



Kitsap County Public Works
Stormwater Division

Quality Assurance Project Plan



Biological Monitoring in Kitsap County Streams: Benthic Macroinvertebrates

Fall 2015 - Revision



(Page intentional left blank)

Publication Information

This plan is available on Kitsap County's website at www.kitsapgov.com/sswm/wq_bugs.htm.

Data for this project will be available on Kitsap County's website at www.kitsapgov.com/sswm/wq_bugs.htm It will also be available at the Puget Sound Stream Benthos website at www.pugetsoundstreambenthos.org.

Author and Contact Information

Mauro Heine
Kitsap County Public Works
Stormwater Division
614 Division St, MS-26A
Port Orchard, WA 98366

For more information contact: Phone: (360) 337-5777

Any use of product or firm names in this publication is for descriptive purposes only and does not imply endorsement by the author or Kitsap County.

Quality Assurance Project Plan

Biological Monitoring in Kitsap County Streams: Benthic Macroinvertebrates

October 2011

Approved by:

Signature: _____ Date: October 2011

Mauro Heine, Author / Project Manager, SSWM

Signature: _____ Date: October 2011

Stan Olsen, Author's Supervisor and Field Investigator, SSWM

Signature: _____ Date: October 2011

Mindy Fohn, Author's Manager, Water Quality Program Manager, SSWM

Signature: _____ Date: October 2011

Chris May, Senior Program Manager, SSWM

Signatures are not available on the Internet version.

Revision History

Page(s)	Description of Change	Author	Effective Date
Fig C-2, App. E	Water quality meter procedure changed, one sample collected per site, vs two	R. Scherdnik	8/2013
Table 1	Staff Changes	R. Scherdnik	Fall 2012
	Mentioned King County BIBI Recalibration	R. Scherdnik	2014
ALL	Changed "SSWM" to "Stormwater Division" or "Clean Water Kitsap"	R. Scherdnik	5/2014
App. I	Added example of Scientific Collection Permit	R. Scherdnik	8/2015

Table of Contents

List of Figures and Tables	7
Abstract	8
Background	9
Project Description	12
Organization and Schedule	13
Budget	15
Quality Objectives	15
Sampling Process Design.....	17
Data Management and Common Applications	21
Audits and Reports.....	21
Data Verification	22
References	25
Appendix A. Glossary, Acronyms, and Abbreviations	26
Appendix B. Homeowner Notification Flyer	31
Appendix C. Site Description, Chemistry	32
Appendix D. Targeted Riffle Sampling Procedures	38
Appendix E. Quality Control Procedures	42
Appendix F. Field Forms.....	48
Appendix G. Field Equipment Checklist	50
Appendix H. Standard Sample Log Form	52
Appendix I. Scientific Collection Permit.....	53

List of Figures and Tables

Figures

Figure 1. Historical Kitsap County Benthic Sites 1998-2006.

Tables

Table 1. Organization of project staff and responsibilities.

Table 2. Proposed schedule for completing field and laboratory work, data entry into EIM.

Table 3. Budget details for approximate costs per year.

Table 4. Field procedures by riffle within a sampling reach.

Table 5. Lab sample information.

Abstract

The Kitsap County Public Works Stormwater Division recognizes stormwater is one of many stressors on streams, the nearshore marine environment, lakes, wetlands, groundwater and open marine water. The County is motivated to establish a long-term ecosystem watershed health monitoring program to assess and improve its surface and stormwater management actions over time.

Selection of monitoring indicators, the ability to determine negative impacts, and long-term trends related to stormwater is challenging. Therefore, the County is careful to select parameters that are most influenced by stormwater flows or pollutants and respond to reduced impacts over time. This monitoring requires detailed planning in order to implement an effective and efficient program. Additionally, once the program is established, commitment for the long term is required in order to observe trends.

The Stormwater Division's Watershed Health Monitoring program proposes three components to be developed in phases:

- 1) Trend Monitoring of Small Streams
Small streams monitoring employs key indicator categories, which are closely related to stormwater impacts. The current key indicator categories are biological integrity, fecal coliform pollution, in stream habitat, riparian condition, watershed land cover, hydrologic regime.
- 2) Effectiveness Monitoring of Stormwater Best Management Practices
Effectiveness Monitoring projects will be implemented to evaluate specific stormwater management actions. These projects may be implemented at the site-scale, catchment-scale, sub-basin scale or watershed scale. Each project will be implemented under separate monitoring plans and is not included in this plan. However, Effectiveness Projects will be reported annually, as results are available, with the Trend Monitoring program results.
- 3) Diagnostic Monitoring
Diagnostic monitoring is performed to track and locate specific pollution sources. This monitoring is performed according to the "Illicit Discharge Detection and Elimination (IDDE) Program."

This document describes Kitsap County's Biological Monitoring Program, which is a component of the Stormwater Division's Trend Monitoring of Small Streams.

The objectives of the Kitsap County Biological Monitoring Program are to:

- Provide baseline information from a variety of streams types (reference to impacted) across the Kitsap County landscape.
- Monitor long-term trends of stream health.
- Examine where and how biological information can be applied in water resource management.
- Guide management decisions that would restore biological integrity of the stream.

Described in this document are the sampling design, site selection process, field implementation, laboratory processing of data, and analysis and interpretation of data.

Appendix A is a glossary that describes acronyms and terms. Field operations methods are found in appendices B-G and are consistent with previous work (Adams, 2010, Merritt, 2009; Plotnikoff, 1992; 1994; 1998; 1999; Plotnikoff and Ehinger, 1997; Plotnikoff and Wiseman, 2001). Karr et al 1991

Background

The Federal Clean Water Act (Section 101(a)) focuses on improving water quality by maintaining and restoring the physical, chemical and biological integrity of the nation's waters, thus biological integrity is an important component of water quality monitoring. Land use such as urban development, forestry, and agriculture impacts water quality and may lower biological integrity, which represents a decline in the overall biological condition of a stream. If the biological condition of the habitat is degraded, it will not support healthy salmonid or other fish and invertebrate populations.

History of Biological Monitoring in Kitsap County

Kitsap County recognizes the importance of conducting a coordinated, comprehensive inventory and assessment of the biological integrity. In response, Kitsap County Surface and Storm Water Management (SSWM) implemented a five-year baseline biological monitoring study in 1998. Due to cost and labor needs associated with biological sampling, SSWM elected to assess the biological integrity of the four largest salmonid producing streams in terms of total biomass (Zischke and Haymes, personal communication). In 2000 the Kitsap County Stream Team initiated a volunteer based Benthic Invertebrate Biological Monitoring Program. The program began by sampling 19 salmonid streams to identify those streams or stream reaches with high biological integrity that should be protected and to help determine where rehabilitation and restoration of degraded habitat should occur. The program collected 7 years

of data, with a peak of 26 streams in 2004. All historical Kitsap County data can be found at www.pugetsoundstreambenthos.org.

The Navy, through its collaborative ENVVEST (ENVironmental inVESTment) program, collected over one hundred samples from 71 sites during a three year span (2000, 2002, and 2003). Some of these sites are in the same location as past Stream Team sites. Both Washington Department of Ecology and City of Bainbridge Island have collected a small number of samples over the last decade.

Study Area and Surroundings

From 1998 to 2006, Kitsap County staff and citizen volunteers collected annual biological samples from riffles (fast-flowing water) of between 5-26 wadeable reference streams in unincorporated Kitsap County. See Figure 1,

Project Description

Goals and Objectives

The goal of this program is to conduct long- term biological monitoring and assessment of representative stream conditions in Kitsap County. Ambient biological monitoring refers to monitoring of aquatic macroinvertebrate communities in a variety of streams. The health of these communities reflects the physical and chemical stream environment. (Adams, 2009)

Data collection and evaluation occurs on an annual basis to meet the monitoring program objectives to:

- Provide baseline information from a variety of streams types (reference to impacted) across the Kitsap County landscape.
- Monitor long-term trends of stream health.
- Examine where and how biological information can be applied in water resource management.
- Guide management decisions that would restore biological integrity of the stream.

General Design

Benthic macroinvertebrate communities are used to assess stream condition. Macroinvertebrates provide information about environmental conditions based on the range of tolerance individual taxa have to environmental conditions. The members present in these communities indicate habitat conditions based on unique tolerance levels of those present or missing taxa (Adams, 2009).

