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ECOLOGY
State of Washington

Quality Assurance Project Plan

Leach Creek (Pierce County)
Mercury and Copper Monitoring

September 2009

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Waterbody Number: WA-12-1110, Chambers Creek.

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Signatures are not available on the Internet version.
SWRO – Southwest Regional Office.
TSU – Toxics Studies Unit.
SCS – Statewide Coordination Section.
WOS – Western Operations Section.
EAP - Environmental Assessment Program.
EIM - Environmental Information Management system.

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Abstract

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 them. After completion of the study, a final report describing the results will be posted to the Internet.

Ecology detected elevated mercury levels at the mouth of Leach Creek in Tacoma during routine water quality monitoring in 2007-08. The study described here will attempt to determine if specific reaches within the creek can be isolated as having significant sources of mercury. Monthly monitoring will be conducted from September 2009 through August 2010 at four locations on the creek and will include focused sampling during stormwater runoff events.

Dissolved copper will also be analyzed in view of concerns about its potential impact to salmon in urbanized watersheds of Puget Sound.

Background

Mercury

Leach Creek is a highly urbanized tributary to lower Chambers Creek in west-central Tacoma (Figure 1). Ambient monitoring by the Washington State Department of Ecology (Ecology) Freshwater Monitoring Unit (FMU) detected elevated levels of mercury in December, February, and August of 2007-08 (Table 1).

Table 1. Ambient Monitoring Data for Mercury at the Mouth of Leach Creek.

Ecology Station 12B070 - Leach Creek near Steilacoom				
Date	Flow (cfs)	Mercury (ug/L)	Turbidity (NTU)	TSS (mg/L)
10/31/2007	8.5	<0.002	0.5	1
12/19/2007	59	**0.012**	19	86
2/27/2008	12	**0.007**	6.8	25
4/23/2008	10	<0.002	2.4	3
6/18/2008	~8.5	<0.002	1.5	2
8/20/2008	>14	**0.037**	55	191

TSS = total suspended solids.
Bold = elevated concentration.

The chronic and acute water quality criteria for mercury are 0.012 (total) and 2.1 ug/L (dissolved), respectively (WAC 173-201A). Leach Creek was at or above the chronic criterion in December 2007 and August 2008, and above detection limits (0.002 ug/L) in February 2008. An earlier Ecology water quality study in 1995 (Johnson, 1996) reported elevated mercury concentrations in wet weather samples from Leach Creek (0.018 - 0.034 ug/L).

The Category 5 303(d) listing requires at least two results do not meet (exceed) the criterion in a three-year period. Although the mercury excursions in Leach Creek are unusual, the ambient data from 2007-08 do not meet this requirement because only one result actually exceeded the criterion.

FMU's annual report for the ambient monitoring program recommended that "additional monitoring should be conducted to confirm mercury in Leach Creek" (Hallock, 2009). The Ecology Southwest Regional Office, Water Quality Program, has requested an investigation to follow up on these recommendations.

