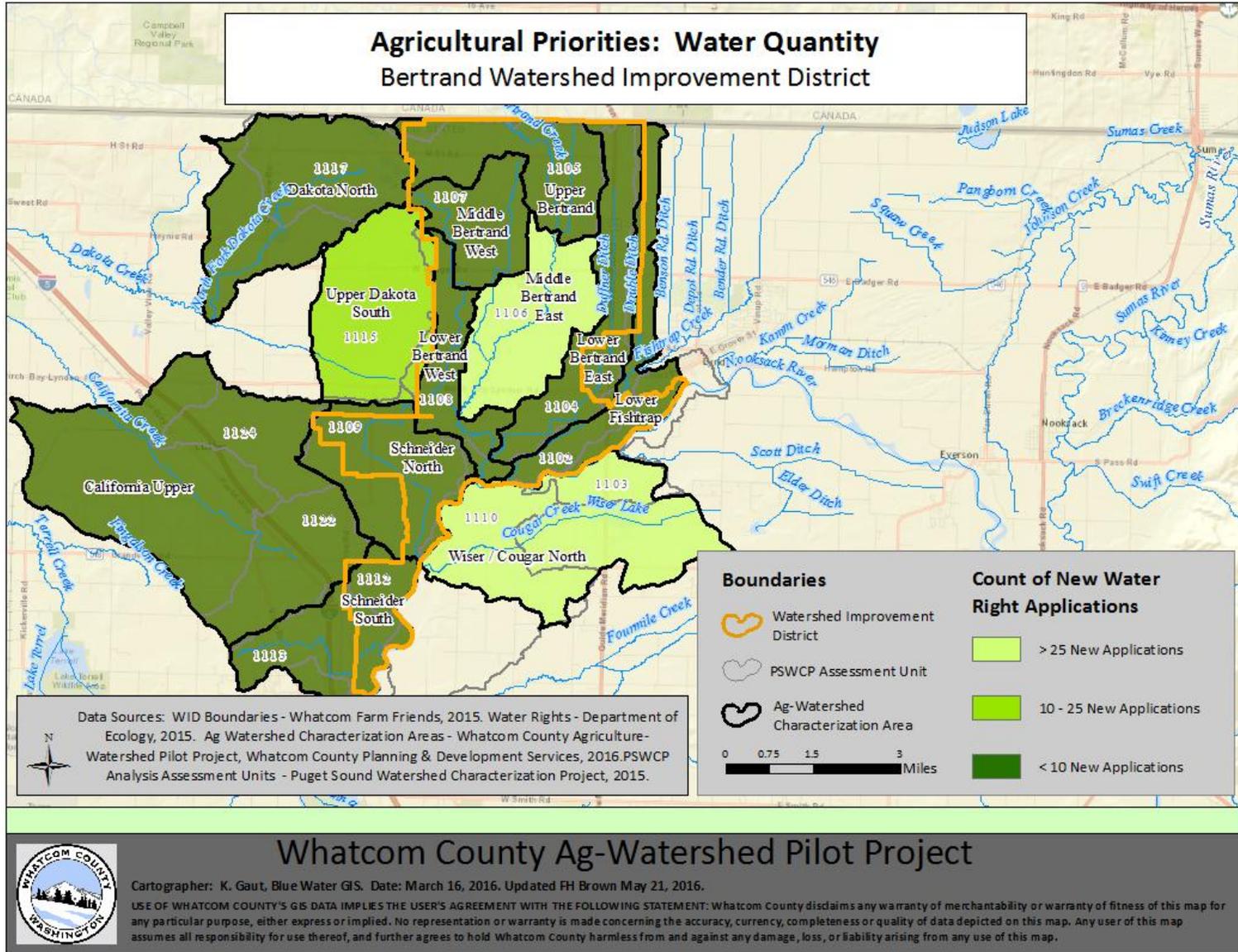


Figure 10. Bertrand WID agricultural priorities: Water for agricultural activities. Data from reference map on water right points of diversion



#### 4.4 Agricultural priorities: Specific actions map

Table 4. Key for actions on agricultural priorities specific actions map

Action # on map	AU #	Priority	Notes
1	1102	Drainage	Plugged culvert
2	1107	Fisheries	Fish barriers and fish habitat functions could be improved, as fishway practices have changed and WCD could help landowners improve.
3	1109	Fisheries	Good opportunities for riparian work. Address barriers on ponds, culverts and ladders.
4	1102/ 1110	Flooding	Flood flows, Duffner Ditch backs up. Have had water on fields in this area during August which is harmful for agriculture. Duffner Ditch needs a new self-regulating floodgate.
5	1109	Flooding	Schneider ditch has floodflow areas, creates flooding on agricultural fields May-Oct which is a problem for farmers.
6	1104	Flooding	Problems with intermittent flooding.
7	1110	Flooding	Problems with flooding.
8	1105	Other	Riparian area management changes in practices to address berry crop pests (fruit flies breed in native veg buffers). Blackberry plants are hosts for pests.
9	1112	Water Quantity	Irrigation water needed.
10	1105	Water Quantity	Low flows out of Canada. During summer they hold back flow and there is not enough for downstream needs.
11	1108	Drainage	Drainage ditch contains debris from trees, needs better maintenance for drainage flow.
12	1112	Drainage	Major drainage problems.
13	1102	Flooding	More floodgates needed on south bank of lower Fishtrap Creek.

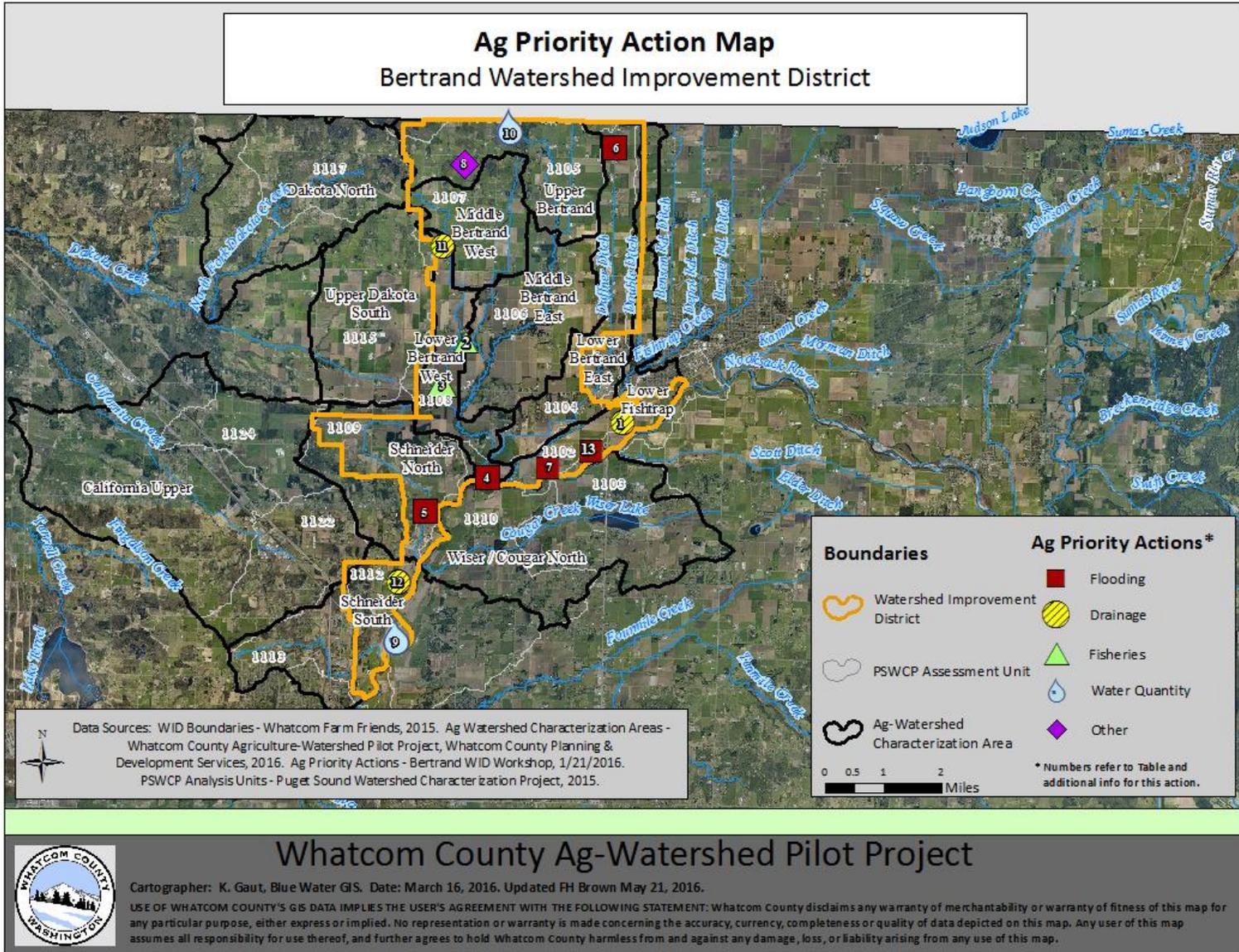


Figure 11. Bertrand WID map of specific actions for agricultural priorities. Information on this map is from the work session in 2016.

## 5 Watershed characterization and mapping for the Bertrand Watershed Improvement District

### 5.1 Methodology

The following description of the watershed characterization methodology has been adapted from that provided in the Appendix to the pilot Agriculture-Watershed Characterization and Mapping Report.<sup>38</sup>

#### 5.1.1 General approach

The watershed characterization assessment uses methods developed by the Puget Sound Watershed Characterization Project.<sup>39</sup> The results of the watershed characterization assessment are intended to assist the WIDs in identifying high priority opportunities for watershed enhancement projects on agricultural land in the lowland areas of Whatcom County, with a focus in areas where watershed and agricultural priorities could be mutually reinforcing.

The *Puget Sound Watershed Characterization (PSWC)* is a set of water and habitat assessments that compare areas within a watershed for relative restoration and protection value. It is a coarse-scale decision-support tool that provides information for regional, county, and watershed-based planning. The information it provides allows local and regional governments, as well as NGOs, to base their land use decisions on a systematic analytic framework. It

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<sup>38</sup> Hume C & Stanley S (2013), Summary of water flow assessment results for Bertrand, Fishtrap and Kamm watersheds. Appendix A in Gill P (2013), Agriculture-Watershed Characterization and Mapping Report for the North Lynden watersheds. Prepared for the Whatcom County Agriculture-Watershed Pilot Project by the Washington Department of Ecology Shorelands and Environmental Assistance Program. <http://www.co.whatcom.wa.us/2260/Agricultural-Watershed-Pilot-Project>

<sup>39</sup> See [http://www.ecy.wa.gov/puget\\_sound/characterization/index.html](http://www.ecy.wa.gov/puget_sound/characterization/index.html)

prioritizes specific geographic areas for protection, restoration, and conservation of our region's natural resources, and identifies where best to focus new development. Application of this method should result in future land-use patterns that protect the health of terrestrial and aquatic resources while directing limited financial resources to the highest priority areas for restoration and protection.

The objective of the PSWC assessment is to "characterize" the watershed in a way that helps to identify priority enhancement opportunities. The relative comparison of assessment units (AUs) for water flow processes across the lowland watersheds allows for a coarse-level snapshot of which areas are relatively important or degraded for water flow. From this snapshot we suggest possible enhancement actions that could contribute to improving or protecting water flow processes at the AU scale. Actual site location of those actions within an assessment unit would require different analyses not described here.

The assessment results in this document address the following primary questions for the Whatcom County lowland watersheds:

- (1) *Where on the landscape* should management efforts be focused first to benefit water flow processes in the watersheds that are part of the Watershed Improvement District?
- (2) *What types of activities and actions* are most appropriate to that place based on the assessment results?

The assessment results therefore address both the "where" and the "what" to focus on, in terms of water flow processes. This integrated approach offers a systematic framework for identifying more important areas within the lowland watersheds and those which are more degraded for water flow processes and water quality, with the intent of identifying areas that offer the most potential for enhancement.

### 5.1.2 Limitations

Care should be taken to use the Puget Sound Watershed Characterization as intended. It is a coarse-scale assessment and is not intended for site-specific application or decision-making at the site scale. Finer scale data, local information and technical expertise is needed for those decisions. In addition:

- The Puget Sound Watershed Characterization is for planning purposes only. This does not affect or alter existing land use/environmental regulations although it may be used to help inform future land use and regulatory decisions.
- For the water flow assessment, the rankings for any single AU are relative only to other AUs in the area of analysis. This means it is only appropriate to compare the WID results with results in other AUs in the lowland area of WRIA 1.
- Results at the AU scale represent land-use planning-level information. At the project- or site scale, each AU will have a combination of on-the-ground challenges and opportunities. Just because an AU is rated as a low priority for restoration does not mean there are no suitable restoration sites or opportunities in that AU. Similarly, not every site in an AU that is a high priority for restoration will be suitable for restoration.
- The assessments are landscape-scale and consequently do not address site-specific issues. These are best addressed through finer-scale studies, which will remain essential to the success of local conservation efforts. When developing site-level plans, the WID should evaluate the need for finer-scale information and collect it where needed.
- The watershed characterization assessment is not intended to address compliance with state or federal water quality law, nor describe the actions necessary to achieve compliance with those laws. It is a violation of state law when activities are shown to cause or have the substantial potential to cause nonpoint source pollution. If the reader has questions about

the water quality laws, they can contact Whatcom County Public Works or the WA Department of Ecology for additional information.

### 5.1.3 Fundamental concepts of watershed characterization

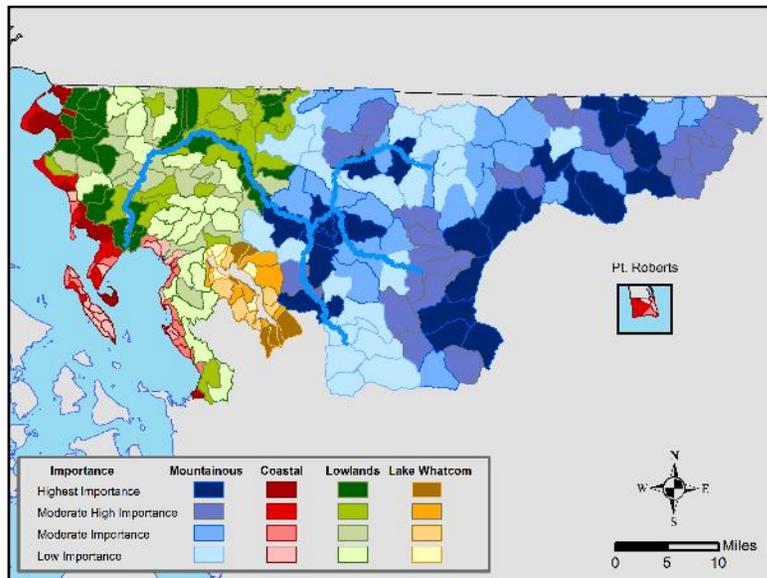
Watershed processes are defined as the dynamic physical and chemical interactions that form and maintain the landscape and ecosystems on a geographic scale of watershed to basins. This includes the movement of water, sediment, nutrients, pathogens, chemicals and wood. Watershed processes are controlled and influenced by natural attributes and human actions. Natural controls on watershed processes include physical attributes of the ecosystem such as geomorphology, geology, and soils. Many human actions influence watershed processes. For example, timber harvest may reduce the amount of wood entering streams. Shoreline armoring can reduce sediment input from bluffs and alter the erosion, movement, and deposition of sediments along beaches. Urban development can increase the amount and amplitude of stormwater runoff. Watershed characterization attempts to model these watershed processes such that areas of the landscape can be identified which are relatively more important (presence of natural controls) or degraded (due to human impacts).

### 5.1.4 Understanding the water flow assessment results

The water flow assessment uses two models to compare the *importance* and *degradation* of water flow processes in a watershed. Together, they identify areas that are relatively more suitable for protection or restoration of water flow processes. Each model provides a ranking from low to high for how important and how degraded each assessment unit is *relative* to the other units in the watershed.

### Water flow importance

The *importance* model evaluates the watershed in its “unaltered” state. This model combines the delivery, surface storage, recharge, and discharge components to compare the relative *importance* of assessment units in maintaining overall water flow processes in a non-degraded setting. When precipitation is “delivered” as either rain or snow, there are physical features that control the surface and subsurface movement of that precipitation within an assessment unit. These physical features include land cover, storage areas such as wetlands and floodplains, areas of higher infiltration and recharge, and areas that discharge groundwater. These areas are considered “important” to the overall water flow processes.



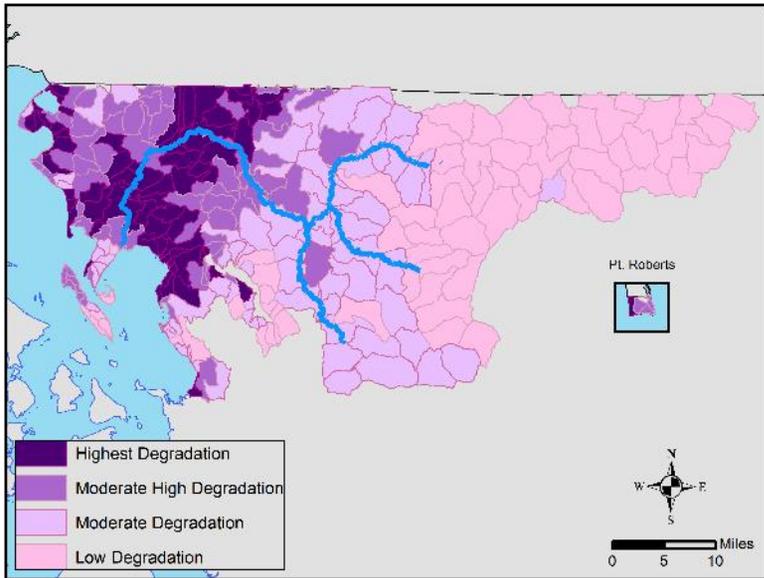
Map: Overall importance to water flow processes: Results of Puget Sound Watershed Characterization assessment for WRIA 1. Darkest colored assessment units are considered highest *importance* relative to other assessment units in the same landscape group of WRIA 1.

In the figure to the left, each landscape group is displayed in a different color gradient (i.e. shades of blue, green, red or tan), which allows for direct comparison within the extent of that landscape group only. Dark green assessment units would be considered *highly important* for overall water flow processes *only* within the lowland area of WRIA 1, and are not comparable to AUs outside of that extent. However, this does allow one to determine which AUs throughout the lowland areas of WRIA 1 are *relatively more important* than others in that same extent.

### Water flow degradation

In the water flow *degradation* model the watershed is evaluated in its “altered” state to consider the impact of human actions on water flow processes. The *degradation* model calculates the degree of alteration to those controls that regulate the delivery, movement and loss of water, such as forest clearing and impervious surfaces. This model combines the delivery, surface storage, recharge, and discharge components to compare the relative *degradation* to overall water flow processes in assessment units. Degradation to these processes generally accelerates the movement of surface flows downstream. This accelerated delivery increases downstream flooding and erosion and subsequently degrades aquatic habitat over time.

The figure below displays the results of the *degradation* to water flow processes for all of WRIA 1. Since degradation is not controlled by landscape, we compare assessment units within the entire extent of the WRIA. A dark pink unit along the coast is comparable in level of degradation to a unit in the lowland area.



Map: Overall degradation of water flow processes: Results of Puget Sound Watershed Characterization assessment for WRIA1. Dark pink assessment units are considered to have the highest *degradation* relative to other assessment units in WRIA1.

### Management matrix for water flow

Combining the results of the *importance* and *degradation* models yields a simple categorical matrix that planners can use, along with other science-based information, to inform land management strategies and actions. At its simplest, this management matrix conveys which areas are relatively important and/or degraded, and what actions might be most appropriate there:

- Highly important – low degradation = protect
- Highly important – high degradation = restore
- Low importance – low degradation = conserve
- Low importance – high degradation = develop

The Puget Sound Watershed Characterization project generally prioritizes restoration or enhancement actions in watersheds which are both highly important and are relatively more degraded for watershed processes (yellow boxes in the Management Matrix Figure below; yellow assessment units in the map below). This does not mean that there are not important areas or necessary restoration actions in assessment units that are not highly important and highly degraded. Rather, given limited funding these might be the first places to focus on in order to increase the likelihood of improving watershed processes.

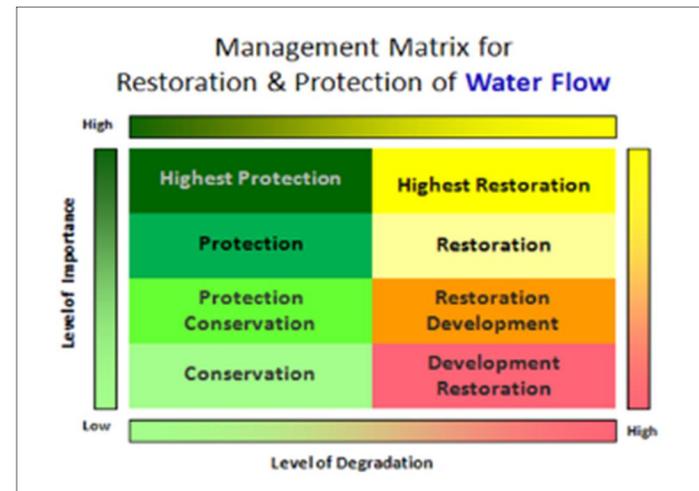
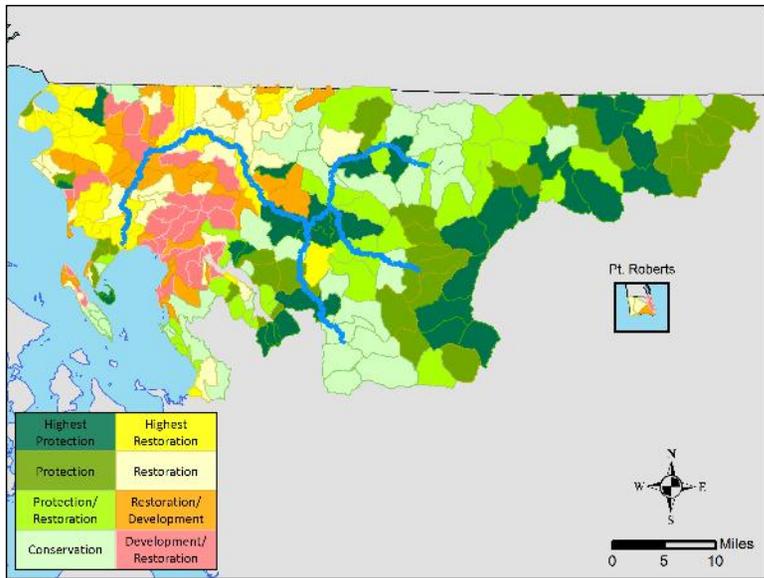


Figure. Management Matrix for Water Flow, indicating relative priorities for restoration and protection of processes. By accounting for both the relative level of *importance* and the relative level of *degradation* of an Assessment Unit one can begin to prioritize which areas of a watershed to apply management strategies which protect water flow processes, and which areas to prioritize restoration of water flow processes.



Map. Overall priorities for restoration and protection of water flow processes in WRIA 1: Results of Puget Sound Watershed Characterization assessment.

### 5.1.5 Using the results of the water flow assessment

For water flow process enhancement or restoration, actions should be directed towards reducing the degradation to controls that regulate the delivery and movement of water through the watershed. These controls include forest cover, areas of surface storage, areas of permeable deposits, areas of slope wetlands and areas of floodplains with permeable deposits.

The terms “restoration” and “protection” as used in this document do not mean a return to historic land cover conditions or retaining 100% forested land cover. Restoration and protection actions should be done in a manner that recognizes and works within the constraints of the existing land use activities. For example, restoration in agricultural areas could mean consideration of

measures that enhance a critical portion of water flow processes such as surface storage. This could involve the retention of water on fields for a longer period to avoid harmful peak flows within streams during the winter months. Restoration and protection measures are, therefore, always proposed here in the context of both the landscape setting and the current land use activities.

There are actions which can offer mutual benefits to both water flow and water quality. For example, there are some areas where wetland restoration or enhancement to surface storage processes could provide some improvements for both. The potential enhancement actions suggested in Table 5 may have additional benefits to other watershed processes and functions particularly in the area of riparian habitat and structure which are critical to salmonid habitats throughout the Whatcom County lowland watersheds.

## 5.2 Watershed characterization tables

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Table 5. Watershed characterization tables for the Bertrand WID

NOTE: Possible actions include: Specific actions identified by WID Actions Map # location and Assessment Unit (AUs), and General actions which do not have locations specified. Some of these actions do not appear on the WID Priority Actions Map due to: (i) action is general in description no location is noted; (ii) action is specific in description but no location noted; (iii) action is general in description, located outside the WID area; (iv) action is specific in description, located outside the WID.

5A. Watershed Enhancement Priorities: Upper Bertrand				
	Wildlife habitat	Salmonid habitat	Water quality	Summary & potential for enhancement
Upper Bertrand AU1105  (October 2012 results + 2016 updates)	-Pacific lamprey <sup>40</sup> -Habitat for cavity nesting duck in northwest portion of this area <sup>41</sup> -Wetland habitat -Rare Plant: bulb-bearing water-hemlock <sup>42</sup>  (See Watershed reference map: Priority Habitats & Species)	-Chinook, chum, coho, cutthroat, sockeye & steelhead <sup>43</sup>  -Salmonid spawning & rearing in mainstem of Bertrand <sup>44</sup>  -No anadromous fish barriers are within shoreline jurisdiction on main Bertrand channel (see Reference map: Fish presence and fish barriers), however there are fish passage barriers on tributaries. <sup>45</sup>	Sections of Bertrand Creek in Upper Bertrand are listed as category 5 <sup>46</sup> for DO, and category 4a <sup>47</sup> for bacteria. <sup>48</sup>	<u>Results of PSWC water flow assessment:</u> An area of moderately high importance for surface storage, recharge, and delivery processes and moderate importance for discharge. Overall water flow processes are moderately degraded, particularly surface storage and discharge. Low flows are a problem for spawning salmonids. <u>Summary:</u> This portion of the Upper Bertrand watershed has moderate relative importance and a moderate-high level of degradation, though it still represents one of the better functioning parts of the project area for water flow processes. Cat 5 assessment for low dissolved oxygen (DO) and cat 4a for bacteria. Chinook and chum are present in east fork. Bertrand has Chinook and chum but also coho, steelhead, sea-run cutthroat, and resident trout. <u>Potential for Enhancement:</u> Moderate potential for enhancement of water flow processes. Actions should concentrate on enhancing storage areas (wetlands or hydric soils), which has the additional potential to assist in denitrifying excess nutrient inputs. Improvements to riparian habitat (increased buffers) can help to reduce sediment export, reduce water temperature and improve habitat for important aquatic species that use the area. Improved livestock management can help to minimize sedimentation.
Upper Bertrand AU1105  (January 2016 work session notes)	Forested areas along Canadian border also provide important nesting and roosting area for raptors.	There are a number of fish barriers on higher-order streams in the watershed. Also work is needed on older ponds not meeting current standards. Fish Barriers and fish habitat functions in Barnhart Road area west of McLellan Creek could be improved as fishway practices have changed. WCD could help landowners.	Need to denitrify water throughout the system.  Need to improve instream water temperature (elevated in some places in summer).	-[BT10] Water Quantity: Low flows from Canada during summer – insufficient for instream needs on the US side of the border. -Irrigators throughout the system may consider switching from surface water source to groundwater source, and removing additional fish passage barriers (these can also cause flooding and affect field drainage).(ii) -General to Bertrand WID: The WID could initiate or facilitate actions to remove fish barriers on private land and improve fish passage generally. County staff noted that the structural requirements are not as strict for fish barriers on private land and private roads that are not carrying emergency response vehicles. WCD staff: can possibly access funding for removal of fish barriers.(ii)

<sup>40</sup> WDFW (2014), *Priority Habitats and Species List 2008 (updated 2014)*. <http://wdfw.wa.gov/publications/00165/wdfw00165.pdf>

<sup>41</sup> Watts S. (1994), *Fish and Wildlife Habitat Atlas of Whatcom County*. Whatcom County Planning & Development Services.

<sup>42</sup> WA Department of Natural Resources (2015), *Washington Natural Heritage Program*. <http://www1.dnr.wa.gov/nhp/refdesk/gis/index.html>

<sup>43</sup> Fish Habitat Technical Team (2004), WRIA 1 Watershed Management Project. Data provided by Sarah Watts, Whatcom County Planning & Development Services.

<sup>44</sup> Watts S. (1994), *Fish and Wildlife Habitat Atlas of Whatcom County*. Whatcom County Planning & Development Services.