The primary tasks conducted by the biological monitoring staff include:

- Collection of
 - Benthic macroinvertebrate samples
 - Site Description data
- Data analysis
- Result summarization on Kitsap County's website at www.kitsapgov.com/sswm/wq_bugs.htm

Index Period

Sampling will occur between August 15 and October 15 of each year. This time frame was chosen for the following reasons:

- Adequate time has passed for the instream environment to stabilize following natural disturbances, e.g., spring floods.
- Many macroinvertebrates reach body sizes that can be readily identified.
- Representation of benthic macroinvertebrate species reaches a maximum, particularly during periods of pre-emergence, typically from mid-spring to late-summer.
- Matches past sampling efforts in Kitsap County

Stream Size

Targeted streams are perennial and wadeable. Ephemeral streams are not included because of the effect drought has on the benthic community. Seasonal drought disturbance selects for distinct specialist communities (Resh et al., 1988; Clifford, 1966) and does not support representative aquatic communities.

Organization and Schedule

The following staff are involved in this project (Table 1). All are employees of Kitsap County. Table 3 outlines the schedule for completing field work, lab analysis, and data entry.

Table 1. Organization of project staff and responsibilities.

Staff / Title	Role/Responsibilities
Renee Scherdnik Water Resources Specialist Public Works – Stormwater Phone: (360) 337-5777	Project Manager/Principal Investigator Revises the QAPP. Oversees field sampling and transportation of samples to the laboratory. Submits and manages Scientific Collection Permit. Conducts QA review of data, analyzes and interprets data. Writes the annual data summary report(s).
Mauro Heine Water Resources Coordinator Public Works – Stormwater Phone: (360) 337-7048	Supervisor for the Project Manager/Investigator Provides internal review of the QAPP and reports, tracks progress, manages consultant contracts, and approves the final QAPP and data summary report(s).
Mindy Fohn Water Quality Manager Public Works – Stormwater Phone: (360) 337-7066	Reviews the project scope, provides internal review the draft QAPP and reports, manages the budget, and approves the final QAPP and reports.

Chris May Senior Program Manager Public Works – Stormwater Phone: (360)-337-7295	Reviews the project scope, approves the budget, and approves the final QAPP and reports.
---	--

QAPP – Quality Assurance Project Plan

Table 2. Proposed schedule for completing field work

Field and laboratory work	Due date	Lead staff
Apply for Scientific Collection Permit	May 1	Renee Scherdnik
Field work completed	August 15 to October 15 annually	Renee Scherdnik
Biological laboratory analyses completed	November of the same year to March of the following year	
Data Reporting on Web		
Calculations and results submitted to Stream Benthos site by Aquatic Biology Assoc., posted to Kitsap County web page.	May following data collection	Renee Scherdnik, ABA Lab
Data Reporting		
Annual data reporting to WDFW for Scientific Collection Permit compliance	April following data collection	
Annual Data Summary Report Draft due to supervisor, peer reviewer(s)	June following data collection	
Final report due on web	November 30, following year	

Budget

Analysis for samples will cost \$250 per sample site, with 25-30 sites collected each year for an estimated \$6,250-7,500 annual cost. It takes two full time persons one day to collect two samples. Total labor cost will depend on salary make up of the two person sampling crew.

Table 3. Budget details for approximate costs per year.

Cost Source	Cost per site	Number of Sites	Total
Sample Analysis	\$250	25-30	\$6,250 - \$7,500
Sample Collection (staff time)	4 hrs x Tot. Salary*	25-30	\$5,100 - \$6,120
Data Management, Analysis, and Reporting			\$5,000
Misc Supplies**	\$5	25-30	\$125 - \$150
Total			\$16,475 - \$31,220

*Approximate total of one summer help salary and one WQ specialist salary per hour.

**Preservative (ethanol) is bought in bulk. Bottles are reused each year.

Quality Objectives

Field Quality Assurance

Quality objectives are met by minimizing bias and ensuring completeness. The 8 ft² method was chosen to limit the potential bias of selecting only one riffle to collect a sample (3 ft² method). The large sample area also allows for more robust sub-sampling by the lab.

Bias

Sampling bias is the difference between the population mean and the true value. Bias usually describes a systematic difference reproducible over time and is characteristic of both the measurement system, and the analyte(s) being measured (Kammin, 2010; Ecology, 2004). Bias may be caused by the same field investigator conducting the same task at each site. It may also occur due to consistent misinterpretation of protocols by a group of field investigators. (Adams, 2010)

Completeness

Completeness is defined as the amount of valid data obtained from a data collection project compared to the planned amount and is usually expressed as a percentage (USEPA, 1997). Our target for completeness of data is 100%. Sample loss is minimized with sturdy sample storage vessels and adequate labeling of each vessel. Sample vessel type and labeling information are described under "Field Sampling Benthos in Wadeable Stream" in the Appendix D-1. Sample contamination occurs when containers are improperly sealed or stored. Loss of material or desiccation diminishes the integrity of the sample. If the validity of the information from the sample is in question, the sample will be flagged and excluded from analysis.

Completeness is determined by four criteria:

- Number of samples collected compared to the sampling plan.
- Number of samples shipped and received in good condition by the taxonomy contractor.
- Laboratory's ability to produce usable results for each sampling event.
- Sample results accepted by the project manager.

Comparability

Comparability describes the degree to which different methods, data sets, and decisions agree or can be represented as similar (USEPA, 1997). Comparable data sets make sharing data with other organizations that adhere to the same protocols, such as field sampling and analytical methods, possible (Adams, 2010). Kitsap County has chosen to use a newer benthic method (8 – 1ft² replicates) which is different than past efforts in Kitsap County. To ensure that the new data is comparable to the historical local data Kitsap County is actively participating in a multi-agency grant funded process to assess benthic sampling in the Puget Sound region.

In 2010 King County received a grant to assess the various benthic methods and bring together the many agencies conducting benthic sampling. One of the main focuses of the grant is to "Derive a cross-walk between collection protocols (3 vs. 8 ft² sample area)," thus allowing direct comparison between new and historical data. If successful, the "cross-walk" will greatly speed up the adoption of the 8 ft² by local agencies.

The 2014 data were deemed to be comparable to previous years' data and, where available, were compared against historical results using the same "0-100" point scoring system.

The taxonomic results were analyzed using the new "0-100" point scoring system (details on [PSSB website](#)). Changes in B-IBI calculation included a change in metric scoring from 1/3/5 scoring to a continuous score from 0-10 for each metric and refinements to the taxonomic lists (King County, 2014).

Sampling Process Design

Field Operations

It takes approximately 4 hours to sample each site. The timing of monitoring activities is variable and should be performed considering efficiency of effort and site-specific conditions. However, the crew must meet these requirements when organizing their day:

- Site Description. (nominal data to track year to year gross changes)
- Measure in-situ water chemistry before in-stream activities upstream.
- Collect the benthic sample immediately after site description is recorded.

Table 4. Field procedures by riffle within a sampling reach.

First Riffle	Middle Riffles	Last Riffle
Site Description ^a Wetted width Bankfull width Substrate sizes Shade Riparian Vegetation Surface Velocity Riffle length In-situ water quality Benthos ^b	Benthos Substrate sizes	In-situ water quality Benthos Substrate sizes

^a Site Description sheet also serves as data record for water chemistry and benthos sampling info and notes.

^b The benthos sample is a composite from eight samples selected from at least 4 riffles.

Table 5. Type of analysis, methods, and quality standards for all measurements.

Analysis	Equipment Type and Method	Accuracy (deviation or % deviation from true value)	Method Reporting Limits and/or Resolution	Number of Samples/ Measurements per site
Field Analysis				
Macroinvertebrate	Surber net - Targeted (Hayslip, 2007)	90% RPD	NA	1 composite from 8 samples from at least 4 riffles
Dissolved Oxygen	YIS 600QS & ProPlus (Heine, 2008)	+/- 0.5 mg/L	0.1 mg/L	1
Specific Conductivity	YIS 600QS & ProPlus (Heine, 2008)	+/- 10 μ S/cm	0.1 μ S/cm 0.2 @ 25° C	1
pH	YIS 600QS & ProPlus (Heine, 2008)	0.075 SU (pH<5.75) +/- 0.15 (pH>5.75)	1 to 14 SU	1
Temperature	YIS 600QS & ProPlus (Heine, 2008)	+/- 1° C of thermometer reading	1 - 26° C	1
Wetted Width	EAP062 (Werner, 2009a)	10% RPD	0.1 meters	1
Bankfull Width	EAP062 (Werner, 2009a)	10% RPD	0.1 meters	1
Shade	EAP064 (Werner, 2009b)	10% RPD	0-100%	1
Riparian Vegetation	Merritt (2009)	10% RPD	NA	1

Site Verification

Sampling crews will arrive at the sample site and verify that the following conditions for sampling are met:

1. They are at the correct location (Appendix C, C-1).
2. It is safe to enter.
3. Access is authorized for sites on private property.

Protocols listed in these appendices apply to waded streams.

