# Quality Assurance Project Plan

# Integrated Ambient Monitoring in Indian Creek: Phase II Study

May 2013

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## Publication Information

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Ecology will post the final report of the study to the Internet.

This Quality Assurance Project Plan is available on Ecology's website at
https://fortress.wa.gov/ecy/publications/SummaryPages/1303110.html

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search User Study ID, BERA0010.

Ecology's Activity Tracker Code for this study is 13-041.

## Author and Contact Information

Brandee Era-Miller and Randall Marshall
P.O. Box 47600
Environmental Assessment Program
Washington State Department of Ecology
Olympia, WA 98504-7710

For more information contact: Communications Consultant, phone 360-407-6834.

Washington State Department of Ecology - www.ecy.wa.gov

- Headquarters, Olympia 360-407-6000
- Northwest Regional Office, Bellevue 425-649-7000
- Southwest Regional Office, Olympia 360-407-6300
- Central Regional Office, Yakima 509-575-2490
- Eastern Regional Office, Spokane 509-329-3400

# Quality Assurance Project Plan

# Integrated Ambient Monitoring in Indian Creek: Phase II Study

May 2013

**Approved by:**

| | |
|---|---|
| Signature: | Date: May 2013 |
| Randall Marshall, Client / Co-author, Water Quality Program | |
| Signature: | Date: May 2013 |
| Kathleen Emmett, Client's Unit Supervisor, Water Quality Program | |
| Signature: | Date: May 2013 |
| Bill Moore, Client's Section Manager, Water Quality Program | |
| Signature: | Date: May 2013 |
| Brandee Era-Miller, Author / Project Manager / EIM Data Engineer, EAP | |
| Signature: | Date: May 2013 |
| Dale Norton, Author's Unit Supervisor, EAP | |
| Signature: | Date: May 2013 |
| Will Kendra, Author's Section Manager, EAP | |
| Signature: | Date: May 2013 |
| Robert F. Cusimano, Section Manager for Project Study Area, EAP | |
| Signature: | Date: May 2013 |
| Joel Bird, Director, Manchester Environmental Laboratory | |
| Signature: | Date: May 2013 |
| Bill Kammin, Ecology Quality Assurance Officer | |

Signatures are not available on the Internet version.
EAP: Environmental Assessment Program
EIM: Environmental Information Management database

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# Abstract


In spring of 2010, an integrated monitoring pilot study identified several toxic chemicals as the potential cause for mortalities of trout fry used during the study. These candidate chemicals (metals, oxygenated polycyclic aromatic hydrocarbons, and captan) were identified through the use of chemical passive samplers, macroinvertebrate and periphyton sampling, and trout fry tissue analysis.

As a follow-up to the work conducted in 2010, the Washington State Department of Ecology will conduct a study in the spring of 2013 using a similar integrated monitoring approach of chemical and biological methods. The goal of this sampling will be to further investigate the potential causes of significant mortalities to the young trout that were deployed for 34 days in Indian Creek in 2010. Indian Creek is an urban creek located in Olympia, Washington.

The 2013 follow-up study will analyze for the candidate stressor chemicals in multiple matrices (surface water, stormwater, groundwater seeps, suspended sediments and trout tissue). In addition, some new analytical methods will be used to analyze for the breakdown products of some of the candidate stressor chemicals identified in 2010:

- Oxygenated PAHs – compounds created when polycyclic aromatic hydrocarbons (PAHs) break down in the presence of sunlight.
- Tetrahydrophthalidimide (THPI) – a breakdown of the fungicide captan.

Along with chemical monitoring in Indian Creek, the instream trout embryo to fry lifestage test will again be used to test for biological toxicity in the creek. Macroinvertebrate and periphyton assessments will also be conducted.

# Background

Indian Creek is located in South Puget Sound and drains into Budd Inlet (Figure 1). The creek is around 3 miles long and its watershed is approximately 1,500 acres containing 35% impervious surface (Reynolds and Wood, 2011).

Indian Creek originates from a wetland complex that includes Bigelow Lake. It flows through a mix of land uses including urban, industrial, residential, and parks. The creek crosses under Interstate 5 twice and under numerous other roads. It eventually joins Moxlie Creek and is then piped under downtown Olympia to the east bay of Budd Inlet.

Many of the culverts on Indian Creek are too small or have too much drop for salmon migration. Despite these barriers, resident trout inhabit various reaches of the creek (City of Olympia, 2013).

Indian Creek is located in Water Resource Inventory Area (WRIAs) 13 and the eight-digit Hydrologic Unit Code (HUC) number is 17110016.

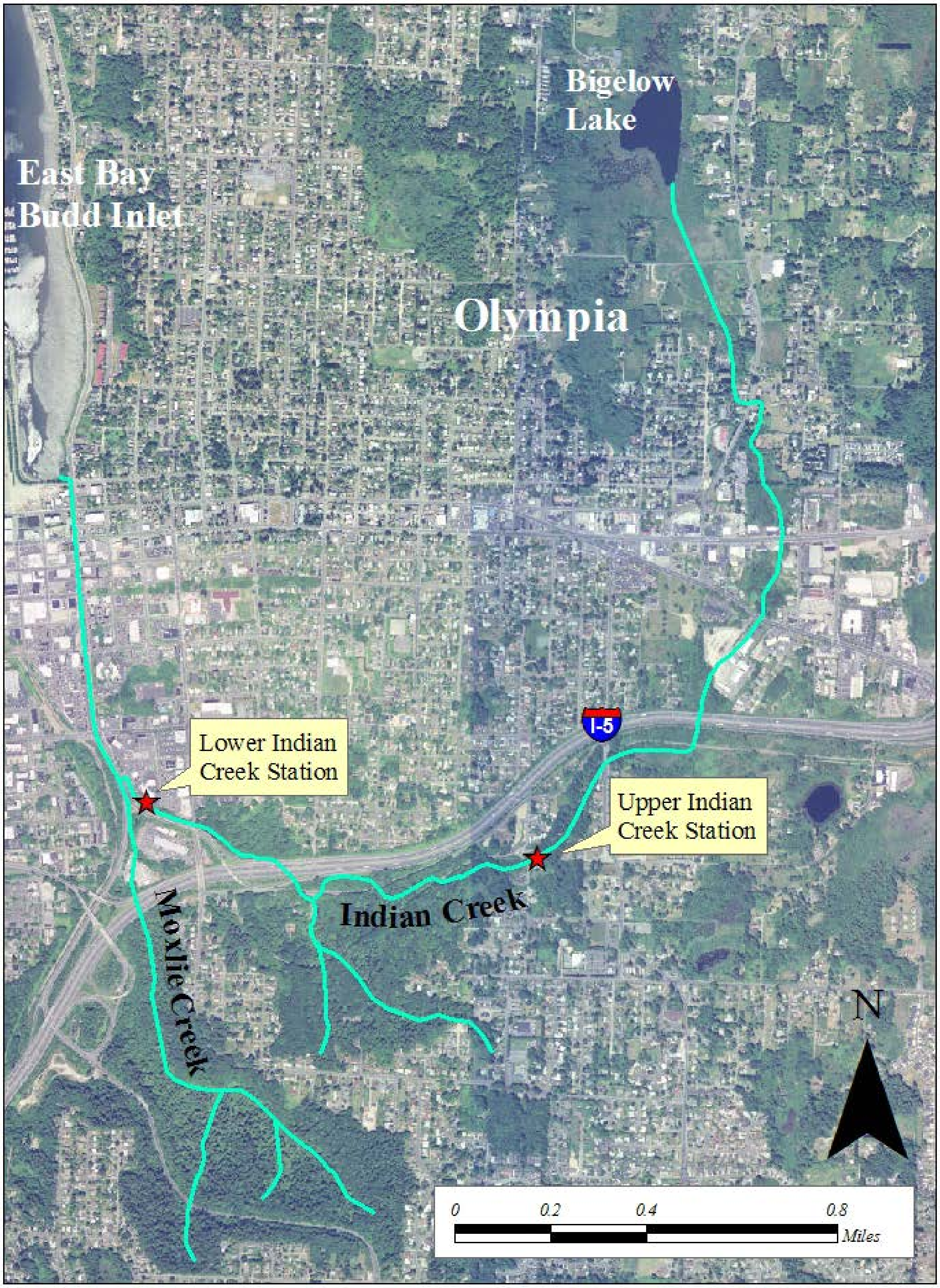


Figure 1. Indian Creek Watershed and Monitoring Locations for the 2010 Pilot Study.

