Quality Assurance Project Plan

Strategies for Preserving and Restoring Small Puget Sound Drainages

Interagency Agreement No. C1300210

January 2014

King County

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NEP Watershed Protection & Restoration Grant Program

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January 2014

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1.0. BACKGROUND

The overall goal of Washington State's Puget Sound Partnership is to restore Puget Sound. Many streams that drain into Puget Sound are threatened from pollutant runoff and altered flow regimes. Such threats may result in extinction of aquatic species or a decline in biodiversity. Stream restoration projects are one way to attempt to maintain or restore ecological health at impaired locations and contribute to the recovery of Puget Sound.

Benthic macroinvertebrates play a crucial role in stream ecosystems and are good indicators of ecological health. The multimetric Puget Lowland Benthic Index of Biotic Integrity (B-IBI) is a standardized scoring system applied to samples of benthic macroinvertebrates collected from streams. The B-IBI was developed in the early 1990's and is widely used to report stream health by over 20 cities, counties, tribes and state agencies in the Puget Sound Basin

B-IBI scores from these entities have been compiled into a regional database maintained by King County, the Puget Sound Stream Benthos (PSSB) data management system (http://www.pugetsoundstreambenthos.org/).

2.0. PROJECT DESCRIPTION

The goal of this project is to develop strategies and cost estimates for preserving all Puget Sound drainages with "excellent" B-IBI scores, and for restoring 30 drainages from "fair" to "good" B-IBI scores. This project is intended to accomplish near-term actions C2.1 NTA 2 and C2.3 NTA 2 from the 2012/2013 Action Agenda for Puget Sound (PSP 2012).

Project objectives include the following:

- Diagramming and describing a decision framework for restoring small stream drainages from "fair" to "good" B-IBI scores including results from the stream basin restoration literature review.
- Identifying restoration sites, developing restoration strategies, and estimating planning level costs.
- Identifying preservation sites, developing preservation strategies, and estimating planning level costs.

This project utilizes existing benthic macroinvertebrate monitoring data from the Puget Sound drainage basin (Water Resource Inventory Areas 1-19) and does not involve collecting new benthic macroinvertebrate data. Existing taxonomic data and B-IBI scores can be downloaded from the PSSB (http://www.pugetsoundstreambenthos.org/). The following analyses will be conducted:

- Identify all sites in the PSSB with a maximum B-IBI score greater than or equal to 46, and all sites with an average score greater than or equal to 46 (excellent scores).
- Identify all sites with a maximum B-IBI score greater than or equal to 42, but less than 46, and all sites with an average B-IBI score greater than or equal to 42, but less than 46.
- Identify all sites with scores greater than or equal to 28 and less than or equal to 36 (fair scores).

Multimetric indexes have evolved since the B-IBI was developed in the 1990s and recommended methods now use continuous scoring rather than bins to reduce variance and use percentiles derived from all metric values (e.g., 10th and 90th) to set upper and lower bounds. As part of an ongoing regional effort to standardize and improve biomonitoring tools the following tasks were completed: (1) individual B-IBI metrics were recalibrated based on improved taxa attributes (tolerance, intolerance, clingers, predators, long-lived) (Fore et al. 2012); (2) individual metric scores were defined along a range from 0-10 instead of 1-3-5 scores so that the B-IBI ranges from 0-100 instead of 10-50; and (3) B-IBI scoring was adjusted to correct for different levels of taxonomic effort. We propose relying on this newly recalibrated B-IBI in this project. Therefore, the targets set for the 10-50 B-IBI will have to be translated to the new 0-100 scale.

For the sites identified as having fair or excellent B-IBI scores, geographic information systems (GIS) analysis will be conducted following the methods laid out by Leinenbach (2011a, 2011b) and Wilhelm et al. (2013) to delineate drainage basins and determine basin area, land ownership, land use/land cover, city or county jurisdiction, and surficial geology. GIS methods and source layers will be described in section 5.0 of this document.