In-Situ Measurements

Initial in-situ measurements should be performed before staff enter upstream of the first riffle sample site. After site verification, the crew can start preparing the in-situ instruments. Calibration and use of a YSI instrument to make these measurements will be conducted before the site visit according to the Standard Operating Procedures for YSI® 600QS Sonde® and Professional Plus® Multiprobes (Heine, 2008). Final in-situ measurements may be made just before leaving the site but are not required. Discharge can be calculated at the time of data entry.

Benthos

Each sample should be collected before staff enter upstream from points of collection. The benthos sampling method is found in Appendix D, D-1. Samples are transported to a taxonomist certified by the North American Benthological Society for identification.

Site Description

Site description information is collected at the first riffle location before benthos sampling if there is enough room to not disturb the sample area. If there is not room then the first riffle should be sampled before continuing with the site description data collection. Due to year to year changes in stream morphology exact sample locations may change.

Safety – Field and Laboratory Preservatives

Biological samples collected from streams must be preserved immediately following storage in containers. Inadequate preservation often results in (1) loss of prey organisms through consumption by predators, (2) eventual deterioration of the macroinvertebrate specimens, and (3) deformation of macroinvertebrate tissue and body structures, making taxonomic identification difficult or impossible.

The field preservative is handled by Kitsap County staff and the Laboratory preservative is handled by the consultant laboratory.

The field preservative used for the biological samples is 85% denatured ethanol. The preservative is prepared from a stock standard of 95% denatured ethanol. Flammability, health risks, and containment information are listed on warning labels supplied with the preservative container. Detailed information can be found with the Safety Data Sheets (SDS) maintained by Stormwater Water Quality. Minimal contact with the 95% denatured ethanol solution is recommended. The preservative used in handling the sorted laboratory samples is 95% ethanol (non-denatured). Seventy percent non-denatured ethanol is used for preserving voucher specimens in two dram vials (8 mL).

Hazard Communication Training is required for all personnel who come into contact with hazardous materials while conducting program duties.

Safety – Miscellaneous

Field activities should be conducted by at least two persons, especially when in remote streams. A contact person should be designated at the Public Works Annex office to which field personnel report at the end of each day at pre-designated times.

Staff must carefully plan field activities and obtain permission to access private land. Each year the homeowner is notified prior to sampling to obtain permission for access. Staff must obtain and record the land owner's written or oral agreement before or at sampling time.

See Appendix B – “Homeowner Notification Flyer”

Chain of Custody (COC) for Biological Samples

A standard chain of custody form is in Appendix J. This form is used for macroinvertebrate samples collected and transferred to the taxonomy lab. This form must be completed before transferring samples to the lab.

Data Form Review

Staff will use the “Kitsap County Stormwater - Benthic Field Form” to facilitate field data entry to the database. Examples of the field data forms are found in Appendix E. Before leaving the site, staff should review for completeness and accuracy. Staff should also scan completed forms for missing data and check for errors at the end of each week.

Scientific Collection Permit

Staff will re-apply each year to renew the Scientific Collection Permit no later than May 1st; refer to permit application and requirements. Permit is valid for one sampling season from August 15th – October 15th and must accompany the sampling crew. Once benthic data is available, a final report will be assembled and reported back to WA Dept. of Fish and Wildlife in the format they provide. This must be completed prior to applying for the next permit renewal. Failure to comply may result in denial of future permits. Example of permit in Appendix I.

Data Management and Common Applications

Data Storage

Field data collected in the “Kitsap County Stormwater - Benthic Field Form” will be entered into the Stormwater water quality data storage system.

The project lead will provide a user name and password to the taxonomic laboratory to allow direct upload of the macroinvertebrate data to the King County Benthos Database (www.pugetsoundstreambenthos.org). Once macroinvertebrate data are uploaded, the taxonomic laboratory will notify the project lead.

Audits and Reports

The taxonomic contractor will submit laboratory reports and QA information to the project lead according to the timeline (Table 2). Taxonomic reports will be delivered within six months from the date they were submitted and should include taxa lists, taxa counts, and standard and requested metrics for macroinvertebrates. The reports will include narratives, numerical results, data qualifiers, and costs.

The laboratory will report any problems and associated corrective actions to the project manager who will flag data. These data may be dropped from analysis if the problem can't be addressed.

The project manager is responsible for periodic audit updates to the sampling team as well as for any reports upon request.

Data Verification

Data Verification

Data verification involves examining the data for errors, omissions, and compliance with quality control (QC) acceptance criteria.

Field staff will verify field results after measuring and before leaving site. They will keep field notes to meet the requirements for documentation of field measurements. The field lead will ensure that field data entries are complete and error-free. The field lead will check for consistency within an expected range of values, verify measurements, ensure measurements are made within the acceptable instrumentation error limits, and record anomalous observations. The project manager will verify field data to ensure that:

- Data are consistent, correct, and complete, with no errors or omissions.
- Results of QC samples accompany the sample results.
- Established criteria for QC results were met.
- Data qualifiers are properly assigned where necessary.
- Data specified in the Sampling Process Design were obtained.
- Methods and protocols specified in this QA Monitoring Plan were followed.

The project manager at the taxonomic lab will verify all taxonomic results. The taxonomic lab will:

- Review and report QC checks on instrument performance.
- Review and report case narratives. This includes comparing QC results with method acceptance criteria such as precision data, and laboratory control sample analysis.
- Explain flags or qualifiers assigned to sample results.
- Report the above information to the project manager or lead.

Data Usability Assessment

Data usability assessment follows verification. This involves a detailed examination of the data package using professional judgment to determine whether the quality objectives have been met. The project manager examines the complete data package to determine compliance with procedures outlined in the QA Monitoring Plan and Standard Operating Procedures. The

project manager also ensures that the quality objectives for precision, bias, and sensitivity are met.

The project manager will assess completeness by examining the (1) number of samples collected compared to the sampling plan; (2) number of samples shipped and received at the taxonomic contractor in good condition; (3) lab's ability to produce usable results for each sample; and (4) sample results accepted by the project manager.

To analyze data for its usability, the project lead will consider precision, completeness, and documentation of adherence to protocols. Data will also be examined for extremes (i.e., against historical records and against the distributions of these project data). Extreme values will require logical explanations. Identified sources of bias will be described in the annual data summary report.

Acceptance Criteria for Existing Data

Data from past efforts within Kitsap County may be used to meet the objectives of this program if the methods result in comparable data. There is a study by King County starting in 2010-11 to analyze the different methods and to determine an appropriate conversion factor for older three replicate methods to the current one composite method.

Data collected during this program will be used to meet the objectives of this program if they meet the requirements outlined above for data precision, completeness, representativeness, and comparability.

Data collected from outside Kitsap County Stormwater will be used to meet the objectives of this program if they meet the requirements of the agency's credible data policy. This requirement does not apply to non-quality data such as flow or meteorological data. These data must have been collected using the protocols outlined in the appendices of this document or using methods that result in comparable data.

Any data that does not meet these criteria should be flagged as such. Those data will not be used to meet the objectives of this program.

Corrective Actions for Inadequate Data

If discrepancies in the data are found, there are two options for correction depending on when the problem is identified.

1. If the problem is identified before the end of the index period (August 15 to October 15), a review of the protocols and SOPs outlined in the appendices of this document is required. After this review, a repeat site visit may be made to re-collect the sample. This may occur if the data set is incomplete or incorrectly collected. Due to the inter-

related nature of chemical and biological conditions, problems identified in the chemical or biological data should be addressed by again collecting the entire suite of chemical and biological analyses parameters. Because the habitat is mostly constant within an index period, if the data in question is related to habitat, only the missing habitat information needs to be collected. Before the second sampling, the investigator must review the SOPs and the appendices of this document to understand the protocols. Equipment should be cleaned and recalibrated and checked for proper function.

2. If the problem is identified after the index period, the data should be flagged and the problem explained in a comment in the database. This will allow the Kitsap County Stormwater investigator, as well as external users of this data, to know how this data may be used in projects. If the data is incomplete, or if some data standard was not met, the data will not be used to meet the objectives of the Biological Monitoring Program.

References

Adams, Karen, 2010. Quality Assurance Monitoring Plan: Ambient Biological Monitoring in Rivers and Stream: Benthic Macroinvertebrates and Periphyton. Washington State Department of Ecology, Olympia, WA. Publication No. 10-03-109. www.ecy.wa.gov/pubs/1003109.pdf.

Ecology, 2004. Guidance for the Preparation of Quality Assurance Project Plans for Environmental Studies. Publication No. 04-03-030. www.ecy.wa.gov/biblio/0403030.html.

Hayslip, G.A. (Ed.), 1993. EPA Region 10 In-Stream Biological Monitoring Handbook: for Wadeable Streams in the Pacific Northwest. U.S. Environmental Protection Agency- Region 10, Environmental Services Division, Seattle, WA. 75 pp.