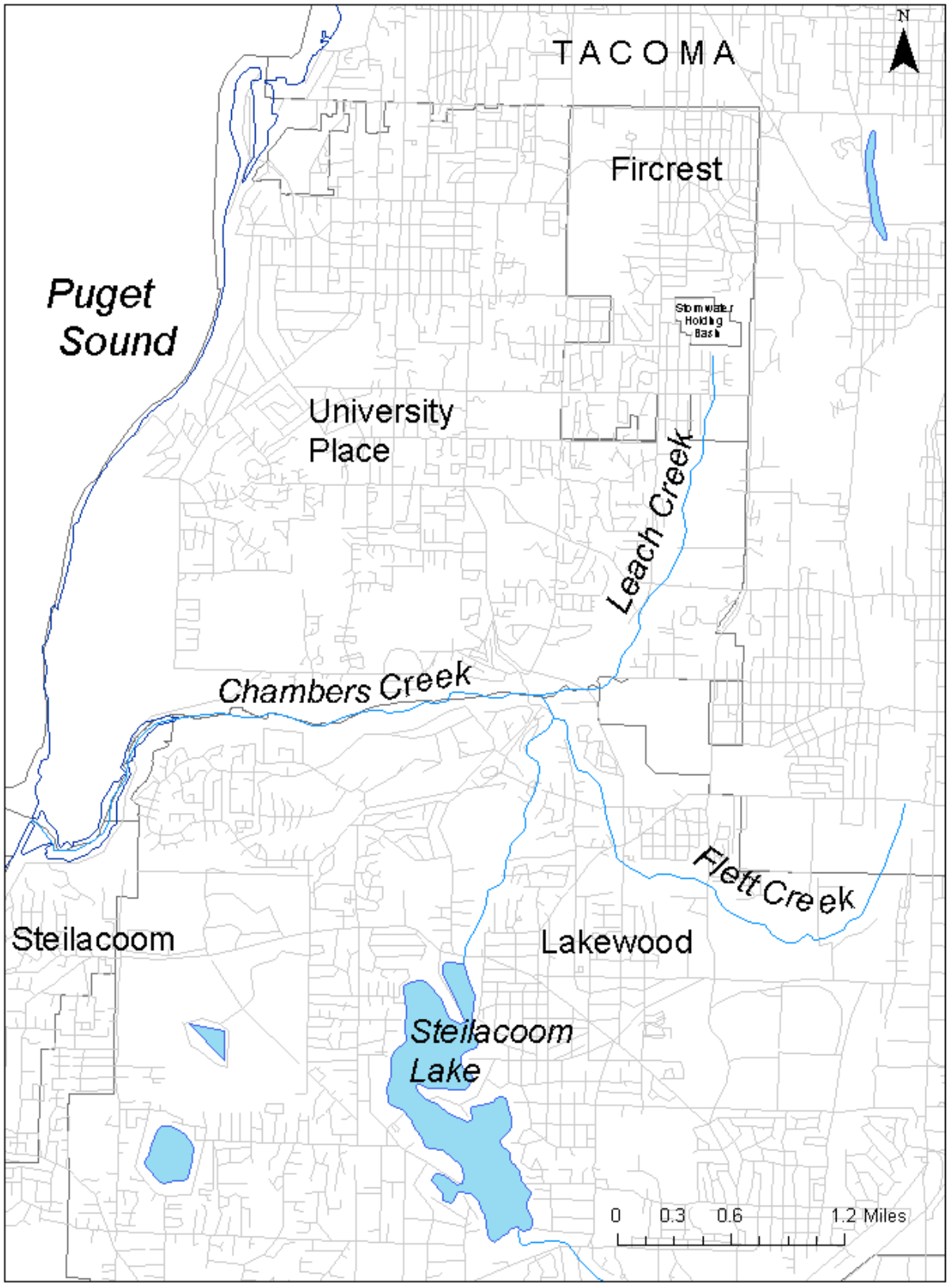

Figure 1. West-Central Tacoma Showing Leach Creek in the Chambers Creek Drainage.

Copper

Copper is an important nonpoint-source pollutant in urbanized aquatic systems of Puget Sound. Considerable research has been devoted to evaluating the impacts of dissolved copper on both juvenile and adult salmon (McIntyre et al., 2008). Since the Chambers/Clover Creek system is used by salmon, copper concentrations will also be determined as part of this study.

There have not been any reports of copper exceeding water quality criteria in Leach Creek or other parts of the Chambers/Clover Creek drainage. Ecology's routine monitoring data show dissolved copper concentrations of 0.48 - 2.4 ug/L in 2007-08. The maximum dissolved copper concentration reported in Ecology's 1995 study (Johnson, 1996) was 3.8 ug/L in Leach Creek, with lower concentrations in Chambers Creek and Clover Creek. The acute and chronic water quality criteria for dissolved copper are 8.9 and 6.8 ug/L, respectively (at 50 mg/L hardness).

Project Description

Mercury and copper concentrations will be monitored in Leach Creek from September 2009 through August 2010. The objectives will be to (1) better characterize mercury and copper concentrations in the creek, and (2) determine if certain reaches have significant sources of these metals. The study will consist of an expanded routine monitoring program timed so as to include stormwater runoff events.

Ecology's Environmental Assessment Program will conduct the study. Ecology's Manchester Environmental Laboratory will analyze the samples.

This Quality Assurance (QA) Project Plan follows the Ecology guidance in Lombard and Kirchmer (2004).

Organization and Schedule

The following people are involved in this project. All are employees of the Washington State Department of Ecology.

Table 2. Organization of Project Staff and Responsibilities.

