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Quality Assurance Project Plan

Assessing the Potential for Excessive Lead and Arsenic in Construction Site Stormwater Discharges

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Quality Assurance Project Plan

Assessing the Potential for Excessive Lead and Arsenic in Construction Site Stormwater Discharges

March 2010

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WQP - Water Quality Program.
EAP - Environmental Assessment Program.
SCS - Statewide Coordination Section.

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Abstract

Each study conducted by the Washington State Department of 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 completion of the study, a final report describing the study results will be posted to the Internet.

Areas with high soils concentrations of lead and arsenic are found in the Tacoma Smelter Plume and in eastern Washington orchard lands where it was a common practice to apply lead arsenate pesticides. The potential for construction sites in areas of contaminated soils to discharge stormwater high in lead and arsenic is not known.

The objective of this study is to provide an indication of whether modifications to the Construction Stormwater General Permit are needed to protect water quality in areas with high soils concentrations of lead and arsenic. A simple leaching test will be used to determine the potential for the release of lead and arsenic from contaminated soils.

Lead and arsenic concentrations in the soils used for the test, as well as leachate concentrations, will be determined. Possible correlations with other parameters such as turbidity and total suspended solids will be considered. If correlations are found, it may be these surrogate parameters of stormwater discharge could be used to protect water quality.

Background

Humans and wildlife are regularly exposed to low levels of naturally occurring lead (Pb) and arsenic (As) in the environment. Two geographic areas in Washington State are known to contain soils with high levels of lead and arsenic from historic sources. One area is associated with the former Asarco smelter in Tacoma. The second is comprised of orchard lands in eastern Washington where lead arsenate pesticides were used.

The former Asarco smelter in Tacoma was closed in 1986 after nearly 100 years in operation. The smelter processed lead and copper from ores with high arsenic concentrations. Fallout from the plume generated by the smelter's 550-foot stack contaminated soils with lead and arsenic in portions of Pierce, King, Snohomish, and Thurston Counties. The affected area, several hundred square miles, is known as the Tacoma Smelter Plume (Pacific Groundwater Group, 2005).

The location of the former smelter is listed as a contaminated site under the Model Toxics Control Act (MTCA). The Washington State Department of Ecology (Ecology) *Washington State Lead Chemical Action Plan* defines "low levels" of lead in soil as below the MTCA Method A Cleanup Level of 250 mg/kg. The document includes guidance on assessment, guiding principles for minimizing potential exposure, particularly for children, and education and outreach (Ecology, 2009). Arsenic in soil below the MTCA Cleanup Level of 20 mg/kg is considered low level (Pacific Groundwater Group, 2005).

In the early 1900s, apple and pear orchards in eastern Washington were commonly sprayed with lead arsenate. This pesticide was commonly used between the years 1905 and 1947 to control the codling moth. Its use has resulted in high lead and arsenic levels in orchard soils. Orchard lands are typically fairly flat, and some are now being developed.

Soils materials entrained in stormwater runoff from construction sites typically either leave the site directly or after detention in an on-site treatment pond. Rain events and soil disturbance at construction sites can mobilize lead and arsenic bound to soils particles. Metals may also be carried in stormwater in dissolved form. Concentrations of lead and arsenic in construction stormwater discharges are not known.

Stormwater discharges leaving a construction site are regulated under the Construction Site Stormwater General Permit. Ecology requires construction projects disturbing more than one acre to obtain a permit aimed at protecting local surface waters from sediment and high stormwater flows (Ecology, 2005). Best management practices (BMPs) commonly used include (1) covering exposed soils to prevent or reduce erosion and (2) constructing detention ponds to attenuate stormwater flows and reduce the sediment content and turbidity.

Water Quality Criteria

Washington State water quality standards apply to receiving waters of the state. Although the criteria defined by the standards do not apply directly to stormwater discharges, the two can be compared for informational purposes. For this study, water quality criteria will be compared with leaching test results.