<sup>45</sup> Whatcom County Public Works (2006), *Whatcom County Fish Passage Barrier Inventory Final Report, January 2006*. [http://salmon.wria1.org/webfm\\_send/73](http://salmon.wria1.org/webfm_send/73)

<sup>46</sup> Category 5 - Polluted waters that require a TMDL (total maximum daily load) or other WQI (water quality Improvement) project: the traditional list of impaired water bodies traditionally known as the 303(d) list. Starting with the 2008 Water Quality Assessment, Washington's 303(d) list of polluted waters were placed under Category 5 in the approved assessment. Placement in this category means that Ecology has data showing that the water quality standards have been violated for one or more pollutants, and there is no TMDL or pollution control plan. WA Department of Ecology, 2015. *Water Quality Assessment Categories*. <http://www.ecy.wa.gov/programs/wq/303d/WQAssessmentCats.html> (Accessed March 28, 2016)

<sup>47</sup> Category 4a - has a TMDL: water bodies that have an approved TMDL in place and are actively being implemented. WA Department of Ecology, 2015. *Water Quality Assessment Categories*. <http://www.ecy.wa.gov/programs/wq/303d/WQAssessmentCats.html> (Accessed March 28, 2016)

<sup>48</sup> Ecology (2012), Water Quality Assessment for Washington. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

5B. Watershed Enhancement Priorities: Middle Bertrand East

	Wildlife habitat	Salmonid habitat	Water quality	Summary & potential for enhancement
<p>Middle Bertrand East AU1106</p> <p>(October 2012 results + 2016 updates)</p>	<p>-Wetland Habitat (see Watershed Reference map: Priority Species and Habitat)</p> <p>-Good edge habitat along riparian areas and open fields.</p>	<p>-Chinook, chum, coho, cutthroat, sockeye &amp; steelhead<sup>49</sup></p> <p>-Spawning &amp; rearing in mainstem of Bertrand<sup>50</sup></p>	<p>A small section of Bertrand Creek in Middle Bertrand East is listed in category 5 for DO, and category 4a for bacteria.<sup>51</sup></p>	<p><u>Results of PSWC water flow assessment:</u> An area of high importance for recharge and moderate importance for delivery. Recharge processes are at moderate-high degradation level; water delivery processes are highly degraded.</p> <p><u>Summary:</u> General water flow process degradation in this portion of the Bertrand is moderate-high, but the area has low relative importance for overall water flow processes. Moderate impairments to water quality and a lack of source control may correspond to downstream water quality concerns.</p> <p><u>Potential for Enhancement:</u> Enhancement actions should address groundwater recharge and water delivery. Improvements in riparian habitat (buffers) and connectivity can contribute to important rearing areas for Chinook. Improve degraded sediment processes and minimize impacts to aquatic habitats that are important to Chinook.</p>
<p>Middle Bertrand East AU1106</p> <p>(January 2016 work session notes)</p>	<p>There are a still a lot of blackberry areas. Riparian buffers planted with appropriate native species could improve stock, diversify plant stocks for bees and native pollinators, providing alternate cycles of flowering (snowberry, twinberry).</p>	<p>Discussion of old fish “ways” (fish ladders) on various sites - these could be removed as in some cases they actually form barriers.</p> <p>Address emergency service access issues, and fish barriers on county roads.</p>	<p>Potential for conventional berry field spray drift (fumigant, pesticide). Need buffers to protect neighboring sites from this drift.</p>	<p>-[BT8] Opportunity to replace Himalayan blackberry (host for spotted wing Drosophila) with native species. Would benefit bees and raspberry growers.</p> <p>--Spotted Wing Drosophila is a new pest on blueberries. WCD has come up with a new list of riparian plantings that eliminates alternate hosts for SWD, and should also help maintain diversity of habitat for native pollinators.(ii)</p> <p>-(Comment) Riparian plantings can enhance pollinators but spray drift from blueberries can then decimate the wild insects.</p> <p>-Improving/restoring riparian vegetation should help to keep water temperatures down in summer (the downstream reach is listed as cat 2 or waters of concern for temperature).(ii)</p> <p>-Many farmers would prefer to have groundwater rights. Groundwater is cleaner and better for berries – need to keep bacteria off of berries.(ii)</p> <p>-General to Bertrand: The WID could initiate or facilitate actions to remove fish barriers on private land and improve fish passage generally.(ii)</p>

<sup>49</sup> Fish Habitat Technical Team (2004), WRIA 1 Watershed Management Project. Data provided by Sarah Watts, Whatcom County Planning & Development Services.

<sup>50</sup> Watts S. (1994), *Fish and Wildlife Habitat Atlas of Whatcom County*. Whatcom County Planning & Development Services.

<sup>51</sup> Ecology (2012), Water Quality Assessment for Washington. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

5C. Watershed Enhancement Priorities: Middle Bertrand West

	Wildlife habitat	Salmonid habitat	Water quality	Summary & potential for enhancement
<p>Middle Bertrand West AU1107</p> <p>(October 2012 results + 2016 updates +2016 edits)</p>	<p>-Wetland Habitat (see Watershed Reference map: Priority Species and Habitat)</p> <p>-Good edge habitat along riparian areas and open fields.</p>	<p>-Important for rearing Chinook in West branch of Bertrand and McClellan Creek. Spawning &amp; rearing in mainstem of Bertrand.<sup>52</sup></p> <p>-Chinook, bull trout, chum, steelhead, pink Bertrand Mainstem: sockeye<sup>53</sup></p> <p>-Chinook, coho, cutthroat &amp; steelhead<sup>54</sup></p>		<p><u>Results of PSWC water flow assessment:</u> An area of moderately high importance for all water flow processes. Overall water flow processes are highly degraded, especially surface storage and discharge processes.</p> <p><u>Summary:</u> Surface storage and discharge processes are highly degraded. No water quality impairments in this area but the downstream reach (AU1108) has impairments listed for dissolved oxygen and bacteria, and concern noted for water temperature.</p> <p><u>Potential for enhancement:</u> Many areas of the upper west branch have storage (historic wetland/hydric soils) areas that could be enhanced which would benefit degraded water flow processes. Enhancement should address groundwater recharge and discharge through actions to reduce impervious cover and decrease the rate of drainage of subsurface water. High enhancement potential for recharge processes given highly permeable soils. Improvements in riparian habitat (buffers) and connectivity can contribute to important rearing areas for Chinook. Improve degraded sediment processes and minimize impacts to aquatic habitats that are important to Chinook. McClellan Creek lacks pool habitats.</p>
<p>Middle Bertrand West AU1107</p> <p>(January 2016 work session notes)</p>	<p>There are a still a lot of blackberry areas.</p> <p>Riparian buffer areas could be added in this section of perennial berry crops.</p>	<p>In the west fork and McLellan Creek there are ponds and dams with fish ladders and fishways. These are old and some are listed as fish barriers.<sup>55</sup></p> <p>Address emergency service access issues, and fish barriers on county roads.</p>	<p>Potential for conventional berry field spray drift (fumigant, pesticide). Need buffers to protect neighboring sites from this drift.</p>	<p>Specific: [BT2] AU1107 There are places in this area where fish habitat could be enhanced further (See Watershed reference map: Fish presence &amp; fish barriers). - (BT3) AU1107 Good opportunities for riparian work. Address barrier on pond, culverts and ladders). General: -Riparian habitat generally appears to have potential for enhancement. There are some existing buffers in McLellan Creek and the west middle Bertrand. This is an area with intensive berry production so space for riparian vegetation is limited and agricultural drainage is needed, but there are still some opportunities.(ii) -Spotted Wing Drosophila is a new pest on blueberries. WCD has come up with a new list of riparian plantings that eliminates alternate hosts for SWD, and should also help maintain diversity of habitat for native pollinators.(ii) -Opportunity to replace Himalayan blackberry (host for spotted wing Drosophila) with native species. Would benefit bees and raspberry growers.(ii) -Many farmers would prefer to have groundwater rights. Groundwater is cleaner and better for berries – need to keep bacteria off berries.(ii) --General to Bertrand: The WID could initiate or facilitate actions to remove fish barriers on private land and improve fish passage generally.(ii)</p>

<sup>52</sup> Watts S. (1994), *Fish and Wildlife Habitat Atlas of Whatcom County*. Whatcom County Planning & Development Services.

<sup>53</sup> Fish Habitat Technical Team (2003), *Fish Presence- WRIA 1 Salmonid Distribution*. Retrieved 2012, from WRIA 1 Salmon Recovery: <http://whatcomsalmon.whatcomcounty.org/maps-fishpresence-chum.html>

<sup>54</sup> Fish Habitat Technical Team (2004), WRIA 1 Watershed Management Project. Data provided by Sarah Watts, Whatcom County Planning & Development Services.

<sup>55</sup> Whatcom County Public Works (2006), *Whatcom County Fish Passage Barrier Inventory Final Report, January 2006*. [http://salmon.wria1.org/webfm\\_send/73](http://salmon.wria1.org/webfm_send/73)

5D. Watershed Enhancement Priorities: Lower Bertrand East

	Wildlife habitat	Salmonid habitat	Water quality	Summary & potential for enhancement
<p>Lower Bertrand East AU1104</p> <p>(October 2012 results + 2016 updates)</p>	<p>Trumpeter swan habitat in the lower reach, and wetland habitat (see Watershed Reference map: Priority species and habitats)</p> <p>Eagle nesting areas near Nooksack River</p>	<p>Chinook, chum, coho, cutthroat, sockeye &amp; steelhead<sup>56</sup></p>	<p>A section of lower Bertrand Creek drainage along Guide Meridian Road is in category 5 for ammonia, and sections of Duffner Ditch in Lower Bertrand East are in category 5 for DO, and category 4a for bacteria.<sup>57</sup></p>	<p><u>Results of PSWC water flow assessment:</u> An area of high importance for surface storage and moderately high importance for recharge, discharge and delivery processes. Overall water flow processes are highly degraded.</p> <p><u>Summary:</u> This area is one of the most important to water flow processes in the Bertrand WID and also one of the most highly degraded. Surface storage is particularly important. There are cat 5 assessments for dissolved oxygen in Duffner Ditch and ammonia-N in this part of lower Bertrand Creek, suggesting a relationship between degraded water flow and water quality processes.</p> <p><u>Potential for enhancement:</u> Actions should focus on retaining surface flow for longer to increase storage, and finding areas where wetland habitat might be restored to provide opportunities for improvement of storage, recharge and delivery processes and to provide potential for additional denitrification. This should have the additional benefit of reducing sediment loads from this area.</p>
<p>Lower Bertrand East AU1104</p> <p>(January 2016 work session notes)</p>		<p>Important area for maintenance and enhancements of river levee deficiencies and for removal of fish barriers.</p>		

<sup>56</sup> Fish Habitat Technical Team (2004), WRIA 1 Watershed Management Project. Data provided by Sarah Watts, Whatcom County Planning & Development Services.

<sup>57</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

5E. Watershed Enhancement Priorities: Lower Bertrand West

	Wildlife habitat	Salmonid habitat	Water quality	Summary & potential for enhancement
<p>Lower Bertrand West AU1108</p> <p>(October 2012 results + 2016 updates)</p>	<p>Critical Habitat: Wetland (1)</p>	<p>Chinook, chum, coho, cutthroat, sockeye &amp; steelhead<sup>58</sup></p>	<p>A section of Bertrand Creek in Lower Bertrand West is in category 5 for DO, and category 4a for bacteria.<sup>59</sup></p>	<p><u>Results of PSWC water flow assessment:</u> An area of moderately high importance for discharge and recharge processes and moderate importance for surface storage and delivery processes. Storage, discharge and delivery processes are highly degraded.</p> <p><u>Summary:</u> This area is of moderate importance for water flow processes overall. Degradation of overall water flow processes is moderate-high. There is a cat 5 listing for dissolved oxygen and cat 4a for bacteria in Bertrand Creek in this area.</p> <p><u>Potential for enhancement:</u> Actions should focus on retaining surface flow for longer to increase storage, and finding areas where wetland habitat might be restored to provide opportunities for improvement of storage, recharge and delivery processes. This should have the additional benefit of reducing sediment loads from this area.</p>
<p>Lower Bertrand West AU1108</p> <p>(January 2016 work session notes)</p>	<p><i>No notes were added at the January 2016 work session.</i></p>			

<sup>58</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>59</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

5F. Watershed Enhancement Priorities: Lower Fishtrap				
	Wildlife habitat	Salmonid habitat	Water quality	Summary & potential for enhancement
<p>Lower Fishtrap</p> <p>AU1102 + portion of AU1103</p> <p>(October 2012 results + 2016 updates)</p>	<p>Wildlife Atlas identifies swan and waterfowl habitat in floodplain, and concentration area for shorebirds and eagle nesting areas at confluence with the Nooksack River.<sup>60</sup></p> <p>Critical Habitat: Shorebird concentration, trumpeter swan and wetland (See Watershed reference map: Priority species &amp; habitats)</p> <p>Low relative conservation value. (See Watershed reference map: Relative conservation value<sup>61</sup>)</p>	<p>Fishtrap mainstem contains fall Chinook, chum, coho, steelhead, cutthroat trout, lamprey, stickleback, Salish sucker, and Nooksack Dace.<sup>62, 63</sup></p>	<p>Sections of Fishtrap Creek in this area are in category 5 for temperature and DO, and category 4a for bacteria. Sections of Double Ditch Drain are category 5 for DO, category 4a for bacteria and category 2 for ammonia-N.<sup>64</sup></p> <p>High measured fecal coliform levels 2013-2016 (See Watershed reference map: Routine water quality monitoring results). Fishtrap State of the Watershed report identifies pesticide contamination in the creek, including DDE, Alpha-BHC, Chlorpyrifos, Dieldrin, Gamma-bhc (Lindane), and Parathion.<sup>65</sup> These are also noted as concerns by Dept. of Ecology (2012).<sup>66</sup></p>	<p><u>Results of PSWC water flow assessment:</u> Area is of high importance for overall water flow processes, relative to other areas of lowland WRIA. Due to the presence of extensive hydric soils and low gradient, this area is of high importance for storage; moderate to high for discharge and recharge processes. Overall Water Flow processes are highly degraded as indicated by loss of wetlands, and high relative alteration of all components.</p> <p><u>Summary:</u> This area is highly important to water flow processes in the watershed but is also highly degraded. Draining, filling and dredging of wetland and stream habitat for both agriculture and urban development have impacted storage and discharge processes particularly. Several tributaries are listed for DO, bacteria and water temperature. ESA listed species are present.</p> <p><u>Potential for enhancement:</u> Investigate measures to restore storage (wetlands) and discharge areas. Focus on source control and delivery reduction for water quality impairments. Improve riparian habitat (buffers) to address temperature impairments.</p>
<p>Lower Fishtrap</p> <p>AU1102 + portion of AU1103</p> <p>(January 2016 work session notes)</p>		<p>Duffner Ditch is a fish barrier in this area.</p> <p>This reach is important as a corridor for fish to move upstream to spawning grounds in the Fishtrap watershed, though the area is not an actual spawning ground itself (substrate is too fine). Historically, this part of the watershed was also an important refuge area for juvenile fish moving downstream in times of high water. That function is not really supported by the stream in its current configuration between high, straight levees.</p>		<p>Might be possible to set back and lower the levee along lower Fishtrap between Guide Meridian and the confluence with the Nooksack. This would help to restore flood plain connectivity and function (but see Ag Priorities: only if this has no adverse effects on farm drainage &amp; protection from flooding)</p>

<sup>60</sup> Watts S. (1994), *Fish and Wildlife Habitat Atlas of Whatcom County*. Whatcom County Planning & Development Services.

<sup>61</sup> Whatcom Legacy Project (2007), *Mapping Biodiversity in Whatcom County: Data and Methods*.

<sup>62</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>63</sup> NSEA (2012), *Fishtrap State of the Watershed Report*. Nooksack Salmon Enhancement Association.

<sup>64</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

<sup>65</sup> NSEA (2012), *Fishtrap State of the Watershed Report*. Nooksack Salmon Enhancement Association

<sup>66</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

5G. Watershed Enhancement Priorities: Schneider Ditch (North)

	Wildlife habitat	Salmonid habitat	Water quality	Summary & potential for enhancement
<p>Schneider Ditch (North)</p> <p>AU1109 + portion of AU1110</p> <p>Notes from reference maps and other documents</p>	<p>Critical Habitat: Band tailed Pigeon and Wetland.</p> <p>Shorebird concentration along Nooksack River in this area. (See Watershed reference map: Priority species &amp; habitats).</p>	<p>AU1109: char, coho, cutthroat, &amp; steelhead</p> <p>AU1110: Chinook, chum, coho, cutthroat, sockeye &amp; steelhead</p>	<p>Sections of Keefe Lake Outlet in Schneider North are in category 5 for DO, and category 4a for bacteria.<sup>67</sup></p>	<p><u>Summary of PSWC water flow assessment:</u>                      Degradation of overall water flow processes is moderate-high, with surface storage and delivery processes in particular being highly degraded. However, this area is of relatively low importance for water flow processes overall in the watershed. There are listings for dissolved oxygen in Keefe Lake Outlet.</p> <p><u>Potential for enhancement:</u>                      Protection and restoration of forest cover and riparian vegetation in this area would help to improve delivery processes. Investigate opportunities to increase surface storage and retain surface flows for longer in this area.</p>
<p>Schneider Ditch (North)</p> <p>AU1109 + portion of AU1110</p> <p>Notes from January 2016 work session</p>	<p>Note differences between listings for endangered species and species of concern.</p>	<p>Coho known to use this area. Culvert in this area which became a pond is a good quality habitat.</p>		<p>Tributary flood gate repairs needed.(ii)</p>

<sup>67</sup> Ecology (2012), *Water Quality Assessment for Washington*. [http://www.ecy.wa.gov/programs/wq/links/wq\\_assessments.html](http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html)

4H. Watershed Enhancement Priorities: Schneider Ditch (South)

	Wildlife habitat	Salmonid habitat	Water quality	Summary & potential for enhancement
<p>Schneider Ditch (South)</p> <p>AU1113 (Whiskey Creek) + portion of AU1112</p> <p>Notes from reference maps and other documents</p>	<p>Critical Habitat: Wetland</p>	<p>Steelhead, coho, fall chum, fall Chinook, and bull trout.<sup>68</sup></p>	<p>No water quality listings.</p>	<p><u>Summary of PSWC water flow assessment:</u> An area of moderately high importance for discharge and moderate importance for recharge and surface storage processes. All water flow processes are highly degraded.</p> <p><u>Potential for enhancement:</u> To improve discharge processes, consider decreasing the rate and quantity of drainage of subsurface waters. Investigate opportunities to restore wetland habitat that will help to increase surface storage. Restore some connectivity with Nooksack River through installation of improved floodgates, in order to increase fish passage into this area.</p>
<p>Schneider Ditch (South)</p> <p>AU1113 (Whiskey Creek) + portion of AU1112</p> <p>Notes from January 2016 work session</p>	<p>AU1113: Streams &amp; wetlands in this area dry up in the summer; overflow causes flooding; look into pipe size and upgrade; daylight some stream tributaries.</p> <p>AU1112: unmaintained ditch below Albert's dike.</p>	<p>AU1113: Whiskey Creek is currently blocked at the confluence with the river by an old style top-hinged flood gate restricting all access to this stream by Nooksack River fish.</p> <p>AU1112: On the right bank of the Nooksack R is a location where one of the flood gates had blown out and was replaced last year (2015) with a more fish friendly regulated gate structure. This system is a series of small channels that feed down to a wetland pond area and finally out to the river. The ponded area is a part of a low wetland area that is believed to be a historic river channel and is an important part of the floodplain high water conveyance regime. Fish have been observed at the culvert location and the pond will be valuable high water refuge and rearing areas for coho, steelhead, chum and potentially out migrating chinook stocks.<sup>69</sup></p>		<p>Consider rebuilding flood gates with a side-hinged float-regulated design that will increase fish passage and access into these areas.(ii)</p> <p>This is an area where transfer of irrigation water from surface water sources to groundwater sources would help.(ii)</p>

<sup>68</sup> Ingram J., WDFW (April 2016 pers. comm.) Data on fish presence from WDFW SalmonScape <http://apps.wdfw.wa.gov/salmonscape/>

<sup>69</sup> Ingram J., WDFW (April 2016 pers. comm.) Data on fish presence from WDFW SalmonScape <http://apps.wdfw.wa.gov/salmonscape/>

### 5.3 Watershed priorities: Summary maps

The water flow assessment maps contained in this section were prepared using data from the Puget Sound Watershed Characterization Project, provided by the WA Department of Ecology. See [http://www.ecy.wa.gov/puget\\_sound/characterization/index.html](http://www.ecy.wa.gov/puget_sound/characterization/index.html)

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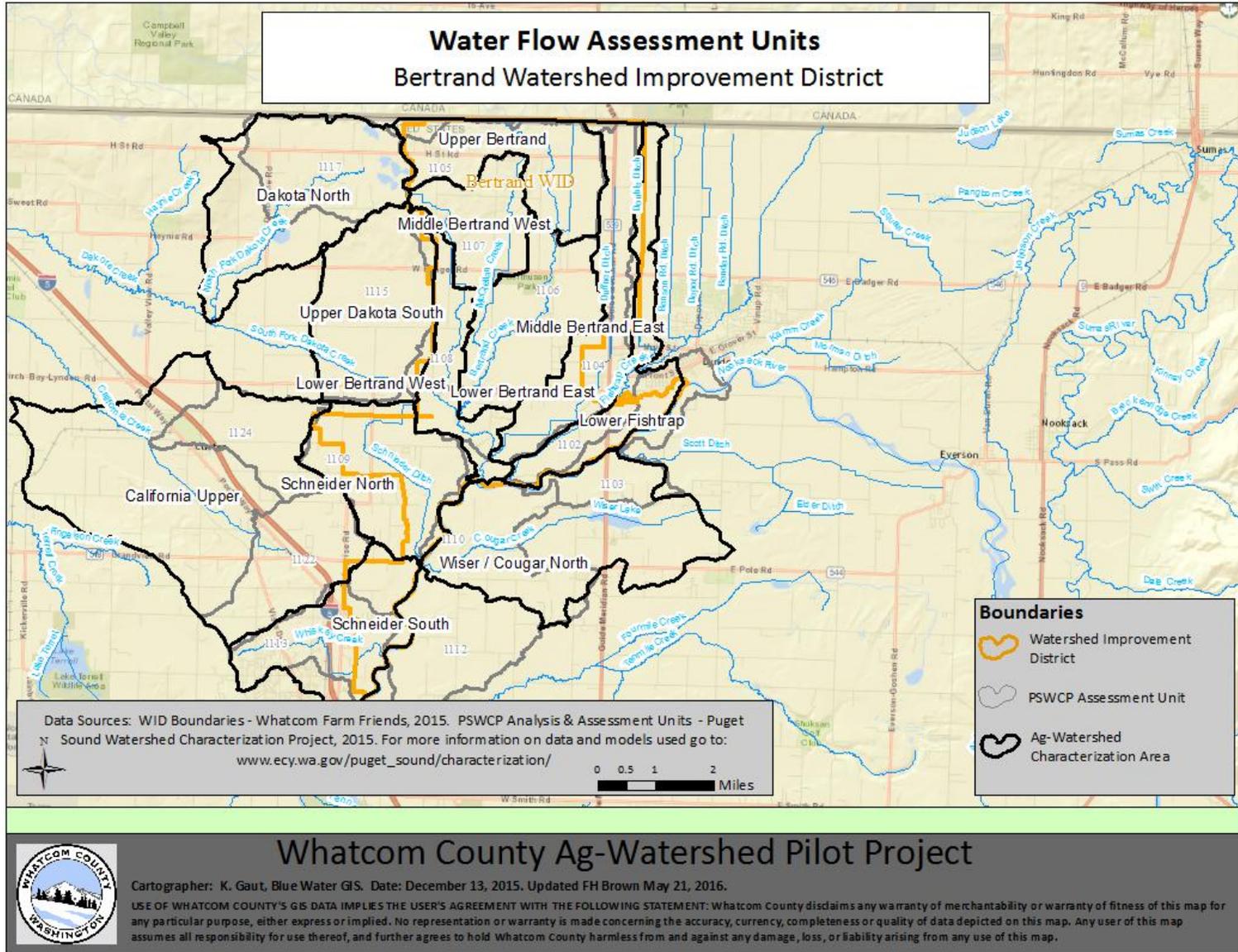


Figure 12. Bertrand WID: Water flow assessment units in relation to the WID area

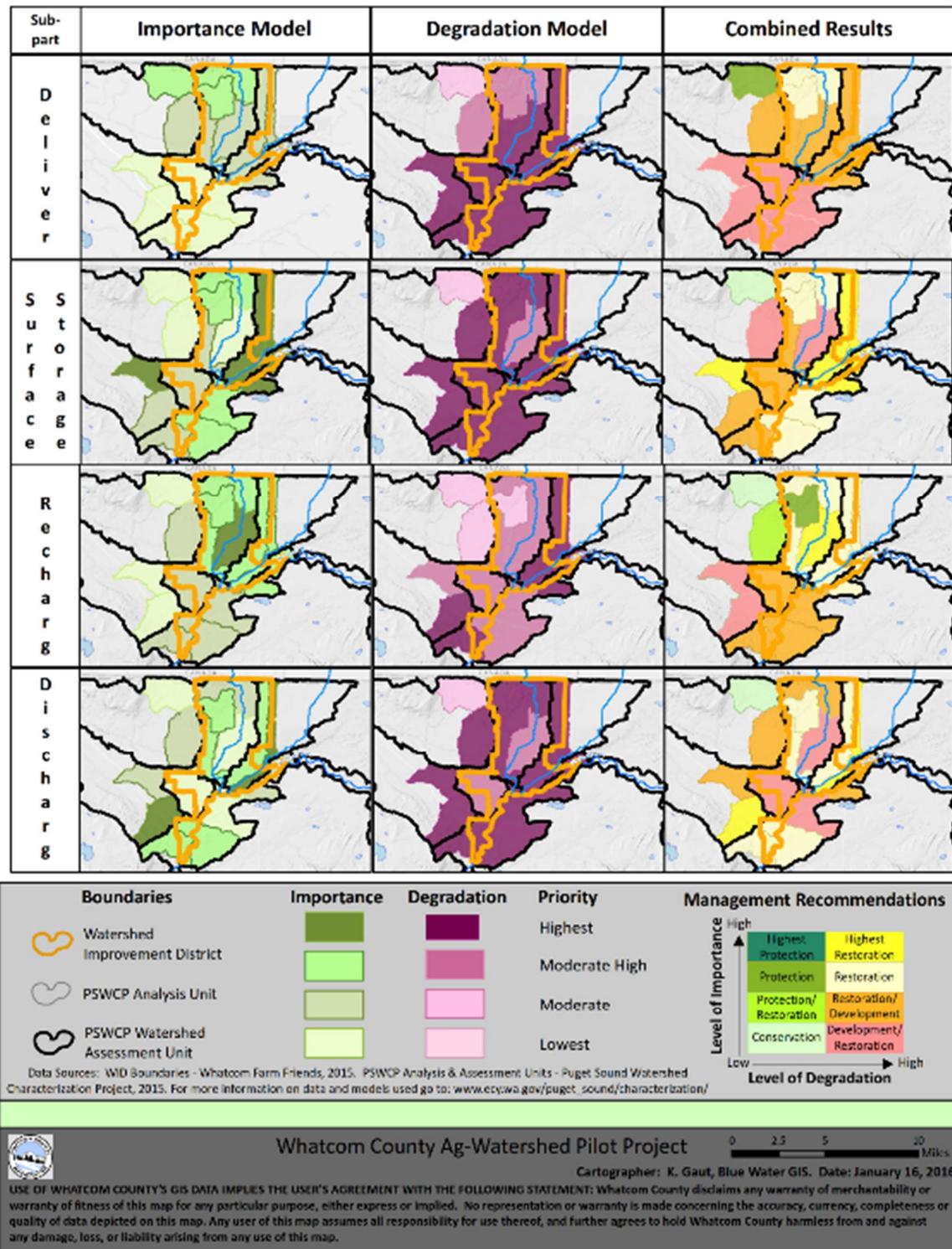


Figure 13. Bertrand WID: Water flow process assessment results

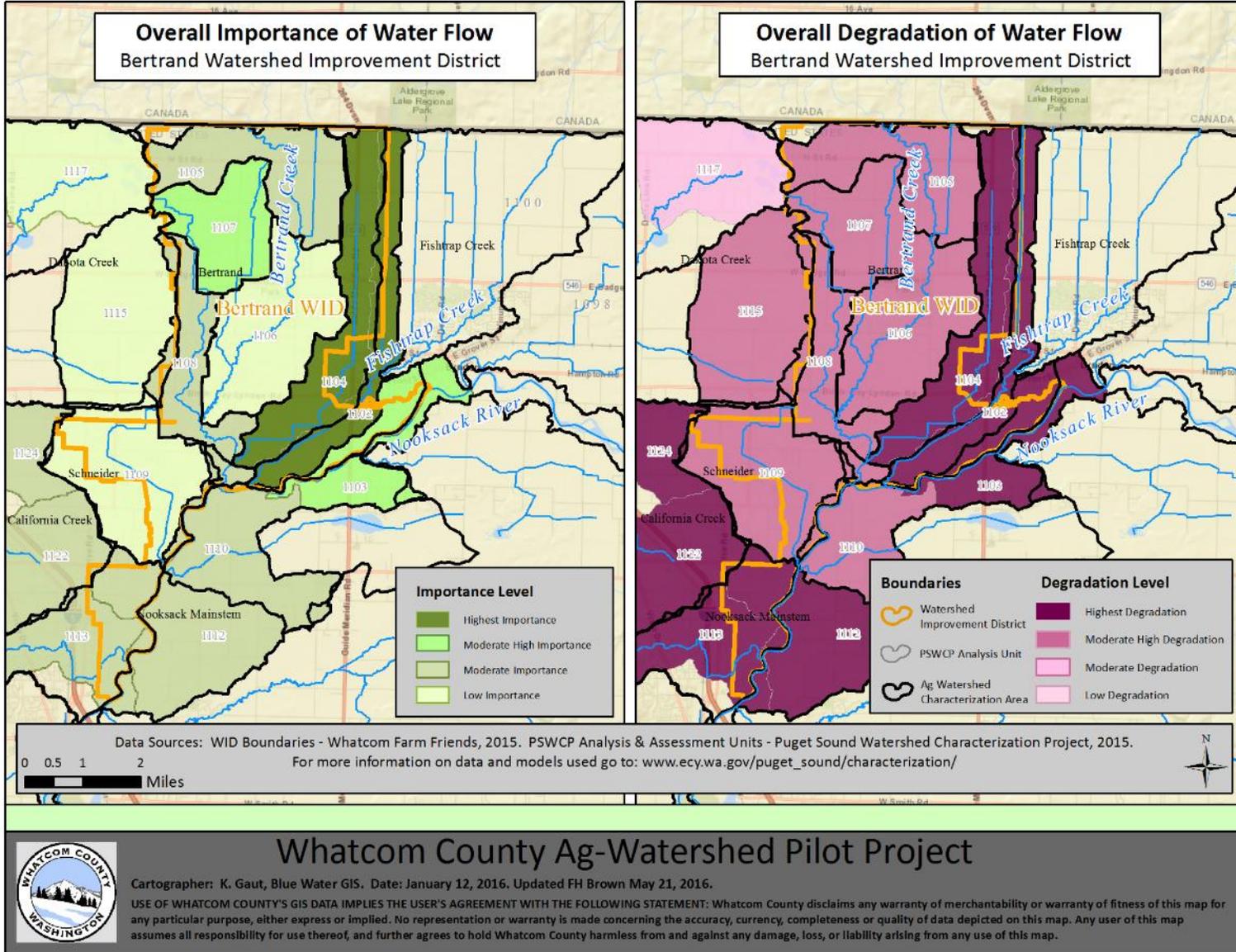


Figure 14. Bertrand WID: Overall importance and degradation of water flow processes