Staff (all are EAP except client)	Title	Responsibilities
Cindy James Water Quality Program Southwest Regional Office Phone: (360) 407-6556	EAP Client	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP.
Art Johnson Toxics Studies Unit SCS Phone: (360) 407-6766	Principal Investigator	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, enters data into EIM. Writes the draft report and final report.
Michael Friese Toxics Studies Unit SCS Phone: (360) 407-6737	Field Assistant	Helps collect samples and records field information.
Dale Norton Toxics Studies Unit SCS Phone: (360) 407-6765	Unit Supervisor for the Principal Investigator	Provides internal review of the QAPP, approves the budget, and approves the final QAPP.
Will Kendra SCS Phone: (360) 407-6765	Section Manager for the Principal Investigator	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Robert F. Cusimano Western Operations Section 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.
Stuart Magoon Manchester Environmental Laboratory Phone: (360) 871-8801	Director	Approves the final QAPP.
William R. Kammin Phone: (360) 407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

EAP – Environmental Assessment Program.
SCS – Statewide Coordination Section.
EIM – Environmental Information Management system.
QAPP – Quality Assurance Project Plan.

Table 3. 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	August 2010	Art Johnson
Laboratory analyses completed	September 2010	
Environmental Information System (EIM) database		
EIM user study ID	AJOH0060	
Product	Due date	Lead staff
EIM data loaded	March 2011	Michael Friese
EIM Quality Assurance	April 2011	Art Johnson
EIM complete	April 2011	Michael Friese
Final report		
Author lead	Art Johnson	
Schedule		
Draft due to supervisor	January 2011	
Draft due to client/peer reviewer	February 2011	
Draft due to external reviewer(s)	na	
Final (all reviews done) due to publications coordinator	March 2011	
Final report due on web	April 2011	

Quality Objectives

Quality objectives for this project are to obtain data of sufficient quality so that uncertainties are minimized, and that accurate and representative results are obtained for the parameters of interest. These objectives will be achieved through careful attention to the sampling, measurement, and quality control (QC) procedures described in this plan.

Measurement Quality Objectives

Ecology's Manchester Laboratory is expected to meet all QC requirements of the analytical methods being used for this project.

Measurement quality objectives (MQOs) for this study are shown in Table 4. The recovery and precision objectives are the acceptance limits of the analytical methods. The lowest concentrations of interest are Manchester's reporting limits.

Table 4. Measurement Quality Objectives.

Sample Type/Analysis	Check Stds./ LCS (% recovery)	Duplicate Samples (RPD)	Matrix Spikes (% recovery)	Matrix Spike Duplicates (RPD)	Lowest Concentration of Interest
Mercury	85-120%	±20%	75-125%	±20%	0.002 ug/L
Copper	85-120%	±20%	75-125%	±20%	0.1 ug/L
Hardness	80-120%	±20%	75-125%	±20%	1 mg/L
Turbidity	80-120%	±20%	NA	NA	1 NTU
Conductivity	80-120%	±20%	NA	NA	1 umhos/cm

LCS = laboratory control sample.
RPD = relative percent difference.
NA = not applicable.
NTU = nephelometric turbidity units.

Watershed Description

The following description of the Leach Creek watershed comes from the City of Tacoma, Surface Water Management Manual, September 22, 2008 edition:

> *"Leach Creek has a drainage area of approximately 6.5 square miles. Land use is residential and commercial. Included in this watershed is a portion of Westgate Shopping Center, James Center, Highland Hills Shopping Center, and Tacoma Community College. A portion of the Tacoma Landfill Superfund site is also included in this watershed. China Lake is also a part of the watershed.*
>
> *Leach Creek is a little over 2 miles long. Salmonid spawning habitat can be found from Chambers Creek up to Bridgeport Way (the lower portion of the Creek). The upper portions of the Creek also have pockets of spawning grounds; however, the elimination of vegetation and channelization by streamside homeowners and erosion during storm events has impacted these areas. Leach Creek flows into Chambers Creek just downstream of the confluence of Flett and Chambers Creek. Chambers Creek is a fish bearing creek and there are two fish hatcheries located on the creek.*
>
> *Stormwater within the watershed is piped to the Leach Creek Holding Basin, which discharges into Leach Creek. The cities of Tacoma and Fircrest discharge to the holding basin. The Leach Creek Holding Basin was constructed by the City of Tacoma in 1961. During heavy rainfall events, stormwater is pumped from the holding basin into the Thea Foss drainage basin to avoid sending high flows to Leach Creek. The City also uses the Holding Basin to augment the flow in the Creek during periods of low flow as part of current Landfill remediation efforts."*

The U.S. Geological Survey (USGS) has operated a stream gaging station on Leach Creek, 0.3 mile upstream from its mouth, from 1957-2005 and currently since September 2008. Monthly mean flow at this site is shown in Figure 2. Low streamflows of 7-8 cfs typically occur in July-September. The highest flows are in December through February, 15-16 cfs on average.