Hayslip, Gretchen, editor, 2007. Methods for the collection and analysis of benthic macroinvertebrate assemblages in wadeable streams of the Pacific Northwest. Pacific Northwest Aquatic Monitoring Partnership, Cook, Washington.
https://www.pnamp.org/sites/default/files/2007_0531PNAMP_macroinvert_protocol_final.pdf

Heine, M., R. Starkgraf 2008. Water Quality Procedure and Protocol Manual. Revision 3 2008. Kitsap County Public Work, Surface and Storm Water Program

Karr, J.R., 1991. Biological Integrity: A long-neglected aspect of water resource management. Ecological Applications, 1:66-84.

King County, 2014. Updating the Benthic Index of Biotic Integrity (B-IBI): Outcomes and Key Findings. Prepared by Elene Dorfmeier (King County Water and Land Resources Division [WLRD]), Leska Fore (Statistical Design), Jo Opdyke Wilhelm (WLRD), and Deb Lester (WLRD). Seattle, WA. <http://pugetsoundstreambenthos.org/Projects/BIBI-Recalibration-Documentation.aspx>

Klemm, D.J., Lazorchak, J.M., and Peck, D.V., 2006. Benthic Macroinvertebrates, Section 10, in Peck, D.V., Herlihy, A.T., Hill, B.H., Hughes, R.M., Kaufmann, P.R., Klemm, D.J., Lazorchak, J.M., McCormick, F.H., Peterson, S.A., Ringold, P.L., Magee, T., and Cappaert, M.R. Environmental Monitoring and Assessment Program-Surface Waters, Western Pilot Study, Field Operations Manual for Wadeable Streams. EPA/620/R-06/003. U.S. Environmental Protection Agency, Washington, D.C. <http://www.epa.gov/wed/pages/publications/authored/EPA620R-06003EMAPSWFieldOperationsManualPeck.pdf>.

YSI, 1999. 6-Series – 600QS Sonde and 650 MDS Display, User Manual. YSI Incorporated. Yellow Springs, OH.

YSI, 2009. Professional Plus User Manual. YSI Incorporated. Yellow Springs, OH.

Appendix A. Glossary, Acronyms, and Abbreviations

Note: This Glossary covers both the main body of the QAPP as well as the Appendices.

Glossary

Bank Material: A measure of the dominant stream bank material. Recorded on the “*Benthic Site Description Form*”.

Bank Stability: A observational measure of how eroded a stream bank is: Stable, Slightly, Moderately, or Severely Eroded. Recorded on the “*Benthic Site Description Form*”.

Bank Vegetation: A appraisal of the different vegetation types along the stream bank. (Barren, Grasses, Herbaceous, Brush, Deciduous, Conifer, Other) Recorded on the “*Benthic Site Description Form*”.

Bankfull Width: Horizontal distance between the bankfull stage on the left bank and the bankfull stage on the right bank. This is measured in tenth of meters.

Benthic Index of Biotic Integrity (BIBI): An index of the health of the benthic macroinvertebrate community in the streams of Western Washington’s Puget Lowland ecoregion (Omernick and Gallant, 1986) by incorporating scores from multiple metrics into a single index number. These “multi-metric” style models were first used for bioassessment of streams by Karr et al. (1991) but have since been created for other locations to address the unique biological and environmental conditions on a level III ecoregional basis (Omernick and Gallant, 1986).

Biological Integrity: “The ability to support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity and functional organization comparable to those of natural habitats within a region” (Karr and Dudley, 1981).

Channel Cross-Section: A record of the general shape of the stream bottom to track major changes over time. (Rectangular, U-Shaped, V-Shaped, W-Shaped, Other) Recorded on the “*Benthic Site Description Form*”.

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation’s waters.

Conductivity: A measure of water’s ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Coniferous: Any of various mostly needle-leaved or scale-leaved, chiefly evergreen, cone-bearing gymnospermous trees or shrubs such as pines, spruces, and firs. This includes larch.

Cover: This can be thought of as the amount of shadow cast by a particular layer alone when the sun is directly overhead. Conceptually remove vegetation from higher layers before estimating.

Culvert: A pipe used to carry water under a road. Potentially reduces benthic macroinvertebrate movement. Nearby culverts are recorded on the “*Benthic Site Description Form*”.

DCE Data Collection Event: Data are indexed using this code which includes the SITE_ID, the date, and the time that the event began. It uses this format:

DCE-KCSSWM-NNN-20YY-MMDD-HHMM

- **NNN** = the number portion of the Stream_ID.
- **YY** = the last two numeric digits of the year that the event occurred.
- **MM** = the two numeric digits for the month that the event occurred.
- **DD** = the two numeric digits for the day within the month that the event occurred.
- **HHMM** = the military time when the event began.

Deciduous: Non-coniferous trees that shed their leaves annually. Examples include alder, oak, maple, and cottonwood.

Dissolved Oxygen (DO): A measure of the amount of oxygen dissolved in water.

LWD: Large woody debris. This is dead wood that is at least 10 cm diameter and more than 2 meters long.

Left Bank: The side of the stream that is to the left of a person facing downstream.

Main Channel: Channels in a stream are divided by islands (dry ground that rises above bankfull stage). Main channels contain the greatest proportion of flow. For this method it is called channel number 0.

Mixed Vegetation: More than 10% of the cover is made up of an alternate type.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities. This includes, but is not limited to, atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of “point source” in section 502(14) of the Clean Water Act.

Nutrient: Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen

vital to aquatic organisms.

Overhanging Vegetation: Potential cover for aquatic vertebrates provided by vegetation that hangs to within 1 m of the water surface. Higher vegetation, e.g., perches for kingfishers or other predators does not count.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Point Source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Pool: A habitat unit that has a maximum depth at least 1.5 times its crest depth.

Professional Plus & 600QS (YSI): The control and display portion of the YSI.

QC Quality control: A quality control check is a measurement of a standard value to estimate the accuracy of an instrument.

Reach: A specific portion or segment of a stream.

Right Bank: The side of the stream that is to the right of a person facing upstream.

Riparian: Relating to the banks along a natural course of water.

Sonde: The cylindrical portion of the YSI. It contains the sensors.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Streamflow: Discharge of water in a surface stream (river or creek).

Surber Net Sample: One of the 8 components to a site's composite benthos sample. One or two samples are collected at each of at least 4 riffle areas within the site. The area of a surber net sample is 1 ft² (0.743 m²) of stream bottom.

Targeted Riffle: The method of choosing benthic sample riffle locations based in the presence of a riffle large enough for sampling.

Turbidity: A measure of water clarity. High levels of turbidity can have a negative impact on aquatic life.

Undercut Banks: For this study, potential cover for aquatic vertebrates provided by banks (at the wetted margin) that extend over deeper water. Fish cover assessment is by area, rather than by length. Therefore undercut banks rarely provide more than 10% cover for a plot.

Understory: For this study, vegetation below 5 meters high but above 0.5 meters high within a 10 meter x 10 meter riparian plot.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Wetted Width: Farthest horizontal distance between water edge on the left and right sides of a channel.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
KC	Kitsap County
KCPW	Kitsap County Public Works
NIST	National Institute of Standards and Technology
QA	Quality assurance
RSD	Relative standard deviation
SOP	Standard operating procedure
SSWM	Kitsap County Surface and Stormwater Program
Stormwater	Kitsap County Public Works- Stormwater Division, formerly SSWM
USGS	U.S. Geological Survey
WDFW	Washington Department of Fish and Wildlife

Units of Measurement

cfs	cubic feet per second
ft	feet
km	kilometer, a unit of length equal to 1,000 meters.
m	meter
mL	milliliters

Appendix B. Homeowner Notification Flyer



July, 20XX

Dear Homeowner or Resident,

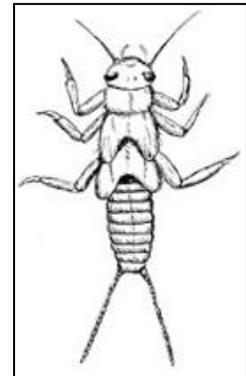
We would like to request access to your property in order to collect stream samples for the Kitsap County Stormwater Division's Watershed Health Monitoring Program. Sampling will start in August, and samples will be collected once every two years at most locations. ***Please contact Renee Scherdnik to give permission to access your property. Contact Renee through Kitsap 1 at (360) 337-5777 or rscherdn@co.kitsap.wa.us.***

Thank you.

Information on our Watershed Health Monitoring Program

Kitsap County Public Works Stormwater Division will monitor stream habitat and benthic macroinvertebrates. These animals live in or near the stream bed and include insects, crustaceans, worms, snails, and clams. Benthic macroinvertebrates are monitored because they are good indicators of the biological health of stream systems and play a crucial role in the stream ecosystem.

