FINAL
OU2 Baseline Ecological Risk Assessment Report
Formosa Mine Superfund Site
Douglas County, Oregon

Prepared for:
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101

Prepared by:
CDM Federal Programs
1218 Third Avenue, Suite 1100
Seattle, Washington 98101

Parametrix
411 108th Avenue NE, Suite 100
Bellevue, Washington 98004

July 11, 2014

R-10 AES (SMALL BUSINESS)
CONTRACT NO. 68-S7-03-04
Task Order No. 047B

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Tony C. Gendusa — July 10, 2014

Prepared by:
Tony C. Gendusa Ph.D.
CDM Smith
Ecological Toxicologist

Jennifer Jones — July 10, 2014

Co-Author:
Jennifer Jones
CDM Smith
Ecological Risk Assessor

Kimberly Zilis — July 10, 2014

QA Review by:
Kim Zilis
CDM Smith
QA Officer

Michael C. Allen — July 10, 2014

Approved by:
Michael C. Allen
CDM Smith Project Manager

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Acronyms

%	percent
ARD	acid rock drainage
BERA	baseline ecological risk assessment
BLM	Bureau of Land Management
BMI	benthic macroinvertebrate
$CaCO_3$	calcium carbonate
CCC	Criterion Continuous Concentration
CF	conversion factor
COI	chemical of interest
COPC	chemical of potential concern
CSM	conceptual site model
CV-AAS	cold vapor atomic absorption spectrometry
DO	dissolved oxygen
DOGAMI	Oregon Department of Geology and Mineral Industries
EA	exposure area
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
EPT	Ephemeroptera, Plecoptera, Trichoptera
ERA	ecological risk assessment
ESL	ecological screening level
FS	feasibility study
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg $CaCo_3$/L	milligrams of calcium carbonate per liter
MIW	mining influenced water
MREF	Middle Creek Reference location
NMFS	National Marine Fisheries Service
NRWQC	National Recommended Water Quality Criteria
OAR	Oregon Administrative Rules
O/E	observed to expected
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OU	Operable Unit
PREDATOR	Predictive Assessment Tool for Oregon
PRGs	preliminary remediation goals
RI/FS	remedial investigation/feasibility study
SFREF	South Fork Middle Creek Reference location
SLERA	screening level ERA
TRVs	toxicity reference values
UCL	upper confidence limit
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey

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Section 1

Introduction

As part of the remedial investigation and feasibility study (RI/FS) for Formosa Mine Operable Unit 2 (OU2), United States Environmental Protection Agency (EPA) is conducting a baseline ecological risk assessment (BERA). Evaluations in the OU2 BERA assess potential threats to the environment that may exist resulting from the release or threatened release of contaminants at or from OU2 if no remedial action is taken. Conclusions (Section 5.6) of the OU2 BERA will be integrated into the future OU2 RI report, which will be prepared in both draft and final versions. The Draft RI for OU2 will include an evaluation of groundwater and surface water data collected from October 2009 through April 2014. The Final RI for OU2 is scheduled to incorporate information from the Formosa Adit removal action being conducted in 2015 by the Bureau of Land Management (BLM) that is designed to contain mine pool water within adit. In the interim, data will be collected to assess the effects to surface and groundwater resulting from sealing the Formosa 1 Adit. EPA anticipates at least three to five years for water within the mine pool to reach equilibrium with the new hydraulic conditions before effects would be seen in down gradient surface water.

OU2 includes surface water, sediment, groundwater, underground workings, and adit water drainage associated with the Formosa Mine. It excludes the surface and subsurface mine wastes (tailings and waste rock) and soils that were deposited outside of the mine workings, represented by OU1 and evaluated as part of the OU1 RI/FS (CDM 2012 and CDM Smith 2013). See the OU1 RI and FS documents for information on previous investigations conducted at the Formosa Mine Site since 1988.

The OU2 BERA is based on an evaluation of surface water data, whereas the OU2 RI will include an evaluation of groundwater and will include a human health risk evaluation.

The OU1 ecological risk assessments (ERA) were reported in the OU1 RI (CDM 2012) to quantify current or potential threats to ecological receptors from environmental contaminants in the absence of any remediation and to help determine whether remedial actions are warranted. The OU1 ERA focused on terrestrial habitats and receptors potentially associated with the former mine site. The OU1 ERA included a screening-level ERA (SLERA) for aquatic environments adjacent to the Formosa Mine site. The SLERA evaluation was based on comparisons of dissolved concentrations of selected metals in surface water at seep and stream locations in the headwaters of Middle Creek and South Fork Middle Creek to surface water ecological screening levels (ESLs). Dissolved metals concentrations, which are the most toxic form, were compared to chronic National Recommended Water Quality Criteria (NRWQC) established by EPA for the protection of aquatic life. The SLERA identified several chemicals of potential concern (COPCs) for the aquatic ecosystems. Based on these findings, a BERA was recommended for OU2. This document presents the OU2 BERA.

1.1 Purpose and Approach

ERAs are performed to determine if ecological receptors are at risk from exposure to site-related contamination. ERAs are most often conducted using a phased approach that follows EPA guidance for conducting ERAs at Superfund sites. The approach used to conduct this ERA follows *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997). It is generally recognized by EPA (1997) and others that those methods for conducting

ERAs must be site specific. The EPA guidance (1997) is therefore not a detailed step-by-step "cookbook" but instead provides recommendations on ERA components to be considered and general approaches for performing ERAs. As much as practicable, the methods, recommendations, and terminology of the 1997 EPA guidance are used to conduct the OU2 BERA.

The first phase of the ERA is a SLERA. The SLERA is used to determine if further investigation is warranted based on a reasonable potential for ecological receptors to suffer adverse effects as a result of exposure to site-related contamination. If the SLERA determines that adverse effects are likely, then the next phase of the ERA process is warranted. This second phase is the OU2 BERA. Where indicated by the results of the SLERA, the BERA is performed to describe ecological risks and to reduce the uncertainties associated with conservative risk estimations in the SLERA.

As the initial step for ecological evaluations, a SLERA was conducted as a component of the OU1 RI (CDM 2012). The SLERA included an evaluation of selected, potentially site-related metals (cadmium, copper, lead, nickel, and zinc) in surface water in the upper reaches of Middle Creek and South Fork Middle Creek. Based on the results of the SLERA, cadmium, copper, and zinc were identified as COPCs for aquatic ecosystems in OU2, and a BERA was recommended to evaluate further the risk to ecological receptors in OU2.

The OU2 BERA refines the conservative assumptions used in the SLERA to provide more confident estimations of risk, provide information that can help establish remedial priorities, and serves as a scientific basis for regulatory and remedial actions for the site. The OU2 BERA is based on an approach using multiple lines of evidence while the SLERA takes a more streamlined approach to estimate risks. A primary line of evidence for both the SLERA and the BERA is a comparison of contaminant concentrations in site surface media (e.g., surface soil) to concentrations associated with adverse effects. Following EPA guidance, the SLERA conservatively compares maximum concentrations of contaminants measured in various media to conservative benchmark concentrations, primarily those termed ESLs. The OU2 BERA differs from this conservative approach by generally assessing a range, e.g., the mean and maximum, or a more realistic and reasonable upper level point estimate, e.g., upper 95th percent (%) confidence limit of the arithmetic mean (95% upper confidence limits [UCL]) of measured contaminant concentrations. These exposure concentrations are then compared to less conservative effects concentrations (termed toxicity reference values or TRVs) that, to the extent possible, are directly relevant to site-specific receptors and exposure scenarios. In the BERA, these primary lines of evidence are supplemented by others such as food web modeling, site observations, biological surveys, or toxicity testing. Finally, additional evaluations or investigations may be performed at the FS stage of the RI/FS process that further refine information presented in the BERA to specifically address remedial design needs.

1.2 Site Description

The Formosa Mine, located in southwest Oregon in Douglas County, is within the Coast Range Klamath Mountains at elevations between 3,200 and 3,700 feet above mean sea level. The area is heavily forested and consists of upland, riparian, and aquatic habitats. The four major watersheds in the vicinity include Upper Middle Creek and South Fork Middle Creek, which are perennial streams that are tributaries to Middle Creek, and Russell Creek and West Fork Canyon Creek. The Upper Middle Creek and South Fork Middle Creek watersheds are the primary surface water drainages in the area of interest for the OU2 BERA. Based on surface water sampling, Russell Creek and West Fork Canyon Creek, north and east of the Formosa Mine, respectively, are not affected by the mine.

1.3 Contaminant Sources

The primary contaminant sources are mine materials that contain sulfide minerals. Exposure of these mine materials to precipitation and oxygen results in sulfide oxidation and subsequent release of dissolved metals and metalloids to the environment. This process is referred to as acid rock drainage (ARD) and is the dominant contaminant release mechanism. The general term mining influenced water (MIW) is used to describe ARD once it transports from the generation source.

Mining was conducted primarily by underground methods, which resulted in construction of a network of underground voids, partial backfill of underground voids with ARD generating mine materials, and placement of ARD generating mine materials on the surface. Reclamation of the mine between 1993 and 1995 included removal of former mineral processing facilities, haulage of low grade ore and tailings into the underground mine, re-grading of waste rock and other mine materials located on the surface, construction of a tailings repository in a former water storage pond (the encapsulation mound), and revegetation.

1.3.1 Surface Water

Surface water sampling has been conducted to assess effects of the MIW discharge on surface water, examine contaminant transport pathways, and evaluate the downstream extent of effects to surface water quality. **Table 1-1** provides a summary of measurements taken by event and location. Sampling events from October 2009 through January 2011 are reported in the OU1 RI document. Water measurements from October 2009 through April 2014 are included in the OU2 RI report. The Final OU2 RI report will document all water data including post removal action monitoring data.

Based on these data, surface water quality in both Middle Creek and South Fork Middle Creek is affected by MIW. A primary source of contaminants in surface waters is MIW discharges from groundwater to surface water.

In Middle Creek, most MIW groundwater discharging to surface water has similar characteristics to the Formosa 1 adit discharge, strongly acidic calcium-sulfate water with high concentrations of iron, copper, zinc, and other trace metals. In South Fork Middle Creek, MIW discharging from groundwater to surface water is strongly acidic calcium-sulfate water with high concentrations of copper, zinc, and other trace metals and relatively lower iron content as compared to the Upper Middle Creek area.

1.3.2 Groundwater

Data from groundwater sampling show the presence of alluvial and bedrock groundwater systems, both of which are transporting inorganics to surface water. The alluvial groundwater system is present within discrete alluvial aquifers that are located within unconsolidated sediments in the base of tributary drainages. The bedrock aquifer is a fracture-controlled aquifer hosted by metavolcanic rocks.

Findings of the limited groundwater investigation suggest that leakage from the water diversion system at the Formosa 1 adit is recharging the alluvial aquifer and contributing to MIW discharges from groundwater to surface water in the upstream reaches of Upper Middle Creek. Although there is potential for the bedrock aquifer to be affected in this area, data from bedrock monitoring wells MW8 and MW2 in the area suggest these effects are minor.

In contrast, the bedrock aquifer is affected west of the encapsulation mound in the headwaters of South Fork Middle Creek. Groundwater samples from MW5 indicate groundwater is acidic and

contains high concentrations of cadmium, copper, zinc, and other inorganics. The alluvial groundwater system in the headwaters area of South Fork Middle Creek is affected by MIW, with similar water quality to the bedrock groundwater system.

1.4 Ecological Investigations

Ecological studies have included benthic macroinvertebrate (BMI) sampling and fish surveys/sampling. BMI sampling was conducted at over 20 locations in 1999 by BLM and Oregon Department of Environmental Quality (ODEQ) (BLM/ODEQ 2000). Data obtained during this sampling event were compared to earlier sampling that was conducted by the U.S. Fish and Wildlife Service (USFWS) in 1982 and 1984 and the Oregon Department of Geology and Mineral Industries (DOGAMI) yearly from 1994 through 1997 (DOGAMI 1990 to 1999). Subsequent BMI community sampling was conducted by BLM from 2000 to 2008. Several fish sampling events were conducted by BLM and the Oregon Department of Fish and Wildlife (ODFW) from 1991 through 2007 (BLM 2009).

BMI and fish presence/absence surveys were conducted for the OU2 BERA in Middle Creek and South Fork Middle Creek in June and September of 2012 and June and September of 2013. Quantitative BMI community sampling from a known area (144 square inches) was conducted via Surber samplers in riffle habitat at several locations. Fish surveys were conducted using backpack electroshocking, focusing on pools at the same locations. BMI sampling and fish surveys followed standardized protocols at all sampling stations to allow for comparisons of BMI relative abundance and diversity and fish presence or absence as detailed in the *OU2 Data Gaps Assessment and Sampling and Analysis Plan Addendum* (CDM Smith 2012). BMI samples were submitted to the National Aquatic Monitoring Center Laboratory at Utah State University for enumeration and identification to lowest possible taxon.

BMI and fish presence/absence surveys were conducted at three reference streams in conjunction with sampling in Middle Creek and South Fork Middle Creek in June and September of 2012 and June and September of 2013. **Figures 1-1a, 1-1b,** and **1-1c** show the ecological sampling locations in addition to the MXR and SFA2 sampling locations. A description of the habitat characteristics of each of the sampling locations is provided in Section 2.2.1.1.

1.5 Organization of this Report

Section 2 serves as the Problem Formulation section of the OU2 BERA. Section 3 presents the Exposure Assessment, and Section 4 presents the Effects Assessment. The information presented in Sections 3 and 4 are integrated in Risk Characterization, Section 5. Section 6 presents the references for the BERA. Tables and Figures are provided following each section, and supporting documentation is provided in appendices.

Table 1-1 Sampling Locations and Dates for Surface Water Samples

Location	Type	Oct 2009	Jan/Feb 2010	Oct 2010	Jan 2011	Sep 2011	Feb 2012	Jun 2012	Sep 2012	Jun 2013[1]	Sep 2013	Apr 2014
MIDDLE CREEK												
Formosa 1 Adit	ADIT	x	x	x	x	x	x		x	x		x
A4	STREAM	x	x									x
A6	STREAM		x									
M1.2	STREAM							❖•	❖•	❖•	❖•	
M2.0	STREAM							❖•	❖•	❖•	❖•	
M3.0	STREAM							❖•	x•	x•	❖•	x
M3.1	STREAM							❖•	❖•	❖•	❖•	x
M5.5	STREAM							•				x
M7.9	STREAM							•	x•	x•	❖•	x
M9.8	STREAM							•				
M13.0	STREAM		x		x	x		•				
MF1	SEEP		❖									x
MF2	SEEP				x		❖		❖	x		
ME1	STREAM		x									
ME2	SEEP						❖					x
ME3	SEEP						x			x		
MXR	STREAM	x	x	x	x	x	x		x	x		x
Seep A	STREAM	x	x									
MA13	SEEP		x									
MA17	SEEP		x				❖		❖	x		x
MA22	SEEP		x									
MA40	SEEP		x									
MA44	SEEP		x				❖		dry			
MA46	STREAM	x					x		x	x		x
MA61	STREAM								❖			
MB1	SEEP		x				❖					x
MB3	SEEP		x									
Martin Creek Reference	STREAM							❖•	❖•	❖•	❖•	x
MREF1	STREAM							❖•	dry	x•	dry	x
Seep at A9	SEEP	x										
SOUTH FORK MIDDLE CREEK												
404 Adit	ADIT	x	x									
404 Adit Lower	ADIT					❖	❖					
SF0.7	STREAM							❖o				x
SF1.0	STREAM	x	x	x	x	x	x	❖•	x•	x•	❖•	x
SF3.0	STREAM							❖•	x•	x•	❖•	x
SF4.7	STREAM							❖•				x
SFA1	STREAM	❖										x
SFA2	STREAM	x	x				x		x	x		x
SFA4	SEEP	x										
SFA5	SEEP		x				❖		❖			
SFA8	STREAM		x									
SFB2	STREAM	x	x									
SFB4	SEEP		x									
SFB14	STREAM						x		x			x
SFD1	SEEP		x									
SFE1	SEEP		x									
SFF1	SEEP					x						
SFG1	SEEP						❖					
SFG2	STREAM						❖					
SFG3	STREAM					❖	x					
SFG4	STREAM					❖						
SFREF1	STREAM							❖•	x•	x•	❖•	x

Table 1-1 Sampling Locations and Dates for Surface Water Samples

Location	Type	Oct 2009	Jan/Feb 2010	Oct 2010	Jan 2011	Sep 2011	Feb 2012	Jun 2012	Sep 2012	Jun 2013[1]	Sep 2013	Apr 2014
RUSSEL CREEK												
SW3	STREAM	x	x									
SW4	STREAM	x	x									
SW5	STREAM	x	x									
WEST FORK CANYON CREEK												
SW6	STREAM	x	x									
SW7	STREAM	x	x									
C1	STREAM	x	x	x								
COW CREEK												
CHAMBERS	STREAM	x	x									
SW1	STREAM	x										
SW2	STREAM	x										
RIDDLE INTAKE	FAUCET	x	x	x	x	x	x		x			

Notes:

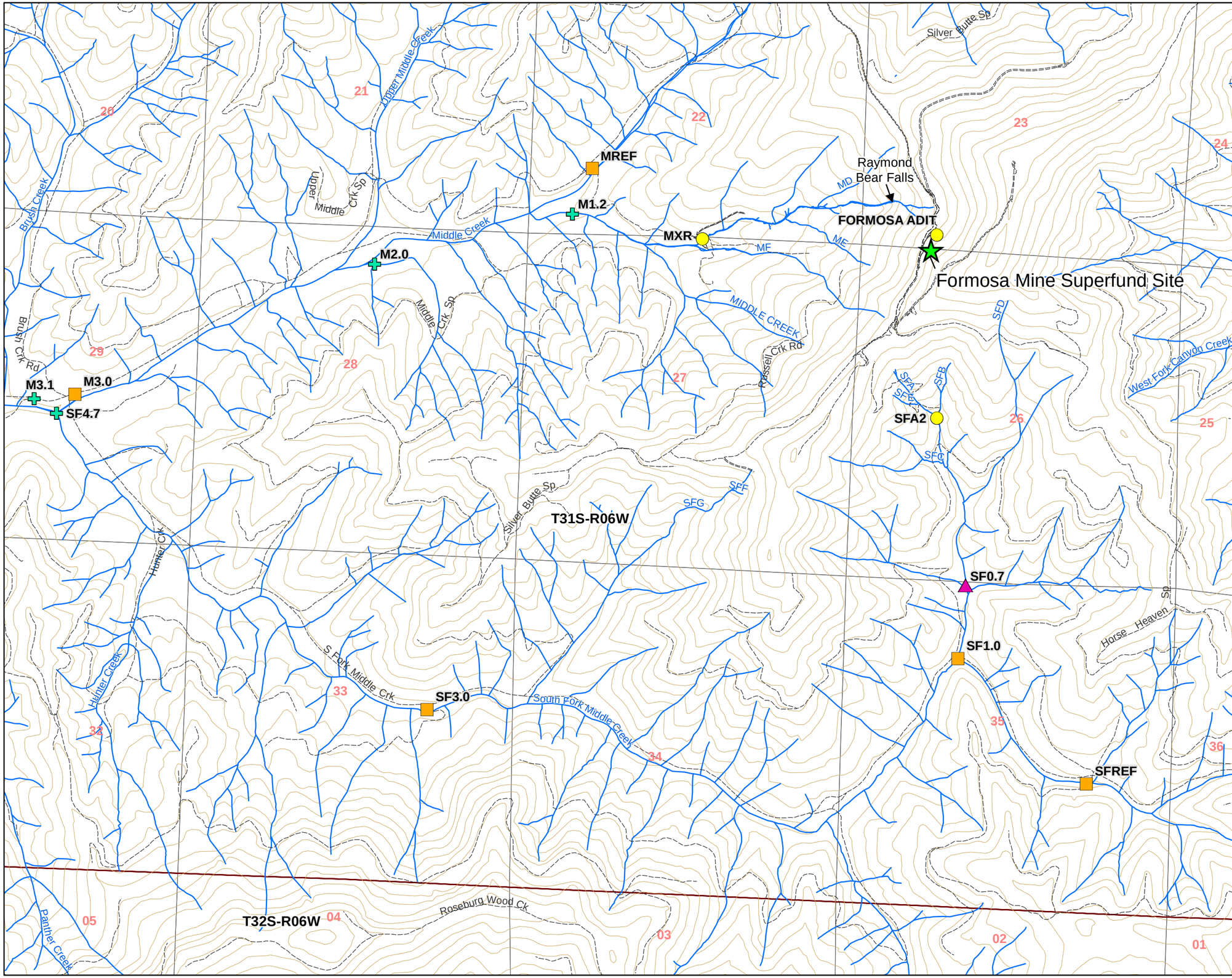
❖Indicates YSI field parameters only collected at this location

x Indicates YSI field parameters and laboratory sample collection at location

• BMI and fish

o BMI

[1]YSI data not reliable for all parameters in June 2013



Legend

Ecological Sampling Locations

- BMI only
- BMI, Fish
- BMI, Fish, Surface Water
- Surface Water
- Roads
- Hydrology
- Contours (100 ft)
- Township/Range
- Sections

*MXR and SFA2 are flume locations

0 0.125 0.25 0.5 Miles

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS Zone 3602

Data Sources:
Bureau of Land Management:
2001 Hydrography
2005 Township, Range, and Topography

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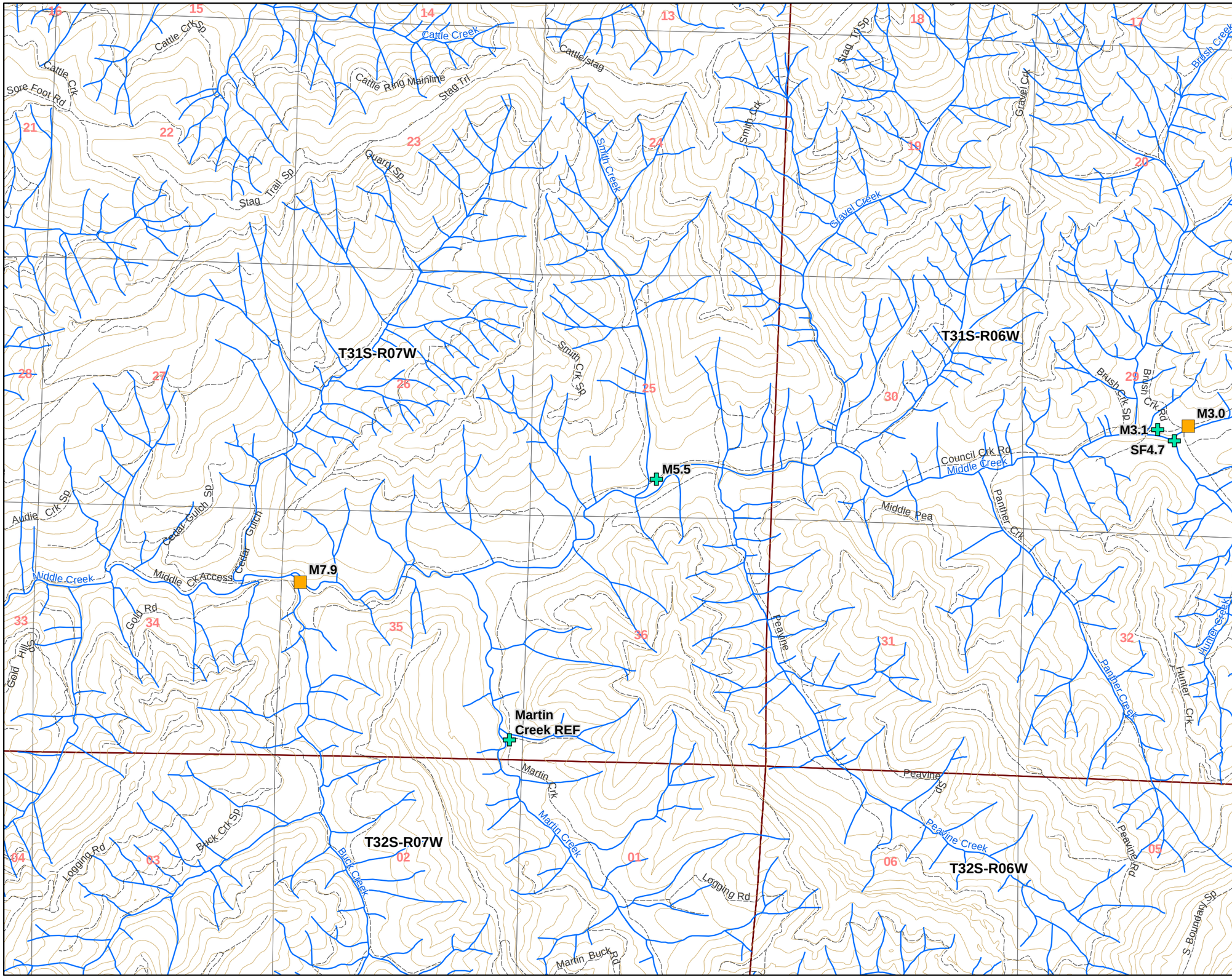
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Figure 1-1a

Ecological Sampling Locations

Formosa Mine
Douglas County, Oregon



Legend

Ecological Sampling Locations

- BMI, Fish
- BMI, Fish, Surface Water
- Surface Water
- Roads
- Hydrology
- Contours (100 ft)
- Township/Range
- Sections

0 0.15 0.3 0.6 Miles

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS Zone 3602

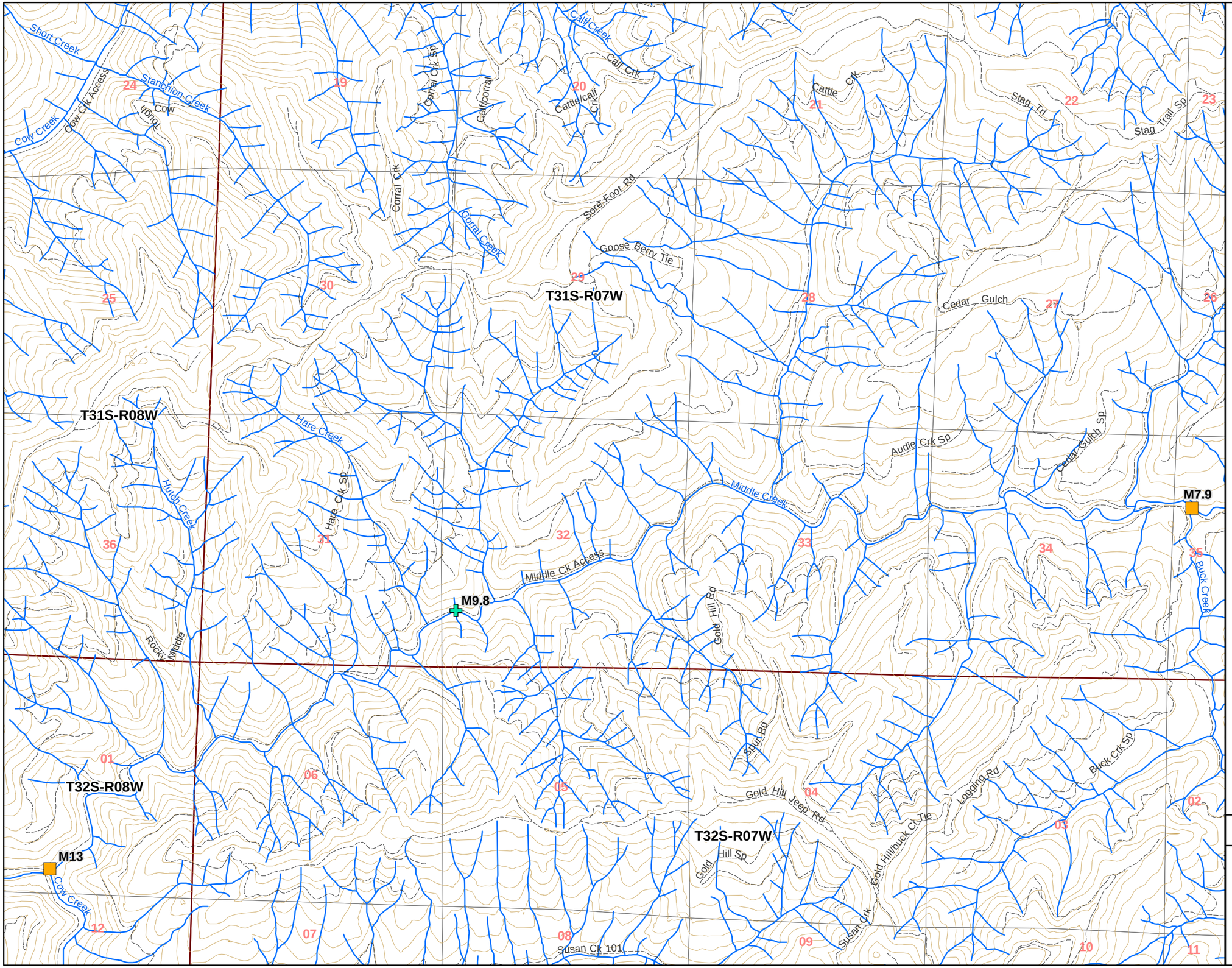
Data Sources:
Bureau of Land Management:
2001 Hydrography
2005 Township, Range, and Topography

CDM Smith

Figure 1-1b

Ecological Sampling Locations

Formosa Mine
Douglas County, Oregon



Legend

Ecological Sampling Locations

- BMI, Fish
- BMI, Fish, Surface Water
- Surface Water
- Roads
- Hydrology
- Contours (100 ft)
- Township/Range
- Sections

0 0.15 0.3 0.6 Miles

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS Zone 3602

Data Sources:
Bureau of Land Management:
2001 Hydrography
2005 Township, Range, and Topography

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Figure 1-1c

Ecological Sampling Locations

Formosa Mine
Douglas County, Oregon

Section 2

BERA Problem Formulation

The Problem Formulation phase of the OU2 BERA establishes the goals and describes the scope and focus of the assessment. As defined in Section 1, OU2 includes all surface water, sediment, groundwater, underground workings, and adit water drainage associated with the Formosa Mine, whereas OU1 includes the surface and subsurface mine wastes and soils that were deposited outside of the mine workings. The study area for this BERA for OU2 includes the aquatic ecosystems potentially affected by MIW, specifically, Middle Creek and South Fork Middle Creek. Based on the findings of the OU1 RI (CDM 2012), surface water quality in both Middle Creek and South Fork Middle Creek is affected by MIW as a result of contaminant transport from the mine wastes and soils to these surface waters via processes of direct adit discharges to alluvium, infiltration of rainfall, and groundwater transport.

This phase of the BERA considers site-specific regulatory and policy issues and requirements and identifies potential stressors (e.g., COPCs) and ecological resources potentially at risk. An important outcome of problem formulation is the conceptual site model (CSM), which describes potential exposure scenarios, including contaminant sources, transport mechanisms, exposure media, exposure routes, and receptors. Information depicted in the CSM is used to reveal relationships between mine-related chemical stressors, ecological receptors, assessment endpoints, measurement endpoints, and preliminary remedial action objectives. Each of these components is defined and described in the following sections. The site-specific CSM is discussed in Section 2.4 and presented in **Figure 2-1**.

2.1 Stressor Identification

Ecological stressors are defined as physical, chemical, or biological entities or conditions that adversely affect or have potential to affect adversely ecological receptors directly or indirectly. This BERA is focused on the potential ecological effects associated with inorganic compounds in surface water, based on the findings of the SLERA for the OU1 RI, which identified mine-related stressors as inorganic chemicals (cadmium, copper, and zinc) and possibly other mining-related stressors such as pH.

Other stressors, including physical (non-chemical) stressors such as habitat disturbance or degradation, may contribute to adverse ecological effects within the aquatic ecosystems of interest in the OU2 BERA. Habitat degradation is observed where surface and subsurface mine wastes and soils were deposited outside of the mine workings and within seeps close to the mine. One example of this degradation that is easily observed is the presence of metal precipitates that can cover substrate and negatively affect BMI and other aquatic organisms. As described in Section 2.2.1.1, metal precipitates have been observed as orange staining and white turbid water in upstream reaches of Middle Creek and South Fork Middle Creek, respectively. Thus, habitat degradation is evident in the aquatic ecosystems of concern in the OU2BERA. However, this occurs at only the most upstream ecological sampling locations.

The effect of MIW on surface water is the focus of the OU2 BERA. As described in Section 2.2.1.2, very little fine-grained sediment was found during ecological investigations for the OU2 BERA, indicating that exposure to mine-related COPCs in sediment is not expected to be a significant exposure pathway

for BMI or fish that consume BMI. Therefore, the abiotic media of concern for aquatic habitats is limited to surface water.

2.1.1 Chemicals and Exposure Media of Potential Concern

The OU1 SLERA preliminarily identified the COPCs, source areas, ecological habitats, and ecological receptors of potential concern considered applicable to the OU2 BERA for the aquatic ecosystems. COPCs identified in the SLERA include cadmium, copper, and zinc. These COPCs were identified based on a screening of dissolved concentrations of selected metals (cadmium, copper, lead, nickel, and zinc) in surface water in the upper reaches of Middle Creek and South Fork Middle Creek.

Terrestrial and riparian habitats upland of and adjacent to Middle Creek and South Fork Middle Creek are not expected to be affected adversely by mine-related materials. As described in the OU1 RI, the significant fate and transport mechanism for COPCs from OU1 is transport via groundwater, which discharges to surface waters in the upper reaches of the creeks. Terrestrial habitats that were impacted directly by mine materials or have the potential to be impacted by COPCs via surface runoff from mine materials were evaluated as part of OU1 and are not included in the OU2 BERA.

Additional abiotic and biological sampling and surveys were conducted in support of the OU2 BERA to supplement this preliminary information and further identify COPCs and exposure media. The findings of ongoing surface water and groundwater sampling and ecological investigations conducted in 2012, 2013, and 2014 were evaluated in the OU2 BERA to refine the list of COPCs. Surface water is the exposure medium of interest in the OU2 BERA.

2.1.2 Refinement of Chemicals of Potential Concern

While the OU1 SLERA evaluated only five metals (cadmium, copper, lead, nickel, and zinc), the screening evaluation conducted for the OU2 BERA included a standard target analyte list of 26 metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chloride, chromium, cobalt, copper, fluoride, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, sulfate, thallium, vanadium, and zinc). The COPC screening process for this BERA included comparisons of maximum detected concentrations of these metals in surface water to conservative ESLs applicable to diverse aquatic life communities (i.e., BMI, fish, aquatic plants, and larval amphibians). Chemicals associated with maximum detected concentrations exceeding ESLs were retained as COPCs for the OU2 BERA. This screening level method is described further in Section 3.5. Based on this screening, cadmium, copper, mercury, and zinc were retained as COPCs for further evaluation in the OU2 BERA.

2.1.3 Summary of Exposure Areas

Surface waters of concern in the OU2 BERA include Middle Creek and South Fork Middle Creek. Each of these streams is identified as separate exposure areas (EAs), and each is applicable to mobile aquatic receptors such as fish that move throughout these creeks. The Middle Creek EA is shown in **Figures 1-1a, 1-1b**, and **1-1c**. The South Fork Middle Creek EA is shown in **Figure 1-1a**. Chemical exposure data applicable to fish and other mobile aquatic receptors are based on data for the entire EA (e.g., mean dissolved copper concentrations for Middle Creek). Chemical exposure data for non-mobile or minimally mobile receptors, such as BMI, do not utilize EAs as described above but instead are based on data from unique surface water and biological sampling stations located on each of these creeks, as described below.

2.2 Ecological Resources at Risk

The following sections summarize information from available documents of previous studies in the Middle Creek watershed and from ecological and habitat observations collected during sampling and reconnaissance surveys conducted in 2012 and 2013.

2.2.1 Habitats

As described in Section 1.4, OU2 ecological investigations were conducted in Middle Creek and South Fork Middle Creek in June and September of 2012 and June and September of 2013.

2.2.1.1 Aquatic Habitats

Middle Creek and South Fork Middle Creek originate as seeps near the former mining area. Multiple seeps and tributaries contribute to each surface water system. Flumes with continuous automated flow-monitoring and water chemistry instrumentation were installed in or near the headwaters of both systems. A flume was installed at MXR for Middle Creek and at SFA2 for South Fork Middle Creek to collect data on flow and water quality and better define seasonal fluctuations in discharge of contaminated waters.

Aquatic habitats of interest to the OU2 BERA include higher gradient/high energy reaches of Middle Creek and South Fork Middle Creek as well as lower energy reaches downgradient of the former mining area. These habitats include perennial instream sections of these water bodies as well as margins and other areas that may be only intermittently wet. Habitat observations as well as observations of the BMI communities and fish during ecological sampling in 2012 and 2013 are described below. **Figures 1-1a, 1-1b,** and **1-1c** show the ecological sampling locations in addition to the MXR and SFA2 sampling locations.

Middle Creek Sampling Locations

Middle Creek extends approximately 13 miles to its confluence with Cow Creek. Cow Creek is a tributary to the South Umpqua River that ultimately becomes the Umpqua River, which reaches the ocean at Winchester Bay. The headwaters of Middle Creek consist of several small seeps that flow down steep slopes through mature coniferous forest dominated by Douglas fir (*Pseudotsuga menziesii*). These drainages converge upstream of the MXR sampling location where the flume is located and continuous flow and water quality monitoring is conducted. MXR is located approximately 0.7 miles from the Formosa Mine and is a second order stream.

The substrate at MXR consists of large cobble, and partial armoring (coating and/or cementing of the rocks by metal precipitates) of the substrate has been observed. Disturbance of the substrate during some periods of the year results in milky, turbid water. Fine-grain sediment is generally lacking. While no ecological sampling has been conducted at MXR, the BMI community is likely impaired due to mine drainage and armoring of the substrate. The culvert just downstream presents a barrier to fish access to MXR under most if not all flow conditions.

The M1.2 sampling location is approximately 0.5 miles downstream of MXR and 1.2 miles from the mine, as measured from the surface water drainage headwaters nearest the mine. This is a third order stream with a gradient of about 3%. The substrate consists primarily of large cobbles and small boulders, with some armoring and orange staining. The bankfull width of Middle Creek at this location is about 12 feet, and the banks are highly incised in areas along this reach. Average depth of the stream is about 0.5 feet. Riparian cover is good, consisting of red alder (*Alnus rubra*), vine maple (*Acer circinatum*), and Douglas fir with 95% canopy coverage over the stream. Large woody debris and a

few pools with depths of 1 to 2 feet are present. Fine-grained sediment is limited to small amounts within pool areas. During ecological sampling in 2012 and 2013, very few BMI were observed at M1.2. One cutthroat trout (*Oncorhynchus clarkia*) was observed at M1.2 in both September 2012 and June 2013, and two cutthroat trout were observed in September 2013.

The M2.0 sampling location is approximately 0.8 miles downstream of M1.2 and 2 miles from the mine. This is a fourth order stream with a gradient of about 1.5%. The substrate consists primarily of cobble. Bankfull width is around 17 feet, with an average depth of 0.5 feet. A small number of 1 to 2 foot deep pools are present. Fine-grained sediment is generally lacking but may be present within pools. An algal "muck" was observed during all 2012 and 2013 sampling events. At the road crossing, there is an approximately 12-foot gap in the riparian vegetation, but elsewhere there is a good riparian corridor consisting of red alder, vine maple, and Douglas fir, providing an average of 60% over-stream shade. During sampling in 2012 and 2013, very few BMI were observed. Young of year salmonids (not identified to species) were observed in both 2012 and 2013. Rough-skinned newt (*Taricha granulosa*) and larval Pacific giant salamanders (*Dicamptodon tenebrosus*) were noted.

The M3.0 sampling location is approximately 1 mile downstream of M2.0 and 3 miles from the mine. This is a fourth order stream with a gradient around 2.5%. The average bankfull width is 16 feet, and average depth is 0.5 feet. The substrate consists primarily of cobble with a fair amount of bedrock present. Fine-grained sediment is limited but may be present within shallow pools. There is very good riparian cover consisting of red alder, vine maple, and Douglas fir, providing an average of 95% over-stream shade. The BMI community appeared good during sampling in 2012 and 2013. During fish surveys in 2012 and 2013, young of year salmonids were observed. Rough-skinned newt and Pacific giant salamanders were noted.

The M3.1 sampling location is approximately 0.1 miles downstream of M3.0 and 3.1 miles from the mine. It is just downstream of the confluence of Middle Creek and South Fork Middle Creek. This is a fifth order stream with a gradient of about 2%. The substrate consists of cobble and gravel with some bedrock. Orange staining and mucky material was noted on the substrate in some areas. Fine-grained sediment is generally lacking but may be present within pools. The bankfull width is around 20 feet, with an average depth of about 1 foot. The dominant riparian vegetation consists of red alder, willow (*Salix* sp.), and Douglas fir, and there are instream islands covered with grasses. Over-stream shade is about 50%. Good BMI community was observed during sampling in 2012 and 2013. Young of year cutthroat trout, coho salmon (*Oncorhynchus kisutch*), steelhead/rainbow trout (*Oncorhynchus mykiss*), and sculpin (*Cottus* sp.) were observed in 2012 and 2013. In addition, a steelhead redd was observed at M3.1 in June 2013.

The M5.5 sampling location is approximately 2.4 miles downstream of M3.1 and 5.5 miles from the mine. Ecological sampling was only conducted at this location in June of 2012. This is a fifth order stream with a gradient around 1.5%. Riparian vegetation is dense, consisting of alder, willow, and vine maple with instream islands covered with grasses and other aquatic vegetation. The bankfull width is approximately 23 feet, and average depth is about 1 foot, with 2-foot pools. Over-stream shade covers around 50% of the stream. The substrate is predominantly cobbles with a few boulders and some bedrock present. Fine-grained sediment is generally lacking but may be present within pools. The BMI community appeared very good during sampling in June 2012. Young of the year coho salmon, rainbow trout, sculpin, and rough-skinned newt were observed.

The M7.9 sampling location is approximately 2.4 miles downstream of M5.5 and 7.9 miles from the mine. This is a sixth order stream with a gradient of approximately 1.5%. The substrate consists of

cobbles and some gravel. Bankfull width is approximately 32 feet, and average depth is about 1 foot, with pools up to 3 feet deep. Sediment is limited but may be present within pools. Riparian vegetation is dense and consists of alder and willow, with instream islands covered with grasses and other aquatic vegetation. Canopy cover shades around 50% of the stream. The BMI community here appeared very good during sampling in both 2012 and 2013. Young of the year coho salmon, cutthroat trout, and sculpin were observed during surveys. Beaver (*Castor canadensis*) sign and rough-skinned newt were observed.

The M9.8 sampling location is approximately 1.9 miles downstream of M7.9 and 9.8 miles from the mine. Ecological sampling was conducted only at this location in June of 2012. This is a sixth order stream with a gradient around 2%. Bankfull width is approximately 29 feet, and average depth is about 8 inches, with pools up to 2.5 feet deep. The dominant substrate is gravel. Sediment is limited but may be present within pools. Riparian vegetation is dense and consists of alder and willow, with instream islands covered with grasses and other aquatic vegetation. Canopy cover shades around 60% of the stream. The BMI community appeared very good during sampling in June 2012. Young of the year coho salmon were observed along with cutthroat trout and sculpin. Beaver sign and rough-skinned newt were observed.

The M13 sampling location is approximately 3.2 miles downstream of M9.8 and 13 miles from the mine. Ecological sampling was only conducted at this location in June 2012. M13 is just upstream of the confluence of Middle Creek and Cow Creek. At this location, Middle Creek is very wide with an approximate bankfull width of 44 feet. At this location, the stream consists mostly of shallow riffle habitat of around 10 inches deep with some pools up to 3.5 feet deep. This is a sixth order stream with a gradient around 1.5%. Sediment is generally lacking but may be present within pools. The riparian corridor is dominated by mature Oregon myrtle (*Umbellularia californica*) and Oregon ash (*Fraxinus latifolia*) and shades approximately 80% of the stream. The dominant substrate is gravel with some cobble. The BMI community appeared very good during sampling in June 2012. Young of the year coho salmon were observed along with rainbow trout, sculpin, and dace (*Rhinichthy*s sp.). A rough-skinned newt was observed.

South Fork Middle Creek Sampling Locations

South Fork Middle Creek begins in a series of small seeps, including SFA2, where a flume has been installed to measure flow and water quality parameters. South Fork Middle Creek flows approximately 5 miles to its confluence with Middle Creek. In June 2012, several locations along South Fork Middle Creek were visited during the OU2 BERA site reconnaissance. Locations were selected to be consistent with previous sampling by BLM and others. The furthest upstream location visited on South Fork Middle Creek was SF0.7, located approximately 0.7 miles from the Formosa Mine and 0.3 miles upstream of SF1.0, a location where water quality sampling is conducted twice per year.

The SF0.7 location is a third order stream with a gradient around 3%. The substrate consists of boulders, cobble, and gravel. Fine-grained sediment was largely absent during the site visit in June 2012. Riparian vegetation is dense and consists of Douglas-fir, bigleaf maple (*Acer macrophyllum*), and vine maple shading approximately 95% of the stream and an understory of salal (*Gaultheria shallon*) and Oregon grape (*Mahonia aquifolium*). Bankfull width is 6 feet, and average depth 4 inches. During the June 2012 visit, highly turbid, “milky” water was observed when the substrate was disturbed, indicating the presence of metal precipitates. BMI sampling was conducted, but no fish surveys were conducted because of the low water level and general lack of suitable habitat for fish. Ecological sampling subsequently was not repeated at this location.

The SF1.0 sampling location is approximately 1 mile from the Formosa Mine. At this location, there is a large pool (around three feet deep) downstream of a large culvert under a road crossing. The South Fork Reference stream (described below) enters South Fork Middle Creek just downstream of SF1.0. The SF1.0 location is a fourth order stream, and the stream gradient at this location is approximately 1.5%. The dominant substrate is cobble. The riparian corridor is dense and consists of red alder, bigleaf maple, vine maple, and Douglas-fir, shading approximately 80% of the stream. The bankfull width is approximately 19 feet, and average depth is approximately 8 inches. A small amount of fine-grained sediment is present within pools. During sampling in 2012 and 2013, the BMI community was sparse. Small numbers (1 or 2) of cutthroat and rainbow trout have been observed during fish surveys.

The SF3.0 sampling location is 2 miles downstream of SF1.0 and 3 miles from the mine. There is a large culvert on the downstream end that likely prevents fish passage except during high flows. This is a fifth order stream with a gradient of approximately 1.5%. The dominant substrate is cobble, with some sand present. Fine-grained sediment is generally lacking but may be present in small amounts within pools. The bankfull width is approximately 30 feet, with an average depth of 0.5 feet. Riparian vegetation consists of red alder, bigleaf maple, vine maple, and Douglas fir, with canopy coverage around 75%. During sampling, the BMI community appeared fair. Higher numbers of fish, including cutthroat and rainbow trout, have been observed during fish surveys as compared to SF1.0. Rough-skinned newts have been observed.

The SF4.7 sampling location is approximately 1.7 miles downstream of SF3.0 and 4.7 miles from the mine. Ecological sampling was only conducted at this location in June of 2012.This location is just upstream of the confluence with Middle Creek. Downstream of the confluence, Middle Creek runs by a large group campsite. This is a fifth order stream with a gradient of approximately 4%. Dominant substrate is boulders and bedrock, and there is little sediment present. Bankfull width is approximately 19 feet, with an average depth of 8 inches. Riparian vegetation consists of red alder, vine maple, willow, and Douglas fir, shading about 60% of the stream. During sampling in June 2012, the BMI community appeared good. Young of the year coho salmon and larger rainbow trout were observed, along with Pacific giant salamanders.

Reference Sampling Locations

The Middle Creek Reference location (MREF) is on a small tributary stream approximately 0.3 miles from its confluence with Middle Creek, which is approximately 0.1 miles downstream of M1.2. At this location, there is a large culvert located under a road crossing. This is a third order stream with a gradient of approximately 1.5%. Dominant substrate is cobble, and there is limited sediment present. The riparian vegetation consists of red alder, vine maple, and Douglas fir, shading about 90% of the stream. Bankfull width is approximately 6 feet, and average depth is about 4 inches. Downstream of the culvert is a pool, about 1.5 feet deep. During sampling, the BMI community appeared good. In June of 2012, no fish were observed, but rough-skinned newts and a Pacific giant salamander were found. In September of both 2012 and 2013, the stream was not flowing, so no sampling was conducted. In June 2013, no fish were observed, but similar to June 2012, two rough-skinned newts were found along with several young Pacific giant salamanders.

The Martin Creek Reference location is approximately 0.3 miles upstream along Martin Creek from its confluence with Middle Creek, which is approximately 0.5 miles upstream of M7.9. This is a fifth order stream with a gradient of around 2%. The dominant substrate is cobble, and there is little sediment present. Bankfull width is around 19 feet, and average depth is about 6 inches. The riparian vegetation

consists of alders and willows, providing about 90% over-stream shade. During sampling, the BMI community appeared very good. Young of the year coho salmon and trout fry were observed along with sculpin and older cutthroat trout and steelhead. Pacific giant salamanders were observed at this location.

The South Fork Middle Creek Reference location (SFREF) is approximately 0.7 miles upstream of SF1.0 on a tributary stream to South Fork Middle Creek. This is a fourth order stream with a gradient of approximately 1.5%. There is a road culvert with a large pool (about 3.25 feet deep) on the downstream end. The dominant substrate is cobble. There is some sediment present. The bankfull width is about 6 feet, with an average depth of about 0.5 feet outside of pools. Riparian vegetation consists of red alder, vine maple, and Douglas fir, providing about 90% canopy coverage. During sampling, the BMI community appeared very good. Cutthroat trout (no young of the year) were observed during fish surveys.

2.2.1.2 Fate and Transport within Aquatic Habitats

Surface water quality in both Middle Creek and South Fork Middle Creek is affected by MIW, primarily from discharge at seeps receiving contaminants from groundwater. Based on the findings of the OU1 RI (CDM 2012), the primary means of transport of MIW is via alluvial groundwater as a result of leaching and direct discharge from the Formosa 1 Adit and subsequent discharge to surface waters. Direct runoff of MIW from the mine materials would only be expected to occur after intense but short-term precipitation or snowmelt events, which occur primarily during late fall though winter.

Based on observations during ecological sampling in 2012 and 2013, fine-grained sediments are minimal within both of these surface water drainages, particularly in higher gradient upper reaches and those dominated by cobble and boulder substrates. Small amounts of sediment are present within larger pools, typically located downstream of culverts. This indicates that sediment transport downstream is not likely a significant means of transport of mine-related metals from OU1 to the downstream aquatic systems of concern in the OU2 BERA.

In addition, ecological data on BMI communities at several sampling locations described above are representative of riffle habitats that are generally lacking in fine-grained sediment. Since benthic macroinvertebrates inhabit these areas that appear to be generally lacking fine-grained sediment, exposure to mine-related COPCs in sediment is not expected to be a significant exposure pathway for benthic macroinvertebrates or fish that consume BMI. Therefore, the abiotic media of concern for aquatic habitats is limited to surface water.

2.2.1.3 Terrestrial Habitats

Upland

Upland vegetation within the OU2 BERA study area consists primarily of coniferous forest dominated by Douglas fir. Golden chinkapin (*Castanopsis chrysophylla*) and Pacific madrone (*Arbutus menziesii*) commonly occur in drier areas while western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) occur in wetter areas or on north aspects. Forest age in and around the mine varies from old-growth stands to younger successional forest and areas of recent timber harvest. Openings in the canopy allow for growth of herbaceous vegetation, shrubs, and saplings. Open dry areas are dominated by wedgeleaf ceanothus (*Ceanothus cuneatus*) and other shrubs as well as Douglas-fir saplings. Grasses and poison oak (*Toxicodendron diversilobum*) become more abundant on open, sunny, south aspects within the study area. Wildlife and plants found in the study area are listed in **Table 2-1**.

Riparian

Riparian vegetation in and around the OU2 BERA study area is dominated by deciduous trees and shrubs, including vine maple, bigleaf maple, and red alder. Along downstream reaches of Middle Creek, black cottonwood (*Populus trichocarpa*), willow, Oregon ash, and Oregon myrtle occur. Sword fern (*Polystichum munitum*) and thimbleberry (*Rubus parviflorus*) are common understory riparian species. Douglas fir occurs adjacent to streams in and around the study area. Wildlife and plants found in the OU2 BERA study area are listed in attached **Table 2-1**.

Terrestrial and riparian habitats adjacent to streams were characterized using field observations and incorporating the use of the Ecological Risk Checklist adapted from EPA guidance for use on hazardous waste sites. Examples of characteristics that were noted via observation include dominant plant species in the overstory, understory, and ground cover within the BERA study area with specific emphasis on habitats adjacent to the streams. These observations are important for documenting the terrestrial habitats used by breeding and nesting animals, including listed species, within the OU2 BERA study area.

2.2.1.4 Fate and Transport within Terrestrial Habitats

Based on observations during ecological sampling, the primary means of transport of mine materials to the aquatic ecosystems is via discharge of MIW. MIW is transported in groundwater to seeps that feed Middle Creek and South Fork Middle Creek and in surface flows through precipitation on exposed mine wastes and mine-impacted surface soils. The terrestrial habitats affected by mine materials were evaluated in the OU1 RI (CDM 2012). The scope of the OU2 BERA and media evaluated are described in Section 2.1.1. The OU2 BERA focuses on assessing risk within aquatic habitats. Risks to terrestrial habitats and receptors are not evaluated quantitatively in the OU2 BERA.

2.2.2 Ecological Receptors

Following the SLERA from OU1, the scope of the OU2 BERA and media evaluated is focused on assessing risk within aquatic habitats.

2.2.2.1 Aquatic Receptors

Aquatic receptors of interest to the OU2 BERA include aquatic plants, water column and BMI, fish, and larval amphibians. Several amphibian species, including rough-skinned newt and Pacific giant salamander, are known to occur in Middle Creek and South Fork Middle Creek and were observed during ecological sampling, as described above.

Freshwater fish that are known to occur in the aquatic ecosystems within the OU2 BERA study area include coho or silver salmon and steelhead/rainbow trout. Fish species observed during fish presence/absence surveys conducted in 2012 and 2013 include coho salmon, steelhead/rainbow trout, cutthroat trout, and sculpin.

Both Pacific lamprey (*Entosphenus tridentatus*) and western brook lamprey (*Lampetra richardsoni*) have been documented downstream of the study area at the ODFW smolt trap in Cow Creek (BLM 2002). Three lampreys (species not identified) were observed in Middle Creek during presence/absence surveys in 1984 and 1988 (Norecol 1989). In 1993, three lampreys (3 to 4 inches long) were observed in Middle Creek above Brush Creek during surveys conducted by ODFW (BLM 2002).

Lampreys were not observed in the study area during fish surveys completed by BLM from 2000 to 2007 or by EPA in 2012 and 2013. The non-observance may be attributed to electroshocking sampling techniques used, which are not the preferred method for collecting or identifying the presence of lampreys. In addition, localized habitat limitations or physical barriers to fish passage may have precluded finding lampreys at the time of these surveys.

Important metrics related to fish as receptors include field data such as number of fish observed by reach, number of fish taxa for a given reach, and ancillary information, including number of coho salmon and/or steelhead redds per specific stream reach. Other important data related to fish as receptors include water quality such as pH, turbidity, and dissolved metals concentrations in surface water. Metrics such as these are used to characterize current conditions with respect to suitability to support fish survival, growth, and reproduction. A substantial amount of fish survey work has been performed in the study area waters over the past several decades. The OU2 BERA relies on the results of these efforts, supplemented by recently collected data, to characterize the baseline conditions of the aquatic environments of interest.

Similarly, benthic invertebrates serve as important aquatic receptors, as water quality affects BMI, and therefore these receptors can be used to assess physical habitat suitability, surface water quality, and sediment quality. As discussed above, the general lack of fine-grained sediment present in the aquatic ecosystems within the study area indicates that surface water quality is the primary exposure medium for focus of the OU2 BERA.

Many BMI species hatch from eggs laid by adults in the summer and grow during the fall, winter, and spring months, emerging as adults in late spring or summer. Thus, they are exposed to water quality conditions in the stream throughout the year.

In higher energy reaches of the streams (i.e., riffles), it is expected that dominant BMI types would include EPT taxa (Ephemeroptera [mayflies], Plecoptera [stoneflies], Trichoptera [caddisflies]). EPT taxa are generally considered sensitive to dissolved metals (Maret et al. 2003, Gerhardt et al. 2004). In slower, lower energy reaches of these streams, it is expected that EPT taxa will still be dominant but of different species, with likely smaller numbers of non-EPT taxa (e.g., dipterans or flies and possibly worms and snails) comprising the BMI community. As for fish, BMI metrics related to abundance and diversity are important metrics for characterizing aquatic habitats as suitable or impaired. Because BMI (1) are generally non-mobile or have limited mobility; (2) have life cycles that generally span 1 to 2 years; (3) integrate physical, chemical, and biological variability over a long time period; and (4) are intimately exposed to both surface water and sediment, they are excellent indicators of water and sediment quality. As described in Section 2.2.1.2, sediment exposures are not considered significant based on the general lack of fine-grained sediment in primary BMI habitat. Much BMI survey work has been performed in the study area waters over the past several decades, and the OU2 BERA relies on the results of these efforts, supplemented by recently collected data, to characterize the baseline conditions of the aquatic environments of interest.

2.2.2.2 Terrestrial Receptors

Terrestrial receptors of interest to the OU2 BERA include wildlife that uses habitats directly adjacent to the streams and nearby forest habitats. Common wildlife within the BERA study area include several species of mammals such as Roosevelt elk (*Cervus canadensis roosevelti*), black-tailed deer (*Odocoileus hemionus columbianus*), coyote (*Canis latrans*), western gray squirrel (*Sciurus griseus*), and black bear (*Ursus americanus*). Common bird species found in the BERA study area include common raven (*Corvus corax*), Steller's jay (*Cyanocitta stelleri*), mountain quail (*Oreortyx pictus*), red-breasted

nuthatch (*Sitta canadensis*), black-capped chickadee (*Poecile atricapillus*), bushtit (*Psaltriparus minimus*), and rufous hummingbird (*Selasphorus rufus*).

As described above, the primary means of transport of contaminants to the OU2 BERA study area is via surface water and groundwater, and not surface soils. Therefore, the exposure pathway of interest for terrestrial receptors relates to use of aquatic habitats (e.g., drinking surface water, consuming aquatic biota). Terrestrial animals, including band-tailed pigeon (*Patagioenas fasciata*) and deer have been observed drinking from the Formosa adit. However, because these terrestrial animals are mobile and have large foraging ranges, their exposure to contaminants via drinking water in Middle Creek or South Fork Middle Creek is considered insignificant.

2.2.2.3 Federally Listed Species

Federal Endangered and Threatened Species

There are 11 federally threatened or endangered species under the jurisdiction of the USFWS that have potential to occur in Douglas County (USFWS 2013). Of these, seven are marine species or associated with coastal habitats not found close to the OU2 BERA study area. The remaining four species include the Northern spotted owl (*Strix occidentalis caurina*) and three plants: Gentner's fritillary (*Fritillaria gentneri*), Kincaid's lupine (*Lupinus sulphureus* ssp*. kincaidii*), and rough popcornflower (*Plagiobothrys hirtus*). In addition, three species, the fisher (*Martes pennanti*), the North Oregon Coast distinct population segment of red tree vole (*Arborimus longicaudus*), and whitebark pine (*Pinus albicaulis*) are candidates for listing. A list of the federally threatened and endangered species is provided in **Table 2-2** along with the potential for each species to occur within the BERA study area. Species with high potential to occur are shaded in the table.

The National Marine Fisheries Service (NMFS) lists three species with potential to occur in or near the BERA study area, including Oregon Coast coho salmon, green sturgeon (*Acipenser medirostris*), and eulachon (*Thaleichthys pacificus*) (NMFS 2013).

Federal Species of Concern

There are a number of federal “species of concern” with potential to occur in or near the OU2 BERA study area based on the USFWS list for Douglas County (USFWS 2013) and NMFS regional lists (NMFS 2013). Species of concern have a conservation status that is of concern to the USFWS and NMFS but for which further information is still needed. These species include 13 birds, 9 mammals, 7 fish, 10 reptiles and amphibians, 5 invertebrates, and 17 plants. Federal species of concern are listed in **Table 2-2** along with the potential for each species to occur within the OU2 BERA study area. Species with high potential to occur are shaded in the table.

Food Web Model Receptors

As discussed further in Section 3.6.2, findings from the investigations and nature of water quality determined that food web modeling was not necessary and was not performed for the OU2 BERA. The COPCs identified for the OU2 BERA include cadmium, copper, mercury, and zinc, which are all bioaccumulative or potentially bioaccumulative chemicals. Cadmium appears to accumulate in lower trophic levels but not in upper trophic levels via dietary exposures. Copper and zinc are essential elements for life, and some accumulation is expected. Only at very high doses are copper and zinc toxic to upper trophic level receptors via diet, yet such doses are unlikely here given the concentrations measured in surface waters and the expectation of infrequent and short duration foraging on site by upper trophic level receptors.

An evaluation of several lines of evidence supports the assumption that mercury is not mine related and does not pose a concern for ecological receptors in the aquatic ecosystems of interest for the OU2 BERA. These lines of evidence are described in detail in Section 3.6.2.1. The lines of evidence evaluated include:

- Results of low level analysis of mercury in upstream surface water locations close to the Formosa Mine
- Low frequency of detection (≤10%) and low concentrations in surface water samples
- Comparison to mercury concentrations in other drainages considered background or reference
- Information on historical operations
- Limited fish tissue sampling by ODEQ (2004)

Based on these lines of evidence, food web modeling associated with exposure to mercury is not warranted for aquatic receptors.

2.3 Endpoints and Risk Questions/Hypotheses

The OU2 BERA is focused on assessing population-level risks associated with mine-related contamination in abiotic media. In general, risks are assessed by comparing COPC concentrations in abiotic media. Guiding the estimation of risks are two types of endpoints: (1) assessment endpoints and (2) measurement endpoints. These endpoints are discussed in Sections 2.3.1 and 2.3.2. Risk questions and hypotheses are developed to test assumptions regarding relationships between selected assessment endpoints, measurement endpoints, and potential exposures to representative receptors. These risk questions/hypotheses are discussed in Section 2.3.3. **Table 2-3** relates the risk questions/hypotheses to each assessment and measurement endpoint.

2.3.1 Objectives and Assessment Endpoints

Assessment endpoints identify the ecological values to be protected. For the OU2 BERA, abundance and diversity of aquatic macroinvertebrates or fish are important assessment endpoints. Assessment endpoints are used in future phases, such as the FS, and integrated into remedial action objectives. Appropriate assessment endpoints are developed by risk assessors and often consider guidance from relevant regulatory agencies.

BERA-related goals and objectives include:

- Re-establishment or maintenance of a balanced and diverse aquatic ecosystem adjacent to and downstream of the Formosa Mine.
    - The aquatic ecosystems of Middle Creek and South Fork Middle Creek are adversely affected by COPCs released from OU1. Historical and recent ecological investigations have identified a spatial zone of impairment in these surface waters that extends downstream of the upper reaches evaluated in the OU1 RI (CDM 2012). This is described further in Sections 5.2 and 5.3.3.
    - This goal includes a spatial component where the zone of impairment, as currently understood from previous investigations, will be reduced in size so that a zone of recovery becomes apparent at locations closer to the current source areas of OU1 (i.e., suitable

conditions are "extended" upstream). The zone of impairment is defined by reduced abundance and diversity of BMI and other aquatic life relative to a nearby reference area un-impacted by mine-related contamination.

- Re-establishment of aquatic ecosystems downstream of the Formosa Mine suitable for supporting all relevant life stages of historical salmonid species.
  - Similar to the above goal, this goal includes a spatial component where the zone of impairment, as currently understood, will be reduced in size so that a zone of recovery becomes apparent at locations closer to the current MIW source areas (i.e., suitable conditions are "extended" upstream). The zone of impairment is defined by reduced abundance of fish, especially salmonids, relative to a nearby reference area un-impacted by mine-related contamination. Achievement of this goal may be assessed by measuring fish abundance as well as increased evidence of reproduction (e.g., presence of young of the year fish, number of redds [i.e., nests]) relative to current conditions.

The OU2 BERA is designed to support decisions related to remedial action goals and objectives. This support consists of selecting appropriate assessment endpoints and evaluating risks related to these endpoints. Risk evaluation and interpretation is guided by development of specific risk questions or hypotheses. The receptors and habitats, contaminants of concern, toxic mechanisms, and exposure pathways were used to select the following assessment endpoints. Implicit in these assessment endpoint statements is the concept of ensuring that these values or resources warrant protection or should be re-established or maintained.

2.3.1.1 Surface Water Based Assessment Endpoints

- Protection of aquatic life, including aquatic plants, water column and BMI, fish, and larval amphibians, from the toxic effects, on survival, growth, and reproduction, of COPCs present in surface water
- Protection of fish populations and communities, especially salmonids, with potential to occur in and in some cases reproduce in aquatic environments of interest to this BERA
  - Protect individuals of federally listed species, including federally threatened Oregon coast coho salmon

2.3.2 Measurement Endpoints

Assessment endpoints are often difficult to measure or evaluate directly. For example, it cannot be predicted with certainty the conditions necessary to ensure the survival and successful reproduction of fish in surface waters adjacent to or downstream of the mine, as this depends on innumerable factors. However, toxicity data based on experimental studies or those designated as critical thresholds by regulatory agencies often can help predict the likely outcome of expected exposures. Measurement endpoints are for the most part TRVs selected from or based on accepted sources such as EPA and other relevant regulatory agencies. Section 4 of the OU2 BERA presents the surface water-specific TRVs selected for estimating risks to ecological receptors.

Measurement endpoints are used where assessment endpoints cannot be directly measured or evaluated. Measurement endpoints are quantitative expressions of observed or measured biological responses to stressors relevant to selected assessment endpoints. For example, survival and growth of aquatic invertebrates (an assessment endpoint) can be evaluated using aquatic toxicity data based on

an appropriate measurement endpoint. As a more specific example, concentrations of metals in surface water can be compared to concentrations in laboratory tests with surface water that resulted in observed ecologically significant effects to sensitive and relevant test species (i.e., the water flea [*Ceriodaphnia dubia*]). This example expresses the relationship between a relevant measurement endpoint (chronic effects concentration of metals in surface water) that is directly related to the assessment endpoints of aquatic invertebrate survival and growth. Measurement endpoints selected for the OU2 BERA include information from appropriate aquatic ecotoxicity studies and water quality studies and, where data allow, site-specific biological data.

For the OU2 BERA, ecologically significant effects are defined as those affecting survival, growth, or reproduction of selected receptors. Other endpoints, such as effects on behavior or histopathological effects, are not considered because these cannot be easily linked to ecologically significant endpoints that can impair populations or communities. Protection of populations and communities is a major goal of the OU2 BERA while protection of individual organisms is warranted for federally listed species and species of concern.

2.3.3 Risk Questions/Hypotheses

Hypotheses or risk questions are used to test assumptions regarding relationships between selected assessment endpoints, measurement endpoints, and potential exposures for selected representative receptors. The hypotheses identified for the OU2 BERA are based on the selected ecological receptors and the major exposure scenarios linked to these receptors. Some receptor groups, although considered important, are not included in the following hypotheses because assessment data are sparse or lacking. For example, protection of local amphibian populations is considered important, but data are lacking to assess the potential impacts on these receptors. A goal of the OU2 BERA is to answer the following risk questions with sufficient confidence to allow appropriate decision making with regard to remediation.

<u>Benthic Macroinvertebrates</u>

- Are the levels of contaminants in surface water greater than the surface water TRVs or surrogate values for the survival, growth, or reproduction of BMI?
    - Data to support a response to this question include COPC as dissolved concentrations in surface water that are hardness adjusted, as applicable, from multiple locations immediately downgradient from the Formosa Mine Site, where habitats are non-supportive of BMI, to downstream locations where BMI habitats have recovered to near-reference conditions.
- Is the structure (based primarily on abundance and diversity) of BMI communities significantly different from reference locations?
    - Data to support a response to this question include historical and recent BMI surveys conducted for the OU2 BERA, emphasizing measurement of metrics related to abundance and diversity from locations including reference and potentially impaired reflecting conditions between highly impaired (i.e., currently non-supportive of BMI) and reference.

<u>Aquatic Life (General)</u>

- Are the concentrations of dissolved contaminants in surface water within the aquatic ecosystems of OU2 greater than the surface water TRVs (dissolved) for the survival, growth,

and reproduction of aquatic life, including aquatic plants, water column and BMI, fish, and larval amphibians?

- Data to support a response to this question include COPC as dissolved concentrations in surface water that are hardness adjusted, as applicable, from multiple locations immediately downgradient from the Formosa Mine Site, where habitats are non-supportive of aquatic life, to downstream locations where aquatic habitats have recovered to near-reference conditions.

Fish

- Are the concentrations of dissolved contaminants in surface water greater than the dissolved surface water TRVs for the survival, growth, and reproduction of fish, with a focus on salmonid fish?
  - Data to support a response to this question include COPC as dissolved concentrations in surface water that are hardness adjusted, as applicable, from multiple locations immediately downgradient from the Formosa Mine Site, where habitats are non-supportive of fish, to where potential fish habitats have apparently recovered to near-reference conditions.
- Is there a difference in fish presence/absence in surface waters affected by MIW compared to reference areas?
  - Data to support a response to this question include fish surveys emphasizing presence/absence and general numbers and types of species relative to reference. Reference is defined here as locations downstream of OU1 where abundance and diversity of fish approach values expected for non-impaired waters in this region. Survey locations encompass areas of severe impairment (i.e., upstream locations currently non-supportive of fish) and reference areas. Multiple locations within these boundaries were surveyed to provide characterization of the current transitional zone between severe impairment and recovery. Sampling locations, methods, and, to the extent possible, agencies/firms/staff used in previous surveys were consistent to allow for comparability over time (note that adverse situations related to attainment of collection permits were minimized using this approach).

Table 2-3 summarizes the relationship between assessment endpoints, representative receptor species, measurement endpoints, and the associated risk questions (i.e., testable hypotheses).

2.4 Conceptual Site Model

The CSM for the OU2 BERA (**Figure 2-1**) is a visual presentation that summarizes key components related to potential ecological exposures resulting from site-related chemical contamination. The CSM is the primary output of the Problem Formulation phase of the ecological risk assessment. It summarizes exposure scenarios and is used to help develop a series of testable null hypotheses, as presented in this section. In addition, the CSM is used to support the selection of appropriate assessment and measurement endpoints.

The CSM presents the potential exposure pathways for representative ecological receptors exposed to mine-related contaminants. To be comprehensive, the CSM includes human health exposure pathways although they are not discussed further in the OU2 BERA. These potential pathways indicate how the

ecological resources can co-occur or come in contact with contaminants and include contaminant sources, fate and transport processes, and exposure routes.

For the OU2 BERA, **Figure 2-1** presents all the components of the CSM. Included on this figure are symbols representing various assumptions about exposure pathways. Solid circles represent complete and significant exposure pathways that are evaluated quantitatively. Open circles represent incomplete exposure pathways. Black triangles represent exposure pathways that are considered one of the following:

- Insignificant and complete (subject to qualitative evaluation where data allow)
- Insignificant and complete (but not evaluated due to lack of data)
- Potentially complete but insignificant or highly unlikely in most cases

Quantitative risk estimation in the OU2 BERA is reserved for the following:

- Aquatic benthic invertebrates based on instream surface water exposures
- Fish and water-column invertebrates and, to a lesser extent, aquatic plants and larval amphibians based on surface water exposures

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Table 2-1 Wildlife and Plants Found at the Formosa Mine OU2 and Vicinity
Douglas County, Oregon

	Scientific Name	Observed?	Notes*
Birds			
Band-tailed pigeon	*Patagioenas fasciata*	Yes	
Black-capped chickadee	*Poecile atricapilla*	Yes	
Bushtit	*Psaltriparus minimus*	Yes	
Common raven	*Corvus corax*	Yes	
Great-horned owl	*Bubo virginianus*	heard only	
Mountain quail	*Oreortyx pictus*	Yes	
Northern Spotted Owl	*Strix occidentalis caurina*	No	Likely to occur
Red-breasted nuthatch	*Sitta canadensis*	Yes	
Red-tailed hawk	*Buteo jamaicensis*	Yes	
Rufous hummingbird	*Selaphorus rufus*	Yes	
Steller's jay	*Cyanocitta stelleri*	Yes	
Turkey vulture	*Cathartes aura*	Yes	
Violet-green swallow	*Tachycineta thalassina*	Yes	
Western screetch owl	*Megascops kennicotti*	Yes	
Wrentit	*Chamaea fasciata*	heard only	
Mammals			
American black bear	*Ursus americanus*	Yes	
Bobcat	*Lynx rufus*	sign	
Coyote	*Canis latrans*	sign	
Mountain lion	*Felis concolor*	No	Likely to occur in low numbers
Mule (black-tailed) deer	*Odocoileus hemionus*	Yes	
Roosevelt elk	*Cervus canadensis roosevelti*	Yes	
Western gray squirrel	*Sciurus griseus*	Yes	
Woodrat	*Neotoma* sp.	Yes	
Fish			
Black crappie	*Pomoxis nigromaculatus*	No	Likely to occur in lower watershed
Bluegill	*Lepomis macrochirus*	No	Likely to occur in lower watershed
Brown bullhead	*Ameiurus nebulosus*	No	Likely to occur in lower watershed
Chinook salmon	*Oncorhynchus tshawytscha*	No	Likely to occur in lower watershed
Coarse-scale sucker	*Catostomus macrocheilus*	No	Likely to occur in lower watershed
Coho salmon	*Oncorhynchus kisutch*	Yes	
Cutthroat trout	*Oncorhynchus clarki*	Yes	
Longnose dace	*Rhinichthys cataractae dulcis*	No	Likely to occur in lower watershed
Pacific lamprey	*Lampetra tridentata*	No	Likely to occur in lower watershed
Rainbow trout	*Oncorhynchus mykiss*	Yes	
Redside shiner	*Richardsonius balteatus hydrophlox*	No	Likely to occur in lower watershed
River lamprey	*Lampetra ayresi*	No	Likely to occur in lower watershed
Salmon	Unknown	Yes	
Sculpin	*Cottus spp.*	Yes	
Smallmouth bass	*Micropterus dolomieu*	No	Likely to occur in lower watershed
Speckled dace	*Rhinichthys osculus*	No	Likely to occur in lower watershed
Umpqua pikeminnow	*Ptychocheilus oregonensis*	No	Likely to occur in lower watershed

Table 2-1 Wildlife and Plants Found at the Formosa Mine OU2 and Vicinity
Douglas County, Oregon

	Scientific Name	Observed?	Notes*
Reptiles and Amphibians			
Common garter snake	*Thamnophis sirtalis*	Yes	
Pacific giant salamander	*Dicamptodon ensatus*	Yes	
Pacific chorus (tree) frog	*Pseudacris regilla*	No	Likely to occur
Rough-skinned newt	*Taricha granulosa*	Yes	
Rubber boa	*Charina bottae*	Yes	
Western fence lizard	*Sceloporus occidentalis*	Yes	
Western skink	*Eumeces skiltonianus*	Yes	Hibernaculum found during sampling
Invertebrates			
Benthic invertebrates	Multiple Taxa	Yes	
Ground beetle	Family Carabidae	Yes	
Lorquin's admiral butterfly	*Limenitis lorquini*	Yes	
Water striders (skimmers)	Family Gerridae	Yes	
Yellow-spotted millipede	*Harpaphe haydeniana*	Yes	
Trees			
Bigleaf maple	*Acer macrophyllum*	Yes	
Black cottonwood	*Populus trichocarpa*	Yes	
California black oak	*Quercus kelloggii*	Yes	
Canyon live oak	*Quercus chrysolepis*	Yes	
Douglas-fir	*Pseudotsuga menziesii*	Yes	
Golden chinkapin	*Chrysolepis chrysophylla*	Yes	
Incense cedar	*Calocedrus decurrens*	Yes	
Jeffrey pine	*Pinus jeffreyi*	Yes	
Oregon ash	*Fraxinus latifolia*	Yes	
Oregon myrtle	*Umbellularia californica*	Yes	
Oregon white oak	*Quercus garryana*	Yes	
Pacific madrone	*Arbutus menziesii*	Yes	
Ponderosa pine	*Pinus ponderosa*	Yes	
Red alder	*Alnus rubra*	Yes	
Sugar pine	*Pinus lambertiana*	Yes	
Tan oak	*Lithocarpus densiflorus*	Yes	
Vine maple	*Acer circinatum*	Yes	
Western hemlock	*Tsuga heterophylla*	Yes	
Western redcedar	*Thuja plicata*	Yes	
Willow	*Salix* sp.	Yes	
Shrubs			
Manzanita	*Arctostaphylos* sp.	Yes	
Oregon grape	*Mahonia aquifolium*	Yes	
Western poison oak	*Toxicodendron diversilobum*	Yes	
Salal	*Gaultheria shallon*	Yes	
Western sword fern	*Polystichum munitum*	Yes	
Thimbleberry	*Rubus parviflorus*	Yes	
Wedgeleaf ceanothus	*Ceanothus cuneatus*	Yes	

*Likely to occur based on habitat and range.