USGS has an additional gaging station 1.7 miles further upstream at Emerson St. (USGS 12091200 Leach Creek at Fircrest). The City of Tacoma also monitors flow at Emerson and at the outlet from the Leach Creek Holding Basin.

Ecology's routine monitoring station is near the mouth of Leach Creek just upstream of the USGS gage. Water quality samples have been collected at this site during 1964-65, 1973, 2007, and 2008. Metals data are limited to 2007-08.

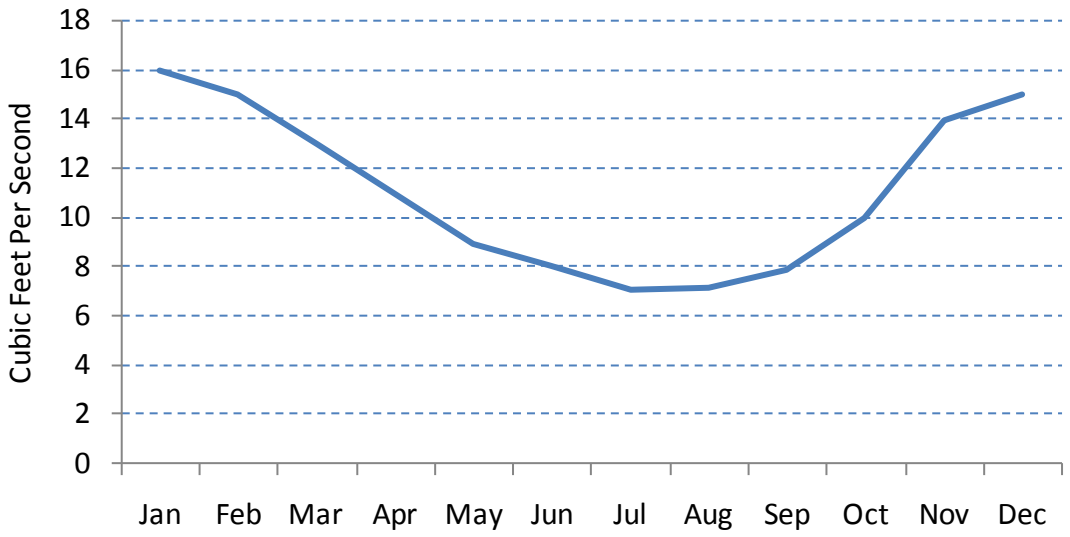

Figure 2. Monthly Mean Flow in Leach Creek.

(USGS 12091300 Leach Creek near Steilacoom, WA; 1957-2005.)

Sampling Design

Ecology's 2007-08 ambient monitoring data indicate that mercury concentrations in lower Leach Creek are correlated with streamflow, turbidity, and total suspended solids (0.89-0.97 R^2). For both mercury and copper, the highest concentrations detected in Ecology's earlier 1995 study occurred during wet weather. Stormwater runoff events are thus implicated.

Large number of storm drains discharge into Leach Creek throughout the length of the creek, from the Holding Basin to the mouth. It is not practical to monitor all these discharges nor is there a basis for selecting a subset of the drains as potential mercury sources. Therefore, the present study will attempt to determine if specific reaches of the creek can be isolated as having significant sources of mercury or copper.

Monthly monitoring will be conducted from September 2009 through August 2010 at four sites on the mainstem (Figure 3). These sites were selected in consultation with the City of Tacoma, Public Works department. The samples will be timed to coincide with runoff events to include the higher flows sampled by Ecology in 2007-08. The purpose of these samples is to better characterize mercury and copper levels in Leach Creek, increase the possibility of detecting excursions, and indentify reaches where sources exist.

The samples will consist of simple grabs. During runoff events, an effort will be made to catch the early part of the storm when turbidity and total suspended solids are typically highest. A total of 48 samples are planned, 12 from each monitoring site.