Water quality criteria for lead and arsenic are based on the dissolved form of the metals, the portion that is most available to biological uptake. Lead criteria for freshwater are dependent on the hardness of the water (mg/L as $CaCO_3$).

Table 1 shows Washington State water quality standards based on toxicity to aquatic organisms (WAC 173-201A, 2006).

Table 1. Washington State Metals Criteria, µg/L.

Substance	Freshwater		Marine Water	
	Acute	Chronic	Acute	Chronic
Lead*	4.91	0.19	210	8.1
Arsenic	360	190	69	36

*For typical low value for hardness in freshwater (10 mg/L).
Freshwater Acute Lead Criterion: $[1.46203-(\ln(\text{hardness})*(0.145712))] *e^{(1.273*(\ln(\text{hardness}))-1.46)}$.
Freshwater Chronic Lead Criterion: $[1.46203-(\ln(\text{hardness})*(0.145712))]*e^{(1.273*(\ln(\text{hardness}))-4.705)}$.

The acute standard is based on a 1-hour average concentration not to be exceeded more than once every 3 years on average. Likewise, the chronic standard is a 4-day average concentration not to be exceeded more than once every 3 years on average (Chapter 173-201A-240 WAC).

The human health criteria for arsenic are 0.018 µg/L and 0.14 µg/L for freshwaters and marine waters, respectively. A study of rivers and streams in Washington State found typical ranges for arsenic of 0.2 - 1.0 µg/L (Johnson, 2002). The human health criteria is considered unrealistically low and not applied by Ecology to National Pollutant Discharge Elimination System (NPDES) discharge permits (Niemi, 2009).

The reporting limits for dissolved lead and arsenic are 0.1 µg/L for samples in HDPE bottles. This is a factor of 2 below the lowest water quality criterion in Table 1; therefore, reporting limits are acceptable.

Current Knowledge and Implications to Construction Site Management

A review of what is known about the presence of lead and arsenic in soils in the Tacoma Smelter Plume and in eastern Washington orchard lands was conducted. Most of the lead and arsenic found in the Tacoma Smelter Plume are restricted to about the top 18 inches of soil, with over 97% of lead samples ranging from 1 - 6,700 mg/kg and 99% of arsenic samples ranging from 0.48 - 1,100 mg/kg (Pacific Groundwater Group, 2005).

Similarly, most of the lead and arsenic found in eastern Washington orchard lands are restricted to the top 16 inches of soil, with lead concentration maxima ranging from 445 - 2,213 mg/kg and arsenic concentrations ranging from 58 - 365 mg/Kg (Peryea and Creger, 1994).

Metals in both regions are often higher than the 250 mg/Kg MTCA cleanup level for lead and the 20 mg/Kg cleanup level for arsenic.

The implications of this relatively shallow zone of soil contamination are that the potential for contaminated stormwater discharges from construction sites is a matter of how the top layer is handled, moved, or removed. If topsoils are disturbed rather than remaining naturally compacted, the opportunity for contact with stormwater run-on and infiltration is increased. The worst case can be considered to be the stockpiling of topsoils near or on banks above drainages such as ditches or creeks.

Potential entrainment of soils and associated metals may depend on such variables as original depth of soil, degree of slope of worked soils, location relative to drainages, degree of compaction of the soils (e.g., the use of tracked heavy equipment or graders), and cover if any to reduce erosion from rainfall and run-on.

Compaction is a major element in potential entrainment of soils in stormwater discharges from a construction site. For example, if topsoils are stockpiled by dumping from backhoes with no further working, the unconsolidated soils can be subject to considerable erosion/entrainment of solids into stormwater runoff as well as infiltration with possible leaching into discharged flow.

Leaching of water through soils can be a source of lead and arsenic in contaminated runoff, though for this to happen the leachate must emerge above the ground surface. If leachate does not surface within the construction site, it may affect groundwater or nearby surface waters such as creeks or ditches.