Table 2-2 Federally Listed, Candidate Species, and Species of Concern and Potential to Occur at the Formosa Mine OU2 and Vicinity Douglas County, Oregon

Common Name	Scientific Name	Listing Status	Potential to Occur[1]
Birds			
Acorn woodpecker	*Melanerpes formicivorus*	SC	Low
American Peregrine falcon	*Falco peregrinus anatum*	DL	Low
Bald eagle	*Haliaeetus leucocephalus*	DL	Low
Band-tailed pigeon	*Patagioenas fasciata*	SC	High
Black oystercatcher	*Haematopus bachmani*	SC	None
Brown pelican	*Pelecanus occidentalis*	DL	None
Harlequin duck	*Histrionicus histrionicus*	SC	Low
Lewis' woodpecker	*Melanerpes lewis*	SC	Low
Marbled murrelet	*Brachyramphus marmoratus*	CH FT	Low
Mountain quail	*Oreortyx pictus*	SC	High
Northern goshawk	*Accipiter gentilis*	SC	Moderate
Northern spotted owl	*Strix occidentalis caurina*	CH FT	High
Olive-sided flycatcher	*Contopus cooperi*	SC	Moderate
Oregon vesper sparrow	*Pooecetes gramineus affinis*	SC	Low
Purple martin	*Progne subis*	SC	Low
Short-tailed albatross	*Phoebastria albatrus*	FE	None
Western burrowing owl	*Athene cunicularia hypugaea*	SC	None
Western snowy (coastal) plover	*Charadrius alexandrinus nivosus*	CH FT	None
White-headed woodpecker	*Picoides albolarvatus*	SC	Low
Yellow-breasted chat	*Icteria virens*	SC	Low
Mammals			
Fisher	*Martes pennanti*	Candidate	Moderate
Fringed myotis bat	*Myotis thysanodes*	SC	Moderate
Long-eared myotis bat	*Myotis evotis*	SC	Moderate
Long-legged myotis bat	*Myotis volans*	SC	Moderate
Pallid bat	*Antrozous pallidus pacificus*	SC	Low
Red tree vole	*Arborimus longicaudus*	Candidate	Moderate
Silver-haired bat	*Lasionycteris noctivagans*	SC	Moderate
Small-footed myotis bat	*Myotis ciliolabrum*	SC	Moderate
Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*	SC	Moderate
White-footed vole	*Arborimus albipes*	SC	Moderate
Yuma myotis bat	*Myotis yumanensis*	SC	Moderate
Fish			
Coastal cutthroat trout	*Oncorhynchus clarki ssp.*	SC	High
Eulachon	*Thaleichthys pacificus*	FT	None
Green sturgeon	*Acipenser medirostris*	SC	None
Millicoma dace	*Rhinichthys cataractae ssp.*	SC	Moderate
Oregon Coast coho salmon	*Oncorhynchus kisutch*	CH FT	High
Oregon Coast steelhead	*Oncorhynchus mykiss*	SC	High
Pacific lamprey	*Lampetra tridentata*	SC	Low
River lamprey	*Lampetra ayresi*	SC	Moderate
Umpqua chub	*Oregonichthys kalawatseti*	SC	Moderate
Reptiles and Amphibians			
California mountain kingsnake	*Lampropeltis zonata*	SC	Moderate
Cascades frog	*Rana cascadae*	SC	Moderate
Coastal tailed frog	*Ascaphus truei*	SC	Moderate
Common kingsnake	*Lampropeltis getula*	SC	Moderate
Del Norte salamander	*Plethodon elongatus*	SC	Low
Foothill yellow-legged frog	*Rana boylii*	SC	Moderate
Green sea turtle	*Chelonia mydas*	FT	None

Table 2-2 Federally Listed, Candidate Species, and Species of Concern and Potential to Occur at the Formosa Mine OU2 and Vicinity Douglas County, Oregon

Common Name	Scientific Name	Listing Status	Potential to Occur[1]
Reptiles and Amphibians (continued)			
Leatherback sea turtle	*Dermochelys coriacea*	FE	None
Loggerhead sea turtle	*Caretta caretta*	FE	None
Northern Pacific pond turtle	*Actinemys marmorata marmorata*	SC	Low
Northern red-legged frog	*Rana aurora aurora*	SC	Low
Olive (=Pacific) ridley sea turtle	*Lepidochelys olivacea*	FT	None
Oregon slender salamander	*Batrachoseps wrighti*	SC	Moderate
Southern torrent (seep) salamander	*Rhyacotriton variegatus*	SC	Moderate
Invertebrates			
Cascades apatanian caddisfly	*Apatania tavala*	SC	Moderate
Franklin's bumblebee	*Bombus franklini*	SC	Moderate
Mt. Hood primitive brachycentrid caddisfly	*Eobrachycentrus gelidae*	SC	Low
Tombstone Prairie farulan caddisfly	*Farula reaperi*	SC	Low
Sagehen Creek goeracean caddisfly	*Goeracea oregona*	SC	Low
Plants			
Bensoniella	*Bensoniella oregona*	SC	Moderate
Cliff paintbrush	*Castilleja rupicola*	SC	Moderate
Clustered lady's-slipper	*Cypripedium fasciculatum*	SC	Low
Cox's mariposa lily	*Calochortus coxii*	SC	Moderate
Fragrant kalmiopsis	*Kalmiopsis fragrans*	SC	Low
Frye's Limbella	*Limbella fryei*	SC	Low
Gasquet manzanita	*Arctostaphylos hispidula*	SC	Moderate
Gentner's fritillary	*Fritillaria gentneri*	FE	Low
Henderson's checker-mallow	*Sidalcea hendersonii*	SC	Low
Hitchcock's blue-eyed grass	*Sisyrinchium hitchcockii*	SC	Moderate
Kincaid's lupine	*Lupinus sulphureus ssp. kincaidii*	CH FT	Low
Koehler's rock-cress	*Arabis koehleri var. koehleri*	SC	Moderate
Pink sand-verbena	*Abronia umbellata ssp. breviflora*	SC	Low
Red-root yampah	*Perideridia erythrorhiza*	SC	Low
Rough popcornflower	*Plagiobothrys hirtus*	FE	Low
Shaggy horkelia	*Horkelia congesta ssp. congesta*	SC	Moderate
Thin leaved peavine	*Lathyrus holochlorus*	SC	Moderate
Umpqua mariposa-lily	*Calochortus umpquaensis*	SC	Low
Wayside aster	*Eucephalus vialis*	SC	Low
Whitebark pine	*Pinus albicaulis*	FC	Low
White meconella	*Meconella oregana*	SC	Moderate

[1]Potential to occur based on range and habitats present at the Formosa OU-2 Site. Shading indicates High potential to occur based on field observations

Notes:

FC = Federal Candidate

FE = Federally Endangered

FT = Federally Threatened

CH = Critical Habitat has been designated for this species

DL = Federally Delisted

SC = Species of Concern

Table 2-3 Relationship between Endpoints and Risk Questions for the Formosa Mine OU2 BERA

Receptor Group	Assessment Endpoint	Representative Receptor	Candidate Measurement Endpoint	Data Quality Objective	Use in Ecological Risk Assessment	Risk Question	Data Need
Benthic macroinvertebrates (BMI)	Survival, growth, and reproduction of BMI	BMI inhabiting Middle and South Fork Middle Creeks	Contaminant concentrations in surface water	Evaluate the potential effects of contaminants on BMI	Comparison of contaminant concentrations in surface water to surface water TRVs	Are the levels of contaminants in surface water greater than the surface water TRVs for the survival, growth, or reproduction of benthic invertebrates?	Contaminant concentrations in surface water
			BMI community metrics associated with abundance and diversity	Evaluate the abundance and diversity of the BMI communities in comparison to that of reference locations	Comparison of metrics to reference locations	Is the abundance and diversity of BMI significantly reduced relative to that of BMI from reference locations?	BMI surveys
Aquatic Life (General)	Survival, growth, and reproduction of aquatic life	Aquatic plants, water column and benthic macroinvertebrates, fish, and larval amphibians	Contaminant concentrations in surface water	Evaluate the potential effects of contaminants on aquatic life	Comparison of contaminant concentrations in surface water to TRVs	Are the concentrations of dissolved contaminants in surface water greater than the surface water TRVs (dissolved) for the survival, growth, and reproduction of aquatic life?	Contaminant concentrations in surface water
Fish	Survival, growth, and reproduction of fish	Coho salmon, trout, and other fish species inhabiting Middle and South Fork Middle Creeks	Contaminant concentrations in surface water	Evaluate the potential effects of contaminants on fish	Comparison of contaminant concentrations in surface water to surface water TRVs and salmonid-specific TRVs	Are the concentrations of dissolved contaminants in surface water within the aquatic ecosystems of OU1 greater than the surface water TRVs (dissolved) for the survival, growth, and reproduction of fish and/or greater than the salmonid-specific TRVs for the survival, growth, and reproduction of salmonid species?	Contaminant concentrations in surface water
			Fish presence/absence	Evaluate the presence/absence of the fish communities in comparison to that of reference locations	Comparison of presence/absence to reference locations	Is there a difference in fish presence/absence in surface waters affected by mine impacted water compared to reference areas?	Fish surveys

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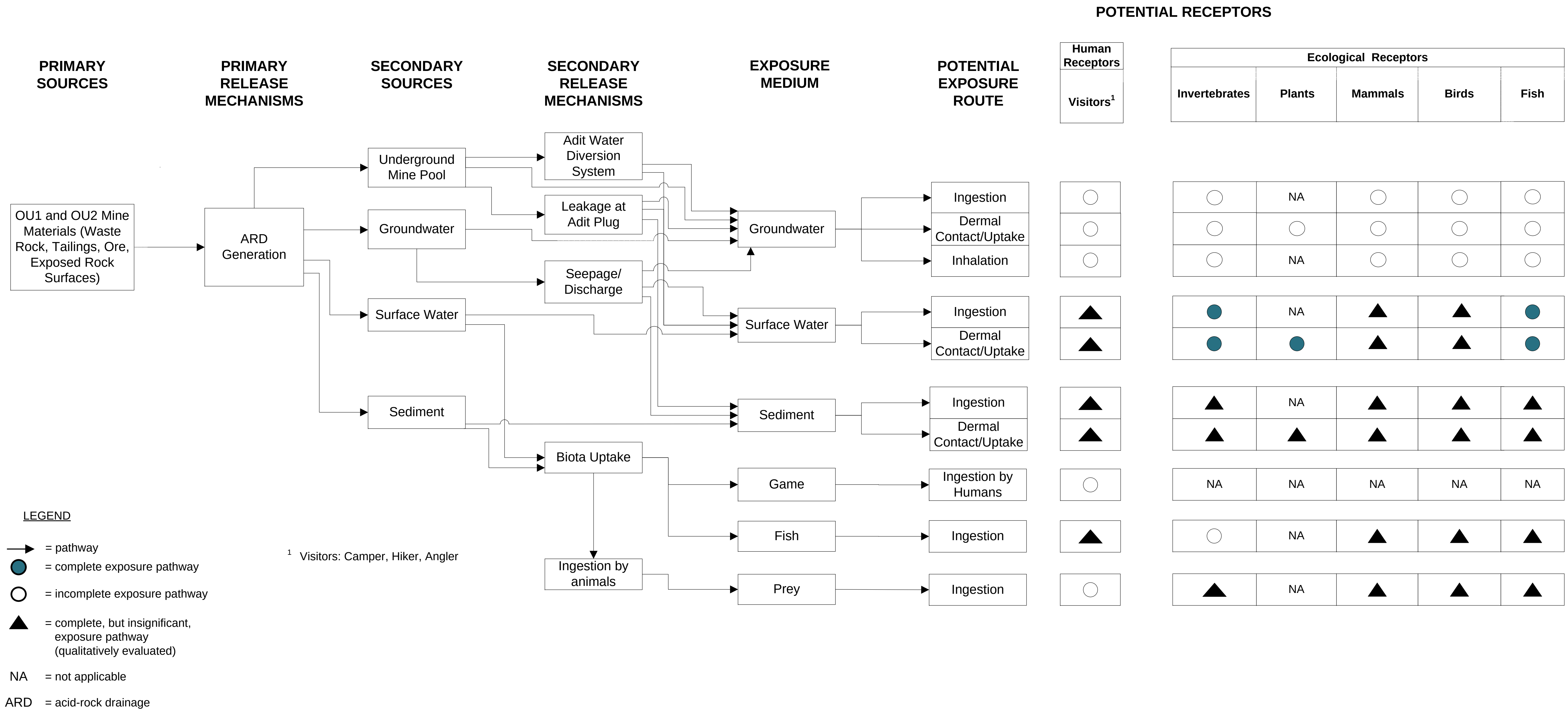

Exposure Medium	Potential Exposure Route	Visitors[1]	Invertebrates	Plants	Mammals	Birds	Fish
Groundwater	Ingestion	○	○	NA	○	○	○
	Dermal Contact/Uptake	○	○	○	○	○	○
	Inhalation	○	○	NA	○	○	○
Surface Water	Ingestion	▲	●	NA	▲	▲	●
	Dermal Contact/Uptake	▲	●	●	▲	▲	●
Sediment	Ingestion	▲	▲	NA	▲	▲	▲
	Dermal Contact/Uptake	▲	▲	▲	▲	▲	▲
Game	Ingestion by Humans	○	NA	NA	NA	NA	NA
Fish	Ingestion	▲	○	NA	▲	▲	▲
Prey	Ingestion	○	▲	NA	▲	▲	▲

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OU2 EXPOSURE MODEL FOR HUMAN AND ECOLOGICAL RECEPTORS

Formosa Mine Superfund Site
Douglas County, Oregon

Dec. 2013 | Figure 2-1

CDM Smith

Section 3

BERA Exposure Assessment

Exposure Assessment evaluates and summarizes available exposure data, including metals concentrations in abiotic media as well as exposure-related information for potential ecological receptors. The primary output of exposure assessment is an exposure profile that presents the magnitude (e.g., concentration) and distribution of potentially hazardous metals to which ecological receptors may be exposed. Exposure profiles serve as input into the final stage of risk assessment, the risk characterization.

3.1 Exposure Media

As described in Section 2 (Problem Formulation), the exposure medium for the OU2 BERA is limited to surface water. Surface water can serve as an exposure medium for aquatic ecological receptors via direct contact or ingestion and can serve as a drinking water source for upper trophic level receptors. For the reasons described in the following sections, dietary and drinking water exposures and associated risks for upper trophic level receptors are not quantified in the OU2 BERA.

3.2 Exposure Areas

Two surface water EAs are defined for the OU2 BERA – Middle Creek and South Fork Middle Creek. These two EAs are most applicable to mobile receptors such as fish. In addition, each individual sampling location from Middle Creek, South Fork Middle Creek, and each reference area will be considered an EA because location-specific EAs are most applicable to non-mobile or minimally mobile receptors such as BMI. As described in Section 2.2.1.1, eight independent ecological sampling locations are identified for Middle Creek, and four are identified for South Fork Middle Creek. The three reference locations include Martin Creek Reference, Middle Creek Reference, and South Fork Reference.

3.3 Data Used in the BERA

A Draft OU2 RI report will address groundwater and surface water data collected from October 2009 through April 2014, and a Final OU2 RI report will incorporate information from the removal action planned for 2015 at the Formosa Adit. Data collected to support the Draft RI for OU2 are used to describe the magnitude and distribution of chemicals in surface waters of concern in the OU2 BERA. Multiple surface water sampling events have taken place from 2009 through 2013; these validated data are included in this evaluation and presented in **Appendix A**. Additional surface water data collected in April 2014 were subject of a comparative evaluation and reported in this Final OU2 BERA, as described in Section 5.6.

Table 1-1 provides a summary of measurements taken by event and location. Field measurements and water samples for chemical analysis have been collected from numerous locations within each EA. The data include different classifications of water types depending on the source water (i.e., adits, seeps, and surface water stream stations). Surface water samples for chemical analyses were collected at select locations, and the number of samples and the sample dates vary at each location. For example, some locations have been sampled multiple times, including during both the wet and dry

seasons (e.g., MXR and SF1.0), while others have been sampled once or twice and only during the dry season (e.g., M3.0, M7.9, MREF, SF3.0, and SFREF).

For the OU2 BERA, only surface water stream locations (i.e., not adits or seeps) were included in the datasets used to evaluate exposure to aquatic receptors. For Middle Creek, sampling locations included in the EA chemical dataset are MXR, M3.0, M7.9, and M13.0. As of September 2013, surface water chemical analyses were not conducted at M1.2, M2.0, M3.1, M5.5, or M9.8; otherwise, these would have been included. For South Fork Middle Creek, sampling locations included in the EA chemical dataset are SF1.0 and SF3.0. As of September 2013, no surface water chemical analyses were conducted at SF0.7 or SF4.7. Each reference area was sampled at one location (i.e., MREF and SFREF). As of September 2013, analytical data had not been collected for the Martin Creek Reference location; therefore, this location is not used in the assessment of metal concentrations in surface water.

Table 3-1 presents a statistical summary of analytical results for each EA. This summary includes the maximum detected dissolved chemical concentration, location of the maximum detection, average detected dissolved chemical concentration, the frequency of detection for each chemical, and the range of reporting limits for each chemical by EA. Analytical results for each surface water sample are provided in **Appendix A**.

3.4 Water Quality Parameters

OU1 RI (CDM 2012) describes the results of surface water sampling of adits, and seeps during four sampling events conducted from October 2009 through January 2011. During these events, surface water samples were collected at multiple locations (see **Table 1-1**) including MXR within Middle Creek and SF1.0 within South Fork Middle Creek. Surface water sampling is part of an ongoing monitoring program, conducted during the wet season in January/February (or April 2014), and during the dry season in September. In addition to the twice-yearly sampling, surface water data were also collected in conjunction with ecological sampling for this BERA. In addition, water quality data have been collected since January 2013, using continuous recording probes, at flumes installed at MXR for Middle Creek and at SFA2 for South Fork Middle Creek.

Water quality parameters have also been collected since 2009 at many locations, as noted by symbols shown in **Table 1-1,** and provide an indicator of ecological conditions in addition to data on COPC concentrations in surface water. Sampling includes collection of data for general water quality parameters, conductivity, dissolved oxygen (DO), pH, and temperature using a water quality meter.

Table 3-2 provides a summary of the water quality data (conductivity, DO, pH, and water temperature) for the Formosa Adit, upstream and seeps near the Formosa Mine, the portions of Middle Creek and South Fork Middle Creek that support aquatic life, and the three reference locations. The MXR and SF0.7 sampling locations are the most upstream locations on Middle Creek and South Fork Middle Creek that are included as supporting aquatic life although these locations are significantly impaired, as evidenced by the data shown in **Table 3-2** and the descriptions provided in Section 2.2.1.1.

As shown in **Table 3-2**, maximum conductivity values in the Formosa adit and the seeps feeding Middle Creek and South Fork Middle Creek were 4185, 1068, and 3432 microsiemens per centimeter (µS/cm), respectively. The maximum conductivity in Middle Creek was 481 µS/cm at MXR. The highest conductivity measured in Middle Creek other than at MXR was 352 µS/cm at M1.2. The maximum conductivity in South Fork Middle Creek was 308 µS/cm at SF0.7. The next highest

conductivity measured (261 µS/cm) was at SF1.0. The highest conductivity measured at any of the three reference sites was 145 µS/cm at the SFREF location.

It is apparent and expected that conductivity generally decreases with distance from the former mine site. In addition, pH and DO show general increases with distance from the mine site. If only the downstream portions of Middle Creek and South Fork Middle Creek that support aquatic life are considered, there is a general decrease in conductivity with distance from the mine, indicating an improvement in water quality.

However, none of the other water quality parameters (DO, pH, or temperature) demonstrate a clear trend with distance from the mine when considering only the portions of the surface waters that support habitat for aquatic life. Excluding MXR, SF0.7 and SF1.0, there is little variation in DO, pH, or temperature among the downstream sampling locations. This indicates that these particular water quality parameters are not reliable indicators of impairment in most portions of Middle Creek and South Fork Middle Creek.

3.5 Screening of Chemicals of Potential Concern

This section of the BERA describes the screening method used to identify final COPCs based on validated data from the final, comprehensive surface water database described in Section 3.3. Data used for this refinement step include surface water data collected from 2009 through 2013.

The primary chemical stressors identified for the aquatic ecosystems of interest in this BERA are dissolved metals in surface water. Additional consideration is given to low pH in surface water because acidity can be directly toxic to aquatic life and can increase the bioavailability of metals in surface water. All potentially hazardous chemicals detected in surface water collected over the dates mentioned above are considered chemicals of interest (COI).

All COI are screened against conservative ESLs to select COPCs and to derive preliminary risk estimates based on the hazard quotient (HQ) approach shown below and discussed in detail in Section 5, Risk Characterization.

$$HQ = EPC/ESL$$

Where EPC = Exposure Point Concentration (Section 3.5.1)
ESL = Ecological Screening Level (Section 3.5.2)

ESLs used to select COPCs include NRWQC Criterion Continuous Concentrations (CCCs) (EPA 2013) and ODEQ Freshwater Water Quality Criteria (2013) adjusted for site-specific hardness where appropriate. These site-specific hardness calculations are provided in **Appendix B**. Any COI for which the EPC exceeds the chemical-specific ESL is identified as a final COPC for the OU2 BERA. COPCs warrant further investigation, and quantitative risk estimates are derived for all surface water COPCs.

3.5.1 Surface Water Exposure Point Concentrations

EPCs are chemical concentrations representing the concentrations to which receptors may be exposed. EPCs serve as input into chemical screening and risk calculation and are derived for surface water COPCs. Selected EPCs for surface water can reflect various levels of potential exposure such as the average, reasonable upper range, or maximum exposure. EPCs can therefore include a single value (e.g., mean) or a range of values (e.g., mean to maximum). Most often, and where data quantity allow,

the single EPC used to represent central tendency exposures is the 95% UCL. ODEQ recommends use of the 90% UCL for assessing risks.

EPCs for the OU2 BERA are derived for dissolved metals because dissolved metals best represent the toxic forms to which aquatic biota are often exposed, and most surface water ESLs are based on dissolved metal concentrations. These ESLs are therefore most appropriately compared to EPCs based on dissolved metals concentrations to calculate quantitative risk estimates as described in Section 5, Risk Characterization.

Although no single concentration value can truly represent the variability of chemical concentrations measured in a medium, EPA guidance (EPA 1997) for conducting ERAs recommends using the maximum detected value of each chemical to assess risk initially. Therefore, for the OU2 BERA, the maximum detected dissolved concentration for each detected chemical in surface water for each EA was selected as the EPC and compared to conservative ESLs to select COPCs from the preliminary list of COI for that EA. Surface water EPCs for COPC selection are presented in **Table 3-1.**

For risk characterization, surface water EPCs for the two primary EAs – Middle Creek and South Fork Middle Creek – were presented for each sampling location. Due to a lack of sufficient number of samples available for each location, 90% UCLs were not calculated. Instead, EPCs used to estimate exposure were the arithmetic mean concentration and the maximum detected concentration for each COPC at each station. Surface water EPCs for individual stations in Middle Creek are presented in **Table 5-1** and for individual stations in South Fork Middle Creek in **Table 5-2** in Section 5, Risk Characterization.

3.5.2 Ecological Screening Levels

Several types of surface water data are available for use as surface water ESLs. Most often and where available chronic water quality criteria from EPA are selected as preferred ESLs for identifying COPCs for surface water. These chronic criteria are described as CCC and are a component of NRWQC (EPA 2013). These chronic ESLs are used to evaluate long-term exposures and are linked to both lethal and sublethal effects. As such, they can be used to identify contaminants in surface water warranting further evaluation (i.e., COPCs).

States often adopt these national criteria. Oregon adopts some national criteria as state criteria without change. For other chemicals in surface water, Oregon modifies national criteria and derives state criteria that differ (often only slightly) from national criteria. The two types of surface water ESLs selected for identifying surface water COPCs and for preliminarily calculating risk estimates for aquatic biota are listed below and described in more detail in Section 4, Effects Assessment.

1. NRWQC – CCC (EPA 2013)
2. ODEQ Freshwater Water Quality Criteria (2013)

3.5.3 Chemical Screening and Selection of Final COPCs

COPCs are defined as any COI for which the maximum detected concentration exceeds one or both of the selected ESLs identified above. Following EPA guidance, if the maximum detected concentration of a chemical exceeds its respective ESL, then a potential for adverse ecological effects may exist. Frequency of detection and a comparison to background concentrations were not criteria employed for the selection of COPCs in the OU2 BERA but may be considered when interpreting the results of risk characterization.

The comparison of maximum detected dissolved concentrations of COIs screened against the two aforementioned ESLs is presented in **Table 3-1**. Maximum detected concentrations of four metals in surface water exceeded one or both of the selected ESLs. As shown in **Table 3-1,** cadmium, copper, mercury, and zinc were selected as COPCs for both Middle Creek and South Fork Middle Creek based on this comparison. COPCs are summarized on **Table 3-3**.

In summary, surface water COPCs retained for further evaluation in the OU2 BERA are:

- Cadmium
- Copper
- Mercury
- Zinc

3.6 Contaminant Fate and Transport

This section of the BERA presents important chemical properties for the metals identified as COPCs for surface water at this site. These properties are discussed below.

3.6.1 Environmental Persistence

Environmental persistence indicates whether a chemical is likely to be long-lasting in the environment or, alternatively, be degraded by natural processes. Of concern to the OU2 BERA is the persistence of metals in the environment. Metals are not significantly degraded by any biological or abiotic process, so reductions in concentrations over time due to natural attenuation are not expected.

3.6.2 Bioconcentration Potential

Bioconcentration potential indicates whether a chemical is likely to be retained in biological tissues after it is taken in by ingestion or other means. Retention of chemicals is not in itself an appropriate measurement endpoint unless it is associated with adverse ecological effects. Retention is, however, useful for verifying exposure and for evaluating bioavailability and the potential for food web effects.

Inorganic COPCs include those that are essential for life and, therefore, are physiologically regulated (e.g., copper and zinc). Retention of metals in biological tissues can therefore be a necessary function for essential elements but for other non-essential metals, can cause adverse effects. Exposed organisms differ in their ability to detoxify and/or eliminate metals following initial uptake. Whether or not a metal is accumulated and retained in biological tissues depends on the metal, the receptor, and the chemical form in which the metal occurs.

Potentially bioaccumulative COPCs have been initially identified in the Problem Formulation phase of the OU2BERA, including those considered essential elements. These include cadmium, chromium, copper, lead, mercury, nickel, and zinc. However, none of the potentially bioaccumulative chemicals detected in site surface waters other than those identified as essential elements (i.e., copper and zinc) are detected at concentrations substantially exceeding those measured in local background surface water samples. Bioaccumulation-related (i.e., dietary) risks to upper trophic level receptors is only qualitatively evaluated in the OU2 BERA, and food web modeling, generally performed to quantify risks to upper trophic level receptors, is not performed for the OU2 BERA.

3.6.2.1 Evaluation of Mercury as a COPC

Water originating in the immediate vicinity of the Formosa Mine forms the headwaters of Middle Creek and South Fork Middle Creek and flows through downstream habitat that supports aquatic life. Thus, the presence of mercury in surface water must be considered with respect to risks from exposures via ingestion of prey items if mercury is to be identified as a mine-related COPC.

Although the maximum detected concentrations of mercury in surface water in Middle Creek (0.044J micrograms per liter [µg/L] at MXR) and South Fork Middle Creek (0.036J µg/L at SF1.0) did not exceed the chronic EPA NRWQC of 0.77 µg/L (EPA 2013), these concentrations did exceed the ODEQ ESL of 0.012 µg/L (ODEQ 2013). Therefore, mercury was selected as a COPC for further evaluation. Further evaluation of mercury concentrations in creek surface water relative to historical mining operations and the water quality in the vicinity of the site is important in determining if mercury is a mine-related COPC and if food web modeling is warranted for evaluation of upper trophic level receptors such as piscivorous birds and mammals. This evaluation of mercury includes the following:

1. A review of historical mining operations
2. Low level analysis of mercury in select water samples
3. Comparison of mercury concentrations in Middle Creek and South Fork Middle Creek relative to background locations and locations representing discharge of water from the mine that would have the highest metals concentrations based on proximity to the mine
4. Frequency of detection
5. Limited available biota tissue data

Historical Mining Processes

A review of historical mining operations described in the OU1 RI (CDM 2012) indicated that mercury was not used as part of the past mining processes and, thus, would not be expected to be a mine-related COPC.

Low Level Mercury Analysis

Low level mercury analysis by EPA Method 1631E was conducted on water samples collected at select adit, seep, and stream locations. Samples were collected in May, August, and October of 2013. Sample locations included MXR, Formosa Adit, SFA2, and Seep A. The sample at Seep A was collected once in May 2013 at the location downslope of the Formosa Adit in the MA drainage of upper Middle Creek. Analytical results for the low level mercury analyses are summarized in **Table 3-4**. The maximum reported total mercury concentration was 0.0036 µg/L in May 2013 at the Formosa Adit. The maximum reported dissolved mercury concentration was in October 2013 at 0.00135 µg/L at the Formosa Adit. These maximum concentrations of mercury using low level analyses were below the ODEQ ESL of 0.012 µg/L in all 10 samples (analyzed for trace mercury), supporting the conclusion that mercury is not a mine-related COPC.

In addition, based on a United States Geological Survey (USGS 2009) study of mercury concentrations in U.S. streams, the mean total mercury concentration in un-mined basins is 0.003 µg/L and is 0.0235 µg/L in mined basins. The low level of mercury concentrations reported in this study appears to correspond to the values determined for un-mined basins, suggesting that mercury is not a mine-related COPC.

Water Quality Comparison and Frequency of Detection

Numerous surface water samples were analyzed for mercury using cold vapor atomic absorption spectrometry (CV-AAS) by EPA method 7471A. Analytical results for mercury are summarized in **Table 3-4**. The standard reporting limit for this method was 0.2 µg/L. Since this reporting limit was higher than the maximum detected concentration in either Middle Creek or South Fork Middle Creek, this value was used conservatively to evaluate whether mercury is a mine-related COPC. The evaluation compared the reporting limit associated with creek water quality samples to mercury concentrations in background locations and seeps, adits, and locations nearest to the mine, which would be expected to have the highest concentrations of mercury if mercury were mine related.

During the OU1 RI, surface water samples were collected from Russell Creek near the upper reaches of the system nearest to the Formosa Mine. The Russell Creek drainage extends from the top of Silver Butte to the north and does not contain any known mine waste dumps, adits, or other mine-related materials and, therefore, represents background conditions. Mercury was not detected in surface water samples from Russell Creek above the detection limit of 0.2 µg/L, suggesting that background levels of mercury in the vicinity of the site are similar to levels in Middle Creek and South Fork Middle Creek, which are at levels below 0.2 µg/L.

Mercury was not detected above this reporting limit in samples collected from reference locations during recent sampling but was detected infrequently and at estimated concentrations below the reporting limit at two sample locations in Middle Creek and a single location in South Fork Middle Creek, as described below.

It would be expected that the highest concentrations of mercury would be identified in samples collected from adits seeps and at stream locations such as MXR. This expectation is based upon these locations being at the headwaters of the creek nearest the mine and are most influenced by the mining operations due to proximity and hydraulic connection with MIW discharged from the mine.

Of the 21 surface water samples collected from Middle Creek, mercury was detected only once at MXR in surface water stream samples and twice in the 16 seep samples collected (MA17 and MA46, **Table 3-4**). Mercury was detected at MXR at a dissolved concentration of 0.044 µg/L (qualified as estimated) in only one of the eight samples collected from that location.

The corresponding total mercury water sample was non-detect. Additionally, mercury was detected in one of the three samples collected at seep location MA46 at a concentration of 0.058 µg/L (qualified as estimated). The corresponding total mercury water sample was non-detect. Thus, the only detections of mercury occurred at locations nearest to the mine; however, these concentrations were estimated below the reporting limit of 0.2 µg/L and, therefore, are within the range of background as evidenced by the lack of detections in samples collected from Russell Creek. Further, mercury was not detected in 20 of the 22 samples collected from Middle Creek, suggesting that mercury is not directly related to the mine. If the mine were the source of mercury in surface water, it would be expected that mercury consistently would be detected at seep and adit locations and would be detected in the creek more frequently downstream of the source.

Similarly, of the 16 surface water samples and 10 seep samples collected in South Fork Middle Creek between 2009 and 2013, mercury was only detected at seep location SFA2 (renamed SFA2F once the flume was installed). Dissolved mercury concentration at this location was 0.16 µg/L in February 2013 (qualified as estimated) and 0.098 µg/L in June 2013 (also qualified as estimated) **(Table 3-4).** Mercury was only detected in one of the eight samples collected from stream location SF1.0 (0.036

µg/L [qualified as estimated] in June 2013). Similar to the evaluation of mercury results described above for Middle Creek, mercury was detected infrequently at two seep locations and on a single occasion in one location within the creek. The detected concentrations were within the range of background and were not identified further downstream. If the mine were a source of mercury in South Fork Middle Creek, it would be expected that detections would occur more frequently and consistently among locations near the mine. The data suggest that the concentrations identified in the creek and the adits are similar to those associated with samples collected from Russell Creek.

Limited Biota Tissue Data

Limited fish tissue sampling was conducted by ODEQ (ODEQ 2004). Fish were collected from three locations, two in Cow Creek and one in Middle Creek. The fish collected in Middle Creek contained no mercury at a detection limit of 0.025 milligrams per kilogram (mg/kg) wet. The EPA criterion for human health is 0.3 mg/kg wet weight and the level for concern for piscivorous mammals is 0.1 mg/kg. Therefore, a detection limit of 0.025 mg/kg is sufficient for evaluating risk to human health and ecological effects. Although only one sample was collected from Middle Creek, the finding suggests that mercury loading is not occurring in Middle Creek.

Summary

Based on the evaluation of multiple lines of evidence conducted above, mercury is not considered a mine-related COPC. Therefore, food web modeling associated with exposure to mercury is not conducted as part of the OU2BERA to evaluate risks to upper trophic level receptors associated with Middle Creek or South Fork Middle Creek. Since it is not considered a mine-related COPC, mercury is not included in the risk characterization in Section 5.

3.6.3 Bioavailability

Bioavailable chemicals are defined as those that exist in a form that has the ability to be assimilated and cause adverse ecological effects or bioaccumulate. For some contaminants, chemical form and, thus, toxicity can change rather rapidly under changing environmental conditions. For example, fluctuations in pH or other conditions related to seasonal conditions, such as snowmelt, can affect surface water quality and metals bioavailability. In addition, low pH soils can increase the bioavailability of some metals such as aluminum. Factors affecting contaminant bioavailability and toxicity in surface water can include the following:

- Hardness (primarily calcium and magnesium concentrations)
- Alkalinity
- Salinity
- Temperature
- Dissolved oxygen
- Total dissolved solids
- Suspended particulates

- Organic carbon
- pH (important as an independent stressor and as a source of increased bioavailability of some metals)

Of these, hardness (measured as calcium carbonate or $CaCO_3$) is most important for affecting the toxicity of certain metals (cadmium, trivalent chromium, copper, lead, nickel, silver, and zinc). Current information suggests that hardness may not in fact affect the toxicity of silver, but that issue has not been fully resolved. Higher hardness levels in surface water decrease bioavailability and toxicity of these metals. The average hardness of surface water from each of the major creeks of interest (Middle Creek and South Fork Middle Creek) is used to adjust the hardness-dependent ESLs described above and TRVs described in Section 4.

Organic carbon content and the presence of particulates in surface water can affect the bioavailability and toxicity of contaminants. Increases in organic carbon and particulates in surface water reduce the bioavailability of some chemicals, but particulates have potential to affect adversely filter feeding aquatic receptors.

3.7 Exposure of Ecological Receptors

Ecological receptors residing in or using aquatic habitats differ in their potential to be exposed to mine-related contaminants. Analytical data and site observations are used to describe the receptors or types of receptors with reasonable potential to be exposed to mine-related contaminants.

As described in preceding sections, soil and sediment within the OU2 BERA study area do not appear to be significantly affected by mine-related contaminants. Fine-grained sediments indicative of depositional areas are absent or uncommonly found in most reaches of Middle Creek and South Fork Middle Creek based on qualitative observations of the substrate during BMI sampling. Terrestrial receptors within the OU2 BERA study area are unlikely to be significantly exposed to mine-related contaminants given the large amount of suitable terrestrial habitat un-impacted by the mine that is available for denning, roosting, foraging, and shelter for birds, mammals, and other terrestrial receptors. Further, aquatic receptors within the OU2 BERA surface waters are unlikely to be substantially exposed to fine-grained sediments. Surface water is the primary abiotic media to which aquatic receptors may be exposed.

Aquatic receptors with known or likely reasonable potential for exposure to mine-related contaminants in surface waters include aquatic plants (primarily Periphyton or attached algae, including diatoms), BMI, fish, and larval amphibians. All of these receptor groups have been observed in the OU2 BERA study area surface waters and are considered representative of aquatic receptors with the greatest potential for exposure to mine-related contaminants. These receptors or receptor groups are exposed to mine-related contaminants primarily via direct contact with and uptake or ingestion of dissolved metals in surface water. These receptor groups are identified as those warranting full evaluation in the OU2 BERA, including quantitative risk estimation as presented in Section 5, Risk Characterization.

In contrast, upper trophic level receptors, such as adult amphibians (terrestrial life stages), reptiles, birds, and mammals, are considered to have low or minimal potential for significant exposure to mine-related contaminants. Such receptors would be at most risk due to exposure via the dietary and water ingestion routes of exposure, but such exposures are considered insignificant because bioaccumulative contaminants are not among the primary COPCs identified for surface waters. Risks

to upper trophic level receptors are therefore not quantified in the OU2 BERA but instead are addressed qualitatively in Section 5, Risk Characterization.

3.8 Uncertainty Analysis

Sources of uncertainty in the exposure assessment include the values used to represent the magnitude and distribution of ecological COPCs in surface water. Surface water cannot be sampled at all locations and under all possible conditions, so some degree of uncertainty is inherent in COPC concentration data underlying the derivation of EPCs. The large number of surface water samples taken from within the study area over several seasons, including reference locations, reduces uncertainties in COPC concentrations to an acceptable level.

Sampling and analyses of surface water for certain COPCs were limited in a few cases, and in others, a COPC was only infrequently detected. In such cases, it was determined to be inappropriate to calculate 95% or 90% UCLs for some sampling stations (i.e., where sufficient data allow) and arithmetic means for other locations (i.e., where data are more limited in quantity). Reliance on arithmetic means and maximum detected concentrations for individual sampling locations allows for station-to-station and creek-to-creek comparisons using the same statistic and provides a range of exposure estimates. This approach is expected to result in appropriate and representative EPCs for assessing risks to exposed aquatic biota. Uncertainties associated with the selection of ESLs for identifying and refining the list of surface water COPCs are discussed in Section 4, Effects Assessment.

Table 3-1 Statistical Summary for Surface Water Analytical Dissolved Results and Selection of Chemicals of Concern

		Statistical Summary									COPC Screening Based on ODEQ CCC							COPC Screening Based on National CCC						
												Maximum Detected Conc.			Average Detected Conc.				Maximum Detected Conc.			Average Detected Conc.		
Exposure Area	Chemical	Number of Detects / Samples	FOD	Minimum Detected Conc.	Average Detected Conc.	Maximum Detected Conc. (EPC)	Minimum Reporting Limit	Maximum Reporting Limit	Units	Location of Maximum Detection	ODEQ CCC Screening Level	HQ (Max Detect)	COPC (Based on Max Detect)?	Rationale	HQ (Avg Detected Conc)	COPC (Based on Avg Detect)?	Rationale	National CCC Screening Level	HQ (Max Detect)	COPC (Based on Max Detect)?	Rationale	HQ (Average Detected Conc.)	COPC (Based on Avg. Detect)?	Rationale
MIDDLE CREEK (1)	ALUMINUM	4 / 15	27%	6.1 J	18.03	33.7 J	6.3	200	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	ANTIMONY	0 / 14	0%	ND	ND	ND	0.12	60	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ARSENIC	1 / 15	7%	0.59 J	0.59	0.59 J	0.095	10	µg/L	MXR	190.0	0.003	No	BSL	0.003	No	BSL	150	0.0	No	BSL	0.0	No	BSL
	BARIUM	8 / 15	53%	18.7	44.54	130 J	200	200	µg/L	M13.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	BERYLLIUM	0 / 15	0%	ND	ND	ND	1	5	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	BORON	0 / 8	0%	ND	ND	ND	19.7	100	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	CADMIUM	11 / 15	73%	0.24 J	3.16	14.2	0.5	0.5	µg/L	MXR	0.3	56.6	Yes	ASL	12.6	Yes	ASL	0.3	56.6	Yes	ASL	12.6	Yes	ASL
	CALCIUM	15 / 15	100%	8020	25988	48100	5000	5000	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	CHLORIDE	15 / 15	100%	2.14	7.33	39.1	0.06	7.5	mg/L	M13.0	230	0.2	No	BSL	0.03	No	BSL	230	0.2	No	BSL	0.03	No	BSL
	CHROMIUM	3 / 15	20%	0.23 J	0.52	0.91 J	0.26	10	µg/L	MXR	75.9	0.01	No	BSL	0.01	No	BSL	75.9	0.01	No	BSL	0.01	No	BSL
	COBALT	4 / 15	27%	0.2 J	0.86	1.6	0.07	50	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	COPPER	14 / 15	93%	3.3	62.81	530	2	30	µg/L	MXR	12.0	44.2	Yes	ASL	5.2	Yes	ASL	9.2	57.7	Yes	ASL	6.8	Yes	ASL
	FLUORIDE	15 / 15	100%	0.0491	0.07	0.152	0.04	0.08	mg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	IRON	3 / 15	20%	3.1 J	18.78	25.7 J	31.5	100	µg/L	M13.0	1000	0.03	No	BSL	0.019	No	BSL	1000	0.03	No	BSL	0.02	No	BSL
	LEAD	2 / 15	13%	0.38 J	0.62	0.85 J	0.05	1	µg/L	MXR	2.6	0.3	No	BSL	0.2	No	BSL	2.6	0.3	No	BSL	0.2	No	BSL
	LITHIUM	0 / 8	0%	ND	ND	ND	100	100	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	MAGNESIUM	15 / 15	100%	2880 J	9244	17500	5000	5000	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MANGANESE	13 / 15	87%	1	20.10	175 J	15	15	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MERCURY	1 / 15	7%	0.044 J	0.04	0.044 J	0.2	0.2	µg/L	MXR	0.012	3.7	Yes	ASL	3.7	Yes	ASL	0.77	0.1	No	BSL	0.1	No	BSL
	MOLYBDENUM	0 / 8	0%	ND	ND	ND	0.46	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	NICKEL	11 / 15	73%	0.42 J	2.66	10.8	0.74	1	µg/L	MXR	53.3	0.2	No	BSL	0.05	No	BSL	53.3	0.2	No	BSL	0.05	No	BSL
	POTASSIUM	7 / 15	47%	320 J	423.55	640 J	5000	5000	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SELENIUM	0 / 15	0%	NS	ND	ND	5	5	µg/L	--	35.0	ND	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	ND	ND
	SILVER	0 / 14	0%	ND	ND	ND	0.024	0.1	µg/L	--	0.1	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SODIUM	15 / 15	100%	1270 J	7268	18000	5000	5000	µg/L	M13.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SULFATE	15 / 15	100%	8.74	66.85	210	0.3	38	mg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	THALLIUM	0 / 15	0%	ND	ND	ND	1	25	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	THORIUM	0 / 8	0%	ND	ND	ND	1	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	URANIUM	0 / 8	0%	ND	ND	ND	1	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	VANADIUM	1 / 14	7%	6.6 J	6.60	6.6 J	2	50	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	ZINC	15 / 15	100%	10.7	504.03	3260	2	60	µg/L	MXR	121.1	26.9	Yes	ASL	4.2	Yes	ASL	121.1	26.9	Yes	ASL	4.2	Yes	ASL
MIDDLE CREEK REFERENCE (2)	ALUMINUM	0 / 1	0%	ND	ND	ND	200	200	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ANTIMONY	0 / 1	0%	ND	ND	ND	60	60	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ARSENIC	0 / 1	0%	ND	ND	ND	10	10	µg/L	--	190	ND	ND	ND	ND	ND	ND	150	ND	ND	ND	ND	ND	ND
	BARIUM	0 / 1	0%	ND	ND	ND	200	200	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	BERYLLIUM	0 / 1	0%	ND	ND	ND	5	5	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	CADMIUM	0 / 1	0%	ND	ND	ND	0.5	0.5	µg/L	--	0.3	ND	ND	ND	ND	ND	ND	0.3	ND	ND	ND	ND	ND	ND
	CALCIUM	1 / 1	100%	12300	12300	12300	5000	5000	µg/L	MREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	CHLORIDE	1 / 1	100%	1.59	1.59	1.59	0.6	0.6	mg/L	MREF	230	0.01	No	BSL	0.01	No	BSL	230	0.01	No	BSL	0.01	No	BSL
	CHROMIUM	0 / 1	0%	ND	ND	ND	10	10	µg/L	--	75.9	ND	ND	ND	ND	ND	ND	75.9	ND	ND	ND	ND	ND	ND
	COBALT	0 / 1	0%	ND	ND	ND	50	50	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	COPPER	1 / 1	100%	0.53 J	0.53	0.53 J	2	2	µg/L	MREF	12	0.04	No	BSL	0.04	No	BSL	9.2	0.1	No	BSL	0.1	No	BSL
	FLUORIDE	1 / 1	100%	0.0467	0.05	0.0467	0.04	0.04	mg/L	MREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	IRON	0 / 1	0%	ND	ND	ND	100	100	µg/L	--	1000.0	ND	ND	ND	ND	ND	ND	1000	ND	ND	ND	ND	ND	ND
	LEAD	0 / 1	0%	ND	ND	ND	1	1	µg/L	--	2.6	ND	ND	ND	ND	ND	ND	2.6	ND	ND	ND	ND	ND	ND
	MAGNESIUM	1 / 1	100%	4930 J	4930	4930 J	5000	5000	µg/L	MREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MANGANESE	0 / 1	0%	ND	ND	ND	15	15	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	MERCURY	0 / 1	0%	ND	ND	ND	0.2	0.2	µg/L	--	0.0	ND	ND	ND	ND	ND	ND	0.8	ND	ND	ND	ND	ND	ND
	NICKEL	0 / 1	0%	ND	ND	ND	1	1	µg/L	--	53.3	ND	ND	ND	ND	ND	ND	53.3	ND	ND	ND	ND	ND	ND
	POTASSIUM	0 / 1	0%	ND	ND	ND	5000	5000	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SELENIUM	0 / 1	0%	ND	ND	ND	5	5	µg/L	--	35.0	ND	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	ND	ND
	SILVER	0 / 1	0%	ND	ND	ND	0.1	0.1	µg/L	--	0.1	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SODIUM	0 / 1	0%	ND	ND	ND	5000	5000	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SULFATE	1 / 1	100%	3.18	3.18	3.18	0.3	0.3	mg/L	MREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	THALLIUM	0 / 1	0%	ND	ND	ND	25	25	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	VANADIUM	0 / 1	0%	ND	ND	ND	50	50	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ZINC	1 / 1	100%	3.1	3.10	3.1	2	2	µg/L	MREF	121.1	0.026	No	BSL	0.026	No	BSL	121.1	0.026	No	BSL	0.026	No	BSL
SOUTH FORK MIDDLE CREEEK (3)	ALUMINUM	3 / 10	30%	12.3 J	14.37	18.3 J	16	200	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	ANTIMONY	0 / 10	0%	ND	ND	ND	2	60	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ARSENIC	1 / 10	10%	0.73 J	0.73	0.73 J	0.11	10	µg/L	SF1.0	190	0.004	No	BSL	0.004	No	BSL	150	0.005	No	BSL	0.005	No	BSL
	BARIUM	4 / 10	40%	5.6 J	6.55	7.4 J	10	200	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	BERYLLIUM	0 / 10	0%	ND	ND	ND	1	5	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	BORON	1 / 5	20%	2.5 J	2.50	2.5 J	100	100	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	CADMIUM	8 / 10	80%	1	3.61	7.6	0.5	0.5	µg/L	SF1.0	0.2	37.9	Yes	ASL	18.0	Yes	ASL	0.2	37.9	Yes	ASL	18.0	Yes	ASL
	CALCIUM	10 / 10	100%	16900	20270	27700	5000	5000	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL

Table 3-1 Statistical Summary for Surface Water Analytical Dissolved Results and Selection of Chemicals of Concern

		Statistical Summary									COPC Screening Based on ODEQ CCC							COPC Screening Based on National CCC						
												Maximum Detected Conc.			Average Detected Conc.				Maximum Detected Conc.			Average Detected Conc.		
Exposure Area	Chemical	Number of Detects / Samples	FOD	Minimum Detected Conc.	Average Detected Conc.	Maximum Detected Conc. (EPC)	Minimum Reporting Limit	Maximum Reporting Limit	Units	Location of Maximum Detection	ODEQ CCC Screening Level	HQ (Max Detect)	COPC (Based on Max Detect)?	Rationale	HQ (Avg Detected Conc)	COPC (Based on Avg Detect)?	Rationale	National CCC Screening Level	HQ (Max Detect)	COPC (Based on Max Detect)?	Rationale	HQ (Average Detected Conc.)	COPC (Based on Avg. Detect)?	Rationale
SOUTH FORK	CHLORIDE	10 / 10	100%	1.31	1.57	1.97	0.06	0.6	mg/L	SF1.0	230	0.01	No	BSL	0.01	No	BSL	230	0.009	No	BSL	0.01	No	BSL
MIDDLE CREEEK	CHROMIUM	0 / 10	0%	ND	ND	ND	0.17	10	µg/L	--	58.2	ND	ND	ND	ND	ND	ND	58.2	ND	ND	ND	ND	ND	ND
(cont.)	COBALT	4 / 10	40%	0.12 J	0.81	1.7	1	50	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	COPPER	10 / 10	100%	3.4	57.85	285	2	200	µg/L	SF1.0	12.0	23.8	Yes	ASL	4.8	Yes	ASL	6.96	40.9	Yes	ASL	8.3	Yes	ASL
	FLUORIDE	10 / 10	100%	0.0528	0.07	0.0988	0.04	0.4	mg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	IRON	2 / 10	20%	36.8 J	78.40	120	28.7	100	µg/L	SF1.0	1000	0.1	No	BSL	0.1	No	BSL	1000.0	0.1	No	BSL	0.1	No	BSL
	LEAD	1 / 10	10%	0.07 J	0.07	0.07 J	1	1	µg/L	SF1.0	1.8	0.04	No	BSL	0.04	No	BSL	1.8	0.04	No	BSL	0.04	No	BSL
	LITHIUM	0 / 5	0%	ND	ND	ND	3.5	100	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	MAGNESIUM	10 / 10	100%	4270 J	5533.75	8760	5000	5000	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MANGANESE	9 / 10	90%	5.6 J	51.39	281 J	1	100	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MERCURY	1 / 10	10%	0.036 J	0.04	0.036 J	0.2	0.2	µg/L	SF1.0	0.012	3.0	Yes	ASL	3.0	Yes	ASL	0.77	0.05	No	BSL	0.05	No	BSL
	MOLYBDENUM	1 / 5	20%	0.34 J	0.34	0.34 J	1	1	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	NICKEL	9 / 10	90%	0.6 J	2.33	8.1	1	1	µg/L	SF1.0	40.5	0.2	No	BSL	0.1	No	BSL	40.5	0.2	No	BSL	0.1	No	BSL
	POTASSIUM	2 / 10	20%	110 J	204.50	299 J	309	5000	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SELENIUM	1 / 10	10%	0.63 J	0.63	0.63 J	5	5	µg/L	SF1.0	35	0.02	No	BSL	0.02	No	BSL	5.0	0.1	No	BSL	0.1	No	BSL
	SILVER	1 / 10	10%	0.0067 J	0.007	0.0067 J	0.1	0.1	µg/L	SF1.0	0.1	0.1	No	BSL	0.1	No	BSL	NV	NV	NV	No ESL	NV	NV	No ESL
	SODIUM	6 / 10	60%	3730 J	4872	5760	5000	5000	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SULFATE	10 / 10	100%	26.4	42.84	75.3	0.3	380	mg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	THALLIUM	0 / 10	0%	ND	ND	ND	0.042	25	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	THORIUM	0 / 5	0%	ND	ND	ND	1	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	URANIUM	0 / 5	0%	ND	ND	ND	1	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	VANADIUM	1 / 10	10%	8.5	8.50	8.5	2.5	50	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	ZINC	10 / 10	100%	58.8	579.53	2120	2	240	µg/L	SF1.0	92	23	Yes	ASL	6.3	Yes	ASL	92.0	23.0	Yes	ASL	6.3	Yes	ASL
SOUTH FORK MIDDLE																								
CREEEK	ALUMINUM	0 / 2	0%	ND	ND	ND	200	200	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
REFERENCE (4)	ANTIMONY	0 / 2	0%	ND	ND	ND	60	60	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ARSENIC	0 / 2	0%	ND	ND	ND	10	10	µg/L	--	190	ND	ND	ND	ND	ND	ND	150	ND	ND	ND	ND	ND	ND
	BARIUM	0 / 2	0%	ND	ND	ND	200	200	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	BERYLLIUM	0 / 2	0%	ND	ND	ND	5	5	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	CADMIUM	0 / 2	0%	ND	ND	ND	0.5	0.5	µg/L	--	0.2	ND	ND	ND	ND	ND	ND	0.2	ND	ND	ND	ND	ND	ND
	CALCIUM	2 / 2	100%	14200	16250	18300	5000	5000	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	CHLORIDE	2 / 2	100%	1.4	1.48	1.55	0.6	0.6	mg/L	SFREF	230	0.01	No	BSL	0.01	No	BSL	230	0.01	No	BSL	0.01	No	BSL
	CHROMIUM	0 / 2	0%	ND	ND	ND	10	10	µg/L	--	58.2	ND	ND	ND	ND	ND	ND	58.2	ND	ND	ND	ND	ND	ND
	COBALT	0 / 2	0%	ND	ND	ND	50	50	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	COPPER	1 / 2	50%	0.83 J	0.83	0.83 J	2	2	µg/L	--	12	0.1	No	BSL	0.1	No	BSL	7.0	0.1	No	BSL	0.1	No	BSL
	FLUORIDE	2 / 2	100%	0.0455	0.05	0.0605	0.04	0.04	mg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	IRON	2 / 2	100%	68 J	179.50	291	100	100	µg/L	SFREF	1000	0.3	No	BSL	0.2	No	BSL	1000	0.3	No	BSL	0.2	No	BSL
	LEAD	0 / 2	0%	ND	ND	ND	1	1	µg/L	--	1.8	ND	ND	ND	ND	ND	ND	1.8	ND	ND	ND	ND	ND	ND
	MAGNESIUM	2 / 2	100%	2780 J	2815	2850 J	5000	5000	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MANGANESE	2 / 2	100%	23 J	24	24.8	1	1	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MERCURY	0 / 2	0%	ND	ND	ND	0.2	0.2	µg/L	--	0.012	ND	ND	ND	ND	ND	ND	0.8	ND	ND	ND	ND	ND	ND
	NICKEL	0 / 2	0%	ND	ND	ND	1	1	µg/L	--	40.5	ND	ND	ND	ND	ND	ND	40.5	ND	ND	ND	ND	ND	ND
	POTASSIUM	0 / 2	0%	ND	ND	ND	5000	5000	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SELENIUM	0 / 2	0%	ND	ND	ND	5	5	µg/L	--	35.0	ND	ND	ND	ND	ND	ND	5.0	ND	ND	ND	ND	ND	ND
	SILVER	0 / 2	0%	ND	ND	ND	0.1	0.1	µg/L	--	0.1	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SODIUM	1 / 2	50%	4780 J	4780	4780 J	5000	5000	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SULFATE	2 / 2	100%	22.6	29.0	35.4	3	3	mg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	THALLIUM	0 / 2	0%	ND	ND	ND	25	25	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	VANADIUM	0 / 2	0%	ND	ND	ND	50	50	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ZINC	2 / 2	100%	1.9 J	3.4	4.8	2	2	µg/L	SFREF	92.0	0.05	No	BSL	0.04	No	BSL	92.0	0.05	No	BSL	0.04	No	BSL

Notes:
CCC = Criterion Continuous Concentration
COPC = Chemical of Concern
ESL = Ecological Screening Level
FOD = Frequency of Detection
J = value qualified by laboratory or data validator as estimated
ND = Not Detected
NV = No Value
ODEQ = Oregon Department of Environmental Quality
-- Not applicable
µg/L = micrograms per liter
mg/L = milligrams per liter
Notes:
(1) Locations included in the Middle Creek dataset are: MXR, M3.0, M7.9, M13.0.
(2) Locations included in the Middle Creek Reference dataset are: MREF
(3) Locations included in the South Fork Middle Creek dataset are: SF1.0, SF3.0
(4) Locations included in the South Fork Middle Creek Reference dataset are: SFREF

Table 3-2 Summary of Water Quality Parameters based on Field Sampling

	Range	Location of Maximum/Minimum[a]	Date of Maximum/Minimum[a]
Conductivity (uS/cm)			
Formosa Adit	1092 - 4185	Formosa Adit	1/26/2011
Middle Creek Seeps and Springs	49 - 1068	MB3	1/30/2010
South Fork Middle Creek Seeps and Springs	75 - 3432	SFA5	2/14/2012
Middle Creek[1]	65 - 481	MXR	10/19/2009
South Fork Middle Creek[2]	122 - 308	SF0.7	6/28/2012
Reference[3]	105 - 145	SFREF	9/12/2013
Dissolved Oxygen (mg/L)			
Formosa Adit	0.09 - 4.09	Formosa Adit	9/26/2011
Middle Creek Seeps and Springs	5.64 - 14.5	MF2	9/10/2012
South Fork Middle Creek Seeps and Springs	6.07 - 12.94	SFC1	10/28/2009
Middle Creek[1]	9.5 - 14.21	MXR	10/19/2009
South Fork Middle Creek[2]	9.62 - 17.5	SF1.0	10/22/2009
Reference[3]	10.81 - 14.4	SFREF1	9/12/2012
pH			
Formosa Adit	2.15 - 4.88	Formosa Adit	1/26/2010
Middle Creek Seeps and Springs	2.4 - 7.58	MA44	2/4/2010
South Fork Middle Creek Seeps and Springs	3.0 - 7.72	SFA5	2/14/2012
Middle Creek[1]	6.21 - 9.28	MXR	10/19/2009
South Fork Middle Creek[2]	6.32 - 7.9	SF1.0	10/22/2009
Reference[3]	6.73 - 8.27	SFREF1	9/12/2012
Water Temperature (Celsius)			
Formosa Adit	9.42 - 9.58	Formosa Adit	1/26/2011
Middle Creek Seeps and Springs	4.61 - 22.1	MF2	9/10/2012
South Fork Middle Creek Seeps and Springs	5.15 -20.52	SFA5	9/13/2012
Middle Creek[1]	5.27 - 14.26	MXR	9/14/2012
South Fork Middle Creek[2]	4.5 - 11.19	SF1.0	9/27/2011
Reference[3]	9.03 - 11.6	MARTIN CREEK REF	6/18/2013

[a]Location and date of maximum value is provided for conductivity and water temperature; location and date of minimum value is provided for dissolved oxygen and pH.

[1] Middle Creek from MXR to M13

[2] South Fork Middle Creek from SF0.7 to SF4.7

[3] Martin Creek Reference, Middle Creek Reference, and South Fork Reference

Table 3-3 Summary of Chemicals of Potential Concern

Metals/Metalloids	Middle Creek		South Fork Middle Creek	
	COPC Based on:		COPC Based on:	
	ODEQ CCC	National CCC	ODEQ CCC	National CCC
ALUMINUM	NV	NV	NV	NV
ANTIMONY	ND	ND	ND	ND
ARSENIC	No	No	No	No
BARIUM	NV	NV	NV	NV
BERYLLIUM	ND	ND	ND	ND
BORON	ND	ND	NV	NV
CADMIUM	Yes	Yes	Yes	Yes
CALCIUM	NV	NV	NV	NV
CHLORIDE	No	No	No	No
CHROMIUM	No	No	ND	ND
COBALT	NV	NV	NV	NV
COPPER	Yes	Yes	Yes	Yes
FLUORIDE	NV	NV	NV	NV
IRON	No	No	No	No
LEAD	No	No	No	No
LITHIUM	ND	ND	ND	ND
MAGNESIUM	NV	NV	NV	NV
MANGANESE	NV	NV	NV	NV
MERCURY	No[1]	No	No[1]	No
MOLYBDENUM	ND	ND	NV	NV
NICKEL	No	No	No	No
POTASSIUM	NV	NV	NV	NV
SELENIUM	ND	ND	No	No
SILVER	ND	ND	No	NV
SODIUM	NV	NV	NV	NV
SULFATE	NV	NV	NV	NV
THALLIUM	ND	ND	ND	ND
THORIUM	ND	ND	ND	ND
URANIUM	ND	ND	ND	ND
VANADIUM	NV	NV	NV	NV
ZINC	Yes	Yes	Yes	Yes

Notes:

CCC = Criterion Continuous Concentration

COPC = Chemical of Potential Concern

ND = Not Detected

NV = No Value

ODEQ = Oregon Department of Environmental Quality

Yes = chemical is selected as a COPC

No = chemical is not selected as COPC

No[1] = mercury is not a COPC based on low level analysis (see Section 3.6.2.1)

Table 3-4 Summary of Mercury Analytical Results

Summary of Low Level Mercury Results By EPA Method 1631E				
Location	**Sample Date**	**Fraction**	**THg (µg/L)**	**MeHg (µg/L)**
ODEQ ESL			**0.012**	**NA**
MXR	5/2/2013	Total	0.0005479	0.000067
Formosa 1 Adit	5/2/2013	Total	0.0033631	0.0000528
SFA2	5/2/2013	Total	0.0011493	0.0000968
Seep A	5/2/2013	Total	0.0012594	0.0000702
MXR	5/2/2013	Dissolved	0.0005801	0.0000457
Formosa 1 Adit	5/2/2013	Dissolved	0.0010543	0.0000249 U
SFA2	5/2/2013	Dissolved	0.0012392	0.0000249 U
Seep A	5/2/2013	Dissolved	0.0009126	0.0000471 J
SFA2	8/21/2013	Total	0.000782	0.0000249 U
Formosa 1 Adit	8/21/2013	Total	0.00218	0.0000249 U
MXR	8/21/2013	Total	0.000679	0.0000249 U
SFA2	8/21/2013	Dissolved	0.000828	0.0000249 U
Formosa 1 Adit	8/21/2013	Dissolved	0.00112	0.0000249 U
MXR	8/21/2013	Dissolved	0.000727	0.0000249 U
SFA2	10/23/2013	Total	0.000641	0.0000249 U
Formosa 1 Adit	10/23/2013	Total	0.00331	0.0000249 U
MXR	10/23/2013	Total	0.000655	0.0000249 U
SFA2	10/23/2013	Dissolved	0.000588	0.0000249 U
Formosa 1 Adit	10/23/2013	Dissolved	0.00135	0.0000249 U
MXR	10/23/2013	Dissolved	0.000563	0.0000249 U

Summary of Mercury Results By EPA Method 7471A															
		Mercury, Results Dissolved Fraction (ug/L)					Mercury, Results Total Fraction (ug/L)								
BASIN	**Location Type**	**Frequency of Detection**	**Min Detected Value**	**Max Detected Value**	**Location of Maximum Detection**	**ODEQ CCC Screening Level**	**Frequency of Detection**	**Min Detected Value**	**Max Detected Value**	**Location of Maximum Detection**	**Minimum Reporting Limit (ug/L)**	**Maximum Reporting Limit (ug/L)**
MIDDLE CREEK	SEEP	2 / 16	0.057 J	0.058 J	MA46	0.012	1 / 16	0.1 J	0.1 J	MA44	0.2	0.2
MIDDLE CREEK (1)	STREAM	1 / 21	0.044 J	0.058 J	MXR	0.012	1 / 21	0 J	0 J	MXR	0.2	0.2
MIDDLE CREEK REFERENCE	STREAM	0 / 1	ND	ND	--		0 / 1	ND	ND	--	0.2	0.2
SOUTH FORK MIDDLE CREEK	SEEP	2 / 16	0.098 J	0.16 J	SFA2	0.012	0 / 16	ND	ND	--	0.2	0.2
SOUTH FORK MIDDLE CREEK (2)	STREAM	1 / 10	0.036 J	0.036 J	SF1.0	0.012	0 / 10	ND	ND	--	0.2	0.2
SOUTH FORK MIDDLE CREEK REFERENCE	STREAM	0 / 1	ND	ND	--		0 / 1	ND	ND	--	0.2	0.2
404 ADIT	ADIT	1 / 2	0.091 J	0.091 J	404 ADIT	0.012	0 / 2	ND	ND	--	0.2	0.2
404 DRAINAGE	SEEP	0 / 1	ND	ND	--		0 / 1	ND	ND	--	0.2	0.2
COW CREEK	STREAM	0 / 7	ND	ND	--		1 / 7	0.1 J	0.1 J	SW2	0.2	0.2
FORMOSA ADIT	ADIT	1 / 8	0.063 J	0.063 J	FORMOSA ADIT	0.012	1 / 8	0.1 J	0.1 J	FORMOSA ADIT	0.2	0.2
RUSSELL CREEK	STREAM	0 / 4	ND	ND	--		0 / 4	ND	ND	--	0.2	0.2
WEST FORK CANYON CREEK	SEEP	0 / 2	ND	ND	--		0 / 2	ND	ND	--	0.2	0.2
WEST FORK CANYON CREEK	STREAM	0 / 4	ND	ND	--		0 / 4	ND	ND	--	0.2	0.2

(1) MA46 was included with seeps, instead of stream locations

(2) SFA2 and SF2F were included with seeps, instead of stream locations

Notes:

-- =	not applicable
ESL =	Environmental Screening Level
J =	Estimated value
MeHg =	methyl mercury
NA =	not applicable
ODEQ =	Oregon Department of Environmental Quality
THg =	total mercury
U =	Below detection limit (reporting limit shown)
µg/L =	micrograms per liter

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Section 4

BERA Effects Assessment

Effects Assessment includes an evaluation and presentation of data for assessing the potential for COPCs to cause adverse effects in exposed receptors. Sources, types, and concentrations of effects data are evaluated, resulting in the selection of media- and chemical-specific toxicity reference values or TRVs. TRVs serve as the ecological effects concentrations for input into risk calculation where TRVs are compared to COPC EPCs, as described in the preceding section.

4.1 Toxicity Reference Values

Preferred TRVs are based on the specific COPCs and receptor species associated with a site. Species-specific toxicity data are, however, often unavailable, and use of surrogate receptors or receptor groups is generally necessary. There are varying degrees of confidence in the ability of selected TRVs to predict risk because of taxa-to-taxa extrapolations. In cases where specific data are unavailable, the effects assessment is based on more general values available in the literature. The use of non-specific or surrogate TRVs increases the uncertainties in risk estimates based on these values. Site-specific toxicity data are unavailable for the OU2 BERA, and all TRVs are therefore taken from literature sources. Literature-based TRVs are presented below.

TRVs for surface water are based on direct contact and ingestion exposures to lower trophic level aquatic receptors. Some of the more general TRVs selected for use as TRVs (i.e., NRWQC CCC and ODEQ chronic criteria) were selected as inputs into chemical screening to identify COPCs (Section 3, Exposure Assessment). These more general TRVs are deemed appropriate for use here as TRVs because they are derived from studies in which a variety of aquatic species were exposed to potentially hazardous chemicals under laboratory conditions. Taxa used in such studies, and those assumed protected if the criterion is not exceeded, include aquatic plants, benthic and water-column invertebrates, fish, and larval amphibians. Use of these more general TRVs for assessing risk is therefore applicable to all these aquatic receptors and diverse aquatic communities.

Other selected TRVs for assessing risks to aquatic receptors are more applicable to specific taxa. Salmonid-specific TRVs, described below, fall into this category. Most of the selected surface water TRVs do not consider bioaccumulation and food web or dietary exposures. The selected TRVs described below are therefore not used to estimate risks to upper trophic level consumers of aquatic biota.

1. NRWQC – CCC (EPA 2013)

Chemical-specific CCCs (EPA 2013) are selected as surface water TRVs for the OU2 BERA (**Table 4-1**). These values are intended to protect 95% of the nation's aquatic (freshwater) species, including aquatic plants, invertebrates, fish, and larval amphibians. For hardness-dependent metals, CCCs are adjusted for the average site-specific hardness measured or estimated in surface water (expressed as milligrams of $CaCO_3$ per liter [mg $CaCO_3$/L]).

2. ODEQ Freshwater Water Quality Criteria (2013)

ODEQ (2013) derived chronic water quality criteria for the protection of freshwater aquatic life (**Table 4-1**). These criteria were updated and effective as of January 31, 2013. Oregon chronic criteria are derived in a manner similar to (and in some cases exactly the same as) NRWQC CCC. Oregon chronic criteria differ from NRWQC for some metals (e.g., arsenic, copper, mercury, silver, and selenium), mostly (but not solely) due to differences in the hardness-adjustment equations. Oregon chronic freshwater criteria are selected as a second type of TRV for assessing risks to aquatic biota.

3. Salmonid-specific TRVs (GEI Consultants 2006)

CEC (now GEI Consultants) derived salmonid-specific TRVs for selected inorganic chemicals in surface water (aluminum, cadmium, chromium (+3), copper, lead, molybdenum, manganese, nickel, and zinc). These salmonid-specific values were accepted by EPA Region 6 for use as surface water TRVs for assessing risks to salmonid fish for the Molycorp Mine Site in northern New Mexico. These TRVs are based on the EPA method for deriving chronic NRWQC but include only studies in which salmonid fish (brown trout, rainbow trout, cutthroat trout, and/or brook trout) were exposed to these metals. These TRVs are derived from laboratory experiments conducted over short (acute, generally 96 hours) and longer (chronic, generally 7 to 30 days) duration exposures. In some cases, chronic TRVs for salmonids are estimated from acute TRVs using acute-to-chronic ratios per EPA guidance for deriving NRWQC. Salmonid-specific TRVs are hardness-adjusted where applicable based on toxicity/hardness relationships derived specifically from the laboratory toxicity studies for trout. The inputs for the salmonid-specific hardness adjustments are presented in **Table 4-2 through Table 4-5**. **Table 4-6** summarizes the TRVs for all exposure areas.

The decision to include salmonid-based TRVs for assessing surface water quality for the aquatic ecosystems of interest to the OU2BERA is based on the following:

- Salmonid fish (steelhead trout and coho [silver] salmon) dominate the fish community of these surface waters.
- Toxicity data for daphnids significantly affect the derivation of NRWQC CCC for several metals. However, water column invertebrates, such as daphnids, are likely rare or non-existent in much of these surface waters due to unsuitable conditions.

Per Oregon Administrative Rules (OAR), “salmon” refers to chinook, chum, coho, sockeye, and pink salmon. “Salmonid or salmonids” refer to native salmon, trout, mountain whitefish, and char (including bull trout). Waters, such as Middle Creek, that are designated for “Salmon and Steelhead Spawning Use” include waters that are or could be used for salmon and steelhead spawning, egg incubation, and fry emergence. These uses are designated on subbasin maps (OAR 340-041-0101 to 340-041-0340: Tables 101B and 121B and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, 320B, and 340B). “Salmon and Trout Rearing and Migration Use” are waters thermally suitable as rearing habitat for salmon, steelhead, rainbow trout, and cutthroat trout as designated on sub-basin maps (OAR 340-041-0101 to 340-041-0340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A).

For hardness-dependent chemicals (aluminum, cadmium, trivalent chromium, copper, lead, manganese, nickel, and zinc), surface water TRVs are adjusted for the creek-specific average hardness (mg $CaCO_3$/L). The hardness slopes for salmonid-specific TRVs are adjusted using salmonid-specific data relating hardness to aquatic toxicity.

Table 4-2 through **Table 4-5** show the salmonid- and hardness-specific chronic TRVs in the form of equations as well as individual input parameters used in the equations. These tables present the conversion factors (CFs) to convert total recoverable metals concentrations to dissolved concentrations. Dissolved metals concentrations better predict toxicity to fish because the dissolved fraction is generally considered the most toxic fraction.

4.2 Uncertainty Analysis

Major sources of uncertainty in the effects assessment are identified, and their potential impact on the OU2 BERA is evaluated in this section. Concentrations of COPCs associated with observed or predicted harmful effects on ecological receptors are the primary source of uncertainty in the effects assessment. These concentrations are used to preliminarily identify COPCs (Section 3, Exposure Assessment) and, where selected as TRVs, to calculate risks to exposed aquatic receptors. TRVs used for risk estimation are selected from a longer list of potential TRVs and other types of concentration data (e.g., screening values) for each surface water COPC. In general, uncertainties are low for surface water TRVs for metals because the most hazardous metals are well-studied, and the associated toxicity databases are extensive.

Selected surface water TRVs linked to protection of diverse aquatic communities (e.g., NRWQC CCC and ODEQ chronic criteria) are associated with low uncertainty because these concentrations are based on experimentally derived values from large databases. Salmonid-specific TRVs are associated with low uncertainty because trout and salmon are among the most-studied aquatic receptors with regard to metals toxicity in surface water. This leads to considerable agreement in the scientific community on effects data for trout exposed to metals. Some uncertainty may stem from using data for trout species other than those known to occur in Middle Creek and South Fork Middle Creek. For example, toxicity data for brook or brown trout may not be fully applicable to steelhead or coho salmon. However, the differences in the responses of various salmonid species to exposure to COPCs of interest to the OU2 BERA are expected to be small because closely related taxa usually respond similarly to exposure to toxic chemicals. Finally, TRVs for hardness-dependent metals are adjusted for creek-specific average hardness values that in some cases may not be representative of long-term averages for large areas. Such uncertainties stem from the relatively few surface water data collected during storm events, major snowmelt events, and other factors that can have severe short-term effects on surface water quality, including hardness.

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Table 4-1 Summary of Aquatic Life Screening Criteria

Metals/Metalloids	*Units*	Hardness Dependent Adjusted Criteria			
		MIDDLE CREEK		SOUTH FORK MIDDLE CREEK	
		ODEQ CCC CCC (ug/L)	**NATIONAL CRITERIA CCC** CCC (ug/L)	**ODEQ CCC** CCC (ug/L)	**NATIONAL CRITERIA CCC** CCC (ug/L)
ALUMINUM	µg/L	NV	NV	NV	NV
ANTIMONY	µg/L	NV	NV	NV	NV
ARSENIC	µg/L	190	150	190	150
BARIUM	µg/L	NV	NV	NV	NV
BERYLLIUM	µg/L	NV	NV	NV	NV
BORON	µg/L	NV	NV	NV	NV
CADMIUM	µg/L	0.25	0.25	0.20	0.20
CALCIUM	µg/L	NV	NV	NV	NV
CHROMIUM	µg/L	75.90	75.90	58.22	58.22
COBALT	µg/L	NV	NV	NV	NV
COPPER	µg/L	12.00	9.18	12.00	6.96
IRON	µg/L	1000	1000	1000	1000
LEAD	µg/L	2.60	2.60	1.82	1.82
LITHIUM	µg/L	NV	NV	NV	NV
MAGNESIUM	µg/L	NV	NV	NV	NV
MANGANESE	µg/L	NV	NV	NV	NV
MERCURY	µg/L	0.012	0.77	0.012	0.77
MOLYBDENUM	µg/L	NV	NV	NV	NV
NICKEL	µg/L	53.30	53.30	40.53	40.53
POTASSIUM	µg/L	NV	NV	NV	NV
SELENIUM	µg/L	35.00	5.00	35.00	5.00
SILVER	µg/L	0.10	NV	0.10	NV
SODIUM	µg/L	NV	NV	NV	NV
THALLIUM	µg/L	NV	NV	NV	NV
THORIUM	µg/L	NV	NV	NV	NV
URANIUM	µg/L	NV	NV	NV	NV
VANADIUM	µg/L	NV	NV	NV	NV
ZINC	µg/L	121.09	121.09	92.03	92.03
Other					
Alkalinity	mg/L (as CaCO3)	20.00	20.00	20.00	20.00
Ammonia as N	mg/L	5.70	5.70	5.70	5.70
CHLORIDE	mg/L	230.00	230.00	230.00	230.00
FLUORIDE	mg/L	NV	NV	NV	NV
SULFATE	mg/L	NV	NV	NV	NV
TDS	mg/L	NV	NV	NV	NV
TSS	mg/L	NV	NV	NV	NV
pH	S.U.	NV	6.5 - 9	NV	6.5 - 9

Notes:
N = Nitrogen
NV = No Value
CCC = Criterion Continuous Concentration
ODEQ = Oregon Department of Environmental Quality
S.U. = Standard Units
TDS = Total dissolved Solids
TSS = Total Suspended Solids
µg/L = micrograms per liter
mg/L = milligrams per liter

Table 4-2 Hardness and Sulfate Adjusted Surface Water Toxicity Reference Values, Middle Creek

ACUTE TRV								TRV = Toxicity Reference Value
SW COPC	**Dissolved (µg/L)**	**Total Recoverable (µg/L)**	**mA**	**hardness**	**ln hardness**	**bA**	**CF**	**Hardness/Sulfate Equations**
Cadmium	3.60	3.82	0.8150	103	4.63	-2.44	0.94	Dissolved Cd acute = $(1.136672-[(\ln \text{hardness})(0.041838)])*e^{0.8150[\ln(\text{hardness})]-2.4369}$
Copper	111	116	0.9809	103	4.63	0.21	0.96	Dissolved Cu acute = $0.960*e^{0.9809[\ln(\text{hardness})]+0.2065}$
Zinc	1,276	1,305	0.8806	103	4.63	3.09	0.978	Dissolved Zn acute = $0.978*e^{0.5812[\ln(\text{sulfate})]+8.3997}$
CHRONIC TRV								
SW COPC	**Dissolved (µg/L)**	**Total Recoverable (µg/L)**	**mC**	**hardness**	**ln hardness**	**bC**	**CF**	Hardness/Sulfate Equations
Cadmium	3.52	3.88	0.7061	103	4.63	-1.92	0.91	Dissolved Cd chronic = $(1.101672-[(\ln \text{hardness})(0.041838)])*e^{0.7061[\ln(\text{hardness})]-1.9172}$
Copper	22	23	0.5897	103	4.63	0.40	0.96	Dissolved Cu chronic = $0.960*e^{0.5897[\ln(\text{hardness})]+0.3979}$
Zinc	772	783	0.8806	103	4.63	2.58	0.986	Dissolved Zn chronic = $0.986*e^{0.8806[\ln(\text{hardness})]+2.5820}$

	Average Hardness		Average Sulfate
SW EA			
	Chronic	**Acute**	
Middle Creek	103	NA	133.03

Notes:
COPC = Chemical of Potential Concern
SW = Surface Water
EA = Exposure Area
µg/L = micrograms per liter
all hardness and sulfate values in mg $CaCO_3$/L
all values rounded to nearest whole number

Table 4-3 Hardness and Sulfate Adjusted Surface Water Toxicity Reference Values, South Fork Middle Creek

ACUTE TRV								TRV = Toxicity Reference Value
SW COPC	Dissolved (µg/L)	Total Recoverable (µg/L)	mA	hardness	ln hardness	bA	CF	Hardness/Sulfate Equations
Cadmium	2.79	2.92	0.8150	74	4.30	-2.44	0.96	Dissolved Cd acute = $(1.136672-[(\ln \text{hardness})(0.041838)])*e^{0.8150[\ln(\text{hardness})]-2.4369}$
Copper	80	84	0.9809	74	4.30	0.21	0.96	Dissolved Cu acute = $0.960*e^{0.9809[\ln(\text{hardness})]+0.2065}$
Zinc	954	975	0.8806	74	4.30	3.09	0.978	Dissolved Zn acute = $0.978*e^{0.5812[\ln(\text{sulfate})]+8.3997}$
CHRONIC TRV								
SW COPC	Dissolved (µg/L)	Total Recoverable (µg/L)	mC	hardness	ln hardness	bC	CF	Hardness/Sulfate Equations
Cadmium	2.83	3.07	0.7061	74	4.30	-1.92	0.92	Dissolved Cd chronic = $(1.101672-[(\ln \text{hardness})(0.041838)])*e^{0.7061[\ln(\text{hardness})]-1.9172}$
Copper	18	19	0.5897	74	4.30	0.40	0.96	Dissolved Cu chronic = $0.960*e^{0.5897[\ln(\text{hardness})]+0.3979}$
Zinc	577	585	0.8806	74	4.30	2.58	0.986	Dissolved Zn chronic = $0.986*e^{0.8806[\ln(\text{hardness})]+2.5820}$

	Average Hardness		Average Sulfate
SW EA			
	Chronic	Acute	
South Fork Middle Creek	74	NA	322.09

Notes:
COPC = Chemical of Potential Concern
SW = Surface Water
EA = Exposure Area
µg/L = micrograms per liter
all hardness and sulfate values in mg $CaCO_3$/L
all values rounded to nearest whole number

Table 4-4 Hardness and Sulfate Adjusted Surface Water Toxicity Reference Values, Middle Creek Reference

ACUTE TRV								TRV = Toxicity Reference Value
SW COPC	Dissolved (µg/L)	Total Recoverable (µg/L)	mA	hardness	ln hardness	bA	CF	Hardness/Sulfate Equations
Cadmium	2.09	2.15	0.8150	51	3.93	-2.44	0.97	Dissolved Cd acute = $(1.136672-[(\ln \text{hardness})(0.041838)])*e^{0.8150[\ln(\text{hardness})]-2.4369}$
Copper	56	58	0.9809	51	3.93	0.21	0.96	Dissolved Cu acute = $0.960*e^{0.9809[\ln(\text{hardness})]+0.2065}$
Zinc	687	703	0.8806	51	3.93	3.09	0.978	Dissolved Zn acute = $0.978*e^{0.5812[\ln(\text{sulfate})]+8.3997}$
CHRONIC TRV								
SW COPC	Dissolved (µg/L)	Total Recoverable (µg/L)	mC	hardness	ln hardness	bC	CF	Hardness/Sulfate Equations
Cadmium	2.21	2.36	0.7061	51	3.93	-1.92	0.94	Dissolved Cd chronic = $(1.101672-[(\ln \text{hardness})(0.041838)])*e^{0.7061[\ln(\text{hardness})]-1.9172}$
Copper	15	15	0.5897	51	3.93	0.40	0.96	Dissolved Cu chronic = $0.960*e^{0.5897[\ln(\text{hardness})]+0.3979}$
Zinc	416	422	0.8806	51	3.93	2.58	0.986	Dissolved Zn chronic = $0.986*e^{0.8806[\ln(\text{hardness})]+2.5820}$

	Average Hardness		Average Sulfate
SW EA			
	Chronic	Acute	
Middle Creek Reference	51	NA	3.18

Notes:
COPC = Chemical of Potential Concern
SW = Surface Water
EA = Exposure Area
µg/L = micrograms per liter
all hardness and sulfate values in mg $CaCO_3$/L
all values rounded to nearest whole number

Table 4-5 Hardness and Sulfate Adjusted Surface Water Toxicity Reference Values, South Fork Middle Creek Reference

ACUTE TRV								TRV = Toxicity Reference Value
SW COPC	**Dissolved (µg/L)**	**Total Recoverable (µg/L)**	**mA**	**hardness**	**ln hardness**	**bA**	**CF**	**Hardness/Sulfate Equations**
Cadmium	2.28	2.36	0.8150	57	4.04	-2.44	0.97	[2] Dissolved Cd acute = $(1.136672-[(\ln \text{hardness})(0.041838)])*e^{0.8150[\ln(\text{hardness})]-2.4369}$
Copper	62	65	0.9809	57	4.04	0.21	0.96	[4] Dissolved Cu acute = $0.960*e^{0.9809[\ln(\text{hardness})]+0.2065}$
Zinc	758	775	0.8806	57	4.04	3.09	0.978	[8] Total Se VI acute = $e^{0.5812[\ln(\text{sulfate})]+8.3997}$
SW COPC	**Dissolved (µg/L)**	**Total Recoverable (µg/L)**	**mA**	**sulfate**	**ln sulfate**	**bA**	**CF**	[9] Dissolved Zn acute = $0.978*e^{0.8806[\ln(\text{hardness})]+3.0924}$
Selenium	35,337	35,337	0.5812	35.4	3.57	8.40	1	CF = Conversion Factor
CHRONIC TRV								
SW COPC	**Dissolved (µg/L)**	**Total Recoverable (µg/L)**	**mC**	**hardness**	**ln hardness**	**bC**	**CF**	Hardness/Sulfate Equations
Cadmium	2.38	2.55	0.7061	57	4.04	-1.92	0.93	[2] Dissolved Cd chronic = $(1.101672-[(\ln \text{hardness})(0.041838)])*e^{0.7061[\ln(\text{hardness})]-1.9172}$
Copper	16	16	0.5897	57	4.04	0.40	0.96	[4] Dissolved Cu chronic = $0.960*e^{0.5897[\ln(\text{hardness})]+0.3979}$
Zinc	459	465	0.8806	57	4.04	2.58	0.986	[8] Dissolved Zn chronic = $0.986*e^{0.8806[\ln(\text{hardness})]+2.5820}$

	Average Hardness		Average Sulfate
SW EA			
	Chronic	**Acute**	
South Fork Middle Creek Reference	57	NA	35.4

Notes:
COPC = Chemical of Potential Concern
SW = Surface Water
EA = Exposure Area
µg/L = micrograms per liter
all hardness and sulfate values in mg $CaCO_3$/L
all values rounded to nearest whole number

Table 4-6 Summary of Chronic Surface Water Toxicity Reference Values - Hardness-Adjusted by Exposure Area

Surface Water COPC	Original Toxicity Reference Value (TRV)		Exposure Area / Mean Hardness (mg/L) / Hardness-Adjusted TRV			
			Middle Creek	Middle Creek Reference	South Fork Middle Creek	South Fork Middle Creek Reference
			Hardness in mg CaCO3/L			
			103	51	74	57
	TRV µg/L	Hardness	TRV µg/L	TRV µg/L	TRV µg/L	TRV µg/L
Cadmium	3.45	100	4	2	3	2
Copper-dissolved	22	100	22	15	18	16
Zinc-dissolved	752	100	772	416	577	459

Notes:
TRV = Toxicity Reference Value
mg = milligram
µg/L = micrograms per liter

Section 5

BERA Risk Characterization

Risk characterization integrates information from the exposure and effects assessments to estimate risks to representative ecological receptors. Several approaches can be used to integrate exposure and effects data, with selected approaches often dependent on the availability of specific types of data. For example, the results of site-specific surveys of certain components of aquatic communities are useful lines of evidence to support quantitative risk estimates as described below. Site-specific community structure and survey data are available for certain aquatic receptor groups identified for this BERA. The results of these surveys, provided in Section 5.2, are used to supplement the primary method of risk estimation—the HQ approach, described below. As discussed in previous sections, COPCs are limited to dissolved metals in surface water, and as a result of screening of chemicals detected in surface water, include cadmium, copper, mercury, and zinc. Mercury is not considered a mine-related COPC as described in Section 3.6.2. Risk characterization for the OU2 BERA is therefore focused on descriptions of risk posed to aquatic ecological receptors from exposure to dissolved concentrations of cadmium, copper, and zinc.