In addition to gathering landscape scale GIS data, stream flow data will be summarized where possible for the sites identified as having fair or excellent B-IBI scores. Konrad and Voss (2012) summarize the available stream gaging data for Puget Sound and this document will be consulted to determine where stream flow data are co-located with macroinvertebrate data. Hydrologic metrics found by DeGasperi et al. (2009) to be most highly correlated with B-IBI will be calculated including measures of frequency (high pulse count), duration (high pulse range), and flashiness (R-B index, T_{Qmean}).

A decision framework (diagram and description) for selecting sites for restoring stream basin B-IBI scores from “fair” to “good” will be developed. This task will also include a literature review of stream basin restoration effectiveness studies with a focus on benthic macroinvertebrates. The methods used in the Puget Sound Watershed Characterization will be reviewed and incorporated as appropriate, with an aim of having the decision framework fit within the Puget Sound Watershed Characterization decision framework to the extent practical (Stanley et al. 2005, Stanley et al. 2012, Wilhere et al. 2013). This will also include review and application of the analytical work being done by King County as part of the USEPA grant funded project “Enhancement and Standardization of Benthic Macroinvertebrate Monitoring and Analysis Tools” refining the relationship between B-IBI and various influencing factors, such as water quality, stream flow, riparian habitat, stream

channel factors (e.g., geology, morphology, land use/land cover, and stormwater management). No additional statistical analysis or refinement of macroinvertebrate analysis tools are anticipated for this project. The decision framework will be developed using input from interested stakeholders and agencies. The information generated by this task will be used to select sites and help develop restoration strategies.

Restoration Sites

This section describes the conceptual approach for prioritizing basin restoration activities in the 30 watersheds that have low B-IBI scores. The final process and scheme for identifying those basin restoration priorities will be carefully documented in the final project report.

Criteria will be developed to prioritize basins with "fair" B-IBI scores for the development of restoration strategies. Example criteria include natural conditions and drivers such as drainage basin size, geology, hydrology, watershed and riparian-scale land covers, and riparian, stream channel and B-IBI sampling site condition, as well as artificially-imposed conditions and boundaries such as impervious area, land ownership and jurisdictional boundaries and number of past B-IBI scores (i.e., reference baseline), relationship to salmon restoration plans, and other factors. The criteria will be applied to drainage basins for all sites with average B-IBI scores in the "fair" range. The 30 highest priority basins will be identified for restoration strategy development.

For each of the 30 selected basins, a more detailed GIS analysis may be conducted to estimate the approximate level of each restoration activity likely to be needed to restore the basin and improve B-IBI scores. Restoration strategies will consist of packages of physical measures or actions, such as stormwater retrofits and restoration of upland, riparian, and stream channel conditions. Planning level cost estimates will be developed for proposed activities, based on estimates per unit of activity – such as square mile of stormwater retrofit, or linear feet of riparian restoration, or linear feet of stream channel restoration.

Preservation Sites

This section describes the conceptual approach for preserving basins with "excellent" B-IBI scores. The final process and scheme for identifying basin preservation priorities will be carefully documented in the final project report. Strategies to be explored include, but are not limited to, public land purchase, conservation easement purchase, and transfer of development rights. Planning level cost estimates for preserving basins with "excellent" B-IBI scores will be developed based on average land costs.

Stakeholder input

The stakeholder team already assembled for the USEPA grant funded project "Enhancement and Standardization of Benthic Macroinvertebrate Monitoring and Analysis Tools" will serve as the technical stakeholder team for this project. This stakeholder team consists of representatives from 16 cities, 6 counties, 3 state agencies, 6 federal agencies, 12 tribes, 7 not-for-profits, 5 private sector companies, and 1 academic university

(Table 1). Two workshops will likely be held, one to provide input and review of the site selection and restoration conceptual framework, and a second to provide peer review and input on the draft preservation and restoration strategies.

Table 1. The stakeholder team consists of representatives from government, tribal, not-for-profit, private, and academic organizations.