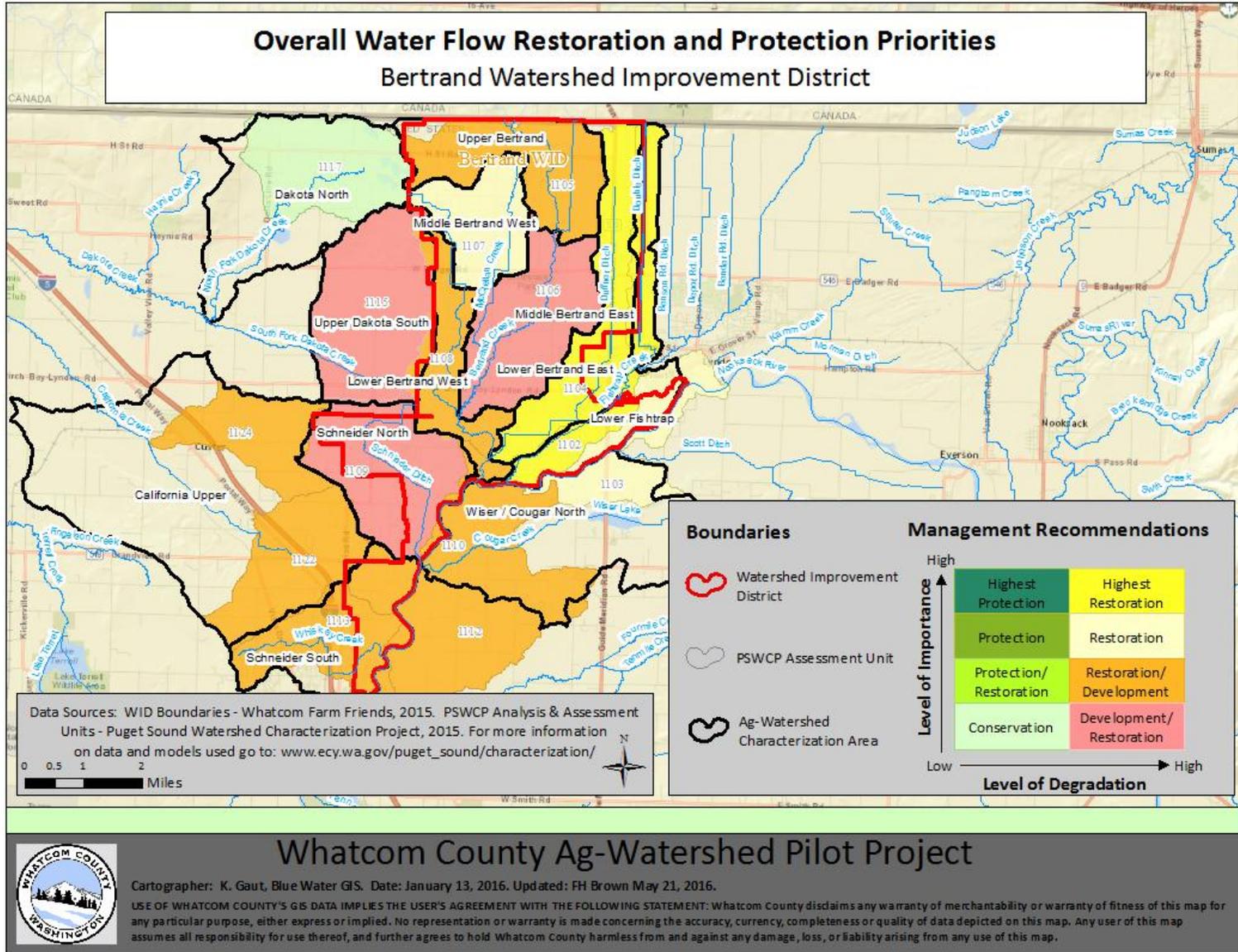


Figure 15. Bertrand WID: Overall water flow restoration and protection priorities

#### 5.4 Watershed priorities: Specific actions map

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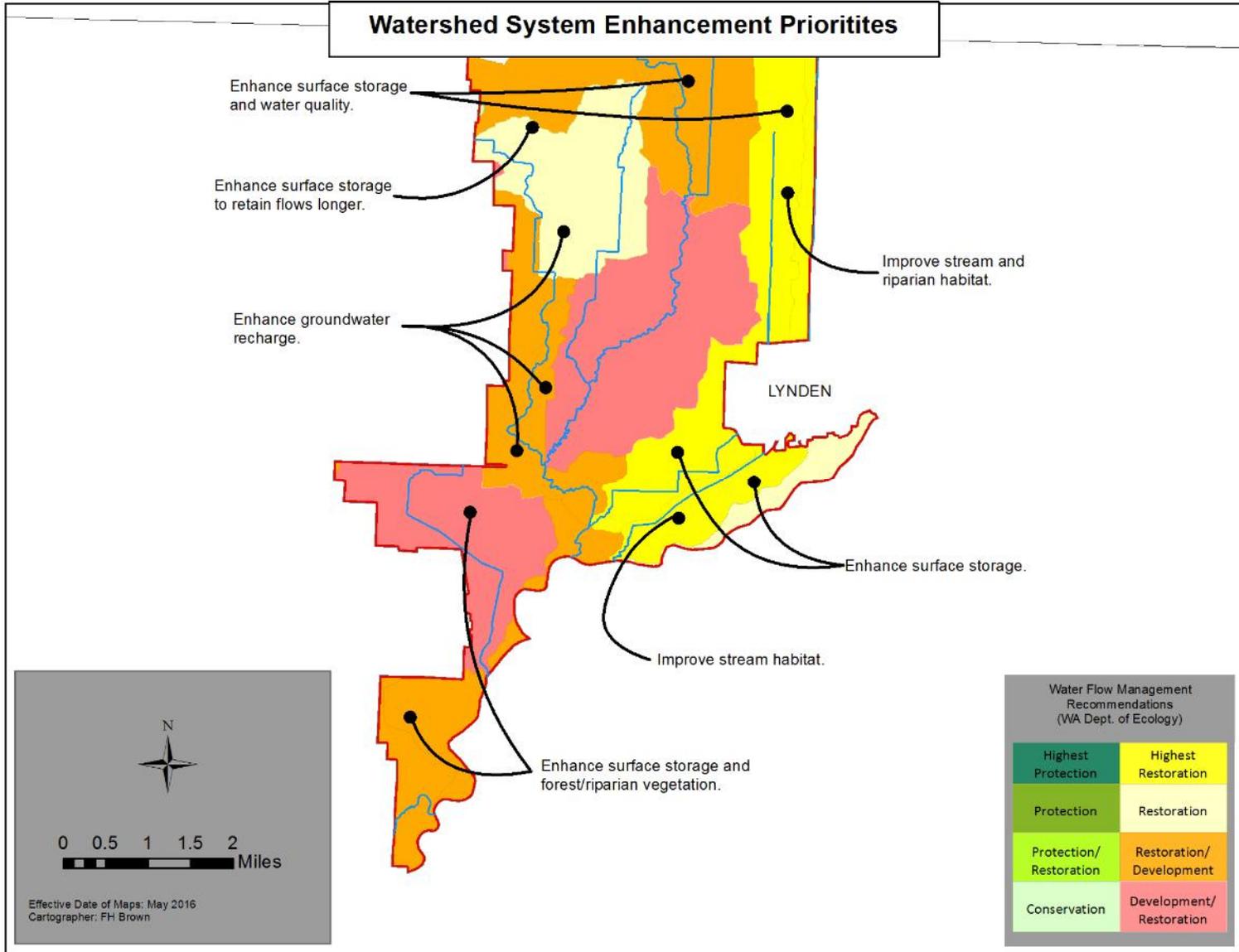


Figure 16. Bertrand WID: Summary watershed system enhancement priorities and specific actions

## 6 Reference maps for the Bertrand Watershed Improvement District

### 6.1 Agriculture reference maps

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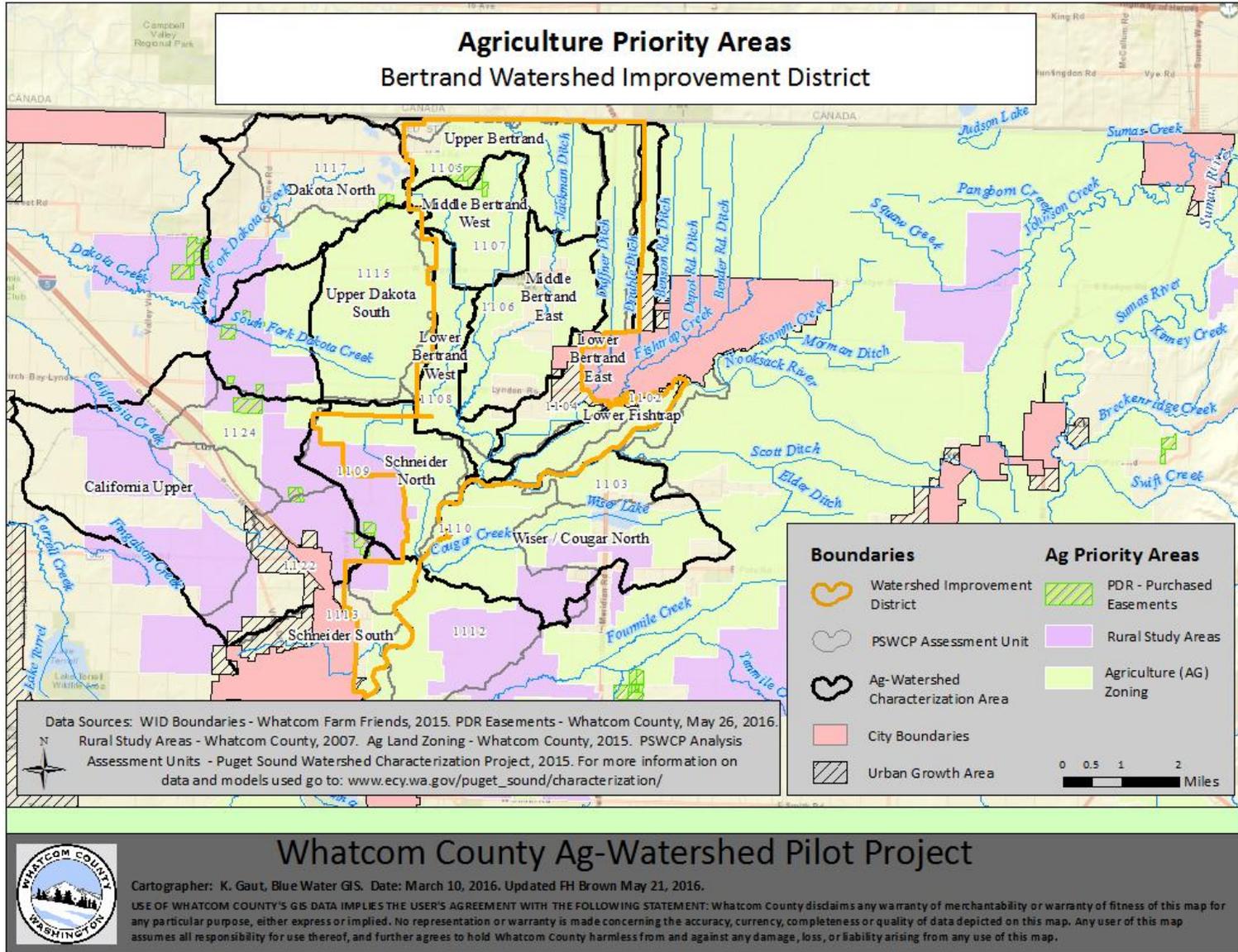


Figure 17. Bertrand WID Reference map: Agriculture priority areas

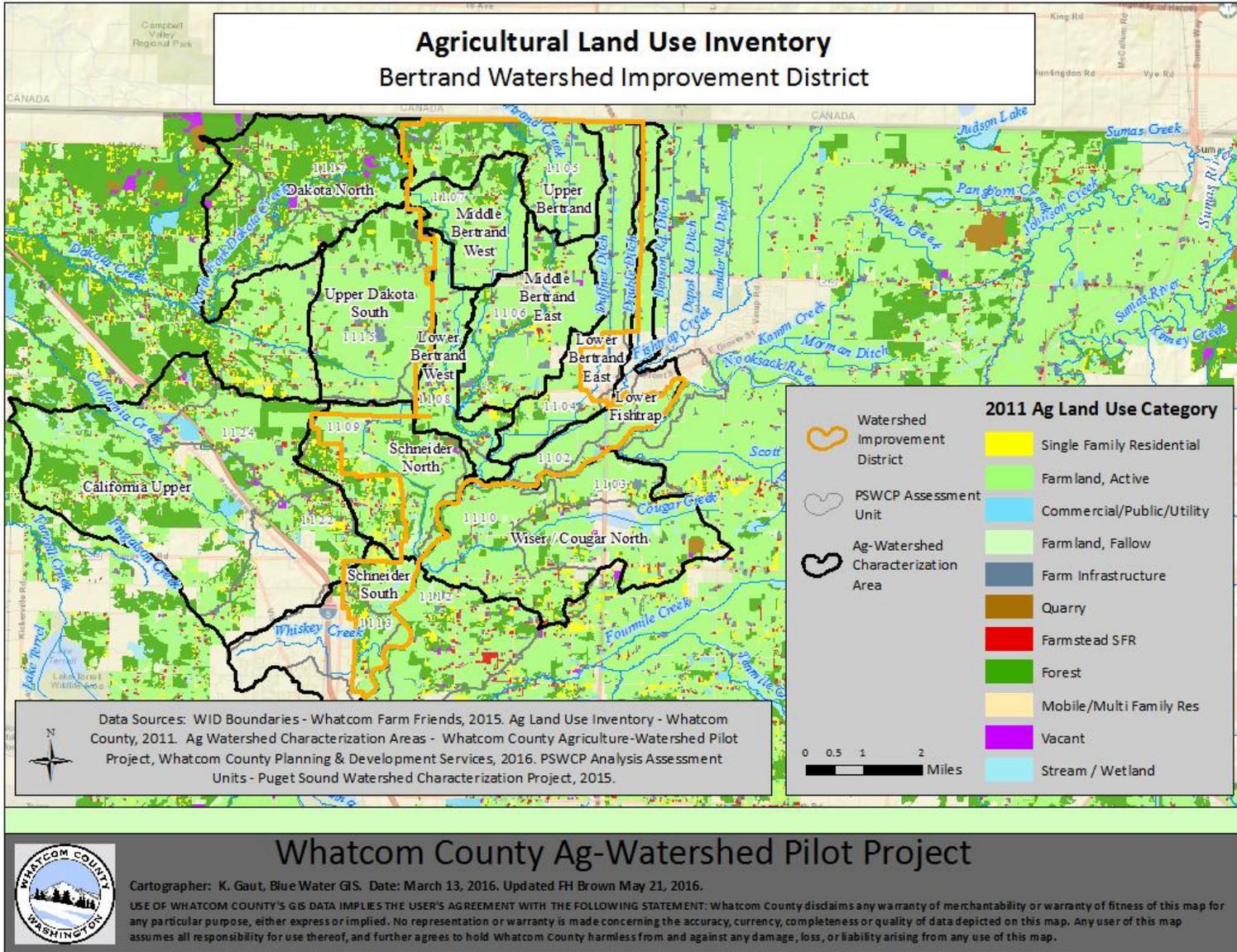


Figure 18. Bertrand WID Reference map: Agricultural land use inventory

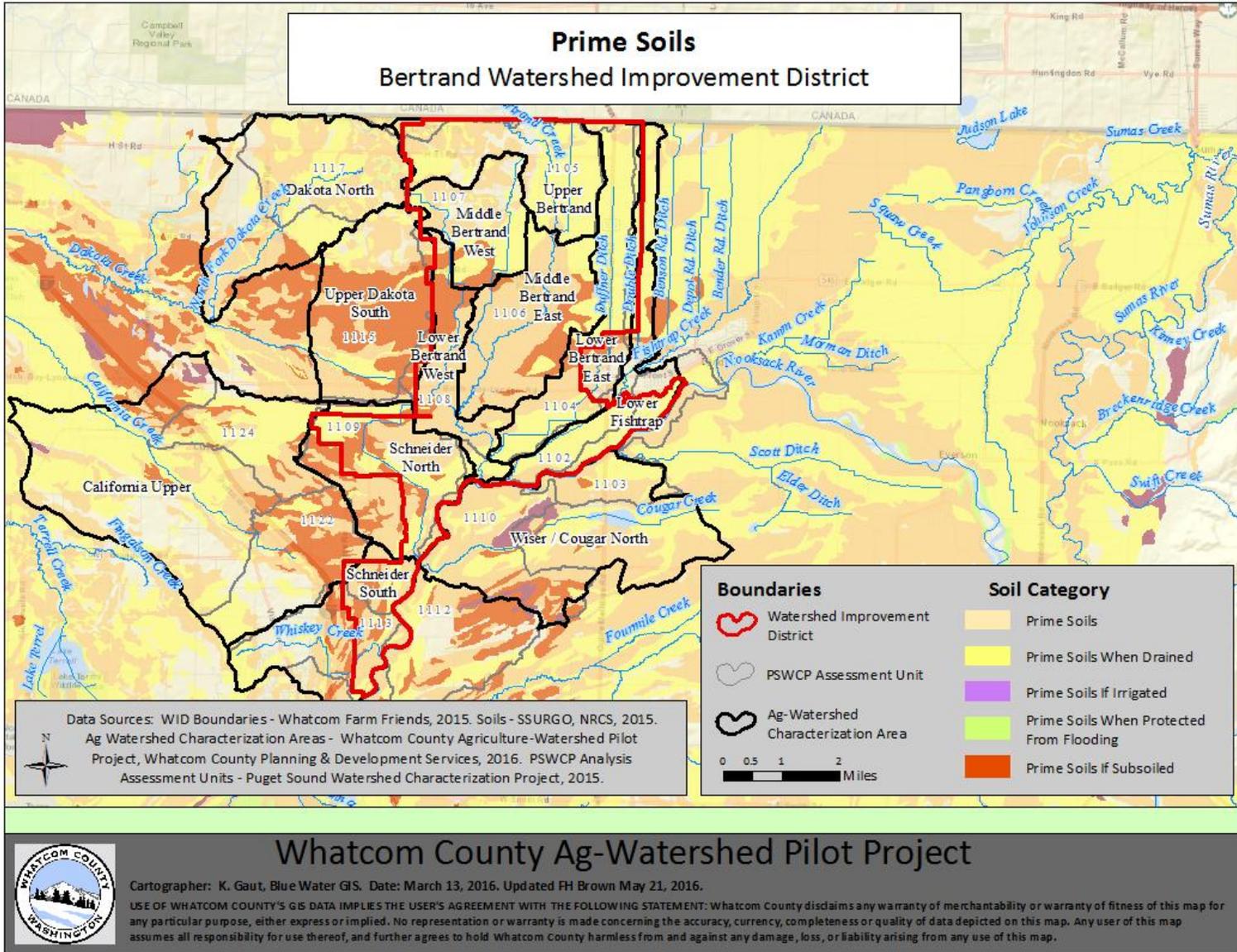


Figure 19. Bertrand WID Reference map: Prime soils

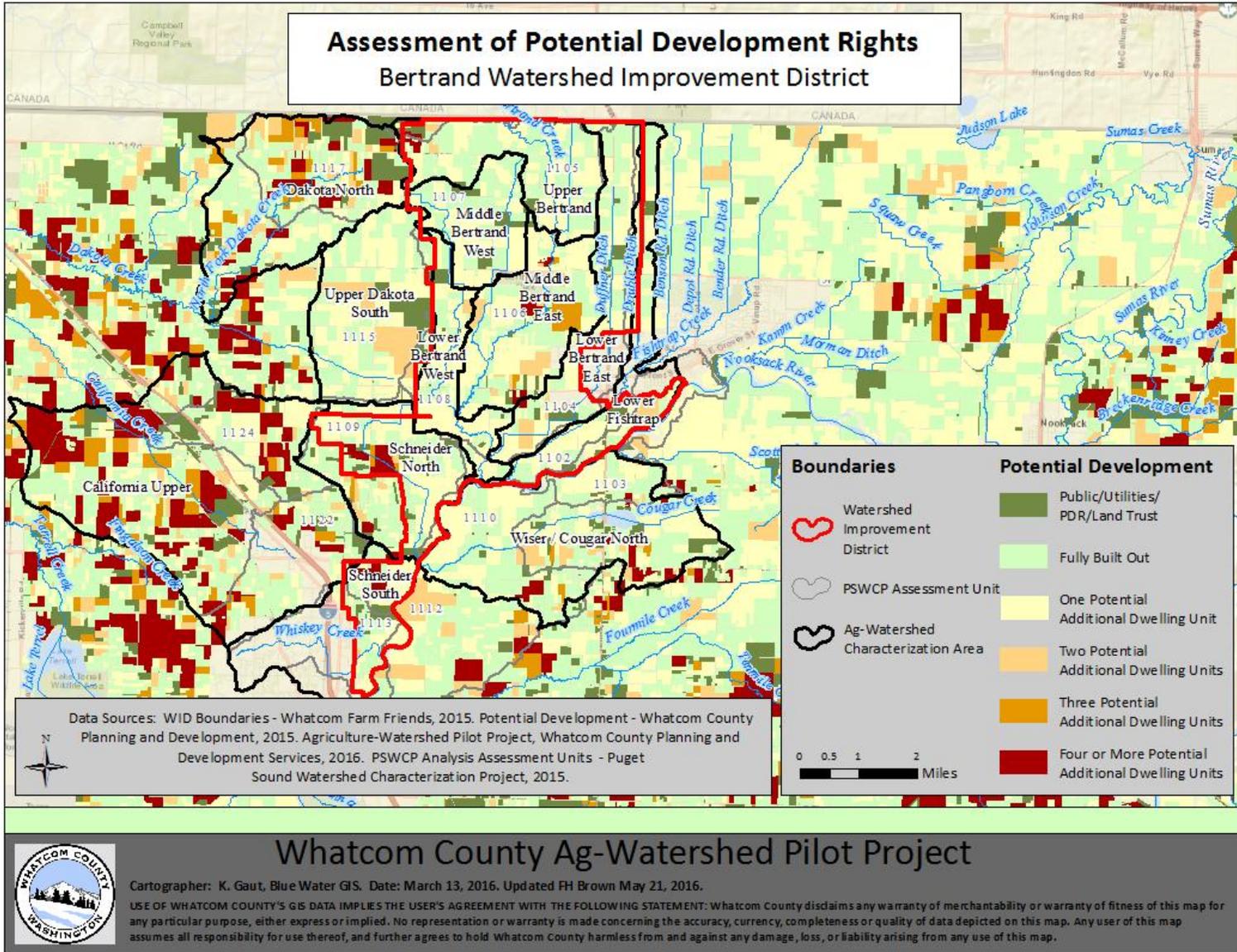


Figure 20. Bertrand WID Reference map: Assessment of potential development rights

