Quality Assurance Project Plan

Squalicum Creek Toxics Screening Study

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November 2002

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Approvals

Approved by:	November 27, 2002
David Laws, Pledge Project Coordinator, Bellingham Field Office	Date
Approved by:	December 2, 2002
Richard Grout, Section Manager, Bellingham Field Office	Date
Approved by:	November 26, 2002
Morgan Roose, Project Manager, Toxics Studies Unit	Date
Approved by:	November 25, 2002
Dale Norton, Unit Supervisor, Toxics Studies Unit	Date
Approved by:	November 25, 2002
Will Kendra, Section Manager, Watershed Ecology Section	Date
Approved by:	November 26, 2002
Stuart Magoon, Director, Manchester Environmental Laboratory	Date
Approved by:	November 20, 2002
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Abstract

The Squalicum Creek watershed drains 6,750 hectares in Whatcom County, Washington State. The surrounding lands are under increasing development from rural agricultural to urban, commercial-industrial. Local groups are concerned with the water quality of this and other watersheds in the area and have formed a group called the Whatcom Watershed Pledge Program.

In the fall of 2002, Ecology will conduct a screening study of the watershed. Storm water from seven sites on the creek and tributaries will be analyzed for pesticides, herbicides, mercury, arsenic, copper, lead, and zinc. Sediment will also be collected from six different catch basins in the watershed and analyzed for the above mentioned metals and components of lube oils, gas, and diesel.

Data from the investigation will be used to assist the pledge program. Ecology will help to prioritize drainage basins in the Squalicum Creek watershed needing source control work and education efforts.

Background and Problem Statement

Whatcom Watersheds Pledge Program

The city of Bellingham is drained via three major streams: Whatcom Creek, Padden Creek, and Squalicum Creek. Increasing residential and urban development in these watersheds led community organizers to create the "Whatcom Watersheds Pledge Program." The Pledge Program is a collaborative effort between Whatcom/Bellingham Chamber of Commerce; Port of Bellingham; RE Sources; Sustainable Connections; Whatcom County Solid Waste Division; Whatcom County Health Department; Washington State Department of Ecology; Western Washington University; and the cities of Bellingham, Blaine, Everson, Ferndale, Lynden, Nooksack, and Sumas. These entities work together to identify pollutants in local water bodies and provide educational materials and technical assistance to businesses and residents living in Whatcom County to help them identify and implement specific actions they can take to reduce water pollution. Details of the program can be found at www.watershedpledge.org.

The pledge program has been implemented in the Whatcom Creek and Padden Creek watersheds. Water, sediment, and fish sampling done on Whatcom Creek helped identify specific contaminants of concern. The pledge program then recommended specific actions residents could take to reduce those pollutants. Residents pledged to reduce or eliminate certain activities or use of chemicals that were detrimental to the creek. Participation was strong; the results were published in the Whatcom Watersheds Pledge Project Report 1998-2000 and will soon be available on the above mentioned web site. The Padden Creek Project focused education and sampling efforts on pesticides and herbicides in water and has completed the first year of a two year study (Seiders, 2001). This study will be completed in the spring of 2002.

Pledge program efforts are now heavily focused in the Squalicum Creek watershed. The residential pledge began in the spring of 2002 and the business pledge will be implemented during the fall of 2002.

Squalicum Creek Watershed

The Squalicum Creek watershed drains 6,750 hectares of land. The combined creeks and tributaries create 84 kilometers of stream habitat that drain water from land of varying uses (Downen, 1999). The creek provides habitat for many salmonid species including chum salmon, fall-run Chinook salmon, Coho salmon, steelhead trout, and sea-run cutthroat (WDFW Stocking Records, Squalicum Creek 1934-1998).

The upper portion of the creek is mostly agricultural and second growth forest. The lower portion of Squalicum Creek is composed of commercial, industrial, and residential properties. These types of land uses in the lower watershed create large areas of impermeable surfaces that potentially contribute contaminants such as metals and components of lube oils, gas, diesel, and coolants associated with motor vehicles and road run-off.

The existence and concentration of these pollutants is unknown. Previous studies on Squalicum Creek have been limited to four categories: macroinvertebrate sampling, conventional sampling, risk assessment, and fish population surveys (Table 1). The location of monitoring sites in Squalicum Creek is shown on Fig.1.

Table 1. Current and Existing Studies on Squalicum Creek.

Organization	Parameters	# of Sites	Sampling Frequency	Years
City of Bellingham	Fecal Coliform, DO, pH, Turbidity, Temp., Conductivity	4	1/month	current
City of Bellingham	Macroinvertibrates	4	1/year-September	2001/2002
NSEA	DO, pH, Temp., Flow, Conductivity	7	1/week	1999-current
WWU	Salmon Population Study, Risk Assessment Study	NA	NA	2001/2002

NSEA=Nooksack Salmon Enhancement Program (NSEA, 2002)
WWU=Western Washington University (Chen, 2001; Downen, 1999)
NA=Not Applicable

Western Washington University's Huxley College has two graduate students that studied Squalicum Creek for their master theses. Joy Chen looked at risk assessment modeling of the Squalicum Creek watershed (Chen, 2002). Her work broke the watershed up into six "risk regions" or land use groupings. Figure 1 outlines the boundaries of each region. Mark Downen studied the relation of salmonid survival, growth, and outmigration to environmental conditions in Squalicum Creek, providing current fish population data (Downen, 1999).