GOVERNMENT	OTHER
Cities	**Tribal**
Arlington	Jamestown S'Klallam Tribe
Bainbridge Island	Columbia River Inter-Tribal Fish Commission
Bellevue	Muckleshoot Indian Tribe
Bellingham	Nisqually Tribe Natural Resources
Bothell	Port Gamble S'Klallam Tribe
Everett	Puyallup Tribe
Federal Way	Skokomish Tribal Nation
Issaquah	Snoqualmie Nation
Kirkland	Stillaguamish Tribe
Mercer Island	Tulalip Tribe
Mountlake Terrace	Upper Skagit Indian Tribe
Redmond	Northwest Indian Fisheries Commission
Seattle	**Not for Profit**
Shoreline	Adopt-A-Stream Foundation
Tacoma	Lake Forest Park Streamkeepers
Tukwila	Lower Columbia Fish Recovery Board
Counties	North Olympic Salmon Coalition
Clallam	Pierce Stream Team
King	Sound Salmon Solutions
Kitsap	Vashon Nature Center
Pierce	**Private Sector**
Snohomish	Aquatic Biology Associates
Thurston	Aquatic Entomology
State	R2 Resource Consultants, Inc.
Puget Sound Partnership	Rhithron
Washington Department of Ecology	Statistical Design
Washington Department of Fish and Wildlife	**Academic**
Federal	University of Washington
Environmental Protection Agency	
National Oceanic and Atmospheric Administration	
North Cascades National Park	
Pacific Northwest Aquatic Monitoring Partnership	
US Fish and Wildlife Service	
US Geologic Society	

Reporting

Three reports will be prepared throughout the course of this project:

1. Site identification, GIS tables, and decision framework: this report will (a) identify all sites with "excellent" B-IBI scores, as well as the basins with "fair" B-IBI scores eligible for restoration strategy development, (b) present results from the initial GIS landcover calculations, (c) summarize the stream restoration literature review, and (d) outline the decision framework criteria for restoring basins from "fair" to "good" B-IBI scores.
2. Restoration and preservation strategies: this report will (a) describe and apply criteria to identify the 30 sites for restoration, (b) describe the relative restoration strategy and costs for each basin, and (c) describe the preservation strategy and cost for each basin.
3. Final project summary report. This report will summarize the work done throughout the course of this project.

3.0. ORGANIZATION AND SCHEDULE

King County Water and Land Resources Division (KCWLRD) is the recipient of the Puget Sound Action Agenda Ecosystem Restoration and Protection federal pass through funds and all key individuals are KCWLRD employees. Key individuals involved in this project are summarized in Table 2; see Table 1 for the organizations represented in the stakeholder team. The QAPP will be distributed to all of the key individuals.

Table 2. Key individuals in the project by agency.

Name	Title	Role
King County Water and Land Resources Division		
Jo Opdyke Wilhelm	Environmental Scientist III	Project manager, principal investigator
Debra Bouchard	Water Quality Planner III	Principal investigator
Ken Rauscher	Senior GIS Analyst	GIS analysis
Chris Knutson	Water Quality Planner I	GIS, data crunching, report writing/review
Chris Gregersen	Environmental Scientist I	GIS, data crunching, report writing/review
Kerry Thrasher	Administrator III	Financial tracking, budgeting
Washington State Department of Ecology		
Tom Gries	NEP Quality Coordinator	Reviews and comments on draft QAPP and report(s). Recommends approval of QAPP
Bill Kammin	QA Officer	Reviews and approves QAPP
Douglas Howie	Stormwater Engineer	Project Manager for Ecology
Kim Harper	Environmental Planner	Project Lead - NEP Watershed Protection & Restoration Grants
Kirsten Weinmeister	Puget Sound Grant Coordinator	Financial Manager for Ecology

Additional staff will be consulted as needed.

Table 3 summarizes key tasks, deliverables and due dates (start date: September, 2013).

Table 3. Project schedule.