5.1 Risks Based on Direct Exposure

Risks based on direct exposure (direct contact and ingestion) to COPC-contaminated media are assessed using the HQ approach. This method of assessing risks is based on the ratio of an exposure concentration to an effects concentration. The general equation follows:

$$HQ = \frac{\textit{Exposure Concentration}}{\textit{Effects Concentration}}$$

More specifically, HQ calculations for this BERA are based on the following:

$$HQ = \frac{EPC}{TRV}$$

Where: EPC = exposure point concentration (e.g., 95% UCL)
TRV = toxicity reference value

In most cases, the selected TRV represents a COPC concentration associated with low but significant likelihood of adverse effects. The TRV is most appropriately a threshold concentration at which adverse effects begin to be observed following longer term exposures (e.g., a chronic value) but, depending on available data, may be a higher concentration at which adverse effects are usually or always observed in more sensitive life stages or taxa.

Exceedance of a chronic or threshold value indicates that further investigation is warranted and adverse effects may occur. Exceedance of a low effect value suggests that there is potential for adverse effects to occur. Where neither the threshold nor the low effect TRV is exceeded, risks are deemed acceptable or so low that they can be considered insignificant. Higher HQs are not necessarily indicative of more severe effects, but instead, where confidence in TRVs is equal, suggest a greater likelihood of adverse effects.

5.1.1 Risks to Aquatic Life

Aquatic life is defined for the purposes of the OU2 BERA to include aquatic plants (e.g., algae), water column and benthic invertebrates, fish, and larval amphibians. Risks to aquatic life are calculated using multiple lines of evidence for the OU2 BERA.

First is a comparison of surface water COPC concentrations (EPCs) to chronic water quality standards or criteria based on adverse effects in tested aquatic organisms. Most aquatic toxicity tests underlying surface water standards and criteria are based on laboratory exposures to water column invertebrates (e.g., daphnids), BMI, and fish. Toxicity data resulting from such tests are used to generate aquatic life standards or criteria intended to protect all or most forms of aquatic life, i.e., a diverse aquatic community. State water quality criteria and national water quality criteria are examples of water quality values intended to protect a diverse aquatic community. Exceedance of these water quality values suggests unacceptable risks to sensitive components of aquatic communities.

Second is a comparison of COPC concentrations in surface water to trout- or salmonid-specific TRVs. Exceedance of salmonid-specific TRVs suggests unacceptable risks to resident or migratory salmonid fish that occur in or frequent the surface waters of interest to the OU2 BERA.

Third is a qualitative evaluation of fish presence or absence at multiple locations downstream of the mine. Although fish species collected via long-term monitoring are noted, the numbers of fish collected are not comparable in this qualitative evaluation because collection methods differed over the collection time period. In addition, recent collection of quantitative fish abundance data is beyond the scope of the sampling design used for this line of evidence. Evaluation of fish survey data is provided in Section 5.2.1.

Fourth is a comparison of BMI community metrics such as abundance or diversity from one location to another. BMI community metrics from locations potentially affected by mine-related contamination are compared to similar metrics from reference locations unaffected by mine-related contamination. This evaluation provides insight into integrated conditions (e.g., physical habitat suitability, sediment quality, and water quality) at specific locations instream. This evaluation is provided in Section 5.2.2.

5.1.1.1 Risks Based on Surface Water COPC Concentrations

Risks based on surface water COPC concentrations are based on comparisons of dissolved surface water EPCs to general (i.e., applicable to aquatic life) and to salmonid-specific surface water TRVs based on dissolved metals concentrations – the potentially most bioavailable and toxic form. As discussed previously, HQs greater than 1 indicate potentially unacceptable risk while HQs less than 1 suggest no or insignificant risk.

Risks to Aquatic Life (General)

Risks presented here are based on concentrations of dissolved metals identified as COPCs divided by chronic water quality criteria intended to protect diverse freshwater aquatic communities. These comparisons result in the derivation of HQs, which provide quantitative estimates of risk to a diverse group of aquatic receptors, including aquatic plants, invertebrates, fish, and larval amphibians. Chronic water quality criteria used in these calculations include Oregon chronic water quality criteria (ODEQ 2013) and chronic NRWQC (EPA 2013), both adjusted for the stream mean hardness expressed as mg $CaCO_3$/L.

An evaluation of acute risks was also conducted using Oregon acute water quality criteria (ODEQ 2013) and acute NRWQC (EPA 2013), both adjusted for the stream mean hardness expressed as mg $CaCO_3$/L (see **Appendix B**). Based on this evaluation, cadmium, copper, and zinc in both Middle Creek and South Fork Middle Creek exceed acute risk criteria, with cadmium concentrations exceeding NRWQC acute criteria and copper and zinc concentrations exceeding both NRWQC and Oregon acute water quality criteria. Acute risk calculations are provided in **Appendix C**.

As presented in **Table 5-1**, HQs for fish in Middle Creek based on chronic exposures to metals in surface water exceed 1.0 for cadmium, copper, and zinc at MXR and cadmium at M3.0 based on comparisons of site data to chronic NRWQC and ODEQ CCC.

At MXR, where fish are unlikely to find suitable conditions and in fact are hindered due to downstream barriers, HQs are highest for copper (58) based on chronic NRWQC. At M3.0, the HQ for cadmium is 3.0 based on the average detection and 3.1 based on the maximum detection. All HQs remain below 1.0 for the downstream sampling locations and the MREF reference location (one sample) based on ODEQ criteria and chronic NRWQC.

As shown in **Table 5-2**, HQs for fish in South Fork Middle Creek exceed 1.0 for cadmium, copper, and zinc at SF1.0 based on NRWQC and ODEQ criteria and for copper at SF3.0 based on chronic NRWQC. At SF1.0, HQs are highest for copper (41) based on chronic NRWQC. At SF3.0, the HQ for copper is 2 based on the maximum detection and 1 based on the average detection. All HQs were below 1 for the SFREF reference location (one sample) based on ODEQ criteria and chronic NRWQC.

These data suggest potentially significant risks to sensitive components of aquatic communities due to elevated concentrations of cadmium, copper, and zinc under long-term exposures. The assumption that *sensitive* components of aquatic communities are at risk is based on the approach used by ODEQ and EPA to derive water quality criteria. That approach derives the final (acute or chronic) criterion for a chemical based on the (generally four) most sensitive organisms exposed to the chemical in aquatic toxicity tests conducted under controlled laboratory conditions.

Risks to Salmonid Fish

As discussed previously, another use of salmonid-based TRVs is to assess surface water quality and to derive HQs for the three metals identified as surface water COPCs: cadmium, copper, and zinc. Derivation of HQs based on salmonid-specific TRVs is applicable to surface water sampling stations on Middle Creek, South Fork Middle Creek, and associated reference locations regardless of current fish absence or presence. This approach is used to determine water quality conditions and suitability of various reaches of these creeks to support salmonid fish now and to establish baseline conditions for future monitoring of water quality improvements.

Table 5-3 reveals the HQs based on salmonid-specific TRVs for surface water sampling locations on Middle Creek, South Fork Middle Creek, and reference locations. Middle Creek and South Fork Middle Creek can be viewed as EAs for wider ranging ecological receptors while individual sampling stations on each stream and reference area can be viewed as independent EAs for minimally mobile or non-mobile receptors such as BMI. As shown on this table, HQs exceed the threshold of 1 at the Middle Creek for cadmium, copper, and zinc; at MXR; and South Fork Middle Creek for cadmium, copper, and zinc at SF1.0. HQs for the MREF and SFREF reference locations are below 1 for all metals.

In summary, risks to fish and other aquatic life from long-term exposures to elevated concentrations of dissolved metals in surface water are significant for the following combinations of metals and locations:

- Middle Creek
  - Cadmium (MXR, M3.0) - Although analytical data were not collected at M1.2 or M2.0, it is assumed that risks from cadmium would be significant at these locations upstream of M3.0.
  - Copper (MXR)
  - Zinc (MXR)
- South Fork Middle Creek
  - Cadmium (SF1.0)
  - Copper (SF1.0, SF3.0)
  - Zinc (SF1.0)

5.1.2 Risk to Upper Trophic Level Receptors

Risks from exposure to surface water COPCs are assumed to be low or insignificant for upper trophic level receptors, such as adult amphibians, reptiles, birds, and mammals, based on the following qualitative or semi-quantitative information.

- Exposure to COPCs in surface water is unlikely to be frequent or of long duration for receptors with larger home or foraging ranges (e.g., birds and most mammals).
- Exposure to COPCs in surface water for most terrestrial and upper trophic level receptors linked to the aquatic environment primarily would be via the drinking water route of exposure. However, the drinking water route of exposure contributes only marginally to overall dose.

5.2 Other Supporting Data

This section presents additional lines of evidence for characterizing risks to ecological receptors in the aquatic ecosystems of interest for the OU22 BERA. These lines of evidence supplement the HQ approach presented above used to quantify risks based on direct contact/ingestion exposures (i.e., comparisons of COPC concentration in surface water to surface water TRVs). Additional lines of evidence are summarized below.

5.2.1 Fish Community Data

Supplemental lines of evidence for assessing risks to aquatic receptors include the presence or absence of fish within study area waters, as discussed below.

5.2.1.1 Historical Data

Winter steelhead and resident rainbow trout, fall and spring chinook salmon, coho salmon, and sea-run and resident cutthroat trout have been documented by the ODFW using the Lower Cow Creek watershed (BLM 2002), which includes the aquatic ecosystems of concern in the OU2 BERA. Based on stream surveys conducted by ODFW in 1993, juvenile coho, steelhead, cutthroat and rainbow trout used Middle Creek for rearing. Cutthroat and steelhead juveniles have been documented using the

upper reaches of most streams in the Lower Cow Creek watershed. The number of fish declined in the upper reaches of Middle Creek possibly because of acid mine drainage from the Formosa Mine, timber harvesting, and the removal of large woody debris from streams in the watershed (BLM 2002).

Fish surveys were conducted by BLM in 2007 at several additional locations along Middle Creek and South Fork Middle Creek (C. Sipher, BLM, personal communication, 2012). These surveys were conducted using backpack electroshocking, as were the recent surveys described below. While the presence or absence of fish can be compared at the same locations that were sampled during BLM surveys in 2007 to those sampled in 2012 and 2013, the numbers of fish observed are not directly comparable due to differences in electroshocking effort.

5.2.1.2 Recent Data

Fish presence/absence surveys were conducted in Middle Creek and South Fork Middle Creek by EPA, and BLM, in June and September of 2012 and 2013. In June 2012, sampling was conducted at eight stations on Middle Creek and four locations on South Fork Middle Creek along with three reference locations: Martin Creek Reference, MREF, and SFREF. During the remaining sampling events (September 2012, June 2013, and September 2013), three locations on Middle Creek and two locations on South Fork Middle Creek were not sampled. In addition, the MREF location was not sampled because it was not flowing in both September 2012 and September 2013. All sampling locations are described in Section 2.2.1.1 and shown in **Figure 1-1a, Figure 1-1b,** and **Figure 1-1c**.

Fish surveys were conducted using backpack electroshocking, focusing on pools that provide suitable fish habitat. Although determining the number of fish collected for a given level of effort, the catch per unit effort was not an objective of these surveys, approximately equal effort was expended at each sampling location, allowing for a general comparison of fish abundance (e.g., none, few, several).

Middle Creek is designated a Tier 1 Key Watershed under the Aquatic Conservation Strategy of the Northwest Forest Plan (USFS and BLM 1994). Tier 1 watersheds are those that contribute directly to conservation of at-risk anadromous salmonids, bull trout, and resident fish species. In addition, Tier 1 Watersheds have a high potential of being restored as part of a watershed restoration program.

Based on observations during field reconnaissance surveys and ecological sampling events (and described in Section 2.2.1), suitable habitat for fish is present in all sampling locations on Middle Creek and South Fork Middle Creek. In higher gradient reaches upstream, some species, such as sculpin, would not be expected to occur. However, salmonids, including coho salmon, steelhead, and cutthroat trout, are able to access these upper reaches where significant barriers are not present.

As described in Section 2.2.1, the M1.2 sampling location is the furthest upstream sampling location on Middle Creek where there is suitable fish habitat and fish access. A large culvert just downstream of the MXR location (approximately 0.5 miles upstream of M1.2) likely prohibits access for fish to MXR and locations further upstream. Other culverts downstream on Middle Creek likely prohibit fish passage at certain times of the year, or during certain years, depending on flow. M1.2 is the most upstream location where fish surveys were conducted on Middle Creek.

Similarly, a large culvert is present on South Fork Middle Creek at the SF1.0 sampling location. This culvert may be passable by fish under high flows, and there appears to be suitable fish habitat just upstream of SF1.0. Similar to Middle Creek, there are other culverts downstream on South Fork Middle Creek that likely prohibit fish passage under certain flows. In June 2012, BMI samples were collected at location SF0.7 further upstream of SF1.0, as described in Section 2 (South Fork Middle

Creek Sampling Locations). No fish surveys were conducted at SF0.7 because of the low water level and general lack of suitable habitat for fish. Therefore, SF1.0 is the most upstream location where fish surveys were conducted on South Fork Middle Creek.

Because habitat is similar and considered suitable for fish at all fish survey locations on Middle Creek and South Fork Middle Creek, observations of fish presence/absence and relative abundance among locations and over time is appropriate and can be considered one line of evidence regarding effects from the Formosa Mine on these key ecological receptors.

Results of Fish Surveys on Middle Creek

Fish were observed at all stations sampled on Middle Creek during one or more of the four survey events (June 2012, September 2012, June 2013, and September 2013). Numbers of fish observed at each sampling location were relatively consistent among sampling events. Few fish were observed at M1.2, and numbers of fish increased with distance from the mine. While no comprehensive population survey was conducted, there is evidence of fish reproduction and rearing in Middle Creek. Young of the year salmonids (coho salmon and trout fry) were observed as far upstream as M2.0. In addition, a steelhead redd was observed at M3.1 in June 2013.

Results of Fish Surveys on South Fork Middle Creek

Fish were observed at all stations sampled on South Fork Middle Creek during one or more of the four survey events, and numbers of fish increased with distance from the mine. Few fish were observed at SF1.0 while several were observed at SF3.0 and SF4.7. Young of the year salmonids (steelhead/rainbow trout fry) were observed as far upstream as SF3.0.

Results of Recent Fish Surveys on Reference Streams

Several fish were observed at both Martin Creek Reference and SFREF during all four survey events. No fish were observed in MREF during any of the survey events (stream location was not flowing during September events). At Martin Creek Reference and SFREF, the number of fish observed was relatively consistent among the four surveys.

The Martin Creek Reference location is a fifth order stream that is a tributary of Middle Creek upstream of M7.9. Species observed included coho salmon, steelhead/rainbow trout, cutthroat trout, and sculpin. Young of year coho and trout fry were observed. Fish abundance and species observed were similar to those at M3.0 and M3.1.

The SFREF location is a fourth order stream that is a tributary of South Fork Middle Creek, with the confluence just downstream of SF1.0. At the SFREF location, small numbers of cutthroat trout were observed. No young of the year fish were observed. Fish abundance and species observed were similar to those at SF3.0.

Comparison of Recent Fish Surveys to Historical Fish Surveys

As mentioned above, the results of recent fish surveys can be compared to historical fish surveys to consider whether or not fish were observed but not to compare numbers of fish observed due to potential differences in electroshocking effort. In 2007, BLM observed fish at all the locations where they sampled, including M3.0, M3.1, M5.5, M7.9, M9.8, SF3.0, SF4.7, and the Martin Creek Reference location. Other locations upstream were not sampled. At some locations, numbers of fish observed were much lower (M3.0 = 3; M3.1 = 9; SF3.0 = 1; SF4.7 = 5) compared to other locations (M5.5 = 59; M7.9 = 67; M9.8 = 78; Martin Creek Reference = 99), indicating impairment in the former locations, assuming the level of electroshocking effort was consistent among all locations.

Table 5-4 presents the numbers of fish observed during surveys conducted in 2000, 2003, 2007, 2012, and 2013. Over this period, fish count surveys were conducted by different techniques, and numbers observed during surveys 2012 and 2013 are qualitatively used to document presence and/or absence of fish, not for quantitative comparisons with historical data. With that limitation in mind, relative numbers of fish are the recommended metric to be used for comparisons and appear to be increasing in both Middle Creek and South Fork Middle Creek when considering M3.0 and SF3.0, which are the locations that have been most frequently measured/observed.

Summary of Fish Surveys

In summary, recently collected data suggest that reaches of Middle Creek and South Fork Middle Creek vary in their current ability to support fish.

- Fish appear to be abundant at M3.0 and further downstream in Middle Creek. In addition, fish appear abundant at SF3.0 and further downstream in South Fork Middle Creek. This suggests that conditions in these reaches are fully suitable for fish survival and possibly suitable for growth and/or reproduction.
- Fish are abundant in the Martin Creek Reference and South Fork Reference locations.
- Fewer fish are found at M2.0 in Middle Creek, suggesting that current conditions may not be optimal but may be acceptable for fish survival. The suitability of current conditions at this location for fish growth and/or reproduction is unknown.
- Fish are found in very low numbers at M1.2 in Middle Creek and SF1.0 in South Fork Middle Creek, suggesting that current conditions at these locations are marginal for supporting fish survival and likely not supportive of fish growth and/or reproduction.
- Fish have not been found recently in the 2012 and 2013 observations, at the Middle Creek Reference location. This likely is related to habitat limitations and low flow conditions.
- Compared to historical surveys conducted by BLM since 1999, the relative numbers of fish appear to be increasing in both Middle Creek and South Fork Middle Creek when considering M3.0 and SF3.0, which are the locations that have been most frequently sampled.

Presence/absence survey data provide limited information on the condition of the fish assemblage in these ecosystems. While species and size were noted during surveys to the extent possible, the goal was to determine fish presence or absence, not to conduct a comprehensive survey of community metrics. Surveys were only conducted during late June and September, and no comprehensive spawning surveys were conducted.

5.2.2 Benthic Macroinvertebrate Community Data

BMI are often used as indicators of water quality because they generally have limited mobility, life cycles that often span 1 to 2 years, and are sensitive to environmental contaminants, including dissolved metals.

5.2.2.1 Historical Data

BMI sampling has been conducted during several previous investigations, including the RI conducted by BLM/ODEQ in 1999 and subsequent BMI community sampling by BLM in 2000, 2001, 2002, 2007, and 2008. The BLM/ODEQ RI report (BLM/ODEQ 2000) compared BMI data from pre-modern mining

operations through 1999 and concluded that the populations of benthic macroinvertebrates in Middle Creek and South Fork Middle Creek were at their poorest condition in 1999. BLM/ODEQ reported that total macroinvertebrate density and number of EPT taxa in Middle Creek (sampling location M3.0) were reduced 96% and 73%, respectively, from pre-modern mining conditions compared to 1999.

For South Fork Middle Creek (sampling location SF4.7), total macroinvertebrate density and number of EPT taxa were reduced 98% and 72%, respectively, from pre-modern mining conditions compared to 1999 (BLM/ODEQ 2000). The RI found a correlation between increasing concentrations of zinc in the surface water and the decline of macroinvertebrate abundance and number of EPT taxa. Data from Cow Creek location C2 (downstream of Cow Creek and Middle Creek confluence) indicate that macroinvertebrate communities have experienced stress, likely due to the releases of heavy metals such as zinc and copper.

BMI community sampling was conducted by BLM in 2000, 2001, 2002, 2007, and 2008 at several additional locations along Middle Creek and South Fork Middle Creek (C. Sipher, BLM, personal communication 2012). Discussion of these data in comparison to recent data collected by EPA is provided following discussion of recent data in Section 5.2.2.2.

5.2.2.2 Recent Data

Sampling of BMI was conducted in Middle Creek and South Fork Middle Creek in June and September of 2012 and 2013. As with fish surveys described above, BMI sampling was conducted in June 2012 at eight stations on Middle Creek and four locations on South Fork Middle Creek along with three reference locations: Martin Creek Reference, MREF, and SFREF. During the remaining sampling events (September 2012, June 2013, and September 2013), three locations on Middle Creek and two locations on South Fork Middle Creek were not sampled. In addition, the MREF location was not sampled because it was not flowing in both September 2012 and September 2013. All sampling locations are described in Section 2.2.1.1 and shown in **Figure 1-a, Figure 1-1b,** and **Figure 1-1c**.

All BMI samples were collected using standardized methods with a Surber sampler in riffle habitats. Eight replicates were collected and combined at each sampling location. These samples were used to determine BMI community structure using a specific set of abundance and diversity metrics. The metrics selected include the following:

- Total invertebrate density (no. of organisms/square meter)
- Total number of taxa
- Number of EPT taxa: E-Ephemeroptera (mayflies), P-Plecoptera (stoneflies), and T-Trichoptera (caddisflies)

Data from BMI sampling are provided in **Appendix D**. As described above, there are differences in habitat suitability for benthic macroinvertebrates among sampling locations, and these differences may contribute to the observed differences in density and abundance of invertebrates described below.

Comparison to Reference Locations

The MREF reference location, which is located on a small tributary to Middle Creek, is most similar in habitat to upstream locations on Middle Creek, including M1.2 and M2.0. The Martin Creek Reference location is most similar to locations somewhat downstream on Middle Creek such as M3.1. Further

downstream, at locations including M7.9, M9.8, and M13, comparison of BMI metrics to reference locations may not be appropriate due to habitat differences in these larger downstream stream reaches as compared to the smaller reference locations.

The SFREF reference location is located on an upstream tributary to South Fork Middle Creek and is similar in habitat to SF1.0. At locations further downstream, such as at SF4.7, it is more appropriate to compare BMI metrics to the Martin Creek Reference location than to SFREF.

Further discussion of habitat variability among sampling locations is provided below.

BMI Abundance

Total numbers of organisms per square meter appear to be reduced at upstream locations on Middle Creek, specifically M1.2, M2.0, and M3.0, compared to downstream locations and reference locations, as shown in **Figure 5-1**. BMI abundance in Middle Creek was approximately equal to or exceeded that at the MREF reference location at all Middle Creek sampling stations except the most upstream, M1.2. However, BMI abundance was generally lower than at the Martin Creek Reference at the Middle Creek sampling locations upstream of M7.9.

Differences in habitat may account for some of this variation, as described further below. In addition, June 2013 abundance data are greater than both June and September 2012 and September 2013 numbers for nearly all sampling locations except Martin Creek Reference. If only June 2013 total abundance data are considered, only the most upstream location on Middle Creek, M1.2, appears impaired relative to the reference locations.

For South Fork Middle Creek, total numbers of organisms per square meter generally increased with distance from the Formosa Mine, with the exception of SF4.7 (**Figure 5-2**). The most upstream locations, SF0.7 and SF1.0, appear impaired compared to the SFREF reference location. Abundance at SF3.0 does not show significant impairment compared to Martin Creek reference; however, abundance at SF4.7 is lower than at Martin Creek reference.

BMI Taxa Richness

The total number of BMI taxa, or taxa richness, increased in Middle Creek with distance from the Formosa Mine, with the exception of the most downstream sampling stations M9.8 and M13 (**Figure 5-3**). These stations were only sampled in June 2012 and were found to have lower total taxa than stations further upstream. Compared to both the Martin Creek reference location and MREF, taxa richness was lower at all Middle Creek sampling locations during all sampling events.

For South Fork Middle Creek, there is no obvious trend in total number of BMI taxa with distance from the mine, particularly downstream of SF0.7 (**Figure 5-4**). Taxa richness was lower at all South Fork Middle Creek sampling locations than the reference locations, with the exception of SF1.0 compared to SFREF in September 2012.

EPT Taxa Richness

EPT taxa are generally considered intolerant to poor water quality. Compared to both the Martin Creek and MREF locations, the number of EPT taxa was lower at all Middle Creek sampling locations (**Figure 5-5**). EPT taxa richness generally increases in Middle Creek with distance from the Formosa Mine.

The number of EPT taxa in South Fork Middle Creek is generally lower than at reference locations (**Figure 5-6**). As with total taxa, there is not an obvious trend in total EPT taxa with distance from the mine, particularly downstream of SF0.7.

Predictive Modeling

Predictive modeling estimates the expected occurrence of macroinvertebrates at a sample location by developing a list of insect species that commonly occur at reference locations that have similar natural characteristic to the sample locations. For the State of Oregon, ODEQ developed the Predictive Assessment Tool for Oregon (PREDATOR), consisting of three regional models that assess the biological integrity of wadeable streams across Oregon. The PREDATOR model for the Western Cordillera and Columbia Plateau ecoregion is based on 167 reference sites grouped into 5 distinct classes based on the similarity of macroinvertebrate assemblage composition among sites following standard methods. ODEQ developed the models to supply a scientifically rigorous bioassessment tool that is easy to apply and provides a more complete understanding of the stream conditions across Oregon (ODEQ 2008).

Similar to other predictive models, PREDATOR generates an expected occurrence probability (how likely a taxon is to occur) for each species at a test site. Common taxa at reference sites with similar environmental conditions will have higher occurrence probabilities at test sites. The sum of the occurrence probabilities is the expected number of reference taxa, "E." Expected taxa are restricted to those taxa that were found at reference sites used for building the model. The observed taxa, or "O," are the number of expected taxa that were actually collected at the test site.

The predictive model output is the observed to expected (O/E) taxa ratio. Scores less than 1 have fewer taxa at a site than were predicted by the model. Scores greater than 1 are either equivalent to the reference location or may have an enhanced insect community as a result of some type of enrichment. Another way to think of the score is in terms of the percentage of taxa loss or gain. Values less than 1.0 represent a loss of common native reference taxa. Percent taxa loss or gain is defined as:

$$(O/E - 1.0) * 100$$

A rating of "good," "fair," or "poor" is given based on the O/E score relative to the distribution of scores for reference sites. Samples with less than the required number of organisms are given an NA or "Null" rating because they did not meet model requirements.

Table 5-5 presents the O/E values for Middle Creek, South Fork Middle Creek, and the reference locations. Based on the PREDATOR model (ODEQ 2008), the condition in Middle Creek improves with increasing distance from Formosa Mine, with the exception of the most downstream location, M13. This is likely due to the different habitat at M13, as described further below.

For South Fork Middle Creek, all locations appear to show a "poor" condition based on PREDATOR Model results. Both the MREF and Martin Creek reference locations scored as having "good" condition. The SFREF location received "poor" and "fair" condition scores, indicating it may not be an appropriate reference location.

Comparison of Recent Data to Historical Data

Historical BMI data collected by BLM and others may not be directly comparable to recent (2012 and 2013) data due to differences in sampling methodology. Historical data were collected using kick nets while recent sampling utilized Surber samplers, which allow for a more quantitative evaluation of BMI

communities. However, comparison of taxa richness metrics (total number of taxa and total number of EPT taxa) among the same sampling locations is useful. **Table 5-6** and **Table 5-7** provide the total number of taxa and total number of EPT taxa, respectively, for Middle Creek locations from both historical and recent sampling.

From these data, it appears that BMI diversity has increased in Middle Creek. Both the number of total taxa and the number of EPT taxa show generally increasing trends at stations that have been consistently sampled since 1999.

Table 5-8 and Table 5-9 provide the total number of taxa and total number of EPT taxa, respectively, for South Fork Middle Creek locations from both historical and recent sampling. While both the number of total taxa and the number of EPT taxa show an obvious increase at the SF1.0 location in South Fork Middle Creek, the other sampling locations do not show an obvious trend, particularly for the number of EPT taxa.

Table 5-10 and **Table 5-11** provide the total number of taxa and total number of EPT taxa, respectively, for the reference locations from both historical and recent sampling. These data indicate a general consistency in these BMI diversity metrics at all three reference locations. The exception to this is the number of EPT taxa at the South Fork Reference location, which appears to be declining slightly based on recent sampling data.

Comparison of BMI Data to Surface Water Concentrations

There are a small number of sampling events where both BMI sampling and surface water sampling for metals analysis were conducted concurrently. They are as follows:

M3.0 was sampled on September 11, 2012 and June 18, 2013.

M7.9 was sampled on September 11, 2012 and June 18, 2013.

SF1.0 was sampled on September 12, 2012 and June 17, 2013.

SF3.0 was sampled on September 12, 2012 and June 19, 2013.

SFREF was sampled on September 12, 2012 and June 19, 2013.

MREF was sampled on June 19, 2013.

Dissolved concentrations of cadmium, copper, and zinc were compared to the total number of taxa and the number of EPT taxa for these events, as shown in **Figure 5-7**. Concentrations of dissolved cadmium, copper, and zinc were correlated with one another. At most locations, there was an inverse relationship between the concentration of dissolved metals and BMI metrics. However, at a few locations, this relationship is not apparent, including SF1.0 in September 2012 where BMI metrics are higher than expected given the relatively high metals concentrations and SF3.0 in June 2013 where BMI metrics are lower than expected given the relatively low metals concentrations. BMI community metrics are indicators of water quality effects over an extended period of time (several months to a year or more), whereas metals concentrations are measurements at one point in time. Although data are too limited to draw important conclusions, it is likely that there are many other variables influencing BMI metrics in addition to surface water metals concentrations.

Summary of BMI Community Sampling

Recently collected data suggest that reaches of Middle Creek and South Fork Middle Creek vary in their current ability to support BMI.

- Total numbers of BMI organisms per square meter appear to be reduced at upstream locations on both Middle Creek and South Fork Middle Creek compared to downstream locations and reference locations.
- The total number of BMI taxa, or taxa richness, generally increased in Middle Creek with distance from the Formosa Mine, with the exception of the most downstream sampling stations where habitat differences may be a determining factor. For South Fork Middle Creek, there is no obvious trend in total number of taxa with distance from the mine, particularly downstream of SF0.7. Compared to reference locations, taxa richness was lower than reference at nearly all Middle Creek and South Fork Middle Creek sampling locations.
- The number of EPT taxa was lower at Middle Creek and South Fork Middle Creek sampling locations than at the reference stations. EPT taxa richness generally increases in Middle Creek with distance from the Formosa Mine. As with total taxa, there is no obvious trend in total number of EPT taxa with distance from the mine in South Fork Middle Creek, particularly downstream of SF0.7.
- Based on predictive modeling using the PREDATOR model (ODEQ 2008), the condition in Middle Creek improves with increasing distance from Formosa Mine, with the exception of the most downstream location, M13, where habitat is significantly different as described below. For South Fork Middle Creek, all locations appear to show a "poor" condition based on PREDATOR model results.
- Compared to historical data collected by BLM since 1999, it appears that both the number of total taxa and the number of EPT taxa in Middle Creek show generally increasing trends at stations that have been consistently sampled. For South Fork Middle Creek, the trend is not obvious, except for at the SF1.0 location where both the number of total taxa and the number of EPT taxa have increased since 1999.

Habitat Variability

Selection of ecological sampling locations is important given natural variability in fish and BMI communities based on habitat. Habitat is a major determinant of aquatic community potential, and effects of such features on sampling results can be minimized by sampling similar habitats at all locations being compared. When there are differences among sampling locations with regard to physical habitat, characterization of those differences is important for proper interpretation of biosurvey results (Barbour et al. 1999).

In 2012 and 2013, ecological sampling locations, including reference locations, were selected to be consistent with previous sampling by BLM and others such that results could be compared to those historical data. The sampling objective centered around identifying the zone of impairment in aquatic systems due to the Formosa Mine. To that end, sampling was conducted over a broad spatial range to the downstream extents of both Middle Creek and South Fork Middle Creek. Within each, appropriate habitat was selected for sample collection; riffle habitats were selected for BMI sampling, whereas pools were targeted for fish surveys.

Table 5-12 provides the habitat features that were characterized at each sampling location. All ecological sampling locations are within the same watershed and have the same predominant surrounding land use type (e.g., no location is disproportionately affected by land uses that contribute to nonpoint pollution such as clearcut areas, agricultural lands). Some locations are adjacent to road crossings and/or cleared areas used for camping, but these alterations are not considered to have a significant effect on aquatic habitat at these locations. There is no extensive channelization of streams in any location.

All locations have riparian vegetation that provides shade, large woody debris, and stabilized banks although some locations do exhibit more bank incisement than others. Some locations have more instream structure, including vegetated islands. All locations had minimal sedimentation. All locations have some diversity of riffles, runs, and pools although some locations are more heterogeneous than others. Generally, the deeper the water at a given sampling location, the more diversity of pools and instream structure. The substrate varies among sampling locations, with some locations having predominantly larger substrate (large cobbles and boulders) and some locations having some bedrock, which reduces the instream refugia and BMI habitat in some areas.

Some sampling locations are located near road culverts and other potential barriers to fish movement. Potential obstructions are further described in Section 2.2.1.1. No comprehensive fish barrier assessment has been completed for Middle Creek or South Fork Middle Creek. Salmonids were found to be present upstream of the culverts at M3.0, M3.1, and SF4.7 on both Middle Creek and South Fork Middle Creek, indicating that these culverts are not posing a barrier to fish passage. On Middle Creek, fish are likely able to move upstream of M1.2 but may not be able to access MXR, which is located upstream of a large culvert. On South Fork Middle Creek, fish may not be able to move upstream of the culvert at SF1.0.

Habitat variability is likely a limiting factor in the ecological sampling conducted for the OU2 BERA. Although habitat was generally characterized and samples were collected from similar habitat at each location, microhabitats, such as substrate size, the amount of leaf litter, sediment, woody debris, and stream bank vegetation, likely differ among locations and result in differences in macroinvertebrate persistence and community composition.

For instance, at the M13 sampling location, which is just upstream of the confluence with Cow Creek, the stream is wide (bankfull width of 44 feet), sixth order, and relatively flat (low gradient). There is an abundance of riffle habitat at M13, but several characteristics of M13 suggest that this habitat differs substantially from the riffle habitat upstream at M3.0, which is considerably more narrow (bankfull width of 16 feet), fourth order, and has a higher gradient and a generally larger sized substrate that provides more suitable conditions for most EPT taxa. These habitat differences are important with regard to BMI community metrics. Although the relative contribution of these attributes to the overall BMI metrics is not easily differentiated, the O/E condition scores may reflect these habitat effects.

Seasonal Variability

Seasonal variability in BMI communities was noted in historical data collected by BLM. For all locations, BLM/ODEQ data indicated a lower abundance and number of EPT taxa in spring 1999 when compared to fall 1999 results. The low numbers in spring correspond to higher concentrations of heavy metals during runoff, but reduced abundance may possibly be affected by increased flows in the spring that have the potential to reduce suitable habitat.

Barbour et al. (1999) suggest that a single index period for BMI sampling can provide a strong database to address objectives, such as determination of a zone of impairment, but would not likely be adequate for assessing seasonal variability or the effects of catastrophic events such as spill.

BMI sampling for the OU2 BERA was conducted in June and September of 2012 and 2013, which can be considered a single index period (summer). While the late June sampling period represents a period when more water is generally present in the systems than in September, both sampling times are outside the spring high flow season, and there has been adequate time for the instream environment to stabilize following those higher flows.

In addition, the BMI community assemblage would not be expected to differ substantially between late June and September based on seasonal life cycles. During this period, many macroinvertebrates reach body sizes that can be readily identified and representation of benthic macroinvertebrate species reaches a maximum, particularly during periods of pre-emergence from mid-spring to late summer.

Although the BMI community assemblage in June is expected to be relatively similar to that observed in September, BMI metrics from recently collected data do appear to be higher in September than in June. This suggests that when evaluating BMI metrics, it is most appropriate to compare June data to June data and September data to September data.

5.3 Risk Summary

This section summarizes the risk estimates of the OU2 BERA based on the information presented in preceding sections. This summary uses the term "UNACCEPTABLE RISK" to describe HQs greater than the threshold of 1 and "ACCEPTABLE RISK" for situations where calculated HQs remain below 1. Risks are summarized by major receptor groups.

5.3.1 Risk to Aquatic and Water-Dependent Receptors

- Unacceptable Risk
  - **Aquatic life -** cadmium, copper, and zinc at MXR; cadmium at M3.0 (and assumed at other locations upstream on Middle Creek, including M1.2 and M2.0). Cadmium, copper, and zinc at SF1.0; copper at SF3.0.
  - **Salmonid fish -** cadmium, copper, and zinc at MXR and SF1.0.
- Acceptable Risk
  - **Aquatic life -** All locations downstream of MXR for copper and zinc. Locations downstream of M3.0 for cadmium.
  - **Salmonid fish-** All locations downstream of MXR and SF1.0 for all COPCs.

5.3.2 Responses to Risk Questions

Section 2.3.3 presented the risk questions or hypotheses developed for the OU2 BERA. An important objective of the BERA is to answer these questions and in doing so provide risk managers with important information regarding risk and the need for remediation. These questions are repeated below, with responses based on the results of the OU2 BERA.

- Aquatic Life (General)
  - Are the levels of contaminants in surface water greater than the chronic surface water criteria serving as TRVs for the survival, growth, or reproduction of aquatic plants, water column and benthic macroinvertebrates, fish, and larval amphibians?

    YES – for cadmium, copper, and zinc at MXR; cadmium at M3.0, and assumed at other locations upstream on Middle Creek, including M1.2 and M2.0. Cadmium, copper, and zinc at SF1.0; copper at SF3.0.

Data to support a response to this question include COPC as dissolved concentrations in surface water that are hardness adjusted, as applicable, from multiple locations.

- BMI metrics at locations in Middle Creek and South Fork Middle Creek were compared to those at reference locations. As described above, habitat and seasonal variability limit the conclusions that can be drawn from the data available. The number of EPT taxa metric was used to make the following observations based on comparisons of June sampling data to reference locations.
  - Is the structure (based primarily on abundance and diversity) of BMI communities different from that of reference locations?

    YES – In Middle Creek, at M1.2, M2.0, M3.0, and M3.1, based on the number of EPT taxa (in June 2012 and 2013) at these locations compared to the MREF and Martin Creek Reference locations.

    YES – In South Fork Middle Creek, at SF1.0 and SF3.0, based on the number of EPT taxa (in June 2012 and 2013) at these locations compared to the SFREF and Martin Creek Reference locations.

Data to support the responses to this question include historical and recent BMI surveys conducted by BLM and EPA, emphasizing measurement of metrics related to abundance and diversity from locations, including reference and potentially impaired reflecting conditions between highly impaired (i.e., as of September 2013, non-supportive of BMI) and reference.

- Salmonid Fish – Are the concentrations of dissolved contaminants in surface water greater than the salmonid-specific surface water TRVs (dissolved) for the survival, growth, and reproduction of salmonid fish?

  YES – For cadmium, copper, and zinc at MXR and SF1.0.

- Is there a difference in fish presence/absence in surface waters affected by MIW compared to reference areas?

  YES – Salmonid fish are abundant in the Martin Creek Reference and South Fork Reference locations. In comparison, fish are found in relatively low numbers at M1.2 and M2.0 in Middle Creek and at SF1.0 in South Fork Middle Creek.

5.3.3 Spatial Extent of Impairment

Previous investigations, including those conducted by BLM, have identified impairment in Middle Creek and South Fork Middle Creek based on water quality, fish surveys, and BMI metrics. As

described in Section 5.2, BLM survey found fewer fish at the most upstream locations sampled (M3.0 and M3.1 on Middle Creek and SF3.0 on South Fork Middle Creek) compared with numbers downstream. Similarly, as shown in Table 5-6 and Table 5-7, BMI data collected by BLM as recent as 2007 show impairment at M3.0 and M3.1 on Middle Creek compared to recent data collected for the OU2 BERA, which indicate these locations may have improved somewhat, and that the zone of impairment is now further upstream at locations M1.2 and M2.0. South Fork Middle Creek also shows some improvement based on BMI data shown in Table 5-8 and Table 5-9, particularly at SF1.0.

BMI O/E condition scores, as described in Section 5.2.2.2 are shown in **Figures 5-8a, 5-8b,** and **5-8c** to illustrate the spatial extent of impairment in Middle Creek and South Fork Middle Creek. HQs for cadmium, copper, and zinc based on ODEQ CCC (based on average detections, hardness-adjusted) are shown in call-out boxes at the locations where surface water sampling has been conducted. HQs are high at MXR and SFA2 near the mine, and decrease with distance from the mine.

HQs are less than 1 for all three metals at M7.9 and SF3.0 and less than 0.1 at reference locations MREF and SFREF. At M13, the HQ is greater than 1 for cadmium. Copper and zinc HQs at M7.9 and M13.0 are similar. Cadmium detections at M13.0 were estimated (J-qualified) because the value was below the reporting limit of (0.5 µg/L). Hardness levels were lower at M13, resulting in higher HQ for cadmium because lower hardness equates to lower thresholds for adverse effects.

As shown in **Figures 5-8a, 5-8b, and 5-8c**, impairment based on BMI O/E condition score is clearly evident in Middle Creek until around M3.1, whereas all of South Fork Middle Creek is clearly impaired. Between M3.1 and M5.5, there appears to be a transition zone between impaired and recovering. Locations downstream of M5.5 appear to be recovering. At M13, the BMI O/E score indicates impairment, likely because of habitat differences as previously discussed. Since M13 is at the downstream end of Middle Creek, impairment downstream is not shown on the scale of **Figure 5-8c**.

Based on HQs, risks to aquatic life are present at MXR (cadmium, copper, and zinc), M3.0 (cadmium only), and M13 (cadmium only, as discussed above). South Fork Middle Creek presents risks to aquatic life upstream of and including SF1.0 for all three metals.

5.3.4 Summary of Risks to Aquatic Life

A summary of the findings of the OU2 BERA based on multiple lines of evidence used to evaluate ecological risks is provided in the bulleted list below. The information is presented by receptor, first for water quality relative to fish and second a summary of evidence relative to BMI.

The following are summary points related to water quality and fish.

- Comparison of surface water COPC concentrations to national and ODEQ water quality criteria
  - Middle Creek: Risk to aquatic life from cadmium, copper, and zinc at MXR and from cadmium at M3.0.
  - South Fork Middle Creek: Risk to aquatic life from cadmium, copper, and zinc at SF1.0 and from copper at SF3.0.
- Comparison of surface water COPC concentrations to salmonid-specific TRVs
  - Middle Creek: Risk to aquatic life from cadmium, copper, and zinc at MXR.

  - South Fork Middle Creek: Risk to aquatic life from cadmium, copper, and zinc at SF1.0.

- Fish presence/absence
  - Middle Creek: Fish abundant at M3.0 and further downstream. Fish present but lower in number at sites upstream.
  - South Fork Middle Creek: Fish abundant at SF3.0 and further downstream. Fish present but lower in number at sites upstream.
  - Fish abundant in the Martin Creek Reference and South Fork Reference locations.

The following are summary points related to measurements of BMI.

- Total number of organisms
  - Middle Creek: Increased with distance from mine. Reduced at upstream locations compared to reference.
  - South Fork Middle Creek: Increased with distance from mine. Reduced at upstream locations compared to reference.
- Total number of taxa
  - Middle Creek: Increased with distance from mine. Reduced at all or most locations compared to reference.
  - South Fork Middle Creek: Reduced at SF0.7; no general trend with distance from mine. Reduced at all locations compared to reference.
- Total number of EPT taxa
  - Middle Creek: Increased with distance from mine. Reduced at all or most locations compared to reference.
  - South Fork Middle Creek: Reduced at SF0.7; no general trend with distance from mine. Reduced at all locations compared to reference.
- PREDATOR model
  - Middle Creek: Condition rating shows impairment in upstream locations, with a transition zone from M3.0 to M5.5, and a zone of recovery downstream of M5.5.
  - South Fork Middle Creek: Condition rating shows impairment at all locations.
- Comparison with historical data
  - Middle Creek: Increasing trends in total taxa and EPT taxa at locations consistently sampled.
  - South Fork Middle Creek: Increasing trends in total taxa and EPT taxa apparent at SF1.0 location only.

5.4 Uncertainty Analysis

Uncertainties at any point in the OU2 BERA can affect confidence in the acceptance or rejection of hypotheses and overall conclusions reached in the ERA. Important areas of potential uncertainty related to exposure assessment and effects assessment are discussed in Sections 3 and 4, respectively. Important components of these presentations are summarized here, along with uncertainties specifically related to risk characterization.

By definition, uncertainties in risk characterization are influenced by uncertainties in exposure assessment and effects assessment. Descriptions of the magnitude and distribution of COPCs within the surface waters potentially impacted by the mine and the reference areas are considered generally to be representative of current conditions within those areas. In spite of the overall confidence in exposure data, some data are clearly biased towards times of the year when sampling is easiest or most desirable.

For example, data collected during storm events are limited and may not represent the wide range of conditions that may be seen during such events. Specifically, recent flows, storm events, degree and location of upwelling of ground water, and other factors can affect surface water metals concentrations and associated EPCs. These biases may, in various ways, affect the EPC calculations. The surface water data used in the OU2 BERA are considered representative of the long-term average or "most likely" conditions to which aquatic receptors are exposed. However, additional surface water sampling in downstream locations of ecological importance (e.g., M3.0, M7.9, M13, SF1.0, SF3.0, SFREF, and MREF) during the wet season would reduce uncertainty in representativeness of the exposure assessment. In the same manner, collection of additional surface water, BMI, and fish survey data in subsequent years (e.g., 2014 and 2015) would help reduce uncertainty associated with the relatively small dataset. Additional BMI sampling at SF0.7, the most upstream location sampled in South Fork Middle Creek, would be valuable to support conclusions regarding the spatial extent of ecological impairment. Similarly, BMI sampling at MXR, which has not been conducted to date, would be useful in verifying ecological impairment near the upstream extent of Middle Creek.

Effects data can contribute to overall uncertainty in risk characterization. Science and scientific investigations cannot prove any hypothesis beyond doubt. The scientific method is instead based on stating hypotheses, testing the hypotheses, and either accepting or rejecting the hypotheses based on one or more lines of evidence. Cause and effect relationships can be inferred, and evidence can support hypotheses, but cause and effect relationships can rarely be proven. Because no data are conclusive, site-specific data are subject to concerns of representativeness. Toxicity data that are not site specific may not be applicable in their entirety to the site being investigated.

There are concerns about laboratory-to-field extrapolation of effects data and concerns with taxa-to-taxa extrapolations. All effects data are, therefore, subject to some degree of uncertainty. Confidence in the ability of selected effects data for use as TRVs to assess potential for ecological risks varies for each data value selected. While each and every effects data value used in this and every other BERA is associated with some degree of uncertainty, it is the general trend described by the comparisons between exposure concentrations and effects concentrations, and the overall confidence in such comparisons, that are most important. For the most part, there is higher confidence in effects data for the major surface water COPCs and for metals-related effects to upper trophic level mammals and birds. In decreasing order of confidence, these are followed by effects data for major COPCs in sediment, surface soil, and whole body fish tissue.

Another potential source of uncertainty is the biological data collected to support the OU2 BERA. For example, natural differences in BMI metrics among varying stream habitat types, along with potential seasonal differences, may be important sources of uncertainty when drawing conclusions from these data.

The risk characterization method itself can contribute to uncertainty. Careful calculation of EPCs, with special attention given to handling non-detect data and infrequently detected values, along with careful review of multiple sources of effects data, minimizes this type of uncertainty. Incorporating general observations and several other lines of evidence (e.g., community structure) into risk characterization reduces the dependence on strict quantitative risk estimates that in some cases are more uncertain.

5.5 Ecological Issues Relating to Remedial Alternatives

The aquatic environments of Middle Creek and South Fork Middle Creek include a variety of habitats, ranging from poor or degraded (based primarily on degree of disturbance, both anthropogenic and natural) to apparently suitable and supportive of diverse ecological communities. Estimated risks vary throughout the watersheds, with some of the upper reaches of the major creeks seemingly the most highly contaminated.

Even the most highly contaminated portions of these creeks can probably support ecological communities with limited diversity and/or abundance. For example, although not abundant, a few types of BMI and in some locations an occasional fish have been collected in some of the upper reaches where concentrations of dissolved metals are high. For this reason, remediation efforts related to instream or stream bank contamination should consider the current level of ecological use and functional value as well as degree of contamination. For the most part, all reaches of Middle Creek and South Fork Middle Creek appear to provide suitable physical habitat conditions that are expected to be supportable of diverse aquatic communities but are currently (September 2013) non-supportable because of poor water quality.

The derivation of quantitative remedial goals, commonly termed preliminary remediation goals or PRGs, can be useful to help determine which areas warrant remediation. Surface water PRGs can be derived for a variety of receptors or receptor groups exposed to dissolved metals using a variety of information sources, including the results of the OU2BERA. The salmonid-specific TRVs selected for use in the OU2 BERA can serve as initial PRGs in many cases for surface water because trout and salmon are among the most sensitive aquatic biota to dissolved metals exposures. These salmonid-specific TRVs can be supplemented by other surface water TRVs to provide a range of potentially useful PRGs for surface water. Supplemental surface water TRVs can include surface water metals concentrations associated with low but ecologically significant adverse effects in aquatic biota. For the OU2 BERA, surface water TRVs based on benthic invertebrates would be preferred over those based on daphnids. Daphnids are known to be sensitive to dissolved metals, but they rarely occur in cold water flowing streams such as Middle Creek and South Fork Middle Creek. Criteria for selecting appropriate surface water TRVs to supplement the salmonid-specific TRVs include the following:

- TRVs should be relevant to receptors or receptor groups of concern to the OU2 BERA (e.g., benthic but not water column invertebrates).
- TRVs should represent threshold COPC concentrations at levels where adverse effects in survival, growth, or reproduction begin to be observed.

- TRVs should be applicable to protection of populations and communities.
- TRVs should be based on COPC concentrations in surface water that are easily measurable and not on biological data such as tissue concentrations.

Table 5-13 shows the PRGs that are initially selected for surface water based on protection of specific receptor groups and on direct contact exposures.

5.6 Conclusions of the OU2 BERA

Based on the analysis presented in the draft OU2 BERA, risks exist to aquatic life, including salmonids, occupying the upper reaches of Middle Creek and South Fork Middle Creek. As summarized in Section 5.3, ecological risks are from exposure to cadmium, copper, and zinc in surface water within these ecosystems.

5.6.1 Evaluation of April 2014 Surface Water Data

Water quality monitoring is ongoing twice annually to support evaluations of the planned removal action at the Formosa Adit and the future remedial action for OU1. During preparation of this Final OU2 BERA, surface water data were collected in April 2014 from several ecological locations evaluated in the OU2 BERA and from locations upstream at the headwaters of the Middle Creek drainage. These data were evaluated as described below.

First, maximum detected concentrations of dissolved metals from samples collected in April 2014 were compared to the same surface water ESLs used in the Draft OU2 BERA, as described in Section 3.5. No new COPCs were identified based on the comparison of ESLs to maximum concentrations of dissolved metals in samples collected in April 2014. Concentrations of COPCs (cadmium, copper, and zinc) in samples collected in April 2014 were also compared to maximum detected concentrations of cadmium, copper, and zinc at M3.0, M7.9, MREF1, SF1.0, SF3.0, and SRFEF1from 2009 through 2013 (i.e., the data used in this BERA and tabulated in Appendix A). As shown in Table 5-14, maximum concentrations at M3.0 and M7.9 in Middle Creek were higher in 2014 for all three COPCs. As shown in Table 5-15, maximum concentrations at SF1.0 and SF3.0 were also higher in 2014. An exception is copper at SF1.0, which was slightly less than previous data. Concentrations at the reference locations sampled in April 2014, MREF and SFREF, were similar to or less than those from 2009-2013.

Surface water samples were collected in April 2014 from two locations in Middle Creek, M3.1 and M5.5, which had not been sampled for surface water previously. Similarly, in South Fork Middle Creek, samples were collected in April 2014 from SF0.7 and SF4.7. Concentrations of COPCs are shown in Table 5-14 (Middle Creek) and Table 5-15 (South Fork Middle Creek).

5.6.2 Evaluation of Biotic Ligand Model

Surface water samples collected in April 2014 were analyzed for dissolved organic carbon (DOC) to derive acute and chronic water quality criteria for copper using the Biotic Ligand Model. The purpose of this evaluation was to determine if the water quality criteria derived using hardness and used in this OU2 BERA are sufficiently protective of aquatic life, or if the Biotic Ligand Model, which requires analysis of DOC in addition to pH, hardness, and other parameters, would provide a different level of protectiveness. A detailed evaluation was provided and reviewed by the Stakeholder technical team in response to comments on the Draft OU2 BERA.

Based on this evaluation, the risk estimates associated with exposure to dissolved copper in surface water would be similar at most sampling locations or stream reaches whether the criteria used for those risk estimates are based on the hardness-only approach or the Biotic Ligand Model approach. This holds true for locations where DOC is near or higher than about 1.5 mg/L. At locations associated with substantially lower DOC (MXR; 1 mg/L in April 2014), the Biotic Ligand Model-estimated CCC is about one third the magnitude of the hardness-only CCC. The effect of this difference in the CCC used for risk estimation (HQ = Copper Concentration/CCC) is not significant given the elevated levels of measured dissolved copper concentration at MXR (443 ug/L in April 2014). Therefore, the use of the approved hardness-only method to derive water quality criteria in this BERA is sufficiently protective of aquatic life.

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Table 5-1 Chronic Hazard Quotients by Location for Fish in Middle Creek

COPC	ODEQ CCC Criteria (µg/L)	NATIONAL CCC CRITERIA (µg/L)	Middle Creek																								Middle Creek Reference			
			MXR						M3.0						M7.9						M13.0						MREF			
			EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC	HQ Based on ODEQ CCC
			Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Only 1 Sample Collected			
CADMIUM	0.25	0.25	14.2	8.5	**57**	**34**	**57**	**34**	0.8	0.8	**3**	**3**	**3**	**3**	ND	ND	NC	NC	NC	NC	0.2	0.2	1.0	1.0	1.0	1.0	ND	0.3	NC	NC
COPPER	12.00	9.18	530.0	236.1	**58**	**26**	**44**	**20**	7.5	7.1	0.8	0.8	0.6	0.6	3.7	3.5	0.4	0.4	0.3	0.3	5.4	4.6	0.6	0.5	0.5	0.4	0.5	0.5	0.1	0.0
ZINC	121.09	121.09	3260.0	1850.5	**27**	**15**	**27**	**15**	101.0	99.6	0.8	0.8	0.8	0.8	34.5	30.2	0.3	0.2	0.3	0.2	48.9	35.8	0.4	0.3	0.4	0.3	3.1	3.1	0.0	0.0
				Total HQ	**141**	**75**	**128**	**69**			**5**	**5**	**5**	**4**			1	1	1	1			**2**	**2**	**2**	**2**			0.1	0.1

Notes:

Concentration > than ODEQ and National Criteria

Concentration > National Criteria

Concentration > ODEQ Criteria

CCC = Criterion Continuous Concentration

COPC = Chemical of Potential Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient

NC = Not Calculated because no toxicity criteria or not detected

ND = Not detected

ODEQ = Oregon Department of Environmental Quality

µg/L = micrograms per liter

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Table 5-2 Chronic Hazard Quotients by Location for Fish in South Fork Middle Creek

COPC	ODEQ CCC Criteria (µg/L)	NATIONAL CCC CRITERIA (µg/L)	South Fork Middle Creek												South Fork Middle Creek Reference					
			SF1.0						SF3.0						SFREF					
			EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC	
			Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect	Max Detect	Average Detect
CADMIUM	0.20	0.20	7.60	3.61	**38**	**18**	**38**	**18**	ND	ND	NC	NC	NC	NC	ND	ND	NC	NC	NC	NC
COPPER	12.00	6.96	285	108.3	**41**	**16**	**24**	**9**	11.40	7.40	**2**	**1**	1	0.6	0.83	0.83	0.1	0.1	0.1	0.1
ZINC	92.03	92.03	2120	1086.75	**23**	**12**	**23**	**12**	85.80	72.30	0.9	0.8	0.9	0.8	4.80	3.40	0.1	0.04	0.1	0.04
				Total HQ	**102**	**45**	**85**	**39**			**3**	**2**	**2**	**1**					0.1	0.1

Notes:

Concentration > than ODEQ and National Criteria

Concentration > National Criteria

CCC = Criterion Continuous Concentration

COPC = Chemical of Potential Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient

NC = Not Calculated because no toxicity criteria or not detected

ND = Not detected

ODEQ = Oregon Department of Environmental Quality

µg/L = micrograms per liter

Table 5-3 Salmonid Specific Hazard Quotients

COPC	Toxicity Reference Value (TRV) for Site Locations	Toxicity Reference Value (TRV) for Reference Location	Middle Creek																					
			Stream				MXR				M3.0				M7.9				M13.0					
			Mean		Max		Mean		Max		Mean		Max		Mean		Max		Mean		Max		Middle Creek Reference	
			EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ
CADMIUM	4	2	6	**2**	14	**4**	8	**2**	14	**4**	1	0.2	1	0.2	ND (<0.5)	ND	ND (<0.5)	ND	0.2	0.07	0.2	0.07	ND (<0.5)	ND
COPPER	22	15	137	**6**	530	**24**	236	**11**	530	**24**	7	0.3	8	0.3	4	0.2	4	0.2	4.6	0.2	5.4	0.25	0.5	0.04
ZINC	772	416	1011	**1**	3260	**4**	1851	**2**	3260	**4**	100	0.1	101	0.1	30	0.04	35	0.04	35.8	0.05	48.9	0.06	3.1	0.007

COPC	Toxicity Reference Value (TRV) for Site Locations	Toxicity Reference Value (TRV) for Reference Location	South Fork Middle Creek													
			Stream				SF1.0				SF3.0				South Fork Middle Creek Reference	
			Mean		Max		Mean		Max		Mean		Max			
			EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ	EPC	HQ
CADMIUM	3	2	4	**1**	8	**3**	4	**1**	8	**3**	ND (<0.5)	ND	ND (<0.5)	ND	ND (<0.5)	ND
COPPER	18	16	88	**5**	285	**16**	108	**6**	285	**16**	7	0.41	11	0.63	ND (<2.0)	ND
ZINC	577	459	884	**2**	2120	**4**	1087	**2**	2120	**4**	72	0.13	86	0.15	2	0.004

Notes:
COPC = Chemical of Potential Concern
EPC = Exposure Point Concentration in ug/L. EPCs are the average of detected dissolved concentrations or the maximum detected concentration
HQ = Hazard Quotient. HQ values rounded to nearest whole number
Mean = Arithmetic mean detected dissolved concentration
Max = Maximum detected dissolved concentration
ND = Not Detected
TRV = Toxicity Reference Value
µg/L = micrograms per liter

Table 5-4 Total Number of Fish Observed during Historical and Recent Surveys

Survey Date	M1.2	M2.0	M3.0	M3.1	M5.5	M7.9	M9.8	M13	SF1.0	SF3.0	SF4.7	MREF	Martin Creek REF	SFREF
Jul-2000 (BLM)			1			29	52	79		0	6		93	
2003 (BLM)		0	1			29	51			0	0		119	
May/June-2007 (BLM)			3	9	59	67	78			1	5		99	
Jun-2012 (EPA)	0	2	9	12	8	8	10	13	1	2	12	0	10	5
Sep-2012 (EPA)	1	8	8	18		15			3	15			15	8
Jun-2013 (EPA)	1	3	21	21		28			0	4		0	16	8
Sep-2013 (EPA)	2	22	16	39		31			1	7			27	8

Fish count surveys were conducted by different techniques and numbers observed during recent surveys (2012 and 2013) are qualitatively used to document presence and/or absence of fish, not for quantitative comparisons with historical data.

Table 5-5 Predictive Modeling Scores and Conditions Based on BMI Data

Sampling Location	Date	O/E Score[1]	Condition[2]
M1.2	Jun-2012	0.529751	Poor
	Sep-2012	0.463532	Poor
	Jun-2013	0.463532	Poor
	Sep-2013	0.463532	Poor
M2.0	Jun-2012	0.654695	Poor
	Sep-2012	0.589226	Poor
	Jun-2013	0.589226	Poor
	Sep-2013	0.589226	Poor
M3.0	Jun-2012	0.710004	Fair
	Sep-2012	0.710499	Fair
	Jun-2013	0.645908	Poor
	Sep-2013	0.710499	Fair
M3.1	Jun-2012	0.70967	Poor
	Sep-2012	0.710073	Fair
	Jun-2013	0.710073	Fair
	Sep-2013	0.90373	Good
M5.5	Jun-2012	0.932406	Good
M7.9	Jun-2012	0.862786	Good
	Sep-2012	0.835925	Fair
	Jun-2013	0.895634	Good
	Sep-2013	0.776216	Fair
M9.8	Jun-2012	0.891229	Good
M13	Jun-2012	0.648783	Poor
SF0.7	Jun-2012	0.066523	NA
SF1.0	Jun-2012	0.464833	NA
	Sep-2012	0.664046	Poor
	Jun-2013	0.398428	NA
	Sep-2013	0.730451	Fair
SF3.0	Jun-2012	0.588528	Poor
	Sep-2012	0.588528	Poor
	Jun-2013	0.523136	Poor
	Sep-2013	0.65392	Poor
SF4.7	Jun-2012	0.645279	Poor
MREF	Jun-2012	0.99423	Good
	Jun-2013	0.927948	Good

Table 5-5 Predictive Modeling Scores and Conditions Based on BMI Data

Sampling Location	Date	O/E Score[1]	Condition[2]
Martin Creek Ref	Jun-2012	0.929664	Good
	Sep-2012	1.052707	Good
	Jun-2013	0.928859	Good
	Sep-2013	1.176555	Good
SFREF	Jun-2012	0.799459	Fair
	Sep-2012	0.666216	Poor
	Jun-2013	0.799459	Fair
	Sep-2013	0.666216	Poor

[1]O/E - observed taxa divided by expected taxa using the Oregon DEQ Predator model (ODEQ 2008). O/E scores were calculated by the BLM lab and used in the table in the format received from the lab.

[2]Rating of "Good", "Fair", or "Poor" based on O/E score relative to the distribution of scores for reference sites. Samples with less than the required number of organisms are given an NA or "Null" rating because they did not meet model requirements.

Table 5-6 Total Number of BMI Taxa at Middle Creek Sampling Locations

Date	M1.2	M2.0	M3.0	M3.1	M5.5	M7.9	M9.8	M13
Jun-99	NS	NS	4	7	NS	12	15	17
Oct-99	NS	NS	11	14	NS	20	17	23
Jul-00	NS	NS	10	9	NS	19	18	17
Jul-01	NS	NS	10	15	NS	15	16	20
Oct-01	NS	NS	13	11	NS	19	14	14
Jul-02	NS	NS	12	10	NS	14	17	16
Nov-02	NS	NS	8	13	NS	15	21	10
Jun-07	NS	NS	13	11	19	22	24	NS
Jul-08	NS	NS	10	24	NS	37	47	NS
Jun-12 (EPA)	12	18	19	16	27	26	25	21
Sep-12 (EPA)	16	17	21	23	NS	28	NS	NS
Jun-13 (EPA)	10	14	15	16	NS	27	NS	NS
Sep-13 (EPA)	16	21	21	23	NS	26	NS	NS

Table 5-7 Total Number of EPT Taxa at Middle Creek Sampling Locations

Date	M1.2	M2.0	M3.0	M3.1	M5.5	M7.9	M9.8	M13
Jun-99	NS	NS	1	4	NS	7	10	11
Oct-99	NS	NS	7	10	NS	12	12	12
Jul-00	NS	NS	4	5	NS	11	12	12
Jul-01	NS	NS	6	10	NS	10	11	13
Oct-01	NS	NS	9	8	NS	10	8	8
Jul-02	NS	NS	8	7	NS	9	11	9
Nov-02	NS	NS	7	8	NS	10	16	8
Jun-07	NS	NS	7	8	14	14	15	NS
Jul-08	NS	NS	1	12	NS	19	20	NS
Jun-12 (EPA)	5	7	11	7	15	14	13	11
Sep-12 (EPA)	6	10	12	12	NS	16	NS	NS
Jun-13 (EPA)	3	7	6	6	NS	17	NS	NS
Sep-13 (EPA)	7	11	12	11	NS	16	NS	NS

Table 5-8 Total Number of BMI Taxa at South Fork Middle Creek Sampling Locations

Date	SF0.7	SF1.0	SF1.7	SF3.0	SF4.7
Jun-99	NS	0	1	4	8
Oct-99	NS	4	5	12	13
Jul-00	NS	2	5	14	11
Jul-01	NS	0	11	10	14
Oct-01	NS	6	8	13	12
Jul-02	NS	0	6	8	8
Nov-02	NS	1	10	10	11
Jun-07	NS	NS	NS	6	8
Jun-12 (EPA)	6	16	NS	12	16
Sep-12 (EPA)	NS	29	NS	18	NS
Jun-13 (EPA)	NS	13	NS	9	NS
Sep-13 (EPA)	NS	22	NS	22	NS

Table 5-9 Total Number of EPT Taxa at South Fork Middle Creek Sampling Locations

Date	SF0.7	SF1.0	SF1.7	SF3.0	SF4.7
Jun-99	NS	0	0	2	4
Oct-99	NS	2	4	6	8
Jul-00	NS	1	2	7	6
Jul-01	NS	0	4	6	10
Oct-01	NS	3	7	9	9
Jul-02	NS	0	4	6	6
Nov-02	NS	1	8	7	8
Jun-07	NS	NS	NS	4	5
Jun-12 (EPA)	1	4	NS	4	9
Sep-12 (EPA)	NS	12	NS	10	NS
Jun-13 (EPA)	NS	5	NS	4	NS
Sep-13 (EPA)	NS	9	NS	12	NS

Table 5-10 Total Number of BMI Taxa at Reference Sampling Locations

Date	Martin Creek REF	MREF	SFREF
Jun-99	NS	28	27
Oct-99	NS	32	33
Jul-00	NS	29	26
Jul-01	NS	31	32
Oct-01	NS	31	30
Jul-02	NS	25	23
Nov-02	NS	30	25
Jun-07	36	NS	NS
Jul-08	54	NS	NS
Jun-12 (EPA)	30	38	36
Sep-12 (EPA)	36	NS	24
Jun-13 (EPA)	32	38	27
Sep-13 (EPA)	35	NS	25

Table 5-11 Total Number of EPT Taxa at Reference Sampling Locations

Date	Martin Creek REF	MREF	SFREF
Jun-99	NS	20	19
Oct-99	NS	19	22
Jul-00	NS	18	18
Jul-01	NS	20	22
Oct-01	NS	20	19
Jul-02	NS	15	23
Nov-02	NS	19	19
Jun-07	22	NS	NS
Jul-08	26	NS	NS
Jun-12 (EPA)	15	20	20
Sep-12 (EPA)	19	NS	9
Jun-13 (EPA)	19	20	13
Sep-13 (EPA)	18	NS	14

Table 5-12 Habitat Characteristics of the Ecological Sampling Locations

Sampling Location	Stream order	Stream gradient (%)	Dominant substrate	Estimate of overstream shade (%)	Bankfull width (feet)	Average depth (feet)	Pool variability	Instream habitat structure	Visual habitat impairment (yes/no)*	Culvert nearby (yes/no)
M1.2	3	3	large cobble/boulder	95	12	0.5	good	good	yes	no
M2.0	4	1.5	cobble	60	17	0.5	low	low	yes	no
M3.0	4	2.5	cobble/bedrock	95	16	0.5	low	low	no	yes
M3.1	5	2	gravel/ cobble/bedrock	50	20	1	good	good	yes	yes
M5.5	5	1.5	cobble/bouder/bedrock	50	23	1	good	good	no	no
M7.9	6	1.5	gravel/cobble	50	32	1	good	good	no	no
M9.8	6	2	gravel	60	29	0.75	good	good	no	no
M13	6	1.5	gravel/cobble	80	44	0.75	good	low	no	no
SF0.7	3	3	gravel/ cobble/bouder	95	6	0.25	low	low	yes	yes
SF1.0	4	1.5	cobble	80	19	0.75	low	good	no	yes
SF3.0	5	1.5	cobble	75	30	0.5	good	good	no	yes
SF4.7	5	4	boulder/bedrock	75	19	0.75	good	low	no	yes
Martin Creek REF	5	2	cobble	90	19	0.5	good	good	no	no
MREF	3	1.5	cobble	90	6	0.25	low	low	no	yes
SFREF	4	1.5	cobble	90	6	0.5	good	good	no	yes

*Visual habitat impairment includes armoring, staining, algal muck, milky turbidity, etc.

Table 5-13 Toxicity Values - Potential TRVs for Surface Water COPCs Based on Protection of Salmonid Fish and BMI

SW COPC	Toxicity Value (ug/L)	Test Species	Toxicity Value or Test Endpoint	Reference
Cadmium	2.694	chinook salmon (*Oncorhyncus tshawytscha*)	SMCV	EPA 1995
	4.289	coho salmon (*Oncorhynchus kisutch*)	SMCV	EPA 1995
	4.841	snail (*Aplexa hypnorum*)	SMCV	EPA 1995
	20.5	oligochaete (*Aeolosoma headleyi*)	SMCV	EPA 1995
Copper	6.066	amphipod (*Gammarus pseudolimnaeous*)	CV	EPA 1985
	<7.4	coho salmon (*Oncorhynchus kisutch*)	SMCV	EPA 1985
	10.39	caddisfly (*Clistornia magnifica*)	CV	EPA 1985
	10.88	snail (*Campeloma decisum*)	CV	EPA 1985
	10.88	snail (*Physa integra*)	CV	EPA 1985
	19.01	rainbow trout (*Oncorhynchus mykiss*)	CV	EPA 1985
Zinc	276.7	rainbow trout (*Oncorhynchus mykiss*)	CV	EPA 1987
	371.1	chinook salmon (*Oncorhyncus tshawytscha*)	CV	EPA 1987
	603	rainbow trout (*Oncorhynchus mykiss*)	CV	EPA 1987
	>5,243	caddisfly (*Clistornia magnifica*)	CV	EPA 1987

Notes:

BMI = benthic macroinvertebrates

Toxicity value - based on dissolved concentration and hardness of 50 mg/L $CaCO_3$ (adjustment to site specific mean hardness required)

Test species includes only benthic and not water column invertebrates and salmonid fish with potential to occur in site surface waters

SMCV = species mean chronic value

CV = chronic value (geo mean of No Effect and Low Effect values)

Table 5-14 Chronic Hazard Quotients by Location for Fish in Middle Creek

COPC	ODEQ CCC Criteria (µg/L)	NATIONAL CCC CRITERIA (µg/L)	Middle Creek																																		Middle Creek Reference					
			MXR						M3.0						M3.1						M5.5						M7.9						M13.0						MREF					
			EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC	
			Max Detect (2007- 2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)
CADMIUM	0.25	0.25	14.2	15.2	**57**	**61**	**57**	**61**	0.8	1.9	**3**	**8**	**3**	**8**	NS	0.8	NC	**3**	NC	**3**	NS	0.5	NC	**2**	NC	**2**	ND	0.27	NC	1.1	NC	1.1	0.2	NS	1.0	NS	1.0	NC	ND	ND	NC	NC	NC	NC
COPPER	12.00	9.18	530	443	**58**	**48**	**44**	**37**	7.5	13.9	0.8	**1.5**	0.6	**1.2**	NS	10.5	NC	**1**	NC	0.9	NS	9.1	NC	1	NC	0.8	3.7	4.5	0.4	0.5	0.3	0.4	5.4	NS	0.6	NS	0.5	NC	0.5	0.4	0.1	0.04	0.04	0.03
ZINC	121.09	121.09	3260	3970	**27**	**33**	**27**	**33**	101	380	0.8	**3.1**	0.8	**3.1**	NS	168	NC	**1**	NC	**1.4**	NS	109	NC	1	NC	0.9	34.5	58.2	0.3	0.5	0.3	0.5	48.9	NS	0.4	NS	0.4	NC	3.1	ND	0.03	NC	0.03	NC
				Total HQ	**141**	**142**	**128**	**130**			**5**	**12**	**5**	**12**			NC	**6**	NC	**6**			NC	**4**	NC	**4**			1	**2**	1	**2**			**2**	NC	**2**	NC			0.1	0.04	0.1	0.03

Notes:

Concentration > than ODEQ and National Criteria

Concentration > National Criteria

Concentration > ODEQ Criteria

CCC = Criterion Continuous Concentration

COPC = Chemical of Potential Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient

NC = Not Calculated because no toxicity criteria or not detected or not sampled

ND = Not detected

NS = Not sampled

ODEQ = Oregon Department of Environmental Quality

µg/L = micrograms per liter

Table 5-15 Chronic Hazard Quotients by Location for Fish in South Fork Middle Creek

COPC	ODEQ CCC Criteria (µg/L)	NATIONAL CCC CRITERIA (µg/L)	South Fork Middle Creek																								South Fork Middle Creek Reference					
			SF0.7						SF1.0						SF3.0						SF4.7						SFREF					
			EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC		EPC (µg/L)		HQ Based on National CCC		HQ Based on ODEQ CCC	
			Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007- 2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007-2012)	Max Detect (2014)	Max Detect (2007- 2012)	Max Detect (2014)	Max Detect (2007- 2012)	Max Detect (2014)	Max Detect (2007- 2012)	Max Detect (2014)	Max Detect (2007- 2012)	Max Detect (2014)
CADMIUM	0.20	0.20	NS	17.5	NC	**87**	NC	**87**	7.60	8.30	**38**	**41**	**38**	**41**	ND	0.71	NC	**3.5**	NC	**3.5**	NS	0.44	NC	**2.2**	NC	**2.2**	ND	ND	NC	NC	NC	NC
COPPER	12.00	6.96	NS	883	NC	**127**	NC	**74**	285	276	**41**	**40**	**24**	**23**	11	18	**2**	**3**	1	**1.5**	NS	9.40	NC	**1**	NC	0.8	0.83	0.29	0.1	0.04	0.1	0.02
ZINC	92.03	92.03	NS	5340	NC	**58**	NC	**58**	2120	2370	**23**	**26**	**23**	**26**	86	175	0.9	**1.9**	0.9	**1.9**	NS	102	NC	**1.1**	NC	**1.1**	4.80	ND	0.1	NC	0.1	NC
				Total HQ	NC	**272**	NC	**219**		Total HQ	**102**	**107**	**85**	**90**			**3**	**8**	**2**	**7**			NC	**5**	NC	**4**			0.17	0.04	0.1	0.02

Notes:

Concentration > than ODEQ and National Criteria

Concentration > National Criteria

CCC = Criterion Continuous Concentration

COPC = Chemical of Potential Concern

EPC = Exposure Point Concentration

HQ = Hazard Quotient

NC = Not Calculated because no toxicity criteria or not detected or not sampled

ND = Not detected

NS = Not sampled

ODEQ = Oregon Department of Environmental Quality

NA = data not available

-- = not analyzed for

µg/L = micrograms per liter

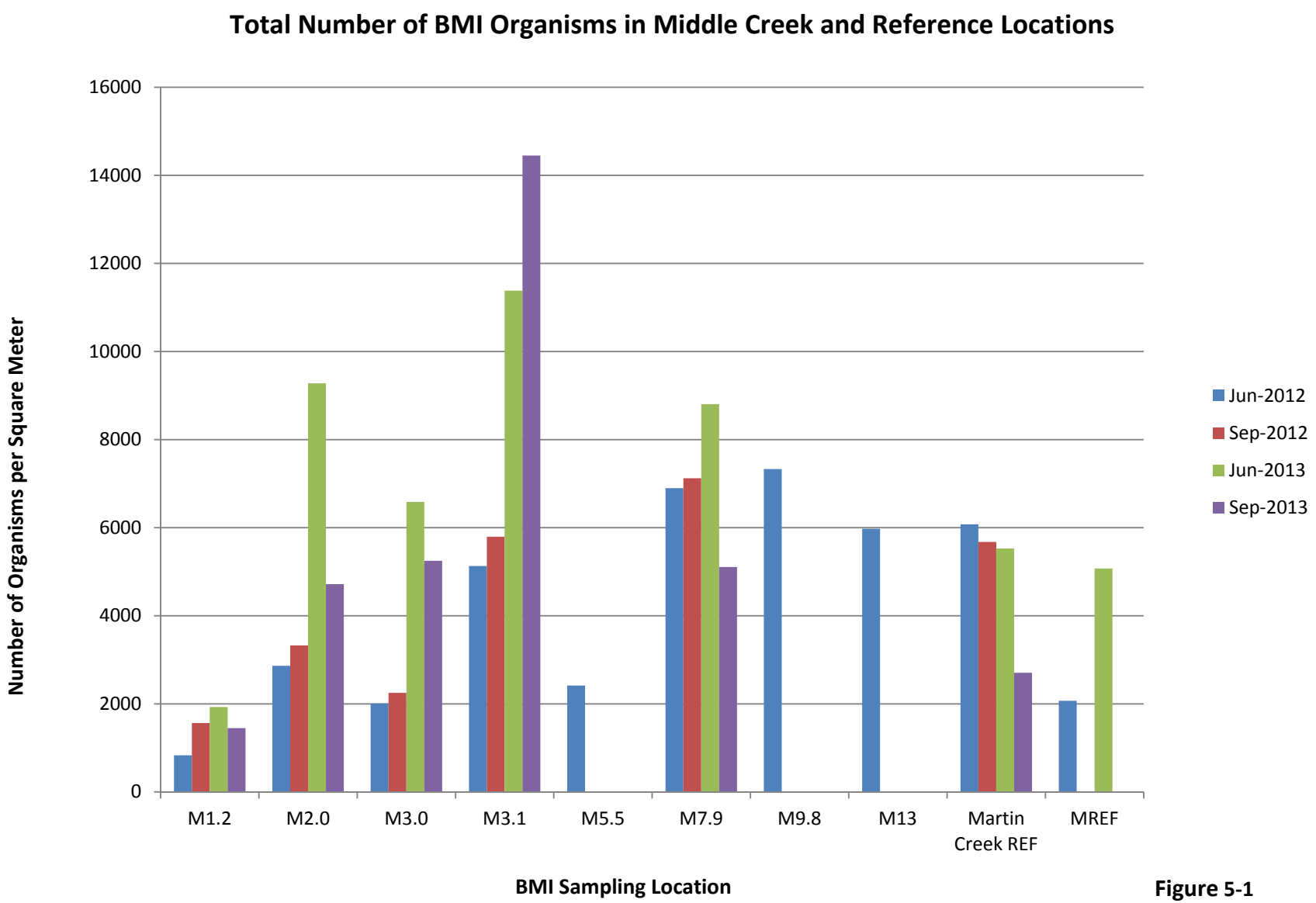

Total Number of BMI Organisms in Middle Creek and Reference Locations
Number of Organisms per Square Meter
16000
14000
12000
10000
8000
6000
4000
2000
0
M1.2
M2.0
M3.0
M3.1
M5.5
M7.9
M9.8
M13
Martin Creek REF
MREF
BMI Sampling Location
Jun-2012
Sep-2012
Jun-2013
Sep-2013

Figure 5-1

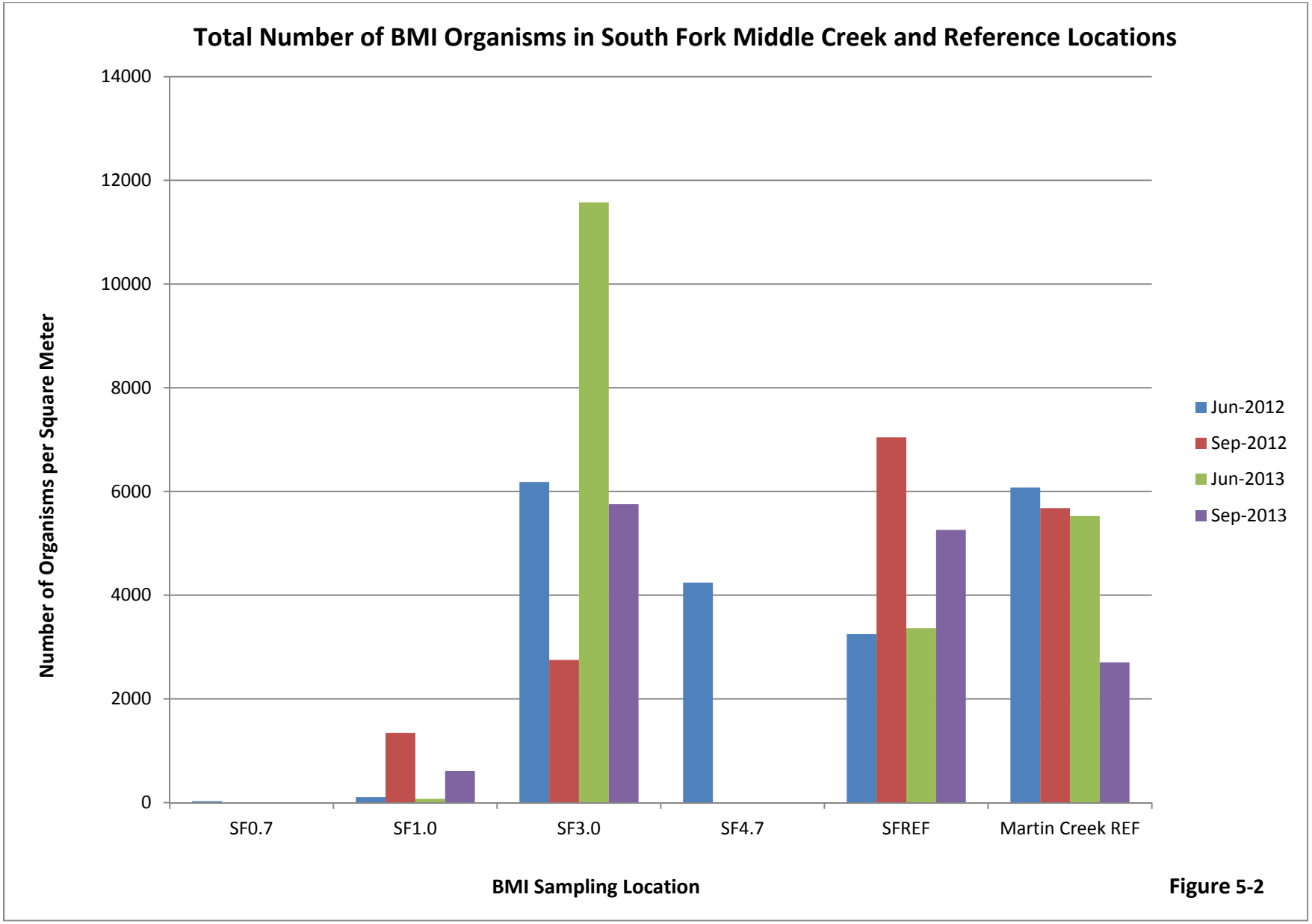

Total Number of BMI Organisms in South Fork Middle Creek and Reference Locations
Number of Organisms per Square Meter
14000
12000
10000
8000
6000
4000
2000
0
SF0.7
SF1.0
SF3.0
SF4.7
SFREF
Martin Creek REF
BMI Sampling Location
Jun-2012
Sep-2012
Jun-2013
Sep-2013