Huxley College has also taken a few sediment samples via a toxicology class taught by Wayne Landis. In 1990, sediment was collected at a site where Squalicum Creek runs through WWU property (Bakerview and Hannegan Road). Bioassays using Daphnia showed toxicity at that time. Samples taken again in 1998 showed no toxicity (Landis, 2002).

While there has been a consistent interest in Squalicum Creek, there has been little data generated regarding the presence and concentration of toxic contaminants. This will be the focus of the current study.

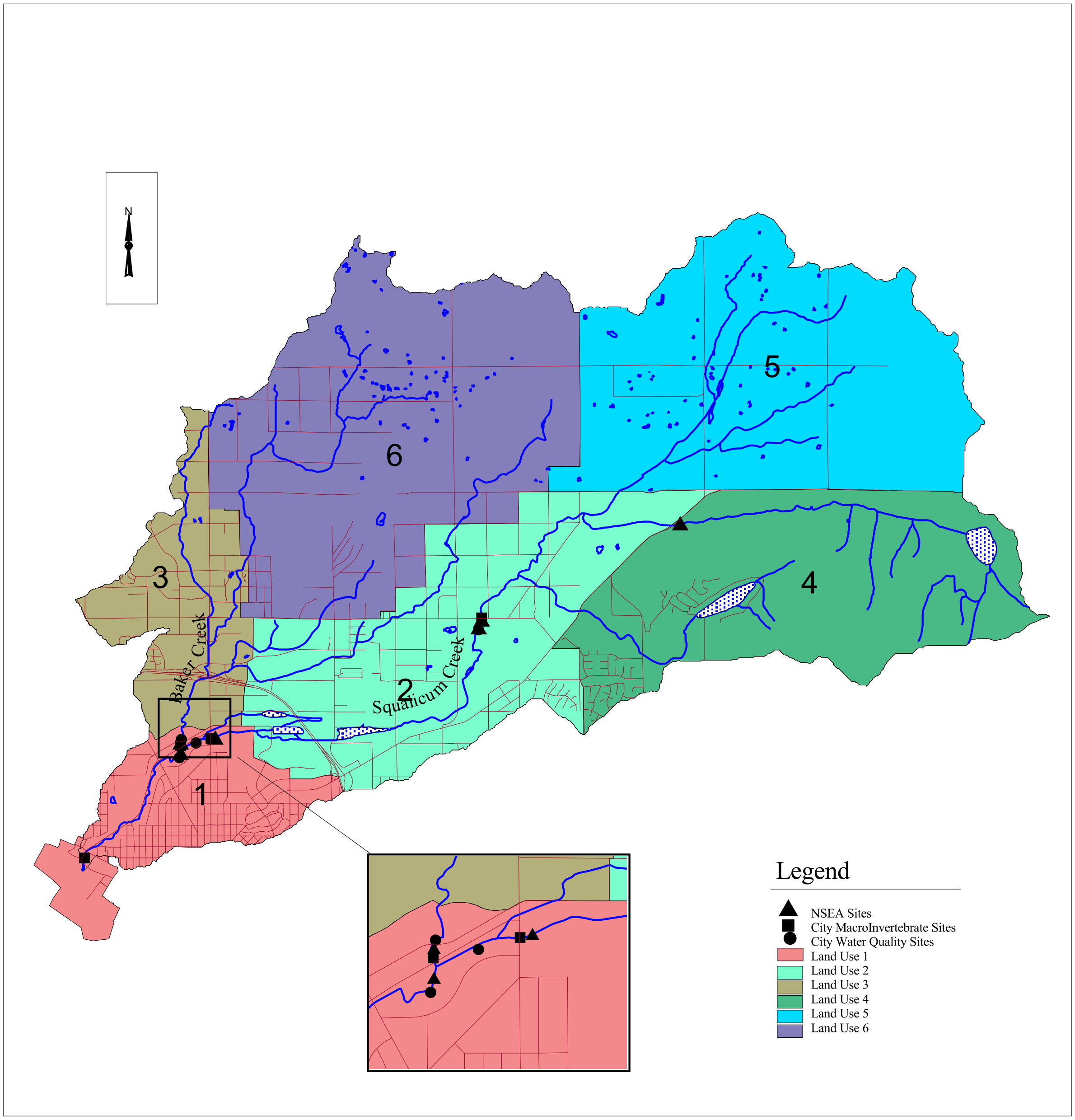

Figure 1. Existing Sampling Sites on the Squalicum Creek Watershed

Project Description

Because of the lack of data regarding the types of chemical contaminants entering Squalicum Creek, this study will screen sediment from six catch basins for arsenic, mercury, lead, copper, zinc, and components of lube oils and diesel. Water from Squalicum Creek and its tributaries will also be collected from seven sites during three unique storm events and analyzed for arsenic, mercury, lead, copper, zinc, total suspended solids, hardness, herbicides, and pesticides.