More information about our benthic sampling program can be found at www.kitsapgov.com/sswm/wq_bugs.htm.



Picture of a stonefly, one example of a benthic macroinvertebrate



The mission of the Clean Water Kitsap (formerly known as SSWM, the Surface and Stormwater Management Program) is to promote and protect public health, safety and welfare by establishing a comprehensive, sustainable approach to surface and stormwater management. For more information, visit www.cleanwaterkitsap.org or call (360) 337-5777.

Appendix C. Site Description, Chemistry

C-1. Site Description

Personnel Responsibilities

This method is performed by 2 or more trained staff.

Equipment, Reagents, Supplies

- 30-m tape
- Permanent marker
- Soft-lead pencil
- Benthic Field Form
- Creek Site Map
- Wading gear
- No. 2 pencil

Summary of Procedure

The crew first navigates to the site using the location description and Creek Site Map.

Establish the Data Collection Event

Prior to leaving the office, refer to the Creek Site Maps. Enter the Stream_ID portion of the DCE using a number 2 pencil onto the Benthic Site Description, Chemistry & Sampling Form.

Determine Site Suitability

After arrival and recording the DCE, determine whether the site is suitable for sampling. Flow levels in the stream must be low enough for sampling with surber sampler (40-50cm).

Record Event and Site Description Information

Next, on the Benthic Site Description (Figure C-1.3), record the information below about the data collection event

Photo Documentation

Take photographs upstream, downstream, left bank, right bank, and straight up. Also record any other notable structures nearby (culverts, etc.)

Site Evaluators

Record the names of those who are in the crew. Also note the organization that each staff represents. The crew lead will be recorded in column 1. Staff sampling roles can

be recorded later, after the day is done, by using the check boxes provided on the form.

Weather

Check the box describing current weather conditions

Culverts

Record if there is a known culvert within a ¼ mile up or down stream from the first riffle location.

Water Description

Check the box describing water appearance, any surface oils or colors

Water Odors

Check the box describing water odors, any sewage or chemical smell

Bank Slope

Check the box describing approximate slope at first sample site

Bank Material

Check the box describing the type of soil/rock the bank is comprised of

Bank Vegetation

Check the box describing the types of vegetation found along the side of the creek.

Stream Shading

Record the approximate % of canopy shade at current location

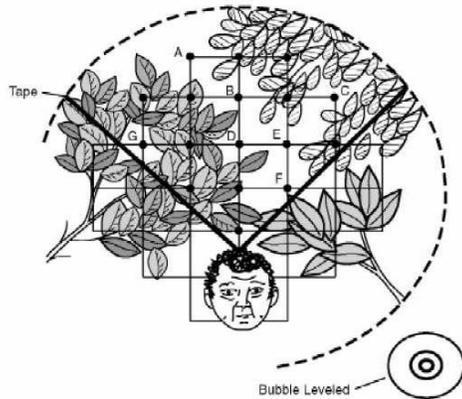


Figure C-1.1. An example reading from a modified convex densiometer. It shows 10 of 17 intersections with shade (a score of “10”). Note the proper positions of the bubble and head reflection (From Mulvey et al. 1992).

Channel Cross-Section

Check the box describing the type of stream channel cross-section

Undercut Banks

Check the box if the site has undercut banks or not

Bankfull Width

Measure the bankfull channel width

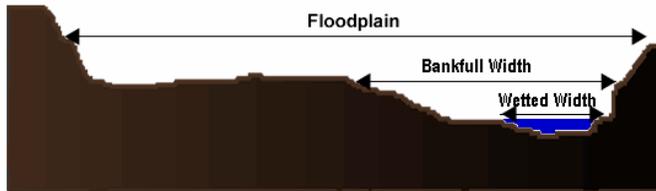


Figure C-1.2. Diagram of widths at the transect (Modified from Endreny 2009).

Surface Velocity

Measure the velocity of the surface flow using a floating object timed over at least a 3 meter length. Record the average of three replicates.

Water Depth

Measure the depth of the water in at least four location equally spaced across the wetted width. Record the average of the replicates.

Riffle Length

Measure the length of the riffle associated with the first sample location

Riffle Wetted Width

Measure the wetted width of the riffle associated with the first sample location

Benthic Field Form

Date _____ Time _____ Photos (Minimum 5)

Site Evaluator Name(s) _____

Stream Site Name _____ Sample# DCE - KCSSWM _____ - 20____ - _____
ID yy mmdd hmmm

Weather Sunny Cloudy Partly Cloudy Raining Foggy

Culverts Upstream No Yes Approx. distance from sampling site _____(meters)
 Downstream No Yes Approx. distance from sampling site _____(meters)

Water Appearance Green Orange/Red Foam Reds Blacks Milky/White
 Muddy/Cloudy Multi-Colored (oily sheen) Clear Other

Surface Oils None Some Lots

Water Odors Normal Sewage Petroleum Chemical Other _____

Bank Slope Steep Moderate Slight Other _____

Bank Stability Stable Slightly Eroded Moderately Eroded Severely Eroded

Bank Material Clay Rock Dirt Mud Stones Other _____

Bank Vegetation Barren Grasses Herbaceous Brush Deciduous
 Conifer Other _____

Channel Cross-Section Rectangular U-Shaped V-shaped W-Shaped
 Other _____

Undercut Banks No Yes

Stream Shading Measured with densiometer: _____, _____, _____, _____, _____
 or approximate _____%

The following six stream measurements are at the first riffle site:

1) Riffle Length _____(meters)

2) Riffle Wetted Width _____(meters)

3) Stream Bankfull Width _____(meters)

4) Water Depth _____(cm/meters) (average of at least 5) _____, _____, _____, _____, _____ cm meter

5) Surface Velocity Distance: _____(meters) Timed Measurements: _____(sec), _____(sec), _____(sec)

Figure C-1.3. The Benthic Field Form, site description sections

C-2. In-Situ Measurements in Wadeable Streams

Purpose and Scope

This method explains how to collect in-situ measures of temperature, dissolved oxygen, pH, and conductivity at wadeable streams using a multi-probe (e.g., YSI Sonde). It requires adherence to calibration techniques discussed elsewhere in this procedure.

Personnel Responsibilities

This method is performed by 1 or more persons. This method is applied at every DCE sampling event. Staff performing this method must have been trained.

Equipment, Reagents, Supplies

- No. 2 pencil.
- Chemistry and Sampling Form.
- Completed Calibration Form.
- YSI Sonde

Summary of Procedure

Calibrate the instrument before sampling according to calibration methods discussed elsewhere in this protocol. Check the instrument after calibration, but before and after sampling, according to those same methods. Measure the stream at least once.

Verify Quality Control

Prior to Sampling

Ensure that the calibrations and that QC checks have been performed according to methods described elsewhere in this protocol. Circle “Yes” on the top section of the Chemistry and Sampling Form (Figure C-2.1) for each sensor that checked out. Proceed with measurements using sensors that are within criteria.

After Sampling

Post-sampling calibration checks can be performed during the following day. Be sure to qualify data that were collected preceding calibration checks that failed to meet criteria.

Measure

Measure pH, water temperature, dissolved oxygen, oxygen percent saturation, and specific conductivity at least once during a DCE. Record time (military) and location (riffle unit #). These in-situ measurements should usually be made near the middle elevation of the site, on the main channel. Measurements should always be taken within the boundaries of the site.

Place the probes into the stream and let them thermally equilibrate to the stream temperature. This might take 3-5 minutes. Then hold the sensors so that they are just below the surface of the water, and completely immersed. Avoid any turbulence. Make sure that readings are

stable. On the chemistry and sampling section of the field form (figure C-2.1), record temperature (°C, nearest tenth), pH (pH unit, nearest hundredth), specific conductivity (µS/cm at 25°C, nearest tenth), dissolved oxygen (mg/L, nearest tenth), and oxygen percent saturation (nearest tenth). Also save the measurements to the internal memory of the YSI sonde. Verify and resample if measurements are outside of expected ranges.

6) Water Quality Meter:

WQ Chemistry, In-Situ	Verification	WQ Calibration
Location: A1		Operator: _____ Unit: _____
Time _____ hrs	Check box & resample if outside these expected ranges	Calibrated Flag
Temp _____ °C	6 - 16 °C <input type="checkbox"/>	Temp Yes No
DO _____ mg/L	8 - 14 mg/L <input type="checkbox"/>	DO Yes No
DO % Sat _____ %	80 - 115 % <input type="checkbox"/>	DO % Yes No
pH _____ pH units	6.5 - 8 pH units <input type="checkbox"/>	pH Yes No
Cond/SPC _____ µS/cm	40 - 300 µS/cm <input type="checkbox"/>	Cond Yes No
Notes: F1 -		

Sample #: DCE – KCSSWM _____ - 20 _____ - _____

Additional Notes: Document below any information or observations you made that are not included on this form.