Figure 5-2

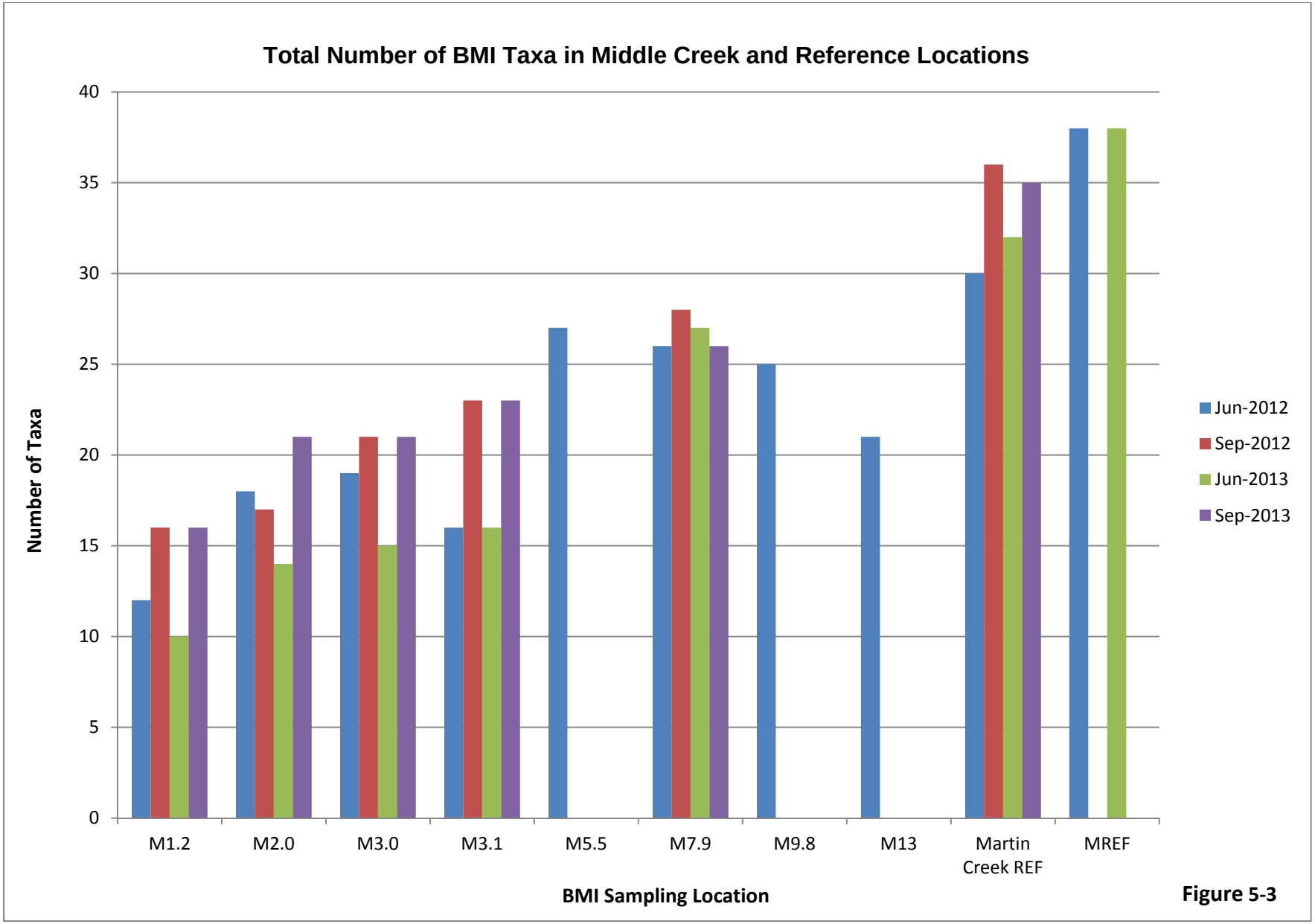

Total Number of BMI Taxa in Middle Creek and Reference Locations
Number of Taxa
40
35
30
25
20
15
10
5
0
M1.2
M2.0
M3.0
M3.1
M5.5
M7.9
M9.8
M13
Martin Creek REF
MREF
BMI Sampling Location
Jun-2012
Sep-2012
Jun-2013
Sep-2013

Figure 5-3

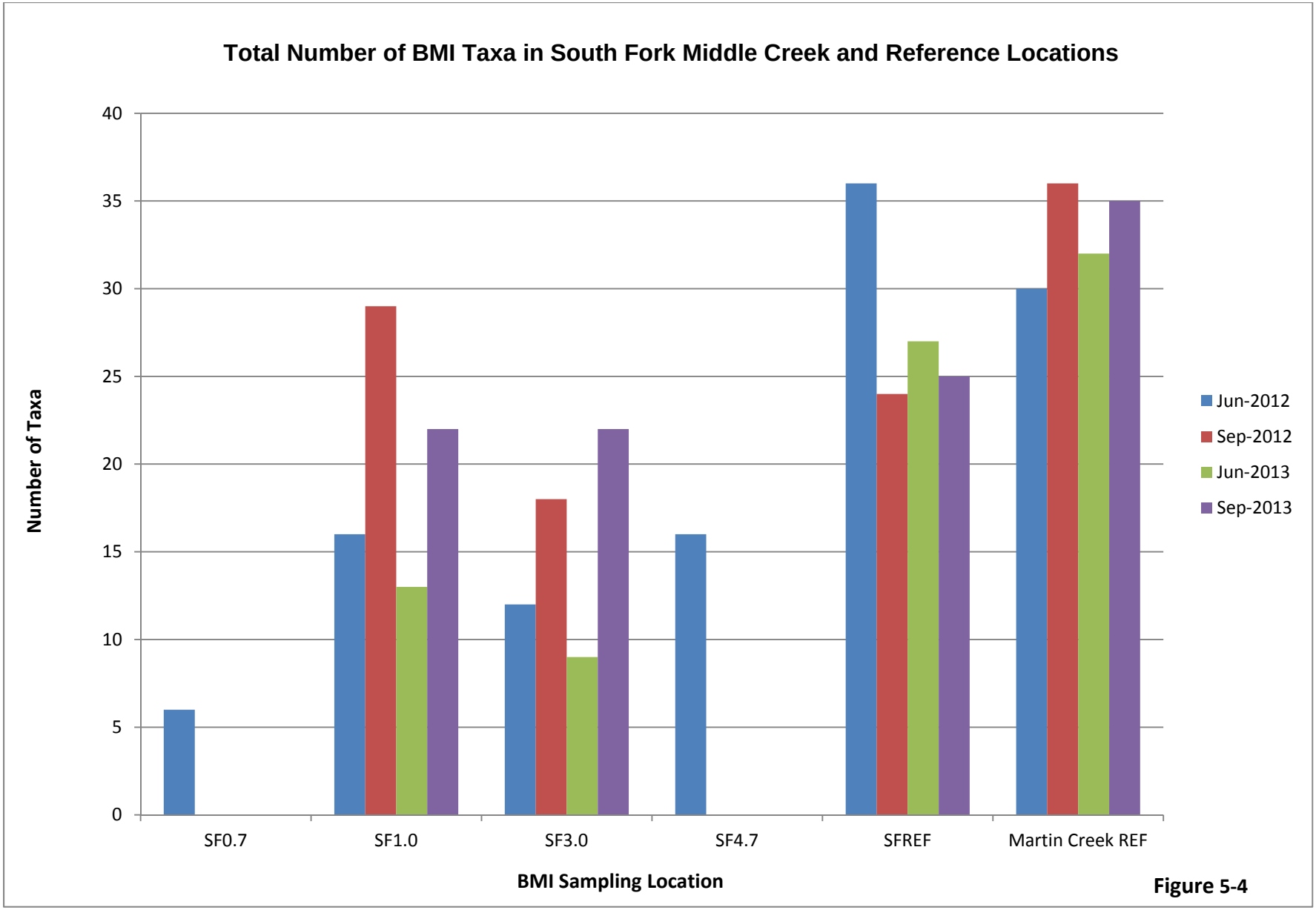

Total Number of BMI Taxa in South Fork Middle Creek and Reference Locations
Number of Taxa
40
35
30
25
20
15
10
5
0
SF0.7
SF1.0
SF3.0
SF4.7
SFREF
Martin Creek REF
BMI Sampling Location
Jun-2012
Sep-2012
Jun-2013
Sep-2013

Figure 5-4

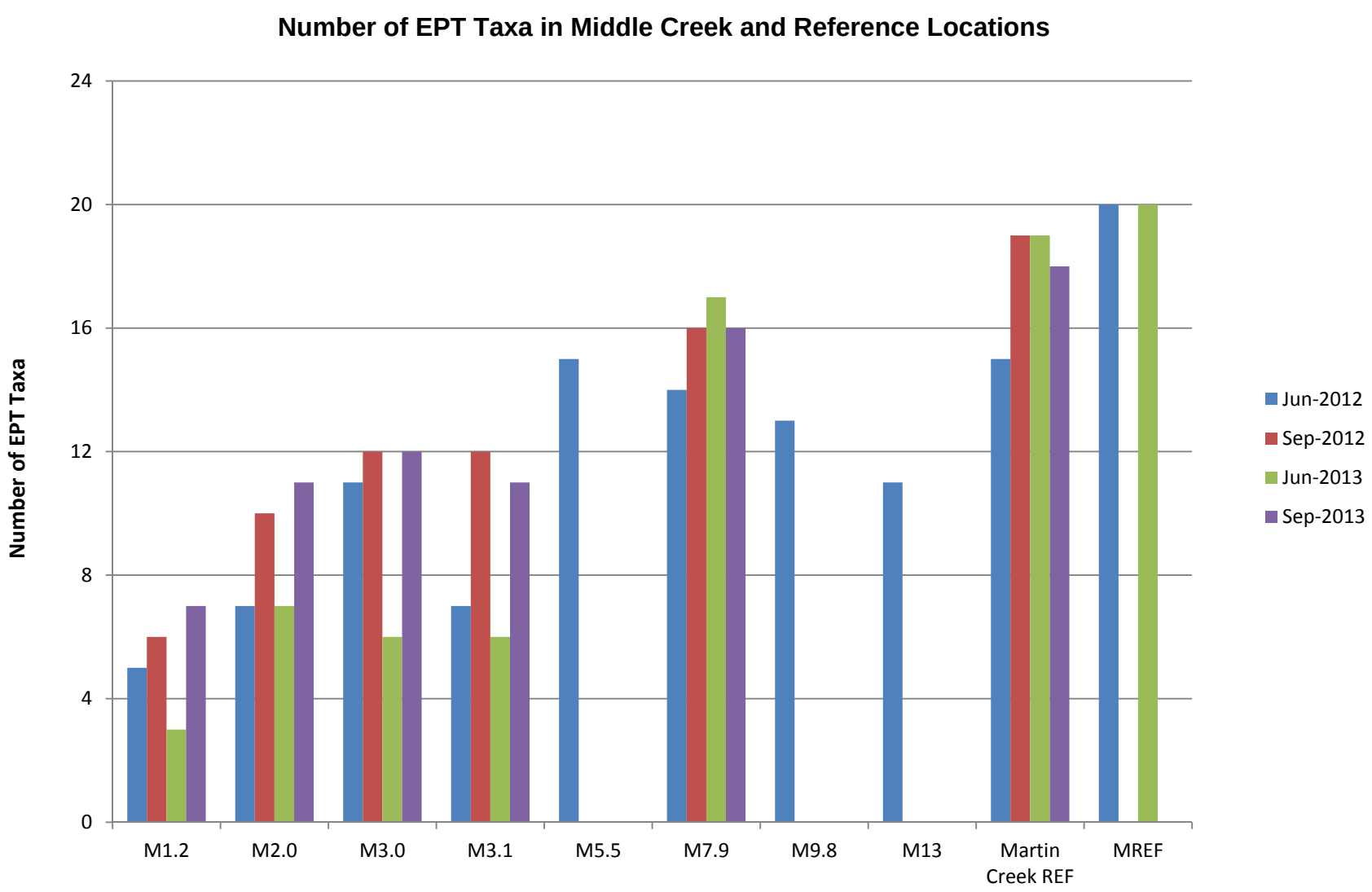

Number of EPT Taxa in Middle Creek and Reference Locations
Number of EPT Taxa
24
20
16
12
8
4
0
M1.2
M2.0
M3.0
M3.1
M5.5
M7.9
M9.8
M13
Martin Creek REF
MREF
BMI Sampling Location
Jun-2012
Sep-2012
Jun-2013
Sep-2013

Figure 5-5

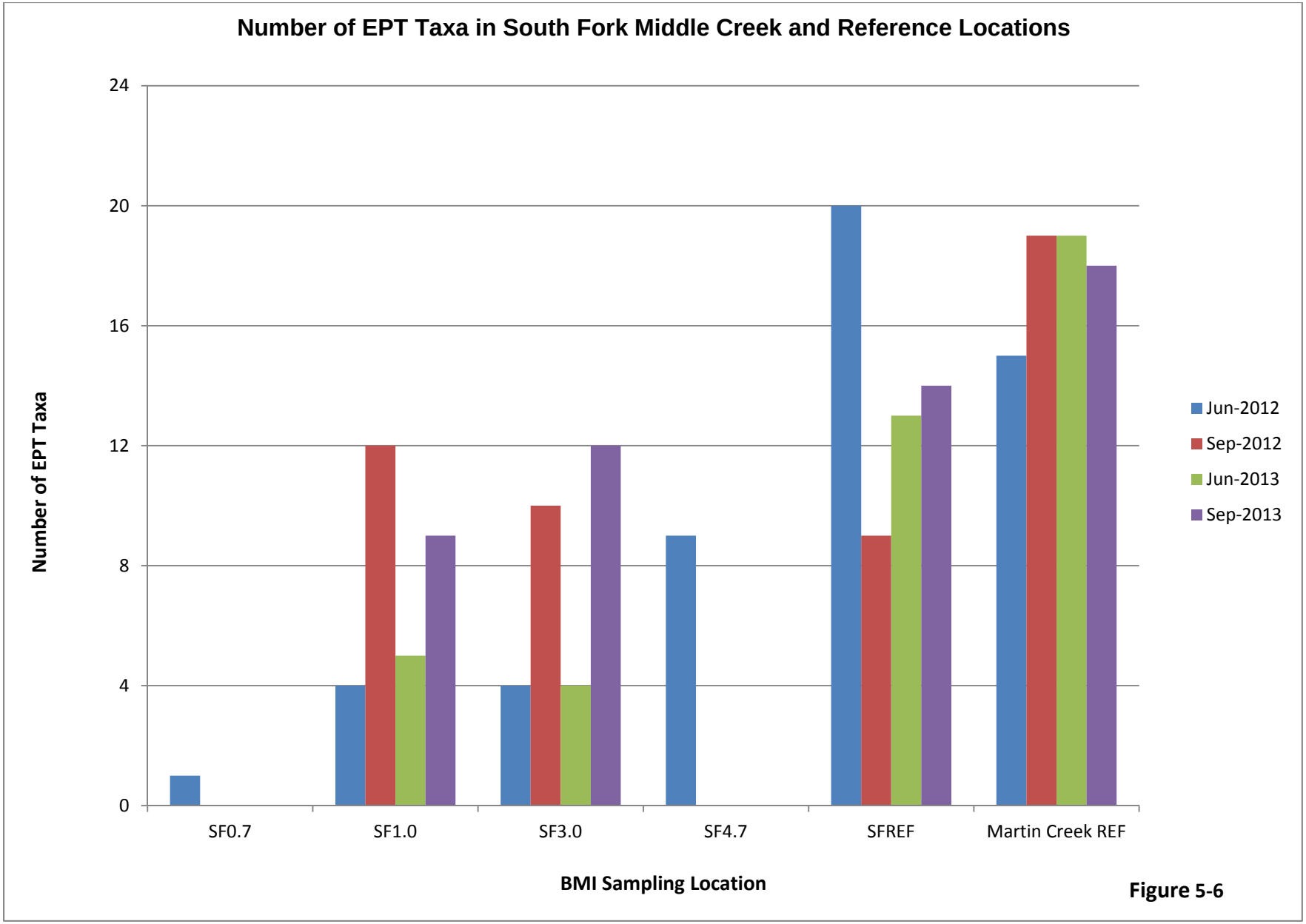

Number of EPT Taxa in South Fork Middle Creek and Reference Locations
Number of EPT Taxa
24
20
16
12
8
4
0
SF0.7
SF1.0
SF3.0
SF4.7
SFREF
Martin Creek REF
BMI Sampling Location
Jun-2012
Sep-2012
Jun-2013
Sep-2013

Figure 5-6

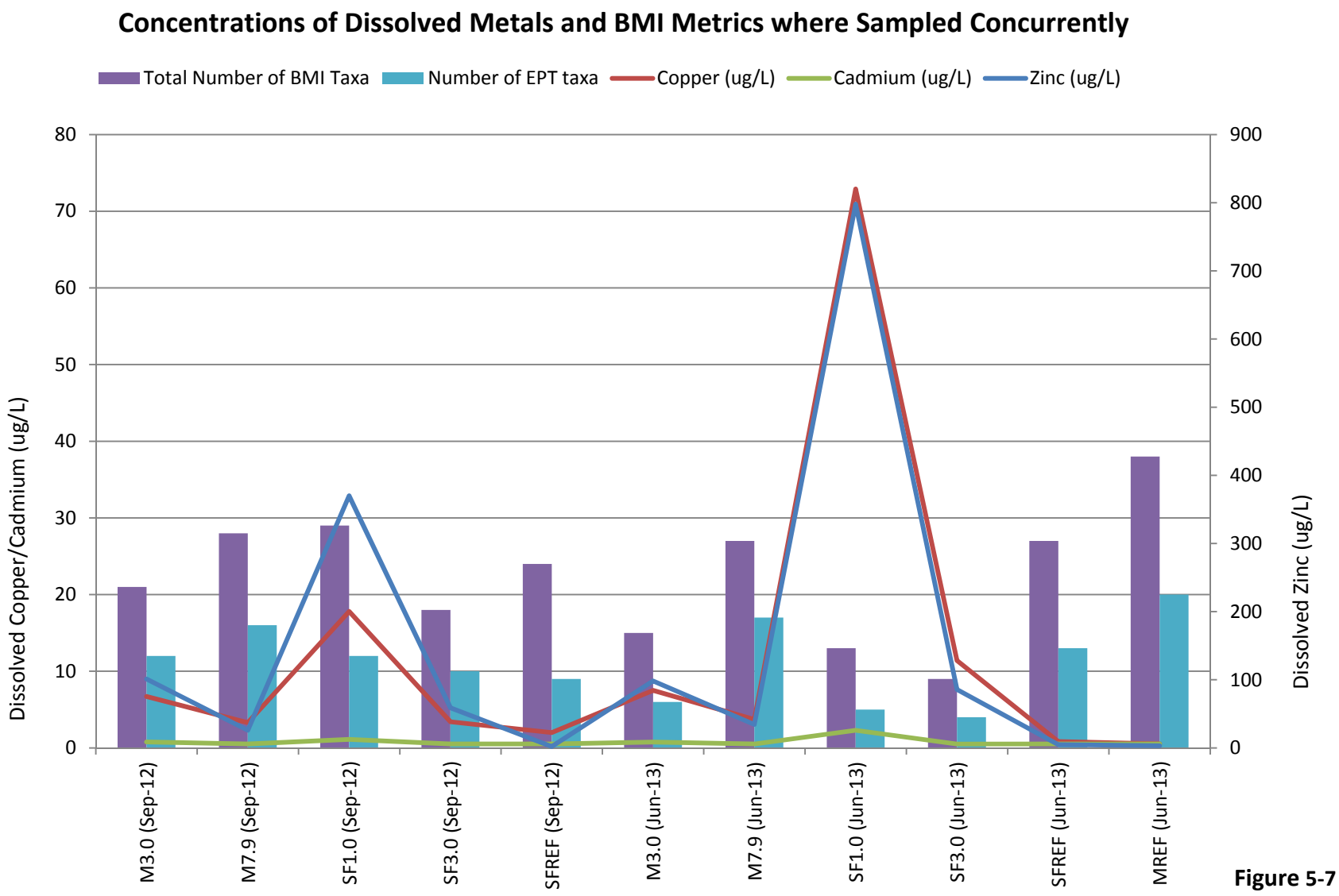
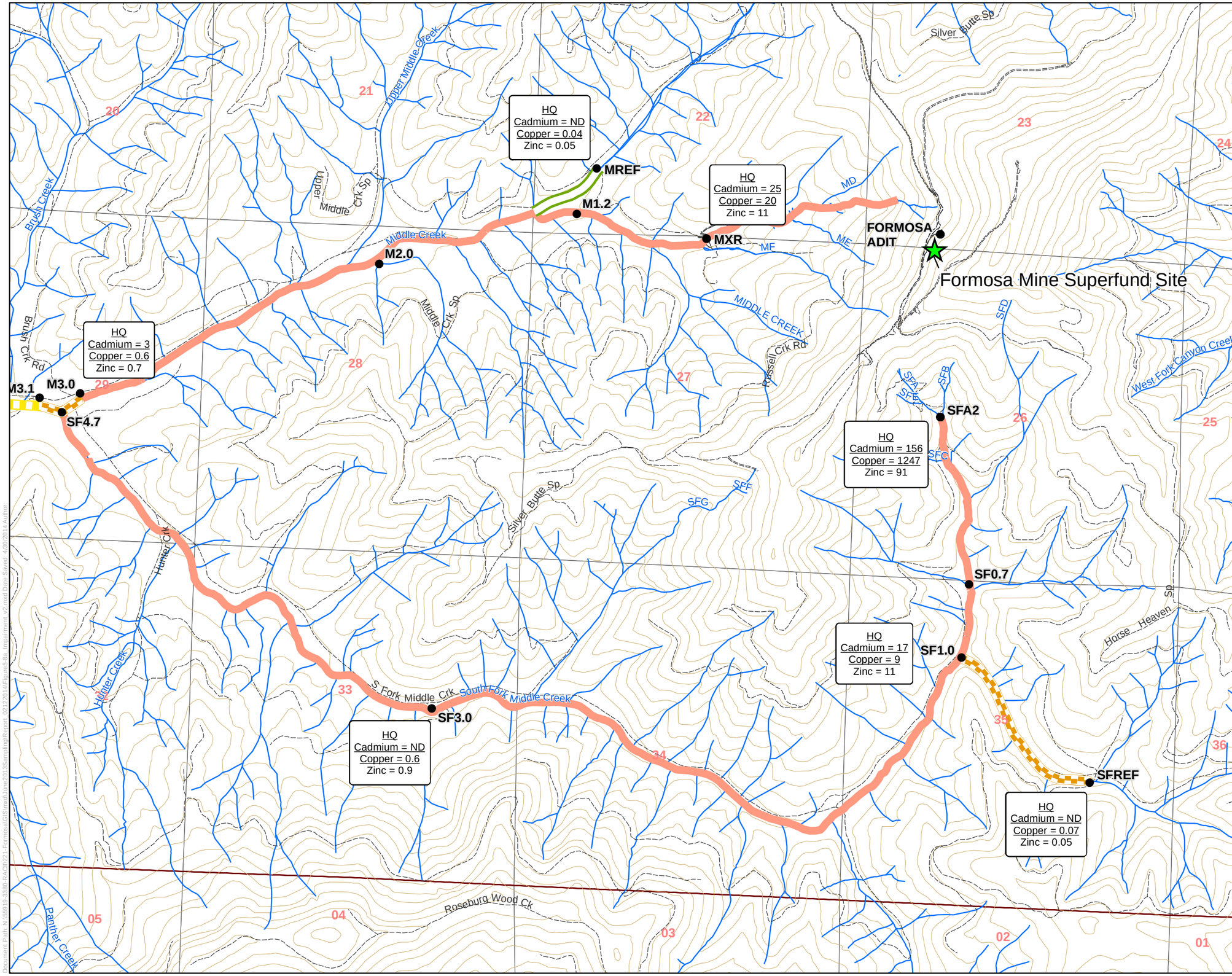

Concentrations of Dissolved Metals and BMI Metrics where Sampled Concurrently
Total Number of BMI Taxa
Number of EPT taxa
Copper (ug/L)
Cadmium (ug/L)
Zinc (ug/L)
Dissolved Copper/Cadmium (ug/L)
Dissolved Zinc (ug/L)
0
10
20
30
40
50
60
70
80
0
100
200
300
400
500
600
700
800
900
M3.0 (Sep-12)
M7.9 (Sep-12)
SF1.0 (Sep-12)
SF3.0 (Sep-12)
SFREF (Sep-12)
M3.0 (Jun-13)
M7.9 (Jun-13)
SF1.0 (Jun-13)
SF3.0 (Jun-13)
SFREF (Jun-13)
MREF (Jun-13)

Figure 5-7



Legend

- Roads
- Hydrology
- Contours (100 ft)
- Township/Range
- Sections
- Ecological Sampling Location

Stream condition based on BMI

- Impaired (average O/E condition score 0-0.49)
- Impaired (average O/E condition score 0.5-0.99)
- Transition (average O/E condition score 1.0-1.49)
- Recovered (average O/E condition score 1.5-2.0)

Hazard Quotient (HQ) based on surface water concentrations

HQ
Cadmium = 17
Copper = 9
Zinc = 11

*MXR and SFA2 are flume locations

0 0.125 0.25 0.5 Miles

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS Zone 3602

Data Sources:
Bureau of Land Management:
2001 Hydrography
2005 Township, Range, and Topography

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Figure 5-8a

Impairment of Streams based on BMI Condition Scores and Ecological Risk HQs

Formosa Mine
Douglas County, Oregon

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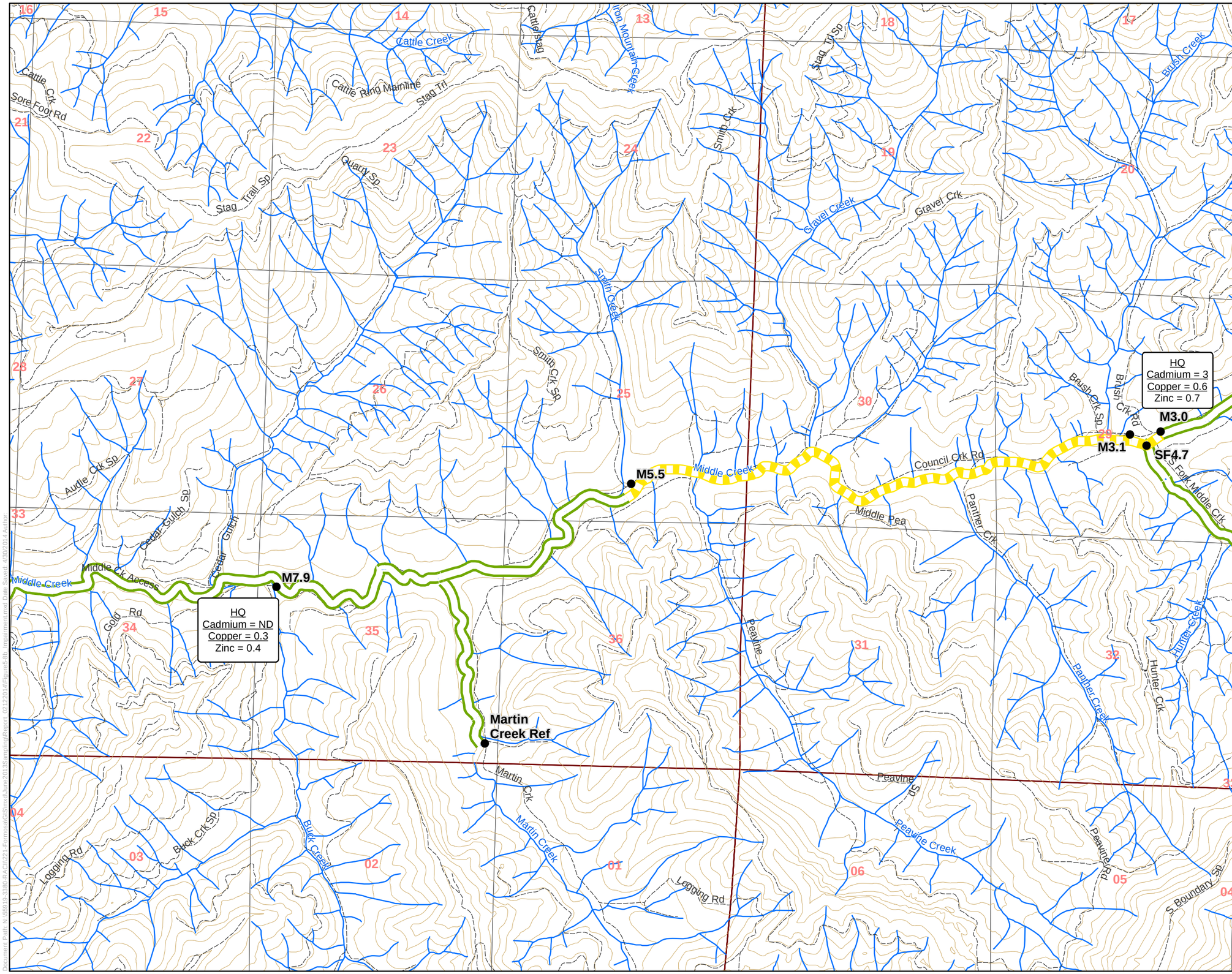

Legend

- Roads
- Hydrology
- Contours (100 ft)
- Township/Range
- Sections
- Ecological Sampling Location

Stream condition based on BMI

- Impaired (average O/E condition score 0-0.49)
- Impaired (average O/E condition score 0.5-0.99)
- Transition (average O/E condition score 1.0-1.49)
- Recovered (average O/E condition score 1.5-2.0)

Hazard Quotient (HQ) based on surface water concentrations

HQ
Cadmium = 17
Copper = 9
Zinc = 11

*MXR and SFA2 are flume locations

0 0.15 0.3 0.6 Miles

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS Zone 3602

Data Sources:
Bureau of Land Management:
2001 Hydrography
2005 Township, Range, and Topography

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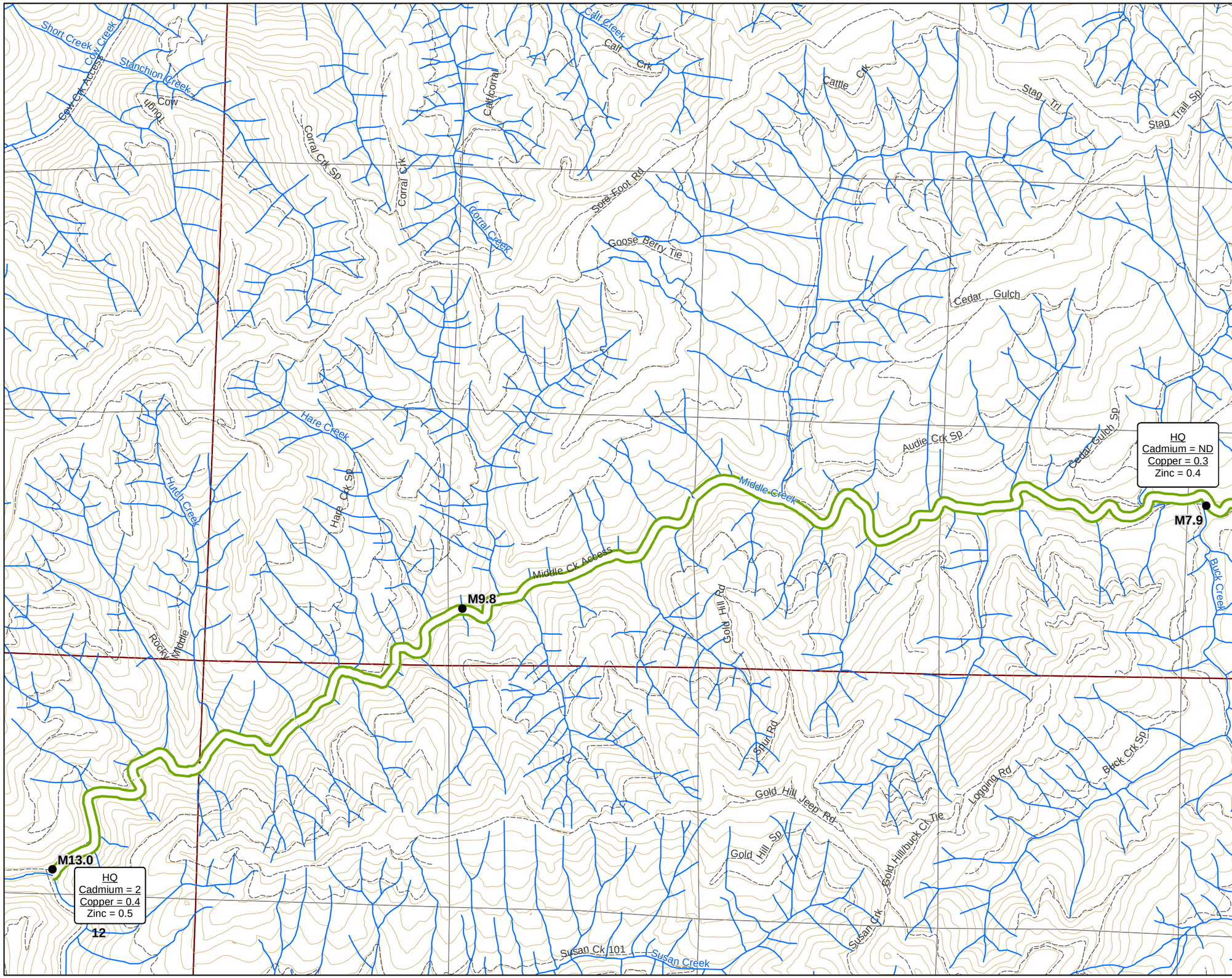
Figure 5-8b

Impairment of Streams based on BMI Condition Scores and Ecological Risk HQs

Formosa Mine
Douglas County, Oregon

Document Path: N:\55919-3380-RA\CI\221-Formosa\GIS\mxd\June2013Sampling\Report_02122014\Figure5-8b_Impairment.mxd Date Saved: 4/30/2014 Author:



Legend

- Roads
- Hydrology
- Contours (100 ft)
- Township/Range
- Sections

Stream Condition

- Impaired (average O/E condition score 0-0.49)
- Impaired (average O/E condition score 0.5-0.99)
- Transition (average O/E condition score 1.0-1.49)
- Recovered (average O/E condition score 1.5-2.0)

Hazard Quotient (HQ) based on surface water concentrations

HQ
Cadmium = 17
Copper = 9
Zinc = 11

*MXR and SFA2 are flume locations

0 0.15 0.3 0.6 Miles

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS Zone 3602

Data Sources:
Bureau of Land Management:
2001 Hydrography
2005 Township, Range, and Topography

CDM Smith

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Figure 5-8c

Impairment of Streams based on BMI Condition Scores and Ecological Risk HQs

Formosa Mine
Douglas County, Oregon

Document Path: N:\55919-3380-RACI\221-Formosa\GIS\mxd\June2013Sampling\Report_02122014\Figure5-8c_Impairment.mxd Date Saved: 4/30/2014 Author:

Section 6

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Appendix A

Surface Water Analytical Data Results and Field Measurements

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Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK	
Location		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		MXR		M3.0		M3.0	
Sample Date		10/19/2009		10/19/2009		01/30/2010		01/30/2010		10/28/2010		10/28/2010		01/24/2011		01/24/2011		09/26/2011		09/26/2011		02/18/2012		02/18/2012		09/14/2012		09/14/2012		06/18/2013		06/18/2013		09/11/2012		09/11/2012	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		T		D		T		D		T		D		T		D		T		D		T		D		T		D		T		D		T		D	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	12.3	U	6.3	U	1090	--	33.7	J	200	J	200	U	690	--	200	U	200	U	200	U	570	--	22	J	200	U	200	U	31.1	J	200	U	200	U	200	U
ANTIMONY	µg/L	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	R	2	R	60	U	60	U	60	U	60	U	60	U	60	U	60	U	60	U
ARSENIC	µg/L	0.62	J	0.59	J	1	U	0.23	U	0.073	U	0.095	U	1	U	1	U	1	UJ	1	UJ	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
BARIUM	µg/L	21.4	--	22.6	--	22.1	--	22.2	--	18.3	--	18.7	--	23.3	--	24	--	22.5	J	22.1	J	200	U	200	U	200	U	200	U	26.3	J	200	U	200	U	200	U
BERYLLIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	UJ	1	UJ	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U
CADMIUM	µg/L	12.4	--	13	--	14.3	--	14.2	--	9.7	--	9.8	--	7.5	--	7.4	--	5	J	4.8	J	9	--	9.8	J	4.7	--	4.6	--	4.3	J	4.3	--	0.84	--	0.78	--
CALCIUM	µg/L	52500	--	48100	--	33100	--	34100	--	47300	--	47600	--	42900	--	42700	--	46500	--	46800	--	47200	--	47000	--	49200	--	9720	--	47100	--	46600	--	34900	--	35300	--
CHROMIUM	µg/L	0.74	J	0.7	J	0.94	J	0.91	J	0.26	U	0.26	U	2	U	2	U	2	UJ	2	UJ	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U
COBALT	µg/L	0.15	J	0.2	J	1.6	--	1.6	--	0.78	J	0.8	J	1	U	1	U	1	UJ	1	UJ	0.73	J	0.85	J	50	U	50	U	50	U	50	U	50	U	50	U
COPPER	µg/L	185	--	190	--	983	--	530	--	276	--	206	--	553	--	329	--	127	J	115	J	545	--	343	J	74.1	--	77.5	--	109	--	98.3	--	9.7	--	6.7	--
IRON	µg/L	21.9	U	31.5	U	98.5	J	20.6	J	100	U	100	U	100	U	100	U	100	U	3.1	J	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U
LEAD	µg/L	0.32	J	0.85	J	0.28	U	0.38	J	1	U	1	U	1	U	1	U	1	UJ	1	UJ	1	U	1	U	0.27	J	1	U	1	U	1	U	1	U	1	U
LITHIUM	µg/L	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	18100	--	16500	--	11800	--	12000	--	17000	--	16900	--	14500	--	14400	--	17400	--	17500	--	16100	--	16200	--	16100	--	3190	J	16800	--	16900	--	13700	--	14100	--
MANGANESE	µg/L	35.4	--	37.7	--	179	--	175	J	120	--	121	--	98.1	--	97.4	--	9.8	--	10.2	--	117	--	119	--	2.9	--	2.8	J	18.3	--	16.5	--	3.2	--	1.6	J
MERCURY	µg/L	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.049	J	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.044	J	0.2	U	0.2	U
MOLYBDENUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	µg/L	6.9	--	8.5	--	9.9	--	10.8	--	6.1	--	6.2	--	6.7	--	7	--	4.4	J	4.4	J	7	--	7.4	J	2.8	--	2.7	--	4	J	3.9	--	1.1	--	0.87	J
POTASSIUM	µg/L	739	J	640	J	477	J	324	J	553	J	611	J	568	J	577	--	366	J	361	J	5000	U	5000	U	5000	U	5000	U	5000	U	5000	U	5000	U	5000	U
SELENIUM	µg/L	5	U	5	U	0.82	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U
SILVER	µg/L	0.1	U	0.1	U	0.13	U	0.1	U	0.016	U	0.024	U	0.1	UJ	0.1	UJ	0.1	R	0.1	R	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
SODIUM	µg/L	7820	--	7210	--	6250	--	6230	--	5750	--	5810	--	5730	--	5750	--	6350	--	6430	--	5840	--	5920	--	6510	--	1270	J	6140	--	6030	--	6950	--	7070	--
THALLIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	25	U	25	U	25	U	25	U	25	U	25	U	25	U	25	U
THORIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
URANIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	UJ	1	UJ	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	µg/L	5	U	5	U	5	U	5	U	2.2	U	2	U	5	U	5	U	7	J	6.6	J	50	U	50	U	50	U	50	U	50	U	50	U	50	U	50	U
ZINC	µg/L	2150	--	2230	--	3250	--	3260	--	1990	--	2020	--	2200	--	2150	--	1010	J	963	J	2250	--	2370	--	878	--	837	--	1010	--	974	--	114	--	101	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	30	--	--	--	20	--	--	--	30	--	--	--	30	--	--	--	5	--	--	--	--	--	--	--	65	--	--	--	55	--	--	--	65	--	--	--
Conductivity	µS/cm	481	--	--	--	377	--	--	--	393	--	--	--	378	--	--	--	1483	--	--	--	244	--	--	--	334	--	--	--	320	--	--	--	241	--	--	--
Dissolved Oxygen	mg/l	9.5	--	--	--	11.52	--	--	--	13.31	--	--	--	14.21	--	--	--	0.09	--	--	--	10.91	--	--	--	11.23	--	--	--	10.54	--	--	--	11.52	--	--	--
Ferrous Iron	mg/l	0.06	--	--	--	0.06	--	--	--	0.03	--	--	--	0.01	--	--	--	22.4	--	--	--	--	--	--	--	--	--	--	--	0.0	--	--	--	--	--	--	--
FLOW	gal/min	11.9	--	--	--	303.05	--	--	--	36.8	--	--	--	1019.8	--	--	--	14.06	--	--	--	129	--	--	--	14	--	--	--	--	--	--	--	--	--	--	--
ORP	millivolts	209	--	--	--	252.2	--	--	--	202.5	--	--	--	140.5	--	--	--	353.6	--	--	--	207.2	--	--	--	197.8	--	--	--	19.2	--	--	--	149.3	--	--	--
PH	S.U.	6.21	--	--	--	6.28	--	--	--	7.8	--	--	--	6.51	--	--	--	3.31	--	--	--	7.27	--	--	--	6.63	--	--	--	7.25	--	--	--	7.8	--	--	--
Temperature	deg C	10.94	--	--	--	7.38	--	--	--	7.75	--	--	--	7.98	--	--	--	9.46	--	--	--	5.27	--	--	--	14.26	--	--	--	13	--	--	--	11.44	--	--	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	UJ	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--
Acidity by titration	mg/l	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	30.4	--	--	--	14.2	--	--	--	34.7	--	--	--	22.7	--	--	--	54.4	--	--	--	27.8	--	--	--	56.1	--	--	--	--	--	--	--	66.6	--	--	--
Ammonia as N (distilled)	mg/l	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	2.72	--	--	--	2.14	--	--	--	2.62	--	--	--	2.24	--	--	--	2.43	--	--	--	2.17	--	--	--	2.59	--	--	--	2.32	--	--	--	2.45	--
FLUORIDE	mg/l	--	--	0.152	--	--	--	0.101	--	--	--	0.121	--	--	--	0.0755	--	--	--	0.129	--	--	--	0.117	--	--	--	0.117	--	--	--	0.0789	--	--	--	0.0588	--
Nitrogen, Nitrate-Nitrite	mg/l	0.11	--	--	--	0.118	--	--	--	0.0937	--	--	--	0.0859	--	--	--	0.05	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	210	--	--	--	155	--	--	--	170	--	--	--	157	--	--	--	135	--	--	--	165	--	--	--	143	--	--	--	140	--	--	--	82.7	--
TDS	mg/l	340	--	--	--	244	--	--	--	262	--	--	--	244	--	--	--	292	--	--	--	298	--	--	--	180	--	--	--	316	--	--	--	190	--	--	--
TSS	mg/l	2.1	U	--	--	3.51	--	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U	--	--	2	U	--	--	2	U	--	--	2.1	U	--	--

Notes:

CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimated value
R = Rejected value
> = Above detection limit (upper reporting limit shown)
U, < = Below detection limit (reporting limit shown)

mg/L = milligrams per liter
µg/L = micrograms per liter
µS/cm = microSiemens per centimeter
mV = millivolts
gal/min = gallons per minute

deg C = degrees centigrade
S.U. = standard units

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK	
Location		M3.0		M3.0		M7.9		M7.9		M7.9		M7.9		M13.0		M13.0		M13.0		M13.0		M13.0		M13.0		M13.0		A4		A4		A4		A4		A6		A9	
Sample Date		06/18/2013		06/18/2013		09/11/2012		09/11/2012		06/18/2013		06/18/2013		02/02/2010		02/02/2010		01/28/2011		01/28/2011		09/27/2011		09/27/2011		10/27/2009		10/27/2009		01/28/2010		01/28/2010		10/26/2009		10/26/2009	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		T		D		T		D		T		D		T		D		T		D		T		D		T		D		T		D		T		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	197	J	200	U	200	U	200	U	76.8	J	200	U	98.3	J	6.1	J	200	U	200	U	58.4	J	10.3	J	8110	J	7670	--	1960	--	815	--	--	--	--	--
ANTIMONY	µg/L	60	U	60	U	60	U	60	U	60	U	60	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	0.15	U	0.12	U	--	--	--	--
ARSENIC	µg/L	10	U	10	U	10	U	10	U	10	U	10	U	1	U	1	U	1	U	1	U	1	U	1	U	0.86	J	0.77	J	1	U	1	U	--	--	--	--
BARIUM	µg/L	200	U	200	U	200	U	200	U	200	U	200	U	39.4	--	38.3	--	35.6	--	33.2	--	134	J	130	J	18.2	J	15.8	J	50.9	--	44.4	--	--	--	--	--
BERYLLIUM	µg/L	5	U	5	U	5	U	5	U	5	U	5	U	1	U	1	U	1	U	1	U	1	U	1	U	0.36	J	0.35	J	1	U	1	U	--	--	--	--
CADMIUM	µg/L	0.8		0.75	--	0.23	J	0.5	U	0.5	U	0.5	U	0.23	J	0.24	J	0.5	U	0.5	U	0.5	U	0.5	U	60.5	--	61.2	--	15.5	--	14.8	--	--	--	--	--
CALCIUM	µg/L	29100	--	27600	--	20700	--	19800	--	19000	--	16900	--	8070	--	8020	--	9380	--	9850	--	23900	--	23600	--	57200	J	54800	--	15100	--	14400	--	--	--	--	--
CHROMIUM	µg/L	10	U	10	U	10	U	10	U	10	U	10	U	0.28	J	0.23	J	2	U	2	U	2	U	2	U	1.3	UJ	1.3	UJ	1.2	J	0.71	J	--	--	--	--
COBALT	µg/L	50	U	50	U	50	U	50	U	50	U	50	U	1	U	0.07	U	1.4	--	1	U	1	U	1	U	8.1	J	8.2	J	2.4	--	2.3	--	--	--	--	--
COPPER	µg/L	22.4	--	7.5	--	4.3	--	3.3	--	10.7	--	3.7	--	7.7	--	5.4	--	44.6	--	3.7	--	4	--	2	U	4260	--	4270	--	1410	--	1280	--	--	--	--	--
IRON	µg/L	191	--	100	U	41.4	J	100	U	122	--	100	U	127	--	25.7	J	--	--	100	U	100	U	100	U	555	J	458	--	1180	--	89.8	J	--	--	--	--
LEAD	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	0.057	U	0.05	U	1	U	1	U	1	U	1	U	0.57	J	0.62	J	0.33	U	0.3	U	--	--	--	--
LITHIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	100	U	100	U	100	U	100	U	100	U	100	U	100	UJ	100	U	100	U	100	U	--	--	--	--
MAGNESIUM	µg/L	12100	--	11500	--	6140	--	5760	--	6370	--	5660	--	2910	J	2880	J	3710	--	3570	--	6480	--	6350	--	13100	--	12400	--	3980	J	3840	J	--	--	--	--
MANGANESE	µg/L	18.3	J	15	U	5.5	--	4.7	J	32	J	15	U	2.1	--	1	--	2.5	--	1.6	--	5.3	J	2.4	J	1020	--	1020	--	249	--	238	J	--	--	--	--
MERCURY	µg/L	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	--	--	--	--
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--
NICKEL	µg/L	1.8	J	1.5	--	0.45	J	0.42	J	0.84	J	1	U	0.95	U	0.74	U	91	--	1	U	1	U	1	U	32.3	J	33	--	9.7	--	8.9	--	--	--	--	--
POTASSIUM	µg/L	440	J	5000	U	5000	U	5000	U	428	J	5000	U	305	J	320	J	510	J	369	J	5000	U	5000	U	791	J	791	J	226	J	230	J	--	--	--	--
SELENIUM	µg/L	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	0.32	U	0.41	U	--	--	--	--
SILVER	µg/L	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	UJ	0.1	UJ	0.1	U	0.1	U	0.1	--	0.1	--	0.1	U	0.1	U	--	--	--	--
SODIUM	µg/L	5850	J	5550	--	8040	--	7710	--	7030	J	6240	--	6710	--	6580	--	5470	--	6040	--	18200	--	18000	--	5610	J	5190	--	4670	J	4930	J	--	--	--	--
THALLIUM	µg/L	25	U	25	U	25	U	25	U	25	U	25	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	0.07	J	1	U	1	U	--	--	--	--
THORIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--
URANIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	0.08	J	0.09	J	1	U	1	U	--	--	--	--
VANADIUM	µg/L	50	U	50	U	50	U	50	U	50	U	50	U	5	U	5	U	5	U	5	U	--	U	--	U	5	UJ	5	UJ	5	U	5	U	--	--	--	--
ZINC	µg/L	120	--	98.2	--	26.5	--	25.9	--	50.8	--	34.5	--	56.8	--	48.9	--	52.9	--	47.8	--	17.4	--	10.7	--	14400	--	14400	--	3410	--	3280	--	--	--	--	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	22	--	--	--	--	--	--	--	--	--	--	--	35	--	--	--	50	--	--	--	5	--	--	--	10	--	--	--	--	--	--	--
Conductivity	µS/cm	262	--	--	--	143	--	--	--	164	--	--	--	86	--	--	--	65	--	--	--	279	--	--	--	711	--	--	--	146	--	--	--	557	--	861	--
Dissolved Oxygen	mg/l	10.52	--	--	--	10.97	--	--	--	10.22	--	--	--	11.72	--	--	--	10.74	--	--	--	10.65	--	--	--	9.18	--	--	--	11.19	--	--	--	8.79	--	8.95	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	0.04	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	--	--	--	--	--	--	--	--	--	--	--	--	14314.66	--	--	--	13906.5	--	--	--	729.7	--	--	--	5	--	--	--	128.87	--	--	--	7	--	10	--
ORP	millivolts	79	--	--	--	118	--	--	--	212	--	--	--	245	--	--	--	128.2	--	--	--	134.4	--	--	--	470.5	--	--	--	384.5	--	--	--	401	--	504.5	--
PH	S.U.	8.9	--	--	--	7.55	--	--	--	7.64	--	--	--	7.66	--	--	--	7.57	--	--	--	7.88	--	--	--	3.16	--	--	--	5.21	--	--	--	3.55	--	3.29	--
Temperature	deg C	12.3	--	--	--	10.83	--	--	--	13.6	--	--	--	7.25	--	--	--	7.06	--	--	--	13.81	--	--	--	7	--	--	--	7.07	--	--	--	9.74	--	9.65	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	10	U	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	10	UJ	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	10	U	--	--	10	U	--	--	--	--	--	--	96	--	--	--	14	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	57.4	--	--	--	--	--	--	--	35.1	--	--	--	33.4	--	--	--	51.7	--	--	--	5	U	--	--	5	U	--	--	--	--	--	--
Ammonia as N (distilled)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	2.38	--	--	--	7.86	--	--	--	5.58	--	--	--	6.6	--	--	--	7.62	--	--	--	39.1	--	--	--	2.45	--	--	--	2.33	--	--	--	--	--
FLUORIDE	mg/l	--	--	0.0514	--	--	--	0.0638	--	--	--	0.0504	--	--	--	0.0491	--	--	--	0.05	--	--	--	0.0627	--	--	--	0.285	--	--	--	0.14	--	--	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	0.05	U	--	--	0.05	U	--	--	0.05	U	--	--	0.307	--	--	--	0.0868	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	61.7	--	--	--	27.1	--	--	--	20.5	--	--	--	8.9	--	--	--	8.74	--	--	--	18.4	--	--	--	301	--	--	--	72.3	--	--	--	--	--
TDS	mg/l	200	--	--	--	118	--	--	--	124	--	--	--	92	--	--	--	20	U	--	--	186	--	--	--	464	--	--	--	132	--	--	--	--	--	--	--
TSS	mg/l	3.85	--	--	--	2.1	U	--	--	8.98	--	--	--	2.1	U	--	--	2.1	U	--	--	6.88	--	--	--	2.1	U	--	--	2.71	--	--	--	--	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimated
R = Rejected
> = Above de
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK	
Location		A6		A6		MA		MA		MA2		MA4		MA7		MA8		MA14		MA19		MA20		MA21		MA23		MA24		MA26		MA27		MA28		MA29	
Sample Date		01/29/2010		01/29/2010		10/27/2009		01/28/2010		10/26/2009		10/26/2009		10/26/2009		10/26/2009		01/28/2010		01/28/2010		01/28/2010		01/28/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		T		D		T		T		T		T		T		T		T		T		T		T		T		T		T		T		T		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	3020	--	1930	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ANTIMONY	µg/L	0.19	U	2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ARSENIC	µg/L	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BARIUM	µg/L	57.5	--	37.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BERYLLIUM	µg/L	0.14	J	0.093	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CADMIUM	µg/L	22	--	22	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CALCIUM	µg/L	17100	--	16400	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	µg/L	1.7	J	0.98	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COBALT	µg/L	3.5	--	3.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COPPER	µg/L	2100	--	2120	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
IRON	µg/L	2640	--	287	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAD	µg/L	1.1	--	0.45	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LITHIUM	µg/L	100	U	100	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	4540	J	4390	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	µg/L	369	--	377	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MERCURY	µg/L	0.2	U	0.2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MOLYBDENUM	µg/L	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	µg/L	12.2	--	12.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
POTASSIUM	µg/L	316	J	266	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SELENIUM	µg/L	0.38	U	0.75	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SILVER	µg/L	0.11	U	0.1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SODIUM	µg/L	4810	J	4750	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THALLIUM	µg/L	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THORIUM	µg/L	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
URANIUM	µg/L	0.077	J	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	µg/L	5	U	5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	µg/L	4680	--	4490	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Conductivity	µS/cm	246	--	--	--	385	--	98	--	238	--	735	--	570	--	524	--	62	--	97	--	100	--	99	--	134	--	193	--	247	--	214	--	248	--	195	--
Dissolved Oxygen	mg/l	11.14	--	--	--	9.85	--	11.11	--	9.04	--	8.72	--	8.48	--	8.32	--	10.75	--	11.18	--	11.24	--	10.4	--	10.01	--	11.04	--	11.26	--	7.91	--	11.08	--	11.19	--
Ferrous Iron	mg/l	0.08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	91.59	--	--	--	2	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORP	millivolts	481.5	--	--	--	274.4	--	299.1	--	265.4	--	470.8	--	377	--	354.6	--	286.9	--	308.2	--	296.7	--	357.9	--	352.3	--	427	--	471.8	--	439.5	--	189.8	--	430	--
PH	S.U.	4.12	--	--	--	5.87	--	6.76	--	6.53	--	3.78	--	5.57	--	6.54	--	7.1	--	6.31	--	6.97	--	6.11	--	6.46	--	5.18	--	4.2	--	4.59	--	4.09	--	5.07	--
Temperature	deg C	7.39	--	--	--	5.68	--	7.43	--	9.55	--	9.69	--	9.69	--	9.75	--	7.32	--	7.48	--	7.33	--	7.11	--	7.44	--	7.48	--	7.47	--	7.4	--	7.47	--	7.49	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ammonia as N (distilled)	mg/l	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	2.28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORIDE	mg/l	--	--	0.162	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	0.116	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	98.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TDS	mg/l	180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TSS	mg/l	7.55	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
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Q = Qualifier
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U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK	
Location		MA30		MA31		MA32		MA33		MA34		MA35		MA36		MA37		MA39		MA41		MA42		MA43		MA45		MA46		MA46		MA46		MA46		MA46	
Sample Date		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/29/2010		01/30/2010		01/30/2010		02/14/2012		02/14/2012		09/10/2012		09/10/2012	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		T		T		T		T		T		T		T		T		T		T		T		T		T		T		T		D		T		D	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6500	--	6260	--	8590	J	9530	--
ANTIMONY	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	U	60	U	60	U	60	U
ARSENIC	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	U	10	U	10	U	10	U
BARIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	200	UJ	200	U	200	U	200	U
BERYLLIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.19	J	0.22	J	5	U	5	U
CADMIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	27.2	J	28.2	J	45.1	--	45.4	--
CALCIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	27800	--	28300	--	51500	--	55100	--
CHROMIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	U	10	U	10	U	10	U
COBALT	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.1	J	5.3	J	50	U	50	U
COPPER	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3220	--	3570	--	4330	--	4360	--
IRON	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2620	J	2480	--	363	--	336	--
LEAD	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	1	U	0.79	J	0.78	J
LITHIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7020	--	7120	--	9810	--	10800	--
MANGANESE	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	642	--	642	--	1250	--	1170	--
MERCURY	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	U	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13.3	J	12.4	J	24.3	--	23.8	--
POTASSIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5000	UJ	5000	U	5000	U	5000	U
SELENIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	J	0.49	J	5	U	5	U
SILVER	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.18	J	0.13	J	0.1	U	0.1	U
SODIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5000	U	5000	U	5240	--	5790	--
THALLIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	25	U	25	U	25	U	25	U
THORIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
URANIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	50	U	50	U	50	U	50	U
ZINC	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6060	--	7230	--	11700	--	11700	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--
Conductivity	µS/cm	285	--	192	--	371	--	193	--	223	--	222	--	193	--	225	--	194	--	200	--	194	--	199	--	343	--	470	--	366	--	--	--	413	--	--	--
Dissolved Oxygen	mg/l	11.03	--	11.08	--	10.95	--	11.02	--	11.05	--	11	--	11.1	--	10.85	--	11.03	--	11.04	--	11	--	10.91	--	11.07	--	11.26	--	12.2	--	--	--	854	--	--	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12.1	--	--	--	0.16	--	--	--
ORP	millivolts	517.8	--	435.1	--	532.7	--	457	--	469.5	--	477.3	--	442.5	--	488.2	--	438	--	433	--	420.4	--	422	--	532.5	--	547.7	--	406	--	--	--	325.7	--	--	--
PH	S.U.	3.86	--	5.16	--	3.62	--	5.17	--	4.44	--	4.42	--	5.13	--	4.33	--	5.15	--	4.9	--	5.2	--	5.02	--	3.69	--	3.45	--	3.61	--	--	--	3.77	--	--	--
Temperature	deg C	7.46	--	7.49	--	7.43	--	7.48	--	7.47	--	7.47	--	7.48	--	7.47	--	7.48	--	7.4	--	7.48	--	7.41	--	6.89	--	6.92	--	4.61	--	--	--	10.56	--	--	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	64	--	--	--	90	--	--	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	U	--	--	5	U	--	--
Ammonia as N (distilled)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.02	--	--	--	2.22	--
FLUORIDE	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.221	--	--	--	0.345	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	153	--	--	--	279	--
TDS	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	248	--	--	--	390	--	--	--
TSS	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	23.7	--	--	--	2.1	U	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK	
Location		MA46		MA46		MA47		MA48		MA49		MA5		MA51		MA52		MA53		MA55		MA56		MA57		MA58		MA59		MA60		MA61		MC1		MC2	
Sample Date		06/20/2013		06/20/2013		01/30/2010		01/30/2010		01/30/2010		10/26/2009		01/30/2010		01/30/2010		01/30/2010		01/30/2010		01/30/2010		01/30/2010		01/30/2010		01/30/2010		01/30/2010		09/10/2012		01/28/2010		01/29/2010	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		T		D		T		T		T		T		T		T		T		T		T		T		T		T		T		N		T		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	9580	--	9760	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ANTIMONY	µg/L	60	U	60	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ARSENIC	µg/L	10	U	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BARIUM	µg/L	35.7	J	200	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BERYLLIUM	µg/L	5	U	5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CADMIUM	µg/L	39.9	J	39.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CALCIUM	µg/L	41200	--	41600	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	µg/L	10	U	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COBALT	µg/L	50	U	50	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COPPER	µg/L	4340	--	4490	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
IRON	µg/L	500	--	494	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAD	µg/L	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LITHIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	9310	--	9500	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	µg/L	1050	--	1020	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MERCURY	µg/L	0.2	U	0.058	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	µg/L	18	J	18.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
POTASSIUM	µg/L	5000	U	5000	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SELENIUM	µg/L	5	U	5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SILVER	µg/L	0.12	--	0.12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SODIUM	µg/L	5020	--	5060	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THALLIUM	µg/L	25	U	25	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THORIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
URANIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	µg/L	50	U	50	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	µg/L	12000	--	11700	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	30	--	--	--	--	--
Conductivity	µS/cm	524	--	--	--	394	--	391	--	388	--	706	--	374	--	368	--	357	--	350	--	348	--	341	--	384	--	324	--	338	--	173	--	121	--	99	--
Dissolved Oxygen	mg/l	9.34	--	--	--	11.34	--	11.38	--	11.48	--	8.7	--	11.41	--	11.42	--	11.39	--	11.43	--	11.38	--	11.54	--	11.42	--	11.25	--	11.64	--	--	--	10.85	--	10.38	--
Ferrous Iron	mg/l	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.19	--	8	--	2	--
ORP	millivolts	--	--	--	--	519.3	--	522.8	--	536.9	--	440.8	--	524.4	--	512.4	--	503.2	--	492.4	--	482.9	--	482.9	--	432.8	--	411	--	360.3	--	178.5	--	295.1	--	275.9	--
PH	S.U.	3.6	--	--	--	3.62	--	3.59	--	3.51	--	3.94	--	3.71	--	3.79	--	3.89	--	3.95	--	3.98	--	4.03	--	4.7	--	5.09	--	5.22	--	7.35	--	6.87	--	6.15	--
Temperature	deg C	--	--	--	--	6.71	--	6.71	--	6.73	--	9.64	--	6.74	--	6.72	--	6.69	--	6.67	--	6.64	--	6.61	--	6.91	--	7.18	--	7.16	--	11.05	--	7.67	--	8.24	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ammonia as N (distilled)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	2.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORIDE	mg/l	--	--	0.0968	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	243	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TDS	mg/l	488	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TSS	mg/l	2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK	
Location		MD1		ME1		ME1		MF1		MA1		MA10		MA11		MA12		MA13		MA13		MA15		MA16		MA17		MA17		MA17		MA17		MA17		MA17	
Sample Date		01/30/2010		02/05/2010		02/05/2010		02/05/2010		10/26/2009		01/26/2010		01/26/2010		01/26/2010		01/26/2010		01/26/2010		01/28/2010		01/28/2010		01/28/2010		01/28/2010		02/14/2012		09/10/2012		06/20/2013		06/20/2013	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep	
Total/Dissolved		T		T		D		T		T		T		T		T		T		D		T		T		T		D		N		N		T		D	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	--	--	200	U	200	U	--	--	--	--	--	--	--	--	--	--	49.4	J	200	U	--	--	--	--	2330	--	2160	--	--	--	--	--	807	--	781	--
ANTIMONY	µg/L	--	--	2	U	0.46	U	--	--	--	--	--	--	--	--	--	--	2	U	0.37	U	--	--	--	--	2	U	2	U	--	--	--	--	60	U	60	U
ARSENIC	µg/L	--	--	1	U	1	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	1	U	1	U	--	--	--	--	10	U	10	U
BARIUM	µg/L	--	--	37.7	--	36.9	--	--	--	--	--	--	--	--	--	--	--	7.7	J	6.5	J	--	--	--	--	15.5	--	15.4	--	--	--	--	--	18.2	J	200	U
BERYLLIUM	µg/L	--	--	1	U	0.05	J	--	--	--	--	--	--	--	--	--	--	1	U	0.05	J	--	--	--	--	0.42	J	0.33	J	--	--	--	--	5	U	5	U
CADMIUM	µg/L	--	--	3.5	--	3.4	--	--	--	--	--	--	--	--	--	--	--	0.5	U	0.5	U	--	--	--	--	37.3	--	38.6	--	--	--	--	--	14.8	J	14.8	--
CALCIUM	µg/L	--	--	58400	--	58900	--	--	--	--	--	--	--	--	--	--	--	6830	--	6940	J	--	--	--	--	40900	--	39500	--	--	--	--	--	28400	--	28800	--
CHROMIUM	µg/L	--	--	0.76	J	0.69	J	--	--	--	--	--	--	--	--	--	--	1.1	J	0.94	J	--	--	--	--	0.82	J	0.71	J	--	--	--	--	10	U	10	U
COBALT	µg/L	--	--	0.08	J	1	U	--	--	--	--	--	--	--	--	--	--	0.26	J	0.09	J	--	--	--	--	5.9	--	6.1	--	--	--	--	--	50	U	50	U
COPPER	µg/L	--	--	3.3	J	3.5	--	--	--	--	--	--	--	--	--	--	--	2.4	--	2.1	--	--	--	--	--	3910	--	3990	--	--	--	--	--	1810	--	1770	--
IRON	µg/L	--	--	23.3	U	27.4	U	--	--	--	--	--	--	--	--	--	--	109	--	117	--	--	--	--	--	37.4	J	16.8	J	--	--	--	--	100	U	100	U
LEAD	µg/L	--	--	0.21	U	0.37	J	--	--	--	--	--	--	--	--	--	--	0.45	J	0.33	J	--	--	--	--	0.28	U	0.22	U	--	--	--	--	1	U	1	U
LITHIUM	µg/L	--	--	100	U	100	U	--	--	--	--	--	--	--	--	--	--	100	U	100	U	--	--	--	--	100	U	100	U	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	--	--	18700	--	18900	--	--	--	--	--	--	--	--	--	--	--	2040	J	2020	J	--	--	--	--	10400	--	9900	--	--	--	--	--	6410	--	6560	--
MANGANESE	µg/L	--	--	3.9	--	2.1	J	--	--	--	--	--	--	--	--	--	--	3.8	J	0.93	J	--	--	--	--	870	--	886	J	--	--	--	--	311	--	309	--
MERCURY	µg/L	--	--	0.2	U	0.2	U	--	--	--	--	--	--	--	--	--	--	0.2	U	0.2	U	--	--	--	--	0.2	U	0.2	U	--	--	--	--	0.2	U	0.057	J
MOLYBDENUM	µg/L	--	--	1	U	0.46	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--
NICKEL	µg/L	--	--	10.2	J	9.8	--	--	--	--	--	--	--	--	--	--	--	1.3	--	1.1	--	--	--	--	--	33.9	--	34	--	--	--	--	--	12	J	12.2	--
POTASSIUM	µg/L	--	--	655	J	669	J	--	--	--	--	--	--	--	--	--	--	133	J	5000	U	--	--	--	--	663	J	565	J	--	--	--	--	5000	U	5000	U
SELENIUM	µg/L	--	--	5	U	0.65	J	--	--	--	--	--	--	--	--	--	--	5	U	0.31	J	--	--	--	--	0.98	U	0.71	U	--	--	--	--	5	U	5	U
SILVER	µg/L	--	--	0.1	UJ	0.1	U	--	--	--	--	--	--	--	--	--	--	0.1	U	0.13	U	--	--	--	--	0.1	U	0.1	U	--	--	--	--	0.1	U	0.1	U
SODIUM	µg/L	--	--	8440	--	8430	--	--	--	--	--	--	--	--	--	--	--	4550	J	4250	J	--	--	--	--	5750	--	5160	--	--	--	--	--	5000	U	5000	U
THALLIUM	µg/L	--	--	1	U	1	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	1	U	1	U	--	--	--	--	25	U	25	U
THORIUM	µg/L	--	--	1	U	0.13	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--
URANIUM	µg/L	--	--	1	U	0.083	J	--	--	--	--	--	--	--	--	--	--	1	U	0.073	J	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--
VANADIUM	µg/L	--	--	5	UJ	5	U	--	--	--	--	--	--	--	--	--	--	5	U	5	U	--	--	--	--	5	U	5	U	--	--	--	--	50	U	50	U
ZINC	µg/L	--	--	2840	--	2800	--	--	--	--	--	--	--	--	--	--	--	6.1	--	5.8	--	--	--	--	--	10300	--	10100	--	--	--	--	--	4730	--	4910	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	15	--	--	--	--	--	45	--	--	--	--	--	--	--	40	--	--	--	--	--	--	--	5	--	--	--	--	--	10	--	5	--	--	--
Conductivity	µS/cm	142	--	508	--	--	--	281	--	310	--	55	--	60	--	145	--	49	--	--	--	71	--	124	--	375	--	--	--	319	--	274	--	249	--	--	--
Dissolved Oxygen	mg/l	9.6	--	8.9	--	--	--	10.95	--	7.42	--	12.84	--	11.98	--	12.91	--	12.69	--	--	--	10.9	--	7.29	--	10.52	--	--	--	--	--	--	--	9.15	--	--	--
Ferrous Iron	mg/l	--	--	0.04	--	--	--	--	--	0.52	--	--	--	--	--	--	--	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--
FLOW	gal/min	--	--	22	--	--	--	50	--	--	--	8	--	8	--	0.5	--	83.44	--	--	--	3	--	3	--	12	--	--	--	10	--	1	--	3	--	--	--
ORP	millivolts	402.6	--	258.9	--	--	--	259	--	225	--	292	--	299.3	--	481.8	--	320.4	--	--	--	749	--	259	--	316	--	--	--	220.5	--	296.2	--	--	--	--	--
PH	S.U.	6.46	--	6.89	--	--	--	7.58	--	6.52	--	6.31	--	6.19	--	3.05	--	5.92	--	--	--	6.76	--	6.41	--	4.87	--	--	--	4.88	--	4.74	--	5.94	--	--	--
Temperature	deg C	8.04	--	8.42	--	--	--	7.71	--	9.75	--	7.81	--	7.81	--	6.39	--	7.24	--	--	--	7.34	--	7.71	--	8.28	--	--	--	7.83	--	11.37	--	--	--	--	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	--	--	--
Acidity by titration	mg/l	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	10	U	--	--	--	--	--	--	44	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	6.27	--	--	--	--	--	--	--	--	--	--	--	--	--	35.3	--	--	--	--	--	--	--	5	U	--	--	--	--	--	--	--	--	--	--
Ammonia as N (distilled)	mg/l	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	--	--	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	--	--	1.49	--	--	--	--	--	--	--	--	--	--	--	--	--	2.34	--	--	--	--	--	--	--	2.01	--	--	--	--	--	--	--	1.72	--
FLUORIDE	mg/l	--	--	--	--	0.0435	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0802	--	--	--	--	--	--	--	0.416	--	--	--	--	--	--	--	0.158	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	0.323	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	U	--	--	--	--	--	--	0.471	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	--	--	277	--	--	--	--	--	--	--	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--	224	--	--	--	--	--	--	--	113	--
TDS	mg/l	--	--	474	--	--	--	--	--	--	--	--	--	--	--	--	--	66	--	--	--	--	--	--	--	366	--	--	--	--	--	--	--	198	--	--	--
TSS	mg/l	--	--	2	U	--	--	--	--	--	--	--	--	--	--	--	--	2.95	--	--	--	--	--	--	--	2.1	U	--	--	--	--	--	--	2	U	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK	
Location		MA18		MA22		MA22		MA25		MA3		MA38		MA40		MA40		MA44		MA44		MA44		MA50		MA54		MA6		MA9		MB		MB1		MB1	
Sample Date		01/28/2010		01/29/2010		01/29/2010		01/29/2010		10/26/2009		01/29/2010		01/30/2010		01/30/2010		02/04/2010		02/04/2010		02/14/2012		01/30/2010		01/30/2010		10/26/2009		10/27/2009		01/28/2010		01/29/2010		01/29/2010	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		STREAM		Seep		Seep	
Total/Dissolved		T		T		D		T		T		T		T		D		T		D		N		T		T		T		T		T		T		D	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	--	--	497	--	488	--	--	--	--	--	--	--	5300	--	5380	--	25900	--	25100	--	--	--	--	--	--	--	--	--	--	--	--	--	1040	--	968	--
ANTIMONY	µg/L	--	--	2	U	2	U	--	--	--	--	--	--	0.26	U	2	U	2	U	2	U	--	--	--	--	--	--	--	--	--	--	--	--	1.1	U	0.17	U
ARSENIC	µg/L	--	--	1	U	0.23	U	--	--	--	--	--	--	0.56	U	1	U	0.37	U	0.22	U	--	--	--	--	--	--	--	--	--	--	--	--	4.5	--	1	U
BARIUM	µg/L	--	--	27.3	--	24.6	--	--	--	--	--	--	--	133	--	14.9	--	13.9	--	11.2	--	--	--	--	--	--	--	--	--	--	--	--	--	421	--	16.7	--
BERYLLIUM	µg/L	--	--	0.097	J	0.14	J	--	--	--	--	--	--	0.29	J	0.24	J	1.2	--	1.4	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	0.083	J
CADMIUM	µg/L	--	--	9.3	--	9.2	--	--	--	--	--	--	--	38.2	--	37.3	--	170	--	170	--	--	--	--	--	--	--	--	--	--	--	--	--	12.3	--	11.3	--
CALCIUM	µg/L	--	--	9360	--	9320	--	--	--	--	--	--	--	20100	--	21900	--	56700	--	55100	--	--	--	--	--	--	--	--	--	--	--	--	--	15000	--	16200	--
CHROMIUM	µg/L	--	--	0.67	J	0.68	J	--	--	--	--	--	--	1.5	J	0.97	J	4.5	--	4.7	--	--	--	--	--	--	--	--	--	--	--	--	--	0.98	J	0.75	J
COBALT	µg/L	--	--	6.2	--	6.1	--	--	--	--	--	--	--	5.8	--	5.6	--	23.7	--	23.9	--	--	--	--	--	--	--	--	--	--	--	--	--	0.82	J	0.8	J
COPPER	µg/L	--	--	589	--	588	--	--	--	--	--	--	--	3830	--	3890	--	17800	--	17700	--	--	--	--	--	--	--	--	--	--	--	--	--	1020	--	962	--
IRON	µg/L	--	--	78.6	J	60.9	J	--	--	--	--	--	--	2470	--	172	--	7010	--	6320	--	--	--	--	--	--	--	--	--	--	--	--	--	2310	--	294	--
LEAD	µg/L	--	--	0.24	U	0.27	U	--	--	--	--	--	--	2.8	--	0.89	J	2	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	14	--	0.6	J
LITHIUM	µg/L	--	--	3	U	3.6	U	--	--	--	--	--	--	100	U	100	U	11.7	U	12.1	U	--	--	--	--	--	--	--	--	--	--	--	--	100	U	100	U
MAGNESIUM	µg/L	--	--	3180	J	3180	J	--	--	--	--	--	--	5180	--	5550	--	14800	--	14600	--	--	--	--	--	--	--	--	--	--	--	--	--	3700	J	3960	J
MANGANESE	µg/L	--	--	442	--	437	J	--	--	--	--	--	--	619	--	593	J	2620	--	2630	--	--	--	--	--	--	--	--	--	--	--	--	--	82	--	73	J
MERCURY	µg/L	--	--	0.2	U	0.2	U	--	--	--	--	--	--	0.2	U	0.2	U	0.14	J	0.2	U	--	--	--	--	--	--	--	--	--	--	--	--	0.2	U	0.2	U
MOLYBDENUM	µg/L	--	--	1	U	1	U	--	--	--	--	--	--	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	0.4	U	1	U
NICKEL	µg/L	--	--	10.3	--	10.4	--	--	--	--	--	--	--	18.7	--	18.1	--	65.3	--	64.8	--	--	--	--	--	--	--	--	--	--	--	--	--	7.9	--	7.1	--
POTASSIUM	µg/L	--	--	395	J	254	J	--	--	--	--	--	--	1030	J	1000	J	702	J	639	J	--	--	--	--	--	--	--	--	--	--	--	--	460	J	482	J
SELENIUM	µg/L	--	--	0.28	U	0.4	U	--	--	--	--	--	--	0.51	U	0.77	U	1.4	U	1.5	U	--	--	--	--	--	--	--	--	--	--	--	--	5	U	0.5	U
SILVER	µg/L	--	--	0.1	U	0.1	U	--	--	--	--	--	--	0.31	U	0.12	U	0.41	--	0.43	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	0.16	U
SODIUM	µg/L	--	--	4420	J	4460	J	--	--	--	--	--	--	4370	J	4490	J	5390	--	5270	--	--	--	--	--	--	--	--	--	--	--	--	--	4880	J	4930	J
THALLIUM	µg/L	--	--	1	U	1	U	--	--	--	--	--	--	1	U	1	U	0.22	J	0.26	J	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U
THORIUM	µg/L	--	--	1	U	1	U	--	--	--	--	--	--	1	U	1	U	0.25	J	0.26	J	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U
URANIUM	µg/L	--	--	1	U	1	U	--	--	--	--	--	--	0.17	J	0.12	J	0.61	J	0.64	J	--	--	--	--	--	--	--	--	--	--	--	--	1	U	0.083	J
VANADIUM	µg/L	--	--	5	U	5	U	--	--	--	--	--	--	5	U	5	U	5	U	5	U	--	--	--	--	--	--	--	--	--	--	--	--	5	U	5	U
ZINC	µg/L	--	--	2150	--	2070	--	--	--	--	--	--	--	7150	--	7670	--	33700	--	34000	--	--	--	--	--	--	--	--	--	--	--	--	--	3030	--	3280	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	0	--	--	--	--	--	--	--	--	--	5	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--
Conductivity	µS/cm	369	--	198	--	--	--	100	--	1065	--	325	--	370	--	--	--	1084	--	--	--	973	--	307	--	321	--	676	--	589	--	0	--	270	--	--	--
Dissolved Oxygen	mg/l	10.18	--	10.36	--	--	--	9.62	--	8.16	--	10.26	--	10.03	--	--	--	7.71	--	--	--	--	--	10.72	--	7.8	--	8.52	--	9.08	--	0	--	9.7	--	--	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	0.98	--	--	--	1.28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	3	--	1	--	--	--	1	--	0.25	--	--	--	--	--	--	--	1	--	--	--	1.5	--	--	--	1	--	--	--	0.25	--	0	--	--	--	--	--
ORP	millivolts	329.7	--	444.6	--	--	--	359	--	504.5	--	460.7	--	467.1	--	--	--	529	--	--	--	437.3	--	482.6	--	479.5	--	426	--	326.4	--	0	--	470.2	--	--	--
PH	S.U.	4.74	--	3.85	--	--	--	5.81	--	3.08	--	4.12	--	3.67	--	--	--	2.4	--	--	--	2.88	--	5	--	4.95	--	5.22	--	4.15	--	--	--	3.6	--	--	--
Temperature	deg C	8.32	--	7.34	--	--	--	8.1	--	10.02	--	7.07	--	6.68	--	--	--	7.85	--	--	--	7.33	--	7.14	--	6.82	--	9.68	--	9.24	--	0	--	7.04	--	--	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	18	--	--	--	--	--	--	--	--	--	64	--	--	--	350	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	26	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	5	U	--	--	--	--	--	--	--	--	5	U	--	--	5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	U	--	--
Ammonia as N (distilled)	mg/l	--	--	0.5	U	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--
Chloride	mg/l	--	--	--	--	2.53	--	--	--	--	--	--	--	--	--	2.27	--	--	--	1.4	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.24	--
FLUORIDE	mg/l	--	--	--	--	0.0887	--	--	--	--	--	--	--	--	--	0.189	--	--	--	0.04	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0987	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	0.107	--	--	--	--	--	--	--	--	--	0.162	--	--	--	0.473	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.116	--	--	--
Sulfate	mg/l	--	--	--	--	62.8	--	--	--	--	--	--	--	--	--	161	--	--	--	623	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	89.5	--
TDS	mg/l	--	--	152	--	--	--	--	--	--	--	--	--	256	--	--	--	1050	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	146	--	--	--
TSS	mg/l	--	--	2.1	U	--	--	--	--	--	--	--	--	34.3	--	--	--	8.75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.5	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimated
R = Rejected
> = Above de
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK	
Location		MB1		MB2		MB3		MB3		ME2		ME3		ME3		ME3		ME3		MF2		MF2		MF2		MF2		MF2		MF2		SEEP A		SEEP A		SEEP A	
Sample Date		02/14/2012		01/28/2010		01/30/2010		01/30/2010		02/17/2012		02/17/2012		02/17/2012		06/20/2013		06/20/2013		01/29/2011		01/29/2011		02/19/2012		9/10/2012		06/20/2013		06/20/2013		10/26/2009		10/26/2009		01/28/2010	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep	
Total/Dissolved		N		T		T		D		N		T		D		T		D		T		D		N		N		T		D		T		D		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	--	--	--	--	25400	--	24900	--	--	--	52.2	J	200	U	200	U	200	U	200	U	200	U	--	--	--	--	200	U	200	U	32.2	U	9.4	U	27.5	J
ANTIMONY	µg/L	--	--	--	--	0.12	U	0.17	U	--	--	60	U	60	U	60	U	60	U	2	U	2	U	--	--	--	--	60	U	60	U	0.39	U	2	U	0.15	U
ARSENIC	µg/L	--	--	--	--	1	U	1	U	--	--	10	U	10	U	10	U	10	U	1	U	1	U	--	--	--	--	10	U	10	U	0.7	J	1	--	1	U
BARIUM	µg/L	--	--	--	--	10.7	--	7.6	J	--	--	200	UJ	200	U	200	U	200	U	31.1	--	29.7	--	--	--	--	--	200	U	200	U	81.1	--	81.2	--	64.7	--
BERYLLIUM	µg/L	--	--	--	--	0.98	J	1.1	--	--	--	5	U	5	U	5	U	5	U	1	U	1	U	--	--	--	--	5	U	5	U	1	U	1	U	1	U
CADMIUM	µg/L	--	--	--	--	157	--	159	--	--	--	9.2	J	10.1	J	6.0		6.1	--	3	--	2.6	--	--	--	--	--	2.5		2.6	--	1.8	--	1.8	--	1.2	--
CALCIUM	µg/L	--	--	--	--	59000	--	57600	--	--	--	89300	--	88600	--	89900	--	83900	--	97200	--	98000	--	--	--	--	--	121000	--	115000	--	30000	--	30900	--	9540	--
CHROMIUM	µg/L	--	--	--	--	5.1	--	5.4	--	--	--	10	U	10	U	10	U	10	U	2	U	2	U	--	--	--	--	10	U	10	U	3.5	--	0.6	U	0.73	J
COBALT	µg/L	--	--	--	--	22.9	--	23.1	--	--	--	50	U	50	U	50	U	50	U	1	U	1	U	--	--	--	--	50	U	50	U	1	U	1	U	0.093	U
COPPER	µg/L	--	--	--	--	16600	--	17400	--	--	--	715	--	829	--	385		400	--	2	U	2	U	--	--	--	--	0.6	J	0.59	J	40.3	--	36.1	--	50.7	--
IRON	µg/L	--	--	--	--	14100	--	13700	--	--	--	100	UJ	100	U	100	U	100	U	100	U	100	U	--	--	--	--	100	U	100	U	41.6	J	35	J	41.4	J
LEAD	µg/L	--	--	--	--	2.2	--	1.9	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	1	U	1	U	0.36	J	0.16	J	0.23	U
LITHIUM	µg/L	--	--	--	--	9	U	8.8	U	--	--	--	--	--	--	--	--	--	--	100	U	100	U	--	--	--	--	--	--	--	--	100	U	100	U	100	U
MAGNESIUM	µg/L	--	--	--	--	16000	--	15600	--	--	--	26300	--	26300	--	26500	--	25000	--	26500	--	26500	--	--	--	--	--	33100	--	31600	--	5890	--	6100	--	2560	J
MANGANESE	µg/L	--	--	--	--	2450	--	2470	J	--	--	43.9	--	43.5	--	15	UJ	15	U	2.2	--	1.3	--	--	--	--	--	15	UJ	15	U	4.2	--	3.6	--	4.6	J
MERCURY	µg/L	--	--	--	--	0.2	U	0.2	U	--	--	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	--	--	--	--	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	0.34	J	0.39	J	1	U
NICKEL	µg/L	--	--	--	--	66.3	--	64.6	--	--	--	8.1	J	7.9	J	6.3		6.4	--	9.2	--	8.6	--	--	--	--	--	9.2		9.6	--	4.6	--	3.4	--	3.2	--
POTASSIUM	µg/L	--	--	--	--	561	J	598	J	--	--	5000	UJ	5000	U	861	J	5000	U	1560	J	1410	--	--	--	--	--	1420	J	5000	U	273	U	311	U	304	J
SELENIUM	µg/L	--	--	--	--	5	U	1.5	U	--	--	5	U	5	U	5	U	5	U	5	U	5	U	--	--	--	--	5	U	5	U	5	U	5	U	0.58	U
SILVER	µg/L	--	--	--	--	0.5	--	0.51	--	--	--	0.1	U	0.1	UJ	0.1	U	0.1	U	0.1	UJ	0.1	UJ	--	--	--	--	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
SODIUM	µg/L	--	--	--	--	5380	--	6120	--	--	--	9830	--	9800	--	10000	J	9210	--	11900	--	12300	--	--	--	--	--	15500	J	14600	--	4130	J	4270	J	4610	J
THALLIUM	µg/L	--	--	--	--	0.22	J	0.24	J	--	--	25	U	25	U	25	U	25	U	1	U	1	U	--	--	--	--	25	U	25	U	1	U	1	U	1	U
THORIUM	µg/L	--	--	--	--	0.24	U	0.3	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	1	U	1	U	1	U
URANIUM	µg/L	--	--	--	--	0.51	J	0.54	J	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	1	U	1	U	1	U
VANADIUM	µg/L	--	--	--	--	5	U	5	U	--	--	50	U	50	U	50	U	50	U	5	U	5	U	--	--	--	--	50	U	50	U	5	U	5	U	5	U
ZINC	µg/L	--	--	--	--	29400	--	29300	--	--	--	3790	--	4010	--	2430	--	2520	--	2240	--	2260	--	--	--	--	--	2080	--	2220	--	552	--	556	--	459	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	5	--	--	--	--	--	15	--	--	--	20	--	--	--	10	--	--	--	10	--	15	--	15	--	--	--	60	--	--	--	40	--
Conductivity	µS/cm	176	--	127	--	1608	--	--	--	435	--	453	--	--	--	691	--	--	--	450	--	--	--	384	--	814	--	870	--	--	--	254	--	--	--	76	--
Dissolved Oxygen	mg/l	--	--	10.82	--	10.02	--	--	--	--	--	8.88	--	--	--	10.8	--	--	--	7.91	--	--	--	--	--	--	--	9.09	--	--	--	8.7	--	--	--	11	--
Ferrous Iron	mg/l	--	--	--	--	1.11	--	--	--	--	--	0.02	--	--	--	0.0	--	--	--	0.01	--	--	--	0.02	--	--	--	0.19	--	--	--	0.47	--	--	--	0.06	--
FLOW	gal/min	0.1	--	1.5	--	12	--	--	--	1.75	--	7.5	--	--	--	0.35	--	--	--	8	--	--	--	2.5	--	0	--	--	--	--	--	0.5	--	--	--	129.33	--
ORP	millivolts	208.2	--	406.1	--	581.1	--	--	--	210.5	--	218.3	--	--	--	--	--	--	--	153.3	--	--	--	191.5	--	146.5	--	-20.7	--	--	--	216	--	--	--	283	--
PH	S.U.	4.18	--	4.7	--	2.65	--	--	--	6.03	--	5.83	--	--	--	5.68	--	--	--	5.58	--	--	--	6.54	--	6.37	--	5.09	--	--	--	6.49	--	--	--	6.68	--
Temperature	deg C	5.09	--	6.55	--	7.79	--	--	--	8.26	--	8.42	--	--	--	9.9	--	--	--	7.86	--	--	--	6.02	--	22.1	--	11.5	--	--	--	9.96	--	--	--	7.43	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	10	U	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	--	--	390	--	--	--	--	--	--	--	--	--	--	--	--	--	11	J	--	--	--	--	--	--	--	--	--	--	10	U	--	--	10	U
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	5	U	--	--	--	--	8.6	--	--	--	--	--	--	--	5.7	--	--	--	--	--	--	--	--	--	--	--	70.2	--	--	--	34.9	--
Ammonia as N (distilled)	mg/l	--	--	--	--	0.18	J	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U
Chloride	mg/l	--	--	--	--	--	--	1.2	J	--	--	--	--	1.52	--	--	--	1.54	--	--	--	1.47	--	--	--	--	--	--	--	1.35	--	--	--	2.37	--	--	--
FLUORIDE	mg/l	--	--	--	--	--	--	0.04	U	--	--	--	--	0.12	--	--	--	0.0871	--	--	--	0.04	U	--	--	--	--	--	--	0.0492	--	--	--	0.115	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	0.477	--	--	--	--	--	--	--	--	--	--	--	--	--	0.456	--	--	--	--	--	--	--	--	--	--	--	0.0811	--	--	--	0.05	U
Sulfate	mg/l	--	--	--	--	--	--	688	--	--	--	--	--	1240	--	--	--	303	--	--	--	418	--	--	--	--	--	--	--	430	--	--	--	48.8	--	--	--
TDS	mg/l	--	--	--	--	1040	--	--	--	--	--	506	--	--	--	516	--	--	--	490	--	--	--	--	--	--	--	674	--	--	--	150	--	--	--	60	--
TSS	mg/l	--	--	--	--	2.1	U	--	--	--	--	2.1	U	--	--	2	U	--	--	2.1	U	--	--	--	--	--	--	3.41	--	--	--	2.1	U	--	--	2.1	U