Study Objectives

The objectives of the Squalicum Creek monitoring program are to:

- Characterize baseline concentrations of pesticides, herbicides, and breakdown products of oil, gas, and diesel in Squalicum Creek during the fall of 2002.
- Screen sediments from several catch basins which drain into Squalicum Creek for toxic chemicals.
- Identify a list of chemicals of concern in the Squalicum Creek watershed.
- Prioritize drainage basins to the Squalicum Creek watershed for source control and education efforts in the pledge program.

Responsibilities

David Laws (360)676-6573. Ecology, Bellingham Field Office (BFO), Project Manager.
Responsible for overall approval of the study design and assisting with coordination of storm water sampling.

Rob Ensley (360)676-6850. City of Bellingham.
Providing technical assistance for sampling sediment from various catch basins around Squalicum Creek watershed.

Stuart Magoon (360)871-8801. Ecology Manchester Environmental Laboratory (MEL).
Responsible for coordinating services for the project at MEL. Bob Carrell and Greg Perez (360)871-8804/8818 will conduct the pesticide and organics analyses.

Cliff Kirchmer (360)407-6455. Ecology Quality Assurance.
As the quality assurance officer for Ecology, Cliff will review this Quality Assurance Project Plan (QA Project Plan) to ensure that it meets Ecology quality standards and will be available to provide assistance with the evaluation of QA/QC data for the project.

Morgan Roose (360)407-6458. Ecology Toxics Studies Unit, Environmental Assessment Program (EA Program) Project Manager.
Responsible for conducting water and sediment sampling, preparation of a final report, and entering data into EIM.

Schedule

QA Project Plan Finalized and Approved	November 2002
Sampling and Analysis	November/December 2002
Report Lab Results	January 2003
Data Entered into EIM System	February 2003
Draft Report	March 2003
Final Report	April 2003

Measurement Quality Objectives

Table 2 gives the measurement quality objectives (MQOs) for this screening study. MQOs are listed for total accuracy, precision, bias, and required reporting limits. Required reporting limits have been chosen based on values at least ten times lower than the water criteria and sediment quality guidelines, which are included in the table for convenience. The water criteria are derived from the water quality standards WAC 173-201A040 (Ecology 1995a). The sediment guidelines shown are from two different sources notes below the table.

Table 2. Measurement Quality Objectives for Sediment and Water Samples.

Parameter	Accuracy % Deviation from True Value	Precision % Relative Standard Deviation	Bias % of True Value	Sediment Guidelines/ Water Quality Criteria	Required Reporting Limit
Sediment					
Copper	30	10	10	32[a] mg/Kg, dry	0.1 mg/Kg, dry
Lead	30	10	10	36[a] mg/Kg, dry	0.1 mg/Kg, dry
Mercury	40	15	10	0.56[b] mg/Kg, dry	0.05 mg/Kg, dry
Zinc	30	10	10	121[a] mg/Kg, dry	5.0 mg/Kg, dry
Arsenic	30	10	10	0.79[a] mg/Kg, dry	0.2 mg/Kg, dry
TOC	40	15	10		0.1% [b]
GC-MS Base-Nuetrals no TIC	55	15	25		200 ug/Kg, dry
GC-MS Acids no TIC	80	15	50		
Diesel Extended Range	45	20	5		50 mg/Kg
Water					
GC/AED Pesticide Screen	50	15	20		0.010 - .10 ug/L
Herbicides	60	20	20		.09 - .70 ug/L
Lead	15	5	5	1.17 ug/L[cd]	0.1 ug/L
Zinc	15	5	5	58.09 ug/L[cd]	5 ug/L
Mercury	25	10	5	.012 ug/L	.005 ug/L
Copper	15	5	5	6.28 ug/L[cd]	0.1 ug/L
Arsenic	15	5	5	190 ug/L[c]	0.1 ug/L
Hardness (Ca+Mg)	25	10	5		200 ug/L
Total Suspended Solids	40	15	10		1000 ug/L[b]

a= Consensus Based Threshold Effect (MacDonald et al., 2000)

b=Lowest Apparent Effects Threshold (Cubbage et al.,1997)

c=WAC 173-201A-040 chronic freshwater criteria

d=based on hardness of 50ug/L

Sampling Design

Water and sediment will be collected from the Squalicum Creek watershed. Water samples at all sites will be collected during three unique storm events. The water samples will be analyzed for zinc, lead, mercury, arsenic, copper, total suspended solids, hardness, pesticides, and herbicides. The sediment samples will come from storm water catch basins and ditches near the creek. Sediment will be tested for BNAs, zinc, lead, mercury, arsenic, copper, grain size, total organic carbon, and a range of diesel breakdown products. The constituents that will be analyzed from the water and sediment represent a range that is found in similar urban settings (Buckler et al., 1999). The results from the water sample analysis will be compared to water quality standards set by the clean water act. The results from the sediment samples will be compared to existing sediment quality guidelines. This will generate a list of contaminants of concern and prioritize areas in the watershed to focus educational efforts.