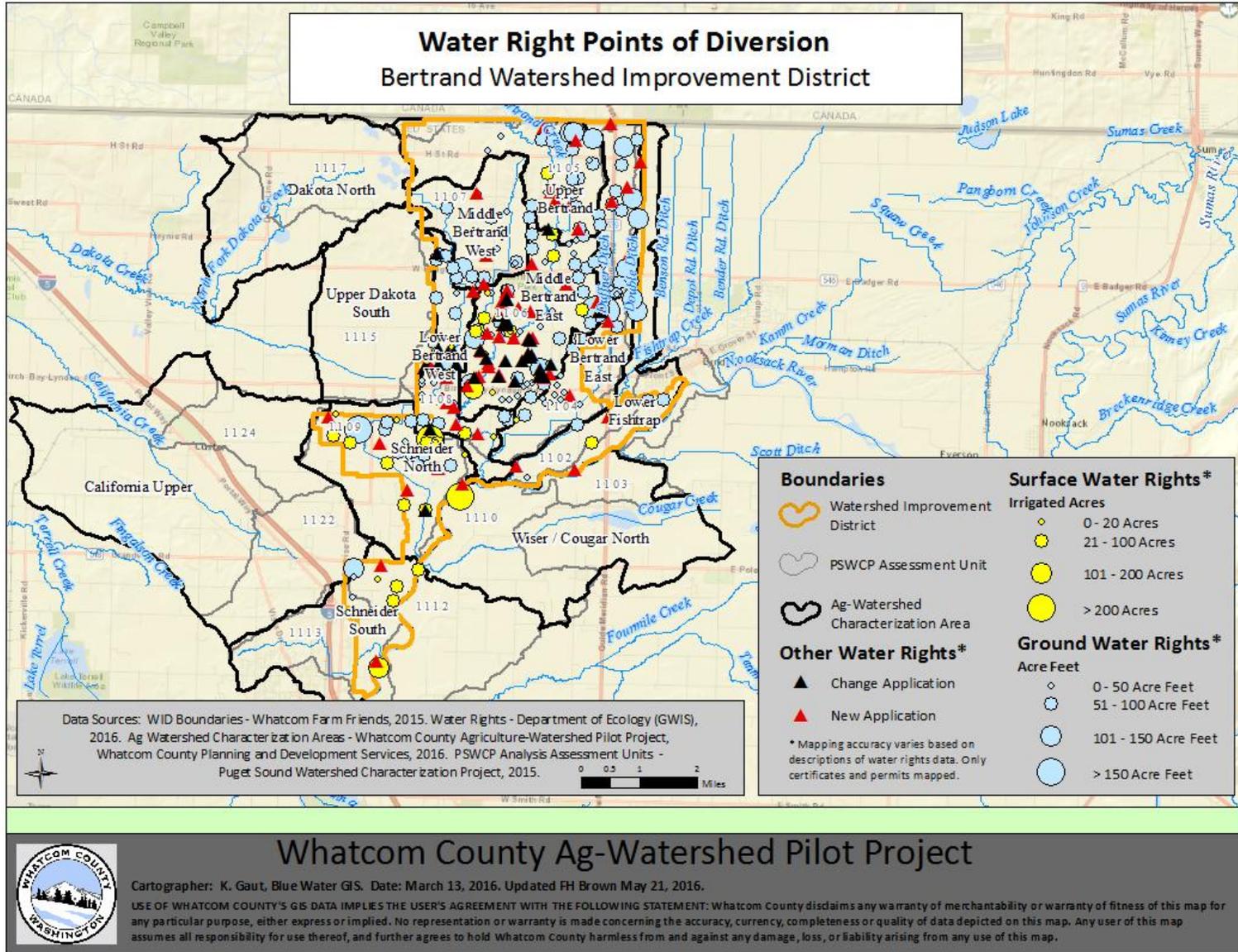


Figure 21. Bertrand WID Reference map: Water right points of diversion

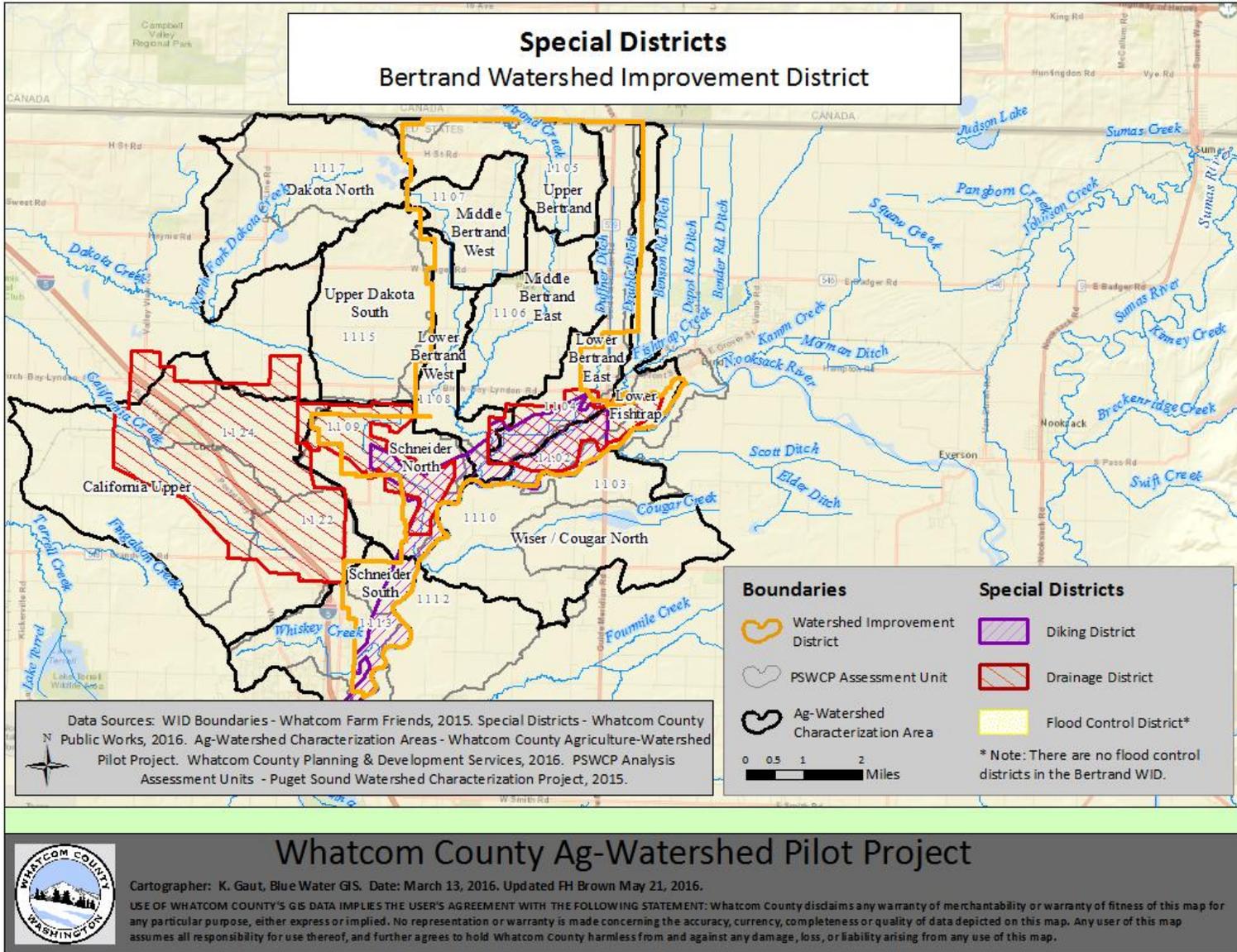


Figure 22. Bertrand WID Reference map: Special districts

## 6.2 Watershed reference maps

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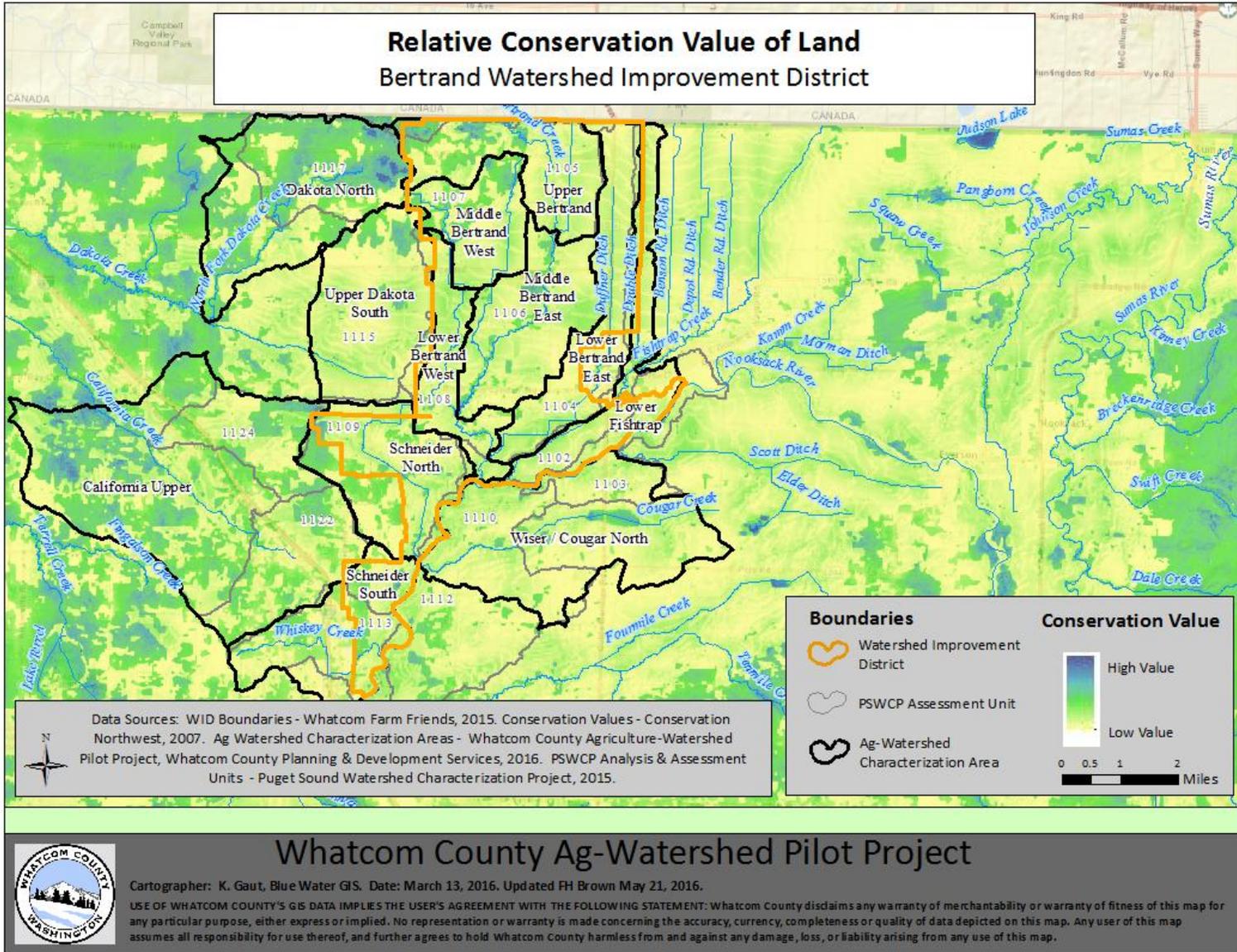


Figure 23. Bertrand WID Reference map: Relative conservation value of land

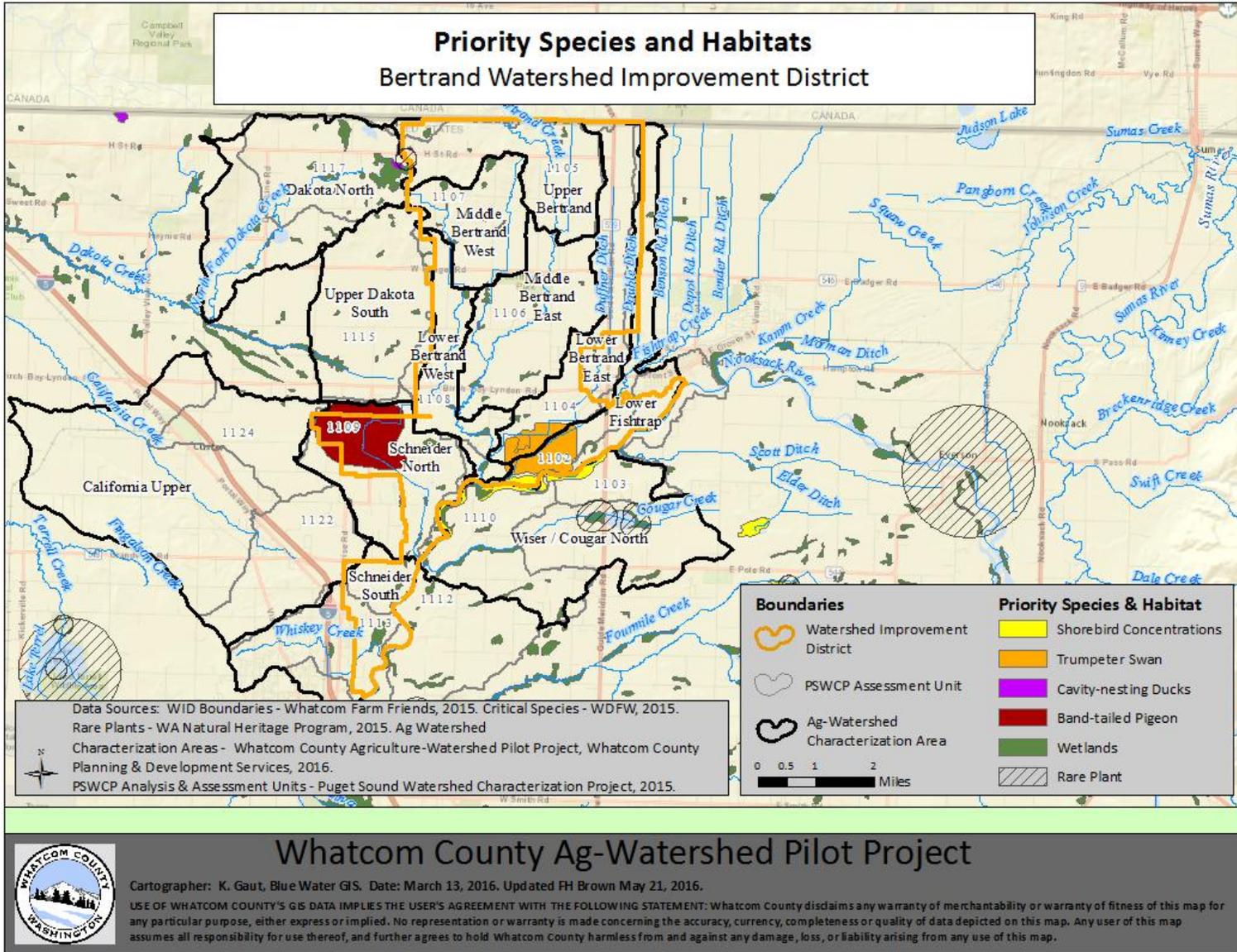


Figure 24. Bertrand WID Reference map: Priority species and habitat

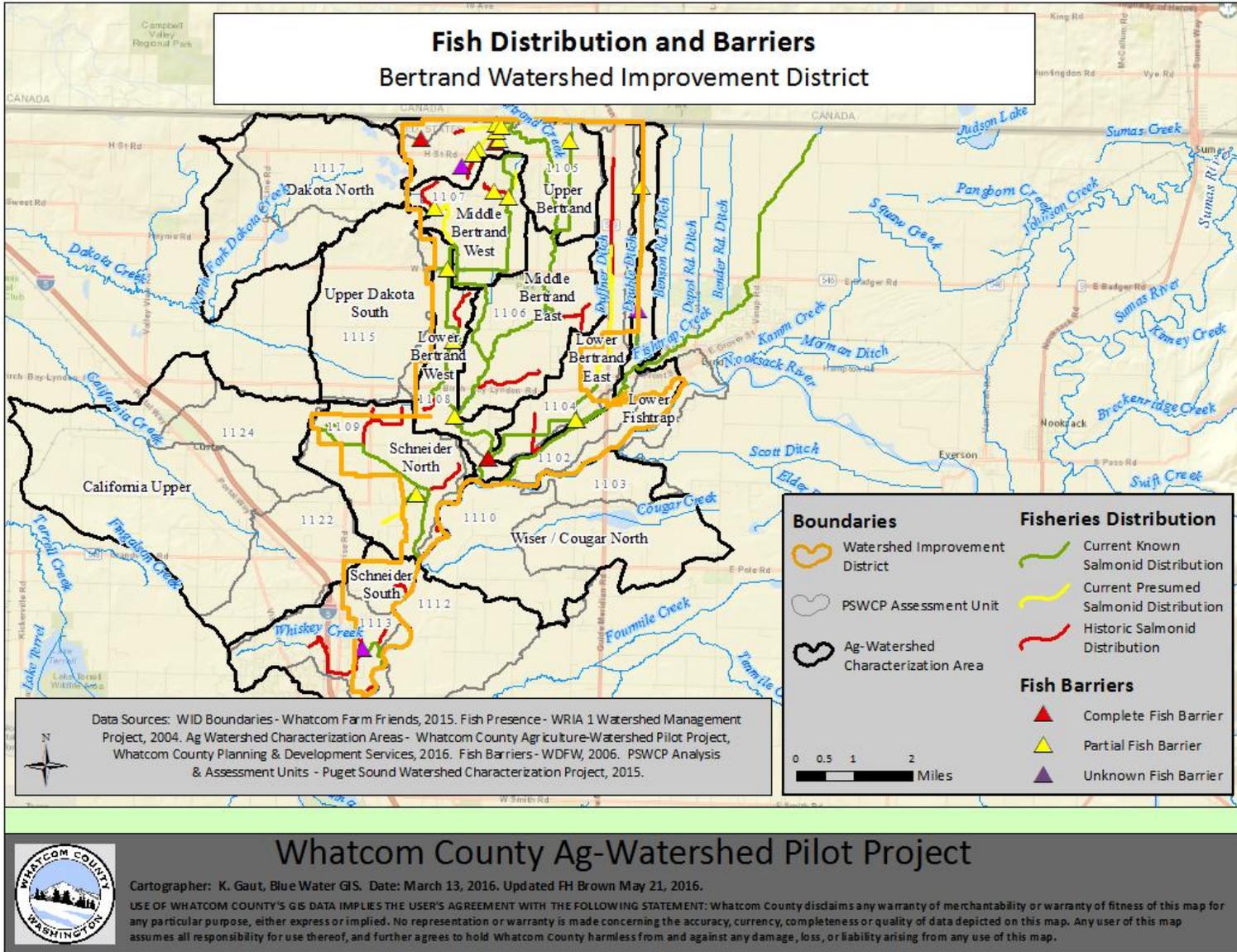


Figure 25. Bertrand WID Reference map: Fish distribution and fish barriers

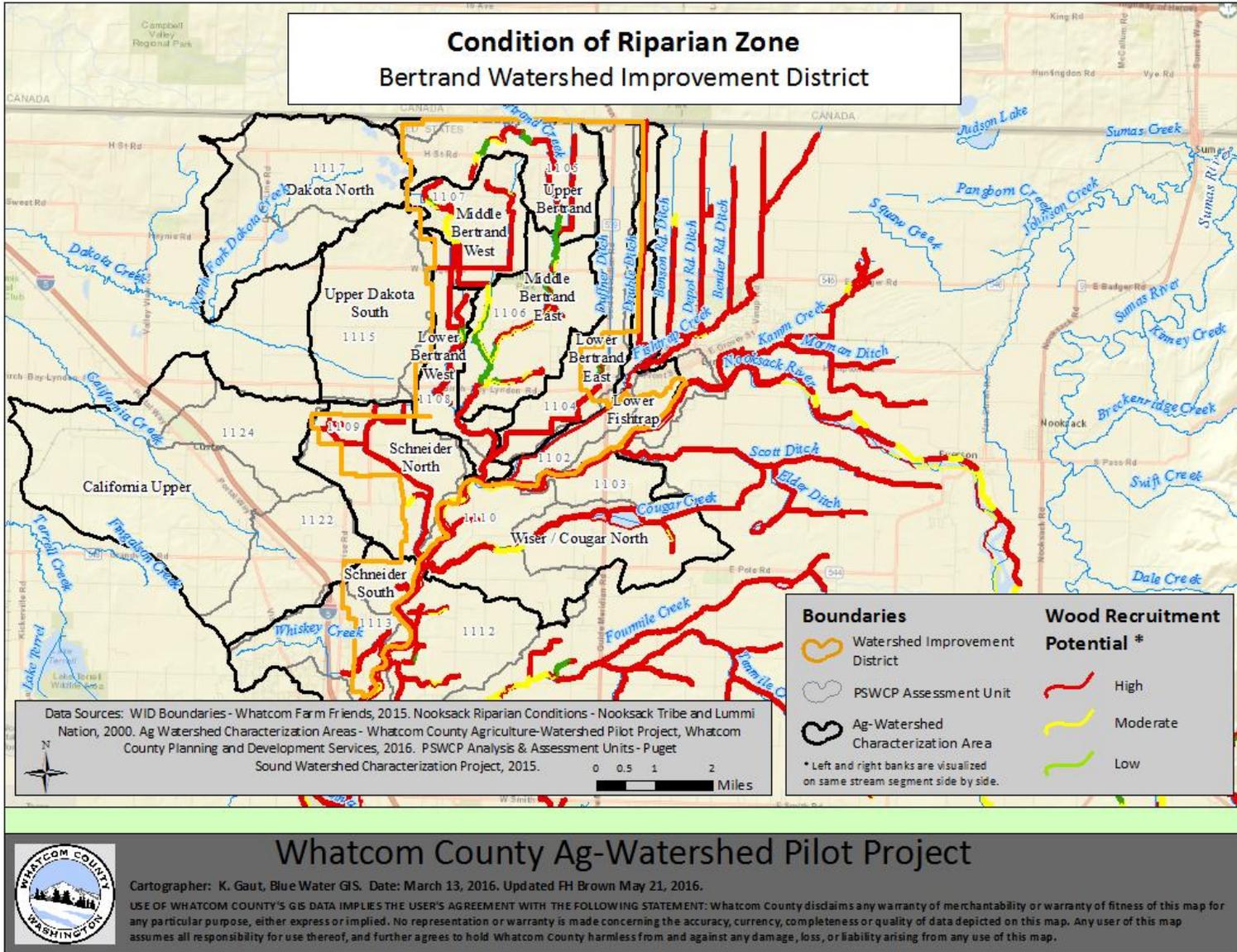


Figure 26. Bertrand WID Reference map: Condition of riparian zone

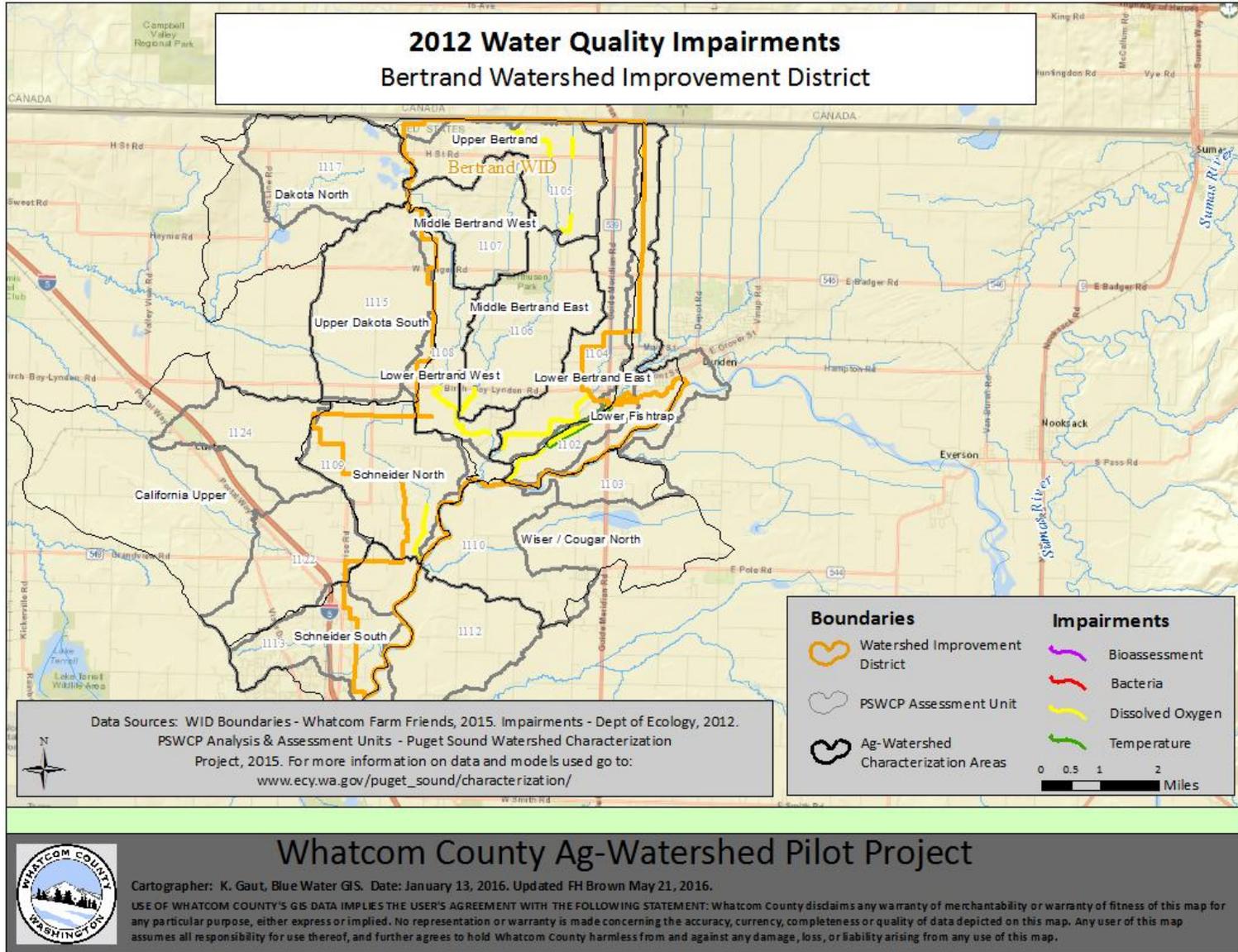
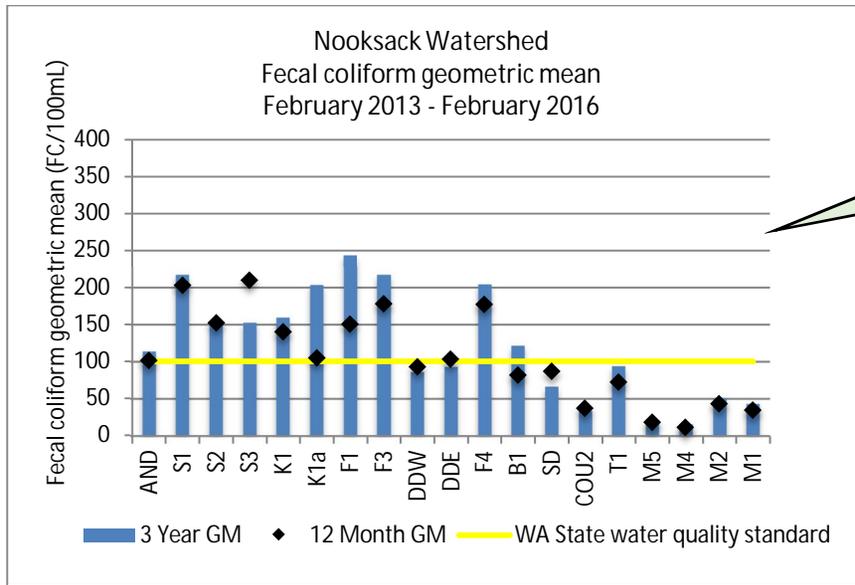
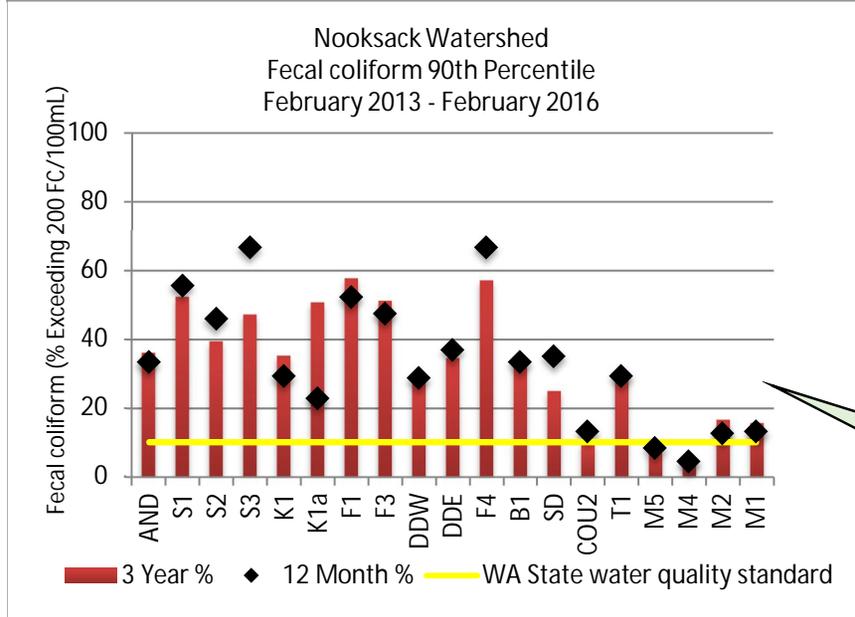
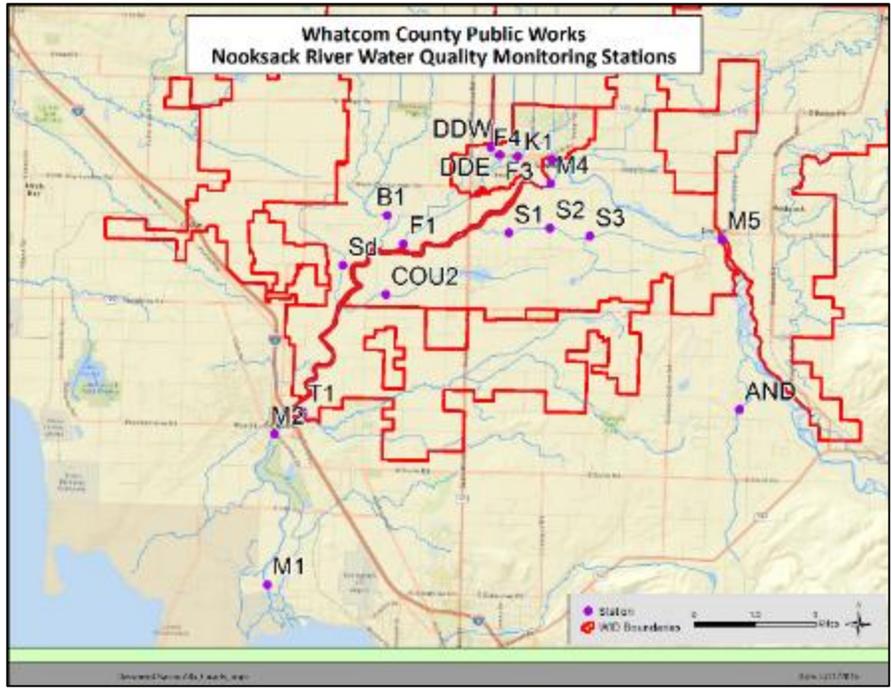


Figure 27. Bertrand WID Reference map: Water quality impairments (2012)



*This graph illustrates fecal coliform geometric means at routine stations. A black dot located above the blue bar indicates that bacteria levels have been increasing in the past twelve months at that site. Data from Whatcom County Public Works.*