Figure C-2.1. The in-situ chemistry section of the Field Form.

Appendix D. Targeted Riffle Sampling Procedures

D-1. Field Sampling Benthos in Wadeable Streams

Purpose and Scope

This method describes how to collect benthic macroinvertebrate samples for conducting community level assessments in Kitsap's Biological Monitoring Program. Data will be used to describe biological integrity and ecological quality (or taxonomic loss). It applies to waded streams. This method requires measurement of the associated physical and chemical environmental variables described in other methods within this protocol.

Personnel Responsibilities

One person or more performs this activity. Staff performing this method must have been trained.

Equipment, Reagents, Supplies

- One or Two Wide-mouth polyethylene jar (1L).
- Surber sampler net with these characteristics.
 - Frame that is 1 ft (30.5 cm) wide by 1 ft tall.
 - 500- μ m mesh net.
- 95% Ethanol (add 3 parts by volume for each part sample).
- Label (waterproof) for jar exterior.
- Label (waterproof) for jar interior.
- Soft-lead pencil.
- 500- μ m mesh sieve.
- Small garden trowel.
- White wash tub.
- Clear tape.
- Electrical tape.
- Pocket knife.
- Wading gear.

Summary of Procedure

Invertebrate sampling is one of the first methods to be performed on-site. It starts concurrently with water sampling, with initial components of the benthos sample collected downstream of the water sample. One sample is collected at each of 8 riffle units and from at least 4 different riffles, then added to the composite sample for the site. This method is taken from Hayslip (2007) with some details provided by Peck et al. (2006).

Identify sample stations

Start at the lowest riffle unit (A) and work upstream (to ending riffle unit letter). At each riffle, visually estimate the distance from left to right where the stream bottom will be sampled (Form D-1.1). Half the stations are in mid-channel. Half are in margins. If the water is too deep to sample at any station, collect the sample from the nearest feasible location. The surber net normally allows sampling up to about 50 cm depths. For each riffle assess if there is enough room for two samples (avoid the lower and upper 1 ft of each riffle). Depending on the distribution and length of riffle in the reach 1 or 3 samples may need to be collected in a riffle unit. The first riffle unit is A then B, C etc, typically A-1, A-2, B-3, B-4, C-5, C-6, D-7, D-8 recorded in the first section of figure D-1-1.

Benthos Sample, Targeted Riffle Method										
Riffle Unit (A-____) & Surber 1ft ² # (1-8)	-1	-2	-3	-4	-5	-6	-7	-8	Substrate Classes	
Dominant Substrate	Fine/Sand	<input type="checkbox"/> F/S	F/S - ladybug or smaller (<2mm)							
	Gravel	<input type="checkbox"/> G	G - ladybug to tennis ball (2 to 64mm)							
	Coarse	<input type="checkbox"/> C	C - tennis ball to car sized (64 to 4000mm)							
	Other: Note in Comments	<input type="checkbox"/> O	O - bedrock, hardpan, wood, etc.							
Distance Across Main Flow	25%	50%	75%	50%	25%	50%	75%	50%	(Left to right)	
1st riffle end to next riffle end distance									Total reach length = _____	
No. of Jars	Comments:									
Additional Benthic Sample Comments:										

Figure D-1-1: Targeted Riffle Benthos Sample section of the Field Form

Collect each surber sample

Once the station is determined, place the net opening into the face of flow. Position the net quickly and securely on the stream bottom to eliminate gaps under the frame. Collect benthic macroinvertebrates from 1ft² (0.9 m²) frame located directly in front of the net. Work from the upstream edge of the frame backward and carefully pick up and rub stones directly in front of the net to remove attached animals. Quickly inspect each stone to make sure you have dislodged everything and then set it aside. If a rock is lodged in the stream bottom, rub it a few times concentrating on any cracks or indentations.

After removing all large stones (greater than golf ball sized), keeping the sampler securely in position, starting at the upstream end of the frame, dig with the trowel in the top 4 to 5 cm of the remaining finer substrate within the frame for 30 seconds. Pull the net up out of the water. Immerse the net in the stream several times or splash the outside of the net with stream water to remove fine sediments and to concentrate organisms at the end of the net. After completing the sample, hold the net vertically and rinse material to the bottom of the net.

After taking a sample, examine the contents of the net. Pick out coarse rocks and sticks. Closely examine them for clinging organisms; pick these animals off of the debris and place them into the sample jar, discard the debris. Repeat for 7 more samples, when the net becomes too full empty the contents into the white wash tub. Once all 8 samples have been collected, empty the net into the tub and wash out any debris. Have one person look over net for any animals still clinging to the net. Pour off any water from tub through sieve. Scoop remaining animals and fine debris from tub and sieve to sample jar. Add enough ethanol to the sample jar so that the resulting solution consists of 1/3 sample and 2/3 ethanol (by volume).

Label and Seal the Composite sample

Using a number 2 pencil, complete two benthos jar labels (Figure D-1.2). Place one into the sample. Screw on the lid securely. Attach the other benthos label to the outside of the jar using clear tape. Record the DCE, which includes the Site ID, and site arrival time (year, month, day, hour, and minute). It should match the DCE recorded on the Site Verification Form.

CAUTION - ALCOHOL <95% (denatured)

500 μ Surber sample	Benthic Jar Label	Jar ____ of ____
Sample #:	DCE-KCSSWM _____ -2015 _____ <small style="margin-left: 40px;">Stream ID</small> <small style="margin-left: 100px;">Date (mmdd)</small> <small style="margin-left: 100px;">Time (hhmm)</small>	
Project:	Kitsap County Watershed Health Monitoring	
Stream:		
Collector(s):		
Sample Size:	_____ ft ²	
Notes:		

CAUTION - ALCOHOL <95% (denatured)

Figure D-1.2. The Benthos Jar Label.

Enter Data to the Chemistry and Sampling Form

The sample jars will be stored by field crews and delivered en mass to the analytical laboratory at the end of the field season. The Targeted Riffle Sample Form (Figure D-1.1) will be used to keep track of sample jar information. Note the Sample ID and number of jars per Sample ID. If there is more than one jar for a Sample ID, then ensure that the jars are located together. Taping the jars together with clear tape may be helpful. For destination, note the immediate place to where the sample will be stored, shipped, or delivered.

D-2. Taxonomic Lab Sampling Benthos from Wadeable Streams

Purpose and Scope

Taxonomic identification is conducted by a lab that employs taxonomists certified by the North American Benthological Society. The taxonomist should have experience with the freshwater macroinvertebrates of the Pacific Northwest. All major orders of freshwater macroinvertebrates are identified to genus/species according to level 3 Pacific Northwest standard taxonomic effort.

Personnel Responsibilities

One person or more performs this activity. Staff performing this method must have been trained.

Summary of Procedure

Sample Preparation

Samples are sub-sampled using a 500-organism minimum count, or the whole sample if it does not meet the 500 threshold.

Appendix E. Quality Control Procedures

E-1. Quality Control for In-Situ Meters

Purpose and Scope

This method explains how to verify that in-situ meters are working properly. Instruments included on the procedure include probes for measuring temperature, pH, conductivity, and dissolved oxygen (YSI Sondes).

Personnel Responsibilities

This method is performed by one or more persons. This method is applied at every DCE at least once. Staff performing this method must have been trained.

Equipment, Reagents, Supplies

- No. 2 pencil.
- Calibration Form.
- YSI, components, maintenance kit (Heine, 2008).
- YSI Manuals (Hach 1999, Hach 2006a, Hach 2006b).
- QCCS (Metcalf and Peck 1993).
- pH 7 buffer (7.00)
- pH 4 buffer (4.01)
- pH 4 buffer (10.00)
- pH 7 standard (6.97)
- Conductivity Standard (1,413 μS) – e.g., VWR 23226-603.
- Conductivity Standard (alternate as available).
- De-ionized water (DI).
- Tap Water.
- Lab tissues (e.g., KimWipes®).
- Barometer.

Summary of Procedure

Calibrate (Conductivity, pH, Dissolved Oxygen, and Velocity)

Calibration of the YSI will be conducted based on (Heine, 2008). Use the Calibration Form (Figure E-1.1) to record calibrations and quality control checks. Each week calibrate conductivity (COND), pH. The dissolved oxygen (DO) should be calibrated daily on-site or near the site, to match local barometric pressure of calibration and sampling as per Heine (2008). The pH and conductivity calibration standards should be chosen to bracket expected values. The order of calibration is normally:

1. DO (YSI).
2. COND (YSI).

3. pH (YSI).