Water

Water samples from seven stations in the Squalicum Creek watershed will be collected during the fall of 2002. Proposed sampling sites are shown in Figure 2 and described in Table 3.

Sites were selected with the following components in mind:

- Site comparability with data collection by NSEA, the city of Bellingham, and WWU.
- Sampling from different land use areas to better understand pollution sources (see Table 4). This information can then, in turn, be used to target pollution prevention projects.
- Sampling site access: since Squalicum is an urban stream, access to stations is limited.

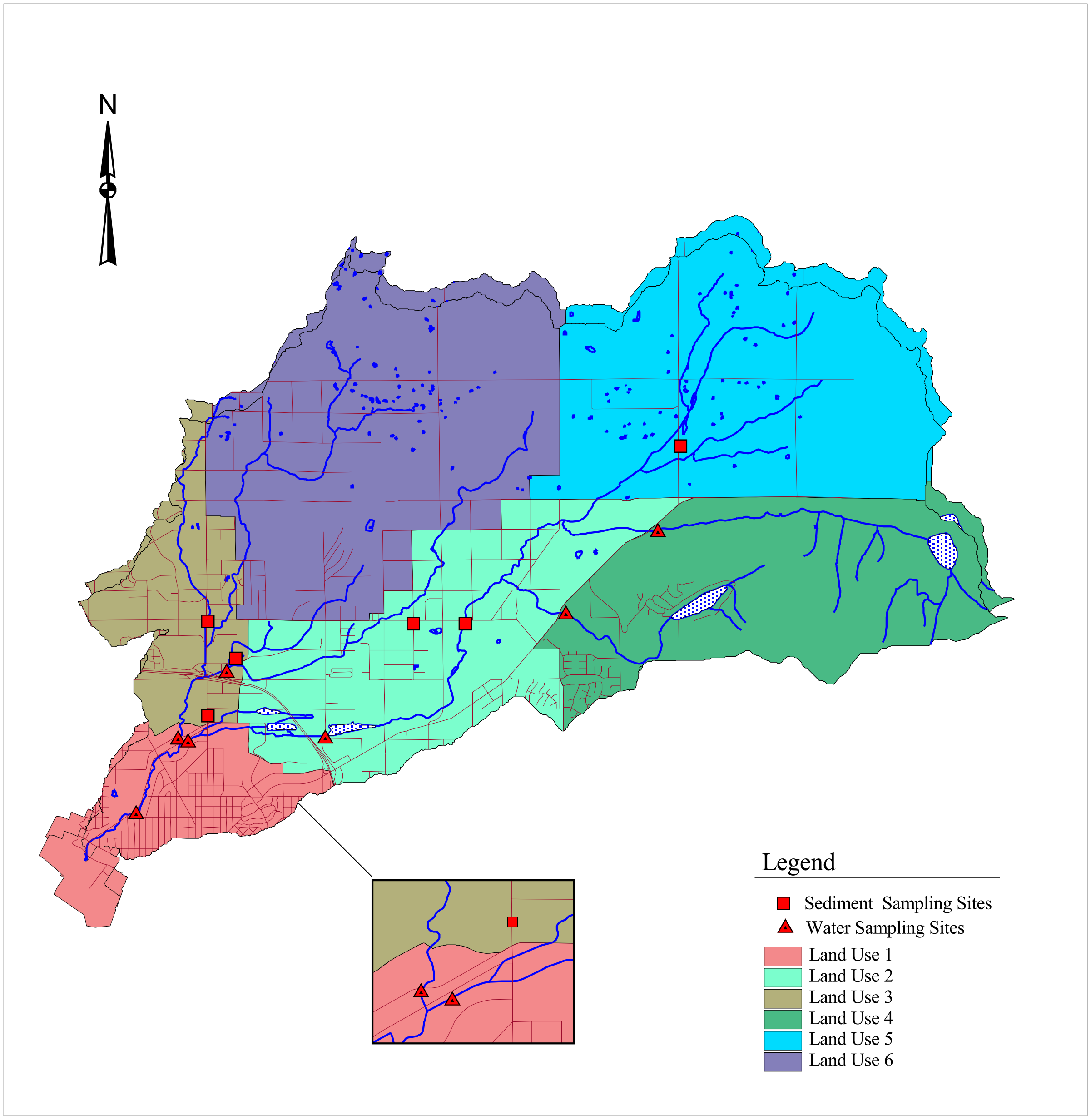

Figure 2. Proposed Sampling Sites and Land Use Regions

Table 3. Proposed Water Sampling Sites and Purpose (See Figure 2).