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		MIDDLE CK		SOUTH FK		SOUTH FK		SOUTH FK		SOUTH FK		SOUTH FK		SOUTH FK		SOUTH FK		SOUTH FK		SOUTH FK		SOUTH FK		SOUTH FK	
Location		SEEP A		SEEP AT A9		SEEP AT A9		SEEP AT A9		MREF1		MREF1		MIDDLE CK SF1.0		MIDDLE CK SF1.0		MIDDLE CK SF1.0		MIDDLE CK SF1.0		MIDDLE CK SF1.0		MIDDLE CK SF1.0		MIDDLE CK SF1.0		MIDDLE CK SF1.0		MIDDLE CK SF1.0		MIDDLE CK SF1.0	
Sample Date		01/28/2010		10/27/2009		10/27/2009		01/30/2010		06/19/2013		06/19/2013		10/22/2009		10/22/2009		02/05/2010		02/05/2010		10/26/2010		10/26/2010		01/28/2011		01/28/2011		09/27/2011		09/27/2011		02/15/2012	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		Seep		Seep		Seep		Seep		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		D		T		D		T		T		D		T		D		T		D		T		D		T		D		T		D		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																			
ALUMINUM	µg/L	200	U	1750	J	141	J	--	--	118	J	200	U	21.6	U	16	U	1170	--	12.5	J	669	--	200	U	200	U	200	U	21.3	J	18.3	J	566	--
ANTIMONY	µg/L	0.15	U	2	U	2	U	--	--	60	U	60	U	0.91	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	60	U
ARSENIC	µg/L	1	U	0.97	J	0.85	J	--	--	10	U	10	U	0.76	J	0.73	J	1	U	1	U	0.2	U	0.11	U	1	U	1	U	1	U	1	U	10	U
BARIUM	µg/L	63.8	--	65.3	J	54.3	J	--	--	200	U	200	U	6.7	J	6.7	J	5.9	J	5.6	J	8.2	J	7.4	J	6.2	J	6.5	J	10	UJ	10	UJ	200	U
BERYLLIUM	µg/L	1	U	1	U	1	U	--	--	5	U	5	U	1	U	1	U	0.18	J	1	U	0.077	J	1	U	1	U	1	U	1	U	1	U	5	U
CADMIUM	µg/L	1.4	--	9.7	--	10.1	--	--	--	0.5	U	0.5	U	2.5	--	2.5	--	7.8	--	7.6	--	5.5	--	5.3	--	3.9	--	3.7	--	1	--	1	--	5.4	--
CALCIUM	µg/L	9250	--	45100	J	45400	J	--	--	12600	--	12300	--	25100	--	24800	--	16800	--	16900	--	27700	--	27700	--	19700	--	19300	--	20700	--	20000	--	23700	--
CHROMIUM	µg/L	0.72	J	3.8	J	7.6	J	--	--	10	U	10	U	0.44	U	0.57	U	2	UJ	2	U	0.43	U	0.17	U	2	U	2	U	2	U	2	U	10	U
COBALT	µg/L	0.083	U	0.84	J	0.75	J	--	--	50	U	50	U	1	U	0.12	J	1.7	J	1.7	--	0.94	J	0.79	J	1	U	1	U	1	U	1	U	0.69	J
COPPER	µg/L	47.1	--	700	--	581	--	--	--	0.56	J	0.53	J	47.6	--	35.2	--	706	J	285	--	327	--	134	--	155	--	112	--	27.8	--	25.5	--	373	--
IRON	µg/L	23.5	J	553	J	32.4	J	--	--	155	--	100	U	73.3	J	36.8	J	172	--	28.7	U	471	--	100	U	100	U	120	--	100	U	100	U	100	U
LEAD	µg/L	0.15	U	0.28	J	0.18	J	--	--	1	U	1	U	0.19	J	0.07	J	1	U	1	U	0.064	U	1	U	1	U	1	U	1	U	1	U	1	U
LITHIUM	µg/L	100	U	100	UJ	100	UJ	--	--	--	--	--	--	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	--	--
MAGNESIUM	µg/L	2470	J	12000	--	12000	--	--	--	5010	--	4930	J	8130	--	8050	--	5390	--	5440	--	8910	--	8760	--	5890	--	5800	--	6480	--	6290	--	7490	--
MANGANESE	µg/L	4.5	J	115	--	110	--	--	--	17.4	J	15	U	41.4	--	16.9	--	289	--	281	J	187	--	169	--	112	--	80	--	7.9	J	7.7	J	161	--
MERCURY	µg/L	0.2	U	0.2	U	0.2	U	--	--	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	1	U	0.38	J	1	U	--	--	--	--	--	--	0.37	J	0.34	J	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--
NICKEL	µg/L	2.8	--	6.6	J	16.5	J	--	--	0.69	J	1	U	2.5	--	3.2	--	7.8	J	8.1	--	5.5	--	5.3	--	4.4	--	4	--	1.7	--	1.6	--	5.6	--
POTASSIUM	µg/L	206	J	578	J	605	J	--	--	637	J	5000	U	268	U	309	U	5000	U	5000	U	308	J	299	J	500	UJ	110	J	5000	U	5000	U	5000	U
SELENIUM	µg/L	5	U	5	U	5	U	--	--	5	U	5	U	5	U	5	U	5	U	0.63	J	0.37	U	5	U	5	U	5	U	5	U	5	U	5	U
SILVER	µg/L	0.1	U	0.1	U	0.1	U	--	--	0.1	U	0.1	U	0.05	U	0.1	U	0.1	UJ	0.1	U	0.1	U	0.0067	J	0.1	UJ	0.1	UJ	0.1	U	0.1	U	0.18	--
SODIUM	µg/L	4420	J	6800	J	6720	J	--	--	4850	J	5000	U	5430	--	5760	--	3550	J	3730	J	4720	J	4730	J	4120	--	3890	--	5000	U	5000	U	3500	J
THALLIUM	µg/L	1	U	1	U	1	U	--	--	25	U	25	U	0.08	J	1	U	1	U	1	U	0.033	U	0.042	U	1	U	1	U	1	U	1	U	25	U
THORIUM	µg/L	1	U	1	U	1	U	--	--	--	--	--	--	0.11	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--
URANIUM	µg/L	1	U	1	U	1	U	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--
VANADIUM	µg/L	5	U	0.67	J	0.74	J	--	--	50	U	50	U	5	U	5	U	0.68	J	5	U	4.3	U	2.5	U	5	U	5	U	9.5	--	8.5	--	50	U
ZINC	µg/L	447	--	2730	--	2770	--	--	--	3.2	--	3.1	--	664	--	648	--	2260	--	2120	--	1700	--	1620	--	1200	--	1050	--	360	--	358	--	1760	--
Field Measurement																																			
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	55	--	--	--	--	--	--	--	--	--	55	--	--	--	30	--	--	--	35	--	--	--	35	--	--	--	50	--	--	--	30	--
Conductivity	µS/cm	--	--	461	--	--	--	298	--	123	--	--	--	261	--	--	--	163	--	--	--	229	--	--	--	173	--	--	--	179	--	--	--	254	--
Dissolved Oxygen	mg/l	--	--	8	--	--	--	8.86	--	11.52	--	--	--	9.62	--	--	--	9.92	--	--	--	13.22	--	--	--	9.81	--	--	--	10.91	--	--	--	17.5	--
Ferrous Iron	mg/l	--	--	0.04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--	--	--	0.02	--	--	--	0	--	--	--	0.02	--
FLOW	gal/min	--	--	1	--	--	--	--	--	--	--	--	--	37.81	--	--	--	1400.23	--	--	--	305	--	--	--	454.3	--	--	--	39.5	--	--	--	381.4	--
ORP	millivolts	--	--	430.1	--	--	--	470.2	--	175.8	--	--	--	222	--	--	--	224.6	--	--	--	211.1	--	--	--	202.6	--	--	--	120.6	--	--	--	215.2	--
PH	S.U.	--	--	5.66	--	--	--	5.73	--	--	--	--	--	6.32	--	--	--	7.33	--	--	--	7.62	--	--	--	7.57	--	--	--	7.74	--	--	--	6.89	--
Temperature	deg C	--	--	8.82	--	--	--	7.96	--	10.1	--	--	--	9.97	--	--	--	7.89	--	--	--	7.41	--	--	--	6.22	--	--	--	11.19	--	--	--	4.5	--
General Chemistry																																			
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	UJ	--	--	10	U
Acidity by titration	mg/l	--	--	10	U	--	--	--	--	--	--	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	58.3	--	--	--	--	--	--	--	--	--	47.8	--	--	--	25.2	--	--	--	35.6	--	--	--	31.9	--	--	--	46.2	--	--	--	30.6	--
Ammonia as N (distilled)	mg/l	--	--	0.49	J	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	--	--
Chloride	mg/l	2.34	--	--	--	2.76	--	--	--	--	--	1.59	--	--	--	1.73	--	--	--	1.35	--	--	--	1.97	--	--	--	1.55	--	--	--	1.46	--	--	--
FLUORIDE	mg/l	0.0781	--	--	--	0.111	--	--	--	--	--	0.0467	--	--	--	0.0797	--	--	--	0.0872	--	--	--	0.0887	--	--	--	0.0708	--	--	--	0.0712	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	0.259	--	--	--	--	--	--	--	--	--	0.05	U	--	--	0.0608	--	--	--	0.201	--	--	--	0.05	U	--	--	0.05	U	--	--	--	--
Sulfate	mg/l	11.4	--	--	--	113	--	--	--	--	--	3.18	--	--	--	68.1	--	--	--	61	--	--	--	75.3	--	--	--	54.1	--	--	--	35.2	--	--	--
TDS	mg/l	--	--	264	--	--	--	--	--	72	--	--	--	178	--	--	--	150	--	--	--	184	--	--	--	20	U	--	--	114	--	--	--	170	--
TSS	mg/l	--	--	23.9	--	--	--	--	--	4.86	--	--	--	2.1	U	--	--	14.3	--	--	--	8.21	--	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifie
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK	
Location		SF1.0		SF1.0		SF1.0		SF1.0		SF1.0		SF3.0		SF3.0		SF3.0		SF3.0		SFA1		SFA2		SFA2		SFA2		SFA2		SFA2		SFA2		SFA2	
Sample Date		02/15/2012		09/12/2012		09/12/2012		06/17/2013		06/17/2013		09/12/2012		09/12/2012		06/19/2013		06/19/2013		10/28/2009		10/28/2009		10/28/2009		02/03/2010		02/03/2010		02/14/2012		02/14/2012		09/14/2012	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		D		T		D		T		D		T		D		T		D		T		T		D		T		D		T		D		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																			
ALUMINUM	µg/L	12.3	J	200	U	200	U	1200	--	200	U	67.6	J	200	U	58.8	J	200	U	--	--	15900	J	16000	J	23100	--	22700	--	31200	--	29500	--	17200	J
ANTIMONY	µg/L	60	U	60	U	60	U	60	U	60	U	60	U	60	U	60	U	60	U	--	--	2	U	2	U	2	U	2	U	60	U	60	U	60	U
ARSENIC	µg/L	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	--	--	0.76	J	0.94	J	0.38	U	0.46	U	3.1	J	3.8	J	10	U
BARIUM	µg/L	200	U	200	U	200	U	8.1	J	200	U	200	U	200	U	200	U	200	U	--	--	10.3	J	9.9	J	38.3	--	38.8	--	200	UJ	200	U	200	U
BERYLLIUM	µg/L	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	--	--	2.6	--	2.5	--	3.5	--	3.4	--	3.3	J	3.2	J	2.4	J
CADMIUM	µg/L	5.4	J	1.1	--	1.1	--	2.7	J	2.3	--	0.27	J	0.5	U	6	--	0.5	U	--	--	122	--	121	--	156	--	158	--	72.4	J	77.5	J	124	--
CALCIUM	µg/L	23900	--	19600	--	19800	--	20500	--	20800	--	22600	--	21500	--	19800	--	18000	--	--	--	137000	J	139000	J	105000	--	103000	--	180000	--	173000	--	166000	--
CHROMIUM	µg/L	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	--	--	0.64	UJ	0.68	UJ	0.12	U	0.22	U	10	U	10	U	10	U
COBALT	µg/L	0.63	J	50	U	50	U	50	U	50	U	50	U	50	U	50	U	50	U	--	--	25.6	J	25.2	J	35.9	--	35.9	--	40.5	J	38.5	J	30.7	J
COPPER	µg/L	184	J	22.5	--	17.8	--	324	--	72.9	--	10.1	--	3.4	--	18.8	--	11.4	--	--	--	11700	--	11500	--	16000	--	16000	--	16300	--	14100	--	15200	--
IRON	µg/L	100	U	33.6	J	100	U	1280	--	100	U	138	--	100	U	90.5	J	100	U	--	--	46.1	J	56.4	J	60.9	U	59.3	U	122	J	100	U	74.9	J
LEAD	µg/L	1	U	1	J	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--	0.1	J	7.8	J	1	U	0.043	J	1	U	1	U	0.26	--
LITHIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100	UJ	100	UJ	7.9	U	8.8	U	--	--	--	--	--	--
MAGNESIUM	µg/L	7480	--	5680	--	5650	--	6590	--	6670	--	4680	J	4330	J	4570	J	4270	J	--	--	50200	--	51100	--	38400	--	38000	--	64400	--	63000	--	54700	--
MANGANESE	µg/L	168	--	6.9	--	5.7	J	106	--	49.1	--	15.8	--	5.6	J	17.5	J	15	U	--	--	4520	--	4460	--	6050	--	6070	--	6790	--	6390	--	5670	--
MERCURY	µg/L	0.2	U	0.2	U	0.2	U	0.2	U	0.036	J	0.2	U	0.2	U	0.2	U	0.2	U	--	--	0.2	U	0.2	U	0.2	U	0.16	J	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	--	--	--	--	--	--
NICKEL	µg/L	6.2	J	1.1	--	1.1	--	2.7	J	2.9	--	0.38	J	0.6	J	0.58	J	1	U	--	--	93.2	J	94.3	J	148	--	148	--	84.3	J	81.7	J	91.5	--
POTASSIUM	µg/L	5000	U	5000	U	5000	U	5000	U	5000	U	5000	U	5000	U	294	J	5000	U	--	--	1290	J	1320	UJ	1270	J	1300	J	5000	UJ	5000	U	2000	J
SELENIUM	µg/L	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	--	--	3.2	J	3.4	J	3.7	J	3.5	J	6.6	--	6.3	--	3.7	J
SILVER	µg/L	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	--	--	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	UJ	0.1	U
SODIUM	µg/L	5000	U	5220	--	5210	--	5000	U	5000	U	5430	--	5080	--	4830	J	5000	U	--	--	10300	J	10500	J	7310	--	7310	--	10800	--	10300	--	11400	--
THALLIUM	µg/L	25	U	25	U	25	U	25	U	25	U	25	U	25	U	25	U	25	U	--	--	1	U	1	U	1	U	1	U	25	U	25	U	25	U
THORIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	--	--	--	--	--	--
URANIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.16	J	0.16	J	0.16	J	0.19	J	--	--	--	--	--	--
VANADIUM	µg/L	50	U	50	U	50	U	50	U	50	U	50	U	50	U	50	U	50	U	--	--	5	UJ	5	UJ	5	U	5	U	50	U	50	U	50	U
ZINC	µg/L	1730	--	354	--	370	--	1030	--	798	--	104	--	58.8	--	90.9	--	85.8	--	--	--	31700	--	31300	--	41600	--	41500	--	39000	--	39700	--	36100	--
Field Measurement																																			
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	45	--	--	--	--	--	--	--	40	--	--	--	--	--	--	--	--	--	10	--	--	--	5	--	--	--	--	--	--	--	5	--
Conductivity	µS/cm	--	--	122	--	--	--	191	--	--	--	124	--	--	--	156	--	--	--	1045	--	1387	--	--	--	1054	--	--	--	1451	--	--	--	1291	--
Dissolved Oxygen	mg/l	--	--	10.07	--	--	--	12.5	--	--	--	11.35	--	--	--	13.4	--	--	--	6.81	--	6.53	--	--	--	9.59	--	--	--	12.31	--	--	--	9.68	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.34	--	--	--	0.69	--	--	--	--	--	--	--	--	--
FLOW	gal/min	--	--	60	--	--	--	100	--	--	--	200	--	--	--	--	--	--	--	2	--	4.39	--	--	--	61.82	--	--	--	14	--	--	--	0.56	--
ORP	millivolts	--	--	128.5	--	--	--	143.5	--	--	--	111.1	--	--	--	141	--	--	--	284.6	--	253.1	--	--	--	449.7	--	--	--	257.1	--	--	--	2426	--
PH	S.U.	--	--	7.31	--	--	--	--	--	--	--	7.57	--	--	--	--	--	--	--	4.67	--	4.3	--	--	--	4.07	--	--	--	4	--	--	--	4.17	--
Temperature	deg C	--	--	8.54	--	--	--	9.4	--	--	--	9.46	--	--	--	10.4	--	--	--	8.43	--	8.59	--	--	--	6.97	--	--	--	5.15	--	--	--	12.74	--
General Chemistry																																			
Acidity by titration	mg CaCO3/L	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	250	--	--	--	220	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	180	--	--	--	260	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	48	--	--	--	--	--	--	--	49.7	--	--	--	--	--	--	--	--	--	5	U	--	--	5	U	--	--	5	U	--	--	5	U
Ammonia as N (distilled)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--
Chloride	mg/l	1.31	--	--	--	1.56	--	--	--	1.38	--	--	--	1.7	--	--	--	1.49	--	--	--	--	--	1.78	--	--	--	1.19	--	--	--	1.28	--	--	--
FLUORIDE	mg/l	0.0988	--	--	--	0.0716	--	--	--	0.0607	--	--	--	0.0671	--	--	--	0.0528	--	--	--	--	--	1.18	--	--	--	0.222	--	--	--	1.79	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.861	--	--	--	0.593	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	68.2	--	--	--	33.6	--	--	--	44	--	--	--	35.1	--	--	--	26.4	--	--	--	--	--	874	--	--	--	836	--	--	--	872	--	--	--
TDS	mg/l	--	--	128	--	--	--	130	--	--	--	116	--	--	--	108	--	--	--	--	--	1440	--	--	--	1300	--	--	--	1460	--	--	--	1670	--
TSS	mg/l	--	--	2.1	U	--	--	24	--	--	--	4.12	--	--	--	2.21	--	--	--	--	--	2.1	U	--	--	2.1	U	--	--	2.7	--	--	--	2.1	U

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimated
R = Rejected
> = Above de
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK	
Location		SFA2		SFA2F		SFA2F		SFA3		SFA3		SFA7		SFA8		SFA8		SFA8		SFB1		SFB1		SFB13		SFB14		SFB14		SFB14		SFB14		SFB14	
Sample Date		09/14/2012		06/19/2013		06/19/2013		10/28/2009		02/03/2010		02/03/2010		10/28/2009		02/03/2010		02/03/2010		10/28/2009		02/03/2010		02/03/2010		02/03/2010		02/14/2012		02/14/2012		09/11/2012		09/11/2012	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		D		T		D		T		T		T		T		T		D		T		T		T		T		T		D		T		D	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																			
ALUMINUM	µg/L	200	U	19500	--	20200	--	--	--	--	--	--	--	--	--	11100	--	8800	--	--	--	--	--	--	--	--	--	42.6	J	200	U	200	U	200	U
ANTIMONY	µg/L	60	U	60	U	60	U	--	--	--	--	--	--	--	--	2	U	2	U	--	--	--	--	--	--	--	--	60	U	60	U	60	U	60	U
ARSENIC	µg/L	10	U	4.6	J	4.9	J	--	--	--	--	--	--	--	--	0.29	U	1	U	--	--	--	--	--	--	--	--	10	U	10	U	10	U	10	U
BARIUM	µg/L	200	U	12.7	J	200	U	--	--	--	--	--	--	--	--	24.4	--	23.2	--	--	--	--	--	--	--	--	--	200	U	200	U	200	U	200	U
BERYLLIUM	µg/L	5	U	5	U	5	U	--	--	--	--	--	--	--	--	1.5	--	1.3	--	--	--	--	--	--	--	--	--	5	U	5	U	5	U	5	U
CADMIUM	µg/L	137	--	75.3	J	74.5	--	--	--	--	--	--	--	--	--	63.8	--	64.7	--	--	--	--	--	--	--	--	--	4	--	4.2	J	6.5	--	6.5	--
CALCIUM	µg/L	49100	--	121000	--	123000	--	--	--	--	--	--	--	--	--	66900	--	66200	--	--	--	--	--	--	--	--	--	58000	--	58300	--	93600	--	92800	--
CHROMIUM	µg/L	10	U	10	U	10	U	--	--	--	--	--	--	--	--	0.13	U	0.053	U	--	--	--	--	--	--	--	--	10	U	10	U	10	U	10	U
COBALT	µg/L	50	U	50	U	50	U	--	--	--	--	--	--	--	--	14.7	--	14.7	--	--	--	--	--	--	--	--	--	50	U	50	U	50	U	50	U
COPPER	µg/L	15100	--	17300	--	18100	--	--	--	--	--	--	--	--	--	5870	--	5770	--	--	--	--	--	--	--	--	--	2.7	--	1.6	J	2.5	--	2.6	--
IRON	µg/L	100	U	100	U	100	U	--	--	--	--	--	--	--	--	346	--	46.2	U	--	--	--	--	--	--	--	--	100	U	100	U	100	U	100	U
LEAD	µg/L	1	U	1	U	1	U	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U
LITHIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.4	U	3.5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	16400	--	43700	--	45200	--	--	--	--	--	--	--	--	--	23500	--	23300	--	--	--	--	--	--	--	--	--	19200	--	19100	--	28600	--	28000	--
MANGANESE	µg/L	6160	--	4360	--	4250	--	--	--	--	--	--	--	--	--	2490	--	2480	--	--	--	--	--	--	--	--	--	15	U	15	U	0.24	J	1	UJ
MERCURY	µg/L	0.2	U	0.2	U	0.098	J	--	--	--	--	--	--	--	--	0.2	U	0.2	U	--	--	--	--	--	--	--	--	0.2	U	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	µg/L	96.3	--	80	J	81.6	--	--	--	--	--	--	--	--	--	61.2	--	62.5	--	--	--	--	--	--	--	--	--	3.8	--	4.1	J	5	--	4.8	--
POTASSIUM	µg/L	5000	U	5000	U	5000	U	--	--	--	--	--	--	--	--	605	J	779	J	--	--	--	--	--	--	--	--	5000	U	5000	U	5000	U	5000	U
SELENIUM	µg/L	3.8	J	7.2	--	8.8	--	--	--	--	--	--	--	--	--	2	U	1.7	U	--	--	--	--	--	--	--	--	5	U	5	U	5	U	5	U
SILVER	µg/L	0.1	U	0.1	U	0.1	U	--	--	--	--	--	--	--	--	0.1	U	0.1	U	--	--	--	--	--	--	--	--	0.1	U	0.1	U	0.1	U	0.1	U
SODIUM	µg/L	6920	--	8000	--	8150	--	--	--	--	--	--	--	--	--	5690	--	5880	--	--	--	--	--	--	--	--	--	4980	J	5080	--	7910	--	7600	--
THALLIUM	µg/L	25	U	25	U	25	U	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	25	U	25	U	25	U	25	U
THORIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
URANIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	µg/L	50	U	50	U	50	U	--	--	--	--	--	--	--	--	0.81	J	5	U	--	--	--	--	--	--	--	--	50	U	50	U	50	U	50	U
ZINC	µg/L	41200	--	49100	--	48200	--	--	--	--	--	--	--	--	--	17200	--	17200	--	--	--	--	--	--	--	--	--	2250	--	2280	--	3790	--	3750	--
Field Measurement																																			
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	5	U	--	--	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	40	--	--	--
Conductivity	µS/cm	--	--	1530	--	--	--	1521	--	1476	--	1261	--	1086	--	631	--	--	--	729	--	343	--	145	--	324	--	473	--	--	--	684	--	--	--
Dissolved Oxygen	mg/l	--	--	8.13	--	--	--	6.93	--	9.24	--	9.01	--	6.47	--	9.53	--	--	--	7.4	--	9.29	--	7.93	--	9.22	--	10.22	--	--	--	9	--	--	--
Ferrous Iron	mg/l	--	--	0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	--	--	--	--	--	--	3	--	--	--	--	--	9	--	151.31	--	--	--	2.28	--	--	--	6	--	69.25	--	21	--	--	--	1	--	--	--
ORP	millivolts	--	--	297.3	--	--	--	250.8	--	475	--	461.8	--	235.8	--	631	--	--	--	119.3	--	395	--	309.3	--	299	--	280.8	--	--	--	164.6	--	--	--
PH	S.U.	--	--	3.88	--	--	--	3.89	--	3.49	--	3.61	--	4.76	--	4.59	--	--	--	6.62	--	6.17	--	6.46	--	5.72	--	6.1	--	--	--	6.84	--	--	--
Temperature	deg C	--	--	12	--	--	--	8.9	--	7.98	--	7.6	--	8.85	--	7.52	--	--	--	7.84	--	8.05	--	8.95	--	7.92	--	5.75	--	--	--	11.1	--	--	--
General Chemistry																																			
Acidity by titration	mg CaCO3/L	--	--	260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	U	--	--	10	U	--	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	U	--	--	--	--	--	--	--	--	--	--	36.6	--	--	--	39.5	--	--	--
Ammonia as N (distilled)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	1.54	--	--	--	1.39	--	--	--	--	--	--	--	--	--	--	--	1.25	--	--	--	--	--	--	--	--	--	--	--	1.35	--	--	--	1.31	--
FLUORIDE	mg/l	1.5	--	--	--	1.49	--	--	--	--	--	--	--	--	--	--	--	0.48	--	--	--	--	--	--	--	--	--	--	--	0.0888	--	--	--	0.067	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	1010	--	--	--	1020	--	--	--	--	--	--	--	--	--	--	--	454	--	--	--	--	--	--	--	--	--	--	--	193	--	--	--	326	--
TDS	mg/l	--	--	1640	--	--	--	--	--	--	--	--	--	--	--	704	--	--	--	--	--	--	--	--	--	--	--	344	--	--	--	540	--	--	--
TSS	mg/l	--	--	2.42	--	--	--	--	--	--	--	--	--	--	--	21.3	--	--	--	--	--	--	--	--	--	--	--	2.1	U	--	--	2.1	U	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK	
Location		SFB15		SFB15		SFA4		SFA4		SFA4		SFA5		SFA5		SFA5		SFA5		SFA6		SFB3		SFB7		SFB8		SFB9		SFG1		SFG2		
Sample Date		10/28/2009		02/03/2010		10/28/2009		10/28/2009		02/03/2010		10/28/2009		02/01/2010		02/01/2010		02/14/2012		09/13/2012		02/03/2010		10/28/2009		02/03/2010		02/03/2010		02/03/2010		02/17/2012		02/17/2012	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		
Total/Dissolved		T		T		T		D		T		T		T		D		N		N		T		T		T		T		N		N		
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																			
ALUMINUM	µg/L	--	--	--	--	22600	J	22200	J	--	--	--	--	75400	--	75300	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ANTIMONY	µg/L	--	--	--	--	2	U	2	U	--	--	--	--	4	U	4	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ARSENIC	µg/L	--	--	--	--	0.72	J	1.1	--	--	--	--	--	2	U	2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BARIUM	µg/L	--	--	--	--	11.2	J	10.5	J	--	--	--	--	10.4	J	10.2	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BERYLLIUM	µg/L	--	--	--	--	4	--	4.1	--	--	--	--	--	16.2	--	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CADMIUM	µg/L	--	--	--	--	179	--	183	--	--	--	--	--	573	--	564	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CALCIUM	µg/L	--	--	--	--	192000	J	191000	J	--	--	--	--	101000	--	100000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	µg/L	--	--	--	--	1.1	UJ	3.9	J	--	--	--	--	9.8	--	9.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COBALT	µg/L	--	--	--	--	35.5	J	36.4	J	--	--	--	--	111	--	110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COPPER	µg/L	--	--	--	--	18400	--	18800	--	--	--	--	--	73600	--	72300	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
IRON	µg/L	--	--	--	--	131	J	47.3	J	--	--	--	--	4560	--	4570	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAD	µg/L	--	--	--	--	0.37	J	0.13	J	--	--	--	--	0.64	--	0.63	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LITHIUM	µg/L	--	--	--	--	100	UJ	100	UJ	--	--	--	--	20.3	U	21	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	--	--	--	--	70700	--	70700	--	--	--	--	--	48500	--	48200	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MANGANESE	µg/L	--	--	--	--	6420	--	6510	--	--	--	--	--	17700	--	17500	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MERCURY	µg/L	--	--	--	--	0.2	U	0.2	U	--	--	--	--	0.2	U	0.2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MOLYBDENUM	µg/L	--	--	--	--	1	U	1	U	--	--	--	--	2	U	2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NICKEL	µg/L	--	--	--	--	127	J	131	--	--	--	--	--	430	--	425	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
POTASSIUM	µg/L	--	--	--	--	1730	J	1700	J	--	--	--	--	630	J	597	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SELENIUM	µg/L	--	--	--	--	5.1	--	4.8	J	--	--	--	--	15.3	--	14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SILVER	µg/L	--	--	--	--	0.1	U	0.1	U	--	--	--	--	0.17	U	0.13	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SODIUM	µg/L	--	--	--	--	13500	J	13000	J	--	--	--	--	7060	--	6970	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THALLIUM	µg/L	--	--	--	--	1	U	0.09	J	--	--	--	--	0.21	--	2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THORIUM	µg/L	--	--	--	--	1	U	1	U	--	--	--	--	1.7	--	1.5	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
URANIUM	µg/L	--	--	--	--	0.23	J	0.24	J	--	--	--	--	3	--	2.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VANADIUM	µg/L	--	--	--	--	5	UJ	5	UJ	--	--	--	--	10	U	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ZINC	µg/L	--	--	--	--	45000	--	45800	--	--	--	--	--	128000	--	126000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Field Measurement																																			
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	5	--	--	--	--	--	--	--	5	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Conductivity	µS/cm	719	--	366	--	1754	--	--	--	1755	--	2017	--	3183	--	--	--	3432	--	2260	--	1288	--	528	--	203	--	213	--	113	--	211	--	160	--
Dissolved Oxygen	mg/l	6.31	--	9.1	--	7.47	--	--	--	7.9	--	6.54	--	10.25	--	--	--	--	--	--	--	8.89	--	6.6	--	8.9	--	8.71	--	8.5	--	--	--	--	--
Ferrous Iron	mg/l	--	--	--	--	0.19	--	--	--	--	--	--	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	5	--	89.49	--	1.81	--	--	--	--	--	--	--	5.72	--	--	--	1	--	0	--	20.24	--	0.75	--	--	--	20	--	10	--	0.1	--	1	--
ORP	millivolts	163	--	319	--	312.1	--	--	--	516.2	--	408	--	590.4	--	--	--	425.5	--	338.5	--	471.8	--	122.8	--	324.3	--	292.3	--	284.1	--	301.4	--	263	--
PH	S.U.	6.3	--	5.48	--	3.84	--	--	--	3.31	--	3.24	--	3.25	--	--	--	3	--	3.39	--	3.57	--	6.78	--	6.54	--	6.49	--	6.7	--	4.13	--	4.56	--
Temperature	deg C	9.39	--	7.78	--	8.85	--	--	--	8.62	--	6.99	--	8.79	--	--	--	7.84	--	20.52	--	7.85	--	9.66	--	8.7	--	8.74	--	8.83	--	7.26	--	6.93	--
General Chemistry																																			
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	--	--	280	--	--	--	--	--	--	--	1600	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	5	U	--	--	--	--	--	--	5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ammonia as N (distilled)	mg/l	--	--	--	--	0.5	U	--	--	--	--	--	--	0.21	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	--	--	--	--	0.816	--	--	--	--	--	--	--	1.26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLUORIDE	mg/l	--	--	--	--	--	--	1.9	--	--	--	--	--	--	--	3	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	1.34	--	--	--	--	--	--	--	2.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	--	--	--	--	1240	--	--	--	--	--	--	--	2850	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TDS	mg/l	--	--	--	--	2070	--	--	--	--	--	--	--	3990	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TSS	mg/l	--	--	--	--	6.04	--	--	--	--	--	--	--	2.1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK	
Location		SFG3		SFG3		SFG3		SFG4		SFB10		SFB11		SFB12		SFB2		SFB2		SFB2		SFB4		SFB4		SFB4		SFB5		SFB5		SFB6	
Sample Date		02/17/2012		02/17/2012		09/29/2011		09/29/2011		02/03/2010		02/03/2010		02/03/2010		10/28/2009		10/28/2009		02/03/2010		02/03/2010		02/03/2010		02/03/2010		10/28/2009		02/03/2010		10/28/2009		02/03/2010	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep		Seep	
Total/Dissolved		T		D		N		N		T		T		T		T		D		T		D		T		D		T		T		T		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																			
ALUMINUM	µg/L	936	--	200	U	--	--	--	--	--	--	--	--	--	--	200	U	200	U	200	U	200	U	200	U	200	U	--	--	--	--	--	--	--	--
ANTIMONY	µg/L	60	U	60	U	--	--	--	--	--	--	--	--	--	--	2	U	2	U	0.29	U	0.12	U	2	U	2	U	--	--	--	--	--	--	--	--
ARSENIC	µg/L	10	U	10	U	--	--	--	--	--	--	--	--	--	--	0.74	J	0.84	J	0.24	U	1	U	1	U	0.25	U	--	--	--	--	--	--	--	--
BARIUM	µg/L	200	UJ	200	U	--	--	--	--	--	--	--	--	--	--	16.9	J	16.1	J	9.2	J	9.2	J	29.3	--	29.3	--	--	--	--	--	--	--	--	--
BERYLLIUM	µg/L	5	U	5	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
CADMIUM	µg/L	0.74	J	0.77	J	--	--	--	--	--	--	--	--	--	--	4.5	--	4.4	--	4.2	--	4.2	--	17.4	--	17.6	--	--	--	--	--	--	--	--	--
CALCIUM	µg/L	28300	--	28800	--	--	--	--	--	--	--	--	--	--	--	84400	J	82600	J	37800	--	38700	--	83000	--	85900	--	--	--	--	--	--	--	--	--
CHROMIUM	µg/L	10	U	10	U	--	--	--	--	--	--	--	--	--	--	0.54	UJ	0.57	UJ	2	U	2	U	2	U	2	U	--	--	--	--	--	--	--	--
COBALT	µg/L	1.6	J	1.8	J	--	--	--	--	--	--	--	--	--	--	1	UJ	1	UJ	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
COPPER	µg/L	68.3	--	41.2	--	--	--	--	--	--	--	--	--	--	--	2.7	--	7.2	--	2.6	--	2.6	--	45.2	--	44.9	--	--	--	--	--	--	--	--	--
IRON	µg/L	100	UJ	100	U	--	--	--	--	--	--	--	--	--	--	100	U	20.2	J	32.9	U	33.8	U	30.6	U	32.7	U	--	--	--	--	--	--	--	--
LEAD	µg/L	1	U	1	U	--	--	--	--	--	--	--	--	--	--	1.1	J	0.14	J	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
LITHIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100	UJ	100	UJ	100	U	100	U	100	U	100	U	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	6660	--	6810	--	--	--	--	--	--	--	--	--	--	--	28400	--	27900	--	12400	--	12500	--	26600	--	27700	--	--	--	--	--	--	--	--	--
MANGANESE	µg/L	144	--	147	--	--	--	--	--	--	--	--	--	--	--	2	--	4.9	--	0.45	U	0.46	U	2	--	2	--	--	--	--	--	--	--	--	--
MERCURY	µg/L	0.2	U	0.2	U	--	--	--	--	--	--	--	--	--	--	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	--	--	--	--	--	--	--	--
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
NICKEL	µg/L	1.1	J	1.1	J	--	--	--	--	--	--	--	--	--	--	4.3	J	4.2	J	3.6	--	3.6	--	11.6	--	11.7	--	--	--	--	--	--	--	--	--
POTASSIUM	µg/L	5000	UJ	5000	U	--	--	--	--	--	--	--	--	--	--	193	U	260	U	205	J	226	J	483	J	448	J	--	--	--	--	--	--	--	--
SELENIUM	µg/L	5	U	5	U	--	--	--	--	--	--	--	--	--	--	5	U	5	U	0.76	U	0.37	U	0.43	U	0.9	U	--	--	--	--	--	--	--	--
SILVER	µg/L	0.1	UJ	0.1	UJ	--	--	--	--	--	--	--	--	--	--	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	--	--	--	--	--	--	--	--
SODIUM	µg/L	5000	U	5000	U	--	--	--	--	--	--	--	--	--	--	7150	J	6980	J	4750	J	4920	J	6450	--	6530	--	--	--	--	--	--	--	--	--
THALLIUM	µg/L	25	U	25	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
THORIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
URANIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
VANADIUM	µg/L	50	U	50	U	--	--	--	--	--	--	--	--	--	--	0.49	J	5	UJ	0.43	J	0.51	J	5	U	5	U	--	--	--	--	--	--	--	--
ZINC	µg/L	177	--	173	--	--	--	--	--	--	--	--	--	--	--	2210	--	2160	--	2180	--	2190	--	6580	--	6570	--	--	--	--	--	--	--	--	--
Field Measurement																																			
ALKALINITY, TOTAL (CACO3)	mg/l	60	--	--	--	130	--	--	--	--	--	--	--	--	--	35	--	--	--	45	--	--	--	25	--	--	--	--	--	--	--	--	--	--	--
Conductivity	µS/cm	131	--	--	--	273	--	260	--	149	--	403	--	96	--	727	--	--	--	332	--	--	--	609	--	--	--	891	--	525	--	861	--	604	--
Dissolved Oxygen	mg/l	9.61	--	--	--	--	--	--	--	7.42	--	8.4	--	8.09	--	6.8	--	--	--	9.18	--	--	--	8.76	--	--	--	6.58	--	8.64	--	6.4	--	8.39	--
Ferrous Iron	mg/l	0	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	7.5	--	--	--	1	--	1	--	15	--	10	--	3	--	1.5	--	--	--	56.82	--	--	--	5	--	--	--	--	--	5	--	0.25	--	6	--
ORP	millivolts	230.6	--	--	--	136.8	--	87.3	--	323.5	--	335.6	--	329.7	--	175.1	--	--	--	302.2	--	--	--	315.6	--	--	--	169.9	--	328	--	165.8	--	365	--
PH	S.U.	6.54	--	--	--	6.76	--	7.07	--	6.41	--	6.22	--	6.16	--	6.84	--	--	--	6.38	--	--	--	6.33	--	--	--	6.58	--	6.38	--	6.59	--	6.3	--
Temperature	deg C	7.03	--	--	--	11.91	--	12.82	--	9.29	--	9.71	--	8.47	--	7.9	--	--	--	8.23	--	--	--	8.42	--	--	--	9.78	--	8.31	--	10.01	--	8.21	--
General Chemistry																																			
Acidity by titration	mg CaCO3/L	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	U	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	62.5	--	--	--	--	--	--	--	--	--	--	--	--	--	38.2	--	--	--	45.6	--	--	--	23.5	--	--	--	--	--	--	--	--	--	--	--
Ammonia as N (distilled)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	2.09	--	--	--	--	--	--	--	--	--	--	--	--	--	1.76	--	--	--	0.83	J	--	--	1.52	--	--	--	--	--	--	--	--	--
FLUORIDE	mg/l	--	--	0.0782	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0667	--	--	--	0.078	--	--	--	0.135	--	--	--	--	--	--	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.112	--	--	--	0.064	--	--	--	0.209	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	33.8	--	--	--	--	--	--	--	--	--	--	--	--	--	326	--	--	--	133	--	--	--	400	--	--	--	--	--	--	--	--	--
TDS	mg/l	140	--	--	--	--	--	--	--	--	--	--	--	--	--	574	--	--	--	248	--	--	--	612	--	--	--	--	--	--	--	--	--	--	--
TSS	mg/l	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U	--	--	--	--	--	--	--	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SOUTH FK MIDDLE CK		SFREF1		SFREF1		SFREF1		SFREF1		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK CHAMBERS		COW CK CHAMBERS	
Location		SFC1		SFD1		SFD1		SFE1		SFE1		SFE2		09/12/2012		09/12/2012		6/9/2013		6/9/2013		C1		C1		C1		C1		C1		C1		C1		C1	
Sample Date		10/28/2009		01/27/2010		01/27/2010		02/01/2010		02/01/2010		02/03/2010		09/12/2012		09/12/2012		6/9/2013		6/9/2013		10/21/2009		10/21/2009		02/02/2010		02/02/2010		10/26/2010		10/26/2010		10/21/2009		10/21/2009	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		Seep		Seep		Seep		Seep		Seep		Seep		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		T		T		D		T		D		T		T		D		T		D		T		D		T		D		T		D		T		D	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	--	--	200	U	200	U	60.8	J	21.2	J	--	--	200	U	200	U	1410		200	U	33.4	U	200	U	52	J	200	U	148	J	200	U	17.9	U	14.9	U
ANTIMONY	µg/L	--	--	2	U	2	U	2	U	2	U	--	--	60	U	60	U	60	U	60	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
ARSENIC	µg/L	--	--	1	U	1	U	1	U	1	U	--	--	10	U	10	U	10	U	10	U	1	--	0.68	J	1	U	0.32	U	0.24	U	0.21	U	0.68	J	0.53	J
BARIUM	µg/L	--	--	3.4	J	3.3	J	2.3	J	1.6	J	--	--	200	U	200	U	200	U	200	U	10.6	--	10.1	--	8	J	7.2	J	10.2	--	8.7	J	22.5	--	21.9	--
BERYLLIUM	µg/L	--	--	1	U	1	U	1	U	1	U	--	--	5	U	5	U	5	U	5	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U
CADMIUM	µg/L	--	--	0.5	U	0.5	U	0.5	U	0.5	U	--	--	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
CALCIUM	µg/L	--	--	11800	--	11000	J	7590	--	7310	--	--	--	18800	--	18300	--	14900	--	14200	--	9940	--	9690	--	7100	--	6980	--	10200	--	10100	--	10500	--	9970	--
CHROMIUM	µg/L	--	--	0.97	J	1	J	0.09	J	0.05	J	--	--	10	U	10	U	10	U	10	U	1.1	J	0.91	J	0.86	J	0.76	J	1	J	0.46	U	0.86	J	0.8	J
COBALT	µg/L	--	--	1	U	1	U	0.05	U	1	U	--	--	50	U	50	U	50	U	50	U	1	U	1	U	0.07	U	0.053	U	0.15	U	0.043	U	1	U	1	U
COPPER	µg/L	--	--	1.5	J	1.5	J	0.74	J	0.53	J	--	--	0.5	J	2	U	3.1		0.83	J	2.3	--	2.7	--	0.73	J	0.73	J	1	J	0.63	J	2.9	--	2.6	--
IRON	µg/L	--	--	27.1	J	20.1	J	185	--	16.6	J	--	--	277	--	68	J	3200	--	291		149	U	53.5	U	167	--	51.1	J	226	--	40.6	J	114	U	42.2	U
LEAD	µg/L	--	--	5	--	0.26	J	1	U	0.05	U	--	--	1	U	1	U	1	U	1	U	0.32	J	0.26	J	1	U	1	U	0.12	U	0.053	U	0.36	J	0.32	J
LITHIUM	µg/L	--	--	100	U	100	U	100	U	100	U	--	--	--	--	--	--	--	--	--	--	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U
MAGNESIUM	µg/L	--	--	3200	J	3030	J	2640	J	2510	J	--	--	2920	J	2780	J	2990	J	2850	J	6020	--	5860	--	5240	--	5140	--	6530	--	6540	--	5360	--	4950	J
MANGANESE	µg/L	--	--	1.6	J	1.3	--	2.5	--	0.057	J	--	--	28.8	--	23	J	139	J	24.8		7.8	--	4.5	--	6	--	3.2	--	18.7	--	3.9	--	6.2	--	4.4	--
MERCURY	µg/L	--	--	0.2	U	0.2	U	0.2	U	0.2	U	--	--	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	--	--	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	0.11	U	1	U	1	U
NICKEL	µg/L	--	--	1.1	--	0.87	J	0.37	U	0.55	U	--	--	1	U	1	U	0.68	J	1	U	2.9	--	2.4	--	3.4	--	2.9	--	3.6	--	2.4	--	2.1	--	1.9	--
POTASSIUM	µg/L	--	--	5000	U	5000	U	5000	U	5000	U	--	--	5000	U	5000	U	424	J	5000	U	648	J	607	J	284	J	294	J	566	J	625	J	732	J	567	J
SELENIUM	µg/L	--	--	0.28	J	5	U	5	U	5	U	--	--	5	U	5	U	5	U	5	U	5	U	5	U	5	U	0.4	J	5	U	5	U	5	U	5	U
SILVER	µg/L	--	--	0.1	U	0.1	U	0.1	U	0.1	U	--	--	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
SODIUM	µg/L	--	--	3520	J	3160	J	4230	J	4790	J	--	--	5150	--	4780	J	4450	J	4780	J	5590	--	5490	--	5040	--	4640	J	4440	J	4440	J	6490	--	5750	--
THALLIUM	µg/L	--	--	1	U	1	U	1	U	1	U	--	--	25	U	25	U	25	U	25	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U
THORIUM	µg/L	--	--	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	0.14	U	1	U	1	U
URANIUM	µg/L	--	--	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U
VANADIUM	µg/L	--	--	5	U	5	U	1.1	J	0.87	J	--	--	50	U	50	U	50	U	50	U	5	U	5	U	0.62	J	0.48	J	4.1	U	3.5	U	5	U	5	U
ZINC	µg/L	--	--	3.7	--	3.8	--	2	J	1.7	J	--	--	9.2	--	1.9	J	12.1	--	4.8		2.8	--	2.9	--	0.9	J	2	J	1.4	U	0.82	U	6.2	--	4.9	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	50	--	--	--	40	--	--	--	--	--	35	--	--	--	--	--	--	--	65	--	--	--	55	--	--	--	50	--	--	--	65	--	--	--
Conductivity	µS/cm	110	--	75	--	--	--	80	--	--	--	518	--	105	--	--	--	124	--	--	--	137	--	--	--	89	--	--	--	123	--	--	--	152	--	--	--
Dissolved Oxygen	mg/l	6.07	--	12.94	--	--	--	9.6	--	--	--	9.12	--	10.81	--	--	--	14.4	--	--	--	8.06	--	--	--	11.6	--	--	--	11.771	--	--	--	8.58	--	--	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--
FLOW	gal/min	1	--	8.12	--	--	--	8	--	--	--	--	--	75	--	--	--	100	--	--	--	37231.23	--	--	--	165056.15	--	--	--	98841.4324	--	--	--	72610.03	--	--	--
ORP	millivolts	218.7	--	92.2	--	--	--	275.2	--	--	--	461.5	--	93.3	--	--	--	124.5	--	--	--	118.6	--	--	--	274	--	--	--	141.9	--	--	--	181.5	--	--	--
PH	S.U.	6.12	--	7.72	--	--	--	5.77	--	--	--	3.92	--	6.73	--	--	--	--	--	--	--	7.05	--	--	--	7.59	--	--	--	7.59	--	--	--	6.73	--	--	--
Temperature	deg C	9.07	--	7.82	--	--	--	8	--	--	--	7.32	--	9.03	--	--	--	9.2	--	--	--	13.98	--	--	--	7.48	--	--	--	10.68	--	--	--	12.86	--	--	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	51.4	--	--	--	41.8	--	--	--	--	--	33.9	--	--	--	29.2	--	--	--	58.5	--	--	--	51.6	--	--	--	53.9	--	--	--	54.6	--	--	--
Ammonia as N (distilled)	mg/l	--	--	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--
Chloride	mg/l	--	--	--	--	1.63	--	--	--	1.2	--	--	--	--	--	1.55	--	--	--	1.4	--	--	--	4.38	--	--	--	2.51	--	--	--	3.36	--	--	--	7.15	--
FLUORIDE	mg/l	--	--	--	--	0.04	U	--	--	0.0557	--	--	--	--	--	0.0605	--	--	--	0.0455	--	--	--	0.047	--	--	--	0.04	U	--	--	0.04	U	--	--	0.049	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	0.05	U	--	--	0.05	U	--	--	--	--	--	--	--	--	--	--	--	--	0.05	U	--	--	0.184	--	--	--	0.05	U	--	--	0.05	U	--	--
Sulfate	mg/l	--	--	--	--	0.803	--	--	--	2.37	--	--	--	--	--	35.4	--	--	--	22.6	--	--	--	4.7	--	--	--	3.99	--	--	--	4.02	--	--	--	5.45	--
TDS	mg/l	--	--	52	--	--	--	20	U	--	--	--	--	106	--	--	--	90	--	--	--	88	--	--	--	64	--	--	--	66	--	--	--	96	--	--	--
TSS	mg/l	--	--	2.1	U	--	--	2.1	U	--	--	--	--	2	U	--	--	63	--	--	--	2.1	U	--	--	2.1	U	--	--	4.79	--	--	--	2.1	U	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimated
R = Rejected
> = Above de
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK		COW CK	
Location		CHAMBERS		CHAMBERS		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE		RIDDLE INTAKE	
Sample Date		02/05/2010		02/05/2010		10/21/2009		10/21/2009		02/02/2010		02/02/2010		10/27/2010		10/27/2010		01/27/2011		01/27/2011		09/27/2011		09/27/2011		02/15/2012		02/15/2012		09/12/2012		09/12/2012	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET		FAUCET	
Total/Dissolved		T		D		T		D		T		D		T		D		T		D		T		D		T		D		T		D	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																	
ALUMINUM	µg/L	198	J	19.2	J	12.8	U	200	U	37.2	J	200	U	129	J	200	U	200	U	200	U	94.2	J	200	U	131	J	200	U	200	U	200	U
ANTIMONY	µg/L	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	60	U	60	U	60	U	60	U
ARSENIC	µg/L	1	U	1	U	0.91	J	0.74	J	0.34	U	1	U	0.22	U	0.2	U	1	U	1	U	1	U	1	U	10	U	10	U	10	U	10	U
BARIUM	µg/L	13.2	--	11.2	--	30.6	--	30	--	20.1	--	19.2	--	25.8	--	24.3	--	18.1	--	17.9	--	22.1	J	20.5	J	200	U	200	U	200	U	200	U
BERYLLIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	5	U	5	U	5	U	5	U
CADMIUM	µg/L	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
CALCIUM	µg/L	6120	--	6080	--	10800	--	10300	--	6500	--	6580	--	11000	--	10900	--	7270	--	7260	--	10200	--	10400	--	8150	--	8150	--	10200	--	9960	--
CHROMIUM	µg/L	0.5	J	0.33	J	0.93	J	1	J	0.73	J	0.71	J	0.78	J	0.54	U	2	U	2	U	2	U	2	U	10	U	10	U	10	U	10	U
COBALT	µg/L	0.073	J	1	U	1	U	1	U	0.057	U	1	U	0.078	U	0.023	U	1	U	1	U	1	U	1	U	50	U	50	U	50	U	50	U
COPPER	µg/L	1.4	J	1	J	4.9	--	3.5	--	3.4	--	3.2	--	4	--	3.5	--	3.7	--	3.4	--	5.8	--	5.1	--	4.9	--	4.2	--	3.7	--	3.5	--
IRON	µg/L	341	--	58.7	J	81.8	U	39.3	U	89.4	J	23.8	J	166	--	100	U	170	--	100	U	160	--	100	U	181	--	100	U	30.2	J	100	U
LEAD	µg/L	0.077	U	1	U	0.37	J	0.7	J	0.04	U	1	U	0.08	U	0.024	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U
LITHIUM	µg/L	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	3160	J	3090	J	6330	--	6130	--	4400	J	4410	J	6720	--	6560	--	5820	--	5770	--	6870	--	6930	--	5660	--	5610	--	6200	--	6070	--
MANGANESE	µg/L	6.7	--	1.5	J	4.2	--	2.3	--	3.4	--	1.1	--	7.9	--	1.5	--	3.8	--	2.1	--	12	J	1.9	J	15	U	15	U	7.3	--	4.7	J
MERCURY	µg/L	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	0.17	U	0.18	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
NICKEL	µg/L	1.5	J	1.2	--	2.5	--	1.5	--	1.4	--	1.4	--	1.9	--	1.5	--	1.8	--	1.5	--	2.2	--	1.8	--	1.8	--	1.3	--	1.5	--	1.4	--
POTASSIUM	µg/L	298	J	242	J	653	J	531	J	302	J	320	J	571	J	581	J	249	J	502	--	5000	U	5000	U	5000	U	5000	U	5000	U	5000	U
SELENIUM	µg/L	5	U	5	U	5	U	5	U	0.81	J	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U
SILVER	µg/L	0.1	UJ	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	UJ	0.1	UJ	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
SODIUM	µg/L	3580	J	3750	J	6930	--	6830	--	5090	--	5850	--	5830	--	5800	--	4030	--	4130	--	5000	U	5000	U	4150	J	4140	J	5870	--	5520	--
THALLIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	25	U	25	U	25	U	25	U
THORIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	0.15	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
URANIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--
VANADIUM	µg/L	5	UJ	5	U	5	U	5	U	0.45	J	5	U	4.5	U	3.6	U	5	U	5	U	9	--	9.1	--	50	U	50	U	50	U	50	U
ZINC	µg/L	9.1	--	3.9	--	5.1	--	4.7	--	5.1	--	3.4	--	3.7	U	3.8	U	7.5	--	38.1	J	7.1	--	6.8	--	19.5	--	6.7	--	5.5	--	5.8	--
Field Measurement																																	
ALKALINITY, TOTAL (CACO3)	mg/l	40	--	--	--	60	--	--	--	50	--	--	--	50	--	--	--	45	--	--	--	60	--	--	--	45	--	--	--	55	--	--	--
Conductivity	µS/cm	66	--	--	--	224	--	--	--	85	--	--	--	164	--	--	--	136	--	--	--	127	--	--	--	151	--	--	--	122	--	--	--
Dissolved Oxygen	mg/l	12.12	--	--	--	6.36	--	--	--	8.82	--	--	--	9.16	--	--	--	6.93	--	--	--	6.27	--	--	--	14.62	--	--	--	5.04	--	--	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	0.14	--	--	--	0.02	--	--	--	0.02	--	--	--	0	--	--	--	--	--	--	--
FLOW	gal/min	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-999	NM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ORP	millivolts	171.4	--	--	--	127.5	--	--	--	254.4	--	--	--	185	--	--	--	169	--	--	--	153	--	--	--	177	--	--	--	113	--	--	--
PH	S.U.	6.73	--	--	--	7.05	--	--	--	7.55	--	--	--	7.41	--	--	--	6.75	--	--	--	7.11	--	--	--	7.43	--	--	--	6.93	--	--	--
Temperature	deg C	8.64	--	--	--	15.52	--	--	--	8.5	--	--	--	10.7	--	--	--	8.02	--	--	--	15.52	--	--	--	7.58	--	--	--	18.11	--	--	--
General Chemistry																																	
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	UJ	--	--	10	U	--	--	10	U	--	--
Acidity by titration	mg/l	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	34.7	--	--	--	58.3	--	--	--	46.2	--	--	--	50.5	--	--	--	43.9	--	--	--	54.4	--	--	--	44.4	--	--	--	54	--	--	--
Ammonia as N (distilled)	mg/l	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	2.07	--	--	--	9.28	--	--	--	3.1	--	--	--	7.23	--	--	--	3.03	--	--	--	4.59	--	--	--	3.96	--	--	--	5.69	--
FLUORIDE	mg/l	--	--	0.04	U	--	--	0.05	--	--	--	0.0411	--	--	--	0.04	U	--	--	0.0423	--	--	--	0.0458	--	--	--	0.0498	--	--	--	0.05	--
Nitrogen, Nitrate-Nitrite	mg/l	0.0689	--	--	--	0.05	U	--	--	0.115	--	--	--	0.05	U	--	--	0.0907	--	--	--	0.05	U	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	2.86	--	--	--	6.05	--	--	--	3.69	--	--	--	4.87	--	--	--	3.33	--	--	--	3.47	--	--	--	4.28	--	--	--	3.9	--
TDS	mg/l	84	--	--	--	90	--	--	--	44	--	--	--	54	--	--	--	20	U	--	--	98	--	--	--	40	--	--	--	98	--	--	--
TSS	mg/l	2.95	--	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U	--	--	3.16	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		COW CK		COW CK		COW CK		COW CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK		RUSSELL CK	
Location		SW1		SW1		SW2		SW2		RCA1		RCB1		RCB2		RCC1		RCD1		RCD2		RCE1		SW3		SW3		SW3		SW3		SW4		SW4		SW4	
Sample Date		10/20/2009		10/20/2009		10/21/2009		10/21/2009		02/04/2010		01/31/2010		01/31/2010		01/31/2010		02/04/2010		02/04/2010		01/31/2010		02/04/2010		02/04/2010		10/29/2009		10/29/2009		02/04/2010		02/04/2010		10/29/2009	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		Seep		Seep		STREAM		Seep		Seep		Seep		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		T		D		T		D		T		T		T		T		T		T		T		T		D		T		D		T		D		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	14.2	U	200	U	10.1	U	6	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	70.1	U	200	U	826	J	6.4	U	18	U	7.3	U	56.3	J
ANTIMONY	µg/L	2	U	2	U	2	U	2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	U	2	U	2	U	2	U	2	U	2	U	2	U
ARSENIC	µg/L	0.73	J	0.66	J	0.72	J	0.76	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.24	U	1	U	1	--	1	--	1	U	1	U	0.88	J
BARIUM	µg/L	22.1	--	22.5	--	22.7	--	23.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.8	J	8.8	J	12.9	J	9.2	J	1.1	J	1	J	2.2	J
BERYLLIUM	µg/L	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	1	U
CADMIUM	µg/L	0.5	U	0.5	U	0.5	U	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
CALCIUM	µg/L	10300	--	10400	--	10900	--	10700	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15800	--	16100	--	18700	J	18100	J	5130	--	5110	--	7230	J
CHROMIUM	µg/L	0.85	J	0.83	UJ	1	J	1.4	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.3	--	7	--	7.6	J	4.8	J	0.13	U	0.15	U	0.66	UJ
COBALT	µg/L	1	U	0.08	UJ	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.27	J	0.097	J	2.1	J	1	UJ	1	U	1	U	1	UJ
COPPER	µg/L	2.8	--	2.7	--	2.8	--	2.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.45	U	0.42	U	3.9	--	18.7	--	0.16	U	0.28	U	2.1	--
IRON	µg/L	147	U	44.9	U	91.1	U	50.4	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	162	--	28.1	U	1710	J	20	J	45.9	U	25.6	U	74.8	J
LEAD	µg/L	1.3	--	0.31	UJ	0.54	J	3.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	0.17	J	0.81	J	1	U	1	U	0.09	J
LITHIUM	µg/L	100	U	100	U	100	U	100	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100	U	100	U	100	UJ	100	UJ	100	U	100	U	100	UJ
MAGNESIUM	µg/L	5170	--	5330	--	5870	--	5700	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	25400	--	25800	--	35300	J	33600	--	1720	J	1680	J	2610	J
MANGANESE	µg/L	6.5	--	4.2	--	5.1	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6	--	0.73	J	93.1	--	3.5	--	0.85	J	1	U	2.6	--
MERCURY	µg/L	0.2	U	0.2	U	0.09	J	0.2	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	0.44	J	1	U	1	U	1	U	1	U	1	U
NICKEL	µg/L	2	--	2.1	--	2.1	--	2.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.3	--	7.9	--	39.4	J	12.9	J	0.16	U	0.14	U	0.51	U
POTASSIUM	µg/L	580	J	691	J	609	J	627	J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	245	J	241	J	402	U	316	U	5000	U	5000	U	157	U
SELENIUM	µg/L	5	U	5	U	5	U	5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.39	U	5	U	5	U	5	U	5	U	0.34	U	5	U
SILVER	µg/L	0.1	U	0.1	U	0.1	U	0.1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
SODIUM	µg/L	6700	--	6730	--	6890	--	6670	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2340	U	2450	U	1940	J	1780	J	3310	J	3150	J	3380	J
THALLIUM	µg/L	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	1	U
THORIUM	µg/L	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	1	U
URANIUM	µg/L	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	1	U	1	U	1	U
VANADIUM	µg/L	5	U	5	U	5	U	5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.99	J	0.88	J	0.61	J	0.79	J	0.61	J	0.63	J	0.35	J
ZINC	µg/L	25	--	6.3	--	5.6	--	25.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.5	U	1.9	U	8.7	--	20.2	--	2	U	1.4	U	7.8	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	65	--	--	--	60	--	--	--	--	--	--	--	--	--	--	--	--	--	200	--	--	--	155	--	--	--	175	--	--	--	30	--	--	--	35	--
Conductivity	µS/cm	153	--	--	--	150	--	--	--	50	--	48	--	59	--	97	--	370	--	281	--	68	--	244	--	--	--	404	--	--	--	45	--	--	--	85	--
Dissolved Oxygen	mg/l	9.04	--	--	--	8.12	--	--	--	8.9	--	9.63	--	10.63	--	10.09	--	8.73	--	9.4	--	10.61	--	9.05	--	--	--	9.1	--	--	--	9.12	--	--	--	9.1	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	0	--	--	--	0.38	--	--	--	0.04	--	--	--	0	--
FLOW	gal/min	56107.49	--	--	--	50987.53	--	--	--	5	--	9	--	5	--	40.54	--	2	--	5	--	5	--	11	--	--	--	1	--	--	--	100	--	--	--	5	--
ORP	millivolts	191.4	--	--	--	124.3	--	--	--	-226.7	--	156.7	--	153.5	--	186.7	--	-173.8	--	-152.1	--	174.2	--	-172.1	--	--	--	110.9	--	--	--	-187	--	--	--	78	--
PH	S.U.	6.7	--	--	--	7.27	--	--	--	7.22	--	6.44	--	6.31	--	6.77	--	7.39	--	7.67	--	6.18	--	7.73	--	--	--	7.45	--	--	--	6.23	--	--	--	7.58	--
Temperature	deg C	12.1	--	--	--	14.7	--	--	--	6.95	--	7.47	--	7.28	--	7.11	--	6.14	--	6.68	--	6.92	--	6.28	--	--	--	8.21	--	--	--	6.87	--	--	--	8.4	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U
ALKALINITY, TOTAL (CACO3)	mg/l	54.8	--	--	--	56.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	156	--	--	--	190	--	--	--	25.1	--	--	--	33.8	--
Ammonia as N (distilled)	mg/l	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.11	J
Chloride	mg/l	--	--	7.41	--	--	--	7.98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.85	--	--	--	1.97	--	--	--	2.57	--	--	--
FLUORIDE	mg/l	--	--	0.0473	--	--	--	0.0491	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	U	--	--	0.04	U	--	--	0.0463	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	0.05	U	--	--	0.05	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	U	--	--	0.123	--	--	--	0.05	U	--	--	0.05	U
Sulfate	mg/l	--	--	5.72	--	--	--	5.58	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	23.4	--	--	--	23.7	--	--	--	0.994	--	--	--
TDS	mg/l	98	--	--	--	102	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	202	--	--	--	214	--	--	--	54	--	--	--	48	--
TSS	mg/l	2.1	U	--	--	2.1	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.17	--	--	--	53.5	--	--	--	2.1	U	--	--	4.42	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		RUSSELL CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK	
Location		SW4		SW5		SW5		SW5		SW5		SW6		SW6		SW6		SW6		SW7		SW7		SW7		SW7		WFA1		WFB1		WFB1		WFB2		WFB2	
Sample Date		10/29/2009		01/27/2010		01/27/2010		10/30/2009		10/30/2009		01/31/2010		01/31/2010		10/30/2009		10/30/2009		01/27/2010		01/27/2010		10/30/2009		10/30/2009		01/27/2010		01/27/2010		10/30/2009		01/27/2010		10/30/2009	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		STREAM		Seep		Seep		Seep		Seep		Seep		STREAM		STREAM		STREAM		STREAM	
Total/Dissolved		D		T		D		T		D		T		D		T		D		T		D		T		D		T		T		T		T		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																					
ALUMINUM	µg/L	6.7	U	26.5	J	12	J	61.6	U	26.5	U	12.4	J	200	U	140	J	200	U	7.9	J	200	U	753	--	10	U	--	--	--	--	--	--	--	--	--	--
ANTIMONY	µg/L	2	U	2	U	2	U	0.81	U	2	U	2	U	0.37	U	2	U	2	U	2	U	2	U	2	U	2	U	--	--	--	--	--	--	--	--	--	--
ARSENIC	µg/L	0.89	J	1	U	1	U	0.95	J	1.1	--	0.52	U	1	U	1.1	--	0.94	J	1	U	1	U	0.87	J	1.1	--	--	--	--	--	--	--	--	--	--	--
BARIUM	µg/L	1.9	J	3.3	J	3.2	J	0.9	J	2	J	0.96	J	1.4	J	1.9	J	1.4	J	3.3	J	3.1	J	5	J	2.5	J	--	--	--	--	--	--	--	--	--	--
BERYLLIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--
CADMIUM	µg/L	0.5	U	0.5	U	0.12	J	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.14	J	0.16	J	0.5	U	0.5	U	--	--	--	--	--	--	--	--	--	--
CALCIUM	µg/L	7010	J	4730	J	4990	J	7180	--	6570	--	9190	--	8820	--	20500	--	20400	--	10700	--	10100	J	16200	--	15700	--	--	--	--	--	--	--	--	--	--	--
CHROMIUM	µg/L	12	J	1.1	J	1.2	J	0.67	J	0.72	J	0.84	J	0.81	J	0.74	J	0.67	J	0.85	J	0.94	J	0.71	J	0.64	J	--	--	--	--	--	--	--	--	--	--
COBALT	µg/L	0.1	J	1	U	1	U	1	U	1	U	1	U	0.14	U	0.19	J	0.09	J	1	U	1	U	0.24	J	1	U	--	--	--	--	--	--	--	--	--	--
COPPER	µg/L	2.9	--	2.2	--	2.5	--	2.8	U	2.1	U	1.5	U	1.4	U	2.7	U	1.9	U	1.1	J	1.5	J	2.2	U	1.6	U	--	--	--	--	--	--	--	--	--	--
IRON	µg/L	100	U	45.6	J	39.7	J	38.6	J	100	U	58.1	J	19.8	J	173	--	100	U	51.7	J	38.4	J	652	--	22.7	J	--	--	--	--	--	--	--	--	--	--
LEAD	µg/L	2.9	J	0.27	J	0.32	J	0.39	J	0.22	J	0.24	U	0.29	U	0.29	J	0.23	J	1.1	--	0.29	J	0.44	J	0.52	J	--	--	--	--	--	--	--	--	--	--
LITHIUM	µg/L	100	UJ	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	100	U	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	2500	J	1220	J	1300	J	2020	J	1860	J	3390	J	3290	J	6470	--	6360	--	2040	J	1950	J	3380	J	3220	J	--	--	--	--	--	--	--	--	--	--
MANGANESE	µg/L	1.8	--	1.7	J	1.9	--	1	U	1	U	0.93	J	0.84	J	5.5	--	1	U	1.4	J	1.2	--	12.6	--	0.78	J	--	--	--	--	--	--	--	--	--	--
MERCURY	µg/L	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	--	--	--	--	--	--	--	--	--	--
MOLYBDENUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	0.41	J	0.43	J	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--
NICKEL	µg/L	6.4	J	1.7	--	2.2	--	0.59	U	0.55	U	0.36	U	0.61	U	0.74	U	1.1	U	1.4	--	1.4	--	0.67	U	0.78	U	--	--	--	--	--	--	--	--	--	--
POTASSIUM	µg/L	131	U	5000	U	122	J	69.2	U	5000	U	5000	U	5000	U	159	U	134	U	140	J	5000	U	167	U	152	U	--	--	--	--	--	--	--	--	--	--
SELENIUM	µg/L	5	U	5	U	5	U	5	U	5	U	0.54	U	0.42	U	5	U	5	U	0.42	J	5	U	5	U	5	U	--	--	--	--	--	--	--	--	--	--
SILVER	µg/L	0.1	U	0.1	U	0.1	U	0.05	J	0.1	U	0.1	U	0.1	U	0.05	J	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	--	--	--	--	--	--	--	--	--	--
SODIUM	µg/L	3490	J	2490	J	2840	J	2790	J	2890	J	4460	J	4510	J	4330	J	4610	J	3690	J	3600	J	3730	J	3570	J	--	--	--	--	--	--	--	--	--	--
THALLIUM	µg/L	1	U	1	U	1	U	0.07	J	1	U	1	U	1	U	0.11	J	0.07	J	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--
THORIUM	µg/L	1	U	1	U	1	U	0.09	J	1	R	1	U	1	U	--	--	--	--	1	U	1	U	--	--	1	R	--	--	--	--	--	--	--	--	--	--
URANIUM	µg/L	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	1	U	--	--	--	--	--	--	--	--	--	--
VANADIUM	µg/L	0.44	J	5	U	5	U	5	U	5	U	5	U	5	U	1.6	J	0.7	J	5	U	5	U	0.93	J	5	U	--	--	--	--	--	--	--	--	--	--
ZINC	µg/L	7.3	--	4.6	--	6.7	--	4.9	--	4.5	--	60	U	60	U	4.6	--	7	--	2.9	--	6	--	4.1	--	4.3	--	--	--	--	--	--	--	--	--	--	--
Field Measurement																																					
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	25	--	--	--	45	--	--	--	60	--	--	--	95	--	--	--	55	--	--	--	70	--	--	--	--	--	--	--	--	--	--	--	--
Conductivity	µS/cm	--	--	32	--	--	--	70	--	--	--	102	--	--	--	194	--	--	--	66	--	--	--	142	--	--	--	96	--	--	--	--	--	--	--	--	--
Dissolved Oxygen	mg/l	--	--	14.12	--	--	--	7.4	--	--	--	10.01	--	--	--	7.52	--	--	--	12.7	--	--	--	7.72	--	--	--	13.11	--	--	--	--	--	--	--	--	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FLOW	gal/min	--	--	72.38	--	--	--	7	--	--	--	35.98	--	--	--	2	--	--	--	40	--	--	--	5	--	--	--	4	--	--	--	--	--	--	--	--	--
ORP	millivolts	--	--	86.5	--	--	--	55.7	--	--	--	181.3	--	--	--	-50.3	--	--	--	119.6	--	--	--	-17.6	--	--	--	120	--	--	--	--	--	--	--	--	--
PH	S.U.	--	--	7.46	--	--	--	6.53	--	--	--	6.77	--	--	--	7.44	--	--	--	7.14	--	--	--	7.2	--	--	--	7.17	--	--	--	--	--	--	--	--	--
Temperature	deg C	--	--	7.39	--	--	--	10.2	--	--	--	8.28	--	--	--	10.21	--	--	--	8.85	--	--	--	9.66	--	--	--	7.92	--	--	--	--	--	--	--	--	--
General Chemistry																																					
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	18	--	--	--	27	--	--	--	52.1	--	--	--	89.6	--	--	--	43	--	--	--	60.5	--	--	--	--	--	--	--	--	--	--	--	--	--
Ammonia as N (distilled)	mg/l	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	0.5	U	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	mg/l	2.82	--	--	--	1.26	--	--	--	2.36	--	--	--	1.52	--	--	--	1.7	--	--	--	1.02	--	--	--	1.2	--	--	--	--	--	--	--	--	--	--	--
FLUORIDE	mg/l	0.04	U	--	--	0.04	U	--	--	0.04	U	--	--	0.0532	--	--	--	0.07	--	--	--	0.0475	--	--	--	0.0669	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	0.05	U	--	--	0.0601	--	--	--	0.05	U	--	--	0.05	U	--	--	0.187	--	--	--	0.179	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/l	1.15	--	--	--	1.07	--	--	--	1.28	--	--	--	1.18	--	--	--	3.75	--	--	--	1.71	--	--	--	4.54	--	--	--	--	--	--	--	--	--	--	--
TDS	mg/l	--	--	44	--	--	--	32	--	--	--	86	--	--	--	126	--	--	--	66	--	--	--	60	--	--	--	--	--	--	--	--	--	--	--	--	--
TSS	mg/l	--	--	2.1	U	--	--	2.1	U	--	--	2.1	U	--	--	9.47	--	--	--	2.1	U	--	--	13	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		WEST FK CANYON CK		404 ADIT LOWER		404 ADIT LOWER		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT	
Location		WFC1		WFD1		WFD1		WFG1		WFG1		WFH1		WFH1																					
Sample Date		01/27/2010		01/27/2010		10/30/2009		01/31/2010		10/30/2009		01/31/2010		10/30/2009		02/17/2012		09/29/2011		10/19/2009		10/19/2009		01/26/2010		01/26/2010		10/25/2010		10/25/2010		01/26/2011		01/26/2011	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		STREAM		STREAM		STREAM		Seep		Seep		STREAM		STREAM		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT	
Total/Dissolved		T		T		T		T		T		T		T		N		N		T		D		T		D		T		D		T		D	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																			
ALUMINUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8980	--	9240	--	25200	--	27700	--	9550	--	9340	--	21200	--	21700	--
ANTIMONY	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.35	U	2	U	10.1	--	10	--	2	U	2	U	5.7	--	5.4	--
ARSENIC	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.4	--	2.8	--	167	--	167	--	6.1	--	3.8	--	124	--	118	--
BARIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.2	--	10.4	--	13.5	--	11.9	--	9.4	J	9.2	J	13.2	--	10.7	--
BERYLLIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.25	J	0.23	J	0.48	J	0.49	J	0.2	J	0.23	J	1	U	1	U
CADMIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	132	--	130	--	651	--	666	--	133	--	131	--	367	--	366	--
CALCIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	171000	--	178000	--	58600	--	64700	J	180000	--	178000	--	71700	--	72200	--
CHROMIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.7	--	2.7	--	18.1	--	18.4	--	2.4	--	2	--	13.3	--	13.7	--
COBALT	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15.5	--	15.4	--	19.8	--	20.5	--	14.6	--	14.6	--	13.6	--	13.7	--
COPPER	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3170	--	3150	--	44000	--	42800	--	2710	--	2700	--	31500	--	32200	--
IRON	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	87000	--	74700	--	239000	--	264000	--	104000	--	88600	--	186000	--	187000	--
LEAD	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.3	--	15.3	--	74	--	78.2	--	16.2	--	14.6	--	73.6	--	73.6	--
LITHIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100	U	100	U	16.6	U	18.1	U	13.9	J	15.8	J	100	U	100	U
MAGNESIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	24300	--	25000	--	21100	--	23200	J	25400	--	25300	--	20100	--	20000	--
MANGANESE	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2340	--	2280	--	2090	J	2150	--	2280	--	2310	--	1750	--	1770	--
MERCURY	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	--	1.1	--	1	U	0.26	U	1	U	1	U
NICKEL	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	70.7	--	71	--	76.4	--	80.2	--	63.3	--	63.6	--	58.4	--	58.9	--
POTASSIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1960	J	2040	J	625	J	714	J	1980	J	1960	J	801	J	816	--
SELENIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.7	J	1.2	J	2.4	J	3.3	J	0.47	U	0.59	U	1.3	J	1.2	J
SILVER	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	J	0.1	U	0.61	--	0.38	--	0.078	J	0.067	J	0.22	J	0.12	J
SODIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11000	--	11500	--	5890	--	6240	--	9670	--	9570	--	5560	--	5990	--
THALLIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.51	J	0.48	J	0.63	J	0.66	J	0.71	J	1.3	--	1	U	1	U
THORIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	0.27	U	0.54	J	0.51	U	1	U	0.37	U	1	U	1	U
URANIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.63	J	0.59	J	3.6	--	3.7	--	0.71	J	0.69	J	2.2	--	2.2	--
VANADIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	U	5	U	13.2	--	14.8	--	1.4	U	0.89	U	5	U	5	U
ZINC	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61900	--	61200	--	140000	--	146000	--	60800	--	61500	--	85600	--	88100	--
Field Measurement																																			
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	5	--	--	--	5	--	--	--	5	--	--	--
Conductivity	µS/cm	--	--	--	--	--	--	132	--	--	--	--	--	--	--	1417	--	2351	--	1579	--	--	--	1925	--	--	--	2543	--	--	--	4185	--	--	--
Dissolved Oxygen	mg/l	--	--	--	--	--	--	9.45	--	--	--	--	--	--	--	--	--	--	--	4.09	--	--	--	1.03	--	--	--	11.91	--	--	--	1.07	--	--	--
Ferrous Iron	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.3	J	--	--	7.53	--	--	--	5.13	--	--	--	7.53	--	--	--
FLOW	gal/min	--	--	--	--	--	--	20	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	42.91	--	--	--	0.8	--	--	--	29.94	--	--	--
ORP	millivolts	--	--	--	--	--	--	194.6	--	--	--	--	--	--	--	375.7	--	400.2	--	369	--	--	--	471.5	--	--	--	428.9	--	--	--	430.9	--	--	--
PH	S.U.	--	--	--	--	--	--	6.87	--	--	--	--	--	--	--	2.69	--	2.7	--	3.29	--	--	--	2.15	--	--	--	3.13	--	--	--	2.85	--	--	--
Temperature	deg C	--	--	--	--	--	--	8.42	--	--	--	--	--	--	--	6.39	--	14.21	--	9.42	--	--	--	9.56	--	--	--	7.17	--	--	--	9.58	--	--	--
General Chemistry																																			
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	340	--	--	--	1200	--	--	--	400	J	--	--	800	J	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	U	--	--	5	U	--	--	5	U	--	--	5	U	--	--
Ammonia as N (distilled)	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	0.44	J	--	--	1.01	J	--	--	0.41	J	--	--
Chloride	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.97	--	--	--	1.69	--	--	--	3.57	--	--	--	2.6	J
FLUORIDE	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.585	--	--	--	1.52	--	--	--	1.44	--	--	--	1.32	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	U	--	--	0.0605	--	--	--	0.05	U	--	--	0.0561	--	--	--
Sulfate	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	947	--	--	--	1560	--	--	--	948	--	--	--	1070	--
TDS	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1450	--	--	--	2340	--	--	--	1390	--	--	--	1510	--	--	--
TSS	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	99.5	--	--	--	2.1	--	--	--	98.5	--	--	--	3.74	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		FORMOSA ADIT		404 DRAINAGE		404 DRAINAGE		NA		NA		NA		NA		NA		NA	
Location																		SFF1		SFF1		404 ADIT		404 ADIT		404 ADIT		404 ADIT		404 ADIT		FORMOSA ADIT-LC	
Sample Date		09/26/2011		09/26/2011		02/13/2012		02/13/2012		09/13/2012		09/13/2012		06/18/2013		06/18/2013		09/29/2011		09/29/2011		02/04/2010		02/04/2010		09/29/2011		10/19/2009		10/19/2009		01/26/2010	
Sample Type		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N		N	
Location Type		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT		Seep		Seep		ADIT		ADIT		ADIT		ADIT		ADIT		ADIT	
Total/Dissolved		T		D		T		D		T		D		T		D		T		D		T		D		T		T		D		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals																																	
ALUMINUM	µg/L	13000	--	13000	--	29300	--	29000	--	11600	J	11800	--	15100	--	14600	--	4230	--	24.9	J	1570	--	1990	--	--	--	1170	--	1080	--	--	--
ANTIMONY	µg/L	7.3	J	6.7	J	60	U	60	U	60	U	60	U	60	U	60	U	2	U	2	U	2	U	2	U	--	--	0.97	U	2	U	--	--
ARSENIC	µg/L	56.8	J	32.6	J	121	J	95.5	--	50.3	--	29.4	--	36.4	--	13.9	--	1.5	--	1	U	7.1	--	7	--	--	--	0.83	J	0.82	J	--	--
BARIUM	µg/L	200	R	200	R	200	UJ	200	U	200	U	200	U	15.1	J	200	U	20.7	J	10	UJ	56.1	--	56	--	--	--	32.7	--	34.3	--	--	--
BERYLLIUM	µg/L	0.35	J	0.32	J	0.49	J	0.48	J	5	U	5	U	5	U	5	U	1	U	1	U	0.057	J	1	U	--	--	1	U	1	U	--	--
CADMIUM	µg/L	219	J	213	J	360	J	353	J	139	--	185	--	167	J	167	--	0.5	U	0.5	U	0.66	--	0.67	--	--	--	0.41	U	0.4	U	--	--
CALCIUM	µg/L	102000	--	104000	--	98600	--	99000	--	103000	--	103000	--	98800	--	97300	--	38400	--	36800	--	18500	--	21600	--	--	--	29400	--	28900	--	--	--
CHROMIUM	µg/L	10	U	10	U	11.8	--	12.8	--	3.9	J	3.9	J	10	U	10	U	2	U	2	U	2	U	2	U	--	--	0.65	J	0.71	J	--	--
COBALT	µg/L	15.5	J	14.8	J	19.8	J	50	U	50	U	50	U	50	U	50	U	4.8	--	1	U	3.1	--	3.5	--	--	--	1.4	--	1.5	--	--	--
COPPER	µg/L	5520	--	5400	--	31800	--	29900	--	3350	--	4360	--	6530	--	6530	--	104	--	2	U	267	--	333	--	--	--	43.5	--	46.9	--	--	--
IRON	µg/L	163000	--	164000	--	244000	J	247000	--	148000	--	142000	--	162000	--	160000	--	3150	--	100	U	34800	--	45900	--	--	--	1010	--	978	--	--	--
LEAD	µg/L	35.2	J	32.9	J	94.9	--	83.5	--	24	--	30.2	--	39	--	39.1	--	2	--	1	U	5.7	--	5.9	--	--	--	3.3	--	2.8	--	--	--
LITHIUM	µg/L	14.9	J	14.5	J	--	--	--	--	--	--	--	--	--	--	--	--	100	U	100	U	100	U	100	U	--	--	100	U	100	U	--	--
MAGNESIUM	µg/L	23900	--	23800	--	27900	--	28600	--	21300	--	20800	--	23200	--	22900	--	8120	--	7850	--	3270	J	3700	J	--	--	5610	--	5450	--	--	--
MANGANESE	µg/L	2280	--	2230	--	2290	--	2290	--	1710	--	2100	--	1850	--	1840	--	476	J	15.4	J	128	--	143	--	--	--	206	--	211	--	--	--
MERCURY	µg/L	0.056	J	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.063	J	0.2	U	0.2	U	0.2	U	0.091	J	--	--	0.2	U	0.2	U	--	--
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	0.49	J	0.4	J	--	--	0.35	U	1	U	--	--
NICKEL	µg/L	76	--	74.1	--	68.1	J	59.5	J	48.4	--	56.6	--	46.6	J	47.7	--	3.5	--	1	U	0.85	U	0.95	U	--	--	1.3	--	1.4	--	--	--
POTASSIUM	µg/L	1880	J	1870	J	5000	UJ	5000	U	2610	J	2460	J	5000	U	5000	U	5000	U	5000	U	566	J	696	J	--	--	1550	J	1530	J	--	--
SELENIUM	µg/L	6.8	J	2.1	J	2	J	1.9	J	1	J	1.2	J	5	U	5	U	0.55	J	5	U	0.33	U	0.33	U	--	--	5	U	5	U	--	--
SILVER	µg/L	7.7	J	7	J	0.17	J	0.13	J	0.1	U	0.1	U	0.1	U	0.1	U	0.12	--	0.1	U	0.1	U	0.1	U	--	--	0.07	J	0.1	U	--	--
SODIUM	µg/L	9160	--	9130	--	7720	--	7660	--	11100	--	10900	--	7900	--	7720	--	5000	U	5000	U	4130	J	3960	J	--	--	4710	J	4160	J	--	--
THALLIUM	µg/L	4.3	J	4	J	25	U	25	U	25	U	25	U	25	U	25	U	1	U	1	U	1	U	1	U	--	--	0.15	J	1	U	--	--
THORIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	0.11	J	0.18	J	--	--	1	U	1	U	--	--
URANIUM	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	U	1	U	1	U	1	U	--	--	1	U	1	U	--	--
VANADIUM	µg/L	5.8	J	5.3	J	11.6	J	11.3	J	50	U	50	U	50	U	50	U	18.7	--	6.7	--	5	U	5	U	--	--	5	U	5	U	--	--
ZINC	µg/L	70300	--	72200	--	100000	--	104000	--	60300	--	68600	--	66400	--	76100	--	121	--	7	--	172	--	177	--	--	--	90.6	--	96.6	--	--	--
Field Measurement																																	
ALKALINITY, TOTAL (CACO3)	mg/l	5	--	--	--	5	--	--	--	0	--	--	--	5	--	--	--	130	--	--	--	5	--	--	--	--	--	5	--	--	--	--	--
Conductivity	µS/cm	1483	--	--	--	2208	--	--	--	1092	--	--	--	1320	--	--	--	220	--	--	--	653	--	--	--	--	--	384	--	--	--	1708	--
Dissolved Oxygen	mg/l	0.09	--	--	--	1.62	--	--	--	0.73	--	--	--	0.8	--	--	--	9.72	--	--	--	6.37	--	--	--	--	--	8.51	--	--	--	12.01	--
Ferrous Iron	mg/l	22.4	--	--	--	8.12	--	--	--	12.9	--	--	--	2.19	--	--	--	0	--	--	--	1.53	--	--	--	--	--	0.59	--	--	--	--	--
FLOW	gal/min	3	--	--	--	13.4	--	--	--	2.5	--	--	--	--	--	--	--	1	--	--	--	0.36	--	--	--	--	--	--	--	--	--	43	--
ORP	millivolts	353.6	--	--	--	400	--	--	--	359.3	--	--	--	405.6	--	--	--	134.8	--	--	--	493.3	--	--	--	--	--	401.6	--	--	--	487.9	--
PH	S.U.	3.31	--	--	--	2.71	--	--	--	3.26	--	--	--	4.88	--	--	--	7.4	--	--	--	2.53	--	--	--	--	--	3.49	--	--	--	2.23	--
Temperature	deg C	9.46	--	--	--	9.55	--	--	--	9.5	--	--	--	9.5	--	--	--	12.19	--	--	--	7.64	--	--	--	14.21	--	11.18	--	--	--	8.98	--
General Chemistry																																	
Acidity by titration	mg CaCO3/L	490	J	--	--	840	--	--	--	440	--	--	--	470	--	--	--	10	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	200	--	--	--	--	--	26	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	5	U	--	--	5	U	--	--	5	U	--	--	--	--	--	--	116	--	--	--	5	U	--	--	--	--	5	U	--	--	--	--
Ammonia as N (distilled)	mg/l	1.06	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	U	--	--	0.5	U	--	--	--	--	0.5	U	--	--	--	--
Chloride	mg/l	--	--	3.52	--	--	--	1.79	--	--	--	3.07	--	--	--	2.42	--	--	--	2.5	J	--	--	2.47	--	--	--	--	--	1.89	--	--	--
FLUORIDE	mg/l	--	--	1.73	--	--	--	1.75	--	--	--	1.55	--	--	--	0.768	--	--	--	0.04	U	--	--	0.135	--	--	--	--	--	0.0799	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	0.05	U	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	U	--	--	0.05	U	--	--	--	--	0.05	U	--	--	--	--
Sulfate	mg/l	--	--	908	--	--	--	1240	--	--	--	807	--	--	--	913	--	--	--	7.93	--	--	--	242	--	--	--	--	--	131	--	--	--
TDS	mg/l	1480	--	--	--	2020	--	--	--	1240	--	--	--	1460	--	--	--	122	--	--	--	318	--	--	--	--	--	232	--	--	--	--	--
TSS	mg/l	2.11	--	--	--	6.4	--	--	--	10.1	--	--	--	18.9	--	--	--	87.6	--	--	--	34.9	--	--	--	--	--	2.1	U	--	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifier
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix A Table A-1
Surface Water Analytical and Field Results