A pilot study conducted during spring of 2010 evaluated biological impairment at two stations in Indian Creek in Olympia, WA (Marshall and Era-Miller, 2012). The purpose of the study was to assess stream health by evaluating the suitability of a stream for salmonid reproduction. The study used an integrated approach that involved a combination of chemical testing (passive samplers and surface water sampling) in conjunction with bioassessment techniques (in-situ toxicity testing, macroinvertebrates and periphyton).

The in-situ deployment of trout embryos was conducted for 34 days to measure survival, hatching success, and development. Trout tissue was also analyzed for five metals (cadmium, copper, lead, nickel, and zinc). Periphyton and benthic macroinvertebrates were collected, identified, and enumerated to provide indications of impairment.

Multiple observations in the 2010 pilot study showed biological impairment at the lower station in Indian Creek. Final trout survival was 88.9% at the upper station and 14.4% at the lower station. Trout tissue results showed that nickel and lead were at elevated concentrations. Benthic invertebrate and periphyton data indicated greater community disturbance in 2010 at the lower station.

A benthic survey was conducted by Ecology for the Deschutes River Multi-parameter Total Maximum Daily Load Effectiveness Monitoring Pilot Project (Collyard and Von Prause, 2009) in the fall of 2012 at the lower Indian Creek station. This study revealed that no invertebrates were present in the stream. Multiple groundwater seeps were found during the benthic survey. These groundwater seeps represent another potential pathway for contaminants to enter lower Indian Creek.

Three types of passive samplers were placed in Indian Creek in 2010 to collect and analyze the same chemicals as the exposed organisms. One type of passive sampler collected metals, another picked up nonpolar organic chemicals, and one sampled polar organic chemicals. Results from the passive samplers showed copper and zinc at concentrations sufficient to explain the periphyton impairment. Passive sampler results also tentatively identified a fungicide, captan, which is highly toxic to trout.

Other passive sampler results included indirect evidence that oxygenated polycyclic aromatic hydrocarbons (OPAHs) were more abundant at the lower station than at the upper station where the trout and benthic organisms were healthier.

# Candidate Stressor Chemicals

## Metals

The 2010 pilot study results provided a preponderance of evidence that metals caused the adverse effects seen in the lower Indian Creek organisms. Metals were the only pollutants clearly at higher concentrations at the lower station. Lead and nickel concentrations were higher in fish tissue from the lower Indian Creek station than from the upper Indian Creek station. The nickel concentration found in the fish tissue from the lower Indian Creek trout was among the highest seen in national data.

Periphyton (which are primarily diatoms) data showed a doubling in the percentage of metals-tolerant species at the lower station. Periphyton data showed a larger percentage of abnormal cells at the lower station, also indicating metals exposure. The highest copper and zinc concentrations measured in stream grab samples or back-calculated from passive samplers overlapped the range of toxic thresholds reported in EPA's EcoTox database for freshwater diatoms exposed to copper or zinc.

## Oxygenated Polycyclic Aromatic Hydrocarbons (OPAHs)

OPAHs, like their parent PAH compounds, are products of incomplete combustion of organic matter such as coal, oil, gas, wood, and garbage. They can be found in some natural products like petroleum oil and coal. OPAHs can also be formed through post-emission oxidation, (chemical oxidation, photooxidation, or biological transformation), of PAHs in the environment. There is also evidence that OPAHs are more polar, soluble, and toxic than PAHs (Lundstedt et al., 2007). These compounds tend to bind on particles in the air, on surfaces such as roofs and parking lots, and in sediments.

PAHs are common in urban environments and can come from spillage of fuels and lubricants, release of combustion byproducts, or wearing of asphalt and tires. Urban transportation provides all of these PAH sources along with the hard surfaces from which PAHs can run into streams during storms.

In 2010, the lower Indian Creek site had fewer and lower concentrations of PAHs than the upper site. Since the lower Indian Creek site is surrounded by parking lots and roads, Ecology scientists hypothesized that PAHs were converted by sunlight in the air and on parking lots to OPAHs. Chemical analyses for OPAHs were not available in 2010.

Oregon State University recently developed standardized methods for analyzing environmental samples for OPAHs. Ecology's Manchester Environmental Laboratory (MEL) is currently developing a similar method for measuring OPAHs. OPAHs will be analyzed in surface water, groundwater, and stormwater for the 2013 study.

## Captan

Captan was tentatively identified at nearly equal amounts in passive samplers from the upper and lower stations in 2010, but sampling rates were not determined so the relative captan water concentrations at the stations were unknown. The amount of captan was an order of magnitude higher than any other pesticide detected in the passive samplers. Given its short half-life and detection in the air blank, captan may have been recently applied in the area. The timing, duration, and magnitude of peak captan stream concentrations cannot be determined from the passive sampler results for either station.

Captan can enter aquatic habitats either from atmospheric drift or stormwater runoff. The trip blank (exposed to air at the lower Indian Creek station at deployment and retrieval) had an amount of captan that was 30% of the amount found in the passive samplers exposed in the stream. The trip blank result indicates that captan was present in the air around the time that the trout were exposed in Indian Creek. Captan is widely used as a fungicide during the spring on berries, fruit, alfalfa, turf, golf courses, and ornamental vegetation. All of these sources exist within a few miles of Indian Creek.

Captan is considered to be very highly toxic to salmonids by EPA's qualitative toxicity classification system. The Tokyo Metropolitan Research Institute for Environmental Protection found the captan 2-day $LC_{50}$ to drop from 570 ug/L for rainbow trout embryos to 75 and 180 ug/L for alevins and fry. The survival of trout at the Indian Creek lower station went from 83.3% (on day 9 just after hatch) to 47.8% (on day 23) to 14.4% (on day 34 just after swim-up). This pattern is consistent with the reported increase in the sensitivity of alevins and fry exposed to captan.

Captan breaks down both within organisms and in the environment into trichloromethylthio (TCMT) which is the toxic agent. The captan half-life ranges from 2.5 to 24 hours, but the half-life of TCMT is not known. The concentrations and durations of exposure for captan and its breakdown product and toxic agent, TCMT, must be combined in an exposure assessment.

TCMT cannot be easily measured. In addition to TCMT, the other main breakdown product of captan is tetrahydrophthalidimide (THPI) which is the central ring structure of the parent captan molecule. THPI can be more easily measured and the result used to estimate the concentration of TCMT because THPI occurs in a 1:1 ratio with TCMT. EPA considers THPI to be essentially nontoxic to fish and aquatic invertebrates.

MEL recently expanded their pesticide analytical method to measure for THPI. THPI will be analyzed in surface water and stormwater for the 2013 study.

# Project Description

The 2010 study identified the 3 candidate stressor chemicals described above (metals, OPAHs, and captan). This study aims to focus on the cause of the trout mortalities and benthic community impairment seen in 2010 by determining sources and quantifying these candidate stressors. In addition, this study will include the groundwater seeps discovered in fall of 2012 along the impaired section of Indian Creek as another potential source to be characterized. Finally, since no sediments were analyzed in 2010, suspended bed load sediments will be sampled in 2013 and analyzed to fill the information gap on sediments as a potential source of toxic chemicals.

This study will also repeat the biological assessments used in 2010. The study will deploy trout embryos in upper and lower Indian Creek and add 2 additional stations in the lower Indian Creek to more precisely characterize the stream impairment in that section. Bug bags will again be used as passive samplers for macroinvertebrates. The results will be compared to the results of kick-net sampling of Indian Creek macroinvertebrates.

The environmental media to be analyzed include stream samples, stormwater discharges, groundwater seeps, sediments, periphyton, and macroinvertebrates. Fish tissue, macroinvertebrates, and periphyton will be analyzed for the original 5 metals from the 2010 study (cadmium, copper, nickel, lead, and zinc) plus arsenic. Arsenic is added to assess the possible influence from the groundwater seeps. Fish tissue will be analyzed for PAHs. Groundwater and sediment samples will be analyzed for BNAs because groundwater and sediment were not analyzed in 2010 when a broad suite of organics were measured.