Project Description

The objective of this study is to evaluate whether modifications to the Construction Site Stormwater General Permit are needed to protect surface water quality in areas of high soils concentrations of lead and arsenic. This will be determined through the use of a leaching test.

The study was intended to be in two parts:

1. Sample stormwater discharging from active construction sites in the Tacoma Smelter Plume and eastern Washington orchard lands.
2. Conduct leaching tests on highly contaminated soils as an indicator of potential worst-case conditions.

Of the five potentially active permitted construction sites in Tacoma Smelter Plume areas of 40 mg/Kg or higher soils arsenic concentrations, only one proved to be active during the project's period of field work (March 2010). From attempts to contact 20 construction site managers in eastern Washington orchard lands, only one site was found to be active. For this reason the project was modified to focus on bench testing.

Specific project objectives are to:

1. Evaluate the potential for elevated concentrations of lead and arsenic in construction site stormwater discharges based on the results of leaching tests.

2. Consider possible correlations between soils metals concentrations, leaching metals concentrations, turbidity, and total suspended solids (TSS).

3. Compare results with stormwater metals data from other monitoring efforts and studies.

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 clients)	Title	Responsibilities
Jeff Killelea Water Quality Program Phone: (360) 407-6127	EAP Client	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP.
Dewey Weaver Water Quality Program Phone: (360) 407-6443	EAP Client	Provides internal review of the QAPP and approves the final QAPP.
Steven Golding Toxics Studies Unit SCS Phone: (360) 407-6701	Project Manager/ Principal Investigator	Writes the QAPP. Oversees sample collection, sampling and transportation to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into EIM. Writes the draft report and final report.
Dale Norton Toxics Studies Unit SCS 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 SCS 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 Western Operations Section Phone: (360) 407-6596	Section Manager for Western Washington Study Area	Reviews the QAPP.
Gary Arnold Eastern Operations Section Phone : (509) 454-4244	Section Manager for Eastern Washington Study Area	Reviews the 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 Leaching Test and Laboratory Work, Data Entry Into EIM, and Reports.

Field (leaching test) and laboratory work	Due date	Lead staff
Soils testing completed	March 2010	Steven Golding
Laboratory analyses completed	April 2010	
	Due date	Lead staff
Final report		
Author lead	Steven Golding	
Schedule		
Interim Data Summary to Client	May 2010	
Draft due to supervisor	June 2010	
Draft due to client/peer reviewer	July 2010	
Draft due to external reviewer(s)	August 2010	
Final (all reviews done) due to publications coordinator	September 2010	
Final report due on web	October 2010	

Quality Objectives

This project is an investigative study. The intent is to evaluate soils and corresponding leachate concentrations as indicative of the potential for excessive levels of lead and arsenic in construction stormwater discharges. It is not intended to represent or evaluate actual concentrations of lead and arsenic in stormwater discharges.

Leaching test results are dependent on the length of time between shaking and sampling such that even a fraction of a minute may cause results to vary considerably. For these reasons the ranges for check standards, duplicate samples, and matrix spike and spike duplicate recovery in Table 4 have been increased somewhat for this project.

Quality objectives for leaching test results are to be consistent with a screening level bench test. These objectives will be achieved by following the *Sampling Procedures* and *Quality Control Procedures* described in this Quality Assurance (QA) Project Plan.

Ecology's Manchester Environmental Laboratory (MEL) will perform chemical analysis of water for these parameters: metals, hardness, and total suspended solids. MEL will also analyze soil for metals. Turbidity will be measured with a portable Hach 2100P turbidimeter.

The analytical measurement quality objectives (MQOs) for project water samples are shown in Table 4. MQOs for laboratory control samples, laboratory duplicates, matrix spikes, and matrix spike duplicates have been widened somewhat beyond MEL's acceptance limits for the selected analyses. MEL is expected to meet quality control (QC) requirements of methods selected for the project.