Drainage		NA		NA		NA		NA	
Location		FORMOSA ADIT-LC		FORMOSA ADIT-LC		SILVER BUTTE ADIT		SILVER BUTTE ADIT	
Sample Date		02/04/2010		10/19/2009		01/26/2010		10/19/2009	
Sample Type		N		N		N		N	
Location Type		ADIT		ADIT		ADIT		ADIT	
Total/Dissolved		T		T		T		T	
Chemical	**Units**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**	**Results**	**Q**
Metals									
ALUMINUM	µg/L	--	--	--	--	--	--	--	--
ANTIMONY	µg/L	--	--	--	--	--	--	--	--
ARSENIC	µg/L	--	--	--	--	--	--	--	--
BARIUM	µg/L	--	--	--	--	--	--	--	--
BERYLLIUM	µg/L	--	--	--	--	--	--	--	--
CADMIUM	µg/L	--	--	--	--	--	--	--	--
CALCIUM	µg/L	--	--	--	--	--	--	--	--
CHROMIUM	µg/L	--	--	--	--	--	--	--	--
COBALT	µg/L	--	--	--	--	--	--	--	--
COPPER	µg/L	--	--	--	--	--	--	--	--
IRON	µg/L	--	--	--	--	--	--	--	--
LEAD	µg/L	--	--	--	--	--	--	--	--
LITHIUM	µg/L	--	--	--	--	--	--	--	--
MAGNESIUM	µg/L	--	--	--	--	--	--	--	--
MANGANESE	µg/L	--	--	--	--	--	--	--	--
MERCURY	µg/L	--	--	--	--	--	--	--	--
MOLYBDENUM	µg/L	--	--	--	--	--	--	--	--
NICKEL	µg/L	--	--	--	--	--	--	--	--
POTASSIUM	µg/L	--	--	--	--	--	--	--	--
SELENIUM	µg/L	--	--	--	--	--	--	--	--
SILVER	µg/L	--	--	--	--	--	--	--	--
SODIUM	µg/L	--	--	--	--	--	--	--	--
THALLIUM	µg/L	--	--	--	--	--	--	--	--
THORIUM	µg/L	--	--	--	--	--	--	--	--
URANIUM	µg/L	--	--	--	--	--	--	--	--
VANADIUM	µg/L	--	--	--	--	--	--	--	--
ZINC	µg/L	--	--	--	--	--	--	--	--
Field Measurement									
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	5	--	--	--	--	--
Conductivity	µS/cm	2010	--	1708	--	--	--	--	--
Dissolved Oxygen	mg/l	1.53	--	9.85	--	--	--	--	--
Ferrous Iron	mg/l	--	--	3.3	J	--	--	--	--
FLOW	gal/min	17.5	--	2	--	--	--	--	--
ORP	millivolts	442.9	--	463.6	--	--	--	--	--
PH	S.U.	2.61	--	2.98	--	--	--	--	--
Temperature	deg C	9.67	--	9.66	--	--	--	--	--
General Chemistry									
Acidity by titration	mg CaCO3/L	--	--	--	--	--	--	--	--
Acidity by titration	mg/l	--	--	--	--	--	--	--	--
ALKALINITY, TOTAL (CACO3)	mg/l	--	--	--	--	--	--	--	--
Ammonia as N (distilled)	mg/l	--	--	--	--	--	--	--	--
Chloride	mg/l	--	--	--	--	--	--	--	--
FLUORIDE	mg/l	--	--	--	--	--	--	--	--
Nitrogen, Nitrate-Nitrite	mg/l	--	--	--	--	--	--	--	--
Sulfate	mg/l	--	--	--	--	--	--	--	--
TDS	mg/l	--	--	--	--	--	--	--	--
TSS	mg/l	--	--	--	--	--	--	--	--

Notes:
CK = Creek
D = Dissolved concentration
N = normal sample
ORP = oxygen reduction potential
T = Total concentration
-- = not analyzed for

Q = Qualifie
J = Estimate
R = Rejected
> = Above d
U, < = Below

Appendix B

Site-Specific Harness Calculations

CDM Smith

Appendix B Table B-1

Hardness Calculation

LOCATION TYPE	BASIN	CALCIUM (µg/L)	MAGNESIUM (µg/L)	HARDNESS (mg/L)
ADIT	404 ADIT	25250.00	4575.00	82
ADIT	FORMOSA ADIT	112025.00	23700.00	377
FAUCET	COW CREEK	9078.57	5925.71	47
Seep	404 DRAINAGE	36800.00	7850.00	124
Seep	MIDDLE CREEK	47094.00	12756.00	170
Seep	SOUTH FK MIDDLE CREEK	73787.14	27505.71	298
Seep	WEST FK CANYON CREEK	12900.00	2585.00	43
STREAM	COW CREEK	9131.43	5230.00	44
STREAM	MIDDLE CREEK	25987.71	9243.85	103
STREAM	MIDDLE CREEK REF	12300.00	4930.00	51
STREAM	RUSSELL CREEK	11580.00	15895.00	94
STREAM	SOUTH FK MIDDLE CREEK	20700.00	5533.75	74
STREAM	SOUTH FK REF	18300.00	2780.00	57
STREAM	WEST FK CANYON CREEK	10195.00	3202.50	39

Hardness = (2.497*(CA/1000))+(4.118*(MG/1000))

mg/L = milligrams per liter

µg/L = micrograms per liter

Appendix B Table B-2, Calculation of Criteria for Hardness Dependent Metals

OREGON DEQ STANDARDS (updated Tables 20, 33A, and 33B, Jan. 31, 2013 per OAR 340-041-0033)

MIDDLE CREEK

Hardness-adjustments

Hardness-specific CMC

OREGON DEQ TABLES 20, 33A, 33B Dissolved Criteria (ug/L)		CMC (ug/L) Dissolved	T/R	exp	ma	hard (mg/L)	ln hard	ba	CF
Cd	3.9	-	-		-	103	4.634316	-	-
Cr III	---	584	1847		0.819	103	4.634316	3.7256	0.316
Cu	18	-	-		-	103	4.634316	-	-
Pb	---	66.7	85		1.273	103	4.634316	-1.46	0.786755
Ni	---	480	481		0.846	103	4.634316	2.255	0.998
Ag	---	3.38	4.0		1.72	103	4.634316	-6.59	0.85
Zn	---	120	123		0.8473	103	4.634316	0.884	0.978
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	360								-
Cr VI	16								0.982
Hg	2.4								-
Se	260								-

Hardness-specific CCC

OREGON DEQ TABLES 20, 33A, 33B Dissolved Criteria (ug/L)		CCC (ug/L) Dissolved	T/R	exp	mc	hard (mg/L)	ln hard	bc	CF
Cd	---	0.25	0.28		0.7409	103	4.634316	-4.719	0.907781
Cr III	---	76	88		0.819	103	4.634316	0.6848	0.86
Cu	12	-	-		-	103	4.634316	-	-
Pb	---	2.6	3.3		1.273	103	4.634316	-4.705	0.786755
Ni	---	53	53		0.846	103	4.634316	0.0584	0.997
Ag	0.10	0.10	0.12		-	103	4.634316	-	0.85
Zn	---	121	123		0.8473	103	4.634316	0.884	0.986
	Hardness = 100 mg/L	Hardness = site (mg/L)							
	Ag chronic not hardness dependent								
As	190								-
Cr VI	11								0.962
Hg	0.012								-
Se	35								-

SOUTH FORK MIDDLE CREEK

Hardness-adjustments

Hardness-specific CMC

OREGON DEQ TABLES 20, 33A, 33B Dissolved Criteria (ug/L)		CMC (ug/L) Dissolved	T/R	exp	ma	hard (mg/L)	ln hard	ba	CF
Cd	3.9	-	-		-	74	4.310475	-	-
Cr III	---	448	1416		0.819	74	4.310475	3.7256	0.316
Cu	18	-	-		-	74	4.310475	-	-
Pb	---	46.8	56		1.273	74	4.310475	-1.46	0.833942
Ni	---	365	366		0.846	74	4.310475	2.255	0.998
Ag	---	1.94	2.3		1.72	74	4.310475	-6.59	0.85
Zn	---	91	93		0.8473	74	4.310475	0.884	0.978
	Hardness = 100 mg/L	Hardness = site (mg/L)							

Hardness-specific CCC

OREGON DEQ TABLES 20, 33A, 33B Dissolved Criteria (ug/L)		CCC (ug/L) Dissolved	T/R	exp	mc	hard (mg/L)	ln hard	bc	CF
Cd	---	0.20	0.22		0.7409	74	4.310475	-4.719	0.92133
Cr III	---	58	68		0.819	74	4.310475	0.6848	0.86
Cu	12	-	-		-	74	4.310475	-	-
Pb	---	1.8	2.2		1.273	74	4.310475	-4.705	0.833942
Ni	---	41	41		0.846	74	4.310475	0.0584	0.997
Ag	0.10	0.10	0.12		-	74	4.310475	-	0.85
Zn	---	92	93		0.8473	74	4.310475	0.884	0.986
	Hardness = 100 mg/L	Hardness = site (mg/L)							
	Ag chronic not hardness dependent								

NATIONAL CRITERIA

MIDDLE CREEK

Hardness-adjustments
National Recommended WQC 2009

	National Dissolved Criteria CMC (ug/L)	CMC (ug/L) Dissolved	CMC (ug/L) T/R	exp	Hardness-specific CMC ma	hard (mg/L)	ln hard	ba	CF
Cd	2.0	2.072	2.20		1.0166	103	4.634316	-3.924	0.942781
Cr III	570	584	1847		0.819	103	4.634316	3.7256	0.316
Cu	13	13.81	14.4		0.9422	103	4.634316	-1.7	0.96
Pb	65	66.7	85		1.273	103	4.634316	-1.46	0.786755
Ni	470	480	481		0.846	103	4.634316	2.255	0.998
Ag	3.2	3.38	4.0		1.72	103	4.634316	-6.59	0.85
Zn	120	120.1	123		0.8473	103	4.634316	0.884	0.978
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	340								1
Cr VI	16								0.982
Hg	1.4								0.85
Se	*								-

* CMC=1/(f1/CMC1)+(f2/CMC2), f1=fraction selenite, f2=fraction selenate, CMC1=185.9 ug/L, CMC2=12.82 ug/L

	National Dissolved Criteria CCC (ug/L)	CCC (ug/L) Dissolved	CCC (ug/L) T/R	exp	Hardness-specific CCC mc	hard (mg/L)	ln hard	bc	CF
Cd	0.25	0.25	0.28		0.7409	103	4.634316	-4.719	0.907781
Cr III	74	76	88		0.819	103	4.634316	0.6848	0.86
Cu	9	9.2	9.6		0.8545	103	4.634316	-1.702	0.96
Pb	2.5	2.6	3.3		1.273	103	4.634316	-4.705	0.786755
Ni	52	53	53		0.846	103	4.634316	0.0584	0.997
Ag	-	-	-		-	103	4.634316	-	-
Zn	120	121	123		0.8473	103	4.634316	0.884	0.986
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	150								1
Cr VI	11								0.962
Hg	0.77								0.85
Se	5.0								-

SOUTH FORK MIDDLE CREEK

Hardness-adjustments
National Recommended WQC 2009

	National Dissolved Criteria CMC (ug/L)	CMC (ug/L) Dissolved	CMC (ug/L) T/R	exp	Hardness-specific CMC ma	hard (mg/L)	ln hard	ba	CF
Cd	2.0	1.512	1.58		1.0166	74	4.310475	-3.924	0.95633
Cr III	570	448	1416		0.819	74	4.310475	3.7256	0.316
Cu	13	10.18	10.6		0.9422	74	4.310475	-1.7	0.96
Pb	65	46.8	56		1.273	74	4.310475	-1.46	0.833942
Ni	470	365	366		0.846	74	4.310475	2.255	0.998
Ag	3.2	1.94	2.3		1.72	74	4.310475	-6.59	0.85
Zn	120	91.3	93		0.8473	74	4.310475	0.884	0.978
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	340								1
Cr VI	16								0.982
Hg	1.4								0.85
Se	*								-

* CMC=1/(f1/CMC1)+(f2/CMC2), f1=fraction selenite, f2=fraction selenate, CMC1=185.9 ug/L, CMC2=12.82 ug/L

	National Dissolved Criteria CCC (ug/L)	CCC (ug/L) Dissolved	CCC (ug/L) T/R	exp	Hardness-specific CCC mc	hard (mg/L)	ln hard	bc	CF
Cd	0.25	0.20	0.22		0.7409	74	4.310475	-4.719	0.92133
Cr III	74	58	68		0.819	74	4.310475	0.6848	0.86
Cu	9	7.0	7.3		0.8545	74	4.310475	-1.702	0.96
Pb	2.5	1.8	2.2		1.273	74	4.310475	-4.705	0.833942
Ni	52	41	41		0.846	74	4.310475	0.0584	0.997
Ag	-	-	-		-	74	4.310475	-	-
Zn	120	92	93		0.8473	74	4.310475	0.884	0.986
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	150								1
Cr VI	11								0.962
Hg	0.77								0.85
Se	5.0								-

OREGON DEQ STANDARDS (updated Tables 20, 33A, and 33B, Jan. 31, 2013 per OAR 340-041-0033)

MIDDLE CREEK REFERENCE

Hardness-adjustments

OREGON DEQ TABLES 20, 33A, 33B Dissolved Criteria (ug/L)		CMC (ug/L) Dissolved	T/R	exp	ma	hard (mg/L)	ln hard	ba	CF
		Hardness-specific CMC							
Cd	3.9	-	-		-	51	3.932117	-	-
Cr III	---	328	1039		0.819	51	3.932117	3.7256	0.316
Cu	18	-	-		-	51	3.932117	-	-
Pb	---	30.8	35		1.273	51	3.932117	-1.46	0.889073
Ni	---	265	265		0.846	51	3.932117	2.255	0.998
Ag	---	1.01	1.2		1.72	51	3.932117	-6.59	0.85
Zn	---	66	68		0.8473	51	3.932117	0.884	0.978
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	360								-
Cr VI	16								0.982
Hg	2.4								-
Se	260								-

OREGON DEQ TABLES 20, 33A, 33B Dissolved Criteria (ug/L)		CCC (ug/L) Dissolved	T/R	exp	mc	hard (mg/L)	ln hard	bc	CF
		Hardness-specific CCC							
Cd	---	0.15	0.16		0.7409	51	3.932117	-4.719	0.93716
Cr III	---	43	50		0.819	51	3.932117	0.6848	0.86
Cu	12	-	-		-	51	3.932117	-	-
Pb	---	1.2	1.4		1.273	51	3.932117	-4.705	0.889073
Ni	---	29	30		0.846	51	3.932117	0.0584	0.997
Ag	0.10	0.10	0.12		-	51	3.932117	-	0.85
Zn	---	67	68		0.8473	51	3.932117	0.884	0.986
	Hardness = 100 mg/L	Hardness = site (mg/L)							
	Ag chronic not hardness dependent								
As	190								-
Cr VI	11								0.962
Hg	0.012								-
Se	35								-

SOUTH FORK MIDDLE CREEK REFERENCE

Hardness-adjustments

OREGON DEQ TABLES 20, 33A, 33B Dissolved Criteria (ug/L)		CMC (ug/L) Dissolved	T/R	exp	ma	hard (mg/L)	ln hard	ba	CF
		Hardness-specific CMC							
Cd	3.9	-	-		-	57	4.045559	-	-
Cr III	---	360	1140		0.819	57	4.045559	3.7256	0.316
Cu	18	-	-		-	57	4.045559	-	-
Pb	---	34.9	40		1.273	57	4.045559	-1.46	0.872543
Ni	---	292	292		0.846	57	4.045559	2.255	0.998
Ag	---	1.23	1.4		1.72	57	4.045559	-6.59	0.85
Zn	---	73	75		0.8473	57	4.045559	0.884	0.978
	Hardness = 100 mg/L	Hardness = site (mg/L)							

OREGON DEQ TABLES 20, 33A, 33B Dissolved Criteria (ug/L)		CCC (ug/L) Dissolved	T/R	exp	mc	hard (mg/L)	ln hard	bc	CF
		Hardness-specific CCC							
Cd	---	0.17	0.18		0.7409	57	4.045559	-4.719	0.932414
Cr III	---	47	54		0.819	57	4.045559	0.6848	0.86
Cu	12	-	-		-	57	4.045559	-	-
Pb	---	1.4	1.6		1.273	57	4.045559	-4.705	0.872543
Ni	---	32	32		0.846	57	4.045559	0.0584	0.997
Ag	0.10	0.10	0.12		-	57	4.045559	-	0.85
Zn	---	74	75		0.8473	57	4.045559	0.884	0.986
	Hardness = 100 mg/L	Hardness = site (mg/L)							
	Ag chronic not hardness dependent								

NATIONAL CRITERIA

MIDDLE CREEK REFERENCE

Hardness-adjustments
National Recommended WQC 2009

National Dissolved Criteria CMC (ug/L)		CMC (ug/L) Dissolved	T/R	exp	Hardness-specific CMC ma	hard (mg/L)	ln hard	ba	CF
Cd	2.0	1.046	1.08		1.0166	51	3.932117	-3.924	0.97216
Cr III	570	328	1039		0.819	51	3.932117	3.7256	0.316
Cu	13	7.13	7.4		0.9422	51	3.932117	-1.7	0.96
Pb	65	30.8	35		1.273	51	3.932117	-1.46	0.889073
Ni	470	265	265		0.846	51	3.932117	2.255	0.998
Ag	3.2	1.01	1.2		1.72	51	3.932117	-6.59	0.85
Zn	120	66.3	68		0.8473	51	3.932117	0.884	0.978
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	340								1
Cr VI	16								0.982
Hg	1.4								0.85
Se	*								-

* CMC=1/(f1/CMC1)+(f2/CMC2), f1=fraction selenite, f2=fraction selenate, CMC1=185.9 ug/L, CMC2=12.82 ug/L

National Dissolved Criteria CCC (ug/L)		CCC (ug/L) Dissolved	T/R	exp	Hardness-specific CCC mc	hard (mg/L)	ln hard	bc	CF
Cd	0.25	0.15	0.16		0.7409	51	3.932117	-4.719	0.93716
Cr III	74	43	50		0.819	51	3.932117	0.6848	0.86
Cu	9	5.0	5.2		0.8545	51	3.932117	-1.702	0.96
Pb	2.5	1.2	1.4		1.273	51	3.932117	-4.705	0.889073
Ni	52	29	30		0.846	51	3.932117	0.0584	0.997
Ag	-	-	-		-	51	3.932117	-	-
Zn	120	67	68		0.8473	51	3.932117	0.884	0.986
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	150								1
Cr VI	11								0.962
Hg	0.77								0.85
Se	5.0								-

SOUTH FORK MIDDLE CREEK REFERENCE

Hardness-adjustments
National Recommended WQC 2009

National Dissolved Criteria CMC (ug/L)		CMC (ug/L) Dissolved	T/R	exp	Hardness-specific CMC ma	hard (mg/L)	ln hard	ba	CF
Cd	2.0	1.168	1.21		1.0166	57	4.045559	-3.924	0.967414
Cr III	570	360	1140		0.819	57	4.045559	3.7256	0.316
Cu	13	7.93	8.3		0.9422	57	4.045559	-1.7	0.96
Pb	65	34.9	40		1.273	57	4.045559	-1.46	0.872543
Ni	470	292	292		0.846	57	4.045559	2.255	0.998
Ag	3.2	1.23	1.4		1.72	57	4.045559	-6.59	0.85
Zn	120	72.9	75		0.8473	57	4.045559	0.884	0.978
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	340								1
Cr VI	16								0.982
Hg	1.4								0.85
Se	*								-

* CMC=1/(f1/CMC1)+(f2/CMC2), f1=fraction selenite, f2=fraction selenate, CMC1=185.9 ug/L, CMC2=12.82 ug/L

National Dissolved Criteria CCC (ug/L)		CCC (ug/L) Dissolved	T/R	exp	Hardness-specific CCC mc	hard (mg/L)	ln hard	bc	CF
Cd	0.25	0.17	0.18		0.7409	57	4.045559	-4.719	0.932414
Cr III	74	47	54		0.819	57	4.045559	0.6848	0.86
Cu	9	5.6	5.8		0.8545	57	4.045559	-1.702	0.96
Pb	2.5	1.4	1.6		1.273	57	4.045559	-4.705	0.872543
Ni	52	32	32		0.846	57	4.045559	0.0584	0.997
Ag	-	-	-		-	57	4.045559	-	-
Zn	120	74	75		0.8473	57	4.045559	0.884	0.986
	Hardness = 100 mg/L	Hardness = site (mg/L)							
As	150								1
Cr VI	11								0.962
Hg	0.77								0.85
Se	5.0								-

Appendix C

Evaluation of Acute Risk

CDM Smith

Appendix C Table C-1 Statistical Summary for Surface Water Analytical Dissolved Results and Selection of Chemicals of Concern Based on Acute Criteria

		Statistical Summary									COPC Screening Based on ODEQ CMC							COPC Screening Based on National CMC						
												Maximum Detected Conc.			Average Detected Conc.				Maximum Detected Conc.			Average Detected Conc.		
Exposure Area	Chemical	Number of Detects / Samples	FOD	Minimum Detected Conc.	Average Detected Conc.	Maximum Detected Conc.	Minimum Reporting Limit	Maximum Reporting Limit	Units	Location of Maximum Detection	ODEQ CMC Screening Level	HQ (Max Detect)	COPC (Based on Max Detect)?	Rationale	HQ (Avg Detected Conc)	COPC (Based on Avg Detect)?	Rationale	National CMC Screening Level	HQ (Max Detect)	COPC (Based on Max Detect)?	Rationale	HQ (Average Detected Conc.)	COPC (Based on Avg. Detect)?	Rationale
MIDDLE CREEK (1)	ALUMINUM	4 / 15	27%	6.1 J	18.03	33.7 J	6.3	200	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	750.0	0.04	No	BSL	0.02	No	BSL
	ANTIMONY	0 / 14	0%	ND	ND	ND	0.12	60	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ARSENIC	1 / 15	7%	0.59 J	0.59	0.59 J	0.095	10	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	340.0	0.002	No	BSL	0.002	No	BSL
	BARIUM	8 / 15	53%	18.7	44.54	130 J	200	200	µg/L	M13.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	BERYLLIUM	0 / 15	0%	ND	ND	ND	1	5	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	BORON	0 / 8	0%	ND	ND	ND	19.7	100	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	CADMIUM	11 / 15	73%	0.24 J	3.16	14.2	0.5	0.5	µg/L	MXR	3.9	3.6	Yes	ASL	0.8	No	BSL	2.1	6.9	Yes	ASL	1.5	Yes	ASL
	CALCIUM	15 / 15	100%	8020	25988	48100	5000	5000	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	CHLORIDE	15 / 15	100%	2.14	7.33	39.1	0.06	7.5	mg/L	M13.0	860.0	0.05	No	BSL	0.01	No	BSL	860.0	0.05	No	BSL	0.01	No	BSL
	CHROMIUM	3 / 15	20%	0.23 J	0.52	0.91 J	0.26	10	µg/L	MXR	584.0	0.002	No	BSL	0.001	No	BSL	584.0	0.002	No	BSL	0.001	No	BSL
	COBALT	4 / 15	27%	0.2 J	0.86	1.6	0.07	50	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	COPPER	14 / 15	93%	3.3	62.81	530	2	30	µg/L	MXR	18.0	29.4	Yes	ASL	3.5	Yes	ASL	13.8	38.4	Yes	ASL	4.5	Yes	ASL
	FLUORIDE	15 / 15	100%	0.0491	0.07	0.152	0.04	0.08	mg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	IRON	3 / 15	20%	3.1 J	18.78	25.7 J	31.5	100	µg/L	M13.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	LEAD	2 / 15	13%	0.38 J	0.62	0.85 J	0.05	1	µg/L	MXR	66.7	0.01	No	BSL	0.01	No	BSL	66.7	0.01	No	BSL	0.01	No	BSL
	LITHIUM	0 / 8	0%	ND	ND	ND	100	100	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	MAGNESIUM	15 / 15	100%	2880 J	9244	17500	5000	5000	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MANGANESE	13 / 15	87%	1	20.10	175 J	15	15	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MERCURY	1 / 15	7%	0.044 J	0.04	0.044 J	0.2	0.2	µg/L	MXR	2.4	0.02	No	BSL	0.02	No	BSL	1.4	0.03	No	BSL	0.03	No	BSL
	MOLYBDENUM	0 / 8	0%	ND	ND	ND	0.46	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	NICKEL	11 / 15	73%	0.42 J	2.66	10.8	0.74	1	µg/L	MXR	480.0	0.02	No	BSL	0.01	No	BSL	480.0	0.02	No	BSL	0.01	No	BSL
	POTASSIUM	7 / 15	47%	320 J	423.55	640 J	5000	5000	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SELENIUM	0 / 15	0%	NS	ND	ND	5	5	µg/L	--	260.0	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SILVER	0 / 14	0%	ND	ND	ND	0.024	0.1	µg/L	--	3.4	ND	ND	ND	ND	ND	ND	3.4	ND	ND	ND	ND	ND	ND
	SODIUM	15 / 15	100%	1270 J	7268	18000	5000	5000	µg/L	M13.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SULFATE	15 / 15	100%	8.74	66.85	210	0.3	38	mg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	THALLIUM	0 / 15	0%	ND	ND	ND	1	25	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	THORIUM	0 / 8	0%	ND	ND	ND	1	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	URANIUM	0 / 8	0%	ND	ND	ND	1	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	VANADIUM	1 / 14	7%	6.6 J	6.60	6.6 J	2	50	µg/L	MXR	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	ZINC	15 / 15	100%	10.7	504.03	3260	2	60	µg/L	MXR	120.0	27.2	Yes	ASL	4.2	Yes	ASL	120.1	27.1	Yes	ASL	4.2	Yes	ASL
MIDDLE CREEK REFERENCE (2)	ALUMINUM	0 / 1	0%	ND	ND	ND	200	200	µg/L	--	NV	ND	ND	ND	ND	ND	ND	750.0	ND	ND	ND	ND	ND	ND
	ANTIMONY	0 / 1	0%	ND	ND	ND	60	60	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ARSENIC	0 / 1	0%	ND	ND	ND	10	10	µg/L	--	NV	ND	ND	ND	ND	ND	ND	340.0	ND	ND	ND	ND	ND	ND
	BARIUM	0 / 1	0%	ND	ND	ND	200	200	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	BERYLLIUM	0 / 1	0%	ND	ND	ND	5	5	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	CADMIUM	0 / 1	0%	ND	ND	ND	0.5	0.5	µg/L	--	3.9	ND	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	ND	ND
	CALCIUM	1 / 1	100%	12300	12300	12300	5000	5000	µg/L	MREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	CHLORIDE	1 / 1	100%	1.59	1.59	1.59	0.6	0.6	mg/L	MREF	860.0	0.002	No	BSL	0.002	No	BSL	860.0	0.002	No	BSL	0.002	No	BSL
	CHROMIUM	0 / 1	0%	ND	ND	ND	10	10	µg/L	--	584.0	ND	ND	ND	ND	ND	ND	584.0	ND	ND	ND	ND	ND	ND
	COBALT	0 / 1	0%	ND	ND	ND	50	50	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	COPPER	1 / 1	100%	0.53 J	0.53	0.53 J	2	2	µg/L	MREF	18.0	0.03	No	BSL	0.03	No	BSL	13.8	0.04	No	BSL	0.04	No	BSL
	FLUORIDE	1 / 1	100%	0.0467	0.05	0.0467	0.04	0.04	mg/L	MREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	IRON	0 / 1	0%	ND	ND	ND	100	100	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	LEAD	0 / 1	0%	ND	ND	ND	1	1	µg/L	--	66.7	ND	ND	ND	ND	ND	ND	66.7	ND	ND	ND	ND	ND	ND
	MAGNESIUM	1 / 1	100%	4930 J	4930	4930 J	5000	5000	µg/L	MREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MANGANESE	0 / 1	0%	ND	ND	ND	15	15	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	MERCURY	0 / 1	0%	ND	ND	ND	0.2	0.2	µg/L	--	2.4	ND	ND	ND	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND
	NICKEL	0 / 1	0%	ND	ND	ND	1	1	µg/L	--	480.0	ND	ND	ND	ND	ND	ND	480.0	ND	ND	ND	ND	ND	ND
	POTASSIUM	0 / 1	0%	ND	ND	ND	5000	5000	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SELENIUM	0 / 1	0%	ND	ND	ND	5	5	µg/L	--	260.0	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SILVER	0 / 1	0%	ND	ND	ND	0.1	0.1	µg/L	--	3.4	ND	ND	ND	ND	ND	ND	3.4	ND	ND	ND	ND	ND	ND
	SODIUM	0 / 1	0%	ND	ND	ND	5000	5000	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SULFATE	1 / 1	100%	3.18	3.18	3.18	0.3	0.3	mg/L	MREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	THALLIUM	0 / 1	0%	ND	ND	ND	25	25	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	VANADIUM	0 / 1	0%	ND	ND	ND	50	50	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ZINC	1 / 1	100%	3.1	3.10	3.1	2	2	µg/L	MREF	120.0	0.026	No	BSL	0.026	No	BSL	120.1	0.026	No	BSL	0.026	No	BSL
SOUTH FORK MIDDLE CREEEK (3)	ALUMINUM	3 / 10	30%	12.3 J	14.37	18.3 J	16	200	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	750.0	0.02	No	BSL	0.02	No	BSL
	ANTIMONY	0 / 10	0%	ND	ND	ND	2	60	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ARSENIC	1 / 10	10%	0.73 J	0.73	0.73 J	0.11	10	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	340.0	0.002	No	BSL	0.002	No	BSL
	BARIUM	4 / 10	40%	5.6 J	6.55	7.4 J	10	200	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	BERYLLIUM	0 / 10	0%	ND	ND	ND	1	5	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	BORON	1 / 5	20%	2.5 J	2.50	2.5 J	100	100	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	CADMIUM	8 / 10	80%	1	3.61	7.6	0.5	0.5	µg/L	SF1.0	3.9	1.9	Yes	ASL	0.9	No	BSL	1.5	5.0	Yes	ASL	2.4	Yes	ASL
	CALCIUM	10 / 10	100%	16900	20270	27700	5000	5000	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL

Appendix C Table C-1 Statistical Summary for Surface Water Analytical Dissolved Results and Selection of Chemicals of Concern Based on Acute Criteria

		Statistical Summary									COPC Screening Based on ODEQ CMC							COPC Screening Based on National CMC						
												Maximum Detected Conc.			Average Detected Conc.				Maximum Detected Conc.			Average Detected Conc.		
Exposure Area	Chemical	Number of Detects / Samples	FOD	Minimum Detected Conc.	Average Detected Conc.	Maximum Detected Conc.	Minimum Reporting Limit	Maximum Reporting Limit	Units	Location of Maximum Detection	ODEQ CMC Screening Level	HQ (Max Detect)	COPC (Based on Max Detect)?	Rationale	HQ (Avg Detected Conc)	COPC (Based on Avg Detect)?	Rationale	National CMC Screening Level	HQ (Max Detect)	COPC (Based on Max Detect)?	Rationale	HQ (Average Detected Conc.)	COPC (Based on Avg. Detect)?	Rationale
SOUTH FORK	CHLORIDE	10 / 10	100%	1.31	1.57	1.97	0.06	0.6	mg/L	SF1.0	860.0	0.002	No	BSL	0.002	No	BSL	860.0	0.002	No	BSL	0.002	No	BSL
MIDDLE CREEEK	CHROMIUM	0 / 10	0%	ND	ND	ND	0.17	10	µg/L	--	448.0	ND	ND	ND	ND	ND	ND	448.0	ND	ND	ND	ND	ND	ND
(cont.)	COBALT	4 / 10	40%	0.12 J	0.81	1.7	1	50	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	COPPER	10 / 10	100%	3.4	57.85	285	2	200	µg/L	SF1.0	18.0	15.8	Yes	ASL	3.2	Yes	ASL	10.2	28.0	Yes	ASL	5.7	Yes	ASL
	FLUORIDE	10 / 10	100%	0.0528	0.07	0.0988	0.04	0.4	mg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	IRON	2 / 10	20%	36.8 J	78.40	120	28.7	100	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	LEAD	1 / 10	10%	0.07 J	0.07	0.07 J	1	1	µg/L	SF1.0	46.8	0.001	No	BSL	0.001	No	BSL	46.8	0.001	No	BSL	0.001	No	BSL
	LITHIUM	0 / 5	0%	ND	ND	ND	3.5	100	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	MAGNESIUM	10 / 10	100%	4270 J	5533.75	8760	5000	5000	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MANGANESE	9 / 10	90%	5.6 J	51.39	281 J	1	100	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MERCURY	1 / 10	10%	0.036 J	0.04	0.036 J	0.2	0.2	µg/L	SF1.0	2.4	0.02	No	BSL	0.02	No	BSL	1.4	0.03	No	BSL	0.03	No	BSL
	MOLYBDENUM	1 / 5	20%	0.34 J	0.34	0.34 J	1	1	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	NICKEL	9 / 10	90%	0.6 J	2.33	8.1	1	1	µg/L	SF1.0	365.0	0.0	No	BSL	0.01	No	BSL	365.0	0.02	No	BSL	0.01	No	BSL
	POTASSIUM	2 / 10	20%	110 J	204.50	299 J	309	5000	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SELENIUM	1 / 10	10%	0.63 J	0.63	0.63 J	5	5	µg/L	SF1.0	260.0	0.002	No	BSL	0.002	No	BSL	NV	NV	NV	No ESL	NV	NV	No ESL
	SILVER	1 / 10	10%	0.0067 J	0.007	0.0067 J	0.1	0.1	µg/L	SF1.0	1.9	0.003	No	BSL	0.003	No	BSL	1.9	0.003	No	BSL	0.003	No	BSL
	SODIUM	6 / 10	60%	3730 J	4872	5760	5000	5000	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SULFATE	10 / 10	100%	26.4	42.84	75.3	0.3	380	mg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	THALLIUM	0 / 10	0%	ND	ND	ND	0.042	25	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	THORIUM	0 / 5	0%	ND	ND	ND	1	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	URANIUM	0 / 5	0%	ND	ND	ND	1	1	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	VANADIUM	1 / 10	10%	8.5	8.50	8.5	2.5	50	µg/L	SF1.0	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	ZINC	10 / 10	100%	58.8	579.53	2120	2	240	µg/L	SF1.0	91.0	23	Yes	ASL	6.4	Yes	ASL	91.3	23.2	Yes	ASL	6.3	Yes	ASL
SOUTH FORK MIDDLE																								
CREEEK	ALUMINUM	0 / 2	0%	ND	ND	ND	200	200	µg/L	--	NV	ND	ND	ND	ND	ND	ND	750.0	ND	ND	ND	ND	ND	ND
REFERENCE (4)	ANTIMONY	0 / 2	0%	ND	ND	ND	60	60	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ARSENIC	0 / 2	0%	ND	ND	ND	10	10	µg/L	--	NV	ND	ND	ND	ND	ND	ND	340.0	ND	ND	ND	ND	ND	ND
	BARIUM	0 / 2	0%	ND	ND	ND	200	200	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	BERYLLIUM	0 / 2	0%	ND	ND	ND	5	5	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	CADMIUM	0 / 2	0%	ND	ND	ND	0.5	0.5	µg/L	--	3.9	ND	ND	ND	ND	ND	ND	1.5	ND	ND	ND	ND	ND	ND
	CALCIUM	2 / 2	100%	14200	16250	18300	5000	5000	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	CHLORIDE	2 / 2	100%	1.4	1.48	1.55	0.6	0.6	mg/L	SFREF	860.0	0.002	No	BSL	0.002	No	BSL	860.0	0.002	No	BSL	0.002	No	BSL
	CHROMIUM	0 / 2	0%	ND	ND	ND	10	10	µg/L	--	448.0	ND	ND	ND	ND	ND	ND	448.0	ND	ND	ND	ND	ND	ND
	COBALT	0 / 2	0%	ND	ND	ND	50	50	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	COPPER	1 / 2	50%	0.83 J	0.83	0.83 J	2	2	µg/L	SFREF	18.0	0.05	No	BSL	0.05	No	BSL	10.2	0.1	No	BSL	0.1	No	BSL
	FLUORIDE	2 / 2	100%	0.0455	0.05	0.0605	0.04	0.04	mg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	IRON	2 / 2	100%	68 J	179.50	291	100	100	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	LEAD	0 / 2	0%	ND	ND	ND	1	1	µg/L	--	46.8	ND	ND	ND	ND	ND	ND	46.8	ND	ND	ND	ND	ND	ND
	MAGNESIUM	2 / 2	100%	2780 J	2815	2850 J	5000	5000	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MANGANESE	2 / 2	100%	23 J	24	24.8	1	1	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	MERCURY	0 / 2	0%	ND	ND	ND	0.2	0.2	µg/L	--	2.4	ND	ND	ND	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND
	NICKEL	0 / 2	0%	ND	ND	ND	1	1	µg/L	--	365.0	ND	ND	ND	ND	ND	ND	365.0	ND	ND	ND	ND	ND	ND
	POTASSIUM	0 / 2	0%	ND	ND	ND	5000	5000	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SELENIUM	0 / 2	0%	ND	ND	ND	5	5	µg/L	--	260.0	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	SILVER	0 / 2	0%	ND	ND	ND	0.1	0.1	µg/L	--	1.9	ND	ND	ND	ND	ND	ND	1.9	ND	ND	ND	ND	ND	ND
	SODIUM	1 / 2	50%	4780 J	4780	4780 J	5000	5000	µg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	SULFATE	2 / 2	100%	22.6	29.0	35.4	3	3	mg/L	SFREF	NV	NV	NV	No ESL	NV	NV	No ESL	NV	NV	NV	No ESL	NV	NV	No ESL
	THALLIUM	0 / 2	0%	ND	ND	ND	25	25	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	VANADIUM	0 / 2	0%	ND	ND	ND	50	50	µg/L	--	NV	ND	ND	ND	ND	ND	ND	NV	ND	ND	ND	ND	ND	ND
	ZINC	2 / 2	100%	1.9 J	3.4	4.8	2	2	µg/L	SFREF	91.0	0.05	No	BSL	0.04	No	BSL	91.3	0.05	No	BSL	0.04	No	BSL

Notes:
CMC = Criterion Maximum Concentration
COPC = Chemical of Concern
ESL = Ecological Screening Level
FOD = Frequency of Detection
J = value qualified by laboratory or data validator as estimated
ND = Not Detected
NV = No Value
ODEQ = Oregon Department of Environmental Quality
-- Not applicable
µg/L = micrograms per liter
mg/L = milligrams per liter

(1) Locations included in the Middle Creek dataset are: MXR, M3.0, M7.9, M13.0.
(2) Locations included in the Middle Creek Reference dataset are: MREF
(3) Locations included in the South Fork Middle Creek dataset are: SF1.0, SF3.0
(4) Locations included in the South Fork Middle Creek Reference dataset are: SFREF

Appendix C Table C-2 Summary of Chemicals of Potential Concern Based on Acute Effects [1]

Metals/Metalloids	Middle Creek		South Fork Middle Creek	
	COPC Based on:		COPC Based on:	
	ODEQ CMC	National CMC	ODEQ CMC	National CMC
ALUMINUM	NV	No	NV	No
ANTIMONY	ND	ND	ND	ND
ARSENIC	NV	No	NV	No
BARIUM	NV	NV	NV	NV
BERYLLIUM	ND	ND	ND	ND
BORON	ND	ND	NV	NV
CADMIUM	No	Yes	No	Yes
CALCIUM	NV	NV	NV	NV
CHLORIDE	No	No	No	No
CHROMIUM	No	No	ND	ND
COBALT	NV	NV	NV	NV
COPPER	Yes	Yes	Yes	Yes
FLUORIDE	NV	NV	NV	NV
IRON	NV	NV	NV	No
LEAD	No	No	No	No
LITHIUM	ND	ND	ND	ND
MAGNESIUM	NV	NV	NV	NV
MANGANESE	NV	NV	NV	NV
MERCURY	No	No	No	No
MOLYBDENUM	ND	ND	NV	NV
NICKEL	No	No	No	No
POTASSIUM	NV	NV	NV	NV
SELENIUM	ND	ND	No	No
SILVER	ND	ND	No	NV
SODIUM	NV	NV	NV	NV
SULFATE	NV	NV	NV	NV
THALLIUM	ND	ND	ND	ND
THORIUM	ND	ND	ND	ND
URANIUM	ND	ND	ND	ND
VANADIUM	NV	NV	NV	NV
ZINC	Yes	Yes	Yes	Yes

Notes:

CMC = Criterion Maximum Concentration

COPC = Chemical of Potential Concern

ND = Not Detected

NV = No Value

ODEQ = Oregon Department of Environmental Quality

Yes = chemical is selected as a COPC

No = chemical is not selected as COPC

[1] Based on comparison of average detected concentrations in each stream to acute criterion

Appendix C Table C-3 Summary of Aquatic Life Screening Criteria

Metals/Metalloids	Units	Hardness Dependent Adjusted Criteria			
		MIDDLE CREEK		SOUTH FORK MIDDLE CREEK	
		ODEQ CCC CCC (ug/L)	NATIONAL CRITERIA CCC CCC (ug/L)	ODEQ CCC CCC (ug/L)	NATIONAL CRITERIA CCC CCC (ug/L)
ALUMINUM	µg/L	NV	NV	NV	NV
ANTIMONY	µg/L	NV	NV	NV	NV
ARSENIC	µg/L	190	150	190	150
BARIUM	µg/L	NV	NV	NV	NV
BERYLLIUM	µg/L	NV	NV	NV	NV
BORON	µg/L	NV	NV	NV	NV
CADMIUM	µg/L	0.25	0.25	0.20	0.20
CALCIUM	µg/L	NV	NV	NV	NV
CHROMIUM	µg/L	75.90	75.90	58.22	58.22
COBALT	µg/L	NV	NV	NV	NV
COPPER	µg/L	12.00	9.18	12.00	6.96
IRON	µg/L	1000	1000	1000	1000
LEAD	µg/L	2.60	2.60	1.82	1.82
LITHIUM	µg/L	NV	NV	NV	NV
MAGNESIUM	µg/L	NV	NV	NV	NV
MANGANESE	µg/L	NV	NV	NV	NV
MERCURY	µg/L	0.012	0.77	0.012	0.77
MOLYBDENUM	µg/L	NV	NV	NV	NV
NICKEL	µg/L	53.30	53.30	40.53	40.53
POTASSIUM	µg/L	NV	NV	NV	NV
SELENIUM	µg/L	35.00	5.00	35.00	5.00
SILVER	µg/L	0.10	NV	0.10	NV
SODIUM	µg/L	NV	NV	NV	NV
THALLIUM	µg/L	NV	NV	NV	NV
THORIUM	µg/L	NV	NV	NV	NV
URANIUM	µg/L	NV	NV	NV	NV
VANADIUM	µg/L	NV	NV	NV	NV
ZINC	µg/L	121.09	121.09	92.03	92.03
Other					
Alkalinity	mg/L (as CaCO3)	20.00	20.00	20.00	20.00
Ammonia as N	mg/L	5.70	5.70	5.70	5.70
CHLORIDE	mg/L	230.00	230.00	230.00	230.00
FLUORIDE	mg/L	NV	NV	NV	NV
SULFATE	mg/L	NV	NV	NV	NV
TDS	mg/L	NV	NV	NV	NV
TSS	mg/L	NV	NV	NV	NV
pH	S.U.	NV	6.5 - 9	NV	6.5 - 9

Notes:
N = Nitrogen
NV = No Value
CCC = Criterion Continuous Concentration
ODEQ = Oregon Department of Environmental Quality
S.U. = Standard Units
TDS = Total dissolved Solids
TSS = Total Suspended Solids
µg/L = micrograms per liter
mg/L = milligrams per liter

Appendix C Table C-4 Summary of Acute Aquatic Life Screening Criteria

Metals/Metalloids	Units	Hardness Dependent Adjusted Criteria			
		MIDDLE CREEK		SOUTH FORK MIDDLE CREEK	
		ODEQ CMC CMC (ug/L)	NATIONAL CRITERIA CMC CMC (ug/L)	ODEQ CMC CMC (ug/L)	NATIONAL CRITERIA CMC CMC (ug/L)
ALUMINUM	µg/L	NV	750	NV	750
ANTIMONY	µg/L	NV	NV	NV	NV
ARSENIC	µg/L	NV	340	NV	340
BARIUM	µg/L	NV	NV	NV	NV
BERYLLIUM	µg/L	NV	NV	NV	NV
BORON	µg/L	NV	NV	NV	NV
CADMIUM	µg/L	3.90	2.07	3.90	1.51
CALCIUM	µg/L	NV	NV	NV	NV
CHROMIUM	µg/L	584	584	448	448
COBALT	µg/L	NV	NV	NV	NV
COPPER	µg/L	18.00	13.81	18.00	10.18
IRON	µg/L	NV	NV	NV	NV
LEAD	µg/L	66.7	66.7	46.8	46.8
LITHIUM	µg/L	NV	NV	NV	NV
MAGNESIUM	µg/L	NV	NV	NV	NV
MANGANESE	µg/L	NV	NV	NV	NV
MERCURY	µg/L	2.40	1.40	2.40	1.40
MOLYBDENUM	µg/L	NV	NV	NV	NV
NICKEL	µg/L	480	480	365	365
POTASSIUM	µg/L	NV	NV	NV	NV
SELENIUM	µg/L	260	NV	260	NV
SILVER	µg/L	3.38	3.38	1.94	1.94
SODIUM	µg/L	NV	NV	NV	NV
THALLIUM	µg/L	NV	NV	NV	NV
THORIUM	µg/L	NV	NV	NV	NV
URANIUM	µg/L	NV	NV	NV	NV
VANADIUM	µg/L	NV	NV	NV	NV
ZINC	µg/L	120	120.1	91	91
Other					
Alkalinity	mg/L (as CaCO3)	NV	NV	NV	NV
Ammonia as N	mg/L	NC	NC	NC	NC
CHLORIDE	mg/L	860	860	860	860
FLUORIDE	mg/L	NV	NV	NV	NV
SULFATE	mg/L	NV	NV	NV	NV
pH	S.U.	NV	NV	NV	NV

Notes:
N = Nitrogen
NC = Not calculated because criteria is life stage dependent
NV = No Value
CMC = Criterion Maximum Concentration
ODEQ = Oregon Department of Environmental Quality
S.U. = Standard Units
TDS = Total dissolved Solids
TSS = Total Suspended Solids
µg/L = micrograms per liter
mg/L = milligrams per liter

Appendix D

Benthic Macroinvertebrate Data from the BLM/USU National Aquatic Monitoring Center

CDM Smith

BLM/USU National Aquatic Monitoring Center (NAMC)
Department of Watershed Sciences (WATS) - Utah State University 5210 Old Main Hill Logan, UT 84322-5210
http://www.usu.edu/buglab/

Report prepared by:
Scott Miller: 435.797.2612 / scott.miller@usu.edu
Sarah Judson: 435.797.3310 / sarah.judson@usu.edu

Report prepared for:

Customer contact:	Cory Sipher
Customer:	BLM - OR - Roseburg District Office
Customer Address :	777 Nw Garden Valley Blvd
Customer City, State, Zip:	Roseburg, OR 97470
Customer Phone:	541-464-3249
Customer Email:	csipher@blm.gov

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Metadata
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Metrics
Species Matrix (Raw)
Species Matrix (Standardized)

Excel Worksheet Name	Worksheet Description
Metrics	Common metrics used to assess freshwater biological integrity, as well as basic field and lab processing information. Note that values for richness based metrics are standardized to operational taxonomic units (OTUs; sensu Cuffney et al. 2007) and a fixed count (i.e., rarefaction) of 300, but density metrics are based on the raw taxa list. Standardized metrics are indicated with an asterisk. NAMC OTU standardization uses the method of removing individuals identified to the coarser taxonomic resolution or merging finer level identifications to coarser levels. We are able to standardize your data to custom OTUs and/or fixed counts if provided, although additional charges may apply. A more detailed explanation of each metric, as well as references, can be obtained by contacting NAMC and will soon be available on our website. **This report was generated with the following settings - OTUs: Genus (Predator WCCP conversion); Fixed Count: 300**
Species Matrix (Raw)	Raw taxonomic and abundance data for sampled sites. Abundance data is the estimated number of individuals per square meter for quantitative samples OR the estimated number of individuals per sample for qualitative samples. Note that the taxonomic data in this worksheet **has not been standardized to operational taxonomic units (OTUs)**, thus considerable redundancy likely exists in the taxonomic hierarchy.
Species Matrix (Standardized)	Taxonomic and abundance data (Species matrix) for sampled sites that has been standardized to Operational Taxonomic Units (OTUs) but not standardized to fixed count. Please note that data has not been standardized to a fixed count as in the 'Standardized Metrics worksheet'. Also, abundance data is the estimated number per square meter for quantitative samples OR is the estimated number per sample for qualitative samples.
OE Output	See details in OE Metdata sheet.

Description of the fields contained in the 'Metrics' worksheet. A more detailed explanation of each metric can be obtained by contacting NAMC and will soon be available on our website.

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Collection information	SampleID	NAMC unique tracking number	NA	NA	NA	NA
	Station (NAMC)	NAMC station tracking id	NA	NA	NA	NA
	Station (Customer)	Station abbreviation provided by the customer	NA	NA	NA	NA
	Waterbody	Specific location name	NA	NA	NA	NA
	County	Administrative boundary	NA	NA	NA	NA
	State	Administrative boundary	NA	NA	NA	NA
	Latitude	Y coordinate in decimal degree units	NA	NA	NA	NA
	Longitude	X coordinate in decimal degree units	NA	NA	NA	NA
	Collection Date	Date of sampling event	NA	NA	NA	NA
	Habitat Sampled	Microhabitat or channel unit(s) where sample(s) was taken. Values are restricted to predetermined values as specified in the PDF metadata.	NA	NA	NA	NA
	Collection Method	Method used to collect sample. Values are restricted to predetermined values as specified in the PDF metadata.	NA	NA	NA	NA
	Field Notes	Field notes provided by customer	NA	NA	NA	NA
	Lab Notes	Laboratory processing notes, particularly regarding condition of received samples and QAQC	NA	NA	NA	NA
	Area Sampled	Total area sampled in square meters	NA	NA	NA	NA

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Laboratory Processing	Field Split	% sample submitted for processing	NA	NA	NA	NA
	Lab Split	% of sample processed to obtain 600 random individuals (if present)	NA	NA	NA	Cuffney et al. (1993), Moulton et al. (2000), Vinson and Hawkins (1996)
	Split Count	# of organisms randomly subsampled from [Lab Split] for identification	NA	NA	NA	"
	Fixed count	# of computationally resampled organisms	NA	NA		"
	Big Rare Count	# of "big and rare" organisms selected NON-RANDOMLY for identification from the entire submitted sample	NA	NA	NA	"
Richness (metrics summarizing all unique taxa in a sample)	Richness	# of unique taxa, standardized to OTU	Decrease	$[\text{Richness}]_{\text{UniqueTaxa}}$	Y	NA
	Abundance	Estimated # number of individuals per unit area (m^2) for quantitative samples OR the estimated number per sample for qualitative samples.	Increase or decrease	(([Split Count]* (100/[Lab Split])) + [Big_Rare Count]) *(100/[Field Split]) *(1/[Area Sampled])	N	NA
	Shannon's Diversity	Measure of richness and evenness (based on relative abundance of each species); weighted toward rare species	Decrease	$-\sum([\text{Relative Abundance}]_{\text{taxa}} * \ln([\text{Relative Abundance}]_{\text{taxa}})$	Y	Ludwig and Reynolds (1988, equation 8.9, page 92)
	Simpson's Diversity	Measure of richness and evenness (based on relative abundance of each species); weighted toward common species	Decrease	$1 - [\text{Simpson's Diversity}] = 1 \sum([\text{Relative Abundance}]_{\text{taxa}})^2$	Y	Ludwig and Reynolds (1988, equation 8.6, page 91), Krebs (1999, equation 12.27 12.30)
	Evenness	Measure of relative abundance indicative of taxa dominance	Decrease	[Shannon's Diversity]/ln([Richness])	Y	Ludwig and Reynolds (1988, equation 8.11, page 93)
	# of EPT Taxa	Richness of Ephemeroptera, Plecoptera, and Trichoptera taxa	Decrease	$[\text{Richness}]_E + [\text{Richness}]_P + [\text{Richness}]_T$	Y	Barbour et al. (1999), Karr and Chu (1998)
	EPT Taxa Abundance	Abundance of Ephemeroptera, Plecoptera, and Trichoptera taxa	Decrease	$[\text{Abundance}]_E + [\text{Abundance}]_P + [\text{Abundance}]_T$	N	"
Dominance Metrics (metrics summarizing all most abundant taxa in a sample)	Dominant Family	Taxonomic family with the highest abundance	NA	NA	N	NA
	Abundance of Dominant Family	Abundance of dominant family	Increase	$[\text{Abundance}]_{\text{dominant family}}$	N	NA
	Dominant Taxa	Individual taxa with the highest abundance	NA	NA	N	NA
	Abundance of Dominant Taxa	Abundance of dominant taxa	Increase	$[\text{Abundance}]_{\text{dominant taxa}}$	N	NA
Tolerance Indices (indices based on the indicator species concept in which taxa are assigned tolerance values)	Hilsenhoff Biotic Index	Abundance-weighted average of family-level pollution tolerances	Increase	$\sum([\text{Abundance}]_{\text{taxa}} * [\text{Tolerance}]_{\text{taxa}}) / [\text{Abundance}]_{\text{Total}}$	Y	Hilsenhoff (1987, 1988)
	# of Intolerant Taxa	# of taxa with an HBI score <= 2	Decrease	$[\text{Richness}]_{\text{intolerant}}$	Y	"
	Intolerant Taxa abundance	Abundance of taxa with an HBI score <= 2	Decrease	$[\text{Abundance}]_{\text{intolerant}}$	N	"
	# of Tolerant Taxa	# of taxa with an HBI score>=8	Increase	$[\text{Richness}]_{\text{tolerant}}$	Y	"
	Tolerant Taxa abundance	Abundance of taxa with an HBI score >=8	Increase	$[\text{Abundance}]_{\text{tolerant}}$	N	"
	USFS Community Tolerance Quotient (d)	Dominance weighted community tolerance quotient	Decrease	$\sum([\text{Tolerance Quotient}] * \log([\text{Abundance}]_{\text{taxa}})) / \sum \log([\text{Abundance}]_{\text{taxa}})$	Y	Winget and Mangum (1979)

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Functional Feeding Groups (classification of organisms based on morphological or behavioral adaptations for where and how food is acquired)	# of shredder taxa	# of taxa utilizing living or decomposing vascular plant tissue and CPOM	Decrease	$[Richness]_{shredder}$	Y	Merritt et. al (2008)
	Shredder Abundance	Abundance of taxa utilizing vascular plant tissue and CPOM	Decrease	$[Abundance]_{shredder}$	N	"
	# of scraper taxa	# of taxa utilizing periphyton, particularly algae and diatoms	Decrease	$[Richness]_{scraper}$	Y	"
	Scraper abundance	Abundance of taxa utilizing periphyton, particularly algae and diatoms	Decrease	$[Abundance]_{scraper}$	N	"
	# of collector-filterer taxa	# of taxa utilizing FPOM in the water column	Variable	$[Richness]_{collector\text{-}filterer}$	Y	"
	Collector-filterer abundance	Abundance of taxa utilizing FPOM in the water column	Variable	$[Abundance]_{collector\text{-}filterer}$	N	"
	# of collector-gatherer taxa	# of taxa utilizing FPOM from benthic deposits	Variable	$[Richness]_{collector\text{-}gatherer}$	Y	"
	Collector-gatherer abundance	Abundance of taxa utilizing FPOM from benthic deposits	Variable	$[Abundance]_{collector\text{-}gatherer}$	N	"
	# of predator taxa	# of taxa utilizing living animal tissue	Decrease	$[Richness]_{predator}$	Y	"
	Predator abundance	Abundance of taxa utilizing living animal tissue	Decrease	$[Abundance]_{predator}$	N	"
Functional Traits (metrics based on morphological and life history traits)	# of clinger taxa	# of taxa with fixed retreats or other strategies for clinging to rocks	Decrease	$[Richness]_{clinger}$	Y	Karr and Chu (1998), Merritt et al. (2008)
	"# of" Long-lived Taxa	# of taxa with 2 to 3 year life cycles	Decrease	$[Richness]_{long\text{-}lived}$	Y	"
Compositional Metrics (richness and abundance of various taxonomic groups)	# of Ephemeroptera taxa		Decrease	$[Richness]_{Ephemeroptera}$	Y	NA
	Ephemeroptera abundance		Decrease	$[Abundance]_{Ephemeroptera}$	N	NA
	# of Plecoptera taxa		Decrease	$[Richness]_{Plecoptera}$	Y	NA
	Plecoptera abundance		Decrease	$[Abundance]_{Plecoptera}$	N	NA
	# of Trichoptera taxa		Decrease	$[Richness]_{Trichoptera}$	Y	NA
	Trichoptera abundance		Decrease	$[Abundance]_{Trichoptera}$	N	NA
	# of Coleoptera taxa		Variable	$[Richness]_{Coleoptera}$	Y	NA
	Coleoptera abundance		Variable	$[Abundance]_{Coleoptera}$	N	NA
	# of Elmidae taxa		Decrease	$[Richness]_{Elmidae}$	Y	NA
	Elmidae abundance		Decrease	$[Abundance]_{Elmidae}$	N	NA
	# of Megaloptera taxa		Variable	$[Richness]_{Megaloptera}$	Y	NA
	Megaloptera abundance		Variable	$[Abundance]_{Megaloptera}$	N	NA
	# of Diptera taxa		Variable	$[Richness]_{Diptera}$	Y	NA
	Diptera abundance		Variable	$[Abundance]_{Diptera}$	N	NA
	# of Chironomidae taxa		Increase	$[Richness]_{Chironomidae}$	Y	NA
	Chironomidae abundance		Increase	$[Abundance]_{Chironomidae}$	N	NA
	# of Crustacea taxa		Variable	$[Richness]_{Crustacea}$	Y	NA
	Crustacea abundance		Variable	$[Abundance]_{Crustacea}$	N	NA
	# of Oligochaete taxa		Increase	$[Richness]_{Oligochaeta}$	Y	NA
	Oligochaete abundance		Increase	$[Abundance]_{Oligochaeta}$	N	NA
	# of Mollusca taxa		Variable	$[Richness]_{Mollusca}$	Y	NA
	Mollusca abundance		Variable	$[Abundance]_{Mollusca}$	N	NA
	# of Insect taxa		Decrease	$[Richness]_{Insect}$	Y	NA
	Insect abundance		Decrease	$[Abundance]_{Insect}$	N	NA
	# of non-insect taxa		Increase	$[Richness]_{Non\text{-}insect}$	Y	NA
	Non-insect abundance		Increase	$[Abundance]_{Non\text{-}insect}$	N	NA

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*Standardized to OTU and fixed count, see Metadata for details

SampleID	Station (NAMC)	Station (Customer)	Waterbody	County	State	Latitude
148576	M13	M13	Middle Creek	Douglas	OR	42.81234936
148577	M9.8	M9.8	Middle Creek	Douglas	OR	42.82859498
148578	MDLCKBK-01	M7.9	Middle Creek at Buck Creek, Mile 7.9	Douglas	OR	42.837
148579	M5.5	M5.5	Middle Creek	Douglas	OR	42.84308499
148580	UPMARTIN-01	MARTIN CREEK REF	Upper Martin Creek, Reference site	Douglas	OR	42.83
148581	MDLCK-3.1	M3.1	Midle Creek, Mile 3.1, below confluence	Douglas	OR	42.847
148582	MDLSFMTH-01	SF4.7	Middle Creek, Mouth of South Fork	Douglas	OR	42.846
148583	MDLCK-3	M3.0	Middle Creek, Mile 3 above confluence of South Fork	Douglas	OR	42.847
148584	MREF1	MREF1	Middle Creek Reference (trib)	Douglas	OR	42.85803487
148585	MIDBEN	M1.2	Middle Bench	Douglas	OR	42.85598678
148586	SFREF1	SFREF1	South Fk Middle Creek Ref (Trib)	Douglas	OR	42.8316279
148587	SF1.0	SF1.0	South Fork Middle Creek	Douglas	OR	42.83696893
148588	UPSF1.0	SF0.7	South Fork Middle Creek	Douglas	OR	42.8402118
148589	SF3.0	SF3.0	South Fork Middle Creek	Douglas	OR	42.83390533
148590	MIDCRMID	M2.0	Middle Creek	Douglas	OR	42.85347712
148984	BFM1	BFM1	Buck Fork	Douglas	OR	43.14218525
148985	BFM2	BFM2	Buck Fork	Douglas	OR	43.1406343
148986	NMM1	NMM1	North Myrtle Creek	Douglas	OR	43.15726935
148987	NMM2	NMM2	North Myrtle Creek	Douglas	OR	43.13686352
148988	MDLCKBK-01	M7.9	Middle Creek at Buck Creek, Mile 7.9	Douglas	OR	42.837
148989	MDLCK-3.1	M3.1	Midle Creek, Mile 3.1, below confluence	Douglas	OR	42.847
148990	UPMARTIN-01	MARTIN CREEK REF	Upper Martin Creek, Reference site	Douglas	OR	42.83
148991	MDLCK-3	M3.0	Middle Creek, Mile 3 above confluence of South Fork	Douglas	OR	42.847
148992	SFREF1	SFREF1	South Fk Middle Creek Ref (Trib)	Douglas	OR	42.8316279
148993	SF1.0	SF1.0	South Fork Middle Creek	Douglas	OR	42.83696893
148994	SF3.0	SF3.0	South Fork Middle Creek	Douglas	OR	42.83390533
148995	MIDBEN	M1.2	Middle Bench	Douglas	OR	42.85598678
148996	MIDCRMID	M2.0	Middle Creek	Douglas	OR	42.85347712

Longitude	Collection Date	Habitat Sampled	Collection Method	Field Notes	Lab Notes	Area sampled (m^2)	Field Split	Lab Split	Split Count	Fixed Count	Big Rare Count
-123.5958457	6/26/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	25	1096	300	37
-123.5638367	6/26/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	21.88	1182	300	22
-123.505	6/26/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	18.75	956	278	6
-123.476519	6/26/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	37.5	668	300	7
-123.488	6/27/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	15.63	696	300	43
-123.437	6/27/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	15.63	589	300	28
-123.435	6/27/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	18.75	588	300	4
-123.434	6/27/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	75	1104	221	11
-123.403607	6/27/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	50	757	300	16
-123.4047075	6/27/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	100	615	300	0
-123.3727245	6/28/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	31.25	737	300	46
-123.3806736	6/28/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	100	77	56	0
-123.3803875	6/28/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	100	19	10	0
-123.4123943	6/28/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	15.63	714	300	7
-123.4164779	6/28/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	50	1054	300	12
-123.0728725	8/1/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	25	608	300	9
-123.0886228	8/1/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	9.38	690	300	24
-123.1240588	8/1/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	18.75	638	300	13
-123.1248168	8/1/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	6.25	667	300	14
-123.505	9/11/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	12.5	658	300	6
-123.437	9/11/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	15.63	668	300	14
-123.488	9/11/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	25	1037	300	54
-123.434	9/11/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	37.5	610	300	38
-123.3727245	9/12/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	12.5	651	300	6
-123.3806736	9/12/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	59.38	585	300	11
-123.4123943	9/12/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	31.25	634	300	7
-123.4047075	9/12/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	50	577	300	3
-123.4164779	9/12/2012	Targeted Riffle	Surber net	NULL	NULL	0.74	100	31.25	756	300	43

Richness*	Abundance	Shannon's Diversity*	Simpson's Diversity*	Evenness*	# of EPT Taxa*	EPT Taxa Abundance	Dominant Family	Abundance of Dominant Family	Dominant Taxa
21	5974	1.865907513	0.708361204	0.612873628	11	2591	Elmidae	2262	Zaitzevia
25	7330	2.320218418	0.854537347	0.720816379	13	4518	Nemouridae	2020	Nemouridae
26	6898	2.697970614	0.90673454	0.828081852	14	4902	Nemouridae	2184	Nemouridae
27	2417	2.490701466	0.867268673	0.755711392	15	1790	Nemouridae	847	Malenka
30	6076	2.861480708	0.926176143	0.841315686	15	3591	Chironomidae	821	Drunella doddsii
16	5130	1.602806854	0.65819398	0.578090375	7	4318	Baetidae	2343	Baetis
16	4243	1.445892752	0.553690078	0.521495576	9	3616	Baetidae	1989	Baetis
19	2004	2.492723655	0.898313451	0.846586964	11	1672	Baetidae	777	Baetidae
38	2068	3.050065377	0.937703456	0.838486085	20	1454	Chironomidae	232	Yoraperla
12	831	0.99363646	0.445930881	0.399868728	5	597	Baetidae	569	Baetis
36	3249	2.803868288	0.909119287	0.782434344	20	2082	Chironomidae	523	Orthocladiinae
16	104	2.098695004	0.811688312	0.756944219	4	53	Rhyacophilidae	30	Rhyacophila
6	26	1.609437912	0.844444444	0.898244402	1	5	Rhyacophilidae	5	Diptera
12	6183	1.091402004	0.514871795	0.439212477	4	4445	Baetidae	3875	Baetis
18	2865	1.846598553	0.783790412	0.638879254	7	2081	Baetidae	1781	Baetidae
34	3299	2.672814365	0.883076923	0.757952667	19	2499	Baetidae	805	Baetis
32	9973	2.589680339	0.876856187	0.747223797	16	6222	Chironomidae	2767	Chironominae
29	4616	1.917842428	0.683433668	0.569549729	16	3621	Baetidae	2148	Baetis
27	14441	2.458906902	0.865797101	0.746064506	14	9205	Baetidae	3807	Baetis
28	7122	2.560623589	0.884570792	0.768447309	16	3714	Chironomidae	1341	Simuliidae
23	5794	2.293435492	0.862162765	0.731443062	12	4192	Nemouridae	1115	Malenka
36	5678	3.027567938	0.936521739	0.844858919	19	3054	Chironomidae	1027	Chironominae
21	2250	2.243805484	0.84780379	0.736997519	12	1745	Nemouridae	445	Malenka
24	7046	2.213922355	0.849877369	0.696628337	9	4489	Chironomidae	1916	Chironominae
29	1346	2.097799806	0.747736901	0.622992428	12	630	Chironomidae	523	Orthocladiinae
18	2751	1.99842828	0.802474916	0.691408735	10	1480	Chironomidae	778	Orthocladiinae
16	1564	1.440150908	0.604526198	0.519424643	6	1238	Baetidae	895	Baetis
17	3327	1.882608331	0.730613155	0.664478139	10	2382	Baetidae	1662	Baetis

Abundance of Dominant Taxa	Hilsenhoff Biotic Index*	# of Intolerant Taxa*	Intolerant Taxa abundance	# of Tolerant Taxa*	Tolerant Taxa abundance	USFS Community Tolerance Quotient (d)*	# of shredder taxa*	Shredder Abundance	# of scraper taxa*
2246	3.94	7	1750	0	0	75	1	1135	1
1834	3.88	8	2732	1	6	70	3	1930	3
2177	3.014388489	7	2736	0	0	71	2	2256	3
479	3.4	9	1303	0	0	68	4	391	3
666	2.376666667	9	2052	0	9	65	3	687	5
2274	3.28	5	1562	0	0	77	0	269	1
1982	3.85	5	1365	0	0	72	2	987	0
728	3.076923077	7	771	0	0	77	0	357	0
149	2.413333333	11	672	0	0	63	4	335	7
557	4.31	2	15	0	0	84	1	8	0
389	2.61	11	1329	0	0	59	4	623	5
23	1.785714286	3	35	0	0	78	1	3	1
9	0.7	1	5	0	0	58	1	1	1
3771	4.256666667	1	220	0	0	88	0	9	1
1668	4.656666667	3	222	0	0	84	0	35	1
741	3.243333333	11	1292	1	5	60	4	412	3
1931	3.75	10	2769	1	73	62	6	1115	2
2112	3.753333333	10	1095	0	0	58	4	375	2
3266	3.816666667	10	4247	1	151	66	2	868	3
930	4.066666667	12	1627	0	0	66	4	922	3
1012	3.393333333	8	2150	0	0	66	3	285	3
670	3.036666667	14	2285	1	81	64	3	653	6
438	3.513333333	9	791	0	0	60	3	43	1
941	3.783333333	5	2251	0	0	67	2	1416	0
469	4.39	5	135	0	0	73	3	67	2
726	4.563333333	8	413	0	0	66	1	69	1
859	3.65	4	343	0	0	76	2	227	0
1432	4.216666667	6	270	0	0	69	1	125	2

Scraper abundance	# of collector-filterer taxa*	Collector-filterer abundance	# of collector-gatherer taxa*	Collector-gatherer abundance	# of predator taxa*	Predator abundance	# of clinger taxa*	Long-lived Taxa*	# of Ephemeroptera taxa*
41	1	162	5	1349	9	799	5	3	4
95	1	552	7	2368	8	1149	8	5	4
96	2	650	9	2141	6	847	11	5	7
32	2	133	7	667	8	585	10	4	6
1528	1	132	6	2245	10	989	11	8	6
19	2	367	4	2594	6	705	7	3	1
0	2	284	6	2184	5	493	7	1	3
5	3	175	6	810	7	515	7	2	4
232	3	123	8	631	10	374	15	8	8
3	2	5	4	750	4	53	4	2	2
266	4	162	6	825	8	779	17	8	7
0	1	11	2	11	8	61	10	8	1
1	0	0	0	1	4	12	2	3	0
0	3	151	2	5223	5	506	6	2	1
11	4	82	3	2162	8	545	7	4	1
373	3	212	8	1308	11	728	11	7	6
521	3	1949	9	4865	10	1148	12	5	5
334	3	377	9	2834	9	516	11	2	6
1496	3	1582	9	7766	7	2101	10	5	5
443	3	1492	6	2627	9	741	10	5	5
86	2	1618	7	2075	6	554	10	3	5
908	2	288	8	1888	12	1120	15	8	6
141	1	532	6	618	9	366	6	3	4
530	3	1115	7	2750	9	746	10	4	2
14	4	372	7	599	9	258	10	8	3
199	2	803	6	1081	6	361	6	2	2
0	3	66	3	1041	7	176	6	1	1
156	3	609	4	2027	6	334	7	3	3

Ephemeroptera abundance	# of Plecoptera taxa*	Plecoptera abundance	# of Trichoptera taxa*	Trichoptera abundance	# of Coleoptera taxa*	Coleoptera abundance	# of Elmidae Taxa*	Elmidae abundance	# of Megaloptera taxa*
649	6	1724	1	218	1	2262	1	838	0
1643	4	2671	5	204	2	896	2	290	1
1506	3	2981	4	415	3	382	3	144	0
443	5	1236	4	111	2	90	2	47	0
1830	5	1333	4	428	5	339	3	112	0
2352	3	1615	3	351	2	26	1	17	0
1996	3	1364	3	256	0	0	0	0	0
785	3	781	4	107	0	0	0	0	0
424	5	755	7	274	4	118	2	19	0
570	0	0	3	27	2	24	1	5	0
421	6	1129	7	532	5	291	5	138	0
1	1	8	2	43	6	12	5	11	1
0	0	0	1	5	4	7	1	1	0
3875	0	321	3	249	2	35	2	17	0
1781	2	100	4	200	4	22	2	14	0
1081	7	865	6	553	3	108	2	70	0
1779	5	1064	6	3379	2	115	2	58	0
2430	4	723	6	468	1	72	1	7	0
4824	4	1973	5	2408	3	649	3	173	0
1395	8	1723	3	596	2	454	2	205	0
1124	2	1427	5	1641	2	43	2	26	0
1289	7	1281	6	484	4	714	3	249	0
428	4	754	4	563	1	4	0	0	0
1114	4	1819	3	1557	3	346	3	195	0
98	2	31	7	501	5	38	3	14	1
484	5	439	3	556	0	4	0	0	0
897	1	32	4	308	0	3	0	0	0
1826	3	89	4	468	1	30	1	17	0

Megaloptera abundance	# of Diptera taxa*	Diptera abundance	# of Chironomidae taxa*	Chironomidae abundance	# of Crustacea taxa*	Crustacea abundance	# of Oligochaete taxa*	Oligochaete abundance	# of Mollusca taxa*
5	6	889	3	684	0	0	0	11	0
6	7	1385	3	778	0	0	0	9	0
0	6	1124	3	375	0	0	0	0	0
0	8	472	3	285	0	0	0	0	0
0	5	913	3	821	0	0	0	278	1
0	5	510	3	242	0	0	0	0	0
0	6	497	3	274	0	0	0	0	0
0	5	274	3	50	0	0	0	0	0
0	9	318	3	232	0	0	0	8	1
0	4	204	3	193	0	0	0	0	0
0	7	690	2	523	0	0	0	108	1
1	4	23	2	12	0	0	0	0	0
0	1	11	0	0	0	0	0	0	0
0	5	1582	2	1409	0	0	0	0	0
0	6	743	3	555	0	0	0	0	0
0	9	622	3	476	0	0	0	32	0
0	11	3418	3	2767	0	0	0	86	1
0	9	800	3	533	0	0	0	29	0
0	8	4262	3	3116	0	0	0	22	1
0	6	2738	2	1341	0	0	0	0	1
0	7	1490	2	579	0	0	0	0	0
0	9	1270	3	1027	0	0	0	76	1
0	6	472	3	324	0	0	0	0	0
0	11	2177	2	1916	0	0	0	0	0
7	7	626	3	523	0	0	0	5	1
0	7	1250	3	778	0	0	0	0	0
0	9	250	3	182	0	0	0	0	0
0	5	875	3	482	0	0	0	0	0

Mollusca abundance	# of Insect taxa*	Insect abundance	# of Non-insect taxa*	Non-insect abundance
0	18	5747	3	227
0	23	6833	2	497
0	24	6459	2	440
0	26	2377	1	40
617	26	4922	4	1154
0	14	4854	2	277
0	15	4114	1	130
0	17	1952	2	52
59	34	1897	4	170
0	11	827	1	4
35	32	3063	4	186
0	15	91	1	14
0	6	24	0	1
0	11	6062	1	121
0	17	2846	1	19
0	32	3245	2	54
14	29	9757	3	216
7	26	4508	3	108
22	25	14138	2	303
11	25	6938	3	184
0	22	5751	1	43
338	33	5124	3	554
0	20	2232	1	18
11	23	7012	1	34
2	25	1303	4	43
0	18	2747	0	4
0	16	1564	0	0
0	17	3323	0	4

Standard format provided to customers, NOT recommended for database storage. See "RawBugData_Example" for preferrable list format.