# Organization and Schedule

Table 1 lists the people involved in this project. All are employees of the Washington State Department of Ecology. Table 2 presents the proposed schedule for this project.

Table 1. Organization of Project Staff and Responsibilities.

| Staff<br>(all are EAP except client) | Title | Responsibilities |
|---|---|---|
| Randall Marshall<br>Water Quality Program<br>Phone: 360-407-6445 | EAP Client | Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP. Assists with data interpretation and co-authors draft and final reports. |
| Brandee Era-Miller<br>Toxics Studies Unit, SCS<br>Phone: 360-407-6771 | Project Manager and Principal Investigator | Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into EIM. Co-authors the draft and final reports. |
| Michael Friese<br>Toxics Studies Unit, SCS<br>Phone: 360-407-6737 | Field Assistant | Helps collect samples and records field information. Reviews final data in EIM. |
| Scott Collyard<br>Directed Studies Unit, WOS<br>Phone: 360-407-6455 | Bioassessment Monitoring Support | Field lead for the benthic macroinvertebrate and periphyton sampling and interpretation. |
| Kirk Sinclair<br>Groundwater Unit, SCS<br>Phone: 360-407-6557 | Groundwater Monitoring Support | Field lead for installation and decommissioning of piezometers. Assists with groundwater sampling. |
| Dale Norton<br>Toxics Studies Unit, SCS<br>Phone: 360-407-6765 | Unit Supervisor for the Project Manager | Provides internal review of the QAPP, approves the budget, and approves the final QAPP. |
| Will Kendra<br>SCS<br>Phone: 360-407-6698 | Section Manager for the Project Manager | Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP. |
| Robert F. Cusimano<br>WOS<br>Phone: 360-407-6596 | Section Manager for the Study Area | Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP. |
| Joel Bird<br>Manchester Environmental Laboratory<br>Phone: 360-871-8801 | Director | Approves the final QAPP. |
| William R. Kammin<br>Phone: 360-407-6964 | Ecology Quality Assurance Officer | Reviews and approves the draft QAPP and the final QAPP. |

EAP: Environmental Assessment Program
EIM: Environmental Information Management database
SCS: Statewide Coordination Section
WOS: Western Operations Section
QAPP: Quality Assurance Project Plan

Table 2. Proposed Schedule for Completing Field and Laboratory Work, Data Entry into EIM, and Reports.

| Field and laboratory work | Due date | Lead staff |
|---|---|---|
| Field work completed | June 2013 | Brandee Era-Miller |
| Laboratory analyses completed | August 2013 | |
| Environmental Information System (EIM) database | | |
| EIM user study ID | BERA0010 | |
| Product | Due date | Lead staff |
| EIM data loaded | October 2013 | Brandee Era-Miller |
| EIM QA | November 2013 | Michael Friese |
| EIM complete | December 2013 | Brandee Era-Miller |
| Final report | | |
| Author lead / Support staff | Brandee Era-Miller / Michael Friese | |
| Schedule | | |
| Draft due to supervisor | October 2013 | |
| Draft due to client/peer reviewer | November 2013 | |
| Draft due to external reviewer(s) | December 2013 | |
| Final (all reviews done) due to publications coordinator | January 2014 | |
| Final report due on web | February 2014 | |

# Quality Objectives

Manchester Environmental Laboratory (MEL) and the biological testing laboratories are expected to meet quality control requirements of methods selected for this project. Quality control procedures used during field sampling and laboratory analyses will provide data for determining the accuracy of the monitoring results. A waiver was obtained for the non-accredited trout in-situ toxicity method to be used in the project. Ecology policy requires waivers for all non-accredited methods under Executive Policy 22-01.

Table 3 shows the measurement quality objectives (MQOs) for the methods selected for the chemical analyses. MQOs for biological assessments (trout in-situ toxicity testing and macroinvertebrate and periphyton assessments) are available in the methods referenced in the *Sampling Procedures* section of this report.

Quality control for sampling, processing and analyzing samples includes measuring for bias and precision. *Bias* is the systematic error due to contamination, sample preparation, calibration, or the analytical process. Most sources of bias are minimized by adherence to established protocols for the collection, preservation, transportation, storage, and analysis of samples. *Precision* is a measure of the ability to consistently reproduce results.

Field blanks are used to detect bias from contamination. This may include contamination from containers, sample equipment, environmental surroundings, preservatives, transportation, storage, other samples, or laboratory analysis.

Analytical precision and bias will be evaluated and controlled by use of laboratory check standards, duplicates, spikes, and blanks analyzed along with study samples. Check standards (also known as laboratory control standards) contain a known amount of an analyte and indicate bias due to sample preparation or calibration.

Method blanks will be analyzed along with all samples to measure any response in the analytical system for target analytes. Method blanks have an expected theoretical concentration of zero.

Table 3. Laboratory Measurement Quality Objectives for Chemical Analyses.

| Parameter | Matrix | Lab Control Samples (% Recovery) | Duplicate samples (RPD) | Matrix Spike (% Recovery) | Matrix Spike Duplicates (RPD) | Surrogate Recoveries (% Recovery) |
|---|---|---|---|---|---|---|
| DOC | Water† | 80 – 120 | ≤20% | 75 – 125 | 20% | NA |
| TSS | | 80 – 120 | ≤20% | NA | NA | NA |
| Alkalinity | | 80 – 120 | ≤20% | NA | NA | NA |
| Hardness | | 85 – 115 | ≤20% | 75 – 125 | 20% | NA |
| As, Cd, Cu, Ni, Pb, & Zinc | | 85 – 115 | ≤20% | 75 – 125 | ≤20% | NA |
| PAHs (SIM) | | 10 – 150[1] | ≤40% | 20 – 150[1] | 40% | 10 – 150[1] |
| OPAHs[2] | | 10 – 150[1] | ≤40% | 20 – 150[1] | 40% | 10 – 150[1] |
| Captan & THPI[3] | | 40 – 170 | ≤40% | 10 – 215 | 40% | 15 – 180[1] |
| BNAs | | 50 – 150[1] | ≤50% | 50 – 150[1] | 40% | 30 – 150[1] |
| As, Cd, Cu, Ni, Pb, & Zinc | Tissue | 85 – 115 | ≤20% | 75 – 125 | 20% | NA |
| PAHs (std list) | | 50 – 150[1] | ≤50% | 50 – 150[1] | 40% | 18 – 150[1] |
| TOC | Sediment | 80 – 120 | ≤20% | 75 – 125 | 20% | NA |
| % solids | | NA | ≤20% | NA | NA | NA |
| As, Cd, Cu, Ni, Pb, & Zinc | | 85 – 115 | ≤20% | 75 – 125 | 20% | NA |
| BNAs | | 50 – 150[1] | ≤50% | 50 – 150[1] | 40% | 18 – 150[1] |

TOC: total organic carbon
DOC: dissolved organic carbon
TSS: total suspended solids
As: arsenic
Cd: cadmium
Cu: copper
Ni: nickel
Pb: lead
PAHs: polycyclic aromatic hydrocarbons
OPAHs: oxygenated PAHs
THPI: tetrahydrophthalidimide
BNAs: bases, neutrals and acids
RPD: relative percent difference
NA: not applicable
† The water matrix includes surface water, groundwater and stormwater.
[1] Recoveries are compound specific.
[2] MQOs for OPAHs have not been established at this time.
[3] MQOs for THPI have not been established at this time.

# Sampling Process Design (Experimental Design)

Study activities for the 2013 follow-up study for integrated monitoring include:

1. Repeat the trout embryo in-situ exposures at 4 locations. Two of the locations will be the same as the Indian Creek deployments in 2010 (upper and lower sites – see Figure 1). Figure 2 shows where the 2 additional locations will be. One location will be near the 2010 lower location of metals passive samplers to see if the passive samplers in 2010 were upstream of the source of nickel. An optional trout station will be located just above the suspect stormwater pipe noted in 2010 to provide for an above and below the stormwater culvert comparison. Trout will be assessed for survival, hatch success, and development. Whole body trout tissue will be analyzed for 6 metals (arsenic, cadmium, copper, lead, nickel, and zinc) and PAHs.