Table 4. Measurement Quality Objectives.

Parameter	Check Standards/LCS (recovery)	Duplicate Samples (RPD*)	Matrix Spikes (recovery)	Matrix Spike Duplicates (RPD)*
Leachate (Water)				
Lead	80-120%	30%	70-130%	25%
Arsenic	80-120%	30%	70-130%	25%
Hardness	80-120%	30%	70-130%	25%
TSS	80-120%	30%	NA	NA
Turbidity	NA	30%	NA	NA
Soil				
Lead	80-120%	30%	NA	NA
Arsenic	80-120%	30%	NA	NA

LCS – laboratory control samples.
*RPD – relative percent difference.
NA – not applicable.

The soils lead reporting limit must be lower than the 250 ppm MTCA cleanup level. The arsenic reporting limit must be lower than the 20 ppm MTCA cleanup level. The MEL reporting limit for each metal is 0.1 mg/Kg, well below cleanup levels.

Bias and precision are indicators of data utility.

Bias can be defined as systematic error due to contamination, sample preparation, calibration, or the analytical process. Most sources of bias can be minimized by adherence to established protocols for collection, preservation, transportation, storage, and analysis of study samples.

Precision is a measure of the ability to consistently reproduce results. Precision will be evaluated by analysis of check standards, duplicates/replicates, spikes, and blanks. Results of multiple analyses will be used as a means to estimate precision. Leaching test replicates will be analyzed to estimate *overall precision* of the entire sampling and analysis process. Analysis of laboratory duplicates, which consist of aliquots from one sample container, will estimate *laboratory precision*. The difference between the precision estimate of the laboratory duplicates and the precision estimate of field replicates is an estimate of *field precision*.

Sampling Process Design (Experimental Design)

Three contaminated soils samples from child care facilities in the Tacoma Smelter Plume, and one sample from an eastern Washington orchard land in pre-construction stage, have been collected and kept at 4°C in the walk-in cooler at Ecology headquarters. Subsamples from these will be mixed with the aim of achieving heterogeneity. Soils samples from each subsample will be analyzed for total lead and arsenic. The other portion of each subsample will be used in the United States Geological Survey (USGS) simple field leach test.

The USGS field leach test will be used to provide an indication of the effects of leaching/runoff from highly contaminated soils. Samples of contaminated topsoils from three child care facility sites in the Tacoma Smelter Plume and one orchard land construction site will be tested. These soil samples will be used instead of the soils collected at construction sites because the child care and orchard sites are known to have high lead and arsenic concentrations while construction soils, because of their mixed nature, may not.

Project staff will perform the USGS test according to the test method (USGS, 2005) and also in a modified form (Appendix A). The test calls for a 5-minute shaking period followed by 10 minutes of settling and filtration. In accordance with the method, the supernatant will be analyzed for dissolved metals. Total metals, hardness, TSS, and turbidity will also be determined. The results can be taken to represent well-mixed soil and water followed by settling in a pond or a low spot where there is some ponding.

The USGS field leach test has been selected because the 5-minute contact time is more representative of the time soil and water mix on a construction site than the 18 hours or more of conventional leaching tests.

Leach Test Procedure

Each soils sample will be used to make 4 serial dilutions for analysis based on approximate turbidity:

1. 5 NTU
2. 25 NTU
3. 100 NTU
4. 250 NTU

These dilutions are to provide an indication of metals concentrations and TSS versus turbidity for soil/water mixtures of varying concentrations. The dilutions have been selected to include the Construction Site Stormwater General Permit turbidity benchmark of 25 NTU as well as the 250 NTU turbidity value that triggers the requirement that a permittee report exceedances to Ecology.