The samples will be analyzed for mercury, copper, hardness, turbidity, and conductivity. Mercury and copper will be analyzed as total and dissolved, respectively, for comparison with the water quality criteria.

Streamflow will be obtained from USGS and the City of Tacoma or measured at the time of sample collection (Leach Creek at S. 50th Street). The flow data will be used to calculate and compare mercury and copper loadings among sampling sites.

Low-level methods will be used for mercury and copper for better confidence in establishing compliance with the chronic water quality criterion. The reporting limits for total mercury and dissolved copper are 0.002 ug/L and 0.1 ug/L, respectively.

Dana de Leon, of the City of Tacoma Public Works, has cautioned that, although elevated mercury or copper levels may be detected in this study, it may not lead to finding point sources. Despite significant efforts at source tracking in the Thea Foss watershed, Tacoma has found it difficult to identify individual metals sources. They have also cleaned sediments out of entire stormwater basins where mercury was of concern but still have seen mercury reappearing in the basin. They have concluded that, due to the large number of historic and everyday sources, the "chemistry is smeared over entire watersheds." (Dana de Leon 5/22/09 email.)

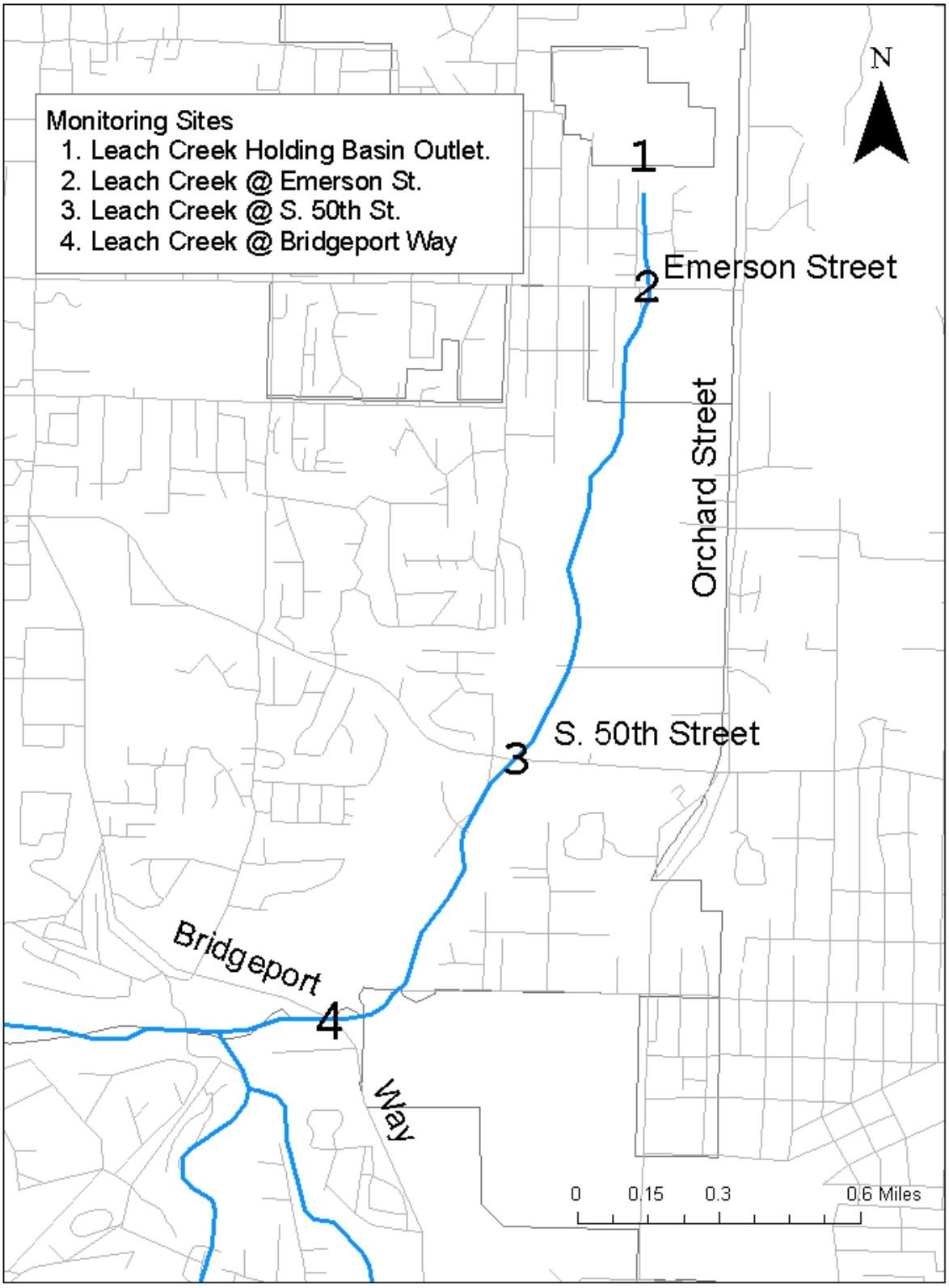

Figure 3. Proposed Monitoring Sites on Leach Creek, 2009-10.

Sampling Procedures

Water samples will be collected in appropriate sample containers (Table 5).

Table 5. Sample Containers, Preservation, and Holding Time.

Analysis	Minimum Sample Size	Container	Preservation	Holding Time
Total Mercury	250 mL	500 mL Teflon	HNO_3 to pH<2, $\leq 6^oC$	28 days
Dissolved Copper	250 mL	500 mL Teflon	Filter, HNO_3 to pH<2, $\leq 6^oC$	6 months
Hardness	100 mL	125 mL poly bottle	H_2SO_u to pH<2, $\leq 6^oC$	6 months
Turbidity	100 mL	500 mL poly bottle	Cool to $\leq 6^oC$	48 hours
Conductivity	300 mL	500 mL poly bottle	Cool to $\leq 6^oC$	28 days

HNO_3 = nitric acid.
H_2SO_u= sulfuric acid.

Sampling procedures for mercury and copper will follow the guidance in EPA Method 1669 *Sampling Ambient Water for Trace Metals at EPA Water Quality Levels*. The mercury and copper samples will be collected directly into pre-cleaned 500-mL Teflon bottles. Dissolved copper samples will be vacuum-filtered in the field through a disposable 0.45-micron cellulose-nitrate filter (#450-0045, type S). The filtrate will be transferred to a clean Teflon bottle. Non-talc nitrile gloves will be worn by personnel collecting the samples.