2. Conduct instream assessments of periphyton and benthic macroinvertebrates in April 2013 before the in-situ trout and bug bags are put in place. Periphyton and macroinvertebrate tissue will be analyzed for metals (arsenic, copper, cadmium, nickel, lead, and zinc).

3. Deploy gravel-containing bug bags as passive samplers for benthic macroinvertebrates at the same locations as 2010 (see Figure 1 for both locations and Figure 2 for lower Indian Creek). Macroinvertebrates from the bug bag samples will be enumerated the same as the instream assessments, but they will not be analyzed for metals concentrations.

4. Collect stormwater samples after at least a 4-day antecedent dry period in May from the suspect stormwater upstream of the 2010 instream activities at the lower Indian Creek station (Figure 2). Stormwater will also be collected from a stormwater pipe discovered during field reconnaissance in 2013. Located at the downstream end of the lower Indian Creek segment (Figure 2). Stormwater samples will be analyzed for 6 metals, PAHs, OPAHs, captan, and THPI.

5. Sample suspended sediments by sediment trap at locations immediately downstream of the two stormwater pipes in lower Indian Creek. Sediments will be analyzed for 6 metals and BNAs.

6. Sample groundwater along the left bank of lower Indian Creek in the vicinity of the prominent seeps observed during base-flow conditions (Figure 2). Two piezometer samplers will be placed at the seeps (approximately 6 to 12 inches deep into the stream bank). An additional piezometer will be placed upland of the seeps. Groundwater samples will be analyzed for six metals, PAHs, OPAHs, and BNAs.

7. Sample ambient stream water twice from the location where the organics passive samplers were deployed in lower Indian Creek in 2010 (Figure 2). Conduct the sampling in April to May when berries and fruit are in flower (a time when the fungicide captan is typically used). Analyze the stream water samples for 6 metals, PAHs, OPAHs, captan, and THPI.

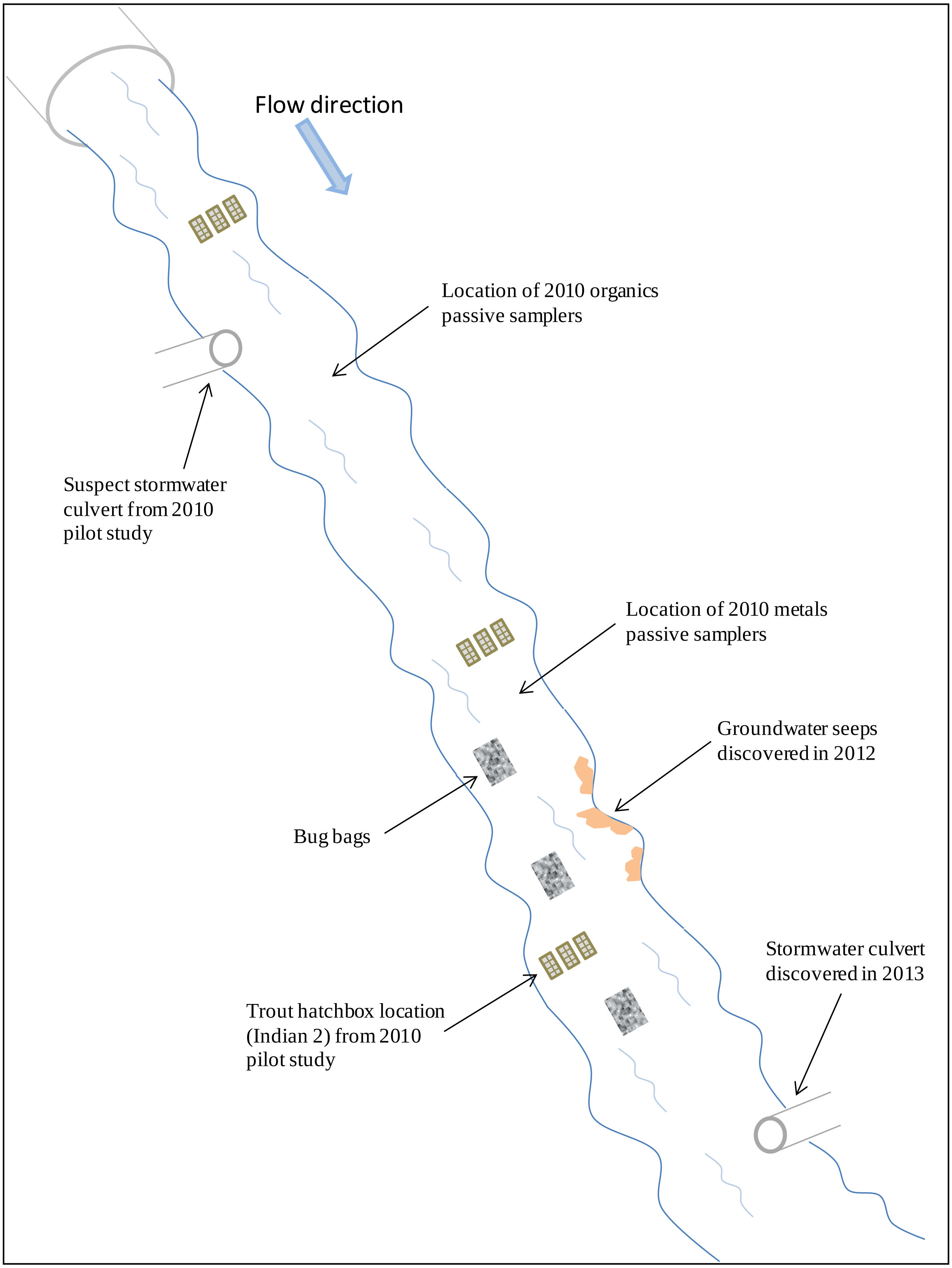


Figure 2. Schematic of Sampling Location for Lower Indian Creek (map not to scale).

# Sampling Procedures

## Chemical Assessments

### Surface Water

Surface water samples will be collected by hand as simple grabs from mid-channel following the EAP *Standard Operating Procedure for Sampling Pesticides in Surface Waters, Version 2.1* (Anderson, 2012). Streamflow in Indian Creek is small and well-mixed, so single grabs will be adequate to represent creek water. Powder-free nitrile gloves will be worn by field staff when they collect and handle samples.

Table 4 gives the requirements for sample containers, preservations, and holding times for all the water, tissue, and sediment samples being collected for the study. The table also details all of the chemical analyses that will be conducted on the various matrices.

Table 4. Sample Containers, Preservations, and Analytical Holding Times.[1]

| Parameter | Matrix | Container | Preservation | Holding Time |
|---|---|---|---|---|
| DOC | Water[†] | 60 mL poly bottle; 0.45 um pore size filters | Filter in field with 0.45um pore size filter; 1:1 HCl to pH<2; Cool to 6°C | 28 days |
| TSS | | 1 L poly bottle | Cool to 6°C | 7 days |
| Alkalinity | | 500 mL poly bottle - no headspace | Refrigerate, 6°C | 14 days |
| Hardness | | taken from the total metals sample bottle | HNO3 to pH<2 by the lab within 24 hours of collection | 6 months after preservation |
| As, Cd, Cu, Ni, Pb and Zinc | | 500 mL HDPE bottle | Field filter for dissolved; HNO3 to pH<2 by the lab within 14 days of collection | 6 months after preservation |
| PAHs (SIM) | | Certified 1 liter amber bottle w/Teflon lid liner | Refrigerate, 6°C | 7 days |
| OPAHs | | Certified 1 liter amber bottle w/Teflon lid liner | Refrigerate, 6°C | 7 days |
| Captan & THPI + TICs | | Certified 1 liter amber bottle w/Teflon lid liner | Refrigerate, 6°C | 12 hours |
| BNAs + TICs | | Certified 1 liter amber bottle w/Teflon lid liner | Refrigerate, 6°C | 7 days |
| As, Cd, Cu, Ni, Pb and Zinc | Tissue | Certified 4-oz glass jar w/Teflon lid liner | Refrigerate at 6°C; can store frozen at -18°C | 6 months; 2 years frozen |
| PAH (std list) | | Certified 4-oz glass jar w/Teflon lid liner | Refrigerate at 6°C; can store frozen at -18°C | 14 days; 1 year frozen |
| % Solids | Sediment | 2-oz glass jar | Cool to 6°C | 7 days; 6 months frozen |
| TOC | | 2-oz glass jar | Cool to 6°C | 14 days; 6 months frozen |
| As, Cd, Cu, Ni, Pb and Zinc | | Certified 4-oz glass jar w/Teflon lid liner | Transport at 6°C; can store frozen at -18°C | 6 months; 2 years frozen |
| BNAs + TICs | | Certified 4-oz glass jar w/Teflon lid liner | Transport at 6°C; can store frozen at -18°C | 14 days; 1 year frozen |