Station Name	Location	Purpose
SQ1	Mouth of Squalicum Creek @ Squalicum Pkwy	Measure contaminants at end of system and Risk Region 1
SQ2	Mouth of Baker Creek before confluence with Squalicum @ Squalicum Pkwy	Isolate contaminants contributed by Baker Creek tributary and Risk Region 3
SQ3	Squalicum Creek before confluence of Baker Creek @ Squalicum Pkwy	Measure contaminants from heavily urbanized area before confluence with Baker Creek
SQ4	Squalicum Creek upstream of I-5 and downstream of Sunset Pond	Measure contaminants upstream of I-5 influence at the end of Risk Region 2
SQ5	Squalicum Creek off of the Baker Hwy	Sample water draining off of Squalicum Lake and upper watershed
SQ6	Mt Baker Hwy @ confluence of Toad Lake Drainage	Sample water draining off of Toad Lake and surrounding land in Risk Region 4
SQ7	McLeod Rd near intersection with Telegraph Rd	Sample water in an urbanized branch of Baker Creek

Table 4. Watershed Land Use Regions (Chen, 2002).

Land Use Region	Land Use Description
1	residential, mining, transportation, park land
2	commercial, mining, heavy industrial, agricultural, and undeveloped
3	commercial, residential, golf course, some undeveloped
4	forested, undeveloped, agricultural, residential
5	agricultural, residential, forested
6	agricultural, residential, forested, undeveloped

Water samples will be analyzed for priority pollutant metals, herbicides, pesticides, hardness, and total suspended solids.

Sediment

Sediment will be collected and analyzed from six catch basins and ditches near the Squalicum Creek Watershed. Four sites will be located throughout the more developed urban area. A sixth site, CB-6, will be higher up in the watershed to serve as a reference for less developed areas (Table 5).

Table 5. Proposed Location of Sediment Sampling.

Station	Location	Description
CB-1	Meridian St South	Highly urbanized location in Land Use Region 1
CB-2	Meridian St North	Highly urbanized location in Land Use Region 3
CB-3	Irongate Rd	Highly urbanized location in Land Use 2
CB-4	Telegraph Rd	Highly urbanized road in Land Use Region 2
CB-5	Bakerview Rd	Drains to Squalicum Creek @ WWU Site
CB-6	Noon Rd	Forested/Agricultural location in Land Use Region 5. Headwaters of Squalicum Creek.

Sediment samples will be analyzed for priority pollutant metals, BNAs, TOC, grain size, % solids, and NWTPH-Dx.

Field Procedures

Water

Sample collection will be attempted when run-off is likely to transport contaminants. The criteria for sampling are several days of dry weather followed by precipitation that causes an increase in stream flow at sample sites. A recent study in the nearby Whatcom Creek basin suggests that a rainfall event of about 0.15 inch will generate a measurable increase in stream flow (Serdar, et al., 1999). These criteria may be modified based on observed responses in stream flow from rainfall and the ability to mobilize sampling crews and meet available lab capacity.

Meteorological forecasts, information from the National Weather Service, and local contacts will be used to help select rainfall events to sample. Three rainfall events will be targeted. A single composite sample at each site will be collected during the event. No effort will be made to sample the entire stream hydrograph because of the logistical challenges and limited resources.

Water samples will be collected using a U.S. Geological Survey depth-integrating sampler for in-stream depths greater than one foot. A hand held bottle will be used to collect samples where the water depth is less than one foot. The depth-integrating sampler consists of a DH-81 adapter with a D-77 cap and a one-liter jar assembled so that water contacts only Teflon or glass. Samples will be collected by slowly lowering the sampler to the bottom then immediately raising the sampler at the same rate to fill the sampler bottle. Three points (quarter-point transects) across the stream at each site will be sampled to create a composite sample. The sub-samples will be split into one-gallon glass sample containers, filling each container one-third full from each quarter-point.

The depth-integrating samplers and other sampling equipment will be cleaned prior to sampling by scrubbing with Liquinox® detergent followed by sequential rinses with tap water, 10% nitric acid, deionized water, and acetone. All cleaned sampling equipment will be wrapped in aluminum foil to prevent contamination. Dissolved metals sampling methods will follow the EPA Method 1669 (EPA, 1996).

Temperature, pH, conductivity, and stream flow will be measured at the time of sampling. Recommended sample bottles, preservatives, and holding times are listed in Table 6. Temperature will be measured with an alcohol thermometer. The measurement of pH will be done using an Orion Model 250 temperature-compensating pH meter. Specific conductance will be measured using an YSI Model 33 S-C-T meter. Sample location coordinates will be determined in the field by using a Magellan GPS 320 global positioning receiver. Stream flow will be measured using a Swoffer Model 2100 TSR or a Marsh-McBirney, Inc. Model 201 flow meter.