The test water will be synthetic rainwater rather than deionized water. The Synthetic Precipitation Leaching Procedure (SPLP) calls for the simulation of acidic rain by adding acid to deionized water (Ecology, 2003). Washington State rainwater (from both eastern and western

Washington) has been found to vary from 5.2 to 5.4 pH (USGS, 2007). Nitric acid (representing contributions from nitrous oxide in the atmosphere) will be added to deionized water adjusted to a pH of 5.3 for the tests. In many leaching tests, deionized water is used. This could be done for this project, but the use of synthetic acidified rain is more aggressive and more defensible as representing actual conditions.

Dissolved metals will be filtered in the field through a 0.45 µm Nalgene filter unit (#450-00045, type S). Nalgene filters will be cleaned for low-level metals at MEL. Samples will be preserved by the preservative in standard HDPE collection bottles.

The samples will be given unique identification numbers. Following collection, and in some cases, filtration, samples will be placed in ice chests at 4ºC. Ice chests will be put in a secure walk-in cooler at Ecology. Samples will be delivered to MEL within 3 days for TSS analysis. Staff will follow chain-of-custody procedures throughout the sampling process (MEL, 2008).

Turbidity will be determined at the test location with a Hach 2100P portable turbidimeter. The turbidimeter will be calibrated with factory-sealed formazin standards before the study begins (March 2010) and again afterward. The manufacturer recommends recalibration every 3 months or as needed. The meter will be checked with formazin standards after its use.

Table 5 shows sample summaries for the USGS leaching test.

Table 5. Modified USGS Leach Test Sampling Summary.

Parameters	Soils sources**	Total number of test samples (4 dilutions)	QA (transfer blank, leaching test replicates)	Total number of samples to lab	Cost
Lead and arsenic total (water) metals	4	16	4 (replicates)	20	1,760
Lead and arsenic dissolved metals (water) **	4	16	5 (one filter blank, 4 replicates)	21	2,604
Hardness and TSS	4	16	--	16	528
Lead and arsenic metals (soil)	4	4	4 (replicates)	8	520
Turbidity (portable meter)	4	16	16 (replicates)	0	0
				Subtotal	$5,412

*****Includes precleaned filter.
** Contaminated soils sources are comprised of 3 from western Washington, 1 from eastern Washington.
Cost estimates reflect a 50% discount for analyses conducted by MEL.

Measurement Procedures

All project samples will be analyzed at MEL. Table 6 shows the expected range of results, sample preparation, and the analytical methods for the project. The turbidity method applies to field use of the Hach turbidimeter. Metals samples will be analyzed by ICP/MS (Inductively Coupled Plasma Mass Spectrometer) using EPA Method 200.8. MEL's reporting limits for dissolved lead (0.1 µg/L) and arsenic (0.1 µg/L) will be adequate for identifying exceedances of water quality criteria. The laboratory may use other appropriate methods following consultation with the project lead.

Table 6. Analytical Methods.

Analyte (no. samples)	Sample Type	Analysis	Expected Range of Results	Sample Preparation Method	Analytical Method
Lead (19)	whole water	total recoverable*	10 – 2,000 µg/L	HNO3/HCl digest	EPA 200.8
Lead (31)	filtered water	dissolved	10 – 2,000 µg/L	HNO3/HCl digest field filtered and preserved	EPA 200.8
Arsenic (19)	whole water	total recoverable	1 – 200 µg/L	HNO3/HCl digest	EPA 200.8
Arsenic (31)	filtered water	dissolved	1 – 200 µg/L	HNO3/HCl digest field filtered and preserved	EPA 200.8
Hardness (19)	whole water	total	1 – 100 mg/L	NA	EPA 200.7
TSS (19)	whole water	total	1 – 50 mg/L	NA	EPA 160.2
Turbidity (43)	whole water	total	2 - 100 NTU	NA	SM 2130
Arsenic & Lead (12)	soil	total	1 – 200 mg/Kg	3050B	EPA 200.8

*the results of total recoverable metals analyses are also known as total metals.
NA = not applicable.
HNO3 = nitric acid.
HCl = hydrochloric acid.
SM = Standard Methods for the Examination of Water and Wastewater 20th Edition (APHA et al., 1998).