*This graph illustrates the percent of samples exceeding 200 FC/100mL at routine monitoring stations. A black dot above the red bar indicates that bacteria levels have been increasing in the past twelve months at that site. Data from Whatcom County Public Works.*

Figure 28. Bertrand WID Reference map: Routine water quality monitoring results



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## GIS data sources

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Agricultural land use inventory	Whatcom County Planning & Development Services (2011). Received from Sarah Watts December 2015.
Agricultural Priority Actions	Generated at WID work sessions in January-February 2016.
Ag-Watershed Characterization Areas	Generated for the Whatcom County Agriculture-Watershed Pilot Project, January 2016.
Cropland	Cropland Data Layers, United States Department of Agriculture, National Agricultural Statistics Service (2015). <a href="http://nassgeodata.gmu.edu/CropScape/">http://nassgeodata.gmu.edu/CropScape/</a>
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Prime soils	Soil Survey Geographic Database (SSURGO), Natural Resources Conservation Service, United States Department of Agriculture. Available online at <a href="http://websoilsurvey.nrcs.usda.gov/">http://websoilsurvey.nrcs.usda.gov/</a> (Last accessed December 2015)
Priority Species and Habitats	Washington Department of Fish & Wildlife (2015). <a href="http://wdfw.wa.gov/mapping/phs/">http://wdfw.wa.gov/mapping/phs/</a>
Rare Plants	Washington Natural Heritage Program (2015). Washington Department of Natural Resources (2015). <a href="http://www1.dnr.wa.gov/nhp/refdesk/gis/index.html">http://www1.dnr.wa.gov/nhp/refdesk/gis/index.html</a>

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Special Districts boundaries	Whatcom County Public Works (2016). Received from Travis Bouma 7 March 2016.
Water Quality Impairments	Washington Department of Ecology (2012). <i>Water Quality Assessment for Washington</i> . <a href="http://www.ecy.wa.gov/programs/Wq/303d/index.html">http://www.ecy.wa.gov/programs/Wq/303d/index.html</a>
Water Quality Monitoring Stations	Whatcom County Department of Public Works. <a href="http://www.co.whatcom.wa.us/2170/Water-Quality-Monitoring-Results#stations">http://www.co.whatcom.wa.us/2170/Water-Quality-Monitoring-Results#stations</a>
Water Resource Inventory Area 1 (WRIA1) boundary	Whatcom County Planning & Development Services (2015).
Water Rights	Washington Department of Ecology, Geographic Water-right Information System (GWIS) 2016. <a href="http://www.ecy.wa.gov/2016Water.html">http://www.ecy.wa.gov/2016Water.html</a>
Watershed characterization	Landscape groups, water flow assessment results from the Puget Sound Watershed Characterization Project <a href="http://www.ecy.wa.gov/puget_sound/characterization/index.html">http://www.ecy.wa.gov/puget_sound/characterization/index.html</a> (Last accessed April 2016)
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## 8 Glossary of key terms used in this report

Agricultural enhancement [protection]	Agricultural enhancement entails maintaining the land base, soil, water, air, plants, animals, production capacity and natural infrastructure necessary to keep farmers farming over the long term as land uses and economic situations change over time. Thus “agricultural enhancement” and “agricultural protection” include but are not limited to agricultural land protection alone.
Agriculture-Watershed Characterization Area (AWCA)	Each WID area has been divided into several smaller “Agriculture-Watershed Characterization Areas”, based on a combination of the WRIA 1 water management areas and the PSWC Project Assessment Units. The AWCAs reflect hydrological and agricultural characteristics in the landscape; are recognizable for WID members and are of a size that is practical for the WIDs to utilize in their planning processes. Importantly, the AWCAs represent common areas within which to characterize and map both agricultural and watershed enhancement priorities.
Assessment Unit (AU)	The assessment units (AUs) used in the Puget Sound Watershed Characterization (PSWC) represent the minimum spatial scale over which the characterization results are meaningful. The AUs were derived from reach-scale catchments delineated by the Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP; NWIFC 2009). The SSHIAP catchments were aggregated into larger units with a mean size 4.7 square miles. See: Stanley et al. (2011) <a href="https://fortress.wa.gov/ecy/publications/documents/1106016.pdf">https://fortress.wa.gov/ecy/publications/documents/1106016.pdf</a> Wilhere et al. (2013) <a href="ftp://www.ecy.wa.gov/gis_a/inlandWaters/ps_project/Docs/Watershed_Characterization_WDFW_Report_Final_Dec2013.pdf">ftp://www.ecy.wa.gov/gis_a/inlandWaters/ps_project/Docs/Watershed_Characterization_WDFW_Report_Final_Dec2013.pdf</a>

Landscape Group	A group of AU’s within the analysis area that each have similar environmental characteristics, such as precipitation, landform, and/or geology. In the current version of the Characterization models, landscape groups are identified strictly on geographical position (coastal, lowland, and mountain, plus a subset of lowland assessment units that drain to one of four large lakes).
Watershed characterization	Watershed ‘characterization’ is a set of water and habitat assessments that compare areas within a watershed for restoration and protection value. It is a coarse-scale tool that supports decisions regarding where on the landscape should efforts be focused first, and what types of actions are most appropriate to that place. See <a href="http://www.ecy.wa.gov/puget_sound/characterization/index.html">http://www.ecy.wa.gov/puget_sound/characterization/index.html</a>
Watershed enhancement	Watershed enhancement actions are those actions which improve the ability of the watershed to provide its natural benefits and services to communities. Watershed enhancement includes the idea of “repairing” major landscape processes related to hydrology and ecosystems, in order to maintain, protect or improve the delivery of watershed services.
Water Resource Inventory Area	Water Resource Inventory Area (WRIA): Administrative watershed boundaries designated by the State of Washington’s natural resource agencies.

## Appendices

Appendix A: Data sources for the Bertrand Watershed Improvement District

Appendix B: WID work session information

Appendix C: Water flow assessment results for Water Resource Inventory Area 1

Appendix D: Fact sheet 5 (Planning, designing and implementing beneficial actions for agricultural & watershed enhancement)





# Appendix A: Sources of Available Data for the Bertrand WID

## July 2016

Prepared by Cheryl Lovato Niles & Heather MacKay

### Whatcom County Ag-Watershed Project

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#### Purpose of this document

The purpose of this document is to collate relevant sources of data, particularly sources for data sets generated through longer-term routine monitoring programs. These data sets are potentially useful for field and desk work in the Bertrand Watershed Improvement District (WID).

Sources for the following data types have been collated for the Bertrand; Lower Fishtrap, and Schneider Watersheds:

- Water quality measures (fecal coliform, temperature, dissolved oxygen, turbidity, nitrogen, and phosphorous) from 2000 to the present,
- Hydrography,
- Stream flow from 2000 to the present,
- Ground water measurements from 2000 to the present,
- Erosion and avulsion hazard in the Nooksack River channel migration zone,
- Surface storage for Bertrand Creek,
- Water rights,
- Fish presence and habitat evaluations from 1990 to the present,
- Salmon and steelhead population boundaries,
- Aquatic nuisance species,
- Instream and streambank vegetation from 1990 to the present,
- Land use and land cover from 2000 to the present,
- Wildlife, and
- Soils.

The following report contains a range of information types including agricultural land use, crop types, fish presence, and hydrology.

- *Bertrand Comprehensive Irrigation District Management Plan*. Economic and Engineering Services, Nov. 2004. Bertrand Watershed Improvement District [planning report] [https://www.piersystem.com/posted/2011/Bertrand\\_Comprehensive\\_Irrigation\\_Dist\\_Mgmt\\_Plan.296855.pdf](https://www.piersystem.com/posted/2011/Bertrand_Comprehensive_Irrigation_Dist_Mgmt_Plan.296855.pdf) [last accessed September 30, 2015]

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Table 1: Fecal coliform monitoring maps and reports

Area	Watershed	Parameter	Source	Description	URL
Bertrand	Lower Bertrand, Lower Bertrand West, Lower Fishtrap, Schneider North	Fecal coliform	Whatcom County	Map of routine monitoring sites and reports of sampling results updated monthly	<a href="http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results">http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results</a> [last accessed February 1, 2016] (see note below for information on how to download FC data)
Bertrand	Lower Bertrand East, Lower Bertrand West, Lower Fishtrap, Schneider North, Schneider South	Fecal coliform	Conservation District	Watershed Health Assessment (November 2015)	<a href="http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results">http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results</a> [last accessed February 1, 2016]
all	All (Department of Agriculture tests numerous stations routinely and also in response to high FC counts – station locations vary)	Fecal coliform	Washington State Departments of Agriculture and Ecology (only WSDA results shown as of 2/9/16). Data is available upon request from WSDA Dairy Nutrient Management group - Michael Isensee 360-961-7412	Map of preliminary source tracking results	<a href="http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results">http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results</a> [last accessed February 1, 2016]

Accessing water quality data from routine monitoring sites: Figure 1 shows the locations of routine water quality monitoring sites that are within the Bertrand Watershed Improvement District.

Whatcom County, the Tribes, Washington State Department of Ecology, and Washington Department of Agriculture coordinate their water quality monitoring efforts. To see the most recent couple of months of data from the map of routine water quality monitoring online at the County's website <http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results>, open the map at <http://wacds.maps.arcgis.com/apps/webappviewer/index.html?id=71fa677503c949c8847066178a531099>, and click on the layers symbol in the upper right hand corner. This opens a box titled Layer List. Select the box to the left of "Preliminary WQ Data Results (All)", and then click on the arrow to the right to open up the drop down menu. Select "Open Attribute Table". A detailed table will open up. Under "Options" in the upper left corner of the table, you can choose to export the data and it will automatically populate an Excel spreadsheet. The purple dots indicate station locations; the blue squares indicate that there is data associated with that station in this system. To find earlier data see the table below.

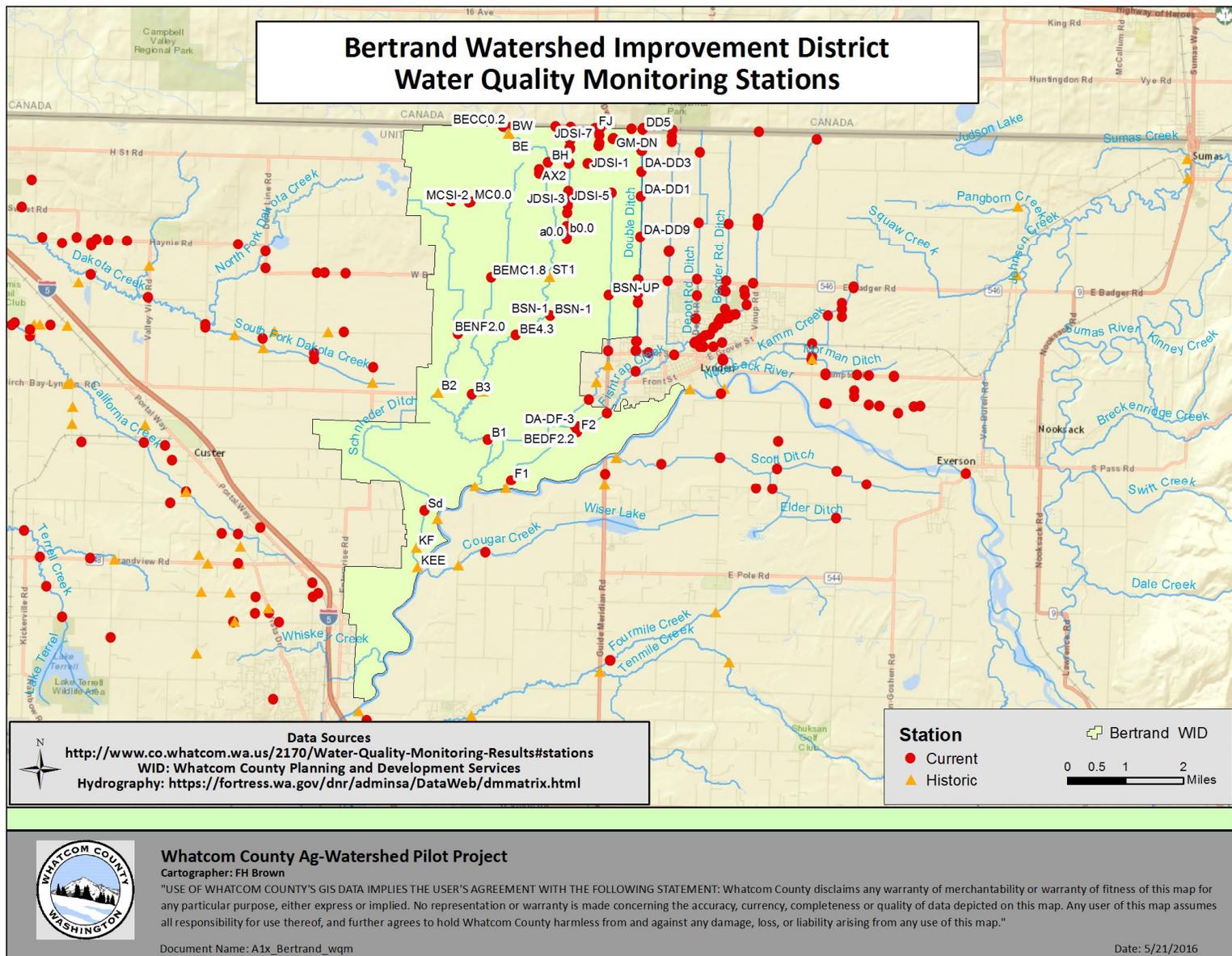


Figure 1. Bertrand WID: Routine water quality monitoring stations. See Tables 1 and 2 for more information.

Table 2: Where to find earlier water quality data from monitoring stations on Whatcom County Water Quality Monitoring Results for Bertrand WID area.

*Data for the County Health Department is not included here because their monitoring focuses entirely on marine water. Earlier Washington Department of Agriculture data is available by request. See table 1 for contact information.*

Who	Department of Ecology	Whatcom County Public Works	Nooksack Tribe	City of Lynden	WSDA
What	Data generally includes FC, pH, T, Conductivity, and DO. Occasionally flow and wetted width are recorded.	Focused on fecal coliform	Fecal coliform, E.coli, T, pH, DO, Conductivity, Turbidity,	Focused on fecal coliform. Sampling is done in collaboration with Whatcom County Public Works.	Focused on fecal coliform
How	You may request the data from the Department of Ecology Bellingham Field office. Details below.	Annual reports for 2011 through 2013 are available online at URL below.	Available by request	Current and archived Whatcom County reports are available at urls below. Periodic "Fishtrap Watershed Water Quality Status" reports are distributed via email. Contact Whatcom County Public Works to request the most recent status report. 360-778-6200	Data is available upon request from WSDA Dairy Nutrient Management group - Michael Isensee 360-961-7412
Details	You may request data for a watershed subbasin from Jessica Kirkpatrick, Steve Hood, or Chris Luerkens at 360-715-5200.	< <a href="http://www.co.whatcom.wa.us/2172/Resource-Library">http://www.co.whatcom.wa.us/2172/Resource-Library</a> >	Jezra Belieau, Water Resources Specialist Nooksack Indian Tribe jbeaulieu@nooksack-nsn.gov	Current Whatcom County report for Nooksack watershed: <a href="http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results">http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results</a> Archived Whatcom County reports: <a href="http://www.co.whatcom.wa.us/2172/Resource-Library">http://www.co.whatcom.wa.us/2172/Resource-Library</a>	Station locations are shown on Whatcom County's map of routine monitoring sites. Results are available there, on the Preliminary Source ID Results map (both maps at < <a href="http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results">http://www.whatcomcounty.us/2170/Water-Quality-Monitoring-Results</a> >) and by request – contact information above.

Who	Department of Ecology	Whatcom County Public Works	Nooksack Tribe	City of Lynden	WSDA
Station Names	B1 B2 B3 BH DD1 DD2 DD3 DD4 DF2 DF3 F1 F2 F3 F4 FT1 FT2 FT3 FT4 FT5 FT6 FT7 FT8 KF LLPL M4 M5 WIS BEJK0.2 BEJK2.0 DD5 DD6 DF1	DDE DDW F5 F5a F6 F7 DDE Badger F2a F3a FT7* FT9 FTAC Sd DDW Badger	SW13 SW14	Numerous	a0.0 b0.0 BEJK2.0 BN-1 BN-2 BN-3 BN4 BN5 BN6 BN7 BSN-1 BSN-UP DA-DD1 DA-DD2 DA-DD3 DA-DD4 DA-DD9 DA-DF-2 DA-DF-3 DD-CA1 DD5 DD6 DDW Badger DF1 F5-Down F5-Up F6b F6of FB-LAT FJ GM-B-DN GM-DN GM-G-UP GM-Zero JD-0.037

Who	Department of Ecology	Whatcom County Public Works	Nooksack Tribe	City of Lynden	WSDA
					JD-0.25 JD-0.31 JD-0.6 JD-0.76 JD-1.0 JD-1.45 JD-1.73 JD-1.83 JD-1.9 JD-F0.34 JD-F0.7 JD-F0.8 JD-F0.84 JD-F1.0 JD-F1.1 JD-F1.1W JD-HLAT JD-ND JDSI-1 JDSI-3 JDSI-4 JDSI-5 JDSI-7 JD-0.38 JD-1.5 JD-A JD-B JD-C JD-F0.0 JD-F0.5 MC0.0 AX1 AX2 DA-DD10 DA-DD8

Table 3: Temperature monitoring from Nooksack Tribe

WID/Area	Watershed	Ongoing/ completed	Station ID	Description	Lat	Long	Collected by	Source
Bertrand	Lower Bertrand East	Ongoing	105	Fishtrap Creek at Flynn Road Bridge	48.9263337	122.5736584	Nooksack Indian Tribe	NNR Office, 2009 data in STORET; currently working on uploading the remaining data to EPA STORET <a href="http://www.epa.gov/storet/">http://www.epa.gov/storet/</a> [URL last accessed September 30, 2015]
Bertrand	Lower Bertrand East	completed	08BE01	Bertrand Creek @ H Street	48.9933996	-122.509918	Nooksack Indian Tribe	NNR Office, 2009 data in STORET; currently working on uploading the remaining data to EPA STORET <a href="http://www.epa.gov/storet/">http://www.epa.gov/storet/</a> [URL last accessed September 30, 2015]

Table 4: Streamflow

Watershed	Ongoing/ Completed	Station ID	Description	Lat	Long	Collected by	Source	URL
Upper Bertrand	Ongoing	08MH152	Bertrand Creek at International Boundary	490009	1223119	Env. Canada	USGS "Summary Information for Continuous Streamflow Gages in and near the WRIA 1 Study Area"	<a href="http://wa.water.usgs.gov/projects/wria01/sw.htm">http://wa.water.usgs.gov/projects/wria01/sw.htm</a> [last accessed October 1, 2015]
Middle Bertrand East	Ongoing	12212500	Bertrand Creek near Lynden	485530	1223150	USGS	USGS "Summary Information for Continuous Streamflow Gages in and near the WRIA 1 Study Area"	<a href="http://wa.water.usgs.gov/projects/wria01/sw.htm">http://wa.water.usgs.gov/projects/wria01/sw.htm</a> [last accessed October 1, 2015]
Lower Bertrand	Ongoing	12212050	Fishtrap Creek at Front Road, Lynden	485622	1222839	USGS	USGS "Summary Information for Continuous Streamflow Gages in and near the WRIA 1 Study Area"	<a href="http://wa.water.usgs.gov/projects/wria01/sw.htm">http://wa.water.usgs.gov/projects/wria01/sw.htm</a> [last accessed October 1, 2015]
Lower Fishtrap	Ongoing	12212100	Fishtrap Creek at Flynn Road, at Lynden	485536	1222942	USGS	USGS "Summary Information for Continuous Streamflow Gages in and near the WRIA 1 Study Area"	<a href="http://wa.water.usgs.gov/projects/wria01/sw.htm">http://wa.water.usgs.gov/projects/wria01/sw.htm</a> [last accessed October 1, 2015]
Lower Fishtrap	Ongoing	08MH156	Pepin Creek at International Boundary, BC	490012	1222814	Env. Canada	USGS "Summary Information for Continuous Streamflow Gages in and near the WRIA 1 Study Area"	<a href="http://wa.water.usgs.gov/projects/wria01/sw.htm">http://wa.water.usgs.gov/projects/wria01/sw.htm</a> [last accessed October 1, 2015]

Table 5: Streamflow plus additional measures

Watershed	Additional parameters	Station ID	Station location	Ongoing/ Completed	Collected by	Source	URL
Lower Bertrand East	T and gage height	12212430	Unnamed Trib to Bertrand Cr nr H St. near Lynden	ongoing	USGS	USGS Washington Water Science Center	<a href="http://maps.waterdata.usgs.gov/map/per/index.html">http://maps.waterdata.usgs.gov/map/per/index.html</a> [last accessed October 1, 2015]
Upper Bertrand	Water and air T and gage height	12212390	Bertrand Creek at International Boundary	ongoing	USGS	USGS Washington Water Science Center	<a href="http://maps.waterdata.usgs.gov/map/per/index.html">http://maps.waterdata.usgs.gov/map/per/index.html</a> [last accessed October 1, 2015]
Middle Bertrand East	Many including: T, Pressure, Cond, DO, pH, Biomass, nutrients, chemicals,	12212450	Bertrand Creek at West Badger Road near Lynden, WA	ongoing	USGS	USGS Washington Water Science Center	<a href="http://maps.waterdata.usgs.gov/map/per/index.html">http://maps.waterdata.usgs.gov/map/per/index.html</a> [last accessed October 1, 2015]
Middle Bertrand East	Many including: T, DO, pH, FC, nutrients, turbidity, and metals	01N060	Bertrand Creek @ Rathbone Road	ongoing	Ecology	River & Stream Water Quality Monitoring	<a href="https://fortress.wa.gov/ecy/eap/river_wq/regions/state.asp">https://fortress.wa.gov/ecy/eap/river_wq/regions/state.asp</a> [last accessed October 1, 2015]
Lower Fishtrap?	T, and gage height	12212050	Fishtrap Creek at Front Street, Lynden	ongoing	USGS	USGS Washington Water Science Center	<a href="http://maps.waterdata.usgs.gov/map/per/index.html">http://maps.waterdata.usgs.gov/map/per/index.html</a> [last accessed October 1, 2015]
Upper Bertrand	FC, hardness, NO3, NO2, DO, pH, pressure, SSC, Sussol, T, TP, TPN, turbidity	01N100	Bertrand @ 0 Avenue	ongoing	Ecology	River & Stream Water Quality Monitoring	<a href="https://fortress.wa.gov/ecy/eap/river_wq/regions/state.asp">https://fortress.wa.gov/ecy/eap/river_wq/regions/state.asp</a> [last accessed January 20, 2016]

Table 6: Additional streamflow reports

Watershed	Title	Published	URL
Fishtrap Creek watersheds Lower Bertrand watershed	USGS Estimating low-flow frequency statistics and hydrologic analysis of selected stream-flow gaging stations, Nooksack River basin, report 2009-5170	USGS Scientific Investigations Report, 2009.	<a href="http://wria1project.whatcomcounty.org/uploads/PDF/WaterQN/2009_USGS%20Report%20for%20Selected%20WRIA%201%20Gage%20Stations.pdf">http://wria1project.whatcomcounty.org/uploads/PDF/WaterQN/2009_USGS%20Report%20for%20Selected%20WRIA%201%20Gage%20Stations.pdf</a>

Table 7: Hydrography

Area	Parameter	Source	URL
US	Hydrography	USGS. The National Map, Hydrography	<a href="http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd">http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd</a> [last accessed September 30, 2015]

Table 8: Erosion and avulsion in Nooksack River channel migration zone

Area	Parameter	Document Title	Author	Date	URL
Bertrand	Erosion and Avulsion	Erosion and Avulsion Hazard Mapping and Methodologies for use in the Nooksack River Channel Migration Zone Mapping	Paul Pittman, LEG Whatcom County Public Works and Peter Gill, Whatcom County Planning and Development Services,	2009	<a href="http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/15492">http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/15492</a> [last accessed February 29, 2016]

Table 9: Groundwater Data

WID/ Area	Water- shed	Parameter	Title of Table/Source	Station ID	Source	URL	Notes
all	all	Well location, use, depth, installation date, open interval	Summary Information for Wells in the WRIA 1 Study Area	1297 wells listed. Latitude and Longitude provided for all.	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/data/well_info.htm">http://wa.water.usgs.gov/projects/wria01/data/well_info.htm</a> via <a href="http://wa.water.usgs.gov/projects/wria01/gw.htm">http://wa.water.usgs.gov/projects/wria01/gw.htm</a> [both last accessed October 1, 2015]	This table contains data for all wells in the WRIA 1 study area that were in the USGS database as of December 14, 1999. There are many wells in the WRIA 1 study area that are not in the database. Additional information regarding wells in this table can be obtained by contacting Luis Fuste, the Information Officer of the USGS Washington Water Science Center of the USGS, at (253) 428-3600 x2653. Information in this table may overlap with information in the database of the Whatcom County Health and Human Services Department See Summary Information for Whatcom County Health and Human Services Department Wells in the WRIA 1 Study Area).

WID/ Area	Water- shed	Parameter	Title of Table/Source	Station ID	Source	URL	Notes
all	all	Well location, use, depth, installation date, open interval	Summary Information for Wells in the WRIA 1 Study Area, Downloaded from the Whatcom County Health and Human Services Department Database	Numerous wells listed. Township, range, section, and quarter section listed for all.	Whatcom County Health and Human Services	<a href="http://wa.water.usgs.gov/projects/wria01/data/tableGW2.htm">http://wa.water.usgs.gov/projects/wria01/data/tableGW2.htm</a> [last accessed October 1, 2015]	This table contains selected data for all wells in the WRIA 1 study area that were in the Whatcom County Health and Human Services Department database as of January 7, 2000. There are many wells in the WRIA 1 study area that are not in the database. Additional information regarding wells in this table can be obtained by contacting Anne Marie Karlberg at the Whatcom County Health and Human Services Department, at (360) 738-2504 x50819. Information in this table may overlap with information in the database of the USGS (see Summary Information for Wells in the WRIA 1 Area, Downloaded from the USGS National Water Information System). Disclaimer: The locations of these wells have not been field checked. Construction information was gathered from driller's logs and may contain errors.
all	all	Well location, use, depth, installation date, open interval	Wells with Sufficient Information to Compute Hydraulic Conductivities, Downloaded from the USGS National Water Information System (NWIS)	Numerous wells listed. Lat. and long. listed for all.	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/data/tableGW4.htm">http://wa.water.usgs.gov/projects/wria01/data/tableGW4.htm</a> [last accessed October 1, 2015]	All information in this table is provisional and subject to revision. The data in the database were collected and entered for a wide variety of projects and purposes over a long period of time and the resulting dataset varies in quality and detail. Although many wells have accurate information (especially those checked and used in recent studies), some problems are known to exist for older entries. Examples of known problems include, but are not limited to, inaccurate well locations, old information regarding the primary use of the well, incorrect installation dates, and erroneous labeling of well locations as having been field-checked. No checks were performed to assure consistency between the latitude and longitude of a well and its assigned local name
all	all	Water level below surface, date of measurement, method	Historical Ground-Water Levels in the WRIA 1 Study Area	Numerous wells listed. USGS ID is lat long.	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/data/water_levels.htm">http://wa.water.usgs.gov/projects/wria01/data/water_levels.htm</a> [last accessed October 1, 2015]	Table contains historical water-level information for wells in the WRIA 1 study area that were in the USGS National Water Information System (NWIS) on December 14, 1999, and for which water-level information was available. Additional information regarding wells in this table can be obtained by contacting Luis Fuste, the Information Officer of the USGS Washington Water Science Center of the USGS, at (253) 428-3600 x2653.