Table 6. Water Sample Containers and Preservation.

Parameter	Sample Container	Preservation	Holding Time till Extraction
Pesticides	1 gallon glass jar	4° C	7 days
Herbicides	1 gallon glass jar	4° C	7 days
TSS	Poly, 1000 mL	4° C	7 days
Hardness	125mL poly	4° C (w/acid)	6 months
Low Level Dissolved Priority Pollutant Metals	1000mL Teflon	4° C Filter and add (add acid)	6 months
Mercury	Same as Metals	Same as Metals	28 days

Sediment

Sediment will be sampled once at six sites. Samples for each site will be taken at the catch basin closest to the mouth of the drain. The road will be marked off with cones with one person directing traffic. The other two field workers will lift the grate off the catch basin using a special pry bar supplied by the city. Once open, a 0.02 m^2 stainless steel Petite Ponar will be lowered to the bottom of the catch basin. The sediment in the grab will be removed with stainless steel scoops, placed in a stainless steel bowl, and homogenized by stirring. Material touching the sidewalls of the grab will not be taken.

The homogenized sediment will be placed in glass jars with Teflon lid liners cleaned to EPA QA/QC specifications (EPA, 1990). Sample containers, preservation, and holding times are shown in Table 7. Excess sample will be retained from each station and stored frozen in the event that additional analysis is required.

Table 7. Sediment Sample Containers and Preservation.

Parameter	Container	Preservation	Holding Time
NWTPH - Dx	8 oz glass; TFE-lined lid	4° C in the dark	14 days (1 year frozen)
BNA's	8 oz glass; TFE-lined lid	4° C in the dark	14 days (1 year frozen)
Grain Size	8 oz glass; TFE-lined lid	4° C in the dark	6 months
TOC	4 oz glass; TFE-lined lid	4° C in the dark	28 days (1 year frozen)
As, Cu, Pb, Zn	8 oz glass; TFE-lined lid	4° C in the dark	6 months (2 years frozen)
% Solids	4 oz glass; TFE-lined lid (analyzed from metals jar)	4° C in the dark	7 days
Mercury	8 oz glass; TFE-lined lid	4° C in the dark	28 days

Stainless steel implements used to collect and manipulate the sediments will be cleaned by washing with Liquinox detergent followed by sequential rinses with tap water, 10% nitric acid, deionized water, and methanol. The equipment will be air-dried and wrapped in aluminum foil.

Between-sample cleaning of the grab will be the same as pre-cleaning procedures. Waste methanol and nitric will be retained in jars until returning to the Ecology building for proper disposal.

All sample containers will be placed into coolers and cooled with ice. Glass sample containers will be protected from breakage by wrapping each in bubble-wrap. Chain-of-custody procedures will be used for all samples. After collection, samples will be stored in a refrigerator at the Ecology Bellingham Field Office building and then transported to the Ecology/EPA Manchester Environmental Laboratory (MEL) by Ecology's sample courier.

Back-up sampling equipment, sample containers, positioning instruments, and spare parts will be carried during field sampling as preventative maintenance.

MEL personnel will observe the condition of the shipped water samples and make note of any samples that are leaking, not cold, or with other problems. Upon receipt of water samples, laboratory personnel will complete all paperwork required to track the shipment and log-in the samples. Water samples will be stored at MEL at 4°C until they are extracted and analyzed.

Laboratory Procedures

Water

Analytical methods for all parameters are summarized in Table 8 below (Ecology, 2000). Appendix A has a complete list of target compounds for each analysis. All samples will be analyzed at MEL. Lab costs include a 50% discount for Manchester Lab.

Table 8. Analytical Methods and Costs for Water Samples.

Parameter	Method	# of Samples*/ Containers**	Cost/Sample	Subtotal
GC/AED Pesticide Screen	GC/AED EPA-8085	8.33	$338	$2,816
Herbicide	EPA 8085	8.33	$184	$1,533
TSS	Gravimetric-EPA160.2	7.66	$10	$77
Hardness	SM2340B	7.66	$12	$92
Cu, Pb, Zn, As (ICP/MS)	EPA Method 200.8	8.66	$96	$831
Filters	NA	8.66	$24	$208
Low Level Mercury	EPA 245.7	8.66	$70	$606
Acid Vials	NA	16.66	$8	$133
Teflon Bottles	NA	16.66	$16	$267
*Includes QA Samples.			**Cost/Sample Event**	**$6,562**
(Fraction represents QA done during one sampling event).			**Cost/3 Sample Events**	**$19,686**

**Some sites require multiple bottles.

Sediment

Analytical methods for all parameters are summarized in Table 9 below. Complete lists of target compounds are available in the Appendix. All sample analysis except grain size will be performed by Manchester.

Table 9. Analytical Methods and Costs for Sediment Samples.