Task	Task Description	Deliverable	Due Date
1	Prj Mgmt	Quality Assurance Project Plan (QAPP) Waiver Form and, if necessary, QAPP	Jan 2014
1	Prj Mgmt	Quarterly progress reports and financial vouchers	Quarterly
1	Prj Mgmt	Semi-annual progress reports for EPA in the Financial and Ecosystem Accounting Tracking System (FEATS) format	Semi-Annually (Apr, Oct)
1	Prj Mgmt	Final project summary report	June 2015
2	GIS	Maps/tables of sites and attributes	Jan 2014
3	Restoration framework	Decision framework diagram and description for restoring small stream drainages from "fair" to "good" B-IBI scores, including results from the literature review	Apr 2014
4	ID Restoration Sites	Criteria for identifying restoration sites, table showing application of criteria to sites with fair B-IBI scores, and map of sites selected for restoration	Apr 2014
5	Restoration strategies	Tables and descriptions of the relative restoration needs and approximate costs by drainage basin	Nov 2014
6	Preservation strategies	Table of preservation strategy and cost per drainage basin	Nov 2014
7	Outreach	Stakeholder workshop summaries and survey results (*decision framework; preservation/restoration strategies)*	Feb/Mar 2014 & Sept/Oct 2014
8	Site ID report	Draft site identification report	May 2014
8	Site ID report	Final site identification report	July 2014
9	Synthesis report	Draft preservation and restoration strategy report	Jan 2015
9	Synthesis report	Final preservation and restoration strategy report	April 2015

4.0. QUALITY OBJECTIVES

Table 4 summarizes non-GIS data needed and data quality objectives.

Table 4. Data quality objectives.

Task	Data quality objective	Status/Source/Storage
Rank B-IBI scores	Evaluate/document metadata that accompanies this dataset. Confirm that taxonomic identification was done by laboratories with taxonomists certified for invertebrate identification and that follow acceptable quality control protocols for subsampling and identification accuracy.	Existing B-IBI scores stored in PSSB (http://www.pugetsoundstreambenthos.org/) with some metadata stored in each project page including the taxonomic laboratory used to identify the organisms.
Acquire stream flow data if available	Evaluate/document metadata that accompanies this dataset. Data obtained from USGS, Ecology, or King County have already been QC'd before being made publicly available. Information obtained from other stream gages needs to be consistent, obtained using standard techniques and technology, and be subject to similar quality assurance and quality control standards.	Gage data if available. USGS gages, Ecology flow monitoring network, King County Hydrologic Information Center, Etc.

5.0. PLANNED GIS ACTIVITIES

For the sites identified as having fair or excellent B-IBI scores, the GIS analysis will be conducted using ESRI Arc10 following the methods laid out by Wilhelm et al. (2013). Table 5 summarizes GIS analysis activities. Source GIS layers are described in Table 6.

Table 5. Summary of GIS analysis activities.

GIS Analysis	Data set	Methods
Delineate drainage basin for fair and excellent B-IBI sites from 30-meter digital elevation model	GIS shapefile of drainage basins for each B-IBI point	Leinenbach 2011a, Leinenbach 2011b, Wilhelm et al. 2013
Identify/delineate land ownership, land use/land cover, city/county jurisdictions, and surficial geology.	Output will be an excel flat file with data for each drainage basin	Leinenbach 2011a, Leinenbach 2011b, Wilhelm et al. 2013

Table 6. Description of GIS data layers.

Data Layer	Source	Year	Scale	Resolution	Description/Reference
National Elevation Dataset	National Hydrography Dataset	2004	1:100,000	30-meter	Portray surface water/ drainage network (rivers, streams, lakes, ponds, coastline, etc.).
State DNR Lands	WA Dept. of Natural Resources	2011	1:24,000	12-meter	Includes ownership parcels, disposed parcels, and easement parcels.
Major Public Lands	WA Dept. of Natural Resources	2013	1:100,000	30-meter	Contains ownership parcels for Federal, State (excluding WA DNR), County and City lands.
NLCD Land Cover	National Land Cover Dataset	2006	1:100,000	30-meter	16-class land cover classification scheme, Fry et al. 2011.
C-CAP Land Cover	Coastal Change Analysis Program	2011 and others	1:100,000	30-meter	Nationally standardized database of land cover and change (1992, 1996, 2001, 2006, and 2011).
City/UGA Areas	WA Dept. of Ecology	2011	1:24,000	12-meter	Combined incorporated City boundaries and unincorporated Urban Growth Areas (UGA).
NAIP Ortho Imagery	US Dept. of Agriculture	2011	N/A	1-meter gsd[1]	County by county mosaics of images produced for National Agricultural Imagery Program.
Watershed Boundary Dataset	US Geologic Society	2007	1:24,000	12-meter (+/- 6m accuracy)	Defines the areal extent of surface water drainage to a point, accounting for all land and surface areas (HUC watersheds).
Surficial Geology	WA Division of Geology and Earth Resources	2010	1:100,000	30-meter	Digital Geology of Washington State.
Population	U.S. Census	2000	1:24,000	12-meter	Census 2000 determined the resident population of the U.S.
Precipitation	PRISM Climate Group	1981-2010	Grid (N/A)	4-km grid cell resolution	Monthly 30-year "normal" dataset averaged over the climatological period 1981-2010.
Steelhead Distribution	StreamNet (PSMFS[2])	2005	1:100,000	30-meter	Winter steelhead distribution, Pacific Northwest compiled from WDFW data
Critical Habitat	United States Fish and Wildlife Service	2011	1:24,000	12-meter	Critical habitat for bull trout and Chinook salmon
WA State 303(d) List	WA Dept. of Ecology	2012	1:24,000	12-meter	Category 5 (impaired) listings for Washington State's 2012 Water Quality Assessment.