Before calibrating, make sure that a post-sampling QC check measurement has been made to verify the quality of sampling at the previously sampled site. QC checking is discussed in detail later in this document.

SSWM WATER QUALITY					
WEEKLY YSI 600QS CALIBRATION LOG					
DATE	PARAMETER	CAL. STD. & UNITS	INITIAL READING	FINAL READING	COMMENTS WITH INITIALS & LAB TEMP
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			
	DO	100% / mg/L	/	/	25.4x = mmHg
	Conductivity	1413 uS/cm			
	pH	7.0 SU			
	pH	4.0 SU			

PERIODIC MAINTENANCE			
(Note: Follow maintenance procedures from the Operational Manual)			
DATE	ITEM	FREQUENCY	COMMENTS / INITIALS
	Replace pH Reference Solution	1/2 yr	
	Clean all Probe/Sensor Surfaces	1/2 yr	
	Replace DO memb. if it will not cal. or has bubble	as needed	
	Calibrate ORP with Zorbell solution	1 yr	
	O-Ring cleaning and greasing as needed	1 - 2 yrs	
	Other:		

Figure E-1.1. The Calibration Form.

Clean the YSI Sonde

Refer to Heine (2008) section 6.

Rinse YSI Sonde Between Each Operation

Rinse three times with tap water, three times with deionized water, then three times with the solution to be used for calibrating or testing.

Calibrate Conductivity to Bracket Expected Field Conductivity:

1. Dry the conductivity probe with a lab tissue (e.g., KimWipe®).
2. Using the YSI, enter 0 into SpCond, to dry calibrate to 0.
3. Fill the calibration cup to within a centimeter of the top of the calibration cup with dilute standard (either 100 µS or 1,000 µS) so that the probes are covered.
4. Make sure there are no bubbles in the cell, wait 2 minutes.
5. Using the YSI, enter the appropriate value for the standard into SpCond.

Table E-1.1. Theoretical pH values by temperature for each pH standard buffer.

Temp (°C)	4a	7b	10c
4	4.00	7.09	10.26
5	4.00	7.08	10.25
6	4.00	7.08	10.23
7	4.00	7.07	10.22
8	4.00	7.07	10.21
9	4.00	7.06	10.20
10	4.00	7.06	10.18
11	4.00	7.05	10.17
12	4.00	7.05	10.16
13	4.00	7.04	10.14
14	4.00	7.04	10.13
15	4.00	7.03	10.12
16	4.00	7.03	10.11
17	4.00	7.02	10.10
18	4.00	7.02	10.09
19	4.00	7.02	10.08
20	4.00	7.01	10.06
21	4.01	7.01	10.05
22	4.01	7.01	10.04
23	4.01	7.00	10.03
24	4.01	7.00	10.02
25	4.01	7.00	10.01
26	4.01	6.99	10.00
27	4.01	6.99	9.99
28	4.01	6.99	9.98
29	4.01	6.99	9.98
30	4.02	6.98	9.97

Buffers: a Thermo 7.00, b Thermo 4.01, c Thermo 10.01.

From: www.thermo.com/com/cda/resources/resources_detail/1,2166,13217,00.html

Calibrate pH to Bracket Expected Field pH

1. Pour the pH 7 buffer into the calibration cup to cover the sensor and reference electrode. Enter the theoretical pH value units the YSI. Theoretical values are based on temperature of the standard and are listed in Table E-1.1.
2. Rinse and repeat step 1, using either the pH 10 buffer (when sampling in basic waters) or pH 4 buffer (when sampling in acidic waters).
3. On the calibration form, record the temperature and theoretical pH values (Table E-1.1) that were used to calibrate. Also record adjustments that were needed to calibrate to these theoretical values.
4. On the calibration form, record the percent slope of the calibration (displayed on the YSI). Be sure this percent slope matches the criteria described on the form. Otherwise, recalibrate.

Calibrate DO Using Water-Saturated Air

1. Fill the calibration cup with about 1/2 inch of DI; it should be below the sensor cap.
2. Use Kimwipes to dry any droplets from the sensor cap.
3. Invert calibration cup's cap and gently rest it on the cup.
4. Wait 5 minutes, making sure that temperature stabilizes.
5. Determine local barometric pressure (mm Hg) and enter this value into the YSI.
6. Click "Calibrate". A "Calibrate Successful" will be displayed.

DO calibration notes:

1. To retain calibration accuracy between measurements, store with the sensor immersed in water or within a water-saturated air environment such as a sealed storage cup with at least 10 ml of water.
2. It is important to have the water-saturated air and the sensor at the same temperature. Therefore, store a jar of DI in the same environment as the sonde, and calibrate in a similar air temperature as the water and sonde.
3. Stay out of direct sun or wind.
4. Refer to Table E-1.2 if necessary.

Table E-1.2. Unit conversions for pressure.

Atmospheres	Bars	Hg mm	inches Hg
1	1.01325	760	29.92126
0.9869233	1	750.0617	29.52999
0.001315789	0.001333224	1	0.03937008
0.03342105	0.03386388	25.4	1

Quality Control

Daily Checks

Check pH and conductivity at the start and end of each DCE by measuring the QCCS. Record the temperature of the QCCS too. The pH should measure between 6.78 and 7.18 pH units. Conductivity should measure between 65.3 and 85.3 $\mu\text{S}/\text{cm}$ at 25 °C. Re-calibrate if the presampling check fails these criteria. Data from the DCE should be qualified if the post-sampling check fails these criteria. Record measurements on the Calibration Form Monthly Checks Once monthly, check the accuracy of the DO sensor on the YSI.

Twice-Seasonal Checks

Before and after the season, check the regular pH calibrations against dilute pH standards:

- pH 7 standard (6.97) – e.g., Thermo 700702.

Calibrate first with the regular buffers as for the daily calibrations (e.g., first 7 and 4), then check using the QCCS. Re-calibrate, this time using the dilute standards (e.g., 6.97 and 4.10).

Measure the QCCS and compare the difference in QCCS measures between calibrations. Repeat for the high-pH calibrations (7 and 10; 6.97 and 9.15). Theoretical values by temperature for the dilute pH standards are found in Table E-1.3.

Table E-1.3. Theoretical values by temperature for the dilute pH standards.

Temp (°C)	4a	7b	9c
10	4.10	7.01	9.27
11	4.10	7.01	9.26
12	4.10	7.00	9.25
13	4.10	7.00	9.25
14	4.10	7.00	9.24
15	4.10	7.00	9.23
16	4.10	6.99	9.22
17	4.10	6.99	9.21
18	4.10	6.99	9.21
19	4.10	6.98	9.20
20	4.10	6.98	9.19
21	4.10	6.98	9.18
22	4.10	6.97	9.18
23	4.11	6.97	9.17
24	4.11	6.97	9.16
25	4.11	6.97	9.16
26	4.11	6.96	9.15
27	4.11	6.96	9.14
28	4.12	6.96	9.13
29	4.12	6.95	9.13
30	4.12	6.95	9.12

a Orion 700402, b Orion 700702, c Orion 700902

The YSI's thermistor is factory calibrated. Check the settings before and after the field season by comparing with an NIST-traceable thermometer. Verify that it measures to within 1° C the thermometer. Do this in an ice water bath and in a warm water bath. Qualify the season's temperature data if the measures fall outside this range.

Appendix F. Field Forms

There are 3 data forms from one 2 sided sheet, to collect data and one label for the inside and outside of the sample bottles.

These are:

- Benthic Site Description Form.
- In Situ Chemistry Form.
- Targeted Riffle Benthos Sample Form.
- The Benthos Jar Label.

Kitsap County Stormwater Division

Benthic Field Form

Date _____ Time _____ Photos (Minimum 5)

Site Evaluator Name(s) _____

Stream Site Name _____ Sample# DCE - KCSSWM _____ - 20____ - _____
ID yy mmdd hhmm

Weather Sunny Cloudy Partly Cloudy Raining Foggy

Culverts Upstream No Yes Approx. distance from sampling site _____(meters)
 Downstream No Yes Approx. distance from sampling site _____(meters)

Water Appearance Green Orange/Red Foam Reds Blacks Milky/White
 Muddy/Cloudy Multi-Colored (oily sheen) Clear Other

Surface Oils None Some Lots

Water Odors Normal Sewage Petroleum Chemical Other _____

Bank Slope Steep Moderate Slight Other _____

Bank Stability Stable Slightly Eroded Moderately Eroded Severely Eroded

Bank Material Clay Rock Dirt Mud Stones Other _____

Bank Vegetation Barren Grasses Herbaceous Brush Deciduous
 Conifer Other _____

Channel Cross-Section Rectangular U-Shaped V-shaped W-Shaped
 Other _____

Undercut Banks No Yes

Stream Shading Measured with densimeter: _____, _____, _____, _____, _____
 or approximate _____ %

The following six stream measurements are at the first riffle site:

1) Riffle Length _____(meters)

2) Riffle Wetted Width _____(meters)

3) Stream Bankfull Width _____(meters)

4) Water Depth _____(cm/meters) (average of at least 5) _____, _____, _____, _____, _____ cm meter

5) Surface Velocity Distance: _____(meters) Timed Measurements: _____(sec), _____(sec), _____(sec)

Figure F-1.1. The Benthic Site Description Form.