Parameter	Method	Number of Samples*	Cost/Sample**	Subtotal
Diesel Extended Range	NWTPH-Dx	9	$112	$1,008
BNA's-no TIC's	EPA 8270	9	$304	$2,736
Grain Size	Sieve& Pipet-EPA (1996)	7	$125	$875
TOC	Combustion/CO2-EPA(1996)	7	$33	$231
Cu, Pb, Zn, As (ICP/MS)	ICP/MS EPA 6020	9	$104	$936
Mercury	EPA 245.5	7	$30	$210
% Solids		7	$10	$70
*Includes QA Samples			**Cost/All Sites**	**$6,066**
**Includes 25% contracting fee for grain size			**Total Sampling Cost**	**$25,752**

Quality Control

Laboratory quality control procedures routinely used by MEL will be sufficient for this project. Should problems with samples or analyses arise, MEL will confer with the project lead about the nature and need for corrective actions.

Field QC for water will include the use of field replicates at one site during two sampling events. Low level metals analyses in water will also include a field blank for the bottle and filter. The use of field instruments will follow manufacturer's calibration and operating procedures. Field QC for sediment will include a field replicate at one site. Commercial standards will be used for calibrating pH and conductivity instruments. The field thermometer will be checked against a laboratory reference thermometer. Table 10 shows the complete table of types of QC to be used.

Table 10. Minimum Quality Control Samples and Frequency of Analyses.

Parameter	Field Replicate*	Method Blank**	Matrix Spike **	Matrix Spike Duplicate**	Bottle Blank*	Filter Blank
Water* **						
GC/AED Pesticide Screen	2nd, 3rd	1st, 2nd, 3rd	1st	1st		
Herbicide	2nd, 3rd	1st, 2nd, 3rd	1st	1st		
TSS	2nd, 3rd	1st, 2nd, 3rd				
As, Pb, Cu, Zn (ICP/MS)	2nd, 3rd	1st, 2nd, 3rd	1st	1st	3rd	
Hg (ICP/MS)	2nd, 3rd	1st, 2nd, 3rd	1st	1st		3rd
Hardness	2nd, 3rd	1st, 2nd, 3rd				
Sediment						
Diesel Extended Range	1/6	1/6	1/6	1/6		
BNA's-no TIC's	1/6	1/6	1/6	1/6		
Grain Size	1/6					
TOC	1/6	1/6				
As, Pb, Cu, Hg, Zn (ICP/MS)	1/6	1/6	1/6	1/6		
% Solids	1/6	1/6				

*Field QA

**Lab QA

***1st, 2nd, and 3rd refer to sampling rounds

Data Reduction, Review, and Reporting

Project data generated in the field or received from the laboratory will be tabulated and then verified. Field measurements will be reviewed by the project lead for quality and the results summarized in narrative form. Data received from MEL will be accompanied by written quality assurance reviews written by MEL staff. Results from field and laboratory measurements will be entered into the Ecology Environmental Information Management (EIM) database.

The Squalicum Creek report will contain the following elements:

- Description of the project.
- Summary of the findings.
- Detailed description of the sampling methods and sampling stations.
- Map and coordinates (latitude/longitude) of the sampling stations.
- Discussion of the analytical methods and data quality.
- Tables of all chemical data.
- Discussion of results including comparison to applicable water quality and sediment guidelines.
- Recommendations for further educational efforts as a result of types of contamination found, if needed.

Data Quality Assessment

Once the data have been reviewed, verified, and validated, the EA Program manager will make a determination if the data can be used to make suggestions to the Pledge Project regarding areas and contaminants of concern. Applicable water quality criteria and sediment guidelines will be used for comparison. Results from analyzing the field and lab QC samples will be used to judge if the MQOs for the project have been met.