Table 10: Additional reports on groundwater

Watershed/ Area	Title	Published	Authors	URL
all	Nitrate Contamination in the Sumas-Blaine Aquifer, Whatcom County, Washington	Publication No. 11-03-027, May 2011	Melanie Redding L. Hg., Barbara Carey L. Hg., and Kirk Sinclair L. Hg., Washington State Department of Ecology	<a href="https://fortress.wa.gov/ecy/publications/documents/1103027.pdf">https://fortress.wa.gov/ecy/publications/documents/1103027.pdf</a> [last accessed February 1, 2016]
all	Sumas-Blaine Aquifer Nitrate Contamination Summary	Department of Ecology Pub. No. 12-03-026, June 2012	Barbara Carey, L. Hg.	<a href="http://www.ecy.wa.gov/biblio/1203026.html">www.ecy.wa.gov/biblio/1203026.html</a> [last accessed February 1, 2016]
all	Hydrogeology, ground water quality, and sources of nitrate in lowland glacial aquifers of Whatcom County, Washington, and British Columbia, Canada	US Geological Survey Water-Resources Investigations Report 98-4195. 1999. 251 pages, 5 plates.	Cox, S. E., and S. C. Kahle	
WRIA1	WRIA 1 Groundwater Data Assessment: Overview. In Bandaragoda, C., C. Lindsay, J. Greenberg, and M. Dumas, editors. WRIA 1 Groundwater Data Assessment	Whatcom County PUD #1, Whatcom County, WA. WRIA 1 Joint Board, 2013.	Lindsay, C. and C. Bandaragoda,	<a href="http://wria1project.whatcomcounty.org/">http://wria1project.whatcomcounty.org/</a> [last accessed 2/1/16]
Bertrand watersheds	Groundwater Investigations of Bertrand and Tenmile Watersheds	Whatcom County Public Works Department, 2008.	Dr. Michael Barber, Dr. Joan Wu, Mr. Erik Pruneda, and Ms. Colette McKenzie, and Dr. Diana Allen	<a href="http://wria1project.whatcomcounty.org/uploads/PDF/wsu/whatcomcounty_wsugwmodel_rpt_6_27_08.pdf">http://wria1project.whatcomcounty.org/uploads/PDF/wsu/whatcomcounty_wsugwmodel_rpt_6_27_08.pdf</a> [last accessed February 1, 2016]

Table 11: Groundwater maps

WID/ Area	Parameter	Title	Last modified	Source	URL	Notes
all	Ground- water movement	Generalized Pattern of Ground -Water Movement for the Puget Sound Aquifer System in the WRIA 1 Study Area	2000	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/maps/mapGW2.pdf">http://wa.water.usgs.gov/projects/wria01/maps/mapGW2.pdf</a> [last accessed October 1, 2015]	Modified from Vaccaro, J.J., Hasen, A.J. and Jones, M.A., 1998. Hydrogeologic Framework of the Puget Sound Aquifer System, Washington and British Columbia; US Geological Survey Professional Paper 1424-D.
all	Selected well locations	Locations of Selected Wells in the WRIA 1 Study Area by Primary Water Use	2000	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/maps/mapGW4.pdf">http://wa.water.usgs.gov/projects/wria01/maps/mapGW4.pdf</a> [last accessed October 1, 2015]	USGS National Water Information System (NWIS), downloaded December 14, 1999. Not all well locations have been verified and therefore they may plot in the wrong locations.
all	Ground- water levels	Water-Level Contours in the Uppermost Aquifer of the Lynden-Everson-Nooksack- Sumas (LENS) Study Area	2000	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/maps/mapGW3.pdf">http://wa.water.usgs.gov/projects/wria01/maps/mapGW3.pdf</a> [last accessed October 1, 2015]	From: Cox, S.E., and Kahle, S.C., 1999, Hydrogeology, Ground-Water Quality, and Sources of Nitrate in Lowland Glacial Aquifers of Whatcom County, Washington, and British Columbia, Canada: U.S. Geological Survey Water-Resources Investigations Report 98-4195, 5 plates, 251 p.
all	Aquifer tests	Approximate Locations of Aquifer Tests in the WRIA 1 Study Area	2000	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/maps/mapGW5.pdf">http://wa.water.usgs.gov/projects/wria01/maps/mapGW5.pdf</a> [last accessed October 1, 2015]	From: Various Hydrogeologic Studies in the WRIA 1 Study Area
all	Selected well locations	Locations of Selected Wells in the WRIA 1 Study Area with Sufficient Information to Compute Hydraulic Conductivities	2000	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/maps/mapGW6.pdf">http://wa.water.usgs.gov/projects/wria01/maps/mapGW6.pdf</a> [last accessed October 1, 2015]	From: USGS National Water Information System (NWIS), downloaded December 14, 1999. Not all well locations have been verified, therefore they may plot in the wrong locations.
all	Selected well locations	Locations of Selected Wells in the WRIA 1 Study Area with Five or More Historical Water Levels	2000	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/maps/mapGW7.pdf">http://wa.water.usgs.gov/projects/wria01/maps/mapGW7.pdf</a> [last accessed October 1, 2015]	From: USGS National Water Information System (NWIS), downloaded December 14, 1999. Not all well locations have been verified and therefore they may plot in the wrong locations

WID/ Area	Parameter	Title	Last modified	Source	URL	Notes
all	Soil types	Distribution of Soil Map Units in the WRIA 1 Study Area	2000	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/maps/mapGW8.pdf">http://wa.water.usgs.gov/projects/wria01/maps/mapGW8.pdf</a> [last accessed October 1, 2015]	From: U.S. Department of Agriculture, 1994, State Soil Geographic (STATSGO) Data Base: Date use information, Soil Conservation Service, National Cartography and GIS Center, Fort Worth, Texas, accessed January 28, 2000, at URL <a href="http://www.ftw.nrcs.usda.gov/stat_data.html">http://www.ftw.nrcs.usda.gov/stat_data.html</a> . Note: The soil information for this map was Natural Resources Conservation Service 1994 STATSGO data. STATSGO was compiled at 1:250,000 and designed to be used primarily for regional, multi-state, state, and river-basin resource planning, management, and monitoring.
all	Soil permeability	Soil Permeability in Parts of the WRIA 1 Study Area	2000	USGS	<a href="http://wa.water.usgs.gov/projects/wria01/maps/mapGW9.pdf">http://wa.water.usgs.gov/projects/wria01/maps/mapGW9.pdf</a> [last accessed October 1, 2015]	Modified from: U.S. Department of Agriculture-Soil Conservation Service, 1992, Soil Survey of Whatcom County Area, Washington, 54 sheets, 481 p.

Table 12: Water rights

Area	Parameter	Title	Source	URL	Notes
all	Quantity, place of use, source, purpose, all documents associated with water rights, and well logs	Water Resources Explorer	Washington State Department of Ecology	<a href="http://www.ecy.wa.gov/progr/ams/wr/info/webmap.html">http://www.ecy.wa.gov/progr/ams/wr/info/webmap.html</a> [last accessed October 1, 2015]	You can search with an interactive map, or using information such as address, township and range, or latitude and longitude.
all	Water rights	WRIA 1 Water Rights Atlas, 2003	Public Utility District No. 1	<a href="http://wria1project.whatcomcounty.org/Resource-Library/Studies-And-Reports/Water-Rights/65.aspx">http://wria1project.whatcomcounty.org/Resource-Library/Studies-And-Reports/Water-Rights/65.aspx</a> [last accessed February 1, 2016]	

Table 13: Land use/Land cover

WID/Area	Watershed	Parameter	Document	URL	Notes
Bertrand	Canadian Fishtrap and Bertrand	Impervious Area	Koole, S. 2005. An Analysis of the Land Use Patterns and the Overall Health of the Canadian Portion of the Bertrand and Fishtrap Creek Watersheds. Envs Thesis Paper. Prof. Karen Steensma, Advisor.		Referenced in North Lynden WID Mgmt Plan, 2009
Bertrand	Canadian Fishtrap and Bertrand	Land use US/Canadian	Koole, S.R. and K.M.M. Steensma. (2007) Land use in the Canadian portions of two transboundary watersheds, Bertrand Creek and Fishtrap Creek. Vancouver, BC: Proceedings of the 2007 Georgia Basin Puget Sound Research Conference		Referenced in North Lynden WID Mgmt Plan, 2009
Bertrand	Fishtrap Creek - Canadian and US	land use map US and Canadian	Bandaragoda, C., Greenberg, J. (2009) Fishtrap Creek Hydrologic Model Update and Assessment, Final Report, Appended to North Lynden WID Mgmt Plan, 2009		
Bertrand	Fishtrap US	Pop. size US/Canadian size elevation Irrigated acreage	North Lynden WID, 2009. Management Plan for Drainage, Flooding, Irrigation and Fish Issues	<a href="https://www.piersystem.com/external/content/document/2012/297519/1/TOC,%20Acknowledgements,%20Executive%20Summary.pdf">https://www.piersystem.com/external/content/document/2012/297519/1/TOC,%20Acknowledgements,%20Executive%20Summary.pdf</a> [last accessed October 1, 2015]	
Whatcom County		Agricultural Land Cover Analysis	Whatcom County Agricultural Land Cover Analysis version 2.3. 2013. Whatcom County Planning and Development Services	<a href="http://www.whatcomcounty.us/documentcenter/view/3989">http://www.whatcomcounty.us/documentcenter/view/3989</a> [last accessed October 1, 2015]	
Bertrand	Bertrand, Fishtrap, Kamm	Ag land use classes	Land Uses and Vegetative Cover in focus area (figure 10) from Agriculture-Watershed Characterization and Mapping Report. 2013. Whatcom County Ag-Watershed Project report.	< <a href="https://sites.google.com/site/wcwatershedag/">https://sites.google.com/site/wcwatershedag/</a> > [last accessed March 1, 2016]	Source: WC-Planning and Development Services, 2013
Whatcom County		Critical Areas Ordinance Maps	Whatcom County's Critical Areas (CAO) are environmentally sensitive natural resources that have been designated for protection and management in accordance with the requirements of the Growth Management	<a href="http://www.whatcomcounty.us/811/County-Wide-Critical-Area-Ordinance-Maps">http://www.whatcomcounty.us/811/County-Wide-Critical-Area-Ordinance-Maps</a> [last accessed February 26, 2016]	

WID/Area	Watershed	Parameter	Document	URL	Notes
			Act.		
Whatcom County		Land Cover Change	WDFW High Resolution Change Detection Project; Whatcom County: Land Cover Change by Sub-Basin	<a href="http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/15805">http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/15805</a> [last accessed February 26, 2016]	

Table 14: Land use/Land cover map and charts from Lower Nooksack Water Budget Overview

*Report includes Bertrand, Schneider, and Fishtrap.*

From: Bandaragoda, C., J. Greenberg, M. Dumas and P. Gill. (2012). Lower Nooksack Water Budget (Chapter 5, Land Cover). Whatcom County, WA: WRIA 1 Joint Board. Retrieved from <a href="http://wria1project.whatcomcounty.org/">http://wria1project.whatcomcounty.org/</a> [last accessed October 1, 2015 ]	Figure
WRIA 1 map of existing land cover	Figure 1
WRIA 1 map of historic land cover classes, produced by Utah State University (Winkelaar 2004).	Figure 2
Areal distribution of existing and historical land cover classes in the Lower Nooksack watershed (top) and the Nooksack Forks watershed (bottom).	Figure 7
Final land cover classification, original data source class, and Lower Nooksack Water Budget land cover parameters.	Table 1
Crop types in the Lower Nooksack Subbasin.	Table 2

Table 15: Land use/Land cover electronic data from Lower Nooksack Water Budget Overview

*Report includes Bertrand, Schneider, and Fishtrap.*

From: Bandaragoda, C., J. Greenberg, M. Dumas and P. Gill. (2012). Lower Nooksack Water Budget (Chapter 5, Land Cover). Whatcom County, WA: WRIA 1 Joint Board. Retrieved from <a href="http://wria1project.whatcomcounty.org/">http://wria1project.whatcomcounty.org/</a> [last accessed October 1, 2015].	Title
Tables of crop type summarized by the 16 drainages of the Lower Nooksack Subbasin	Appendix Chap5A_LN_AgLandUse.pdf
Classes and descriptions of original NOAA CCAP dataset	Appendix Chap5B_LandCoverClass.pdf
Classes and descriptions of original Whatcom County Agricultural Land Cover Analysis	Appendix Chap5C_WhatcomCountyLandCover.pdf
GIS data, Whatcom County Agricultural Land Cover Analysis	Agrural-use-pds2011.shp
Parameter grids (ascii files) and Excel spreadsheets of parameter values by land cover class	Land Cover Model Parameter Lookup Tables (Folder: Ascii grids/ see lulc_existing.xls and lulc_historic.xls
Matlabcode to convert raster, lookup tables, and shapefile data to area averaged parameter values	Topnet-WM Preprocessing Program files
ArcGIS 10 Files Geodatabase Raster Grids 30 Meter Pixel resolution; Metadata xml	wria1_lulc_water_budget.gdb, 1. Existing Land Cover GIS data (<Lulc_exist>) 2. Historical Land Cover GIS data (<Lulc_hist>)
Lower Nooksack Subbasin Land cover tables and charts from GIS data	Lulc_charts_lowerNookonly.xlsx
WRIA 1 Land cover codes, tables, and charts from GIS data	Lulc_charts_wria1.xlsx

Table 16: NSEA spawner surveys

*NSEA has spawner survey reports from 1998 to the present. This table includes every relevant reach surveyed since 2005. Some reaches were not surveyed every year.*

Watershed	Creek	Station Location	Collected by	Source	Notes
Middle Fishtrap	Fishtrap lower	RM 4.9-5.7, close to Depot Road bridge	trained NSEA staff and volunteers	Nooksack Salmon Enhancement Spawning Grounds data and reports. <a href="http://www.n-sea.org/archived-publications">http://www.n-sea.org/archived-publications</a> [last accessed Feb 1, 2016]	Live salmon, carcasses and redds are recorded. The reports include brief descriptions of the reach. The monitored reaches have changed somewhat over time.
Upper Bertrand	Bertrand Creek	RM 8.2-8.7	trained NSEA staff and volunteers	Nooksack Salmon Enhancement Spawning Grounds data and reports. <a href="http://www.n-sea.org/archived-publications">http://www.n-sea.org/archived-publications</a> [last accessed Feb 1, 2016]	Live salmon, carcasses and redds are recorded. The reports include brief descriptions of the reach. The monitored reaches have changed somewhat over time.
Lower Fishtrap and/or Lower Kamm	Fishtrap Creek Lower	RM 3.0-4.1	trained NSEA staff and volunteers	Nooksack Salmon Enhancement Spawning Grounds data and reports. <a href="http://www.n-sea.org/archived-publications">http://www.n-sea.org/archived-publications</a> [last accessed Feb 1, 2016]	Live salmon, carcasses and redds are recorded. The reports include brief descriptions of the reach. The monitored reaches have changed somewhat over time.

Table 17: WDFW spawner surveys

Watershed	Parameter	Creek	Station location	Frequency	Date	Collected by	Source
Bertrand Creek	salmon (coho pink, chinook, chum): live, dead, and redds	Bertrand Cr	RM 8.4 and 9.7	annually	2005-2007	WDFW and NSEA field crews	WDFW Tasha Geiger Nooksack River Stock Assessment 360-305-2023 Natasha.geiger@dfw.wa.gov
Bertrand Creek	Steelhead: live, dead, and redds	Bertrand Cr	numerous sites	every two weeks to every month in spring	2008 - 2012	WDFW and NSEA field crews	WDFW Tasha Geiger Nooksack River Stock Assessment 360-305-2023 Natasha.geiger@dfw.wa.gov
Lower Fishtrap?	salmon (coho pink, chinook, chum): live, dead, and redds	Fishtrap Cr	RM 3.0 and 8.5	annually	2005 and 2007	WDFW and NSEA field crews	WDFW Tasha Geiger Nooksack River Stock Assessment 360-305-2023 Natasha.geiger@dfw.wa.gov
Lower Fishtrap?	Steelhead: live, dead, and redds	Fishtrap Cr	numerous sites	every two weeks to every month in spring	2008 - 2012	WDFW and NSEA field crews	WDFW Tasha Geiger Nooksack River Stock Assessment 360-305-2023 Natasha.geiger@dfw.wa.gov
Schneider	Limited field data from a one year survey to assess adult Steelhead spawning habitat: Steelhead redds or suitable gravel for Steelhead spawning.	Specifics are available upon request	Specifics are available upon request	One-time	2009	WDFW and NSEA field crews	WDFW Tasha Geiger Nooksack River Stock Assessment 360-305-2023 Natasha.geiger@dfw.wa.gov

Table 18: Aquatic nuisance species

Area	Title - Parameter	Notes	Frequency	Date		Source
Washington State	Aquatic invasive species	Description of aquatic nuisance species with distribution maps. Organized by organism.	ongoing		<a href="http://wdfw.wa.gov/ais">http://wdfw.wa.gov/ais</a> [last accessed October 1, 2015]	WDFW
Washington State	Washington Herp Atlas		unknown	Maps updated 2013	<a href="http://www1.dnr.wa.gov/nhp/r efdesk/herp/herpmain.html">http://www1.dnr.wa.gov/nhp/r efdesk/herp/herpmain.html</a> [last accessed October 1, 2015]	DNR
Washington State	Washington Nature Mapping Program – wildlife distribution maps		unknown	unknown	<a href="http://naturemappingfoundation.org/natmap/maps/">http://naturemappingfoundatio n.org/natmap/maps/</a> [last accessed October 1, 2015]	NatureMapping Program
US	USGS NAS – Nonindigenous Aquatic Species – presence and distribution	Searchable database/maps of nonindigenous aquatic species sightings organized by group, i.e. amphibians, fish, mammals.	unknown	Date of info varies	<a href="http://nas.er.usgs.gov/queries/default.aspx">http://nas.er.usgs.gov/queries/d efault.aspx</a> [last accessed October 1, 2015]	USGS
Washington State	Washington Department of Ecology Environmental Assessment Aquatic Plant Monitoring	Description of aquatic nuisance plants with distribution maps, searchable survey results by county, lake, or plant name, and downloadable survey data.	ongoing	Date of info varies	<a href="http://www.ecy.wa.gov/programs/wq/plants/weeds/index.html">http://www.ecy.wa.gov/progra ms/wq/plants/weeds/index.htm l</a> [last accessed October 1, 2015]	WA Department of Ecology
Whatcom County	Whatcom County Noxious Weeds webpages	Distribution map of some noxious weeds. Field guides and information about noxious weeds.	unknown	Map date is 2008. Website date is 2007. Other material is undated.	<a href="http://www.whatcomcounty.us/DocumentCenter/View/2506">http://www.whatcomcounty.us/Do cumentCenter/View/2506</a> [last accessed October 1, 2015]	Whatcom County
Pacific Northwest	Aquatic and Riparian Effectiveness Monitoring Program Invasive Species Report	Description of monitoring program and presence of invasive species in surveyed areas.	2010	2011	<a href="http://www.reo.gov/monitoring/reports/watershed/AREMP%20Aquatic%20Invasive%20Species%20Report%202010.pdf">http://www.reo.gov/monitoring /reports/watershed/AREMP%20 Aquatic%20Invasive%20Species %20Report%202010.pdf</a> [last accessed October 1, 2015]	UW Forest Service and Bureau of Land Management

Table 19: Additional habitat/wildlife documents

Watershed/area	Parameter	Document
Does not include Dakota, California, or Sumas River watersheds	Riparian function	Coe, T. 2001. Nooksack River Watershed Riparian Function Assessment. Nooksack Indian Tribe Natural Resources Department. < <a href="http://salmon.wria1.org/resources/documents">http://salmon.wria1.org/resources/documents</a> > [last accessed January 4, 2016]
Relevant to all WID areas	Fish barriers	Whatcom County Public Works, 2006. Whatcom County Fish Passage Barrier Inventory Final Report - IAC Project Number: 01-1258 N. January, 2006. < <a href="http://salmon.wria1.org/resources/documents">http://salmon.wria1.org/resources/documents</a> > [last accessed January 4, 2016]
WRIA 1	Fish habitat	Smith, C.J. 2002. Salmon and steelhead habitat limiting factors in WRIA 1, the Nooksack basin. Washington State Conservation Commission, Lacey, Washington. 325 pp.
Bertrand Creek watersheds Fishtrap Creek watersheds	2013 Data Integration of WRIA 1 Hydraulic, Fish Habitat, and Hydrology Models	Bandaragoda, C. Joanne Greenberg, and Mary Dumas (2013). Data integration of WRIA 1 Hydraulic, Fish Habitat, and Hydrology Models. 134 pp. Nooksack Indian Tribe, Whatcom County, WA. WRIA 1 Joint Board. Retrieved [Date], from <a href="http://wria1project.whatcomcounty.org/">http://wria1project.whatcomcounty.org/</a> [last accessed February 1, 2016]
Bertrand	Habitat assessment	Bertrand Creek Habitat Assessment, Final Report, June 2002. Prepared for Whatcom Conservation District by Lynden Biological
Fishtrap	Fish presence	Pearson, M. P., 2004. The Ecology, Status, and recovery prospects of the Nooksack Dace ( <i>Rhinichthys cataractae</i> ) and the Salish Sucker ( <i>Catostomus</i> sp) in Canada. The University of British Columbia, July 2004.
Nooksack	Fish presence	Nooksack Tribe, 2004. Referenced in North Lynden Watershed Improvement District Management Plan for Drainage, flooding, Irrigation and Fish Issues, 2009. Bibliography entry is unclear.
WRIA 1	Fish presence	Anchor Environmental, LLC. 2003. Fish periodicity in WRIA 1. Prepared for City of Bellingham Public Works Department. Seattle, Washington. 43 pp+ Appendices
Bertrand, Fishtrap	Juvenile salmonids (salmon, steelhead, trout)	This data was collected by Bob Vadas (WDFW) and is not an official report but it does speak to juvenile population numbers found in Bertrand Cr, Fishtrap Cr and Deer Cr sampling locations where also sampled for comparison. This data has not been fully analyzed at this time and should only be used as an initial look into juvenile populations. Sampling was conducted from 2006-2010.
Numerous watercourses in Fishtrap watershed	Vegetation, habitat, fish use	North Lynden Watershed Improvement District, 2009. Management Plan for Drainage, Flooding, Irrigation, and Fish Issues

Watershed/area	Parameter	Document
Whatcom County	Biodiversity	Nelson, R., 2007. Mapping Biodiversity in Whatcom County: Data and Methods. Submitted to the Whatcom Legacy Project, August 2007. < <a href="http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/15493">http://wa-whatcomcounty.civicplus.com/DocumentCenter/View/15493</a> > [last accessed February 29, 2016]
Whatcom County	Wildlife	Eissinger, A., 1994. Significant Wildlife Areas. (Available through the public library)

Table 20: Additional habitat/wildlife maps and databases

Watershed/ Area	Parameter	Document/Website	URL	Source
Whatcom County	Fish Presence Char, Chinook, Chum, Coho, Cutthroat, Pink, Steelhead, Bull Trout/Dolly Varden	Maps: Fish Presence by species available on Whatcom County Critical Areas Ordinance Maps page	<a href="http://www.co.whatcom.wa.us/811/County-Wide-Critical-Area-Ordinance-Maps">http://www.co.whatcom.wa.us/811/County-Wide-Critical-Area-Ordinance-Maps</a> [last accessed February 24, 2016]	Whatcom County
Bertrand, Fishtrap	Fish Presence	Fish Presence map (figure 7) from Agriculture Watershed Characterization and Mapping Report	< <a href="https://sites.google.com/site/wcwatershedag/">https://sites.google.com/site/wcwatershedag/</a> > [last accessed February 24, 2016]	Data source listed as Fish Habitat Technical Team, 2003
Bertrand, Fishtrap	Salmonid Streams	Fish presence in the Lynden North Watershed management unit (figure 14) from Agriculture Watershed Characterization and Mapping Report	< <a href="https://sites.google.com/site/wcwatershedag/">https://sites.google.com/site/wcwatershedag/</a> > [last accessed February 24, 2016]	Source: WRIA 1, NWIFC, WCD, WCC
Bertrand, Fishtrap	Riparian wood recruitment potential	Condition of Riparian zone in the Study Area (figure 15) from Agriculture Watershed Characterization and Mapping Report	< <a href="https://sites.google.com/site/wcwatershedag/">https://sites.google.com/site/wcwatershedag/</a> > [last accessed February 24, 2016]	Source: Whatcom County Shoreline Characterization and Inventory Report 2006
Bertrand, Fishtrap	Priority Habitat and Species	Priority Habitat and Species (figure 9) from Agriculture Watershed Characterization and Mapping Report	< <a href="https://sites.google.com/site/wcwatershedag/">https://sites.google.com/site/wcwatershedag/</a> > [last accessed February 24, 2016]	Source listed as Whatcom County Critical Areas maps
Bertrand, Fishtrap	Wildlife Habitat	Western Whatcom County Wildlife Habitat Assessment and Significant Biological Areas Map (figure 6) from	< <a href="https://sites.google.com/site/wcwatershedag/">https://sites.google.com/site/wcwatershedag/</a> > [last	Washington Department of Fish and Wildlife

Watershed/ Area	Parameter	Document/Website	URL	Source
		Agriculture Watershed Characterization and Mapping Report	accessed February 24, 2016]	
Whatcom County	Wildlife	The Whatcom County mappings were completed in 2007, as part of a project to characterize ecosystem processes and wildlife habitat in the Birch Bay Watershed.	<a href="http://wdfw.wa.gov/conservation/habitat/planning/lha/whatcom.html">http://wdfw.wa.gov/conservation/habitat/planning/lha/whatcom.html</a> [last accessed February 1, 2016]	Washington Department of Ecology and Washington Department of Fish and Wildlife
Washington State	Priority Habitats and Species on the Web	PHS on the Web is a Washington Department of Fish and Wildlife web-based, interactive map for citizens, landowners, cities and counties, tribal governments, other agencies, developers, conservation groups, and interested parties to find basic information about the known location of Priority Habitats and Species (PHS) in Washington State.	<a href="http://wdfw.wa.gov/mapping/phs/">http://wdfw.wa.gov/mapping/phs/</a> [last accessed October 1, 2015]	Washington Department of Fish and Wildlife
Washington State	Salmon distribution, status, and habitats	SalmonScape is an interactive mapping application designed to display and report a wide range of data related to salmon distribution, status, and habitats. The data sources used by SalmonScape include stream specific fish and habitat data, and information about stock status and recovery evaluations.	< <a href="http://apps.wdfw.wa.gov/salmonscape/">http://apps.wdfw.wa.gov/salmonscape/</a> > [last accessed October 1, 2015]	Washington Department of Fish and Wildlife
West Coast	Salmon	Maps of salmon and steelhead population boundaries	< <a href="http://www.westcoast.fisheries.noaa.gov/maps_data/maps_and_gis_data.html">http://www.westcoast.fisheries.noaa.gov/maps_data/maps_and_gis_data.html</a> > [last accessed October 1, 2015]	NOAA Fisheries, West Coast Region
Whatcom County	Marine species and Habitats	Whatcom County Marine Resources maps of marine species and habitats	<a href="http://www.mrc.whatcomcounty.org/library">http://www.mrc.whatcomcounty.org/library</a> [last accessed October 1, 2015]	Whatcom County Marine Resources Committee Library
US	Critical habitat maps for marine and anadromous fishes	Website links to data and maps. The critical habitat maps provided here are for illustrative purposes only. Textual descriptions of critical habitats, which are provided in the associated <i>Federal Register</i> notices (see links below), are the definitive sources for determining critical habitat boundaries. Map and <i>Federal Register</i> notice links are PDF files.	<a href="http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm">http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm</a> [last accessed January 21, 2016]	NMFS NOAA

Watershed/ Area	Parameter	Document/Website	URL	Source
US	Threatened and Endangered Species	Environmental Conservation Online System, data and maps.	<a href="http://ecos.fws.gov/ecp/">http://ecos.fws.gov/ecp/</a> [last accessed February 18, 2016]	US FWS
Washington State	Rare plants, animals, ecological communities	Reference Desk of the Washington Natural Heritage Program. Includes searchable databases	<a href="http://www1.dnr.wa.gov/nhp/refdesk/gis/index.html">http://www1.dnr.wa.gov/nhp/refdesk/gis/index.html</a> [last accessed October 1, 2015]	Washington State Department of Natural Resources
Puget Sound Region	Wetlands	National Wetlands Inventory, data and maps	<a href="http://www.fws.gov/wetlands/">http://www.fws.gov/wetlands/</a> [last accessed February 1, 2016]	US FWS

Table 21: Soils

WID/Area	Parameter	Document	URL	Source
National	Soils	Web Soil Survey	< <a href="http://websoilsurvey.nrcs.usda.gov/app/">http://websoilsurvey.nrcs.usda.gov/app/</a> > last accessed October 1, 2015	USDA Natural Resource Conservation Service

Table 22: WRIA 1 materials online

*In addition to the WRIA 1 materials included in this memo, there are many additional resources available on the WRIA1 Resource Library webpages*

Watersheds	Type of Resource	Topics or Titles	URL
all	Studies	Water rights, Water Quantity, Water Quality, and Habitat and Instream Flow; The 2010 State of the Watershed Report, 2013 WRIA Groundwater Data Assessment, 2013 Data Integration of WRIA 1 Hydraulic, Fish Habitat and Hydrology Models, The Whatcom County Coordinated Water System Plan (2000), and 2005 Numerical Groundwater Flow Model of the Abbotsford-Sumas Aquifer	< <a href="http://wria1project.whatcomcounty.org/Resource-Library/8.aspx">http://wria1project.whatcomcounty.org/Resource-Library/8.aspx</a> > [last accessed February 1, 2016]
all	Maps	WRIA 1 Watersheds Map V3 Historic Land Cover Map - USU Existing Land Cover Future Land Cover – USGS Impervious Surfaces – NOAA Population Density – WA DOE Approximate Depth to Water Combined Hydrology Mechanisms, Draft – 11 Precipitation – PRISM Surface Water Storage Alterations Water Right Watershed Status Long Term Monitoring Adopted Map, and Interactive WRIA Monitoring Stations.	< <a href="http://wria1project.whatcomcounty.org/Resource-Library/Maps/38.aspx">http://wria1project.whatcomcounty.org/Resource-Library/Maps/38.aspx</a> > [last accessed February 1, 2016]



## Appendix B: WID Work session information Bertrand Watershed Improvement District

### 1. Overview of Bertrand WID characterization and mapping work

Bertrand Watershed Improvement District (Bertrand WID) hosted a work session with the ag-watershed project team to prepare agricultural-watershed characterization and mapping work products for use in the Bertrand WID's ongoing comprehensive planning. Some of the final work products will also be used as part of the Ag-Watershed Project final report to the Whatcom County Planning & Development Services (WCPDS) Agriculture Program and to the Washington Department of Commerce.<sup>1</sup>

This appendix provides documentation of the January 2016 WID work session, a summary of materials used to gather and document input both before and after the work session, and a list of participants engaged in developing and reviewing the agricultural-watershed characterization and mapping work.