The Teflon sample bottles and filters will be acid-cleaned by Manchester Laboratory, as described in the Clean Room Standard Operating Procedures, and sealed in plastic bags. The mercury and copper samples will be preserved to pH <2 after receipt at Manchester.

Field activities will be recorded in a bound notebook of waterproof paper. A hand-held GPS will be used to record sampling locations. Streamflow will be obtained from USGS and the City of Tacoma or measured at the time of sample collection (Leach Creek at S. 50th Street).

The metals samples will be placed in polyethylene bags immediately after collection. All field samples will be transported on ice to Ecology headquarters. The samples will be kept in a secure cooler and transported to Manchester Laboratory within one day of collection. Chain-of-custody procedures will be followed.

Laboratory Procedures

Project samples will be analyzed at Manchester Laboratory.

Table 6. Laboratory Procedures.

Analysis	Estimated Number of Samples*	Expected Range of Results	Reporting Limit	Analytical Method
Mercury	58	<0.002 - 0.05 ug/L	0.002 ug/L	CVAF, EPA 245.7
Copper	58	1 - 10 ug/L	0.1 ug/L	ICP/MS EPA 200.8
Hardness	52	10-100 mg/L	1 mg/L	SM2340B
Turbidity	52	1 - 200 NTU	1 NTU	SM2310
Conductivity	52	1 - 500 umhos/cm	1 umhos/cm	SM2510B

*Including field blanks (mercury and copper only) and replicate samples.
CVAA = Cold Vapor Atomic Absorption.
ICP/MS = Inductively coupled plasma/mass spectrometry.
SM = Standard Methods.

The laboratory cost for this project is estimated at $14,000. This includes the 50% discount for Manchester Laboratory.

Quality Control Procedures

Field

Transfer blanks and filter blanks will be analyzed for mercury and copper to assess potential for contamination arising from sample containers or handling. The transfer blanks will be prepared by pouring Manchester blank water between sample bottles in the field. Manchester blank water will be filtered in the field to prepare the filter blanks.

Replicate samples will be collected to provide estimates of the variability in the data (field + laboratory).

Approximately 20% of the samples collected for this project will consist of field blanks and replicates.