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Appendices

Appendix A

Manchester Laboratory Target Compounds for Pesticide Screen

Abate (Temephos)	Di-allate (Avadex)	Methoxychlor
Alachlor	Diazinon	Methyl Chlorpyrifos
Aldrin		Methyl Paraoxon
Ametryn		Methyl Parathion
Atraton	Dichlobenil	Metolachlor
Atrazine	Dichlorvos (DDVP)	Metribuzin
Azinphos (Guthion)	Dieldrin	Mevinphos
Benefin		Mirex
*alph*a-BHC	Dimethoate	Molinate
*bet*a-BHC		Monocrotophos
*delt*a-BHC	Dioxathion	Napropamide
*gamm*a-BHC (Lindane)	Diphenamid	*tran*s-Nonachlor
Bolstar (Sulprofos)	Disulfoton (Di-Syston)	Norflurazon
Bromacil	Diuron	Oxychlordane
Butachlor	EPN	Oxyfluorfen
Butifos (DEF)	Endosulfan I	Parathion
Butylate	Endosulfan II	Pebulate
Captafol	Endosulfan Sulfate	Pendimethalin
Captan	Endrin	Phenothrin
Carbophenothion	Endrin Aldehyde	Phorate
Carboxin	Endrin Ketone	Phosphamidan
*ci*s-Chlordane *(alph*a-Chlordane)	Eptam	Profluralin
*tran*s-Chlordane *(gamm*a)	Ethalfluralin (Sonalan)	Prometon (Pramitol 5p)
*alph*a-Chlordene	Ethion	Prometryn
*gamm*a-Chlordene	Ethoprop	Pronamide (Kerb)
Chlorothalonil (Daconil)	Ethyl Azinphos (Ethyl Guthion)	Propachlor (Ramrod)
Chlorpropham	Fenamiphos	Propargite
Chlorpyrifos	Fenarimol	Propazine
*ci*s-Permethrin	Fenitrothion	Propetamphos
*ci*s-Nonachlor	Fensulfothion	
Coumaphos	Fenthion	Ronnel
Cyanazine	Fenvalerate (2 isomers)	Simazine
Cycloate	Fluridone	Sulfotepp
2,4'-DDD	Fonofos	Tebuthiuron
4,4'-DDD	Heptachlor	Terbacil
2,4'-DDE	Heptachlor Epoxide	Terbutryn (Igran)
4,4'-DDE	Hexazinone	Tetrachlorvinphos (Gardona)
DDMU	Imidan	
2,4'-DDT	Kelthane	Treflan (Trifluralin)
4,4'-DDT	MGK264	Triadimefon
	Malathion	Triallate
Demeton-O	Merphos (1 & 2)	
Demeton-S	Metalaxyl	Vernolate

Appendix B

Manchester Laboratory Target Compounds for BNA

Acenaphthene	1,4-Dichlorobenzene	2-Nitrophenol
Acenaphthylene	2,4-Dichlorophenol	4-Nitrophenol
Aniline	2,4-Dimethylphenol	*N*-Nitroso-Di-N-Propylamine
Anthracene	2,4-Dinitrophenol	N-Nitrosodiphenylamine
Benzidine	2,4-Dinitrotoluene	2,2'-Oxybis[1-chloropropane]
Benzo (a) anthracene	2,6-Dinitrotoluene	Pentachlorophenol
Benzo (a) pyrene	1,2-Diphenylhydrazine	Bis (2-Ethylhexyl) Phthalate
Benzo (b) fluoranthene	Fluoranthene	Diethylphthalate
Benzo (k) fluoranthene	Fluorene	Dimethylphthalate
Benzo (g,h,i) perylene	2-Fluorophenol	Di-N-Octyl Phthalate
Benzoic Acid	Hexachlorobenzene	Phenanthrene
Benzyl Alcohol	Hexachlorobutadiene	Phenol
Butylbenzylphthalate	Hexachlorocyclopentadiene	Pyridine
4-Bromophenyl-Phenylether	Hexachloroethane	Pyrene
Di-N-Butylphthalate	Indeno (1,2,3-cd) pyrene	Retene
Caffeine	Isophorone	1,2,4-Trichlorobenzene
Carbazole	4,6-Dinitro-2-Methylphenol	2,4,5-Trichlorophenol
4-Chloro-3-Methylphenol	1-Methylnaphthalene	2,4,6-Trichlorophenol
4-Chloroaniline	2-Methylnaphthalene	**Surrogates**
Bis(2-Chloroethoxy) Methane	2-Methylphenol	D4-2-Chlorophenol
Bis(2-Chloroethyl) Ether	4-Methylphenol	1,2-Dichlorobenzene-D4
Bis(2-Chloroisopropyl) Ether	Naphthalene	2-Fluorobiphenyl
2-Chloronaphthalene	2-Nitroaniline	D5-Nitrobenzene
2-Chlorophenol	3-Nitroaniline	D5-Phenol
4-Chlorophenyl-Phenylether	4-Nitroaniline	D10-Pyrene
Chrysene	Nitrobenzene	D14-Terphenyl
3B-Coprostanol		
Dibenzo (a,h) anthracene		
Dibenzofuran		
3,3'-Dichldorobenzidine		
1,2-Dichlorobenzene		
1,3-Dichlorobenzene		

Appendix C

Manchester Laboratory Target Compounds for Herbicides

2,4-D	Picloram
Dacthal (DCPA)	2,4,5-T
2,4-DB	2,4,5-TB
Dicamba I	2,3,4,5-Tetrachlorophenol
3,5-Dichlorobenzoic Acid	2,3,4,6-Tetrachlorophenol
Dichlorprop	2,4,5-TP (Silvex)
Diclofop-Methyl	2,4,5-Trichlorophenol
Dinoseb	2,4,6-Trichlorophenol
MCPA	Trichlopyr
MCPP (Mecoprop)	Acifluorfen (Blazer)
4-Nitrophenol	Bentazon
Pentachlorophenol	

Additional Analytes for Water Matrix Only

Bromoxynil (water only)
Ioxynil (water only)

Surrogates

2,4,6-Tribromophenol and
2,4-dichlorophenylacetic acid