[1] Information in table was adapted from MEL, 2008.
[†] The water matrix includes surface water, groundwater seeps and stormwater. Captan, THPI and TSS will only be analyzed in surface water and stormwater. BNAs will only be analyzed in groundwater.
TOC: total organic carbon; DOC: dissolved organic carbon; TSS: total suspended solids
As: arsenic; Cd: cadmium; Cu: copper; Ni: nickel; Pb: lead
PAHs: polycyclic aromatic hydrocarbons; OPAHs: oxygenated PAHs
THPI: tetrahydrophthalidimide
BNAs: bases, neutrals and acids
TICs: Tentatively Identified Compounds

### Streamflow Monitoring

Flow will be measured using a Marsh-McBirney flow meter and top-setting rod as described in the EAP *Standard Operating Procedure for Estimating Streamflow: Version 1.0* (Sullivan, 2007). An effort will be made to measure flow during water sampling events as time allows. Flow will be measured downstream of all instream activities to avoid disturbance of the instream test areas.

### Hydrolab and Tidbit Data

A MiniSonde® will be used to measure ambient stream temperature, pH, conductivity, and dissolved oxygen each time a project-related activity occurs at the sites, e.g., during water sampling and in-situ trout deployment, checks, and retrieval. The MiniSonde® will be calibrated and operated following the EAP *Standard Operating Procedure for Hydrolab® DataSonde® and MiniSonde® Multiprobes, Version 1.0* (Swanson, 2007).

Tidbit temperature loggers will be deployed at each in-situ trout monitoring location. Tidbits will be set to log on the half-hour.

### Metals

Collection of water samples for metals analyses will follow the EAP *Standard Operating Procedure (SOP) for the Collection and Field Processing of Metals Samples, Version 1.3* (Ward, 2007). Surface water and stormwater will be analyzed for both total and dissolved metals, while the groundwater seep samples will only be analyzed for dissolved metals.

Samples for dissolved metals will be filtered in the field using pre-cleaned filters from MEL. Field filtering and acidification will take place within fifteen minutes of collection.

## Groundwater

Groundwater will be sampled once during the project at 2 seep locations. A shallow groundwater sampling device called a piezometer will be installed along the creek bank by each of the 2 groundwater seeps being sampled. An additional piezometer will be placed upgradient from the 2 seep piezometers as shown in Figure 3. The upgradient piezometer will sample shallow groundwater before it reaches the seeps.

A licensed hydrogeologist from the EA Program, Kirk Sinclair, will assist with installation, sampling and removal of the piezometers following EAP *Standard Operating Procedure for Installing, Measuring, and Decommissioning Hand-driven in-water Piezometers – Version 1.1* (Kirk and Sinclair, 2010) Ecology has a Hydraulic Project Approval HPA (No. 114142-2) from WDFW for installation of piezometers.

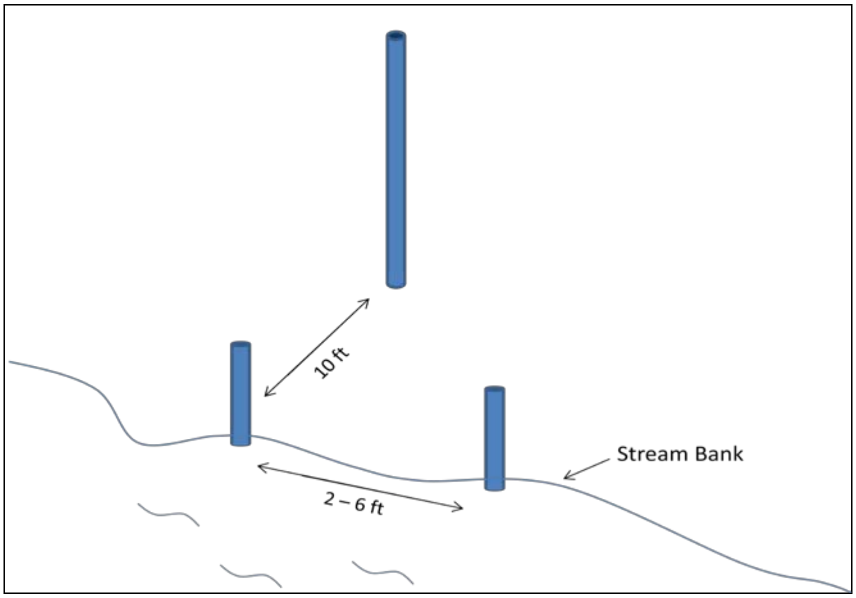

Figure 3.  Diagram of Groundwater Seep Sampling Method.

## Stormwater

Stormwater will be sampled directly from 2 stormwater runoff pipes near the lower Indian Creek monitoring site once during the project.  The goal will be to catch a storm after at least a 4-day antecedent dry period during April or May, while the trout are instream.

## Suspended Particulates

Hamlin sediment traps will be deployed at 2 locations at the lower Indian Creek monitoring site to capture suspended sediments in the creek, while the trout are instream.   A picture of the Hamlin sampler is shown in Figure 4.  The Hamlin sampler is constructed using 14-gage solid stainless steel and has two distinct chambers.  The top piece or “tongue” deflects flowing water up the ramp and into the ¼-inch-wide slots where water can fall through to the upper chamber. Dimensions are 21.5L x 9.25W x 4H inches.  The weight (approximately 25 lbs) is enough to withstand low flows like those in Indian Creek without being secured to the stream bottom (Lubliner, 2012).

Traps will be de-contaminated prior to deployment with sequential rinses of hot water and Liquinox detergent followed by a 10% nitric acid rinse and deionized water.  The traps will be dried in a clean chemical hood and then rinsed with acetone.  Once the acetone has evaporated, the traps will be covered with aluminum foil until deployment in the stream.


Figure 4. Hamlin Sediment Trap Used to Collect Suspended Sediments.

*Assembled (right), Upper Chamber (top left) and Lower Chamber (bottom left, with baffles, tray, and exit ports). Lubliner, 2012.*

# Biological Assessments

## Trout Toxicity Testing

Environment Canada (1998) developed a toxicity test using the embryo, alevin, and fry (EAF) lifestages of rainbow trout (*Oncorhynchus mykiss*) because of concern over water quality in salmonid spawning streams. Each lifestage is sensitive to different pollutants. An environmental exposure encompassing all of these lifestages is a true chronic test. The biological effects assessed include mortality, failure to hatch, abnormal development, and reduced growth. The EAF early lifestage test works well in a laboratory or in hatchboxes set in a stream.

Rainbow trout in-situ testing for the pilot study will be conducted by an aquatic testing laboratory familiar with the testing procedure with assistance from Ecology. The method is based on the British Columbia Ministry of the Environment *Field Sampling Manual* (BC MoE, 2003).

The laboratory will obtain trout eyed-embryos for the in-situ toxicity testing from Trout Lodge in Sumner, Washington. Ecology has acquired a Hydraulic Project Approval (HPA No. 119775-1) permit from the Washington State Department of Fish and Wildlife (WDFW) for the trout in-situ work. Washed stream gravel (1 to 2-inch diameter) will be used to supplement the native stream gravel in filling and covering the cages containing hatchboxes and trout embryos.

Thirty eyed-embryos will be placed in each Whitlock-Vibert hatchbox at the stream site. Hatchboxes are then closed and placed within steel wire cages (approximately 7 by 14 inches). Gravel is placed inside the cages to hold the hatchboxes in place. Three or 4 cages, each containing one hatchbox, will then be deployed side-by-side at each stream station, making for a total of 90-120 eyed-embryos per sampling location.