[1] Gsd is ground sample distance.
[2] PSMFS is the Pacific States Marine Fisheries Commission

6.0. GIS DATA ASSESSMENT

Table 7 summarizes GIS data and acceptance criteria.

Table 7. GIS data quality objectives.

Data needed	Data quality objective	Status/Source/Storage	Data acceptance criteria
GIS basin boundaries	Ensure that drainage basins are correct for each macroinvertebrate sampling location. QC checks are described in Leinenbach 2011a, Leinenbach 2011b, and Wilhelm et al. 2013.	Existing GIS drainage basins compiled by Jo Wilhelm, King County and Peter Leinenbach, USEPA.	• Basins have realistic drainage areas (e.g., not 0 ft^2). • Visually check basins to ensure site snapped to correct stream segment. • See methods description from previous Puget Sound work: http://pugetsoundstreambenthos.org/Projects/EPA_Grant_2010/Data/GIS_Memo.pdf
GIS layers	Evaluate metadata that accompanies source GIS layers (land cover, geology, etc.).	Existing GIS data and landscape metrics compiled by Jo Wilhelm, King County and Peter Leinenbach, USEPA.	Data used are generally large national data sets (e.g., National Landcover Dataset) or statewide data sets (e.g., Washington geology) that adhere to strict metadata documentation. See methods: http://pugetsoundstreambenthos.org/Projects/EPA_Grant_2010/Data/GIS_Shapefile_and_Data_Description_May_2013.pdf

7.0. CONCLUSIONS

Various deliverables will be generated – see table 3 in the organization and schedule section. In addition to internal KCWLRD review by the core project team, a technical stakeholder team created for a USEPA funded grant will serve as reviewers of these deliverables primarily via email.

It is anticipated that various programs/projects will have pertinent information that will be used to support elements of this work, e.g., linkages of macroinvertebrates to various physical parameters, suites of stormwater retrofit techniques, costs of stormwater retrofit techniques, land preservation approaches, etc.

These related projects include the following:

- WRIA 9 EPA retrofit grant (http://www.kingcounty.gov/environment/watersheds/green-river/stormwater-retrofit-project.aspx)
- EPA grant Enhancement and Standardization of Benthic Macroinvertebrate Monitoring and Analysis Tools for the Puget Sound Region (http://pugetsoundstreambenthos.org/Projects/BIBI-Recalibration.aspx)
- WRIA 8 EPA status and trends grant (http://www.govlink.org/watersheds/8/planning/five-year-progress-report/3_Section_3_Watershed_Status.pdf)
- Juanita Creek stormwater retrofit study (http://www.kingcounty.gov/environment/watersheds/cedar-river-lake-wa/documents/juanita-creek-stormwater-retrofit.aspx)
- Normative Flows project (http://www.kingcounty.gov/environment/watersheds/general-information/normative-flow-studies.aspx)
- Preservation Strategies
    - http://www.kingcounty.gov/environment/stewardship/sustainable-building/resource-protection-incentives.aspx
    - http://www.kingcounty.gov/environment/stewardship/sustainable-building/transfer-development-rights.aspx
    - http://www.kingcounty.gov/environment/stewardship/sustainable-building/land-stewardship.aspx

After completion of this planning project, the next step anticipated is the implementation of preservation strategies and restoration projects in selected stream basins. Monitoring the preservation sites and restoration sites will be needed to evaluate success of these strategies and activities over time.