Laboratory

Table 7. Laboratory Quality Control Samples.

Analysis	Check Standards/ LCS	Method Blanks	Analytical Duplicates	MS/MSD
Mercury	1/batch	1/batch	1/batch	1/batch
Copper	1/batch	1/batch	1/batch	1/batch
Hardness	1/batch	1/batch	1/batch	1/batch
Turbidity	1/batch	1/batch	1/batch	NA
Conductivity	1/batch	1/batch	1/batch	NA

LCS = laboratory control sample.
MS/MSD = matrix spike and matrix spike duplicate.
NA = not analyzed or not applicable.

In the above table, analytical duplicates are samples split at the laboratory as opposed to replicate samples collected separately in the field. The field team will identify the samples that are to be analyzed in duplicate (split) by the laboratory.

Data Management Procedures

Field recorded data will be transferred to Excel spreadsheets and verified for accuracy by another individual on the project team.

Manchester's data will be downloaded from the Laboratory Information Management System into Excel spreadsheets.

Audits and Reports

Audits

Manchester Laboratory participates in performance and system audits of their routine procedures. Results of these audits are available on request.

Reports

On or before February 2011, a draft report will be prepared for peer and client review. The draft report for this project will include:

- Maps of the study area showing sampling sites.
- Coordinates and descriptions of each sampling site.
- Descriptions of field and laboratory methods.
- Discussion of data quality and the significance of any problems encountered in the analyses.
- Summary tables of the chemical data.
- Comparisons with water quality criteria.
- Assessment of changes in mercury and copper loads between sampling sites.
- Conclusions as to the location of mercury and copper sources.

The final project report is anticipated by March 2011. The responsible staff member for the report is Art Johnson.

All project data will be entered into Ecology's Environmental Information Management System (EIM) on or before March 2011. The responsible staff member is Michael Friese.

Data Verification

Manchester Laboratory will conduct a review of all chemistry data and associated case narratives. Manchester will verify that methods and protocols specified in this QA Project Plan were followed; that all calibrations, checks on quality control, and intermediate calculations were performed for all samples; and that the data are consistent, correct, and complete, with no errors or omissions. Evaluation criteria will include the acceptability of holding times, instrument calibration, procedural blanks, spike sample analyses, precision data, and laboratory control sample analyses, as well as appropriateness of data qualifiers assigned. Manchester will prepare written data verification reports based on the results of their data review. A case summary will meet the requirements for a data verification report.

The project lead will review the laboratory data packages and data verification reports. To determine if project MQOs have been met, results for check standards, laboratory control samples, duplicate samples, and matrix spikes will be compared to QC limits. Method and field blank results will be examined to verify there was no significant contamination of the samples. To evaluate whether the targets for reporting limits have been met, the results will be examined for non-detects and to determine if any values exceed the lowest concentration of interest.

Based on these assessments, the data will be either accepted, accepted with appropriate qualifications, or rejected and re-analysis or re-sampling considered.

Data Quality (Usability) Assessment

After the data have been verified, the project lead will determine if the data can be used to make the calculations, determinations, and decisions for which the project was conducted. If the MQOs have been met, the quality of the data should be useable for meeting project objectives and report preparation will proceed. The project report will assess the quality of the data and identify any shortcomings in its usefulness.

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Appendices

Glossary

303(d) list: Federal Clean Water Act 303(d) list of impaired waters for Washington State.

Ambient: Background (environmental). Away from point sources of contamination.

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.

Nonpoint source: Unconfined and diffuse sources of contamination. Pollution that enters water from 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 National Pollutant Discharge Elimination System program.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property, whose values determine environmental characteristics or behavior.

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.

Reach: A specific portion or segment of a stream.

Total suspended solids: Portion of solids retained on a filter.

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

Acronyms and Abbreviations

Ecology	Washington State Department of Ecology
EAP	Environmental Assessment Program
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
FMU	Freshwater Monitoring Unit (Ecology)
GPS	Global Positioning System
MQO	Measurement quality objective
QA	Quality assurance
QC	Quality control
RPD	Relative percent difference
USGS	U.S. Geological Survey
WAC	Washington Administrative Code

Units of Measurement

cfs	cubic feet per second
mg/L	milligrams per liter (parts per million)
NTU	Nephelometric turbidity units
µg/L	micrograms per liter (parts per billion)