Analytical Costs

The total laboratory cost for the project is estimated at $5,412 (Table 5). MEL will conduct all analyses. The cost estimates reflect a 50% discount for analyses conducted by MEL.

Quality Control Procedures

Quality objectives for this project are to obtain high quality data so that uncertainties are minimized and results are comparable to other studies using these methods. These objectives will be achieved through careful attention to the sampling, measurement, and quality control (QC) procedures described in this plan.

Soils and Leaching Test

Table 7 shows a list of field QA samples to be analyzed for the project. "Field" is used to refer to the leaching test. The intent of QA samples is to provide an estimate of the total variability of each analysis, field plus laboratory. Field QA will consist of collection and analysis of replicate samples and filter blanks.

Replicate samples will be taken at a frequency of 20% for the project. Replicates are made up from 2 samples collected one after the other as close to the same time and location as possible.

Filter blanks will consist of reagent-grade water prepared by MEL and placed in Teflon containers. They are taken to the field during a sample event, filtered with other samples, transferred to a new clean Teflon container, acidified, and returned to MEL along with study samples.

Table 7. Field Quality Assurance Samples.

Analysis	Number of QA Samples
Field Replicates	
Total Recoverable and Dissolved Lead	4/ study
Total Recoverable and Dissolved Arsenic	4/ study
Total Lead and Total Arsenic in Soils	4/ study
Filter Blanks	
Dissolved Lead	1/ study
Dissolved Arsenic	1/ study

Laboratory

MEL will follow standard operating procedures (SOPs) as described in the *Manchester Environmental Laboratory Quality Assurance Manual* (MEL, 2007). Laboratory QC samples will include laboratory control samples, methods blanks, analytical duplicates, and matrix spikes and matrix spike duplicates. Types and frequencies of laboratory QC samples to be analyzed for the project are presented in Table 8.

Table 8. Laboratory Quality Control Samples.

Analysis	Laboratory Control Sample	Method Blank	Analytical Duplicate	Matrix Spikes and Spike Duplicates
TR and Dissolved Lead	1/batch	1/batch	1/batch	1/batch
TR and Dissolved Arsenic	1/batch	1/batch	1/batch	1/batch
Lead and Arsenic in Soils	1/batch	1/batch	1/batch	1/batch
Hardness	1/batch	1/batch	1/batch	NA
Turbidity	1/batch	1/batch	1/batch	NA
Total Suspended Solids	1/batch	1/batch	1/batch	NA

TR – Total recoverable.

Filter blank results indicate whether there is contamination from the field or laboratory. Total variation (field plus lab) will be assessed by collecting replicate samples for metals in water and soils. These replicates will be used to assess whether the data quality objectives for precision were met. If the objectives are not met, the data will be qualified. MEL routinely analyzes duplicate sample analyses in the laboratory for QC purposes. The difference between field and laboratory variability is a measure of the sample field variability.

MEL will not be able to directly assess bias from field procedures. However, bias will be minimized by strictly following standard protocols for field work.

Data Management Procedures

MEL will conduct a QA review of all laboratory data and case narratives. This will include a verification that (1) methods and protocols specified in this QA Project Plan were followed, (2) all calibrations, checks on quality control, and intermediate calculations were performed for all samples, and (3) 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, laboratory control sample analyses, and appropriateness of data qualifiers assigned.

MEL will prepare case narratives for each data set. The data package from MEL will include a case narrative discussing any problems with the analyses, corrective actions taken, any changes to the referenced method, and an explanation of data qualifiers. The project manager will review the data packages to determine if analytical MQOs were met for laboratory control samples, laboratory duplicates, and matrix spikes. The field and method blank results will be examined to verify there was no significant contamination of the samples.