8.0. REFERENCES

DeGasperi, C. L., H. B. Berge, K. R. Whiting, J. J. Burkey, J. L. Cassin, and R. R. Fuerstenberg. 2009. Linking hydrologic alteration to biological impairment in urbanizing streams of the Puget Lowland, Washington, USA. Journal of the American Water Resources Association 45:512-533.

Fore, L., R. Wisseman, J. O. Wilhelm, D. Lester, K. Adams, G. Hayslip, and P. Leinenbach. 2012. Using natural history attributes of stream invertebrates to measure stream health. King County Department of Natural Resources and Parks, Seattle, WA. http://pugetsoundstreambenthos.org/Projects/EPA_Grant_2010/TechDocs/Final/Invertebrate_Attributes_2013_v2.pdf

Fry, J. A., G. Xian, S. Jin, J. A. Dewitz, C. G. Homer, L. Yang, C. A. Barnes, N. D. Herold, and J. D. Wickham. 2011. Completion of the 2006 National Land Cover Database for the

Conterminous United States. Programmatic Engineering and Remote Sensing **77**:858-864. http://www.mrlc.gov/nlcd2006.php

Konrad, C.P., and Voss, F.D., 2012, Analysis of streamflow-gaging network for monitoring stormwater in small streams in the Puget Sound Basin, Washington: U.S. Geological Survey Scientific Investigations Report 2012–5020, 16 p. http://pubs.usgs.gov/sir/2012/5020/pdf/sir20125020.pdf

Leinenbach, P. 2011a. Automated watershed digitization using NHDPlus datasets and the ArcHydro extension. U.S. Environmental Protection Agency (USEPA), Seattle, WA. http://pugetsoundstreambenthos.org/Projects/EPA_Grant_2010/Data/GIS_Methods_Watershed_Area_Calculation_Memo.pdf

Leinenbach, P. 2011b. Landscape sampling of the 1027 sampling sites in the Puget Sound Basin. United States Environmental Protection Agency (USEPA), Seattle, WA. http://pugetsoundstreambenthos.org/Projects/EPA_Grant_2010/Data/GIS_Methods_Puget_Sound_Sampling_Memo.pdf

[PSP]Puget Sound Partnership (2012) The 2012/2013 Action Agenda for Puget Sound. 499 pages. Puget Sound Partnership, Olympia, Washington. http://www.psp.wa.gov/action_agenda_2012-13.php

Stanley, S., J. Brown, and S. Grigsby. 2005. Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes. Washington Department of Ecology, Olympia, Washington. https://fortress.wa.gov/ecy/publications/publications/0506013.pdf

Stanley, S., S. Grigsby, D. Booth, D. Hartley, R. Horner, T. Hruby, J. Thomas, P. Bissonnette, R. Fuerstenberg, J. Lee, P. Olson, and G. Wilhere. 2012. Puget Sound Characterization - Volume 1: The Water Resource Assessments (Water Flow and Water Quality) Washington State Department of Ecology, Olympia, Washington. https://fortress.wa.gov/ecy/publications/publications/0506013.pdf

Wilhelm, J. O., P. Leinenbach, L. Fore, D. Lester, K. Adams, and G. Hayslip. 2013. Watershed delineation and land cover calculations for Puget Sound stream basins. Page 20. King County Water and Land Resources Division, Seattle, Washington. http://pugetsoundstreambenthos.org/Projects/EPA_Grant_2010/Data/GIS_Memo.pdf

Wilhere, G. F., T. Quinn, D. Gombert, J. Jacobson, and A. Weiss. 2013. The Puget Sound Watershed Characterization Project Volume 2: A Coarse-scale Assessment of the Relative Value of Small Drainage Areas and Marine Shorelines for the Conservation of Fish and Wildlife Habitats in Puget Sound Basin. Washington Department of Fish and Wildlife, Habitat Program, Olympia, Washington. ftp://www.ecy.wa.gov/gis_a/PS_PROJECT/Docs/Watershed_Characterization_WDFW_Report_Final_Feb2013.pdf