The method for instream placement of cages and hatchboxes is intended to create conditions in the hatchboxes that mimic natural salmonid spawning conditions (eggs are exposed to flowing water in gravels while being protected from high-flow events and predators). Field staff will select stream locations that have suitable gravel and a steady unidirectional flow outside of the main current (thalweg).

See Figure 5 for a diagram of the arrangement of the cage placements. The sampling site will be excavated by digging an area deep enough so the tops of the cages will be at about the same elevation as the streambed. The cages will then be covered with a small mound of gravel after being placed side-by-side in the excavated area at each station. Continuous temperature monitors will be deployed with the cages.

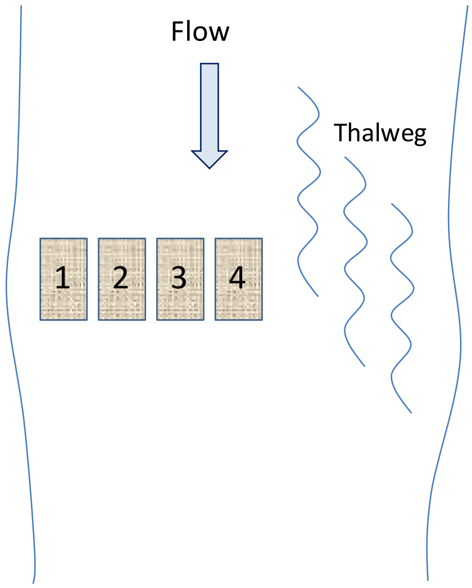


Figure 5. Diagram of In-Situ Trout Hatchbox Deployment.

The lab control trout will be kept at a similar temperature to the stream-exposed trout, not only for quality assurance and statistical comparison purposes, but also to track developmental milestones and time field visits to monitor the instream trout. Field visits will be timed to coincide with embryo hatch and fry swim-up in the laboratory controls. The field checks involve removal, inspection, and reburial of the cages and hatchboxes. The number hatched, number alive, and general observations on fish health are recorded at each field visit.

The test will be terminated once yolk sacs have been absorbed, at which point the fish will be transported to the laboratory where they will be evaluated for characteristics such as deformities and growth. Once at the laboratory and prior to measurements of length and weight and processing for analysis, the trout will be anesthetized and killed with MS-222 (tricaine methanesulfonate).

**Metals and PAHs in Trout Tissue**

Directly after the trout fry are anesthetized and measured at the contract laboratory, Ecology staff will place composites of whole body fry into certified contaminant-free jars provided by MEL. Composite samples will be analyzed from each station and the lab control. The number of fish fry needed for each composite depends on the analysis. Composite samples will be placed on ice and shipped to MEL for metals analysis.

For analysis of metals, two grams of tissue are needed to ensure that the required reporting limits are met. As each fish fry typically weighs about .01 grams, approximately 20 fry are needed for each sample. The fish will be digested whole body as part of the analysis preparation method and analyzed for arsenic, cadmium, copper, lead, nickel, and zinc.

Ten grams of tissue is needed to ensure that the desired reporting limits are met for PAH analysis. Ten grams is roughly equivalent to 100 fry. It is likely that 120 fry (for metals and PAHs) won't be available at the end of the trout deployment period. An amount less than 10 grams can still be analyzed for PAHs, but reporting limits will likely be raised. Ecology staff will evaluate whether or not there is enough fry tissue available for PAH analysis at the end of the deployment period. If enough tissue is available for PAH analysis, then the composited fish will be frozen whole in certified glass jars and then homogenized prior to analysis with a fish tissue homogenizer.

## Benthic Macroinvertebrates

**D-Frame Kicknet Sampling**

Invertebrates are more sensitive than fish to many pollutants such as metals and insecticides. For this reason, benthic macroinvertebrate assessments are now standard tools for determining stream health. The displacement of pollutant-sensitive species by pollutant-tolerant species can be easily measured.

Instream benthic macroinvertebrates will be collected from the native substrate at both the upper and lower Indian Creek sites, the same as it was done during the 2010 study. Benthic macroinvertebrates and periphyton will be collected before trout hatchboxes and sediment traps are installed to avoid disturbance from placement of these devices.
Macroinvertebrates will be collected by Scott Collyard of Ecology's Environmental Assessment Program (EAP). He specializes in macroinvertebrate monitoring and follows Ecology's collection protocols as described in the Ecology publication: *Benthic Macroinvertebrate Biological Monitoring Protocols for Rivers and Streams: 2001 Revision* (Plotnikoff and Wiseman, 2001).

Eight biological samples will be collected from riffle habitat in a reach: 2 samples will be from each of 4 riffles. A variety of riffle habitats will be chosen within the reach to ensure representativeness of the biological community. This sampling design maximizes the chance of collecting a large number of benthic macroinvertebrate taxa from a reach.

Macroinvertebrate samples are collected with a D-Frame 500-micrometer mesh kicknet. The base of the D-Frame kicknet encloses a one-square-foot area of substrate in front of the sampler. Larger cobble and gravels within the sampled area are scraped by hand and brushed softly, visually examined to ensure removal of all organisms, then discarded downstream of the sampler. Remaining substrate within the sampler is then thoroughly agitated to a depth of 2 to 3 inches (5 to 8 cm).

Net contents are then emptied into a rinse tub by inverting the net and gently pulling it inside out. Tub contents are poured into a U.S. Standard No. 35 sieve. The tub is rinsed into the sieve and examined to ensure all organisms have been removed. This procedure is repeated for each of the 8 sub-samples.

All of the sieve contents are placed in a sample bottle. Each bottle is filled about 2/3 full to allow room for an alcohol preservative (85% non-denatured ethanol). Sample bottles are then labeled and shipped to Rhithron Associates, Inc in Missoula, Montana for analysis.

**Bug Bags**

Bug bags worked well for the 2010 study and provided data comparable to the D-Frame Kicknet method. In fact, the bug bag method more clearly reflected water quality differences between the upper and lower Indian Creek sites, because substrate effects were taken out of the equation (Marshall and Era-Miller, 2012). This same bug bag method will be used in 2013.

The bug bags will be deployed for approximately 40 days at the upper and lower Indian Creek monitoring stations. This is similar to a method used by the state of Maine (Davies and Tsomides, 2002).

Bug bags are made using 2-inch gravel stuffed inside square pieces of mesh fencing held together at the edges with zip ties. Each bag has the same dimensions of 12 x 18 inches. Three bug bags will be distributed in downstream transects at each site, encompassing at least 2 riffles. Distances between the bug bags at each site will range from 10 to 35 feet.

Upon retrieval, the bug bags will be gently scooped up from the substrate in a D-Frame kicknet and then transferred into a tub. The mesh bags are cut open allowing rocks, debris, and bugs to fall into the rinse tub. Tub contents are then sieved and placed into sample bottles, in the same way as was done for the instream benthic macroinvertebrate collection. Samples will be shipped to Rhithron for analysis.

## Periphyton

Periphyton is a complex community of microbes, algae, and bacteria that live on hard substrate such as rock, shells, and logs in aquatic environments. A common analysis of periphyton, including for this study, focuses on algae or diatoms. Similar to benthic macroinvertebrate assessments, diatom community assessments are a key indicator of stream health.

Periphyton will be collected from native substrates at the same time as macroinvertebrate collection using a modified method from Wyoming's *Manual of Standard Operating Procedures for Sample Collection and Analysis* (WDEQ/WQD, 2005).

Rocks (2.5 – 4 inches in diameter) will be collected from 8 quadrants across a riffle in the stream. Periphyton is gently scrubbed off the rocks and rinsed off into a container. The rinsate is then poured into a 500 mL Nalgene sample bottle and preserved. Samples will be kept in a darkened cooler and then shipped to Rhithron for analysis.

Foil templates of the rocks will be made by wrapping the areas where the periphyton sample was removed. These templates are later used to calculate the surface area of periphyton collection.

# Laboratory Measurement Procedures

MEL's reporting limits and analytical methods for surface water, groundwater seeps, stormwater, fish tissue and sediments are presented in Table 5.