								SampleID	148576	148577	148578	148579	148580	148581	148582	148583	148584	148585	148586	148587	148588	148589	148590	148984	148985	148986	148987	148988	148989	148990	148991	148992	148993	148994	148995	148996
								Station (NAMC)	M13	M9.8	MDLCKBK-01	M5.5	UPMARTIN-01	MDLCK-3.1	MDLSFMTH-01	MDLCK-3	MREF1	MIDBEN	SFREF1	SF1.0	UPSF1.0	SF3.0	MIDCRMID	BFM1	BFM2	NMM1	NMM2	MDLCKBK-01	MDLCK-3.1	UPMARTIN-01	MDLCK-3	SFREF1	SF1.0	SF3.0	MIDBEN	MIDCRMID
								Station (Customer)	M13	M9.8	M7.9	M5.5	MARCRREF	M3.1	SF4.7	M3.0	MREF1	MIDBEN	SFREF1	SF1.0	UPSF1.0	SF3.0	MIDCRMID	BFM1	BFM2	NMM1	NMM2	M7.9	M3.1	MARTIN CREEK REF	M3.0	SFREF1	SF1.0	SF3.0	M1.2	M2.0
								Waterbody	Middle Creek	Middle Creek	Middle Creek at Buck Creek, Mile 7.9	Middle Creek	Upper Martin Creek, Reference site	Midle Creek, Mile 3.1, below confluence	Middle Creek, Mouth of South Fork	Middle Creek, Mile 3 above confluence of South Fork	Middle Creek Reference (trib)	Middle Bench	South Fk Middle Creek Ref (Trib)	South Fork Middle Creek	South Fork Middle Creek	South Fork Middle Creek	Middle Creek	Buck Fork	Buck Fork	North Myrtle Creek	North Myrtle Creek	Middle Creek at Buck Creek, Mile 7.9	Midle Creek, Mile 3.1, below confluence	Upper Martin Creek, Reference site	Middle Creek, Mile 3 above confluence of South Fork	South Fk Middle Creek Ref (Trib)	South Fork Middle Creek	South Fork Middle Creek	Middle Bench	Middle Creek
								County	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas
								State	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
								Latitude	42.81234936	42.82859498	42.837	42.84308499	42.83	42.847	42.846	42.847	42.85803487	42.85598678	42.8316279	42.83696893	42.8402118	42.83390533	42.85347712	43.14218525	43.1406343	43.15726935	43.13686352	42.837	42.847	42.83	42.847	42.8316279	42.83696893	42.83390533	42.85598678	42.85347712
								Longitude	-123.5958457	-123.5638367	-123.505	-123.476519	-123.488	-123.437	-123.435	-123.434	-123.403607	-123.4047075	-123.3727245	-123.3806736	-123.3803875	-123.4123943	-123.4164779	-123.0728725	-123.0886228	-123.1240588	-123.1248168	-123.505	-123.437	-123.488	-123.434	-123.3727245	-123.3806736	-123.4123943	-123.4047075	-123.4164779
								Collection Date	6/26/2012	6/26/2012	6/26/2012	6/26/2012	6/27/2012	6/27/2012	6/27/2012	6/27/2012	6/27/2012	6/27/2012	6/28/2012	6/28/2012	6/28/2012	6/28/2012	6/28/2012	8/1/2012	8/1/2012	8/1/2012	8/1/2012	9/11/2012	9/11/2012	9/11/2012	9/11/2012	9/12/2012	9/12/2012	9/12/2012	9/12/2012	9/12/2012
								Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
								Collection Method	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net
								Field Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
								Lab Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
								Area sampled (m^2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
								Field Split	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
								Lab Split	25	21.88	18.75	37.5	15.63	15.63	18.75	75	50	100	31.25	100	100	15.63	50	25	9.38	18.75	6.25	12.5	15.63	25	37.5	12.5	59.38	31.25	50	31.25
								Split Count	1096	1182	956	668	696	589	588	1104	757	615	737	77	19	714	1054	608	690	638	667	658	668	1037	610	651	585	634	577	756
Code	Phylum	Class	Order	Family	SubFamily	Genus	Species																													
19	Annelida	Clitellata							11	9	0	0	278	0	0	0	8	0	108	0	0	0	0	32	86	29	22	0	0	76	0	0	5	0	0	0
58	Arthropoda	Arachnida	Trombidiformes						65	290	231	11	78	52	29	13	22	1	22	11	0	0	14	0	29	0	86	32	0	11	4	0	25	0	0	4
65	Arthropoda	Arachnida	Trombidiformes	Hydryphantidae		Protzia			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	5	0	0	0	0	0	0
2139	Arthropoda	Arachnida	Trombidiformes	Hydryphantidae		Wandesia			0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	Arthropoda	Arachnida	Trombidiformes	Hygrobatidae					0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	Arthropoda	Arachnida	Trombidiformes	Lebertiidae		Lebertia			0	31	0	4	26	0	7	0	0	0	0	0	0	9	0	11	0	0	22	0	0	32	4	0	0	0	0	0
2150	Arthropoda	Arachnida	Trombidiformes	Mideopsidae		Mideopsis			0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0
2154	Arthropoda	Arachnida	Trombidiformes	Oxidae		Oxus			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
66	Arthropoda	Arachnida	Trombidiformes	Sperchonidae					0	0	22	0	0	0	0	9	3	0	0	0	0	9	0	0	0	0	0	32	9	0	0	11	0	0	0	0
67	Arthropoda	Arachnida	Trombidiformes	Sperchonidae		Sperchon			0	6	0	0	0	9	0	0	0	1	9	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
2162	Arthropoda	Arachnida	Trombidiformes	Sperchonidae		Sperchonopsis			0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
54	Arthropoda	Arachnida	Trombidiformes	Torrenticolidae					0	0	130	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2172	Arthropoda	Arachnida	Trombidiformes	Torrenticolidae		Torrenticola			124	148	0	14	121	95	94	0	41	1	4	1	0	104	5	5	43	14	151	54	35	65	7	11	0	0	0	0
94	Arthropoda	Entognatha	Collembola						5	0	0	0	9	0	0	0	0	0	4	1	1	0	0	0	29	0	0	0	0	0	4	0	5	0	0	0
684	Arthropoda	Insecta	Coleoptera	Curculionidae					0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
105	Arthropoda	Insecta	Coleoptera	Dytiscidae					0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	4	0	5	0	0	0
108	Arthropoda	Insecta	Coleoptera	Dytiscidae	Agabinae	Agabus			0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5434	Arthropoda	Insecta	Coleoptera	Dytiscidae	Agabinae	Platambus			0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
118	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporinae	Oreodytes			0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	Arthropoda	Insecta	Coleoptera	Elmidae					16	0	238	40	112	0	0	0	62	0	0	0	0	0	3	0	0	43	130	249	0	5	0	97	5	0	3	0
1743	Arthropoda	Insecta	Coleoptera	Elmidae		Cleptelmis	addenda		0	0	58	0	35	0	0	0	0	0	13	0	0	0	0	0	14	0	0	0	0	5	0	0	0	0	0	0
128	Arthropoda	Insecta	Coleoptera	Elmidae		Heterlimnius			0	0	0	0	0	0	0	0	14	8	78	0	0	0	0	49	72	0	259	0	0	18	0	32	0	0	0	0
129	Arthropoda	Insecta	Coleoptera	Elmidae		Heterlimnius	corpulentus		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
846	Arthropoda	Insecta	Coleoptera	Elmidae		Heterlimnius	koebelei		0	0	0	0	0	0	0	0	5	1	35	0	0	9	3	0	0	0	22	0	0	0	0	0	5	0	0	0
130	Arthropoda	Insecta	Coleoptera	Elmidae		Lara			0	0	0	0	0	0	0	0	0	1	13	0	0	0	0	0	14	0	0	0	0	0	0	162	10	0	0	0
1075	Arthropoda	Insecta	Coleoptera	Elmidae		Lara	avara		0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
847	Arthropoda	Insecta	Coleoptera	Elmidae		Microcylloepus	pusillus		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
133	Arthropoda	Insecta	Coleoptera	Elmidae		Narpus			0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	14	0	0	0	238	0	0	0	0	0	0
135	Arthropoda	Insecta	Coleoptera	Elmidae		Optioservus			0	31	0	0	0	0	0	0	0	0	0	0	1	0	11	0	0	0	130	0	0	0	0	0	0	0	0	0
1076	Arthropoda	Insecta	Coleoptera	Elmidae		Optioservus	quadrimaculatus		0	12	22	32	0	0	0	0	0	0	0	1	0	17	0	0	0	0	43	22	9	0	0	0	0	4	0	30
1077	Arthropoda	Insecta	Coleoptera	Elmidae		Ordobrevia	nubifera		0	0	0	0	78	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	253	0	0	0	0	0	0
144	Arthropoda	Insecta	Coleoptera	Elmidae		Zaitzevia			2246	852	0	18	69	17	0	0	8	3	147	0	0	9	0	49	14	14	65	184	26	169	0	54	7	0	0	0
146	Arthropoda	Insecta	Coleoptera	Elmidae		Zaitzevia	parvulus		0	0	65	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1219	Arthropoda	Insecta	Coleoptera	Hydraenidae		Hydraena			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0
153	Arthropoda	Insecta	Coleoptera	Hydrophilidae					0	0	0	0	9	0	0	0	3	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	2	0	0	0
154	Arthropoda	Insecta	Coleoptera	Hydrophilidae		Ametor			0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
166	Arthropoda	Insecta	Coleoptera	Hydrophilidae	Hydrophilinae	Tropisternus			0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
167	Arthropoda	Insecta	Coleoptera	Psephenidae					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
670	Arthropoda	Insecta	Coleoptera	Psephenidae		Acneus			0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1079	Arthropoda	Insecta	Coleoptera	Psephenidae	Eubrianacinae	Eubrianax	edwardsii		0	0	0	0	36	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0
173	Arthropoda	Insecta	Diptera						0	0	7	0	9	0	22	4	0	0	13	1	9	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0
176	Arthropoda	Insecta	Diptera	Blephariceridae					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0
179	Arthropoda	Insecta	Diptera	Ceratopogonidae					5	6	7	0	0	9	0	9	0	0	0	1	0	0	43	5	14	0	43	22	0	0	0	11	2	0	0	9
748	Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	Bezzia			0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0
908	Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	Probezzia			16	0	0	11	0	17	22	23	3	0	9	0	0	86	0	0	14	0	43	11	78	11	14	11	0	26	3	9
851	Arthropoda	Insecta	Diptera	Ceratopogonidae	Dasyheleinae	Dasyhelea			0	0	0	0	0	0	0	11	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0
2854	Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	43	0	0	0	0	0	0	0	0	0	0	0
180	Arthropoda	Insecta	Diptera	Chironomidae					49	68	14	7	35	0	14	0	0	8	99	0	0	130	11	27	86	0	151	22	9	43	11	97	7	17	0	22
182	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae				262	266	43	43	225	9	22	2	59	11	35	0	0	0	11	119	1931	202	954	854	26	670	11	941	7	26	16	79
184	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae				357	383	295	126	432	182	144	13	124	162	389	8	0	1219	332	238	549	303	1968	465	536	211	283	878	469	726	124	252
187	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae				16	62	22	108	130	52	94	36	49	12	0	4	0	61	201	92	202	29	43	0	9	103	19	0	41	9	42	129
197	Arthropoda	Insecta	Diptera	Dixidae					0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	0	0	0	0	0	0	7	0	0	4	0	0
198	Arthropoda	Insecta	Diptera	Dixidae		Dixa			0	6	0	0	0	0	0	0	11	0	0	0	0	0	0	11	29	22	0	0	0	7	0	54	2	4	3	4
1830	Arthropoda	Insecta	Diptera	Dixidae		Meringodixa	chalonensis		0	0	0	4	0	0	0	0	5	0	0	0	0	0	0	0	43	0	22	0	0	0	0	22	7	13	0	0
200	Arthropoda	Insecta	Diptera	Empididae					0	6	14	4	0	0	7	13	0	8	4	4	0	9	35	0	14	7	0	22	0	16	4	22	55	0	8	4
202	Arthropoda	Insecta	Diptera	Empididae		Clinocera			0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
2253	Arthropoda	Insecta	Diptera	Empididae		Neoplasta			0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
204	Arthropoda	Insecta	Diptera	Empididae		Oreogeton			0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0
206	Arthropoda	Insecta	Diptera	Empididae		Wiedemannia			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
4055	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae				0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0
201	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae	Chelifera			0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	22	86	0	9	0	0	0	0	0	0	0
213	Arthropoda	Insecta	Diptera	Pelecorhynchidae		Glutops			0	0	0	4	10	0	0	0	0	0	53	3	0	0	0	16	29	36	151	0	0	5	0	32	7	0	0	0
215	Arthropoda	Insecta	Diptera	Psychodidae		Maruina			0	6	0	0	9	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	81	0	0	0	0	0	0
216	Arthropoda	Insecta	Diptera	Psychodidae		Pericoma			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	59	0	151	0	0	0	0	0	0	0	0	0
221	Arthropoda	Insecta	Diptera	Simuliidae					0	0	382	14	0	69	7	95	0	0	0	0	0	17	65	0	0	0	22	930	78	0	0	11	0	22	8	30
223	Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	Simulium			81	531	259	112	0	164	159	69	3	3	4	0	0	52	12	38	289	151	627	378	683	50	112	23	0	368	26	328
231	Arthropoda	Insecta	Diptera	Tabanidae					5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
233	Arthropoda	Insecta	Diptera	Tabanidae		Tabanus			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
689	Arthropoda	Insecta	Diptera	Thaumaleidae					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	4	0	2	0	0	0
234	Arthropoda	Insecta	Diptera	Tipulidae					81	12	14	0	9	0	0	0	24	0	22	0	0	0	3	0	29	0	0	0	0	0	0	0	0	0	0	0
237	Arthropoda	Insecta	Diptera	Tipulidae		Dicranota			16	12	14	18	9	0	0	0	5	0	35	0	0	9	5	27	43	14	0	11	1	19	4	11	24	4	9	9
241	Arthropoda	Insecta	Diptera	Tipulidae		Hexatoma			0	0	0	0	4	0	0	0	24	0	10	1	0	0	0	0	0	0	0	0	1	49	0	32	4	0	0	0
245	Arthropoda	Insecta	Diptera	Tipulidae		Pedicia			0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
236	Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	Antocha	monticola		0	25	50	22	35	9	7	0	0	0	0	0	0	0	0	0	29	7	0	11	35	5	4	11	0	0	0	0
244	Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	Limonia			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
667	Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	Rhabdomastix			0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
247	Arthropoda	Insecta	Diptera	Tipulidae	Tipulinae	Tipula			0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	17	0	0	0	0	0	0	0
303	Arthropoda	Insecta	Ephemeroptera	Ameletidae		Ameletus			0	0	0	4	0	0	0	2	8	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
249	Arthropoda	Insecta	Ephemeroptera	Baetidae					22	0	1038	43	0	69	0	728	30	11	0	0	0	104	1668	0	0	22	0	627	130	0	0	130	0	30	35	0
907	Arthropoda	Insecta	Ephemeroptera	Baetidae		Acentrella			38	56	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0
250	Arthropoda	Insecta	Ephemeroptera	Baetidae		Baetis			195	1241	43	198	510	2274	1982	35	128	557	61	0	0	3771	114	741	1546	2112	3266	22	839	119	232	22	82	255	859	1432
252	Arthropoda	Insecta	Ephemeroptera	Baetidae		Centroptilum			0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	36	0	7	0	0	229
834	Arthropoda	Insecta	Ephemeroptera	Baetidae		Diphetor	hageni		351	235	86	133	259	0	7	14	22	1	23	0	0	0	0	65	45	14	541	184	61	114	23	32	0	0	0	0
2277	Arthropoda	Insecta	Ephemeroptera	Baetidae		Pseudocloeon			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
262	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae					5	12	36	22	9	0	0	0	0	0	0	0	0	0	0	0	29	29	0	22	0	211	0	0	0	0	0	0
263	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Attenella			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0
1180	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Drunella			0	0	0	0	0	0	0	0	11	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1281	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Drunella			0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
267	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Drunella	doddsii		0	12	29	14	666	0	0	0	0	0	0	0	0	0	0	205	102	180	778	22	35	219	0	0	0	0	0	0
271	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Serratella			0	0	22	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
943	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Serratella	tibialis		0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
276	Arthropoda	Insecta	Ephemeroptera	Heptageniidae					11	6	36	0	17	0	0	0	24	1	61	0	0	0	0	0	14	0	86	389	26	114	0	465	0	4	0	4
278	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Cinygma			0	6	0	0	0	0	0	0	49	0	6	0	0	0	0	5	0	7	0	0	0	0	0	0	0	0	0	0
280	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Epeorus			0	25	151	22	177	0	7	5	0	0	36	1	0	0	0	11	14	36	22	119	0	16	0	119	0	0	0	4
282	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Ironodes			11	6	0	4	27	9	0	0	7	0	160	0	0	0	0	22	14	23	23	0	9	114	137	0	9	195	0	151
285	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Rhithrogena			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0
305	Arthropoda	Insecta	Ephemeroptera	Leptohyphidae					0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
287	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae					16	31	36	0	164	0	0	0	0	0	0	0	0	0	0	32	14	7	86	0	0	0	0	346	0	0	0	4
292	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae		Paraleptophlebia			0	0	0	0	0	0	0	0	138	0	66	0	0	0	0	0	0	0	0	0	0	346	0	0	0	0	0	0
792	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae		Traverella	albertana		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
326	Arthropoda	Insecta	Hemiptera	Gerridae					0	0	0	0	0	0	0	0	3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
925	Arthropoda	Insecta	Hemiptera	Gerridae	Gerrinae	Aquarius			0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1549	Arthropoda	Insecta	Hemiptera	Gerridae	Gerrinae	Limnoporus			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1
338	Arthropoda	Insecta	Hemiptera	Veliidae					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0
340	Arthropoda	Insecta	Hemiptera	Veliidae	Microveliinae	Microvelia			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
1186	Arthropoda	Insecta	Megaloptera	Corydalidae		Orohermes	crepusculus		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
359	Arthropoda	Insecta	Megaloptera	Sialidae		Sialis			5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0
2307	Arthropoda	Insecta	Odonata						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0
385	Arthropoda	Insecta	Odonata	Gomphidae					0	14	50	25	79	0	0	5	5	0	0	0	0	0	0	16	1	14	0	22	26	76	11	0	0	13	73	35
1542	Arthropoda	Insecta	Odonata	Gomphidae		Octogomphus	specularis		0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
403	Arthropoda	Insecta	Plecoptera						0	0	339	18	61	95	0	0	122	0	0	3	0	17	5	0	86	22	0	54	0	16	61	0	11	0	16	17
404	Arthropoda	Insecta	Plecoptera	Capniidae	Capniinae				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	7	0	54	0	0	0	0	0	0	0	0
412	Arthropoda	Insecta	Plecoptera	Chloroperlidae					0	0	0	83	0	43	0	0	5	0	0	0	0	0	0	0	0	0	86	0	0	0	0	0	0	13	0	0
415	Arthropoda	Insecta	Plecoptera	Chloroperlidae		Kathroperla			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	1	0	0	0	0	0	0	0	0	0	0
416	Arthropoda	Insecta	Plecoptera	Chloroperlidae		Paraperla			0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	23	0	0	0	4	0	0
419	Arthropoda	Insecta	Plecoptera	Chloroperlidae		Sweltsa			0	12	0	14	17	35	0	27	5	0	23	0	0	0	5	22	14	14	108	32	26	238	49	32	2	48	0	19
5757	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Chloroperlinae				114	154	209	54	182	173	79	102	116	0	251	1	0	242	11	103	0	65	0	303	121	59	25	357	0	177	3	4
418	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Chloroperlinae	Suwallia			5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	11	0	0	0	0
420	Arthropoda	Insecta	Plecoptera	Leuctridae					0	6	0	0	0	0	0	0	43	0	26	3	0	0	0	34	0	72	43	0	0	76	0	130	0	0	0	0
1189	Arthropoda	Insecta	Plecoptera	Leuctridae		Moselia	infuscata		0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
429	Arthropoda	Insecta	Plecoptera	Nemouridae					903	1834	2177	357	450	259	930	357	49	0	43	0	0	9	32	0	0	72	0	659	104	0	0	389	0	4	3	0
431	Arthropoda	Insecta	Plecoptera	Nemouridae		Malenka			114	185	7	479	26	769	144	14	95	0	26	0	0	0	5	11	101	0	173	216	1012	32	438	0	0	52	11	19
1190	Arthropoda	Insecta	Plecoptera	Nemouridae		Visoka	cataractae		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
439	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada			141	0	0	0	43	0	36	0	14	0	381	0	0	0	0	281	494	123	801	22	0	16	0	281	14	4	0	0
2360	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada			0	0	0	4	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
909	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada	cinctipes		0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	58	0	0	0	486	7	0	0	52	0	4
1280	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada	columbiana		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	454	0	4	0	0
1443	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada	frigida		0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
440	Arthropoda	Insecta	Plecoptera	Peltoperlidae					0	0	0	0	0	0	7	0	3	0	9	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
441	Arthropoda	Insecta	Plecoptera	Peltoperlidae		Soliperla			0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	27	0	7	0	0	0	0	0	11	0	0	0	0

443	Arthropoda	Insecta	Plecoptera	Peltoperlidae		Yoraperla			0	0	58	11	164	0	0	0	149	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0
444	Arthropoda	Insecta	Plecoptera	Perlidae					400	395	151	173	129	199	123	220	97	0	242	0	0	43	41	342	59	195	411	141	104	103	115	119	0	22	0	4	
837	Arthropoda	Insecta	Plecoptera	Perlidae		Calineuria	californica		35	39	39	33	11	33	45	9	15	0	4	1	0	10	0	24	29	1	46	14	53	126	59	0	4	59	0	21	
1193	Arthropoda	Insecta	Plecoptera	Perlidae		Doroneuria	baumanni		0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
838	Arthropoda	Insecta	Plecoptera	Perlidae		Hesperoperla	pacifica		8	36	1	1	47	0	0	0	0	0	0	0	0	0	0	0	151	65	151	23	0	12	0	0	0	0	0	0	
455	Arthropoda	Insecta	Plecoptera	Perlodidae					0	0	0	0	0	0	0	52	38	0	0	0	0	0	0	0	86	22	86	86	9	65	0	0	0	0	0	0	
462	Arthropoda	Insecta	Plecoptera	Perlodidae	Isoperlinae	Isoperla			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	32	0	0	0	0	
469	Arthropoda	Insecta	Plecoptera	Perlodidae	Perlodinae	Skwala			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65	0	0	22	0	0	0	0	0	0	
473	Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcyinae	Pteronarcys			0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
799	Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcyinae	Pteronarcys	californica		0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
1267	Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcyinae	Pteronarcys	princeps		0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
480	Arthropoda	Insecta	Trichoptera						0	0	202	4	1	0	50	7	3	0	0	1	0	0	5	16	73	0	65	119	0	8	25	22	9	0	24	6	
531	Arthropoda	Insecta	Trichoptera	Apataniidae		Apatania			0	0	0	0	79	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	
1199	Arthropoda	Insecta	Trichoptera	Brachycentridae		Amiocentrus	aspilus		0	0	0	4	0	52	0	2	0	0	0	0	0	0	0	0	375	7	432	0	415	11	7	0	5	4	0	0	
484	Arthropoda	Insecta	Trichoptera	Brachycentridae		Micrasema			0	31	0	0	17	1	14	0	27	0	4	0	0	0	0	0	375	36	0	65	78	49	4	0	0	0	0	0	
1200	Arthropoda	Insecta	Trichoptera	Calamoceratidae	Calamoceratinae	Heteroplectron	californicum		0	19	0	0	0	0	0	0	0	1	0	0	0	0	0	54	14	0	0	0	0	0	0	0	0	0	0	0	
487	Arthropoda	Insecta	Trichoptera	Glossosomatidae					16	19	22	11	0	0	0	4	11	0	4	0	0	0	0	86	304	22	284	0	0	5	0	54	0	0	0	0	
491	Arthropoda	Insecta	Trichoptera	Glossosomatidae	Glossosomatinae	Glossosoma			0	0	0	0	78	0	0	0	38	1	4	0	0	0	0	49	72	88	151	22	17	0	0	0	0	0	0	0	
495	Arthropoda	Insecta	Trichoptera	Hydropsychidae					0	6	0	0	9	0	0	2	0	3	17	11	0	26	0	130	1501	167	650	76	847	168	421	897	248	412	11	203	
807	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	Arctopsyche	grandis		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	
502	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	Parapsyche			0	0	0	0	0	0	0	0	0	0	17	0	0	9	0	5	0	0	0	0	1	0	0	0	24	1	0	0	
499	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	Hydropsyche			3	3	9	7	4	134	118	9	1	0	35	0	0	47	3	5	0	7	132	97	9	65	0	151	98	0	5	48	
506	Arthropoda	Insecta	Trichoptera	Hydroptilidae					16	31	0	4	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2074	Arthropoda	Insecta	Trichoptera	Hydroptilidae		Palaeagapetus	nearcticus		0	0	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
519	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostomatinae	Lepidostoma			5	19	0	4	0	0	0	0	22	5	17	0	0	0	0	38	145	7	22	0	86	16	32	0	41	4	222	121	
528	Arthropoda	Insecta	Trichoptera	Limnephilidae					0	0	3	0	4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	11	0	3	0	0	0	0	0	0	
529	Arthropoda	Insecta	Trichoptera	Limnephilidae		Allocosmoecus			0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1201	Arthropoda	Insecta	Trichoptera	Limnephilidae		Allocosmoecus	partitus		0	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
535	Arthropoda	Insecta	Trichoptera	Limnephilidae		Cryptochia			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	2	0	0	0	
536	Arthropoda	Insecta	Trichoptera	Limnephilidae	Dicosmoecinae	Dicosmoecus			1	3	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
555	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilinae	Psychoglypha			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
565	Arthropoda	Insecta	Trichoptera	Philopotamidae					70	12	0	0	61	0	0	0	51	0	9	0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	
568	Arthropoda	Insecta	Trichoptera	Philopotamidae	Philopotaminae	Wormaldia			8	0	0	0	50	0	0	0	66	0	58	0	0	0	3	34	101	14	151	0	0	0	0	32	0	0	0	0	
573	Arthropoda	Insecta	Trichoptera	Polycentropodidae					0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	
578	Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropodinae	Polycentropus			0	0	0	4	0	0	0	4	1	8	0	1	0	9	51	0	0	0	0	0	0	0	5	0	5	4	0	47	
584	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila			0	12	137	43	61	95	43	61	5	3	47	23	5	71	114	92	346	30	369	185	78	92	25	378	57	53	5	21	
1706	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	angelita group		0	0	0	0	9	37	9	2	1	0	0	0	0	88	22	9	0	29	86	0	0	0	0	0	0	0	0	0	
1668	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	betteni group		96	45	22	21	43	29	22	14	14	1	17	0	0	0	0	23	0	0	0	22	39	45	29	0	5	45	1	21	
1206	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	brunnea/vemna group		0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	29	9	0	0	62	5	14	0	0	32	0	0	
1710	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	coloradensis group		0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1495	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	grandis		0	0	0	0	0	1	0	0	3	4	6	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	
1496	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	grandis group		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	
1708	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	hyalinata group		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	7	43	0	0	5	0	0	0	0	0	0	
1498	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	narvae		0	0	0	4	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2355	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	Isbirica group B		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	5	0	
1715	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	verrula group		0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1505	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	vofixa group		0	0	0	0	0	0	0	0	0	0	282	0	0	0	0	0	0	0	0	0	0	0	0	22	7	0	14	0	
587	Arthropoda	Insecta	Trichoptera	Sericostomatidae		Gumaga			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	
549	Arthropoda	Insecta	Trichoptera	Uenoidae	Thremmatinae	Neophylax			1	0	0	0	0	0	0	0	5	0	13	0	0	0	0	0	0	14	22	0	0	0	0	0	9	0	0	0	
81	Arthropoda	Malacostraca	Decapoda	Astacidae		Pacifastacus			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	
646	Mollusca	Bivalvia	Veneroida	Pisidiidae					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	
647	Mollusca	Bivalvia	Veneroida	Pisidiidae	Pisidiinae	Pisidium			0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	14	0	0	11	0	5	0	0	2	0	0	0	
596	Mollusca	Gastropoda							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	
854	Mollusca	Gastropoda	Basommatophora	Ancylidae		Ferrissia	rivularis		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	
636	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae		Juga			0	0	0	0	617	0	0	0	59	0	13	0	0	0	0	0	0	0	22	0	0	322	0	0	0	0	0	0	
652	Nemata								0	0	0	0	26	121	0	14	0	0	4	0	0	0	0	0	14	58	0	0	0	0	0	0	5	0	0	0	
655	Platyhelminthes	Turbellaria							22	6	58	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	43	0	16	0	0	0	0	0	0	

Standard format provided to customers, NOT recommended for database storage. See "RawBugData_Example" for preferrable list format.

							SampleID	148576	148577	148578	148579	148580	148581	148582	148583	148584	148585	148586	148587	148588	148589	148590	148984
							Station (NAMC)	M13	M9.8	MDLCKBK-01	M5.5	UPMARTIN-01	MDLCK-3.1	MDLSFMTH-01	MDLCK-3	MREF1	MIDBEN	SFREF1	SF1.0	UPSF1.0	SF3.0	MIDCRMID	BFM1
							Station (Customer)	M13	M9.8	M7.9	M5.5	MARCRREF	M3.1	SF4.7	M3.0	MREF1	MIDBEN	SFREF1	SF1.0	UPSF1.0	SF3.0	MIDCRMID	BFM1
							Waterbody	Middle Creek	Middle Creek	Middle Creek at Buck Creek, Mile 7.9	Middle Creek	Upper Martin Creek, Reference site	Midle Creek, Mile 3.1, below confluence	Middle Creek, Mouth of South Fork	Middle Creek, Mile 3 above confluence of South Fork	Middle Creek Reference (trib)	Middle Bench	South Fk Middle Creek Ref (Trib)	South Fork Middle Creek	South Fork Middle Creek	South Fork Middle Creek	Middle Creek	Buck Fork
							County	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas
							State	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
							Latitude	42.81234936	42.82859498	42.837	42.84308499	42.83	42.847	42.846	42.847	42.85803487	42.85598678	42.8316279	42.83696893	42.8402118	42.83390533	42.85347712	43.14218525
							Longitude	-123.5958457	-123.5638367	-123.505	-123.476519	-123.488	-123.437	-123.435	-123.434	-123.403607	-123.4047075	-123.3727245	-123.3806736	-123.3803875	-123.4123943	-123.4164779	-123.0728725
							Collection Date	6/26/2012	6/26/2012	6/26/2012	6/26/2012	6/27/2012	6/27/2012	6/27/2012	6/27/2012	6/27/2012	6/27/2012	6/28/2012	6/28/2012	6/28/2012	6/28/2012	6/28/2012	8/1/2012
							Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
							Collection Method	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net
							Field Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
							Lab Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
							Area sampled (m^2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
							Field Split	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
							Lab Split	25	21.88	18.75	37.5	15.63	15.63	18.75	75	50	100	31.25	100	100	15.63	50	25
							Split Count	1096	1182	956	668	696	589	588	1104	757	615	737	77	19	714	1054	608
OTUCode	**Phylum**	**Class**	**Order**	**Family**	**Genus**	**Species**	**OTUName**																
158	Annelida	Clitellata			NULL	NULL	Oligochaeta	0	0	0	0	104	0	0	0	3	0	78	0	0	0	0	22
4	Arthropoda	Arachnida	Trombidiformes	(blank)	NULL	NULL	Trombidiformes	65	198	382	29	147	52	79	38	32	3	26	12	0	95	11	16
113	Arthropoda	Insecta	Coleoptera	Curculionidae	NULL	NULL	Curculionidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
233	Arthropoda	Insecta	Coleoptera	Dytiscidae	NULL	NULL	Dytiscidae	0	0	0	0	0	0	0	0	0	7	0	1	1	0	3	0
66	Arthropoda	Insecta	Coleoptera	Elmidae	Cleptelmis	NULL	Cleptelmis	0	0	58	0	26	0	0	0	0	0	4	0	0	0	0	0
43	Arthropoda	Insecta	Coleoptera	Elmidae	Heterlimnius	NULL	Heterlimnius	0	0	0	0	0	0	0	0	5	5	69	1	0	0	3	38
231	Arthropoda	Insecta	Coleoptera	Elmidae	Lara	NULL	Lara	0	0	0	0	0	0	0	0	0	1	4	4	0	0	0	0
131	Arthropoda	Insecta	Coleoptera	Elmidae	Microcylloepus	NULL	Microcylloepus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	Arthropoda	Insecta	Coleoptera	Elmidae	Narpus	NULL	Narpus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
70	Arthropoda	Insecta	Coleoptera	Elmidae	Optioservus	NULL	Optioservus	0	19	22	18	0	0	0	0	0	0	0	1	1	17	11	0
135	Arthropoda	Insecta	Coleoptera	Elmidae	Ordobrevia	NULL	Ordobrevia	0	0	0	0	69	0	0	0	3	0	0	0	0	0	0	0
140	Arthropoda	Insecta	Coleoptera	Elmidae	Zaitzevia	NULL	Zaitzevia	941	290	65	18	43	17	0	0	5	1	78	3	0	0	0	32
153	Arthropoda	Insecta	Coleoptera	Hydraenidae	NULL	NULL	Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
81	Arthropoda	Insecta	Coleoptera	Hydrophilidae	NULL	NULL	Hydrophilidae	0	0	0	0	0	0	0	0	3	0	0	0	3	0	3	0
60	Arthropoda	Insecta	Coleoptera	Psephenidae	Acneus	NULL	Acneus	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0
120	Arthropoda	Insecta	Coleoptera	Psephenidae	Eubrianax	NULL	Eubrianax_edwardsi	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0
107	Arthropoda	Insecta	Diptera	Blephariceridae	NULL	NULL	Blephariceridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101	Arthropoda	Insecta	Diptera	Ceratopogonidae	(blank)	NULL	Ceratopogoninae	11	0	0	4	0	9	14	34	5	0	4	0	0	17	22	0
148	Arthropoda	Insecta	Diptera	Ceratopogonidae	NULL	NULL	Forcipomyiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
46	Arthropoda	Insecta	Diptera	Chironomidae	NULL	NULL	Tanypodinae	0	25	22	72	86	35	7	65	36	32	7	0	4	0	52	176	59
2	Arthropoda	Insecta	Diptera	Chironomidae	NULL	NULL	Orthocladiinae	114	191	295	90	233	69	101	13	84	88	190	8	0	571	276	178
168	Arthropoda	Insecta	Diptera	Chironomidae	NULL	NULL	Chironominae	92	99	43	25	138	9	14	2	41	9	13	0	0	0	11	81
62	Arthropoda	Insecta	Diptera	Dixidae	Dixa	NULL	Dixa	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	11
1	Arthropoda	Insecta	Diptera	Dixidae	Meringodixa	NULL	Meringodixa	0	0	0	4	0	0	0	0	3	0	0	0	0	0	0	0
49	Arthropoda	Insecta	Diptera	Empididae	Clinocera	NULL	Clinocera	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
183	Arthropoda	Insecta	Diptera	Empididae	Oreogeton	NULL	Oreogeton	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
6	Arthropoda	Insecta	Diptera	Pelecorhynchidae	Glutops	NULL	Glutops	0	0	0	0	9	0	0	0	0	0	43	3	0	0	0	11
212	Arthropoda	Insecta	Diptera	Psychodidae	Maruina	NULL	Maruina	0	6	0	0	9	0	0	0	0	0	0	0	0	0	0	0
89	Arthropoda	Insecta	Diptera	Psychodidae	Pericoma	NULL	Pericoma/Telmatoscopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
210	Arthropoda	Insecta	Diptera	Simuliidae	Simulium	NULL	Simulium	27	204	259	76	0	95	123	65	3	1	4	0	0	35	8	16
221	Arthropoda	Insecta	Diptera	Tipulidae	Antocha	NULL	Antocha	0	6	50	7	26	9	0	0	0	0	0	0	0	0	0	0
41	Arthropoda	Insecta	Diptera	Tipulidae	Dicranota	NULL	Dicranota	0	6	14	14	9	0	0	0	5	0	26	0	0	0	5	16
143	Arthropoda	Insecta	Diptera	Tipulidae	Hexatoma	NULL	Hexatoma	0	0	0	0	0	0	0	0	14	0	4	1	0	0	0	0
136	Arthropoda	Insecta	Diptera	Tipulidae	Limonia	NULL	Limonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
173	Arthropoda	Insecta	Diptera	Tipulidae	Pedicia	NULL	Pedicia	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
204	Arthropoda	Insecta	Diptera	Tipulidae	Rhabdomastix	NULL	Rhabdomastix	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
31	Arthropoda	Insecta	Diptera	Tipulidae	Tipula	NULL	Tipula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	Arthropoda	Insecta	Ephemeroptera	Ameletidae	Ameletus	NULL	Ameletus	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0	0
18	Arthropoda	Insecta	Ephemeroptera	Baetidae	Acentrella	NULL	Acentrella	5	25	29	0	0	0	0	0	0	0	0	0	0	0	0	0
191	Arthropoda	Insecta	Ephemeroptera	Baetidae	Baetis	NULL	Baetis	76	500	43	141	277	1401	1470	32	81	269	39	0	0	1712	95	481
150	Arthropoda	Insecta	Ephemeroptera	Baetidae	Centroptilum	NULL	Centroptilum	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
230	Arthropoda	Insecta	Ephemeroptera	Baetidae	Diphetor	hageni	Diphetor_hageni	135	80	86	90	164	0	7	14	14	0	13	0	0	0	0	49
21	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Attenella	NULL	Attenella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
211	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Drunella	(blank)	Drunella_coloradensis/flavilinea	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
171	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Drunella	doddsii	Drunella_doddsi	0	6	29	4	406	0	0	0	0	0	0	0	0	0	0	130
108	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Serratella	NULL	Serratella	0	0	22	0	0	0	0	0	8	0	0	0	0	0	0	0
202	Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Cinygma	NULL	Cinygma	0	0	0	0	0	0	0	0	22	0	4	0	0	0	0	5
141	Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Epeorus	NULL	Epeorus	0	6	151	14	104	0	0	5	0	0	9	1	0	0	0	5
10	Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Ironodes	NULL	Ironodes	5	0	0	4	9	9	0	0	5	0	69	0	0	0	0	11
134	Arthropoda	Insecta	Ephemeroptera	Heptageniidae	Rhithrogena	NULL	Rhithrogena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	NULL	NULL	Leptophlebiidae	0	12	36	0	78	0	0	0	103	0	30	0	0	0	0	27
99	Arthropoda	Insecta	Megaloptera	Corydalidae	NULL	NULL	Corydalidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
203	Arthropoda	Insecta	Megaloptera	Sialidae	Sialis	NULL	Sialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Arthropoda	Insecta	Odonata	Gomphidae	NULL	NULL	Gomphidae	0	6	50	22	52	0	0	5	5	0	0	0	0	0	0	11
226	Arthropoda	Insecta	Plecoptera	Capniidae	NULL	NULL	Capniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
227	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Paraperla	NULL	Paraperla	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
47	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Suwallia	NULL	Suwallia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
236	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Sweltsa	NULL	Sweltsa	0	0	0	7	9	26	0	25	3	0	4	0	0	0	5	16
126	Arthropoda	Insecta	Plecoptera	Leuctridae	Moselia	NULL	Moselia	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0	0
196	Arthropoda	Insecta	Plecoptera	Nemouridae	Malenka	NULL	Malenka	59	86	7	357	26	527	86	14	65	0	13	0	0	0	5	11
138	Arthropoda	Insecta	Plecoptera	Nemouridae	Zapada	NULL	Zapada	43	0	0	4	26	0	22	0	8	0	212	0	0	0	0	151
80	Arthropoda	Insecta	Plecoptera	Peltoperlidae	Soliperla	NULL	Soliperla	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	5
103	Arthropoda	Insecta	Plecoptera	Peltoperlidae	Yoraperla	NULL	Yoraperla	0	0	58	4	52	0	0	0	86	0	0	0	0	0	0	0
92	Arthropoda	Insecta	Plecoptera	Perlidae	Calineuria	NULL	Calineuria	5	12	36	7	0	9	36	7	5	0	0	1	0	0	0	16
165	Arthropoda	Insecta	Plecoptera	Perlidae	Doroneuria	NULL	Doroneuria	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0
67	Arthropoda	Insecta	Plecoptera	Perlidae	Hesperoperla	NULL	Hesperoperla	5	12	0	0	35	0	0	0	0	0	0	0	0	0	0	0
32	Arthropoda	Insecta	Plecoptera	Perlodidae	Isoperla	NULL	Isoperla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
52	Arthropoda	Insecta	Plecoptera	Perlodidae	Skwala	NULL	Skwala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcys	NULL	Pteronarcys	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	Arthropoda	Insecta	Trichoptera	Apataniidae	Apatania	NULL	Apatania	0	0	0	0	26	0	0	0	3	0	0	0	0	0	0	0
68	Arthropoda	Insecta	Trichoptera	Brachycentridae	Amiocentrus	NULL	Amiocentrus	0	0	0	0	0	35	0	2	0	0	0	0	0	0	0	0
156	Arthropoda	Insecta	Trichoptera	Brachycentridae	Micrasema	NULL	Micrasema	0	19	0	0	9	0	0	0	22	0	0	0	0	0	0	0
235	Arthropoda	Insecta	Trichoptera	Calamoceratidae	Heteroplectron	NULL	Heteroplectron	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	32
72	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsyche	NULL	Arctopsyche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsyche	NULL	Hydropsyche	0	0	7	4	0	78	94	7	3	0	9	0	0	0	3	5
234	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Parapsyche	NULL	Parapsyche	0	0	0	0	0	0	0	0	0	0	17	0	0	9	0	5
96	Arthropoda	Insecta	Trichoptera	Hydroptiliidae	Palaeagapetus	NULL	Palaeagapetus	0	0	7	4	0	0	0	0	0	0	0	0	0	0	0	0
179	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostoma	NULL	Lepidostoma	0	0	0	4	0	0	0	0	11	3	13	0	0	0	0	16
167	Arthropoda	Insecta	Trichoptera	Limnephilidae	Allocosmoecus	NULL	Allocosmoecus	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	Arthropoda	Insecta	Trichoptera	Limnephilidae	Cryptochia	NULL	Cryptochia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Arthropoda	Insecta	Trichoptera	Limnephilidae	Dicosmoecus	NULL	Dicosmoecus	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0
201	Arthropoda	Insecta	Trichoptera	Philopotamidae	Wormaldia	NULL	Wormaldia	0	0	0	0	35	0	0	0	35	0	26	0	0	0	3	32
155	Arthropoda	Insecta	Trichoptera	Polycentropodidae	NULL	NULL	Polycentropodidae	0	0	0	4	9	0	0	4	0	5	0	1	0	9	49	0
30	Arthropoda	Insecta	Trichoptera	Rhyacophilidae	Rhyacophila	NULL	Rhyacophila	32	25	166	50	43	121	50	77	16	5	177	30	5	78	124	81
37	Arthropoda	Insecta	Trichoptera	Sericostomatidae	Gumaga	NULL	Gumaga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
160	Arthropoda	Insecta	Trichoptera	Uenoidae	Neophylax	NULL	Neophylax	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
104	Mollusca	Bivalvia	Veneroida	Pisidiidae	NULL	NULL	Pisidiidae	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0
64	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae	Juga	NULL	Juga	0	0	0	0	294	0	0	0	27	0	4	0	0	0	0	0
169	Nemata				NULL	NULL	Nematoda	0	0	0	0	17	95	0	14	0	0	4	0	0	0	0	0
192	Platyhelminthes				NULL	NULL	Turbellaria	5	0	58	0	0	0	0	0	22	0	0	0	0	0	0	0

148985	148986	148987	148988	148989	148990	148991	148992	148993	148994	148995	148996
BFM2	NMM1	NMM2	MDLCKBK-01	MDLCK-3.1	UPMARTIN-01	MDLCK-3	SFREF1	SF1.0	SF3.0	MIDBEN	MIDCRMID
BFM2	NMM1	NMM2	M7.9	M3.1	MARTIN CREEK REF	M3.0	SFREF1	SF1.0	SF3.0	M1.2	M2.0
Buck Fork	North Myrtle Creek	North Myrtle Creek	Middle Creek at Buck Creek, Mile 7.9	Midle Creek, Mile 3.1, below confluence	Upper Martin Creek, Reference site	Middle Creek, Mile 3 above confluence of South Fork	South Fk Middle Creek Ref (Trib)	South Fork Middle Creek	South Fork Middle Creek	Middle Bench	Middle Creek
Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas
OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
43.1406343	43.15726935	43.13686352	42.837	42.847	42.83	42.847	42.8316279	42.83696893	42.83390533	42.85598678	42.85347712
-123.0886228	-123.1240588	-123.1248168	-123.505	-123.437	-123.488	-123.434	-123.3727245	-123.3806736	-123.4123943	-123.4047075	-123.4164779
8/1/2012	8/1/2012	8/1/2012	9/11/2012	9/11/2012	9/11/2012	9/11/2012	9/12/2012	9/12/2012	9/12/2012	9/12/2012	9/12/2012
Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
100	100	100	100	100	100	100	100	100	100	100	100
9.38	18.75	6.25	12.5	15.63	25	37.5	12.5	59.38	31.25	50	31.25
690	638	667	658	668	1037	610	651	585	634	577	756
43	14	22	0	0	43	0	0	2	0	0	0
43	14	130	130	26	43	11	11	14	4	0	4
0	0	0	0	0	0	0	0	2	0	0	0
0	0	0	0	0	0	0	0	5	0	0	0
14	0	0	0	0	5	0	0	0	0	0	0
58	0	151	0	0	5	0	32	5	0	0	0
14	0	0	0	0	0	0	119	7	0	0	0
0	0	0	0	9	0	0	0	0	0	0	0
0	7	0	0	0	81	0	0	0	0	0	0
0	0	65	22	0	0	0	0	0	4	0	17
0	0	0	0	0	92	0	0	0	0	0	0
14	0	43	173	17	65	0	54	7	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	2	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	11	0	0	0	0	0	0	0	0
14	0	22	11	52	5	11	11	0	9	0	4
14	0	0	0	0	0	0	0	0	0	0	0
115	14	22	0	0	16	11	0	25	4	19	35
288	137	1016	443	320	92	184	703	316	441	76	104
1066	123	562	832	9	211	7	746	7	22	5	35
14	14	0	0	0	0	0	43	0	4	3	0
14	0	22	0	0	0	0	22	2	9	0	0
0	0	0	0	0	0	0	0	0	0	5	0
0	0	0	0	0	0	0	0	0	0	0	0
14	22	108	0	0	5	0	22	5	0	0	0
0	0	0	0	0	32	0	0	0	0	0	0
43	0	65	0	0	0	0	0	0	0	0	0
158	86	324	368	432	22	65	22	0	255	14	125
29	7	0	11	9	0	4	11	0	0	0	0
0	14	0	11	0	16	4	11	11	4	3	9
0	0	0	0	0	27	0	11	0	0	0	0
0	0	0	0	0	0	0	0	0	0	3	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	17	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	11	0	0	0	0	0	0	0	0
980	1218	1665	22	458	38	173	22	61	147	497	610
0	0	0	0	17	0	29	0	5	0	0	91
0	0	259	184	17	27	18	11	0	0	0	0
0	0	22	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
72	130	432	22	17	81	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
14	22	22	119	0	0	0	108	0	0	0	4
14	7	0	0	9	43	97	0	9	143	0	74
0	0	0	0	0	11	0	0	0	0	0	0
14	7	86	0	0	130	0	238	0	0	0	4
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	5	0	0	0
0	7	0	22	17	22	7	0	0	9	32	17
29	7	0	54	0	0	0	0	0	0	0	0
0	0	0	0	0	5	0	0	0	0	0	0
0	0	0	11	0	0	0	0	0	0	0	0
0	14	43	32	17	70	32	22	0	30	0	13
0	0	0	0	0	0	0	0	0	0	0	0
86	0	86	205	614	5	306	0	0	39	3	13
303	115	303	22	0	146	4	562	11	39	0	4
0	0	0	0	0	0	0	11	0	0	0	0
0	0	0	108	0	0	0	0	0	0	0	0
14	0	22	11	26	32	40	0	2	43	0	9
0	0	0	0	0	0	0	0	0	0	0	0
115	43	108	22	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	22	0	0	0	0
0	0	43	0	0	5	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
202	7	324	0	268	5	4	0	2	4	0	0
173	22	0	65	43	16	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
0	14	0	0	0	0	0	0	0	0	0	0
0	0	65	97	9	32	0	108	77	0	5	26
0	0	0	0	0	0	0	0	9	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
72	7	0	0	69	5	29	0	27	0	119	61
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	2	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
43	7	108	0	0	0	0	22	0	0	0	0
0	0	0	0	0	0	0	0	5	0	11	17
187	43	303	184	121	54	47	303	50	86	16	22
0	0	0	0	0	0	0	0	0	0	0	0
0	7	22	0	0	0	0	0	0	0	0	0
14	7	0	11	0	0	0	0	2	0	0	0
0	0	22	0	0	114	0	0	0	0	0	0
14	22	0	0	0	0	0	0	5	0	0	0
0	0	0	32	0	16	0	0	0	0	0	0

*Raw Bug data can be provided to customers in a variety of formats. This an example of the format used for a few existing customers who feed the data into internal, EPA, and other databases. The data is pulled from multiple related tables and compiled for particular customer needs. This is NOT intended for import into a database without further consultation, hence only a subset of data (100 records) from this sample set is provided.

Station	ReachID	SampleID	SampDate	Phylum	Class	Order	SubOrder	Family	SubFamily	Tribe	Genus	Species	Code	LifeStage	Notes	LabCount	Big Rare Count
Middle Creek	M13	148576	6/26/2012	Arthropoda	Entognatha	Collembola					NULL	NULL	94	A	NULL	1	0
Middle Creek	M13	148576	6/26/2012	Annelida	Clitellata						NULL	NULL	19	A	NULL	2	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Arachnida	Trombidiformes					NULL	NULL	58	A	U	12	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae			NULL	NULL	180	P	NULL	9	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae	Chironominae		NULL	NULL	182	L	NULL	48	2
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			NULL	NULL	121	L	I	3	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae	Orthocladiinae		NULL	NULL	184	L	NULL	65	4
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			Zaitzevia	NULL	144	L	NULL	316	2
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			Zaitzevia	NULL	144	A	NULL	99	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Ceratopogonidae			NULL	NULL	179	P	NULL	1	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae	Tanypodinae		NULL	NULL	187	L	NULL	3	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Brachycera	Tabanidae			NULL	NULL	231	L	NULL	1	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Tipulidae			NULL	NULL	234	L	NULL	13	4
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Tipulidae			NULL	NULL	234	P	NULL	1	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Tipulidae			Dicranota	NULL	237	L	NULL	3	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae			Baetis	NULL	250	L	NULL	36	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Furcatergalia	Ephemerellidae			NULL	NULL	262	L	I	1	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Setisura	Heptageniidae			NULL	NULL	276	L	I	2	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Plecoptera	Systellognatha	Chloroperlidae	Chloroperlinae		Suwallia	NULL	418	L	NULL	1	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Plecoptera	Euholognatha	Nemouridae			Malenka	NULL	431	L	NULL	21	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Plecoptera	Euholognatha	Nemouridae			Zapada	NULL	439	L	I	26	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Plecoptera	Systellognatha	Perlidae			NULL	NULL	444	L	I	74	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Glossosomatidae			NULL	NULL	487	L	I	3	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Limnephilidae	Dicosmoecinae		Dicosmoecus	NULL	536	L	NULL	0	1
Middle Creek	M13	148576	6/26/2012	Platyhelminthes	Turbellaria						NULL	NULL	655	A	NULL	4	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae			Diphetor	hageni	834	L	NULL	65	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae			Acentrella	NULL	907	L	NULL	7	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Simuliidae	Simuliinae	Simuliini	Simulium	NULL	223	L	NULL	15	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae			NULL	NULL	249	L	I	4	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Setisura	Heptageniidae			Ironodes	NULL	282	L	NULL	2	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Furcatergalia	Leptophlebiidae			NULL	NULL	287	L	I	3	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Megaloptera		Sialidae			Sialis	NULL	359	L	NULL	1	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Plecoptera	Euholognatha	Nemouridae			NULL	NULL	429	L	I	167	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Hydropsychidae	Hydropsychinae		Hydropsyche	NULL	499	L	NULL	0	2
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Hydroptilidae			NULL	NULL	506	L	I	2	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Hydroptilidae			NULL	NULL	506	P	NULL	1	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Lepidostomatidae	Lepidostomatinae		Lepidostoma	NULL	519	L	NULL	1	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Uenoidae	Thremmatinae		Neophylax	NULL	549	L	NULL	0	1
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Philopotamidae			NULL	NULL	565	L	I	13	0
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Trichoptera		Philopotamidae	Philopotaminae		Wormaldia	NULL	568	L	NULL	1	2
Middle Creek	M13	148576	6/26/2012	Arthropoda	Insecta	Plecoptera	Systellognatha	Perlidae			Calineuria	californica	837	L	NULL	5	6
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Plecoptera	Systellognatha	Perlidae			Calineuria	californica	837	L	NULL	5	6
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Philopotamidae			NULL	NULL	565	L	I	2	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Hydroptilidae			NULL	NULL	506	L	I	5	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Lepidostomatidae	Lepidostomatinae		Lepidostoma	NULL	519	L	NULL	3	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Hydropsychidae			NULL	NULL	495	L	I	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Hydropsychidae	Hydropsychinae		Hydropsyche	NULL	499	L	NULL	0	2
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Plecoptera	Euholognatha	Leuctridae			NULL	NULL	420	L	I	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Plecoptera	Euholognatha	Nemouridae			NULL	NULL	429	L	I	297	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Megaloptera		Sialidae			Sialis	NULL	359	L	NULL	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Plecoptera	Systellognatha	Chloroperlidae			Sweltsa	NULL	419	L	NULL	2	0

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Station	ReachID	SampleID	SampDate	Phylum	Class	Order	SubOrder	Family	SubFamily	Tribe	Genus	Species	Code	LifeStage	Notes	LabCount	Big Rare Count
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Setisura	Heptageniidae			Ironodes	NULL	282	L	NULL	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Furcatergalia	Leptophlebiidae			NULL	NULL	287	L	I	5	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Tipulidae	Tipulinae		Tipula	NULL	247	L	NULL	0	1
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Tipulidae	Limoniinae		Antocha	monticola	236	L	NULL	4	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Setisura	Heptageniidae			Cinygma	NULL	278	L	NULL	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Setisura	Heptageniidae			Epeorus	NULL	280	L	NULL	4	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Simuliidae	Simuliinae	Simuliini	Simulium	NULL	223	L	NULL	86	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae			Acentrella	NULL	907	L	NULL	9	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			Optioservus	quadrimaculatus	1076	A	NULL	2	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae			Diphetor	hageni	834	L	NULL	38	0
Middle Creek	M9.8	148577	6/26/2012	Platyhelminthes	Turbellaria						NULL	NULL	655	A	NULL	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Rhyacophilidae			Rhyacophila	NULL	584	L	I	2	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Limnephilidae	Dicosmoecinae		Dicosmoecus	NULL	536	L	NULL	0	2
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Glossosomatidae			NULL	NULL	487	L	I	3	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Plecoptera	Systellognatha	Perlidae			NULL	NULL	444	L	I	64	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Plecoptera	Systellognatha	Pteronarcyidae	Pteronarcyinae	Pteronarcyini	Pteronarcys	NULL	473	L	U	0	1
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Trichoptera		Brachycentridae			Micrasema	NULL	484	L	NULL	5	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Plecoptera	Euholognatha	Nemouridae			Malenka	NULL	431	L	NULL	30	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Furcatergalia	Leptohyphidae			NULL	NULL	305	L	I	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Odonata	Anisoptera	Gomphidae			NULL	NULL	385	L	I	2	1
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Furcatergalia	Ephemerellidae			NULL	NULL	262	L	I	2	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Setisura	Heptageniidae			NULL	NULL	276	L	I	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Furcatergalia	Ephemerellidae			Drunella	doddsii	267	L	NULL	2	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae			Baetis	NULL	250	L	NULL	201	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Tipulidae			Dicranota	NULL	237	L	NULL	2	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Tipulidae			NULL	NULL	234	L	I	2	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Psychodidae			Maruina	NULL	215	L	NULL	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae	Tanypodinae		NULL	NULL	187	L	NULL	10	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Brachycera	Empididae			NULL	NULL	200	P	NULL	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Ceratopogonidae			NULL	NULL	179	L	I	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			Optioservus	NULL	135	L	NULL	5	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			Zaitzevia	NULL	144	L	NULL	100	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			Zaitzevia	NULL	144	A	NULL	38	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae	Orthocladiinae		NULL	NULL	184	L	NULL	62	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Dixidae			Dixa	NULL	198	L	NULL	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Arachnida	Trombidiformes	Prostigmata	Sperchonidae			Sperchon	NULL	67	A	NULL	1	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae			NULL	NULL	180	P	NULL	11	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae	Chironominae		NULL	NULL	182	L	NULL	43	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Arachnida	Trombidiformes					NULL	NULL	58	A	U	47	0
Middle Creek	M9.8	148577	6/26/2012	Arthropoda	Arachnida	Trombidiformes	Prostigmata	Lebertiidae			Lebertia	NULL	63	A	NULL	5	0
Middle Creek	M9.8	148577	6/26/2012	Annelida	Clitellata						NULL	NULL	19	A	NULL	1	2
Middle Creek at Buck Creek, Mile 7.9	MDLC	148578	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			Zaitzevia	parvulus	146	A	NULL	9	0
Middle Creek at Buck Creek, Mile 7.9	MDLC	148578	6/26/2012	Arthropoda	Arachnida	Trombidiformes	Prostigmata	Torrenticolidae			NULL	NULL	54	A	U	18	0
Middle Creek at Buck Creek, Mile 7.9	MDLC	148578	6/26/2012	Arthropoda	Arachnida	Trombidiformes					NULL	NULL	58	A	U	32	0
Middle Creek at Buck Creek, Mile 7.9	MDLC	148578	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae			NULL	NULL	180	P	U	2	0
Middle Creek at Buck Creek, Mile 7.9	MDLC	148578	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae	Chironominae		NULL	NULL	182	L	NULL	6	0
Middle Creek at Buck Creek, Mile 7.9	MDLC	148578	6/26/2012	Arthropoda	Arachnida	Trombidiformes	Prostigmata	Sperchonidae			NULL	NULL	66	A	U	3	0
Middle Creek at Buck Creek, Mile 7.9	MDLC	148578	6/26/2012	Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae			NULL	NULL	121	L	I	33	0
Middle Creek at Buck Creek, Mile 7.9	MDLC	148578	6/26/2012	Arthropoda	Insecta	Diptera	Nematocera	Chironomidae	Orthocladiinae		NULL	NULL	184	L	NULL	41	0

Excel Worksheet Name	Worksheet Description
OE output	O/E (Observed/Expected) scores along with corresponding biological condition. Prior to O/E score computation, taxa are standardized to Operational Taxonomic Units (OTUs) and a fixed count of 300 individuals (unless otherwise requested).

The O/E model used for this analysis was the Oregon DEQ Predator 2005 (WCCP) model.
See additional documentation below and at http://www.usu.edu/buglab and http://www.cnr.usu.edu/wmc.

Description of the fields contained in the 'OE output' worksheet. A more detailed explanation of each metric is given at http://www.usu.edu/buglab.

Column Name	Explanation	Predicted response to increasing perturbation	Calculation	Reference
OE	O/E (Observed/Expected) score based on a 0.5 probability of capture threshold.	Decrease	[Observed probability of caputre]/[Expected probability of capture]	WMC, Hawkins et al. 2000, Stoddard et al. 2006
Condition	Rating of "Good", "Fair", or "Poor" based on O/E score relative to the distribution of scores for reference sites. Samples with less than the required number of organisms are given an NA or "Null" rating because they did not meet model requirements.	A "Poor" rating should receive additional analysis or sampling before classifying the sites as impaired.	>Mean±2SD = "Poor", >Mean±1SD = "Fair", <Mean±1SD = "Good"	WMC, Hawkins et al. 2000, Stoddard et al. 2006
PassFail	This field indicates whether or not the site's habitat variables were within the range of experience of the model. A fail ("F") indicates the model had to extrapolate, rather than interpolate, to accommodate one or more of the habitat variables. O/E scores and condition ratings should be interpretted cautiosly if a site failed the model.	NA	NA	WMC

Analysis methods

We used the Oregon Department of Environmental Quality observed/expected (O/E) index, aka "Predator", to assess biological condition of sampled sites (Hubler, 2008). O/E models compare the macroinvertebrate taxa observed at sites of unknown biological condition (i.e., 'test sites') to the assemblages expected to be found in the absence of anthropogenic stressors (see Hawkins et al. 2000 for details). The Predator O/E model for the Western Cordillera and Columbia Plateau ecoregion is based on 167 reference sites grouped into 5 distinct classes based on the similarity of macroinvertebrate assemblage composition among sites following the standard methods of Hawkins et al. (2000) and described in detail within the EMAP-West statistical summary (Stoddard et al. 2006). The expected class membership and subsequent reference macroinvertebrate assemblage (E) for comparison to test sites is predicted by linear discriminant function models using outlet elevation, mean annual maximum air temperature, mean annual precipitation, and location in western or eastern Oregon. Prior to computing O/E scores, data for all test sites was standardized to the operational taxonomic units used to derive the Predator O/E model (Hubler, 2008) and re-sampled to a 300 fixed-count. Following the recommendations of Hawkins et al. (2000), O/E scores were calculated for taxa having a probability of capture $\geq$ 0.5 to increase the precision of O/E estimates and subsequent model sensitivity to stressors. Biological condition was subsequently assessed based on the precision of the reference site data set used to develop the Predator WCCP O/E model (mean =1.01, standard deviation (SD) = 0.15), with test sites scoring less than one SD below the mean of reference sites in "Good" biological condition (i.e. comparable to reference conditions); sites scoring between one SD and two SD in "Fair" biological condition; and sites scoring more than two SD below the mean of reference sites in "Poor" biological condition. For the Predator O/E model, the minimum count required for assinging an O/E score and biological condition rating is 200 individuals. Samples with less than 200 individuals were not given a condition rating.

REFERENCES

Hawkins, C. P., R. H. Norris, J.N. Hogue, and J. M. Feminella. 2000. Development and evaluation of predictive models for measuring the biological integrity of streams. Ecological Applications 10:1456–1477.

Hubler, S. 2008. PREDATOR: Development and use of RIVPACS-type macroinvertebrate models to assess the biotic condition of wadeable Oregon streams. Oregon Department of Environmental Quality. Report: DEQ08-LAB-0048-TR.

Stoddard, J. L., D. V. Peck, A. R. Olsen, D. P. Larsen, J. Van Sickle, C. P. Hawkins, R. M. Hughes, T. R. Whittier, G. Lomincky, A. T. Herlihy, and P.R. Kaufmann. 2006. Environmental Monitoring and Assessment Program (EMAP): western streams and rivers statistical summary. EPA 620/R-05/006. US Environmental Protection Agency, Washington, DC.

Sample Id	Station (NAMC)	Station (Customer)	Stream	County	State	Latitude	Longitude	Collection Date	Habitat Sampled	Collection Method	Field Notes	Lab Notes	Area sampled (m^2)	Field Split	Lab Split	# of SubSampled Organisms	# of Resampled Individuals	OTU_ Richness	OE	Condition	PassFail
148576	M13	M13	Middle Creek	Douglas	OR	42.81234936	-123.5958457	6/26/2012	Targeted Riffle	Surber net			0.74	100	25	1096	300	21	0.6488	Poor	P
148577	M9.8	M9.8	Middle Creek	Douglas	OR	42.82859498	-123.5638367	6/26/2012	Targeted Riffle	Surber net			0.74	100	21.88	1182	300	25	0.8912	Good	P
148578	MDLCKBK-01	M7.9	Middle Creek at Buck Creek, Mile 7.9	Douglas	OR	42.837	-123.505	6/26/2012	Targeted Riffle	Surber net			0.74	100	18.75	956	278	26	0.8628	Good	P
148579	M5.5	M5.5	Middle Creek	Douglas	OR	42.84308499	-123.476519	6/26/2012	Targeted Riffle	Surber net			0.74	100	37.5	668	300	27	0.9324	Good	P
148580	UPMARTIN-01	MARCRREF	Upper Martin Creek, Reference site	Douglas	OR	42.83	-123.488	6/27/2012	Targeted Riffle	Surber net			0.74	100	15.63	696	300	30	0.9297	Good	P
148581	MDLCK-3.1	M3.1	Midle Creek, Mile 3.1, below confluence	Douglas	OR	42.847	-123.437	6/27/2012	Targeted Riffle	Surber net			0.74	100	15.63	589	300	16	0.7097	Poor	P
148582	MDLSFMTH-01	SF4.7	Middle Creek, Mouth of South Fork	Douglas	OR	42.846	-123.435	6/27/2012	Targeted Riffle	Surber net			0.74	100	18.75	588	300	16	0.6453	Poor	P
148583	MDLCK-3	M3.0	Middle Creek, Mile 3 above confluence of South Fork	Douglas	OR	42.847	-123.434	6/27/2012	Targeted Riffle	Surber net			0.74	100	75	1104	221	19	0.71	Fair	P
148584	MREF1	MREF1	Middle Creek Reference (trib)	Douglas	OR	42.85803487	-123.403607	6/27/2012	Targeted Riffle	Surber net			0.74	100	50	757	300	38	0.9942	Good	P
148585	MIDBEN	MIDBEN	Middle Bench	Douglas	OR	42.85598678	-123.4047075	6/27/2012	Targeted Riffle	Surber net			0.74	100	100	615	300	12	0.5298	Poor	P
148586	SFREF1	SFREF1	South Fk Middle Creek Ref (Trib)	Douglas	OR	42.8316279	-123.3727245	6/28/2012	Targeted Riffle	Surber net			0.74	100	31.25	737	300	36	0.7995	Fair	P
148587	SF1.0	SF1.0	South Fork Middle Creek	Douglas	OR	42.83696893	-123.3806736	6/28/2012	Targeted Riffle	Surber net		Resampled macroinvertebrate count is insufficient for model requirements to determine condition.	0.74	100	100	77	56	16	0.4648	NA	P
148588	UPSF1.0	UPSF1.0	South Fork Middle Creek	Douglas	OR	42.8402118	-123.3803875	6/28/2012	Targeted Riffle	Surber net		Resampled macroinvertebrate count is insufficient for model requirements to determine condition.	0.74	100	100	19	10	6	0.0665	NA	P
148589	SF3.0	SF3.0	South Fork Middle Creek	Douglas	OR	42.83390533	-123.4123943	6/28/2012	Targeted Riffle	Surber net			0.74	100	15.63	714	300	12	0.5885	Poor	P
148590	MIDCRMID	MIDCRMID	Middle Creek	Douglas	OR	42.85347712	-123.4164779	6/28/2012	Targeted Riffle	Surber net			0.74	100	50	1054	300	18	0.6547	Poor	P
148984	BFM1	BFM1	Buck Fork	Douglas	OR	43.14218525	-123.0728725	8/1/2012	Targeted Riffle	Surber net			0.74	100	25	608	300	34	1.0329	Good	P
148985	BFM2	BFM2	Buck Fork	Douglas	OR	43.1406343	-123.0886228	8/1/2012	Targeted Riffle	Surber net			0.74	100	9.38	690	300	32	0.9791	Good	P
148986	NMM1	NMM1	North Myrtle Creek	Douglas	OR	43.15726935	-123.1240588	8/1/2012	Targeted Riffle	Surber net			0.74	100	18.75	638	300	29	1.0129	Good	P
148987	NMM2	NMM2	North Myrtle Creek	Douglas	OR	43.13686352	-123.1248168	8/1/2012	Targeted Riffle	Surber net			0.74	100	6.25	667	300	27	0.9161	Good	P
148988	MDLCKBK-01	M7.9	Middle Creek at Buck Creek, Mile 7.9	Douglas	OR	42.837	-123.505	9/11/2012	Targeted Riffle	Surber net			0.74	100	12.5	658	300	28	0.8359	Fair	P
148989	MDLCK-3.1	M3.1	Midle Creek, Mile 3.1, below confluence	Douglas	OR	42.847	-123.437	9/11/2012	Targeted Riffle	Surber net			0.74	100	15.63	668	300	23	0.7101	Fair	P
148990	UPMARTIN-01	MARTIN CREEK REF	Upper Martin Creek, Reference site	Douglas	OR	42.83	-123.488	9/11/2012	Targeted Riffle	Surber net			0.74	100	25	1037	300	36	1.0527	Good	P
148991	MDLCK-3	M3.0	Middle Creek, Mile 3 above confluence of South Fork	Douglas	OR	42.847	-123.434	9/11/2012	Targeted Riffle	Surber net			0.74	100	37.5	610	300	21	0.7105	Fair	P
148992	SFREF1	SFREF1	South Fk Middle Creek Ref (Trib)	Douglas	OR	42.8316279	-123.3727245	9/12/2012	Targeted Riffle	Surber net			0.74	100	12.5	651	300	24	0.6662	Poor	P
148993	SF1.0	SF1.0	South Fork Middle Creek	Douglas	OR	42.83696893	-123.3806736	9/12/2012	Targeted Riffle	Surber net			0.74	100	59.38	585	300	29	0.664	Poor	P
148994	SF3.0	SF3.0	South Fork Middle Creek	Douglas	OR	42.83390533	-123.4123943	9/12/2012	Targeted Riffle	Surber net			0.74	100	31.25	634	300	18	0.5885	Poor	P
148995	MIDBEN	M1.2	Middle Bench	Douglas	OR	42.85598678	-123.4047075	9/12/2012	Targeted Riffle	Surber net			0.74	100	50	577	300	16	0.4635	Poor	P
148996	MIDCRMID	M2.0	Middle Creek	Douglas	OR	42.85347712	-123.4164779	9/12/2012	Targeted Riffle	Surber net			0.74	100	31.25	756	300	17	0.5892	Poor	P

BLM/USU National Aquatic Monitoring Center (NAMC) Department of Watershed Sciences (WATS) - Utah State University 5210 Old Main Hill
Logan, UT 84322-5210
http://www.usu.edu/buglab/

Report prepared by:
Scott Miller: 435.797.2612 / scott.miller@usu.edu
Sarah Judson: 435.797.3310 / sarah.judson@usu.edu

Report prepared for:

Customer contact:	Cory Sipher
Customer:	BLM - OR - Roseburg District Office
Customer Address :	777 Nw Garden Valley Blvd
Customer City, State, Zip:	Roseburg OR 97470
Customer Phone:	541-464-3249
Customer Email:	csipher@blm.gov

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Metrics
Species Matrix (Raw)
Species Matrix (Standardized)

Excel Worksheet Name	Worksheet Description
Metrics	Common metrics used to assess freshwater biological integrity, as well as basic field and lab processing information. Note that values for richness based metrics are standardized to operational taxonomic units (OTUs; sensu Cuffney et al. 2007) and a fixed count (i.e., rarefaction) of 300, but density metrics are based on the raw taxa list. Standardized metrics are indicated with an asterisk. NAMC OTU standardization uses the method of removing individuals identified to the coarser taxonomic resolution or merging finer level identifications to coarser levels. We are able to standardize your data to custom OTUs and/or fixed counts if provided, although additional charges may apply. A more detailed explanation of each metric, as well as references, can be obtained by contacting NAMC and will soon be available on our website. **This report was generated with the following settings - OTUs: Genus (Oregon Predator WCCP); Fixed Count: 300.**
Species Matrix (Raw)	Raw taxonomic and abundance data for sampled sites. Abundance data is the estimated number of individuals per square meter for quantitative samples OR the estimated number of individuals per sample for qualitative samples. Note that the taxonomic data in this worksheet **has not been standardized to operational taxonomic units (OTUs)**, thus considerable redundancy likely exists in the taxonomic hierarchy.
Species Matrix (Standardized)	Taxonomic and abundance data (Species matrix) for sampled sites that has been standardized to Operational Taxonomic Units (OTUs) but not standardized to fixed count. Please note that data has not been standardized to a fixed count as in the 'Standardized Metrics worksheet'. Also, abundance data is the estimated number per square meter for quantitative samples OR is the estimated number per sample for qualitative samples.

Description of the fields contained in the 'Metrics' worksheet. A more detailed explanation of each metric is available on our website (http://usu.edu/buglab/SampleProcessing/ResultsAndReports/#item=85).