Audits and Reports

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

The following reports will be prepared for this project:

- MEL will provide the data to the project manager in printed and electronic formats.
- The project manager, Steven Golding, will prepare a draft technical report on or before August 2010.
- A final technical report is anticipated in October 2010.

Data Verification and Evaluation

The project manager will review the laboratory data packages, verify the report, and assess the usability of the data. Based on these assessments, the data will be either 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 QC samples to MQOs. To evaluate whether the targets for reporting limits have been met, the results will be examined for non-detects to determine if any values exceed the lowest concentration of interest.

Data Quality (Usability) Assessment

Once the data have been verified, the project lead will determine whether the data are usable for the purposes of the study.

Data analysis will include, but not necessarily be limited to, compiling summary statistics and constructing plots to (1) examine the distribution of contaminant concentrations detected in the samples, (2) compare levels in stormwater and leachate results to soil concentrations, and (3) compare levels in stormwater and leachate results to ambient water criteria.

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Appendices

Appendix A. USGS Leach Test Procedures

The Standard USGS Field Leach Test (FLT) Procedure

The procedures for the USGS field leach tests (USGS, 2005) follow:

The first step is to collect a representative sample. After collection, the sample is air dried, if necessary, and dry sieved as desired (less than 2 millimeters for most samples). Some samples do not need to be sieved (for example, dusts).

To leach, 50.0 grams of prepared sample is weighed into a 1-liter (L) plastic bottle. Approximately 1.0 L deionized water is added slowly so that no dust is lost. (*Depending on the amount of solid material available, other leachate volumes can be used as long as the 20:1 water-to-solid ratio is maintained.*) The bottle is capped and vigorously hand shaken for 5 minutes. The contents are then allowed to settle for approximately 10 minutes. After settling, subsamples of the leachate are measured for pH, specific conductance, and other parameters. A portion of leachate is filtered using a 60-cc (cubic centimeter) syringe and a 0.45-micrometer pore-size nitrocellulose filter. If filtration is difficult, a 0.70-micrometer glass fiber prefilter can be used in conjunction with the 0.45-micrometer filter in a serial manner. Subsamples of the filtrate are collected and preserved for analysis.

Modifications of the USGS Leach Test for this Project

The USGS procedure above will be modified so that:

- Soils are added in amounts so that turbidities of the mixed samples (after 5 minutes hand shaken) will equal approximately:
    1. 5 NTU
    2. 25 NTU
    3. 100 NTU
    4. 250 NTU
- pH of deionized mixing water will be adjusted with nitric acid to pH 5.3 (typical of Washington state rainwater).
- Soils samples will not be sieved since sieving is not a requirement for soils metals analyses at MEL (Momohara, 2010).

The mass of each soil sample added to the test container will be measured before adding. The procedure will then be carried out as in the USGS procedure above.

Appendix B. Glossary, Acronyms, and Abbreviations

Glossary

Ambient: Background or away from point sources of contamination.

Leachate: The liquid that drains or “leaches” from a landfill.

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

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.

Tacoma Smelter Plume: The area with lead and arsenic contaminated soils caused by the former Asarco smelter in Tacoma. The affected area, several hundred square miles, is in portions of Pierce, King, Snohomish, and Thurston Counties.

Total suspended solids (TSS): Portion of solids retained by 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
EPA	U.S. Environmental Protection Agency
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
MTCA	Model Toxics Control Act
QA	Quality assurance
QC	Quality control
SOP	Standard operating procedures
TSS	(See Glossary above)
USGS	U.S. Geological Survey
WAC	Washington Administrative Code

Units of Measurement

°C	degrees centigrade
ft	feet
g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams
m	meter
mg	milligram
mg/Kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mL	milliliter
mm	millimeter
NTU	nephelometric turbidity unit
mg/Kg	milligram per kilogram (parts per million)
ug/Kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)