Table 5. Manchester Environmental Laboratory Reporting Limits and Analytical Methods for Water, Fish Tissue, and Sediments.

| Analysis | Matrix | Laboratory Reporting Limits | Analytical Method |
|---|---|---|---|
| DOC | Water[†] | 1 mg/L | SM 5310B |
| TSS | | 1 mg/L | SM 2540D |
| Alkalinity | | 5 mg/L | EPA 310.2; SM 2320B |
| Hardness | | 0.3 mg/L | EPA 200.7; SM |
| As, Cu, & Ni - Diss | | 0.1 ug/L | EPA 200.8; SM |
| Cd & Pb - Diss | | 0.02 ug/L | |
| Zinc - Diss | | 1 ug/L | |
| PAHs (SIM) | | 0.1 ug/L | GCMS, EPA method (modified) SW 846 8270 |
| OPAHs | | 0.5 – 5 ug/L | |
| Captan & THPI + TICs | | 0.03 – 0.05 ug/L | |
| BNAs + TICs | | 0.25 – 5 ug/L[2] | |
| As, Cu, Ni, & Pb | Fish Tissue[1] | 0.1 mg/Kg ww | EPA 200.8; SM |
| Cadmium | | 0.01 mg/Kg ww | |
| Zinc | | 5 mg/Kg ww | |
| PAHs (std list) | | 25 ug/Kg ww | GCMS, EPA method (modified) SW 846 8270 |
| TOC | Sediment | 0.1 % | PSEP - TOC |
| % solids | | 1 % | SM 2540G |
| As, Cu, Ni, & Pb | | 0.1 mg/Kg dw | EPA 200.8; SM |
| Cadmium | | 0.01 mg/Kg dw | |
| Zinc | | 5 mg/Kg dw | |
| BNAs + TICs | | 12 – 250 ug/Kg dw[3] | GCMS, EPA method (modified) SW 846 8270 |

TOC: total organic carbon
DOC: dissolved organic carbon
TSS: total suspended solids
As: arsenic
Cd: cadmium
Cu: copper
Ni: nickel
Pb: lead
*(continued on next page)*

PAHs: polycyclic aromatic hydrocarbons;
OPAHs: oxygenated PAHs
THPI: tetrahydrophthalidimide
BNAs: bases, neutrals and acids
GCMS: Gas Chromatography/Mass Spectroscopy
LCMS: Liquid Chromatography/Mass Spectroscopy
BNAs: Bases, neutrals, and acids
SM: Standard Methods
PSEP: Puget Sound Estuary Protocols
TICs: Tentatively Identified Compounds
Diss: Dissolved
dw: dry weight; ww: wet weight
[†] The water matrix includes surface water, groundwater seeps and stormwater.
[1] MEL needs 2 grams of tissue to achieve the stated reporting limits.
[2] Method reporting limits vary depending on the analyte and matrix quality.
[3] Method reporting limits vary depending on the analyte, matrix quality, and percent solids.

# Project Budget

The total cost for the project is $27,040 as shown in Table 6. Costs for the trout toxicity testing, bug bags, and field equipment is $10,560. The cost for chemical analyses to be performed by MEL is $16,480 as itemized in Table 7.

Table 6. Total Costs for the Integrated Monitoring Project Phase II.

| Item | No. Units | Unit Price | Total Price |
|---|---|---|---|
| Trout toxicity testing | 4 sites + lab control | NA | 9,500 |
| Bug bag enumeration | 2 | 300 | 600 |
| Bug bag supplies | NA | NA | 100 |
| Teflon acid vials for metals | 8 | 10 | 80 |
| Pre-cleaned filters for dissolved metals | 5 | 30 | 150 |
| Standards for Hydrolab | NA | NA | 130 |
| | Bioassessments & Equipment Costs: | | $ 10,560 |
| | MEL Analytical Costs: | | $ 16,480 |
| | Total Project Costs: | | **$ 27,040** |

NA: not applicable

Table 7. Itemized Costs for Chemical Analyses.[1]

| Analysis | Matrix | No. Samples | No. QC Samples* | QC Sample Type | Total No. Samples | Price per Unit | Total Price |
|---|---|---|---|---|---|---|---|
| DOC | | 2 | 1 | replicate | 3 | 40 | $ 120 |
| TSS | | 2 | 1 | " | 3 | 12 | $ 36 |
| Alkalinity | | 2 | 1 | " | 3 | 17 | $ 51 |
| Hardness | | 2 | 1 | " | 3 | 22 | $ 66 |
| 6 Metals - total | Surface Water | 2 | 2 | rep/blank | 4 | 129 | $ 516 |
| 6 Metals - diss | | 2 | 2 | " | 4 | 129 | $ 516 |
| PAH (SIM) | | 2 | 2 | " | 4 | 200 | $ 800 |
| OPAHs | | 2 | 2 | " | 4 | 205 | $ 820 |
| Captan & THPI + TICs | | 2 | 2 | " | 4 | 250 | $ 1,000 |
| DOC | | 2 | 1 | replicate | 3 | 40 | $ 120 |
| TSS | | 2 | 1 | " | 3 | 12 | $ 36 |
| Alkalinity | | 2 | 1 | " | 3 | 17 | $ 51 |
| Hardness | | 2 | 1 | " | 3 | 22 | $ 66 |
| 6 Metals - total | Stormwater | 2 | 1 | " | 3 | 129 | $ 387 |
| 6 Metals - diss | | 2 | 1 | " | 3 | 129 | $ 387 |
| PAH (SIM) | | 2 | 3 | rep/MS/MSD | 5 | 200 | $ 1,000 |
| OPAHs | | 2 | 3 | " | 5 | 205 | $ 1,025 |
| Captan & THPI + TICs | | 2 | 3 | " | 5 | 250 | $ 1,250 |
| DOC | | 3 | 0 | none | 3 | 40 | $ 120 |
| Alkalinity | | 3 | 0 | " | 3 | 17 | $ 51 |
| Hardness | | 3 | 0 | " | 3 | 22 | $ 66 |
| 6 Metals - diss | Groundwater Seeps | 3 | 1 | blank | 4 | 129 | $ 516 |
| PAH (SIM) | | 3 | 1 | " | 4 | 200 | $ 800 |
| OPAHs | | 3 | 1 | " | 4 | 205 | $ 820 |
| BNAs + TICs | | 3 | 4 | rep/blank/MS/MSD | 7 | 325 | $ 2,275 |
| % Solids | | 2 | 1 | replicate | 3 | 12 | $ 36 |
| TOC | Sediment Traps | 2 | 1 | " | 3 | 45 | $ 135 |
| 6 Metals | | 2 | 1 | " | 3 | 137 | $ 411 |
| BNAs + TICs | | 2 | 2 | rep/MS/MSD | 4 | 379 | $ 1,516 |
| 6 Metals | Fish Tissue | 4 | 1 | replicate | 5 | 137 | $ 685 |
| PAH (std list) | | 2 | 0 | " | 2 | 401 | $ 802 |
| | | | | | | Total MEL Costs | **$ 16,480** |

[1] Analytical costs include a 50% cost discount for analysis conducted at MEL.
* Does not include internal laboratory QC samples
TOC: total organic carbon
DOC: dissolved organic carbon
TSS: total suspended solids
PAHs: polycyclic aromatic hydrocarbons
OPAHs: oxygenated PAHs
THPI: tetrahydrophthalidimide
BNAs: bases, neutrals and acids
BNAs: Bases, neutrals, and acids
TICs: Tentatively Identified Compounds
diss: dissolved
QC: Quality Assurance
MS: matrix spike
MS: matrix spike duplicate
rep: replicate sample

# Quality Control Procedures

## Field

Table 8 lists the field quality control samples that will be analyzed for the chemical analyses. Field quality control samples provide an estimate of the total variability of the results (field plus laboratory) and will consist of the collection and analysis of field replicates and equipment or field blanks.

Equipment and field blanks will be conducted using clean deionized water from MEL. For the surface water and stormwater grab samples, the deionized water will be transferred from the laboratory bottle straight into the sample bottle while in the field. For samples where field equipment is involved (Nalgene® filters for dissolved metals and piezometers and Silastic® tubing for the groundwater sampling) deionized water will be run through the equipment and into the sample containers while in the field.

All efforts will be made to avoid cross-contamination of samples. Field staff will wear non-talc nitrile gloves throughout the sampling process and carefully follow all SOPs referenced in the *Sampling Procedures* section of this QA Project Plan.