The Bertrand WID Board reviewed and approved:

- the scope of work for Task 6 (extended ag-watershed characterization and mapping: December 2015),
- draft characterization tables from the work session and preliminary draft maps (February-March 2016),
- the draft summary report documenting methods and results (April-May 2016), and
- the full draft report on the WID characterization and mapping (this document: May-June 2016).

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<sup>1</sup> The Ag-Watershed Project is a research and development project funded by a National Estuary Program Watershed Protection and Restoration Grant (June 2012 to June 2016) to Whatcom County Planning & Development Services, administered by the Washington Department of Commerce. Project partners include: Whatcom Farm

### 2. Bertrand WID work session

The January 21, 2016 work session participants included Bertrand WID members and guests who contributed local knowledge and expertise to identify agriculture and watershed priorities and enhancement opportunities within in the WID area.

Participants were introduced to a structured process to identify specific characteristics of the agricultural and watershed systems and locate these on maps of the WID area. Small groups of participants then worked together to identify, characterize and locate agricultural system characteristics and enhancement opportunities in the WID area.

The January 2016 work session orientation included an overview of the Bertrand WID area and instruction on the method used for the characterization and mapping activities.

#### Background information provided at the work session:

- January 21, 2016 Agenda and work session overview.
- Summary of the Agricultural Analysis Method, included in an excerpt from the 2013 Ag-Watershed Characterization & Mapping Report.
- Fact sheet #2 "Identifying Opportunities to Strengthen Agriculture & Watershed Systems in Whatcom County."
- "*About the Bertrand WID*" website excerpt describing the WID boundary locations and list of WID priorities for agriculture and watershed services.

Friends-Community Education, Whatcom Conservation District, and Washington State Department of Fish & Wildlife. Project fact sheets and links to all previous work, including technical reports and reference documents can be found at <http://whatcomcounty.us/2260/Agricultural-Watershed-Pilot-Project>

### Reference information provided at the work session:

Prior to the WID work session, the Ag-Watershed Project team compiled information from existing planning and reference documents describing agricultural and watershed systems and enhancement priorities in the Bertrand WID area. Background maps and materials were prepared for use in table-top mapping activities (see complete list of work session maps and supporting materials below).



Figure 1. 2016 WID Work session table-top materials.

### Work session materials:

- Bertrand WID large-scale locality maps for table-top discussion and note-taking purposes.
- Bertrand WID Agricultural Enhancement Priorities: Tables & Worksheets.
- Bertrand WID Watershed Enhancement Priorities: Tables & Worksheets.
- Bertrand WID Background Maps featuring Water Flow Assessments:
  - Water Flow Assessment Unit (AU) map.
  - Water Flow Characterization Results (All) from Puget Sound Watershed Characterization Project (PSWCP) 2015 management recommendations.

- Importance and Degradation of Water Flow from PSWCP 2015 analysis.
- Overall Water Flow Restoration & Protection Management Recommendations from PSWCP 2015 analysis.

### Reference maps provided at the work session:

- Overview and Locality Map: Preliminary showing PSWCP 2015 Area Units & Bertrand WID sub-area names, locations.
- Agricultural Priority Areas: Preliminary Draft from Whatcom County Planning & Development Services (WCPDS), 2015 Purchase of Development Rights (PDR) Easements.
- Agriculture Priority Areas and Zoning from WCPDS, 2015.
- Actively Farmed Land from WCPDS, 2015.
- Fish Presence from WRIA 1 Watershed Management Project, 2004.
- Relative Conservation Value of Land from Conservation Northwest, 2007.
- Agricultural Land Use Classes from WCPDS, 2011.
- Priority Habitats and Species from WA Department of Fish & Wildlife 2014 and WA Natural Heritage Program, 2015.
- Prime Soils from SSURGO, NRCS, 2015.
- Water Rights: Points of Diversion from WA Department of Ecology, 2016.
- Condition of Riparian Zone from Nooksack Tribe and Lummi Nation Nooksack Riparian Conditions, 2000.
- Potential Development Rights from WCPDS, 2015.
- 303d Water Quality Impairments (2012) from WA Department of Ecology.
- Watershed health assessment results from Whatcom Conservation District, 2015.



Figure 2. 2016 work Session in action.

**Work session participants:**

The objective of the January 2016 Bertrand WID work session was to gather input on agricultural system characteristics and enhancement opportunities from a representative mix of agricultural producers and landowners, with the goal of 51% of participants who are active farmers and/or landowners and Bertrand WID members.

The WID Board invited a mix of participants considering: (i) location within the WID sub-basins; (ii) type of agricultural operation; (iii) size of agricultural operation; and (iv) parcel size. The WID Board identified additional guests to assist with and advise the work session participants, to provide additional technical inputs at the work sessions, and to review work products for accuracy. See Table 1 for a summary of Bertrand WID work session invitees and attending participants\*.

Table 1. Bertrand WID Work Session Invitees and Participants.

WID Invitees & Participants*	WID Area	Ag Type
Glen Blankers	Lower Bertrand East	Dairy
John & Karen Steensma	Lower Bertrand West	Dairy
Justin (JB) Bouma*	Lower Bertrand West	Dairy
Richard Kaufman*	Lower Bertrand West	Small Farm
Hilary Kaufman*	Lower Bertrand West	Small Farm
Larry & Cheryl DeHaan	Upper Bertrand	Dairy
Morrie DeBoer	Lower Bertrand East	Dairy
Jay & Ryan Kaemingk	Lower Bertrand West	Crop
Terrence R. DeValois*	Lower Bertrand West	Dairy
Doug Bajema	Middle Bertrand West	Horse
Robert & Debbi Smit	Middle Bertrand East	Heifer
Al DeBoer*	Schneider North	Dairy
Rich DeVries	Upper Bertrand	Cattle
Jag Alamwala	Middle Bertrand West	Berry
Kevin Berendsen*	Middle Bertrand West	Berry
Vern VandeGarde*	Middle Bertrand East	Berry
Scott Bedlington*	Schneider North	Potato
Mike Schoneveld*	Lower Bertrand West	Dairy
Pete Vlas	Middle Bertrand East	Dairy
Greg Ebe	Middle Bertrand West	Potato
John Clark	Middle Bertrand West	Berry
WID Guests	Expertise	Agency
Karin Beringer*	Ag land priorities, enhancements	Ag Land Program,
Chris Elder*		WCPDS
Mark Personius*		
Paula Harris*	Flood, drainage enhancements	Flood, WCPW
Joel Ingram*	Fish & wildlife habitat enhancements	WA Dept. of Fish Wildlife
Frank Corey*	Riparian priorities, enhancements, CREP, water quality	Whatcom Conservation District
Steve Banham	Flooding & stormwater	City of Lynden
Mark Sandal		(Public Works)

### 3. Record of meetings

During WID Board meetings, WID Commissioners reviewed the proposed scope of the ag-watershed characterization and mapping work products, the draft work session materials, and preliminary draft work products prior to the completion of the final project deliverables.

Meetings included:

December 1, 2015 - Bertrand WID Board reviewed project scope of work (SOW) and proposed Memorandum of Understanding (MOU) with Whatcom County Planning and Development Services.

January 5, 2016 - Bertrand WID Board reviewed and approved proposed SOW, MOU, and work session agenda and invitees.

March 22, 2016 - Bertrand WID Board reviewed summary of work session input and preliminary draft report contents.

May-June 2016 - Bertrand WID Board reviewed and confirmed the final Bertrand WID Agriculture-Watershed Characterization and Mapping Report.

### 4. Record of documents

The Bertrand WID Board worked with Ag-Watershed Project staff to conduct work session outreach and proceedings. This record of documents includes administrative documents used to guide the project work and documentation of Ag-Watershed Project team and participant contributions to the final work products and analysis (maps, tables and summary report).

Administrative materials included:

- December 2015 SOW for Bertrand WID agricultural and watershed characterization and mapping project (see Table 2 on page 4 with excerpt on the Agricultural Analysis Method).
- December 2015 draft MOU with WCPDS.
- January 21, 2016 Bertrand WID work session invitation and RSVP tracking list.

- January 21, 2016 Bertrand WID Work Session Agenda.

Information materials provided for preliminary review included:

#### Tables

- Table 1. Summary of results of ag-watershed characterization mapping for the Bertrand WID.
- Table 2. Agricultural characterization tables for Bertrand WID characterization mapping for the Bertrand WID.
- Table 3. Key actions on agricultural priorities specific actions map.
- Table 4. Watershed characterization tables for the Bertrand WID.

#### Maps

- Bertrand WID overview and locality.
- Bertrand WID agricultural priorities: Proportion of prime soils. Data from reference map of prime soils.
- Bertrand WID agricultural priorities: Drainage of agricultural land. Data from reference maps of prime soils and special districts.
- Bertrand WID agricultural priorities: Protection of agricultural land from flooding. Data from reference maps of prime soils and special districts plus WCPDS GIS data on FEMA flood areas.
- Bertrand WID agricultural priorities: Protection of the agricultural land base. Data from reference map of agriculture priority areas.
- Bertrand WID agricultural priorities: Water for agricultural activities. Data from reference map on water right points of diversion.
- Bertrand WID map of specific actions for agricultural priorities (generated at January 2016 work session).
- Bertrand WID: Overall water flow restoration & protection priorities.
- Bertrand WID: Water flow assessment units in relation to WID area.
- Bertrand WID: Water flow process assessment results.
- Bertrand WID: Overall water flow restoration & protection priorities.

Table 2. Excerpt: Ag-Watershed Project Agricultural Analysis Method<sup>2</sup>

<i>Priority What?</i>	<i>Where?</i>	<i>Related Background Info.</i>
Soils	Primary, secondary, tertiary soils for all crop types and rotations. Selection Criteria: Prime Agricultural soils are present in the watershed.	Map: Ag Priority Areas Map: Ag Land Use Map: Prime soils
Water Quantity	Water for irrigation, livestock and agricultural processing. Selection Criteria: One or more applications for new water rights are present, and identified in the Ag Mapping Workshop.	Map: Water Rights
Land Drainage	Includes timing of field drainage for agricultural crops and storage opportunities. Selection Criteria: Over 50% of area contains Prime Ag soils only if drained, or identified in the Ag Mapping Workshop.	Map: Prime soils
Flood Protection	Relief from high flashy flows and sustained flooding events. Selection Criteria: Contains prime Ag soils only if protected from flooding, or identified in the Ag Mapping Workshop.	Map: Ag Land Use Map: Prime soils
Protection of the Ag Land Base	Use of purchase or transfer of unrealized development rights in order to protect working ag land from conversion pressures. Selection Criteria: over 50% the area includes any combination of land zoned Agriculture, "Rural Study Area", or in PDR easements.	Map: Ag Priority Areas Map: Ag Land Use Map: Potential Development Rights

<sup>2</sup> Agricultural Analysis Method from the Agriculture-Watershed Characterization & Mapping Report combines information on existing agricultural protection programs, local knowledge and available GIS data. See: Gill P (2013). *Agriculture-Watershed Characterization and Mapping Report for the North Lynden watersheds*. Prepared for the Whatcom County Agriculture-

Watershed Pilot Project, Whatcom County Planning & Development Services, Bellingham. <http://www.co.whatcom.wa.us/2260/Agricultural-Watershed-Pilot-Project>



# Appendix C: Water Flow Assessment Results for Water Resource Inventory Area 1

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# 1 Methodology

The description of the watershed characterization methodology has been adapted from that provided in the Appendix to the pilot agriculture-watershed characterization and mapping report.<sup>1</sup>

## 1.1 General approach

The watershed characterization assessment uses methods developed by the Puget Sound Watershed Characterization Project.<sup>2</sup> The results of the watershed characterization assessment are intended to assist the WIDs in identifying high priority opportunities for watershed enhancement projects on agricultural land in the lowland areas of Whatcom County, with a focus in areas where watershed and agricultural priorities could be mutually reinforcing.

The *Puget Sound Watershed Characterization (PSWC)* is a set of water and habitat assessments that compare areas within a watershed for relative restoration and protection value. It is a coarse-scale decision-support tool that provides information for regional, county, and watershed-based planning. The information it provides allows local and regional governments, as well as NGOs, to base their land use decisions on a systematic analytic framework. It prioritizes specific geographic areas for protection, restoration, and conservation of our region's natural resources, and identifies where best to focus new development. Application of this method should result in future land-

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<sup>1</sup> Hume C & Stanley S (2013). *Summary of Water Flow Assessment Results for Bertrand, Fishtrap and Kamm Watersheds*. Appendix A in Gill P (2013). *Agriculture-Watershed Characterization and Mapping Report for the North Lynden watersheds*. Prepared for the Whatcom County Agriculture-Watershed Pilot Project by the Washington Department of Ecology Shorelands and Environmental Assistance Program.

<http://www.co.whatcom.wa.us/2260/Agricultural-Watershed-Pilot-Project>

<sup>2</sup> See [http://www.ecy.wa.gov/puget\\_sound/characterization/index.html](http://www.ecy.wa.gov/puget_sound/characterization/index.html)

use patterns that protect the health of terrestrial and aquatic resources while directing limited financial resources to the highest priority areas for restoration and protection.

The objective of the PSWC assessment is to “characterize” the watershed in a way that helps to identify priority enhancement opportunities. The relative comparison of assessment units (AUs) for water flow processes across the lowland watersheds allows for a coarse-level snapshot of which areas are relatively important or degraded for water flow. From this snapshot we suggest possible enhancement actions that could contribute to improving or protecting water flow processes at the AU scale. Actual site location of those actions within an assessment unit would require different analyses not described here.

The assessment results in this document address the following primary questions for the Whatcom County lowland watersheds:

(1) *Where on the landscape* should management efforts be focused first to benefit water flow processes in the watersheds that are part of the Watershed Improvement District?

(2) *What types of activities and actions* are most appropriate to that place based on the assessment results?

The assessment results therefore address both the “where” and the “what” to focus on, in terms of water flow processes. This integrated approach offers a systematic framework for identifying more important areas within the lowland watersheds and those which are more degraded for water flow processes and water quality, with the intent of identifying areas that offer the most potential for enhancement.

## 1.2 Limitations

Care should be taken to use the Puget Sound Watershed Characterization as intended. It is a coarse-scale assessment and is not intended for site-specific application or decision-making at the site scale. Finer scale data, local information and technical expertise is needed for those decisions. In addition:

- The Puget Sound Watershed Characterization is for planning purposes only. This does not affect or alter existing land use/environmental regulations although it may be used to help inform future land use and regulatory decisions.
- For the water flow assessment, the rankings for any single AU are relative only to other AUs in the area of analysis. This means it is only appropriate to compare the Watershed Improvement District (WID) results with results in other AUs in the lowland area of WRIA 1.
- Results at the AU scale represent land-use planning-level information. At the project- or site scale, each AU will have a combination of on-the-ground challenges and opportunities. Just because an AU is rated as a low priority for restoration does not mean there are no suitable restoration sites or opportunities in that AU. Similarly, not every site in an AU that is a high priority for restoration will be suitable for restoration.
- The assessments are landscape-scale and consequently do not address site-specific issues. These are best addressed through finer-scale studies, which will remain essential to the success of local conservation efforts. When developing site-level plans, the WID should evaluate the need for finer-scale information and collect it where needed.
- The watershed characterization assessment is not intended to address compliance with state or federal water quality law, nor describe the actions necessary to achieve compliance with those laws. It is a violation of state law when activities are shown to cause or have the substantial potential to cause nonpoint source

pollution. If the reader has questions about the water quality laws, they can contact Whatcom County Public Works or the WA Department of Ecology for additional information.

## 1.3 Fundamental Concepts of Watershed Characterization

Watershed processes are defined as the dynamic physical and chemical interactions that form and maintain the landscape and ecosystems on a geographic scale of watershed to basins. This includes the movement of water, sediment, nutrients, pathogens, chemicals and wood. Watershed processes are controlled and influenced by natural attributes and human actions. Natural controls on watershed processes include physical attributes of the ecosystem such as geomorphology, geology, and soils. Many human actions influence watershed processes. For example, timber harvest may reduce the amount of wood entering streams. Shoreline armoring can reduce sediment input from bluffs and alter the erosion, movement, and deposition of sediments along beaches. Urban development can increase the amount and amplitude of stormwater runoff. Watershed characterization attempts to model these watershed processes such that areas of the landscape can be identified which are relatively more important (presence of natural controls) or degraded (due to human impacts).

## 1.4 Understanding the Water Flow Assessment results

The Water Flow Assessment uses two models to compare the *importance* and *degradation* of water flow processes in a watershed. Together, they identify areas that are relatively more suitable for protection or restoration of water flow processes. Each model provides a ranking from low to high for how important and how degraded each assessment unit is *relative* to the other units in the watershed.

### Water Flow importance

The *importance* model evaluates the watershed in its “unaltered” state. This model combines the delivery, surface storage, recharge, and discharge components to compare the relative *importance* of assessment units in maintaining overall water flow processes in a non-degraded setting. When precipitation is “delivered” as either rain or snow, there are physical features that control the surface and subsurface movement of that precipitation within an assessment unit. These physical features include land cover, storage areas such as wetlands and floodplains, areas of higher infiltration and recharge, and areas that discharge groundwater. These areas are considered “important” to the overall water flow processes.

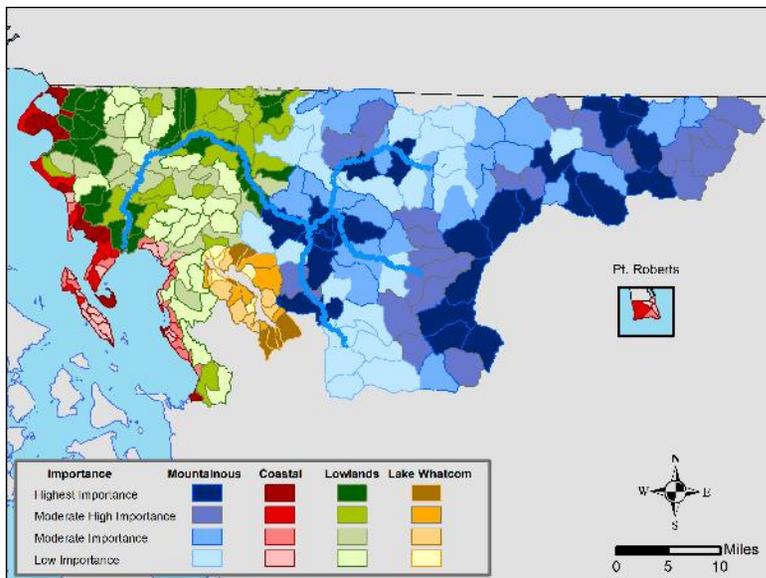


Figure. Overall importance to water flow processes: Results of Puget Sound Watershed Characterization assessment for WRIA 1. Darkest colored assessment units are considered highest *importance* relative to other assessment units in the same landscape group of WRIA 1.

In the figure to the left, each landscape group is displayed in a different color gradient (i.e. blue, green, red or tan), which allows for direct comparison within the extent of that landscape group only. Dark green assessment units would be considered *highly important* for overall water flow processes *only* within the lowland area of WRIA 1, and are not comparable to AUs outside of that extent. However, this does allow one to determine which AUs throughout the lowland areas of WRIA 1 are *relatively more important* than others in that same extent.

### Water flow degradation

In the water flow *degradation* model the watershed is evaluated in its “altered” state to consider the impact of human actions on water flow processes. The *degradation* model calculates the degree of alteration to those controls that regulate the delivery, movement and loss of water, such as forest clearing and impervious surfaces. This model combines the delivery, surface storage, recharge, and discharge components to compare the relative *degradation* to overall water flow processes in assessment units. Degradation to these processes generally accelerates the movement of surface flows downstream. This accelerated delivery increases downstream flooding and erosion and subsequently degrades aquatic habitat over time.

The figure below displays the results of the *degradation* to water flow processes for all of WRIA 1. Since degradation is not controlled by landscape, we compare assessment units within the entire extent of the WRIA. A dark pink unit along the coast is comparable in level of degradation to a unit in the lowland area.

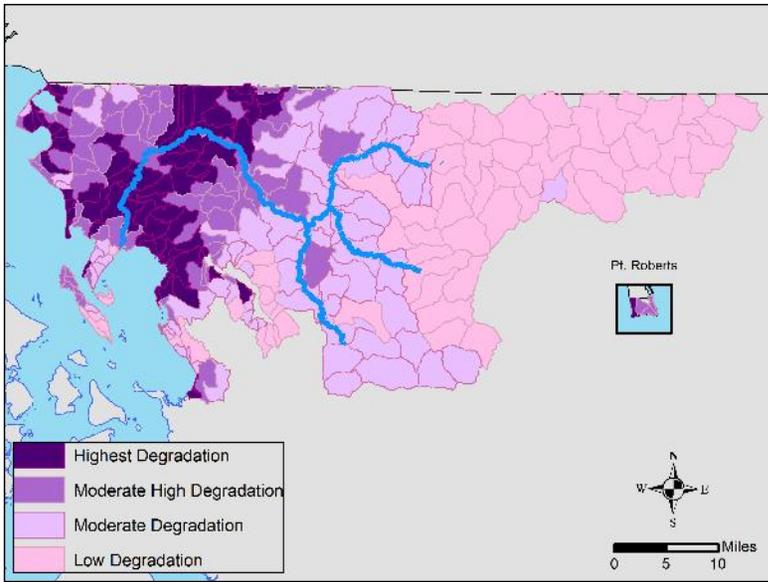


Figure. Overall degradation of water flow processes: Results of Puget Sound Watershed Characterization assessment for WRIA1. Dark pink assessment units are considered to have the highest *degradation* relative to other assessment units in WRIA1.

#### Management matrix for water flow

Combining the results of the *importance* and *degradation* models yields a simple categorical matrix that planners can use, along with other science-based information, to inform land management strategies and actions. At its simplest, this management matrix conveys which areas are relatively important and/or degraded, and what actions might be most appropriate there:

- Highly important – low degradation = protect
- Highly important – high degradation = restore
- Low importance – low degradation = conserve
- Low importance – high degradation = develop

The Puget Sound Watershed Characterization project generally prioritizes restoration or enhancement actions in watersheds which

are both highly important and are relatively more degraded for watershed processes (yellow boxes in the Management Matrix Figure below). This does not mean that there are not important areas or necessary restoration actions in assessment units that are not highly important and highly degraded. Rather, given limited funding these might be the first places to focus on in order to increase the likelihood of improving watershed processes.

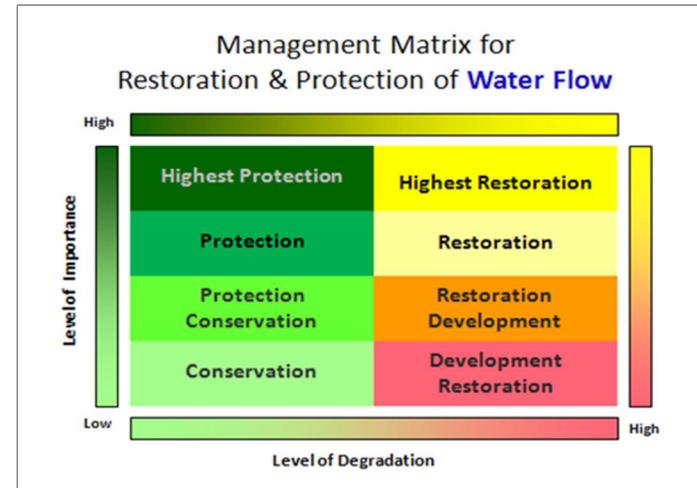


Figure: Management Matrix for Water Flow, indicating relative priorities for restoration and protection of processes. By accounting for both the relative level of *importance* and the relative level of *degradation* of an Assessment Unit one can begin to prioritize which areas of a watershed to apply management strategies which protect water flow processes, and which areas to prioritize restoration of water flow processes.

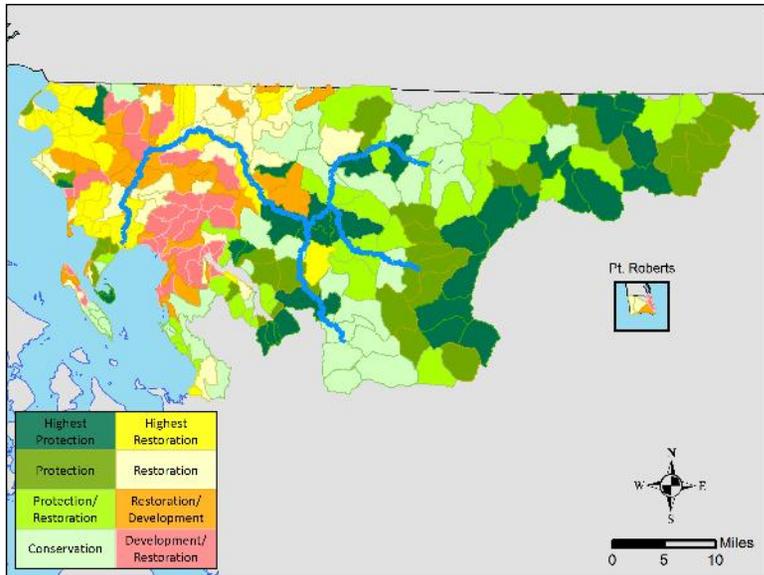


Figure. Overall priorities for restoration and protection of water flow processes in WRIA 1: Results of Puget Sound Watershed Characterization assessment.

## 2 Using the results of the water flow assessment

For water flow process enhancement or restoration, actions should be directed towards reducing the degradation to controls that regulate the delivery and movement of water through the watershed. These controls include forest cover, areas of surface storage, areas of permeable deposits, areas of slope wetlands and areas of floodplains with permeable deposits.

The terms “restoration” and “protection” as used in this document do not mean a return to historic land cover conditions or retaining 100% forested land cover. Restoration and protection actions should be done in a manner that recognizes and works within the constraints of the existing land use activities. For example, restoration in agricultural areas could mean consideration of measures that enhance

a critical portion of water flow processes such as surface storage. This could involve the retention of water on fields for a longer period to avoid harmful peak flows within streams during the winter months. Restoration and protection measures are, therefore, always proposed here in the context of both the landscape setting and the current land use activities.

There are actions which can offer mutual benefits to both water flow and water quality. For example, there are some areas where wetland restoration or enhancement to surface storage processes could provide some improvements for both. Enhancement actions for water flow processes may have additional benefits to other watershed processes and functions particularly in the area of riparian habitat and structure which are critical to salmonid habitats throughout the Whatcom County lowland watersheds.