6) Water Quality Meter:

WQ Chemistry, In-Situ	Verification	WQ Calibration
Location: A1		Operator: _____ Unit: _____
Time _____ : _____ hrs	Check box & resample if outside these expected ranges	Calibrated _____ Flag _____
Temp _____ °C	6 - 16 °C <input type="checkbox"/>	Temp Yes No
DO _____ mg/L	8 - 14 mg/L <input type="checkbox"/>	DO Yes No
DO % Sat _____ %	80 - 115 % <input type="checkbox"/>	DO % Yes No
pH _____ pH units	6.5 - 8 pH units <input type="checkbox"/>	pH Yes No
Cond/SPC _____ µS/cm	40 - 300 µS/cm <input type="checkbox"/>	Cond Yes No
Notes: F1 -		

Sample #: DCE - KCSSWM _____ - 20 _____ - _____

Additional Notes: Document below any information or observations you made that are not included on this form.

Figure F-1.2. The In Situ Chemistry Form, with examples of in-situ data records.

Benthos Sample, Targeted Riffle Method									
Riffle Unit (A-____) & Surber 1ft ² # (1-8)	-1	-2	-3	-4	-5	-6	-7	-8	Substrate Classes
Dominant Substrate	Fine/Sand	<input type="checkbox"/> F/S	F/S - ladybug or smaller (<2mm)						
	Gravel	<input type="checkbox"/> G	G - ladybug to tennis ball (2 to 64mm)						
	Coarse	<input type="checkbox"/> C	C - tennis ball to car sized (64 to 4000mm)						
	Other: Note in Comments	<input type="checkbox"/> O	O - bedrock, hardpan, wood, etc						
Distance Across Main Flow	25%	50%	75%	50%	25%	50%	75%	50%	(Left to right)
1st riffle end to next riffle end distance									Total reach length = _____
No. of Jars	Comments:								
Additional Benthic Sample Comments:									

Figure F-1-3: Targeted Riffle Benthos Sample Form

CAUTION - ALCOHOL <95% (denatured)

500 µ Surber sample		Benthic Jar Label		Jar _____ of _____
Sample #:	DCE-KCSSWM _____ -2015 _____	Stream ID	Date (mmdd)	Time (hhmm)
Project:	Kitsap County Watershed Health Monitoring			
Stream:				
Collector(s):				
Sample Size:	_____ ft ²			
Notes:				

CAUTION - ALCOHOL <95% (denatured)

Figure F-1.4. The Benthos Jar Label.

Appendix G. Field Equipment Checklist

Table G-1. Checklist of equipment necessary to complete the procedures in the Biological Monitoring Program at Kitsap County SSWM.

Check Box (✓)	Category	Item
	General	No. 2 Pencils
	General	Pencil sharpener
	General	Waders/Boots
	General	Backpacks
	General	This manual
	General	Clip Board
	General	Camera
	General	Calculator
	General	Field notebook
	General	Stopwatch
	General	Calipers
	Forms and labels	Benthic Field Form
	Forms and labels	Benthos Label (waterproof) for jar exterior
	Forms and labels	Benthos Label (waterproof) for jar interior
	Calibration	YSI, components, maintenance kit
	Calibration	YSI Manuals
	Calibration	QCCS
	Calibration	pH 7 buffer (7.00)
	Calibration	pH 4 buffer (4.01)
	Calibration	pH 10 buffer (10.01)
	Calibration	pH 7 standard (6.97)
	Calibration	Conductivity Standard (100 μ S)
	Calibration	Conductivity Standard (1,000 μ S)
	Calibration	Conductivity Standard (alternate as available)
	Calibration	De-ionized water (DI)
	Calibration	Tap Water
	Calibration	Lab tissues (e.g., KimWipes [®])
	Calibration	Barometer
	In-situ	YSI, components, maintenance kit
	In-situ	YSI Manuals

Check Box (✓)	Category	Item
	Benthos sampling	Wide-mouth polyethylene 1L bottle (2)
	Benthos sampling	Surber net with handle and frame
	Benthos sampling	95% Ethanol (add 3 parts by volume for each part
	Benthos sampling	Clear tape
	Benthos sampling	Rinse water tub with 500um screen
	Benthos sampling	White wash tub
	Benthos sampling	500um sieve
	Benthos sampling	Misc tweezers and spoons
	Benthos sampling	Scientific Collection Permit

Appendix H. Standard Sample Log Form

Sample Log				
	Client:			Page 1 of 1
	Contact person:			
	Phone :			
	e-mail:			
	Project name:			
	Date sent:			
	Sampler Type	Surber - 500 micron		
	Area Sampled	8 square feet		
Sample ID	Creek Name	Date	Number of Sample Bottles	Comments
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

Appendix I. Scientific Collection Permit

Example of Scientific Collection Permit (pg 1 of 6, 2015 approved permit).



Washington
Department of
**FISH and
WILDLIFE**

WASHINGTON STATE SCIENTIFIC COLLECTION PERMIT Washington Department of Fish and Wildlife

Please see **SCIENTIFIC/EDUCATION COLLECTION PERMIT (SCP) INSTRUCTIONS**
Attach a brief Study Plan, Applicant Qualifications and \$117. Allow **60 days** for processing.

Applications and annual reports can be submitted via e-mail to scp@dfw.wa.gov or standard mail to:
WDFW Licensing Division
Attn: SCP
600 Capitol Way North
Olympia, WA 98504-3150

If you have questions please contact:
phone: (360) 902-2464, Option 4
e-mail: scp@dfw.wa.gov

Permit Number (WDFW Use Only): **FOHN 15-253**

WHO:	1. APPLICANT INFORMATION			
	Name: Melinda Fohn		Agency: Kitsap County Public Works, Stormwater Division	
	Phone Number: 360-337-7066		Mailing Address: 614 Division St. MS-26A	
	E-mail: Mfohn@co.kitsap.wa.us		City: Port Orchard	State: WA
	Zip Code: 98366-4614			
	2. SUB-PERMIT HOLDERS			
	Name/phone number:		Name/phone number:	
	Renee Scherdnik/ 360-337-5777 x3643		Mauro Heine/ 360-337-7048	
	3. THIS APPLICATION IS:			
	<input checked="" type="checkbox"/> New		<input type="checkbox"/> Renewal of last year's Permit # _____	
<input type="checkbox"/> Amendment to Permit # _____		<input type="checkbox"/> SALVAGE PERMIT ONLY		
4. PURPOSE OF COLLECTION OR HANDLING (check both if applicable)				
<input type="checkbox"/> Instruction/Education Display				
<input checked="" type="checkbox"/> Research/Scientific Investigation (includes ELECTROFISHING)				
5. RESEARCH OBJECTIVES (check all that apply):				
<input type="checkbox"/> Aging	<input type="checkbox"/> Behavior	<input type="checkbox"/> Physiology	<input type="checkbox"/> Artificial Propagation	
<input type="checkbox"/> Census	<input checked="" type="checkbox"/> Presence/Absence	<input type="checkbox"/> Population Distribution	<input type="checkbox"/> Life History	
<input type="checkbox"/> Lab Use	<input type="checkbox"/> Pathology	<input type="checkbox"/> Tissue Sampling	<input type="checkbox"/> Genetic	
<input type="checkbox"/> Stream Typing	<input type="checkbox"/> Other: _____			
WHEN:	6. PERMIT TIMELINE*:			
	Project Start Date: 8/15/2015		Project End Date: 10/15/2015	
	Permit Expiration Date (WDFW Use Only): 10/15/2015		*SCPs are valid for a maximum of 12 months.	
WHAT:	7. TYPE OF ANIMALS TO BE COLLECTED OR HANDLED:			
	<input type="checkbox"/> Wildlife*	<input type="checkbox"/> Fish	<input checked="" type="checkbox"/> Aquatic Invertebrates – specify:	<input type="checkbox"/> Marine <input checked="" type="checkbox"/> Freshwater
*Amphibians and terrestrial invertebrates – please check Wildlife				
WHAT:	8. SPECIFIC TYPE(S) (check all that apply):			
	Wildlife	Fish		