Table 8. Field Quality Control Samples for Chemical Analyses.

| Parameter | Matrix | Field Replicate | Equipment/ Field Blank |
|---|---|---|---|
| DOC, Alkalinity and Hardness | Water† | 2/project | none |
| TSS | Surface Water and Stormwater | 2/project | none |
| As, Cd, Cu, Ni, Pb & Zinc - Total | | 2/project | 1/project |
| As, Cd, Cu, Ni, Pb & Zinc - Dissolved | | 2/project | 1/project |
| PAHs (SIM) | | 2/project | 1/project |
| OPAHs | | 2/project | 1/project |
| Captan & THPI + TICs | | 2/project | 1/project |
| As, Cd, Cu, Ni, Pb & Zinc - Dissolved | Groundwater | none | 1/project |
| PAHs (SIM) | | none | 1/project |
| OPAHs | | none | 1/project |
| BNAs + TICs | | 1/project | 1/project |
| As, Cd, Cu, Ni, Pb & Zinc | Tissue | 1/project | none |
| PAH (std list) | | none | none |
| % Solids & TOC | Sediment | 1/project | none |
| As, Cd, Cu, Ni, Pb & Zinc | | 1/project | none |
| BNAs + TICs | | 1/project | none |

† The water matrix includes surface water, groundwater seeps, and stormwater.
NA: not applicable
TOC: total organic carbon
DOC: dissolved organic carbon
TSS: total suspended solids
PAHs: polycyclic aromatic hydrocarbons
OPAHs: oxygenated PAHs
THPI: tetrahydrophthalidimide
BNAs: bases, neutrals and acids
TICs: Tentatively Identified Compounds

## Laboratory

The laboratory quality control procedures routinely followed by MEL and the contract laboratories (Nautilus and Rhithron) will be satisfactory for the purposes of this project. MEL will follow SOPs as described in the *Manchester Environmental Laboratory Quality Assurance Manual* (MEL, 2012).

The laboratory control samples that will be used for the chemical analyses of this project are listed in Table 9.

Table 9. Laboratory Quality Control Samples.

| Parameter | Matrix | Method Blank | Laboratory Control Sample | Laboratory Duplicate | Matrix Spike/Matrix Spike Duplicate | Surrogate Spikes |
|---|---|---|---|---|---|---|
| TSS & Alkalinity | Water† | 2/project | 2/project | 2/project | NA | NA |
| DOC & Hardness | | 2/project | 2/project | 2/project | 1/project | |
| As, Cd, Cu, Ni, Pb & Zinc - Total | | 1/project | 1/project | 1/project | 1/project | NA |
| As, Cd, Cu, Ni, Pb & Zinc - Dissolved | | 1/project | 1/project | 1/project | 1/project | NA |
| PAHs (SIM) | | 1/batch | 1/batch | NA | 2/project | All samples |
| OPAHs | | 1/batch | 1/batch | NA | 2/project | All samples |
| Captan & THPI + TICs | | 1/batch | 1/batch | NA | 2/project | All samples |
| BNAs + TICs | | 1/batch | 1/batch | NA | 2/project | All samples |
| As, Cd, Cu, Ni, Pb & Zinc | Tissue | 1/project | 1/project | 1/project | 1/project | NA |
| PAH (std list) | | 1/project | 1/project | NA | | All samples |
| % Solids | Sediment | 1/project | 1/project | 1/project | NA | NA |
| TOC | | 1/project | 1/project | 1/project | 1/project | NA |
| As, Cd, Cu, Ni, Pb & Zinc | | 1/project | 1/project | 1/project | 1/project | NA |
| BNAs + TICs | | 1/project | 1/project | NA | 2/project | All samples |

† The water matrix includes surface water, groundwater seeps and stormwater.
NA: not applicable
Batch: One sampling event
TOC: total organic carbon; DOC: dissolved organic carbon; TSS: total suspended solids
As: arsenic; Cd: cadmium; Cu: copper; Ni: nickel; Pb: lead
PAHs: polycyclic aromatic hydrocarbons; OPAHs: oxygenated PAHs
THPI: tetrahydrophthalidimide
BNAs: bases, neutrals and acids
TICs: Tentatively Identified Compounds

# Data Management Procedures

Field data will be recorded in a field notebook. Relevant information will be carefully transferred to electronic data sheets and reviewed for potential transfer errors.

The data packages from MEL, Nautilus, and Rhithron will include case narratives discussing any problems encountered during analysis, corrective actions taken, and an explanation of data qualifiers. The project manager will then review the data packages to determine if analytical MQOs (laboratory control samples, laboratory duplicates, and matrix spikes) were met.

Chemical data will be entered into Ecology's Environmental Information Management (EIM) database for availability to the public and interested parties. Data entered into EIM follow a formal data review process where data are reviewed by the project manager, the person entering the data, and an independent reviewer.

Trout toxicity data will also be entered into Ecology's CETIS™ database by Randall Marshall. CETIS™ will help interpret toxicity results from the trout tests.

# Audits and Reports

MEL participates in performance and system audits of their routine procedures. The results of these audits are available on request.

The Ecology draft technical report will be provided to internal Ecology reviewers, collaborating entities, external reviewers, and other interested parties by December 2013. The final technical report will be completed in February 2014 and will include the following elements:

- Information about the sampling locations, including geographic coordinates and maps.
- Descriptions of field and laboratory methods.
- Tables presenting all the data.
- Discussion of project data quality.
- Summary of significant findings.
- Recommendations for future follow-up work.

Upon completion of the study, most of the data will be entered into Ecology's EIM database. Electronic data and the final report for the study will be available to the public on Ecology's internet homepage (www.ecy.wa.gov).

Nautilus may also publish reports relating to their part of the project. Ecology has agreed to let them use any and all data generated from the project.

# Data Verification

The project manager will review laboratory data packages and data verification reports.  Based on these assessments, the data will either be accepted, accepted with appropriate qualifications, or rejected and re-analysis considered.

To determine if analytical MQOs have been met, the project manager will compare results of the field and laboratory quality control samples to MQOs.

Formal (third party) validation of the data will not be necessary for this project.

# Data Quality (Usability) Assessment

Once the data have been reviewed and verified, the project manager, in consultation with the client, will determine if the data are useable for the purposes of the project.

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# Appendix. Glossary, Acronyms, and Abbreviations

## Glossary

**Ambient:** Background or away from point sources of contamination.

**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.

**Dissolved oxygen:** A measure of the amount of oxygen dissolved in water.

**Parameter:** A physical chemical or biological property whose values determine environmental characteristics or behavior.

**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.

**Reach:** A specific portion or segment of a stream.

**Salmonid:** Fish that belong to the family *Salmonidae*. Any species of salmon, trout, or char. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

**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).

**Total suspended solids (TSS):** Portion of solids retained by a filter.

**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.

## Acronyms and Abbreviations

| | |
|---|---|
| DOC | Dissolved organic carbon |
| e.g. | For example |
| Ecology | Washington State Department of Ecology |
| EIM | Environmental Information Management database |
| EPA | U.S. Environmental Protection Agency |
| et al. | And others |
| i.e. | In other words |
| MEL | Manchester Environmental Laboratory |

| | |
|---|---|
| MQO | Measurement quality objective |
| QA | Quality assurance |
| RPD | Relative percent difference |
| SOP | Standard operating procedures |
| TOC | Total organic carbon |
| TSS | (See Glossary above) |
| WDFW | Washington Department of Fish and Wildlife |
| WRIA | Water Resource Inventory Area |

*Metals*

| | |
|---|---|
| As | Arsenic |
| Cd | Cadmium |
| Cu | Copper |
| Ni | Nickel |
| Pb | Lead |
| Zn | Zinc |

*Units of Measurement*

| | |
|---|---|
| °C | degrees centigrade |
| dw | dry weight |
| ft | feet |
| g | gram, a unit of mass |
| L | liter |
| mg | milligram |
| mg/Kg | milligrams per kilogram (parts per million) |
| mg/L | milligrams per liter (parts per million) |
| mL | milliliters |
| ug/Kg | micrograms per kilogram (parts per billion) |
| ug/L | micrograms per liter (parts per billion) |
| ww | wet weight |