### 3 Water flow assessment results for WRIA1

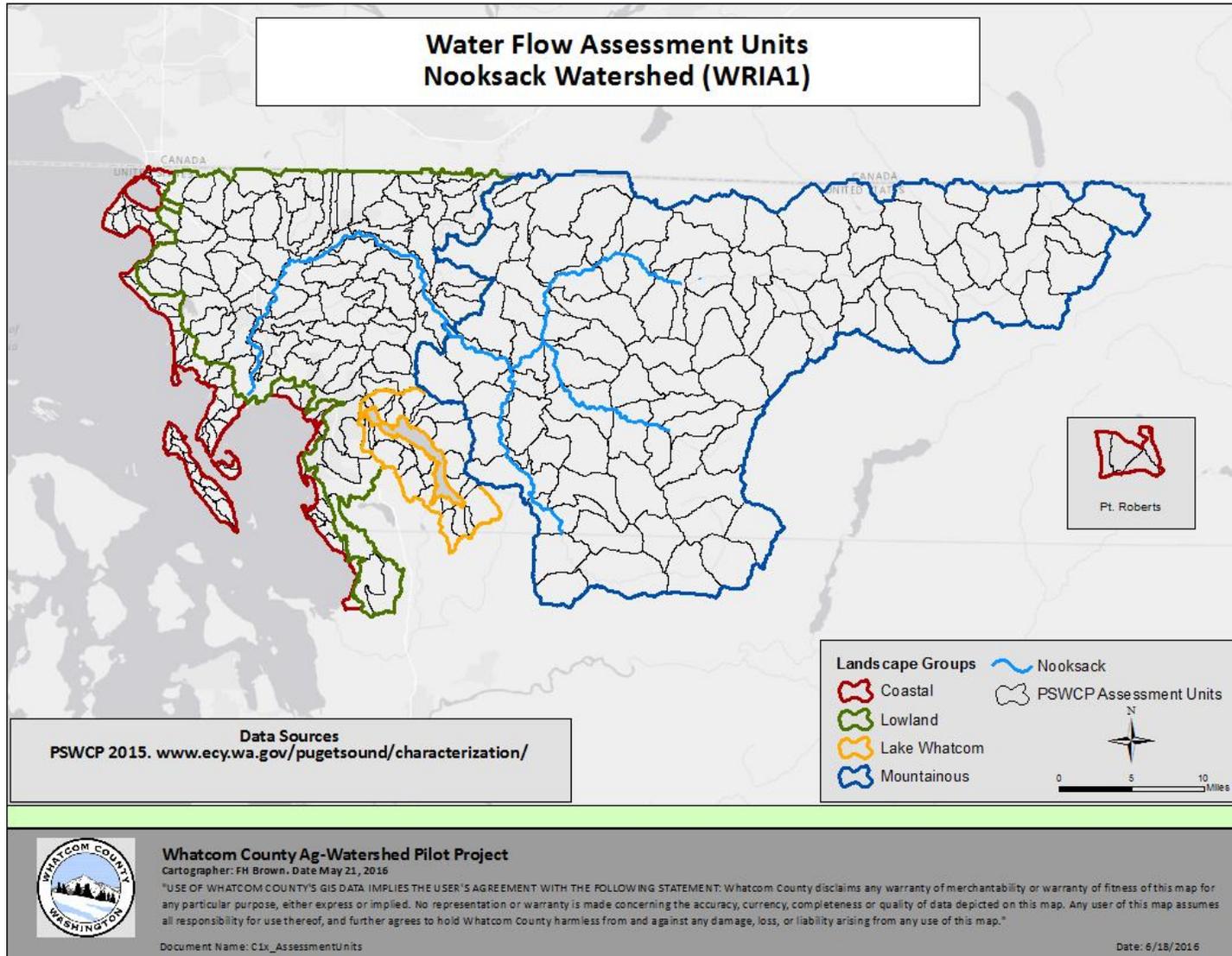


Figure 1. Water flow assessment units used in the Puget Sound Watershed Characterization.

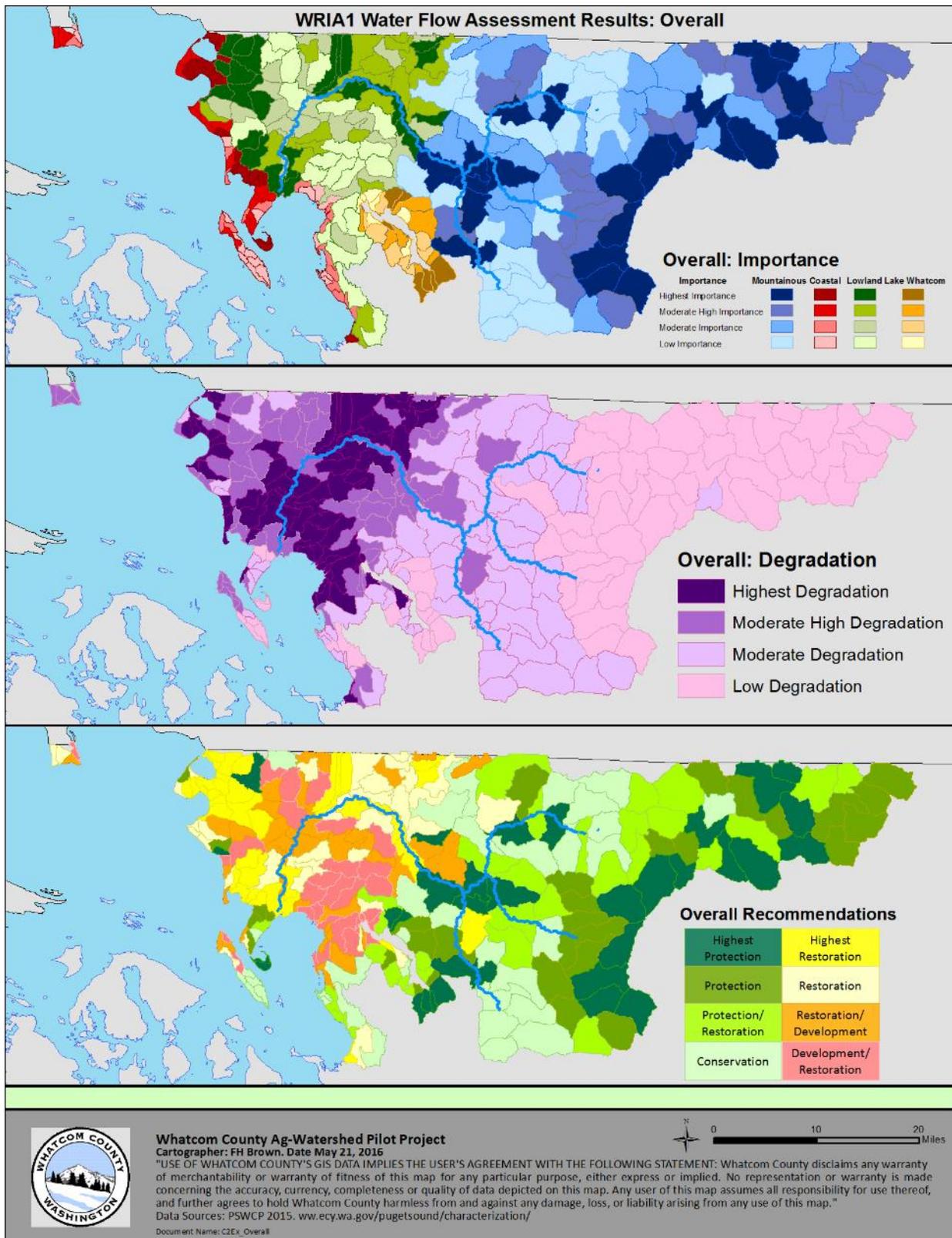


Figure 2. Overall water flow assessment results for WRIA1.

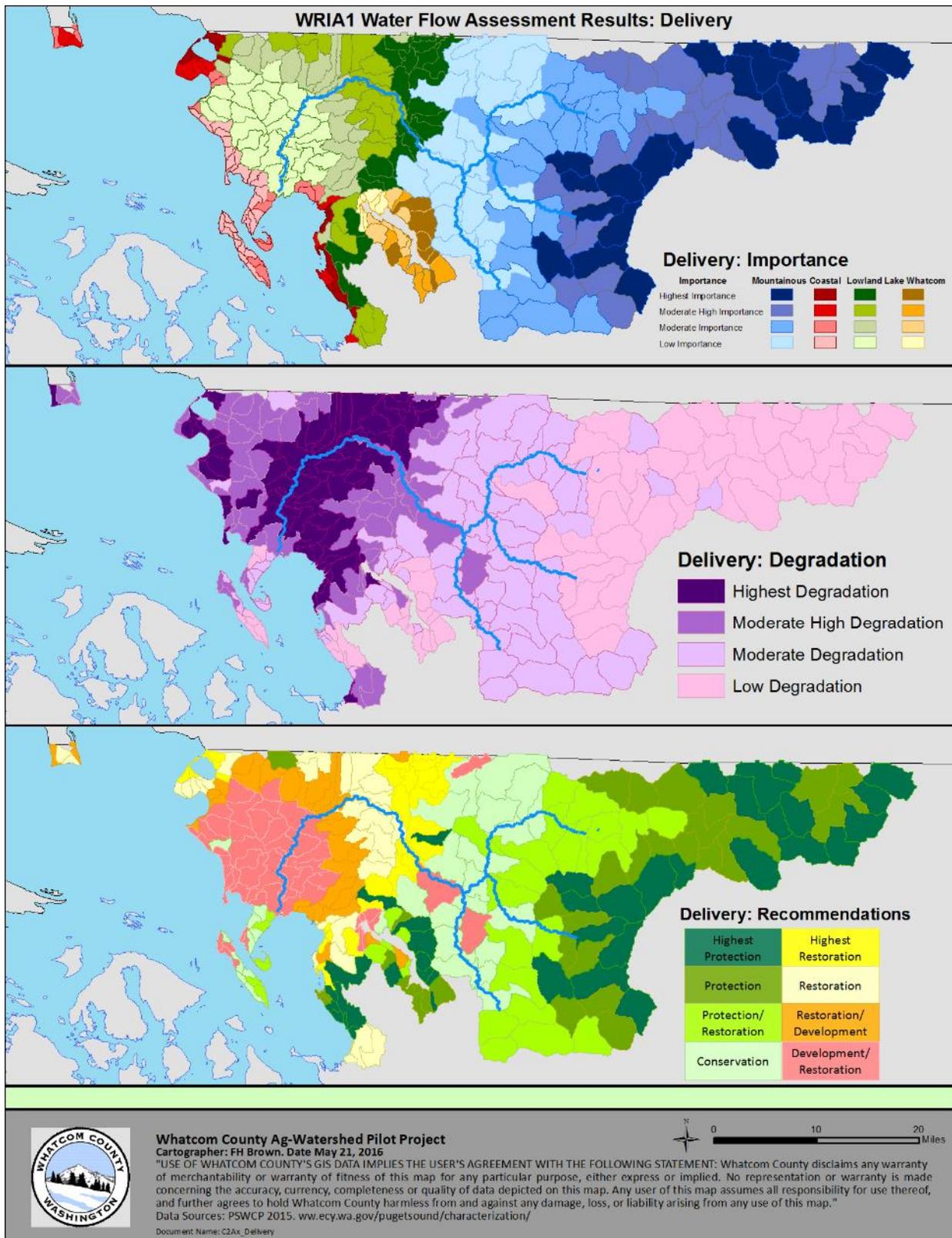


Figure 3. Delivery processes: Assessment results for WRIA1.

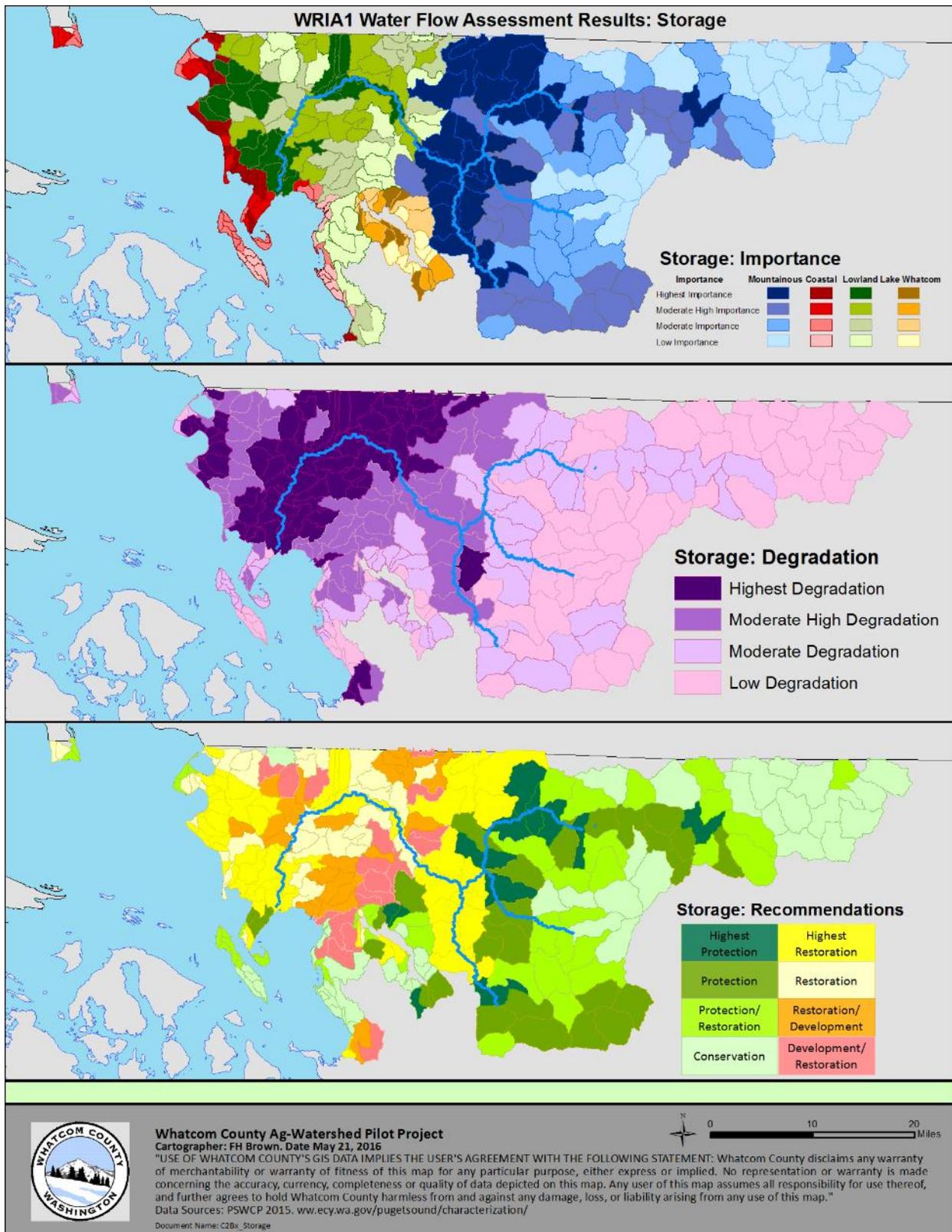


Figure 4. Storage processes: Assessment results for WRIA1.

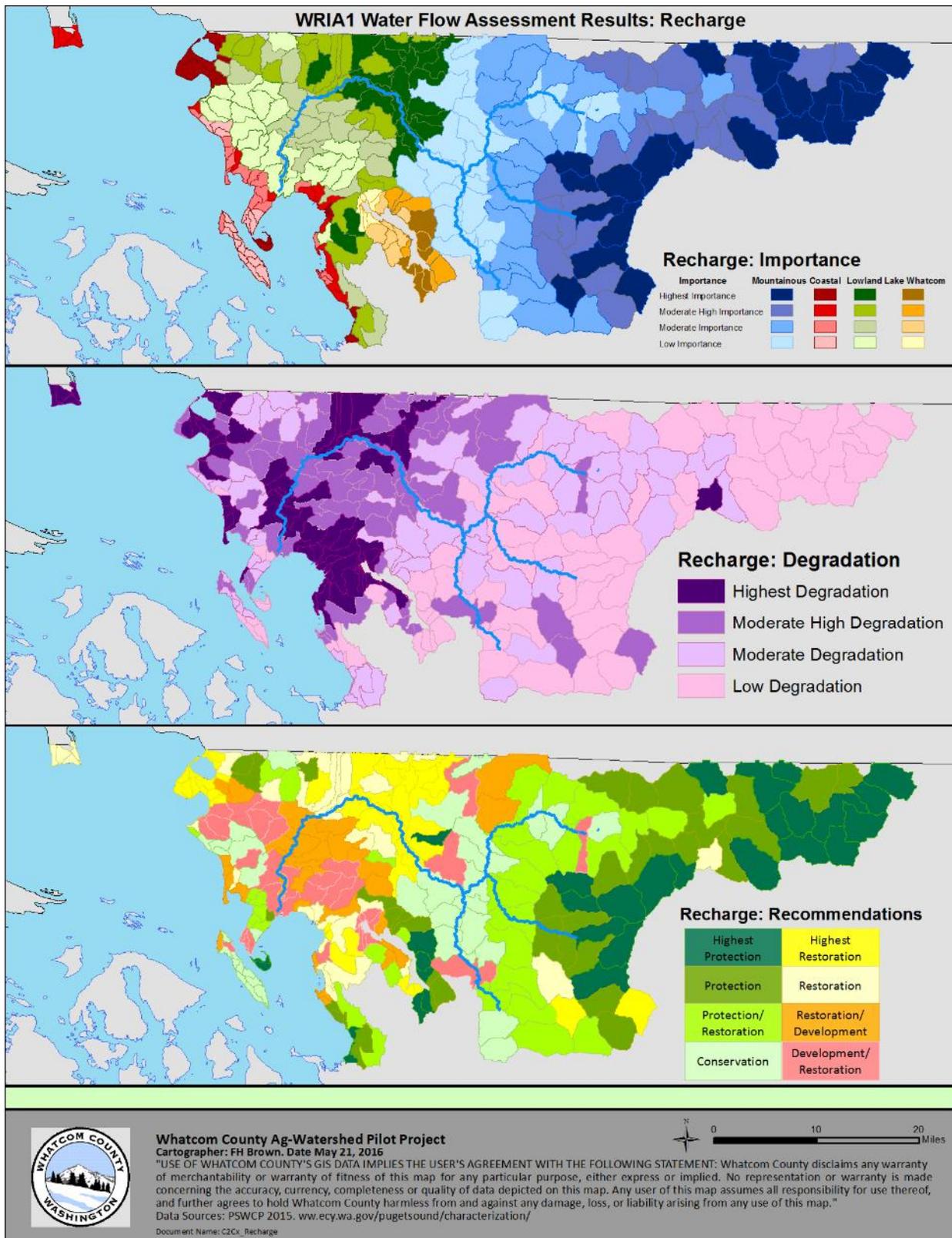


Figure 5. Recharge processes: Assessment results for WRIA1.

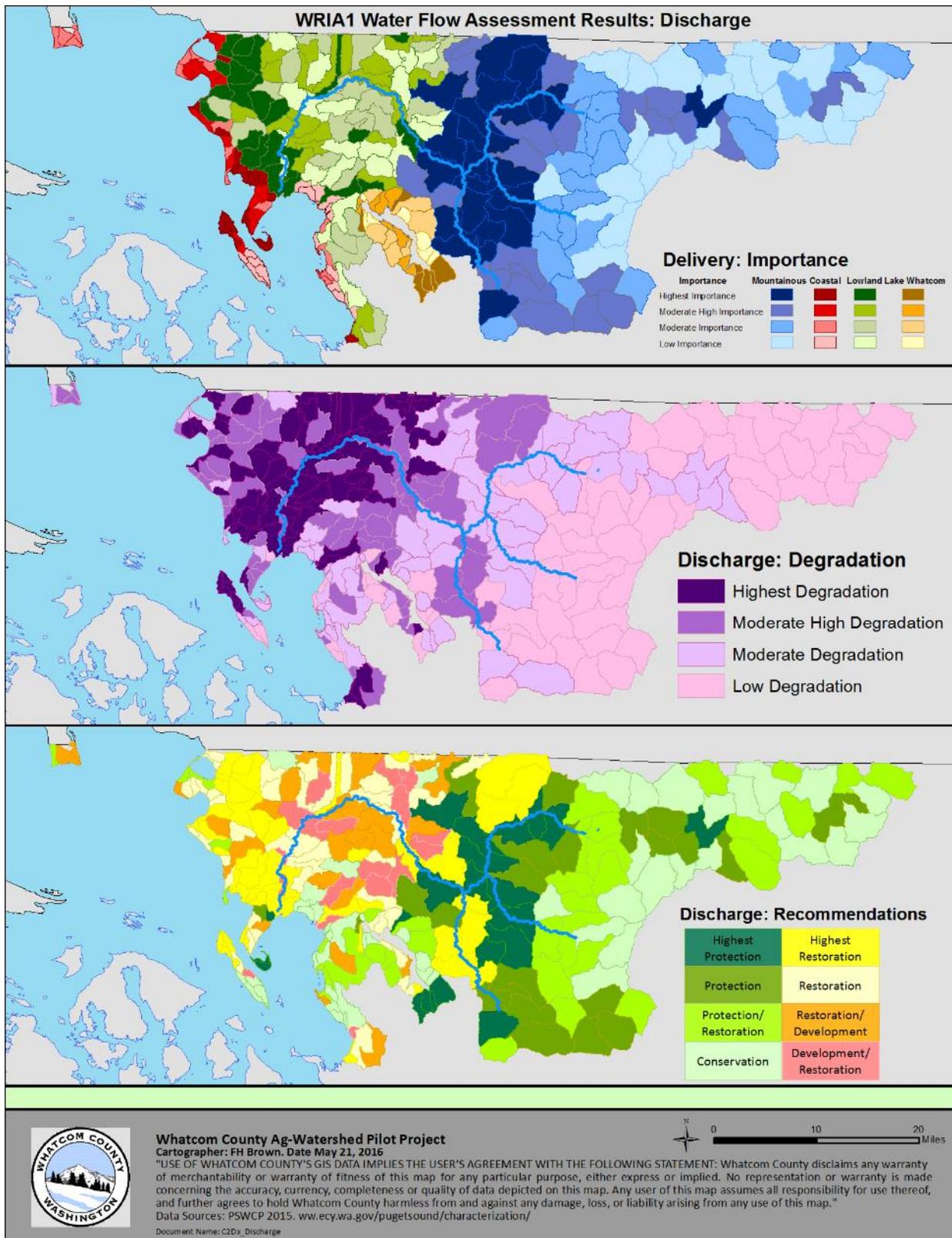


Figure 6. Discharge processes: Assessment results for WRIA1.

Appendix D. Ag-Watershed Project Fact Sheet #5:

Planning, designing and implementing beneficial actions for agricultural & watershed enhancement



# Whatcom County Ag-Watershed Project Fact Sheet #5

Planning, designing and implementing beneficial actions for agricultural & watershed enhancement

The Whatcom County Agriculture-Watershed Pilot Project (the "Ag-Watershed Project") has examined ways to reward beneficial actions by farmers and landowners who voluntarily go beyond existing regulation to maintain, restore or enhance large-scale watershed processes, while also strengthening agriculture in Whatcom County (see [Fact Sheet #1](#)).

Agricultural landowners and farmers have worked with the Project Partners (Whatcom County, Whatcom Conservation District, Whatcom Farm Friends and Washington Department of Fish & Wildlife) to test ways to better integrate agriculture and watershed planning and to design, select and implement effective local enhancement projects.

The project has used pilot studies on agricultural land in Whatcom County to test

- planning tools to identify high-priority, high-value opportunities to take actions for agricultural and watershed enhancement and/or protection,
- scientific measurement tools that connect specific beneficial actions on working farmland to measurable outcomes for agriculture and watersheds, and
- administrative tools to verify, track and account for the benefits of these actions over time.

Fact sheet #5 shows how Agriculture-Watershed Characterization and Mapping can be used as a planning tool to:

- integrate local agricultural priorities into routine planning for consideration alongside adopted watershed priorities in Whatcom County and the Puget Sound region, and
- design local projects on a single farm or group of farms that help to achieve both agricultural and watershed enhancement priorities.

## STEP1: CHARACTERIZE AND MAP AGRICULTURAL AND WATERSHED ENHANCEMENT PRIORITIES

The characterization and mapping process combines information from current agriculture and watershed plans with existing spatial data, field experience and farmers' local knowledge to identify agricultural priorities and needs in the area alongside watershed priorities and needs, as shown below in the example maps for a Watershed Improvement District. (See [Fact Sheet #2](#) for more detailed information on the characterization and mapping process.)

Farmers, planners and landowners identify, characterize & map enhancement priorities, using local field knowledge, existing data and reference maps.

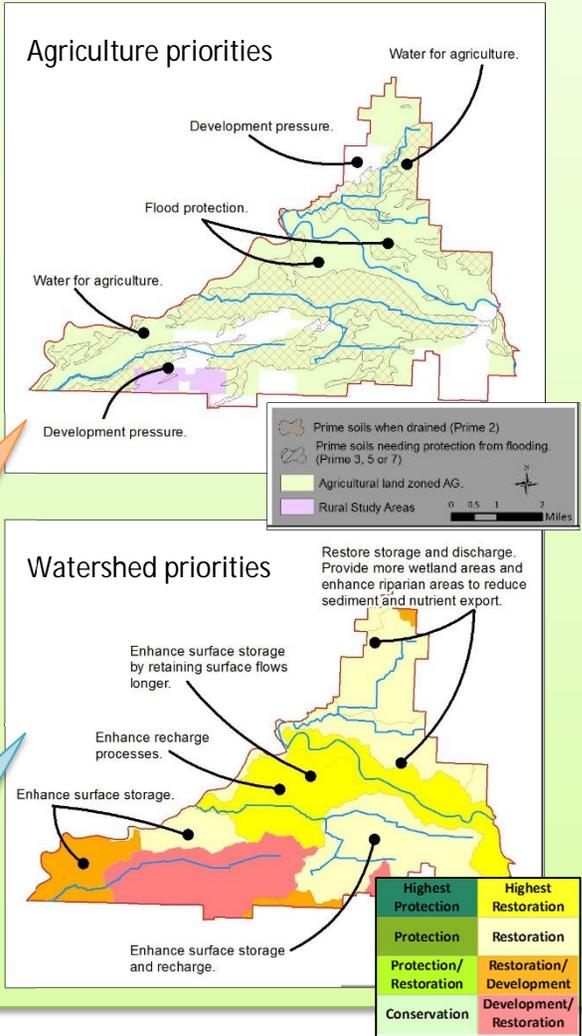


Working agricultural lands. Needs and enhancement priorities:

- Water quantity for out of stream uses
- Water quality for agricultural use
- Drainage of fields
- Flood protection
- Protection of agricultural land base and soils
- Pollination

Watershed systems. Protection, restoration and enhancement priorities:

- Water quality
- Habitat (riparian, instream, fish, wildlife, wetlands)
- Water quantity
- Water flow processes (recharge, discharge, surface water storage, water delivery)



**STEP 2: IDENTIFY PLACES WHERE AGRICULTURAL AND WATERSHED PRIORITIES COINCIDE**

In some locations, agricultural and watershed priorities may be in competition; in other locations they may be complementary. Ideally, projects should enhance watershed processes while also strengthening agriculture. Sometimes, however, acceptable tradeoffs must be found between agricultural and watershed priorities. Mapping these priorities concurrently allows farmers and planners to identify the places in the landscape that offer opportunities to address both watershed and agricultural needs most efficiently and effectively.

**STEP 3: SELECT SPECIFIC ACTIONS FOR AGRICULTURAL AND WATERSHED ENHANCEMENT**

Watershed Improvement Districts (WIDs) and other special districts, planners and landowners can use the maps and characterization reports to determine which agricultural enhancements or conservation actions might be most appropriate at a site, given current regulation. Scientific measurement tools (metrics) allow planners and WIDs to develop potential scenarios for optimizing agricultural and watershed enhancements before pursuing project design, verification and implementation (see [Fact Sheet #3](#)).

**STEP 4: INTEGRATE ACTIONS INTO WATERSHED & LAND USE PLANS AND INVESTMENT STRATEGIES**

Priority actions and projects can be integrated into farmers' business plans, ongoing WID planning, land and watershed management efforts and funding programs (see [Fact Sheet #4](#)). Tracking progress against longer-term goals helps to quantify the benefits of investing in actions for watershed and agricultural enhancement on working farmland.

**AG-WATERSHED PROJECT PILOTS & CASE STUDIES: EXAMPLES OF BENEFICIAL ACTIONS & PROJECTS**

Pilot 1 (single landowner)

Proposed enhancement: Avoided conversion of wetland habitat resulting from beaver activity in the headwaters of an important salmon bearing stream, on a site that could be returned to active farming at the end of the Conservation Reserve Enhancement Program (CREP) lease.

Agricultural benefits: diversification of revenue from payment for permanent wetland conservation easement on marginal farmland.

Watershed benefits: wetland habitat and surface water storage capacity in the upper watershed are permanently protected.



Pilot 2 (multiple landowners):

Improve flood protection and field drainage for low-lying farmland, while concurrently increasing stream width and channel complexity, improving stream-floodplain connectivity and restoring riparian vegetation in a highly channelized reach.

Agricultural benefits: improved flood protection and drainage for fields on prime farmland [proposed project design addresses faster removal of flood waters from fields & improved efficiency of drainage ditches].

Watershed benefits: stream function and habitat condition in the reach are enhanced in exchange for a small amount of agricultural land taken out of production to accommodate channel widening.

Case study (land use planning): Measuring the potential agricultural benefits of different land use options. The demonstration site is an undeveloped property located in the Nooksack basin lowlands, within the floodway. Soils are mostly agricultural, but prone to flooding. Surrounding land use is mixed urban and agricultural.

Future option 1 (agricultural use)

- Entire site actively farmed, except for creek buffer
- Permanent Agricultural Conservation Easement protects

- land for farming
- Maintain soil drainage for fields

Future option 2 (mixed use)

- NE portion actively farmed, SW portion converted to recreation/open space
- Watershed enhancement along creek & floodway