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Collection information	SampleID	NAMC unique tracking number	NA	NA	NA	NA
	Station (NAMC)	NAMC station tracking id	NA	NA	NA	NA
	Station (Customer)	Station abbreviation provided by the customer	NA	NA	NA	NA
	Waterbody	Specific location name	NA	NA	NA	NA
	County	Administrative boundary	NA	NA	NA	NA
	State	Administrative boundary	NA	NA	NA	NA
	Latitude	Y coordinate in decimal degree units	NA	NA	NA	NA
	Longitude	X coordinate in decimal degree units	NA	NA	NA	NA
	Collection Date	Date of sampling event	NA	NA	NA	NA
	Habitat Sampled	Microhabitat or channel unit(s) where sample(s) was taken. Values are restricted to predetermined values as specified in the PDF metadata.	NA	NA	NA	NA
	Collection Method	Method used to collect sample. Values are restricted to predetermined values as specified in the PDF metadata.	NA	NA	NA	NA
	Field Notes	Field notes provided by customer	NA	NA	NA	NA
	Lab Notes	Laboratory processing notes, particularly regarding condition of received samples and QAQC	NA	NA	NA	NA
	Area Sampled	Total area sampled in square meters	NA	NA	NA	NA

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Laboratory Processing	Field Split	% sample submitted for processing	NA	NA	NA	NA
	Lab Split	% of sample processed to obtain 600 random individuals (if present)	NA	NA	NA	Cuffney et al. (1993), Moulton et al. (2000), Vinson and Hawkins (1996)
	Split Count	# of organisms randomly subsampled from [Lab Split] for identification	NA	NA	NA	"
	Fixed count	# of computationally resampled organisms	NA	NA		"
	Big Rare Count	# of "big and rare" organisms selected NON-RANDOMLY for identification from the entire submitted sample	NA	NA	NA	"
Richness (metrics summarizing all unique taxa in a sample)	Richness	# of unique taxa, standardized to OTU	Decrease	$[\text{Richness}]_{\text{UniqueTaxa}}$	Y	NA
	Abundance	Estimated # number of individuals per unit area (m^2) for quantitative samples OR the estimated number per sample for qualitative samples.	Increase or decrease	(([Split Count]* (100/[Lab Split])) + [Big_Rare Count]) *(100/[Field Split]) *(1/[Area Sampled])	N	NA
	Shannon's Diversity	Measure of richness and evenness (based on relative abundance of each species); weighted toward rare species	Decrease	$-\sum([\text{Relative Abundance}]_{\text{taxa}} * \ln([\text{Relative Abundance}]_{\text{taxa}}))$	Y	Ludwig and Reynolds (1988, equation 8.9, page 92)
	Simpson's Diversity	Measure of richness and evenness (based on relative abundance of each species); weighted toward common species	Decrease	$1 - [\text{Simpson's Diversity}] = 1 - \sum([\text{Relative Abundance}]_{\text{taxa}})^2$	Y	Ludwig and Reynolds (1988, equation 8.6, page 91), Krebs (1999, equation 12.27-12.30)
	Evenness	Measure of relative abundance indicative of taxa dominance	Decrease	[Shannon's Diversity]/ln([Richness])	Y	Ludwig and Reynolds (1988, equation 8.11, page 93)
	# of EPT Taxa	Richness of Ephemeroptera, Plecoptera, and Trichoptera taxa	Decrease	$[\text{Richness}]_E + [\text{Richness}]_P + [\text{Richness}]_T$	Y	Barbour et al. (1999), Karr and Chu (1998)
	EPT Taxa Abundance	Abundance of Ephemeroptera, Plecoptera, and Trichoptera taxa	Decrease	$[\text{Abundance}]_E + [\text{Abundance}]_P + [\text{Abundance}]_T$	N	"
Dominance Metrics (metrics summarizing all most abundant taxa in a sample)	Dominant Family	Taxonomic family with the highest abundance	NA	NA	N	NA
	Abundance of Dominant Family	Abundance of dominant family	Increase	$[\text{Abundance}]_{\text{dominant family}}$	N	NA
	Dominant Taxa	Individual taxa with the highest abundance	NA	NA	N	NA
	Abundance of Dominant Taxa	Abundance of dominant taxa	Increase	$[\text{Abundance}]_{\text{dominant taxa}}$	N	NA

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Tolerance Indices (indices based on the indicator species concept in which taxa are assigned tolerance values)	Hilsenhoff Biotic Index	Abundance-weighted average of family-level pollution tolerances	Increase	$\sum([Abundance]_{taxa} * [Tolerance]_{taxa}) / [Abundance]_{Total}$	Y	Hilsenhoff (1987, 1988)
	# of Intolerant Taxa	# of taxa with an HBI score <= 2	Decrease	$[Richness]_{intolerant}$	Y	"
	Intolerant Taxa abundance	Abundance of taxa with an HBI score <= 2	Decrease	$[Abundance]_{intolerant}$	N	"
	# of Tolerant Taxa	# of taxa with an HBI score>=8	Increase	$[Richness]_{tolerant}$	Y	"
	Tolerant Taxa abundance	Abundance of taxa with an HBI score >=8	Increase	$[Abundance]_{tolerant}$	N	"
	USFS Community Tolerance Quotient (d)	Dominance weighted community tolerance quotient	Increase	$\sum([Tolerance\ Quotient] * \log([Abundance]_{taxa})) / \sum \log([Abundance]_{taxa})$	Y	Winget and Mangum (1979)
Functional Feeding Groups (classification of organisms based on morphological or behavioral adaptations for where and how food is acquired)	# of shredder taxa	# of taxa utilizing living or decomposing vascular plant tissue and CPOM	Decrease	$[Richness]_{shredder}$	Y	Merritt et. al (2008)
	Shredder Abundance	Abundance of taxa utilizing vascular plant tissue and CPOM	Decrease	$[Abundance]_{shredder}$	N	"
	# of scraper taxa	# of taxa utilizing periphyton, particularly algae and diatoms	Decrease	$[Richness]_{scraper}$	Y	"
	Scraper abundance	Abundance of taxa utilizing periphyton, particularly algae and diatoms	Decrease	$[Abundance]_{scraper}$	N	"
	# of collector-filterer taxa	# of taxa utilizing FPOM in the water column	Variable	$[Richness]_{collector\text{-}filterer}$	Y	"
	Collector-filterer abundance	Abundance of taxa utilizing FPOM in the water column	Variable	$[Abundance]_{collector\text{-}filterer}$	N	"
	# of collector-gatherer taxa	# of taxa utilizing FPOM from benthic deposits	Variable	$[Richness]_{collector\text{-}gatherer}$	Y	"
	Collector-gatherer abundance	Abundance of taxa utilizing FPOM from benthic deposits	Variable	$[Abundance]_{collector\text{-}gatherer}$	N	"
	# of predator taxa	# of taxa utilizing living animal tissue	Decrease	$[Richness]_{predator}$	Y	"
	Predator abundance	Abundance of taxa utilizing living animal tissue	Decrease	$[Abundance]_{predator}$	N	"
Functional Traits (metrics based on morphological and life history traits)	# of clinger taxa	# of taxa with fixed retreats or other strategies for clinging to rocks	Decrease	$[Richness]_{clinger}$	Y	Karr and Chu (1998), Merritt et al. (2008)
	"# of" Long-lived Taxa	# of taxa with 2 to 3 year life cycles	Decrease	$[Richness]_{long\text{-}lived}$	Y	"

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Compositional Metrics (richness and abundance of various taxonomic groups)	# of Ephemeroptera taxa		Decrease	$[\text{Richness}]_{\text{Ephemeroptera}}$	Y	NA
	Ephemeroptera abundance		Decrease	$[\text{Abundance}]_{\text{Ephemeroptera}}$	N	NA
	# of Plecoptera taxa		Decrease	$[\text{Richness}]_{\text{Plecoptera}}$	Y	NA
	Plecoptera abundance		Decrease	$[\text{Abundance}]_{\text{Plecoptera}}$	N	NA
	# of Trichoptera taxa		Decrease	$[\text{Richness}]_{\text{Trichoptera}}$	Y	NA
	Trichoptera abundance		Decrease	$[\text{Abundance}]_{\text{Trichoptera}}$	N	NA
	# of Coleoptera taxa		Variable	$[\text{Richness}]_{\text{Coleoptera}}$	Y	NA
	Coleoptera abundance		Variable	$[\text{Abundance}]_{\text{Coleoptera}}$	N	NA
	# of Elmidae taxa		Decrease	$[\text{Richness}]_{\text{Elmidae}}$	Y	NA
	Elmidae abundance		Decrease	$[\text{Abundance}]_{\text{Elmidae}}$	N	NA
	# of Megaloptera taxa		Variable	$[\text{Richness}]_{\text{Megaloptera}}$	Y	NA
	Megaloptera abundance		Variable	$[\text{Abundance}]_{\text{Megaloptera}}$	N	NA
	# of Diptera taxa		Variable	$[\text{Richness}]_{\text{Diptera}}$	Y	NA
	Diptera abundance		Variable	$[\text{Abundance}]_{\text{Diptera}}$	N	NA
	# of Chironomidae taxa		Increase	$[\text{Richness}]_{\text{Chironomidae}}$	Y	NA
	Chironomidae abundance		Increase	$[\text{Abundance}]_{\text{Chironomidae}}$	N	NA
	# of Crustacea taxa		Variable	$[\text{Richness}]_{\text{Crustacea}}$	Y	NA
	Crustacea abundance		Variable	$[\text{Abundance}]_{\text{Crustacea}}$	N	NA
	# of Oligochaete taxa		Increase	$[\text{Richness}]_{\text{Oligochaeta}}$	Y	NA
	Oligochaete abundance		Increase	$[\text{Abundance}]_{\text{Oligochaeta}}$	N	NA
	# of Mollusca taxa		Variable	$[\text{Richness}]_{\text{Mollusca}}$	Y	NA
	Mollusca abundance		Variable	$[\text{Abundance}]_{\text{Mollusca}}$	N	NA
	# of Insect taxa		Decrease	$[\text{Richness}]_{\text{Insect}}$	Y	NA
	Insect abundance		Decrease	$[\text{Abundance}]_{\text{Insect}}$	N	NA
	# of non-insect taxa		Increase	$[\text{Richness}]_{\text{Non-insect}}$	Y	NA
	Non-insect abundance		Increase	$[\text{Abundance}]_{\text{Non-insect}}$	N	NA

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*Standardized to OTU and fixed count, see Metadata for details

SampleID	Station (NAMC)	Station (Customer)	Waterbody	County	State	Latitude
150160	MDLCKBK-01	M7.9	Middle Creek at Buck Creek, Mile 7.9	Douglas	OR	42.837
150161	UPMARTIN-01	Martin Creek ref	Upper Martin Creek, Reference site	Douglas	OR	42.83
150162	MDLCK-3	M3.0	Middle Creek, Mile 3 above confluence of South Fork	Douglas	OR	42.847
150163	MDLCK-3.1	M3.1	Middle Creek, Mile 3.1, below confluence	Douglas	OR	42.847
150164	MIDCRMID	M2.0	Middle Creek	Douglas	OR	42.85348
150165	MIDBEN	M1.2	Middle Bench	Douglas	OR	42.85599
150166	MREF1	MREF	Middle Creek Reference (trib)	Douglas	OR	42.85803
150167	SFREF1	SFREF	South Fk Middle Creek Ref (Trib)	Douglas	OR	42.83163
150168	SF1.0	SF1.0	South Fork Middle Creek	Douglas	OR	42.83697
150169	SF3.0	Sf3.0	South Fork Middle Creek	Douglas	OR	42.83391

Longitude	Collection Date	Habitat Sampled	Collection Method	Field Notes	Lab Notes	Area sampled (m^2)	Field Split	Lab Split	Split Count	Fixed Count	Big Rare Count
-123.505	6/18/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	12.5	810	300	36
-123.488	6/18/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	18.75	764	300	15
-123.434	6/18/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	12.5	608	300	8
-123.437	6/18/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	7.81	657	300	10
-123.4164779	6/18/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	9.38	643	300	11
-123.4047075	6/19/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	50	712	300	2
-123.403607	6/19/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	18.75	699	300	27
-123.3727245	6/19/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	25	621	300	4
-123.3806736	6/19/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	100	53	23	0
-123.4123943	6/19/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	7.81	668	300	12

Richness*	Abundance	Shannon's Diversity*	Simpson's Diversity*	Evenness*	# of EPT Taxa*	EPT Taxa Abundance	Dominant Family	Abundance of Dominant Family
27	8805	2.280721975	0.824659978	0.692000869	17	4435	Simuliidae	3070
32	5527	2.651307181	0.879487179	0.765005544	19	3662	Chironomidae	1362
15	6584	1.391001738	0.6	0.51365434	6	4873	Baetidae	2681
16	11381	1.801955354	0.76599777	0.649918013	6	8315	Baetidae	3202
14	9278	1.007146159	0.424214047	0.381631027	7	7564	Baetidae	6318
10	1927	1.002784507	0.46729097	0.435503778	3	1408	Baetidae	1311
38	5074	2.815402141	0.886822742	0.773975383	20	2943	Chironomidae	1235
27	3362	2.365475847	0.859576366	0.717716302	13	2296	Nemouridae	746
13	72	2.343960444	0.916996047	0.913842777	5	15	Chironomidae	8
9	11575	0.567205926	0.251884058	0.258146542	4	10102	Baetidae	9712

Dominant Taxa	Abundance of Dominant Taxa	Hilsenhoff Biotic Index*	# of Intolerant Taxa*	Intolerant Taxa abundance	# of Tolerant Taxa*	Tolerant Taxa abundance	USFS Community Tolerance Quotient (d)*	# of shredder taxa*
Simulium	3016	4.173333333	10	2759	0	0	62	3
Baetis	1038	3.533333333	12	1732	0	0	58	2
Baetis	2681	4.203333333	3	1224	0	0	79	0
Baetis	3202	3.823333333	4	4797	0	0	79	1
Baetis	6174	4.18	4	1158	0	0	75	1
Baetis	1311	4.346666667	1	47	0	0	76	0
Orthocladiinae	976	3.44	10	1708	1	14	61	4
Orthocladiinae	681	3.196666667	8	1334	0	0	56	4
Diptera	30	2.782608696	1	3	0	0	85	1
Baetis	9712	4.076666667	3	92	0	0	75	0

Shredder Abundance	# of scraper taxa*	Scraper abundance	# of collector-filterer taxa*	Collector-filterer abundance	# of collector-gatherer taxa*	Collector-gatherer abundance	# of predator taxa*	Predator abundance	# of clinger taxa*
486	3	199	2	3168	9	2243	7	1022	11
613	3	575	2	124	10	3041	10	691	13
832	1	32	3	643	4	3611	6	370	6
242	0	52	2	2046	4	5003	7	1322	5
259	1	0	2	174	4	7629	5	1043	4
0	0	0	1	8	4	1697	5	214	3
486	4	965	4	285	9	1725	12	958	11
497	2	162	1	97	5	1276	12	557	8
1	1	1	1	3	4	12	5	23	3
17	0	0	0	91	3	10768	6	457	2

Long-lived Taxa*	# of Ephemeroptera taxa*	Ephemeroptera abundance	# of Plecoptera taxa*	Plecoptera abundance	# of Trichoptera taxa*	Trichoptera abundance	# of Coleoptera taxa*	Coleoptera abundance	# of Elmidae Taxa*
5	7	1572	6	2507	4	357	3	346	3
7	6	1557	8	1356	5	749	3	137	3
1	1	2681	2	1799	3	393	0	0	0
1	1	3202	3	3221	2	1891	1	35	0
1	2	6318	3	895	2	351	1	29	1
1	1	1311	0	0	2	97	1	11	0
6	7	570	6	1395	7	978	1	130	1
6	4	568	5	1422	4	307	5	178	3
2	2	4	0	3	3	8	1	1	0
1	1	9712	2	298	1	92	0	1	0

Elmidae abundance	# of Megaloptera taxa*	Megaloptera abundance	# of Diptera taxa*	Diptera abundance	# of Chironomidae taxa*	Chironomidae abundance	# of Crustacea taxa*	Crustacea abundance	# of Oligochaete taxa*
151	0	0	6	3776	3	638	0	0	0
36	0	0	7	1519	3	1362	0	0	0
0	0	0	7	1678	3	995	0	0	0
0	0	0	7	2824	3	1942	0	0	0
14	0	0	5	1671	3	1484	0	0	0
0	0	0	5	497	3	430	0	0	0
65	0	0	12	1502	3	1235	0	0	0
59	0	0	8	834	2	692	0	0	0
0	1	1	5	42	3	8	0	0	0
0	0	0	4	1246	3	1090	0	0	0

Oligochaete abundance	# of Mollusca taxa*	Mollusca abundance	# of Insect taxa*	Insect abundance	# of Non-insect taxa*	Non-insect abundance
32	0	0	26	8568	1	238
72	0	7	30	5332	2	195
0	1	11	13	6551	2	32
0	0	0	14	11208	2	173
0	0	0	13	9264	1	14
0	0	0	9	1922	1	5
7	1	428	34	4589	4	486
0	0	5	26	3308	1	54
0	0	0	12	61	1	11
0	0	0	8	11350	1	225

								SampleID	150160	150161	150162	150163	150164	150165	150166	150167	150168	150169
								Station (NAMC)	MDLCKBK-01	UPMARTIN-01	MDLCK-3	MDLCK-3.1	MIDCRMID	MIDBEN	MREF1	SFREF1	SF1.0	SF3.0
								Station (Customer)	M7.9	Martin Creek ref	M3.0	M3.1	M2.0	M1.2	MREF	SFREF	SF1.0	Sf3.0
								Waterbody	Middle Creek at Buck Creek, Mile 7.9	Upper Martin Creek, Reference site	Middle Creek, Mile 3 above confluence of South Fork	Middle Creek, Mile 3.1, below confluence	Middle Creek	Middle Bench	Middle Creek Reference (trib)	South Fk Middle Creek Ref (Trib)	South Fork Middle Creek	South Fork Middle Creek
								County	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas
								State	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
								Latitude	42.837	42.83	42.847	42.847	42.85347712	42.85598678	42.85803487	42.8316279	42.83696893	42.83390533
								Longitude	-123.505	-123.488	-123.434	-123.437	-123.4164779	-123.4047075	-123.403607	-123.3727245	-123.3806736	-123.4123943
								Collection Date	6/18/2013	6/18/2013	6/18/2013	6/18/2013	6/18/2013	6/19/2013	6/19/2013	6/19/2013	6/19/2013	6/19/2013
								Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
								Collection Method	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net
								Field Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
								Lab Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
								Area sampled (m^2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
								Field Split	100	100	100	100	100	100	100	100	100	100
								Lab Split	12.5	18.75	12.5	7.81	9.38	50	18.75	25	100	7.81
								Split Count	810	764	608	657	643	712	699	621	53	668
Code	**Phylum**	**Class**	**Order**	**Family**	**SubFamily**	**Genus**	**Species**											
19	Annelida	Clitellata							32	72	0	0	0	0	7	0	0	0
58	Arthropoda	Arachnida	Trombidiformes						151	36	11	87	0	0	36	27	8	104
65	Arthropoda	Arachnida	Trombidiformes	Hydryphantidae		Protzia			0	0	0	0	14	0	0	0	0	0
63	Arthropoda	Arachnida	Trombidiformes	Lebertiidae		Lebertia			0	29	0	0	0	0	0	0	0	0
2150	Arthropoda	Arachnida	Trombidiformes	Mideopsidae		Mideopsis			11	0	0	0	0	0	0	0	0	0
67	Arthropoda	Arachnida	Trombidiformes	Sperchonidae		Sperchon			0	0	11	0	0	0	0	11	0	0
2162	Arthropoda	Arachnida	Trombidiformes	Sperchonidae		Sperchonopsis			22	0	0	0	0	0	0	0	0	0
54	Arthropoda	Arachnida	Trombidiformes	Torrenticolidae					0	0	0	0	0	3	0	0	0	0
2172	Arthropoda	Arachnida	Trombidiformes	Torrenticolidae		Torrenticola			11	50	0	69	0	0	7	0	0	104
94	Arthropoda	Entognatha	Collembola						0	0	0	0	0	3	0	11	3	17
105	Arthropoda	Insecta	Coleoptera	Dytiscidae					0	0	0	0	0	0	0	27	0	1
118	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporinae	Oreodytes			0	0	0	0	14	0	0	0	0	0
121	Arthropoda	Insecta	Coleoptera	Elmidae					0	86	0	0	0	3	7	59	0	0
1743	Arthropoda	Insecta	Coleoptera	Elmidae		Cleptelmis	addenda		11	7	0	0	0	0	0	0	0	0
128	Arthropoda	Insecta	Coleoptera	Elmidae		Heterlimnius			0	0	0	0	0	0	101	5	0	0
846	Arthropoda	Insecta	Coleoptera	Elmidae		Heterlimnius	koebelei		0	0	0	0	0	0	0	5	0	0
130	Arthropoda	Insecta	Coleoptera	Elmidae		Lara			0	0	0	0	0	0	0	5	0	0
133	Arthropoda	Insecta	Coleoptera	Elmidae		Narpus			11	0	0	0	0	3	0	0	0	0
135	Arthropoda	Insecta	Coleoptera	Elmidae		Optioservus			108	0	0	0	0	0	0	0	0	0
1076	Arthropoda	Insecta	Coleoptera	Elmidae		Optioservus	quadrimaculatus		22	0	0	0	14	0	0	0	0	0
1077	Arthropoda	Insecta	Coleoptera	Elmidae		Ordobrevia	nubifera		0	14	0	0	0	0	0	0	0	0
144	Arthropoda	Insecta	Coleoptera	Elmidae		Zaitzevia			195	14	0	17	0	0	0	65	0	0
153	Arthropoda	Insecta	Coleoptera	Hydrophilidae					0	0	0	17	0	5	0	11	1	0
670	Arthropoda	Insecta	Coleoptera	Psephenidae		Acneus			0	0	0	0	0	0	22	0	0	0
1079	Arthropoda	Insecta	Coleoptera	Psephenidae	Eubrianacinae	Eubrianax	edwardsii		0	14	0	0	0	0	0	0	0	0
173	Arthropoda	Insecta	Diptera						0	0	0	0	14	0	0	0	30	0
179	Arthropoda	Insecta	Diptera	Ceratopogonidae					0	0	22	52	14	0	0	0	1	17
908	Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	Probezzia			0	0	43	104	58	3	29	5	0	0
180	Arthropoda	Insecta	Diptera	Chironomidae					32	108	32	35	0	32	7	0	0	0
182	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae				65	368	65	35	14	5	137	5	1	17
184	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae				530	771	822	1507	1297	319	976	681	4	1021
187	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae				11	115	76	366	173	73	115	5	3	52
198	Arthropoda	Insecta	Diptera	Dixidae		Dixa			0	29	0	0	0	0	94	70	1	0
1830	Arthropoda	Insecta	Diptera	Dixidae		Meringodixa	chalonensis		0	7	0	0	0	0	50	0	0	0
200	Arthropoda	Insecta	Diptera	Empididae					0	0	22	0	0	11	0	0	0	0
202	Arthropoda	Insecta	Diptera	Empididae		Clinocera			0	0	0	87	29	0	0	0	0	69
204	Arthropoda	Insecta	Diptera	Empididae		Oreogeton			0	0	0	0	0	0	7	5	0	0
201	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae	Chelifera			0	0	32	0	0	22	0	11	0	0
213	Arthropoda	Insecta	Diptera	Pelecorhynchidae		Glutops			0	14	0	0	0	0	7	22	1	0
216	Arthropoda	Insecta	Diptera	Psychodidae		Pericoma			0	0	0	0	0	0	14	0	0	0
221	Arthropoda	Insecta	Diptera	Simuliidae					54	0	500	0	0	3	0	0	0	0
223	Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	Simulium			3016	50	32	433	72	0	14	0	0	52
237	Arthropoda	Insecta	Diptera	Tipulidae		Dicranota			35	14	22	0	0	5	22	22	0	17
241	Arthropoda	Insecta	Diptera	Tipulidae		Hexatoma			0	5	0	0	0	0	29	7	0	0
236	Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	Antocha	monticola		32	36	11	208	0	24	0	0	0	0
303	Arthropoda	Insecta	Ephemeroptera	Ameletidae		Ameletus			0	0	0	0	0	0	16	0	0	0
249	Arthropoda	Insecta	Ephemeroptera	Baetidae					0	58	0	0	101	0	7	0	0	0
907	Arthropoda	Insecta	Ephemeroptera	Baetidae		Acentrella			11	0	0	0	0	0	0	0	0	0
250	Arthropoda	Insecta	Ephemeroptera	Baetidae		Baetis			811	1038	2681	3202	6174	1311	297	378	3	9712
252	Arthropoda	Insecta	Ephemeroptera	Baetidae		Centroptilum			0	0	0	0	43	0	0	0	0	0
834	Arthropoda	Insecta	Ephemeroptera	Baetidae		Diphetor	hageni		435	144	0	0	0	0	50	22	0	0
1180	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Drunella			22	0	0	0	0	0	14	5	0	0
267	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Drunella	doddsii		11	14	0	0	0	0	0	0	0	0
271	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Serratella			22	14	0	0	0	0	0	0	0	0
276	Arthropoda	Insecta	Ephemeroptera	Heptageniidae					0	58	0	0	0	0	37	114	0	0
278	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Cinygma			0	0	0	0	0	0	65	0	0	0
280	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Epeorus			250	86	0	0	0	0	0	22	0	0

282	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Ironodes			0	36	0	0	0	0	14	0	1	0
287	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae					11	0	0	0	0	0	69	27	0	0
292	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae		Paraleptophlebia			0	108	0	0	0	0	0	0	0	0
326	Arthropoda	Insecta	Hemiptera	Gerridae					0	0	0	0	0	5	7	0	1	0
359	Arthropoda	Insecta	Megaloptera	Sialidae		Sialis			0	0	0	0	0	0	0	0	1	0
1187	Arthropoda	Insecta	Odonata	Cordulegastridae		Cordulegaster	dorsalis		0	0	0	0	0	0	7	0	0	0
385	Arthropoda	Insecta	Odonata	Gomphidae					11	14	0	35	0	0	0	0	0	0
403	Arthropoda	Insecta	Plecoptera						11	0	551	17	0	0	137	114	0	87
404	Arthropoda	Insecta	Plecoptera	Capniidae	Capniinae				227	0	0	0	0	0	0	0	0	0
419	Arthropoda	Insecta	Plecoptera	Chloroperlidae		Sweltsa			22	43	0	35	29	0	39	178	0	37
5757	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Chloroperlinae				76	223	143	138	29	0	137	211	1	138
418	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Chloroperlinae	Suwallia			0	7	0	0	0	0	0	0	0	0
420	Arthropoda	Insecta	Plecoptera	Leuctridae					0	36	0	0	0	0	36	97	0	0
429	Arthropoda	Insecta	Plecoptera	Nemouridae					54	454	832	208	245	0	79	259	0	0
431	Arthropoda	Insecta	Plecoptera	Nemouridae		Malenka			1341	195	249	2474	115	0	137	373	0	0
439	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada			173	36	0	35	14	0	79	114	0	17
441	Arthropoda	Insecta	Plecoptera	Peltoperlidae		Soliperla			0	0	0	0	0	0	22	0	0	0
443	Arthropoda	Insecta	Plecoptera	Peltoperlidae		Yoraperla			11	86	0	0	0	0	195	5	0	0
444	Arthropoda	Insecta	Plecoptera	Perlidae					318	144	0	311	375	0	440	65	1	0
837	Arthropoda	Insecta	Plecoptera	Perlidae		Calineuria	californica		241	16	23	3	1	0	51	5	0	19
1193	Arthropoda	Insecta	Plecoptera	Perlidae		Doroneuria	baumanni		0	7	0	0	0	0	0	0	0	0
838	Arthropoda	Insecta	Plecoptera	Perlidae		Hesperoperla	pacifica		35	79	0	0	0	0	0	0	0	0
455	Arthropoda	Insecta	Plecoptera	Perlodidae					0	29	0	0	86	0	43	0	0	0
480	Arthropoda	Insecta	Trichoptera						23	22	151	69	0	5	115	0	0	17
531	Arthropoda	Insecta	Trichoptera	Apataniidae		Apatania			0	108	0	0	0	0	7	0	0	0
481	Arthropoda	Insecta	Trichoptera	Brachycentridae					86	0	0	1488	101	0	166	0	0	0
1199	Arthropoda	Insecta	Trichoptera	Brachycentridae		Amiocentrus	aspilus		0	115	0	0	0	0	0	0	0	0
484	Arthropoda	Insecta	Trichoptera	Brachycentridae		Micrasema			0	0	0	0	0	0	22	0	0	0
1200	Arthropoda	Insecta	Trichoptera	Calamoceratidae	Calamoceratinae	Heteroplectron	californicum		0	0	0	0	0	0	0	0	1	0
487	Arthropoda	Insecta	Trichoptera	Glossosomatidae					22	72	22	52	0	0	339	38	0	0
491	Arthropoda	Insecta	Trichoptera	Glossosomatidae	Glossosomatinae	Glossosoma			0	254	0	0	0	0	14	0	0	0
495	Arthropoda	Insecta	Trichoptera	Hydropsychidae					0	14	0	0	0	5	0	38	3	0
502	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	Parapsyche			0	0	0	0	0	0	22	5	0	19
499	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	Hydropsyche			11	1	111	125	1	0	0	0	0	20
519	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostomatinae	Lepidostoma			11	0	0	0	0	0	68	16	0	0
528	Arthropoda	Insecta	Trichoptera	Limnephilidae					0	0	0	0	0	0	7	0	0	0
1201	Arthropoda	Insecta	Trichoptera	Limnephilidae		Allocosmoecus	partitus		0	7	0	0	0	0	0	0	0	0
536	Arthropoda	Insecta	Trichoptera	Limnephilidae	Dicosmoecinae	Dicosmoecus			36	1	0	0	0	0	0	0	0	0
555	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilinae	Psychoglypha			1	0	0	0	0	0	9	0	0	0
568	Arthropoda	Insecta	Trichoptera	Philopotamidae	Philopotaminae	Wormaldia			0	58	0	0	0	0	76	49	0	0
578	Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropodinae	Polycentropus			0	0	11	0	58	39	22	0	3	17
584	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila			151	79	65	35	101	22	29	103	0	0
1706	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	angelita group		1	1	12	1	62	26	0	46	0	0
1668	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	betteni group		3	13	22	121	29	0	68	5	0	17
1495	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	grandis		0	0	0	0	0	0	0	1	0	0
1496	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	grandis group		0	0	0	0	0	0	0	0	0	1
1505	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	vofixa group		0	0	0	0	0	0	0	0	1	0
587	Arthropoda	Insecta	Trichoptera	Sericostomatidae		Gumaga			11	0	0	0	0	0	0	0	0	0
550	Arthropoda	Insecta	Trichoptera	Uenoidae		Oligophlebodes			0	0	0	0	0	0	0	5	0	0
549	Arthropoda	Insecta	Trichoptera	Uenoidae	Thremmatinae	Neophylax			0	3	0	0	0	0	16	0	0	0
647	Mollusca	Bivalvia	Veneroida	Pisidiidae	Pisidiinae	Pisidium			0	0	0	0	0	0	7	5	0	0
633	Mollusca	Gastropoda	Neotaenioglossa	Hydrobiidae					0	0	11	0	0	0	0	0	0	0
636	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae		Juga			0	7	0	0	0	0	421	0	0	0
652	Nemata								0	0	0	0	0	0	7	0	0	0
655	Platyhelminthes	Turbellaria							11	0	0	17	0	0	0	0	0	0

							SampleID	150160	150161	150162	150163	150164	150165	150166	150167	150168	150169
							Station (NAMC)	MDLCKBK-01	UPMARTIN-01	MDLCK-3	MDLCK-3.1	MIDCRMID	MIDBEN	MREF1	SFREF1	SF1.0	SF3.0
							Station (Customer)	M7.9	Martin Creek ref	M3.0	M3.1	M2.0	M1.2	MREF	SFREF	SF1.0	Sf3.0
							Waterbody	Middle Creek at Buck Creek, Mile 7.9	Upper Martin Creek, Reference site	Middle Creek, Mile 3 above confluence of South Fork	Middle Creek, Mile 3.1, below confluence	Middle Creek	Middle Bench	Middle Creek Reference (trib)	South Fk Middle Creek Ref (Trib)	South Fork Middle Creek	South Fork Middle Creek
							County	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas
							State	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
							Latitude	42.837	42.83	42.847	42.847	42.85347712	42.85598678	42.85803487	42.8316279	42.83696893	42.83390533
							Longitude	-123.505	-123.488	-123.434	-123.437	-123.4164779	-123.4047075	-123.403607	-123.3727245	-123.3806736	-123.4123943
							Collection Date	6/18/2013	6/18/2013	6/18/2013	6/18/2013	6/18/2013	6/19/2013	6/19/2013	6/19/2013	6/19/2013	6/19/2013
							Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
							Collection Method	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net
							Field Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
							Lab Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
							Area sampled (m^2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
							Field Split	100	100	100	100	100	100	100	100	100	100
							Lab Split	12.5	18.75	12.5	7.81	9.38	50	18.75	25	100	7.81
							Split Count	810	764	608	657	643	712	699	621	53	668
OTUCode	**Phylum**	**Class**	**Order**	**Family**	**Genus**	**Species**	**OTUName**										
27	Arthropoda	Insecta	Coleoptera				Oreodytes	0	0	0	0	14	0	0	0	0	0
43	Arthropoda	Insecta	Coleoptera	Elmidae			Optioservus	108	0	0	0	14	0	0	0	0	0
231	Arthropoda	Insecta	Coleoptera	Elmidae			Oreogeton	0	0	0	0	0	0	7	5	0	0
228	Arthropoda	Insecta	Diptera	Chironomidae			Clinocera	0	0	0	87	29	0	0	0	0	69
89	Arthropoda	Insecta	Diptera	Psychodidae			Tanypodinae	11	115	76	366	173	73	115	5	3	52
143	Arthropoda	Insecta	Diptera	Tipulidae			Cinygma	0	0	0	0	0	0	65	0	0	0
237	Arthropoda	Insecta	Diptera	Tipulidae			Glutops	0	14	0	0	0	0	7	22	1	0
244	Arthropoda	Insecta	Diptera	Tipulidae			Simuliidae	3016	50	500	433	72	3	14	0	0	52
227	Arthropoda	Insecta	Plecoptera	Chloroperlidae			Chelifera_Metachela_Neoplasta	0	0	32	0	0	22	0	11	0	0
225	Arthropoda	Insecta	Plecoptera	Leuctridae			Meringodixa	0	7	0	0	0	0	50	0	0	0
84	Arthropoda	Insecta	Plecoptera	Nemouridae			Chironominae	65	368	65	35	14	5	137	5	1	17
80	Arthropoda	Insecta	Plecoptera	Peltoperlidae			Ceratopogoninae	0	0	43	104	58	3	29	5	0	0
5	Arthropoda	Insecta	Plecoptera	Peltoperlidae			Other_Oligochaeta	32	72	0	0	0	0	7	0	0	0
240	Arthropoda	Insecta	Trichoptera				Pericoma_Telmatoscopus	0	0	0	0	0	0	14	0	0	0
86	Arthropoda	Insecta	Trichoptera	Glossosomatidae			Orthocladiinae	530	771	822	1507	1297	319	976	681	4	1021
72	Arthropoda	Insecta	Trichoptera	Hydropsychidae			Eubrianax	0	14	0	0	0	0	0	0	0	0
36	Arthropoda	Insecta	Trichoptera	Hydropsychidae			Lara	0	0	0	0	0	0	0	5	0	0
40	Arthropoda	Insecta	Trichoptera	Leptoceridae			Narpus	11	0	0	0	0	3	0	0	0	0
71	Arthropoda	Insecta	Trichoptera	Limnephilidae			Acneus	0	0	0	0	0	0	22	0	0	0
48	Arthropoda	Insecta	Trichoptera	Limnephilidae			Zaitzevia	195	14	0	17	0	0	0	65	0	0
33	Arthropoda	Insecta	Trichoptera	Philopotamidae			Cleptelmis	11	7	0	0	0	0	0	0	0	0
223	Arthropoda	Insecta	Trichoptera	Philopotamidae			Dixa	0	29	0	0	0	0	94	70	1	0
7	Mollusca	Bivalvia					Acari	151	50	11	87	14	3	36	27	8	104
44	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae			Ordobrevia	0	14	0	0	0	0	0	0	0	0

Excel Worksheet Name	Worksheet Description
OE output	O/E (Observed/Expected) scores along with corresponding biological condition. Prior to O/E score computation, taxa are standardized to Operational Taxonomic Units (OTUs) and a fixed count of 300 individuals (unless otherwise requested).

The O/E model used for this analysis was the Oregon DEQ Predator 2005 (WCCP) model.
See additional documentation below and at http://www.usu.edu/buglab and http://www.cnr.usu.edu/wmc.

Description of the fields contained in the 'OE output' worksheet. A more detailed explanation of each metric is given at http://www.usu.edu/buglab

Column Name	Explanation	Predicted response to increasing perturbation	Calculation	Reference
OE	O/E (Observed/Expected) score based on a 0.5 probability of capture threshold.	Decrease	[Observed probability of caputre]/[Expected probability of capture]	WMC, Hawkins et al. 2000, Stoddard et al. 2006
Condition	Rating of "Good", "Fair", or "Poor" based on O/E score relative to the distribution of scores for reference sites. Samples with less than the required number of organisms are given an NA or "Null" rating because they did not meet model requirements.	A "Poor" rating should receive additional analysis or sampling before classifying the sites as impaired.	>Mean±2SD = "Poor", >Mean±1SD = "Fair", <Mean±1SD = "Good"	WMC, Hawkins et al. 2000, Stoddard et al. 2006
PassFail	This field indicates whether or not the site's habitat variables were within the range of experience of the model. A fail ("F") indicates the model had to extrapolate, rather than interpolate, to accommodate one or more of the habitat variables. O/E scores and condition ratings should be interpretted cautiosly if a site failed the model.	NA	NA	WMC

Analysis methods

We used the Oregon Department of Environmental Quality observed/expected (O/E) index, aka "Predator", to assess biological condition of sampled sites (Hubler, 2008). O/E models compare the macroinvertebrate taxa observed at sites of unknown biological condition (i.e., 'test sites') to the assemblages expected to be found in the absence of anthropogenic stressors (see Hawkins et al. 2000 for details). The Predator O/E model for the Western Cordillera and Columbia Plateau ecoregion is based on 167 reference sites grouped into 5 distinct classes based on the similarity of macroinvertebrate assemblage composition among sites following the standard methods of Hawkins et al. (2000) and described in detail within the EMAP-West statistical summary (Stoddard et al. 2006). The expected class membership and subsequent reference macroinvertebrate assemblage (E) for comparison to test sites is predicted by linear discriminant function models using outlet elevation, mean annual maximum air temperature, mean annual precipitation, and location in western or eastern Oregon. Prior to computing O/E scores, data for all test sites was standardized to the operational taxonomic units used to derive the Predator O/E model (Hubler, 2008) and re-sampled to a 300 fixed-count. Following the recommendations of Hawkins et al. (2000), O/E scores were calculated for taxa having a probability of capture $\geq$ 0.5 to increase the precision of O/E estimates and subsequent model sensitivity to stressors. Biological condition was subsequently assessed based on the precision of the reference site data set used to develop the Predator WCCP O/E model (mean =1.01, standard deviation (SD) = 0.15), with test sites scoring less than one SD below the mean of reference sites in "Good" biological condition (i.e. comparable to reference conditions); sites scoring between one SD and two SD in "Fair" biological condition; and sites scoring more than two SD below the mean of reference sites in "Poor" biological condition. For the Predator O/E model, the minimum count required for assinging an O/E score and biological condition rating is 200 individuals. Samples with less than 200 individuals were not given a condition rating.

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Sample Id	Station (NAMC)	Station (Customer)	Stream	County	State	Latitude
150160	MDLCKBK-01	M7.9	Middle Creek at Buck Creek, Mile 7.9	Douglas	OR	42.837
150161	UPMARTIN-01	Martin Creek ref	Upper Martin Creek, Reference site	Douglas	OR	42.83
150162	MDLCK-3	M3.0	Middle Creek, Mile 3 above confluence of South Fork	Douglas	OR	42.847
150163	MDLCK-3.1	M3.1	Middle Creek, Mile 3.1, below confluence	Douglas	OR	42.847
150164	MIDCRMID	M2.0	Middle Creek	Douglas	OR	42.85347712
150165	MIDBEN	M1.2	Middle Bench	Douglas	OR	42.85598678
150166	MREF1	MREF	Middle Creek Reference (trib)	Douglas	OR	42.85803487
150167	SFREF1	SFREF	South Fk Middle Creek Ref (Trib)	Douglas	OR	42.8316279
150168	SF1.0	SF1.0	South Fork Middle Creek	Douglas	OR	42.83696893
150169	SF3.0	Sf3.0	South Fork Middle Creek	Douglas	OR	42.83390533

Longitude	Collection Date	Habitat Sampled	Collection Method	Field Notes	Lab Notes	Area sampled(m^2)	Field Split
-123.505	6/18/2013	Targeted Riffle	Surber net			0.74	100
-123.488	6/18/2013	Targeted Riffle	Surber net			0.74	100
-123.434	6/18/2013	Targeted Riffle	Surber net			0.74	100
-123.437	6/18/2013	Targeted Riffle	Surber net			0.74	100
-123.4164779	6/18/2013	Targeted Riffle	Surber net			0.74	100
-123.4047075	6/19/2013	Targeted Riffle	Surber net			0.74	100
-123.403607	6/19/2013	Targeted Riffle	Surber net			0.74	100
-123.3727245	6/19/2013	Targeted Riffle	Surber net			0.74	100
-123.3806736	6/19/2013	Targeted Riffle	Surber net		Resampled macroinvertebrate count is insufficient for model requirements to determine condition.	0.74	100
-123.4123943	6/19/2013	Targeted Riffle	Surber net			0.74	100

Lab Split	# of SubSampled Organisms	# of Resampled Individuals	OTU_ Richness	OE	Condition	Pass/ Fail
12.5	810	300	27	0.895634	Good	P
18.75	764	300	32	0.928859	Good	P
12.5	608	300	15	0.645908	Poor	P
7.81	657	300	16	0.710073	Fair	P
9.38	643	300	14	0.589226	Poor	P
50	712	300	10	0.463532	Poor	P
18.75	699	300	38	0.927948	Good	P
25	621	300	27	0.799459	Fair	P
100	53	23	13	0.398428	NA	P
7.81	668	300	9	0.523136	Poor	P

BLM/USU National Aquatic Monitoring Center (NAMC)
Department of Watershed Sciences (WATS) - Utah State University 5210 Old Main Hill Logan, UT 84322-5210
http://www.usu.edu/buglab/

Report prepared by:
Scott Miller: 435.797.2612 / scott.miller@usu.edu
Sarah Judson: 435.797.3310 / sarah.judson@usu.edu

Report prepared for:

Customer contact:	Cory Sipher
Customer:	BLM - OR - Roseburg District Office
Customer Address :	777 Nw Garden Valley Blvd
Customer City, State, Zip:	Roseburg OR 97470
Customer Phone:	541-464-3249
Customer Email:	csipher@blm.gov

Report Table of Contents

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Metrics
Species Matrix (Raw)
Species Matrix (Standardized)

Excel Worksheet Name	Worksheet Description
Metrics	Common metrics used to assess freshwater biological integrity, as well as basic field and lab processing information . Note that values for richness based metrics are standardized to operational taxonomic units (OTUs; sensu Cuffney et al. 2007) and a fixed count (i.e., rarefaction) of 300, but density metrics are based on the raw taxa list. Standardized metrics are indicated with an asterisk. NAMC OTU standardization uses the method of removing individuals identified to the coarser taxonomic resolution or merging finer level identifications to coarser levels. We are able to standardize your data to custom OTUs and/or fixed counts if provided, although additional charges may apply. A more detailed explanation of each metric, as well as references, can be obtained by contacting NAMC and will soon be available on our website. **This report was generated with the following settings - OTUs: Genus (Oregon Predator WCCP); Fixed Count: 300.**
Species Matrix (Raw)	Raw taxonomic and abundance data for sampled sites. Abundance data is the estimated number of individuals per square meter for quantitative samples OR the estimated number of individuals per sample for qualitative samples. Note that the taxonomic data in this worksheet **has not been standardized to operational taxonomic units (OTUs)**, thus considerable redundancy likely exists in the taxonomic hierarchy.
Species Matrix (Standardized)	Taxonomic and abundance data (Species matrix) for sampled sites that has been standardized to Operational Taxonomic Units (OTUs) but not standardized to fixed count. Please note that data has not been standardized to a fixed count as in the 'Standardized Metrics worksheet'. Also, abundance data is the estimated number per square meter for quantitative samples OR is the estimated number per sample for qualitative samples.

Description of the fields contained in the 'Metrics' worksheet. A more detailed explanation of each metric is available on our website (http://usu.edu/buglab/SampleProcessing/ResultsAndReports/#item=85).

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Collection information	SampleID	NAMC unique tracking number	NA	NA	NA	NA
	Station (NAMC)	NAMC station tracking id	NA	NA	NA	NA
	Station (Customer)	Station abbreviation provided by the customer	NA	NA	NA	NA
	Waterbody	Specific location name	NA	NA	NA	NA
	County	Administrative boundary	NA	NA	NA	NA
	State	Administrative boundary	NA	NA	NA	NA
	Latitude	Y coordinate in decimal degree units	NA	NA	NA	NA
	Longitude	X coordinate in decimal degree units	NA	NA	NA	NA
	Collection Date	Date of sampling event	NA	NA	NA	NA
	Habitat Sampled	Microhabitat or channel unit(s) where sample(s) was taken. Values are restricted to predetermined values as specified in the PDF metadata.	NA	NA	NA	NA
	Collection Method	Method used to collect sample. Values are restricted to predetermined values as specified in the PDF metadata.	NA	NA	NA	NA
	Field Notes	Field notes provided by customer	NA	NA	NA	NA
	Lab Notes	Laboratory processing notes, particularly regarding condition of received samples and QAQC	NA	NA	NA	NA
	Area Sampled	Total area sampled in square meters	NA	NA	NA	NA

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Laboratory Processing	Field Split	% sample submitted for processing	NA	NA	NA	NA
	Lab Split	% of sample processed to obtain 600 random individuals (if present)	NA	NA	NA	Cuffney et al. (1993), Moulton et al. (2000), Vinson and Hawkins (1996)
	Split Count	# of organisms randomly subsampled from [Lab Split] for identification	NA	NA	NA	"
	Fixed count	# of computationally resampled organisms	NA	NA		"
	Big Rare Count	# of "big and rare" organisms selected NON-RANDOMLY for identification from the entire submitted sample	NA	NA	NA	"
Richness (metrics summarizing all unique taxa in a sample)	Richness	# of unique taxa, standardized to OTU	Decrease	$[\text{Richness}]_{\text{UniqueTaxa}}$	Y	NA
	Abundance	Estimated # number of individuals per unit area (m^2) for quantitative samples OR the estimated number per sample for qualitative samples.	Increase or decrease	(([Split Count]* (100/[Lab Split])) + [Big_Rare Count]) *(100/[Field Split]) *(1/[Area Sampled])	N	NA
	Shannon's Diversity	Measure of richness and evenness (based on relative abundance of each species); weighted toward rare species	Decrease	$-\sum([\text{Relative Abundance}]_{\text{taxa}} * \ln([\text{Relative Abundance}]_{\text{taxa}})$	Y	Ludwig and Reynolds (1988, equation 8.9, page 92)
	Simpson's Diversity	Measure of richness and evenness (based on relative abundance of each species); weighted toward common species	Decrease	$1 - [\text{Simpson's Diversity}] = 1 - \sum([\text{Relative Abundance}]_{\text{taxa}})^2$	Y	Ludwig and Reynolds (1988, equation 8.6, page 91), Krebs (1999, equation 12.27-12.30)
	Evenness	Measure of relative abundance indicative of taxa dominance	Decrease	[Shannon's Diversity]/ln([Richness])	Y	Ludwig and Reynolds (1988, equation 8.11, page 93)
	# of EPT Taxa	Richness of Ephemeroptera, Plecoptera, and Trichoptera taxa	Decrease	$[\text{Richness}]_E + [\text{Richness}]_P + [\text{Richness}]_T$	Y	Barbour et al. (1999), Karr and Chu (1998)
	EPT Taxa Abundance	Abundance of Ephemeroptera, Plecoptera, and Trichoptera taxa	Decrease	$[\text{Abundance}]_E + [\text{Abundance}]_P + [\text{Abundance}]_T$	N	"
Dominance Metrics (metrics summarizing all most abundant taxa in a sample)	Dominant Family	Taxonomic family with the highest abundance	NA	NA	N	NA
	Abundance of Dominant Family	Abundance of dominant family	Increase	$[\text{Abundance}]_{\text{dominant family}}$	N	NA
	Dominant Taxa	Individual taxa with the highest abundance	NA	NA	N	NA
	Abundance of Dominant Taxa	Abundance of dominant taxa	Increase	$[\text{Abundance}]_{\text{dominant taxa}}$	N	NA
Tolerance Indices (indices based on the indicator species concept in which taxa are assigned tolerance values)	Hilsenhoff Biotic Index	Abundance-weighted average of family-level pollution tolerances	Increase	$\sum([\text{Abundance}]_{\text{taxa}} * [\text{Tolerance}]_{\text{taxa}}) / [\text{Abundance}]_{\text{Total}}$	Y	Hilsenhoff (1987, 1988)
	# of Intolerant Taxa	# of taxa with an HBI score <= 2	Decrease	$[\text{Richness}]_{\text{intolerant}}$	Y	"
	Intolerant Taxa abundance	Abundance of taxa with an HBI score <= 2	Decrease	$[\text{Abundance}]_{\text{intolerant}}$	N	"
	# of Tolerant Taxa	# of taxa with an HBI score>=8	Increase	$[\text{Richness}]_{\text{tolerant}}$	Y	"
	Tolerant Taxa abundance	Abundance of taxa with an HBI score >=8	Increase	$[\text{Abundance}]_{\text{tolerant}}$	N	"
	USFS Community Tolerance Quotient (d)	Dominance weighted community tolerance quotient	Increase	$\sum([\text{Tolerance Quotient}] * \log([\text{Abundance}]_{\text{taxa}})) / \sum \log([\text{Abundance}]_{\text{taxa}})$	Y	Winget and Mangum (1979)

Category	Column Name	Explanation	Predicted response to increasing perturbation (Barbour et al. 1999)	Calculation	Standardized (OTU and Rarefication)	Reference
Functional Feeding Groups (classification of organisms based on morphological or behavioral adaptations for where and how food is acquired)	# of shredder taxa	# of taxa utilizing living or decomposing vascular plant tissue and CPOM	Decrease	$[\text{Richness}]_{\text{shredder}}$	Y	Merritt et. al (2008)
	Shredder Abundance	Abundance of taxa utilizing vascular plant tissue and CPOM	Decrease	$[\text{Abundance}]_{\text{shredder}}$	N	"
	# of scraper taxa	# of taxa utilizing periphyton, particularly algae and diatoms	Decrease	$[\text{Richness}]_{\text{scraper}}$	Y	"
	Scraper abundance	Abundance of taxa utilizing periphyton, particularly algae and diatoms	Decrease	$[\text{Abundance}]_{\text{scraper}}$	N	"
	# of collector-filterer taxa	# of taxa utilizing FPOM in the water column	Variable	$[\text{Richness}]_{\text{collector-filterer}}$	Y	"
	Collector-filterer abundance	Abundance of taxa utilizing FPOM in the water column	Variable	$[\text{Abundance}]_{\text{collector-filterer}}$	N	"
	# of collector-gatherer taxa	# of taxa utilizing FPOM from benthic deposits	Variable	$[\text{Richness}]_{\text{collector-gatherer}}$	Y	"
	Collector-gatherer abundance	Abundance of taxa utilizing FPOM from benthic deposits	Variable	$[\text{Abundance}]_{\text{collector-gatherer}}$	N	"
	# of predator taxa	# of taxa utilizing living animal tissue	Decrease	$[\text{Richness}]_{\text{predator}}$	Y	"
	Predator abundance	Abundance of taxa utilizing living animal tissue	Decrease	$[\text{Abundance}]_{\text{predator}}$	N	"
Functional Traits (metrics based on morphological and life history traits)	# of clinger taxa	# of taxa with fixed retreats or other strategies for clinging to rocks	Decrease	$[\text{Richness}]_{\text{clinger}}$	Y	Karr and Chu (1998), Merritt et al. (2008)
	"# of" Long-lived Taxa	# of taxa with 2 to 3 year life cycles	Decrease	$[\text{Richness}]_{\text{long-lived}}$	Y	"
Compositional Metrics (richness and abundance of various taxonomic groups)	# of Ephemeroptera taxa		Decrease	$[\text{Richness}]_{\text{Ephemeroptera}}$	Y	NA
	Ephemeroptera abundance		Decrease	$[\text{Abundance}]_{\text{Ephemeroptera}}$	N	NA
	# of Plecoptera taxa		Decrease	$[\text{Richness}]_{\text{Plecoptera}}$	Y	NA
	Plecoptera abundance		Decrease	$[\text{Abundance}]_{\text{Plecoptera}}$	N	NA
	# of Trichoptera taxa		Decrease	$[\text{Richness}]_{\text{Trichoptera}}$	Y	NA
	Trichoptera abundance		Decrease	$[\text{Abundance}]_{\text{Trichoptera}}$	N	NA
	# of Coleoptera taxa		Variable	$[\text{Richness}]_{\text{Coleoptera}}$	Y	NA
	Coleoptera abundance		Variable	$[\text{Abundance}]_{\text{Coleoptera}}$	N	NA
	# of Elmidae taxa		Decrease	$[\text{Richness}]_{\text{Elmidae}}$	Y	NA
	Elmidae abundance		Decrease	$[\text{Abundance}]_{\text{Elmidae}}$	N	NA
	# of Megaloptera taxa		Variable	$[\text{Richness}]_{\text{Megaloptera}}$	Y	NA
	Megaloptera abundance		Variable	$[\text{Abundance}]_{\text{Megaloptera}}$	N	NA
	# of Diptera taxa		Variable	$[\text{Richness}]_{\text{Diptera}}$	Y	NA
	Diptera abundance		Variable	$[\text{Abundance}]_{\text{Diptera}}$	N	NA
	# of Chironomidae taxa		Increase	$[\text{Richness}]_{\text{Chironomidae}}$	Y	NA
	Chironomidae abundance		Increase	$[\text{Abundance}]_{\text{Chironomidae}}$	N	NA
	# of Crustacea taxa		Variable	$[\text{Richness}]_{\text{Crustacea}}$	Y	NA
	Crustacea abundance		Variable	$[\text{Abundance}]_{\text{Crustacea}}$	N	NA
	# of Oligochaete taxa		Increase	$[\text{Richness}]_{\text{Oligochaeta}}$	Y	NA
	Oligochaete abundance		Increase	$[\text{Abundance}]_{\text{Oligochaeta}}$	N	NA
	# of Mollusca taxa		Variable	$[\text{Richness}]_{\text{Mollusca}}$	Y	NA
	Mollusca abundance		Variable	$[\text{Abundance}]_{\text{Mollusca}}$	N	NA
	# of Insect taxa		Decrease	$[\text{Richness}]_{\text{Insect}}$	Y	NA
	Insect abundance		Decrease	$[\text{Abundance}]_{\text{Insect}}$	N	NA
	# of non-insect taxa		Increase	$[\text{Richness}]_{\text{Non-insect}}$	Y	NA
	Non-insect abundance		Increase	$[\text{Abundance}]_{\text{Non-insect}}$	N	NA

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*Standardized to OTU and fixed count, see Metadata for details

SampleID	Station (NAMC)	Station (Customer)	Waterbody	County	State
150886	MDLCKBK-01	M7.9	Middle Creek at Buck Creek, Mile 7.9	Douglas	OR
150887	UPMARTIN-01	Martin Creek Ref	Upper Martin Creek, Reference site	Douglas	OR
150888	MDLCK-3.1	M3.1	Middle Creek, Mile 3.1, below confluence	Douglas	OR
150889	MDLCK-3	M3.0	Middle Creek, Mile 3 above confluence of South Fork	Douglas	OR
150890	MIDCRMID	M2.0	Middle Creek	Douglas	OR
150891	MIDBEN	M1.2	Middle Bench	Douglas	OR
150892	SFREF1	SFREF1	South Fk Middle Creek Ref (Trib)	Douglas	OR
150893	SF1.0	SF1.0	South Fork Middle Creek	Douglas	OR
150894	SF3.0	SF3.0	South Fork Middle Creek	Douglas	OR

Latitude	Longitude	Collection Date	Habitat Sampled	Collection Method	Field Notes	Lab Notes	Area sampled (m^2)	Field Split
42.837	-123.505	9/11/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100
42.83	-123.488	9/11/2013	Targeted Riffle	Surber net	uncontaminated from mine site	NULL	0.74	100
42.847	-123.437	9/11/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100
42.847	-123.434	9/11/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100
42.85348	-123.416478	9/11/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100
42.85599	-123.404708	9/12/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100
42.83163	-123.372725	9/12/2013	Targeted Riffle	Surber net	uncontaminated by mine runoff	NULL	0.74	100
42.83697	-123.380674	9/12/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100
42.83391	-123.412394	9/12/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100

Lab Split	Split Count	Fixed Count	Big Rare Count	Richness*	Abundance	Shannon's Diversity*	Simpson's Diversity*	Evenness*	# of EPT Taxa*	EPT Taxa Abundance
18.75	707	300	8	26	5106	2.7194797	0.91090301	0.8346836	16	2983
37.5	728	300	60	35	2705	3.0111642	0.93404682	0.84693935	18	1636
6.25	668	300	5	23	14450	2.2016183	0.83114827	0.7021599	11	9755
17.19	665	300	14	21	5247	2.2505917	0.84499443	0.7392265	12	3787
18.75	652	300	15	21	4719	1.7738144	0.69977703	0.58262483	11	2205
68.75	734	300	4	16	1448	1.4681137	0.59585284	0.52951007	7	1096
15.63	606	300	15	25	5260	2.3351187	0.8374359	0.72544542	14	2711
100	452	300	0	22	611	1.9851129	0.79018952	0.64221469	9	212
15.63	661	300	30	22	5755	1.9815411	0.77855072	0.64105916	12	3781

Dominant Family	Abundance of Dominant Family	Dominant Taxa	Abundance of Dominant Taxa	Hilsenhoff Biotic Index*	# of Intolerant Taxa*	Intolerant Taxa abundance	# of Tolerant Taxa*
Chironomidae	937	Orthocladiinae	742	3.513333333	9	1628	0
Chironomidae	462	Ironodes	288	3.003333333	11	1042	1
Nemouridae	3503	Malenka	3286	3.24	8	4653	0
Hydropsychidae	1140	Malenka	1015	3.446666667	9	1845	0
Chironomidae	2186	Orthocladiinae	1977	4.913333333	7	515	0
Baetidae	915	Baetis	892	3.57	4	275	0
Chironomidae	2179	Chironominae	1470	4.176666667	7	1485	0
Chironomidae	357	Orthocladiinae	195	4.926666667	4	43	0
Baetidae	1602	Baetis	1592	3.903333333	8	410	0

Tolerant Taxa abundance	USFS Community Tolerance Quotient (d)*	# of shredder taxa*	Shredder Abundance	# of scraper taxa*	Scraper abundance	# of collector-filterer taxa*	Collector-filterer abundance	# of collector-gatherer taxa*	Collector-gatherer abundance
0	64	4	1255	2	533	3	793	6	1528
22	62	4	441	5	696	3	134	9	911
22	67	2	757	0	43	2	4411	8	3484
0	63	3	246	2	165	2	1274	5	1635
0	71	3	167	1	29	3	700	6	3023
0	73	1	71	0	2	3	61	3	1046
0	62	3	939	2	330	3	429	6	2793
0	79	2	8	0	4	2	54	6	307
0	68	2	122	1	62	3	2130	5	2274

# of predator taxa*	Predator abundance	# of clinger taxa*	Long-lived Taxa*	# of Ephemeroptera taxa*	Ephemeroptera abundance	# of Plecoptera taxa*	Plecoptera abundance	# of Trichoptera taxa*	Trichoptera abundance
7	586	13	5	4	843	6	1477	6	663
10	443	19	9	7	794	5	470	6	372
8	1193	8	3	3	1686	5	3895	3	4174
8	785	10	3	3	786	4	1472	5	1529
7	455	7	2	3	973	3	412	5	820
8	232	4	2	2	917	1	33	4	145
7	438	8	4	6	762	3	1327	5	622
10	199	8	6	3	73	3	11	3	128
8	898	7	4	3	1655	5	443	4	1683

# of Coleoptera taxa*	Coleoptera abundance	# of Elmidae Taxa*	Elmidae abundance	# of Megaloptera taxa*	Megaloptera abundance	# of Diptera taxa*	Diptera abundance	# of Chironomidae taxa*	Chironomidae abundance
3	389	3	130	0	0	5	1582	2	937
5	116	4	22	0	0	9	589	3	462
1	65	1	43	0	0	8	4241	3	1711
1	16	1	8	0	0	7	1326	2	1069
1	29	1	7	0	0	8	2421	3	2186
1	2	0	0	0	0	6	177	2	132
2	91	2	26	0	0	7	2398	3	2179
5	14	3	5	0	0	7	378	3	357
1	17	1	9	0	0	7	1482	3	742

# of Crustacea taxa*	Crustacea abundance	# of Oligochaete taxa*	Oligochaete abundance	# of Mollusca taxa*	Mollusca abundance	# of Insect taxa*	Insect abundance	# of Non-insect taxa*	Non-insect abundance
0	0	0	0	0	0	24	4955	2	151
0	0	0	0	1	276	33	2400	2	305
0	0	0	0	0	0	21	14082	2	368
0	0	0	0	0	0	21	5207	0	39
0	0	0	0	0	0	21	4719	0	0
0	0	0	0	0	0	15	1444	1	4
0	0	0	0	0	0	23	5199	2	61
0	0	0	0	0	0	21	604	1	7
0	0	0	0	0	0	21	5289	1	467

								SampleID	150886	150887	150888	150889	150890	150891	150892	150893	150894
								Station (NAMC)	MDLCKBK-01	UPMARTIN-01	MDLCK-3.1	MDLCK-3	MIDCRMID	MIDBEN	SFREF1	SF1.0	SF3.0
								Station (Customer)	M7.9	Martin Creek Ref	M3.1	M3.0	M2.0	M1.2	SFREF1	SF1.0	SF3.0
								Waterbody	Middle Creek at Buck Creek, Mile 7.9	Upper Martin Creek, Reference site	Middle Creek, Mile 3.1, below confluence	Middle Creek, Mile 3 above confluence of South Fork	Middle Creek	Middle Bench	South Fk Middle Creek Ref (Trib)	South Fork Middle Creek	South Fork Middle Creek
								County	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas
								State	OR	OR	OR	OR	OR	OR	OR	OR	OR
								Latitude	42.837	42.83	42.847	42.847	42.85347712	42.85598678	42.8316279	42.83696893	42.83390533
								Longitude	-123.505	-123.488	-123.437	-123.434	-123.4164779	-123.4047075	-123.3727245	-123.3806736	-123.4123943
								Collection Date	9/11/2013	9/11/2013	9/11/2013	9/11/2013	9/11/2013	9/12/2013	9/12/2013	9/12/2013	9/12/2013
								Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
								Collection Method	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net
								Field Notes	NULL	uncontaminated from mine site	NULL	NULL	NULL	NULL	uncontaminated by mine runoff	NULL	NULL
								Lab Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
								Area sampled (m^2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
								Field Split	100	100	100	100	100	100	100	100	100
								Lab Split	18.75	37.5	6.25	17.19	18.75	68.75	15.63	100	15.63
								Split Count	707	728	668	665	652	734	606	452	661
Code	**Phylum**	**Class**	**Order**	**Family**	**SubFamily**	**Genus**	**Species**										
58	Arthropoda	Arachnida	Trombidiformes						22	4	151	24	0	4	26	4	52
65	Arthropoda	Arachnida	Trombidiformes	Hydryphantidae		Protzia			7	0	0	0	0	0	0	0	9
59	Arthropoda	Arachnida	Trombidiformes	Hygrobatidae					7	0	0	0	0	0	0	0	0
63	Arthropoda	Arachnida	Trombidiformes	Lebertiidae		Lebertia			29	4	0	0	0	0	0	0	0
2150	Arthropoda	Arachnida	Trombidiformes	Mideopsidae		Mideopsis			0	0	0	0	0	0	0	3	0
66	Arthropoda	Arachnida	Trombidiformes	Sperchonidae					0	0	0	0	0	0	0	0	35
67	Arthropoda	Arachnida	Trombidiformes	Sperchonidae		Sperchon			0	7	0	0	0	0	0	0	0
2162	Arthropoda	Arachnida	Trombidiformes	Sperchonidae		Sperchonopsis			22	0	43	0	0	0	9	0	0
2171	Arthropoda	Arachnida	Trombidiformes	Torrenticolidae		Testudacarus			0	0	108	0	0	0	0	0	0
2172	Arthropoda	Arachnida	Trombidiformes	Torrenticolidae		Torrenticola			58	7	0	8	0	0	0	0	372
94	Arthropoda	Entognatha	Collembola						0	4	0	8	0	0	9	0	0
101	Arthropoda	Insecta	Coleoptera	Amphizoidae		Amphizoa			0	0	0	0	0	0	0	1	0
105	Arthropoda	Insecta	Coleoptera	Dytiscidae					0	0	0	0	0	0	0	1	0
118	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporinae	Oreodytes			0	0	0	0	0	2	0	0	0
121	Arthropoda	Insecta	Coleoptera	Elmidae					144	40	0	0	0	0	35	1	0
1743	Arthropoda	Insecta	Coleoptera	Elmidae		Cleptelmis	addenda		7	7	0	0	0	0	0	0	0
128	Arthropoda	Insecta	Coleoptera	Elmidae		Heterlimnius			0	18	0	0	0	0	0	1	0
130	Arthropoda	Insecta	Coleoptera	Elmidae		Lara			0	4	22	0	0	0	39	3	0
847	Arthropoda	Insecta	Coleoptera	Elmidae		Microcylloepus	pusillus		0	0	0	0	14	0	0	0	0
135	Arthropoda	Insecta	Coleoptera	Elmidae		Optioservus			65	0	0	0	0	0	0	0	0
1076	Arthropoda	Insecta	Coleoptera	Elmidae		Optioservus	quadrimaculatus		14	0	0	16	14	0	0	0	9
1077	Arthropoda	Insecta	Coleoptera	Elmidae		Ordobrevia	nubifera		0	14	0	0	0	0	0	0	0
144	Arthropoda	Insecta	Coleoptera	Elmidae		Zaitzevia			159	7	43	0	0	0	17	5	9
1079	Arthropoda	Insecta	Coleoptera	Psephenidae	Eubrianacinae	Eubrianax	edwardsii		0	26	0	0	0	0	0	0	0
173	Arthropoda	Insecta	Diptera						0	0	0	0	0	1	0	0	0
179	Arthropoda	Insecta	Diptera	Ceratopogonidae					0	0	65	0	0	0	0	0	61
908	Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	Probezzia			0	7	43	55	101	0	0	1	17
671	Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae	Atrichopogon			0	0	0	16	0	2	0	0	0
750	Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae	Forcipomyia			0	0	0	0	0	0	0	0	9
180	Arthropoda	Insecta	Diptera	Chironomidae					50	7	86	63	29	2	78	8	9
182	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae				144	255	22	8	65	0	1470	28	26
184	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae				742	126	1473	888	1977	127	588	195	593
187	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae				0	74	130	110	115	4	43	126	114
197	Arthropoda	Insecta	Diptera	Dixidae					0	0	0	0	0	0	0	1	0
198	Arthropoda	Insecta	Diptera	Dixidae		Dixa			0	0	43	0	0	2	104	4	0
200	Arthropoda	Insecta	Diptera	Empididae					0	0	0	0	0	0	0	7	17
202	Arthropoda	Insecta	Diptera	Empididae		Clinocera			0	0	0	16	0	2	0	0	3
2253	Arthropoda	Insecta	Diptera	Empididae		Neoplasta			7	0	0	0	36	2	9	0	35
206	Arthropoda	Insecta	Diptera	Empididae		Wiedemannia			14	11	0	0	0	0	0	0	0
4055	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae				0	0	0	8	0	0	0	0	0
201	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae	Chelifera			0	7	0	0	0	0	0	0	0
203	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae	Hemerodromia			58	0	0	0	0	0	0	0	0
213	Arthropoda	Insecta	Diptera	Pelecorhynchidae		Glutops			0	0	0	0	0	0	1	0	0
215	Arthropoda	Insecta	Diptera	Psychodidae		Maruina			0	22	0	0	0	0	0	0	0
216	Arthropoda	Insecta	Diptera	Psychodidae		Pericoma			0	0	22	0	0	0	0	0	0
221	Arthropoda	Insecta	Diptera	Simuliidae					14	0	1773	0	7	0	0	3	0
223	Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	Simulium			533	43	432	134	22	18	17	0	571
237	Arthropoda	Insecta	Diptera	Tipulidae		Dicranota			17	11	86	4	10	18	53	3	27
241	Arthropoda	Insecta	Diptera	Tipulidae		Hexatoma			0	4	0	0	0	0	35	3	0
236	Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	Antocha	monticola		0	22	65	16	0	0	0	0	0
244	Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	Limonia			0	0	0	8	59	0	0	0	0
247	Arthropoda	Insecta	Diptera	Tipulidae	Tipulinae	Tipula			1	0	0	1	0	0	0	0	1
303	Arthropoda	Insecta	Ephemeroptera	Ameletidae		Ameletus			7	0	0	0	0	0	9	0	0
4077	Arthropoda	Insecta	Ephemeroptera	Baetidae					0	0	0	24	0	0	0	0	0
250	Arthropoda	Insecta	Ephemeroptera	Baetidae		Baetis			86	18	1405	590	843	892	147	61	1592
252	Arthropoda	Insecta	Ephemeroptera	Baetidae		Centroptilum			7	0	0	8	94	24	0	3	10
834	Arthropoda	Insecta	Ephemeroptera	Baetidae		Diphetor	hageni		166	40	43	0	0	0	182	0	0
262	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae					7	97	0	0	0	0	0	1	0
267	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		Drunella	doddsii		0	5	0	0	0	0	0	1	0
276	Arthropoda	Insecta	Ephemeroptera	Heptageniidae					137	65	0	8	0	0	95	3	0
278	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Cinygma			0	0	0	0	0	0	43	0	0

280	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Epeorus			101	36	238	0	7	0	0	4	0
282	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Ironodes			324	288	0	157	29	2	122	0	53
285	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		Rhithrogena			7	50	0	0	0	0	0	0	0
287	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae					0	0	0	0	0	0	164	0	0
292	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae		Paraleptophlebia			0	195	0	0	0	0	0	0	0
1549	Arthropoda	Insecta	Hemiptera	Gerridae	Gerrinae	Limnoporus			0	0	0	8	0	0	0	0	0
340	Arthropoda	Insecta	Hemiptera	Veliidae	Microveliinae	Microvelia			0	0	0	16	0	0	0	0	0
385	Arthropoda	Insecta	Odonata	Gomphidae					0	59	22	55	65	169	0	0	9
403	Arthropoda	Insecta	Plecoptera						0	7	0	39	72	12	0	0	79
1439	Arthropoda	Insecta	Plecoptera	Chloroperlidae		Kathroperla	perdita		0	0	22	0	0	0	0	0	10
416	Arthropoda	Insecta	Plecoptera	Chloroperlidae		Paraperla			0	0	0	0	0	0	0	0	9
419	Arthropoda	Insecta	Plecoptera	Chloroperlidae		Sweltsa			14	71	66	49	22	0	78	4	47
5757	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Chloroperlinae				14	14	22	31	22	0	216	0	86
420	Arthropoda	Insecta	Plecoptera	Leuctridae					0	14	0	0	0	0	69	0	0
429	Arthropoda	Insecta	Plecoptera	Nemouridae					0	0	0	0	7	0	173	0	9
431	Arthropoda	Insecta	Plecoptera	Nemouridae		Malenka			216	4	3286	1015	223	22	9	0	78
439	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada			86	130	0	16	0	0	61	1	0
1318	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada			0	0	0	0	0	0	26	0	0
909	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada	cinctipes		634	79	216	31	22	0	372	3	43
1280	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada	columbiana		0	0	0	0	0	0	157	1	0
1443	Arthropoda	Insecta	Plecoptera	Nemouridae		Zapada	frigida		0	4	0	0	0	0	0	0	0
441	Arthropoda	Insecta	Plecoptera	Peltoperlidae		Soliperla			0	1	22	0	0	0	0	0	0
443	Arthropoda	Insecta	Plecoptera	Peltoperlidae		Yoraperla			267	25	0	0	0	0	0	0	0
444	Arthropoda	Insecta	Plecoptera	Perlidae					72	7	216	111	0	0	69	0	0
837	Arthropoda	Insecta	Plecoptera	Perlidae		Calineuria	californica		85	65	45	178	44	0	0	1	82
1193	Arthropoda	Insecta	Plecoptera	Perlidae		Doroneuria	baumanni		0	0	0	0	0	0	89	0	0
838	Arthropoda	Insecta	Plecoptera	Perlidae		Hesperoperla	pacifica		66	40	0	0	0	0	0	0	0
455	Arthropoda	Insecta	Plecoptera	Perlodidae					22	7	0	0	0	0	9	0	0
480	Arthropoda	Insecta	Trichoptera						0	6	1189	0	0	0	0	32	0
531	Arthropoda	Insecta	Trichoptera	Apataniidae		Apatania			0	5	0	0	0	0	0	0	0
1199	Arthropoda	Insecta	Trichoptera	Brachycentridae		Amiocentrus	aspilus		65	18	0	55	7	0	0	0	35
484	Arthropoda	Insecta	Trichoptera	Brachycentridae		Micrasema			259	47	519	31	0	0	0	0	17
487	Arthropoda	Insecta	Trichoptera	Glossosomatidae					0	5	22	0	0	0	0	0	0
491	Arthropoda	Insecta	Trichoptera	Glossosomatidae	Glossosomatinae	Glossosoma			0	7	22	0	0	0	61	0	0
495	Arthropoda	Insecta	Trichoptera	Hydropsychidae					14	47	1492	935	447	20	190	15	1478
502	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	Parapsyche			0	0	0	0	1	2	10	0	17
1002	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	Parapsyche	elsis		0	1	0	0	0	0	0	0	0
499	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	Hydropsyche			209	35	714	204	223	22	121	36	62
519	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostomatinae	Lepidostoma			7	135	0	159	79	71	35	0	52
528	Arthropoda	Insecta	Trichoptera	Limnephilidae					0	0	0	0	0	0	9	0	0
565	Arthropoda	Insecta	Trichoptera	Philopotamidae					0	0	0	0	0	0	17	0	0
567	Arthropoda	Insecta	Trichoptera	Philopotamidae	Philopotaminae	Dolophilodes			0	0	0	0	0	0	0	0	1
568	Arthropoda	Insecta	Trichoptera	Philopotamidae	Philopotaminae	Wormaldia			22	0	0	0	0	0	73	0	0
578	Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropodinae	Polycentropus			0	4	0	0	16	18	0	15	0
584	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila			65	11	195	24	14	6	9	24	0
1668	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	betteni group		22	19	1	113	30	2	0	0	17
1206	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	brunnea/vemna group		0	12	22	8	0	0	0	0	3
1496	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	grandis group		0	0	0	0	0	2	9	0	0
1498	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	narvae		0	11	0	0	0	0	43	0	0
1715	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	verrula group		0	0	0	0	0	0	46	0	0
1505	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		Rhyacophila	vofixa group		0	0	0	0	1	4	0	5	0
587	Arthropoda	Insecta	Trichoptera	Sericostomatidae		Gumaga			0	4	0	0	0	0	0	0	0
549	Arthropoda	Insecta	Trichoptera	Uenoidae	Thremmatinae	Neophylax			0	5	0	0	0	0	0	0	0
1225	Chordata	Actinopterygii	Scorpaeniformes	Cottidae					0	4	0	0	0	0	0	0	0
647	Mollusca	Bivalvia	Veneroida	Pisidiidae	Pisidiinae	Pisidium			0	7	0	0	0	0	0	0	0
636	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae		Juga			0	268	0	0	0	0	0	0	0
655	Platyhelminthes	Turbellaria							7	0	65	0	0	0	17	0	0

							SampleID	150886	150887	150888	150889	150890	150891	150892	150893	150894
							Station (NAMC)	MDLCKBK-01	UPMARTIN-01	MDLCK-3.1	MDLCK-3	MIDCRMID	MIDBEN	SFREF1	SF1.0	SF3.0
							Station (Customer)	M7.9	Martin Creek Ref	M3.1	M3.0	M2.0	M1.2	SFREF1	SF1.0	SF3.0
							Waterbody	Middle Creek at Buck Creek, Mile 7.9	Upper Martin Creek, Reference site	Middle Creek, Mile 3.1, below confluence	Middle Creek, Mile 3 above confluence of South Fork	Middle Creek	Middle Bench	South Fk Middle Creek Ref (Trib)	South Fork Middle Creek	South Fork Middle Creek
							County	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas	Douglas
							State	OR	OR	OR	OR	OR	OR	OR	OR	OR
							Latitude	42.837	42.83	42.847	42.847	42.85347712	42.85598678	42.8316279	42.83696893	42.83390533
							Longitude	-123.505	-123.488	-123.437	-123.434	-123.4164779	-123.4047075	-123.3727245	-123.3806736	-123.4123943
							Collection Date	9/11/2013	9/11/2013	9/11/2013	9/11/2013	9/11/2013	9/12/2013	9/12/2013	9/12/2013	9/12/2013
							Habitat Sampled	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle	Targeted Riffle
							Collection Method	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net	Surber net
							Field Notes	NULL	uncontaminated from mine site	NULL	NULL	NULL	NULL	uncontaminated by mine runoff	NULL	NULL
							Lab Notes	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
							Area sampled (m^2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
							Field Split	100	100	100	100	100	100	100	100	100
							Lab Split	18.75	37.5	6.25	17.19	18.75	68.75	15.63	100	15.63
							Split Count	707	728	668	665	652	734	606	452	661
OTUCode	**Phylum**	**Class**	**Order**	**Family**	**Genus**	**Species**	**OTUName**									
192							Turbellaria		7	0	65	0	0	0	17	0	0
4	Arthropoda	Arachnida					Trombidiformes		58	7	151	24	0	4	26	4	372
159	Arthropoda	Insecta	Coleoptera				Amphizoa		0	0	0	0	0	0	0	1	0
233	Arthropoda	Insecta	Coleoptera				Dytiscidae		0	0	0	0	0	2	0	1	0
66	Arthropoda	Insecta	Coleoptera	Elmidae			Cleptelmis		7	7	0	0	0	0	0	0	0
43	Arthropoda	Insecta	Coleoptera	Elmidae			Heterlimnius		0	18	0	0	0	0	0	1	0
231	Arthropoda	Insecta	Coleoptera	Elmidae			Lara		0	4	22	0	0	0	39	3	0
131	Arthropoda	Insecta	Coleoptera	Elmidae			Microcylloepus		0	0	0	0	14	0	0	0	0
70	Arthropoda	Insecta	Coleoptera	Elmidae			Optioservus		65	0	0	16	14	0	0	0	9
135	Arthropoda	Insecta	Coleoptera	Elmidae			Ordobrevia		0	14	0	0	0	0	0	0	0
140	Arthropoda	Insecta	Coleoptera	Elmidae			Zaitzevia		159	7	43	0	0	0	17	5	9
120	Arthropoda	Insecta	Coleoptera	Psephenidae			Eubrianax_edwardsi		0	26	0	0	0	0	0	0	0
101	Arthropoda	Insecta	Diptera	Ceratopogonidae			Ceratopogoninae		0	7	43	55	101	0	0	1	17
148	Arthropoda	Insecta	Diptera	Ceratopogonidae			Forcipomyiinae		0	0	0	16	0	2	0	0	9
168	Arthropoda	Insecta	Diptera	Chironomidae			Chironominae		144	255	22	8	65	0	1470	28	26
2	Arthropoda	Insecta	Diptera	Chironomidae			Orthocladiinae		742	126	1473	888	1977	127	588	195	593
46	Arthropoda	Insecta	Diptera	Chironomidae			Tanypodinae		0	74	130	110	115	4	43	126	114
62	Arthropoda	Insecta	Diptera	Dixidae			Dixa		0	0	43	0	0	2	104	4	0
49	Arthropoda	Insecta	Diptera	Empididae			Clinocera		0	0	0	16	0	2	0	0	3
163	Arthropoda	Insecta	Diptera	Empididae			Hemerodromia		58	0	0	0	0	0	0	0	0
127	Arthropoda	Insecta	Diptera	Empididae			Neoplasta		7	0	0	0	36	2	9	0	35
219	Arthropoda	Insecta	Diptera	Empididae			Wiedemannia		14	11	0	0	0	0	0	0	0
6	Arthropoda	Insecta	Diptera	Pelecorhynchidae			Glutops		0	0	0	0	0	0	1	0	0
212	Arthropoda	Insecta	Diptera	Psychodidae			Maruina		0	22	0	0	0	0	0	0	0
89	Arthropoda	Insecta	Diptera	Psychodidae			Pericoma/Telmatoscopus		0	0	22	0	0	0	0	0	0
210	Arthropoda	Insecta	Diptera	Simuliidae			Simulium		533	43	432	134	22	18	17	0	571
221	Arthropoda	Insecta	Diptera	Tipulidae			Antocha		0	22	65	16	0	0	0	0	0
41	Arthropoda	Insecta	Diptera	Tipulidae			Dicranota		17	11	86	4	10	18	53	3	27
143	Arthropoda	Insecta	Diptera	Tipulidae			Hexatoma		0	4	0	0	0	0	35	3	0
136	Arthropoda	Insecta	Diptera	Tipulidae			Limonia		0	0	0	8	59	0	0	0	0
31	Arthropoda	Insecta	Diptera	Tipulidae			Tipula		1	0	0	1	0	0	0	0	1
145	Arthropoda	Insecta	Ephemeroptera				Ameletus		7	0	0	0	0	0	9	0	0
76	Arthropoda	Insecta	Ephemeroptera				Leptophlebiidae		0	195	0	0	0	0	164	0	0
191	Arthropoda	Insecta	Ephemeroptera	Baetidae			Baetis		86	18	1405	590	843	892	147	61	1592
150	Arthropoda	Insecta	Ephemeroptera	Baetidae			Centroptilum		7	0	0	8	94	24	0	3	10
230	Arthropoda	Insecta	Ephemeroptera	Baetidae			Diphetor_hageni		166	40	43	0	0	0	182	0	0
171	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae	Drunella		Drunella_doddsi		0	5	0	0	0	0	0	1	0
202	Arthropoda	Insecta	Ephemeroptera	Heptageniidae			Cinygma		0	0	0	0	0	0	43	0	0
141	Arthropoda	Insecta	Ephemeroptera	Heptageniidae			Epeorus		101	36	238	0	7	0	0	4	0
10	Arthropoda	Insecta	Ephemeroptera	Heptageniidae			Ironodes		324	288	0	157	29	2	122	0	53
134	Arthropoda	Insecta	Ephemeroptera	Heptageniidae			Rhithrogena		7	50	0	0	0	0	0	0	0
17	Arthropoda	Insecta	Odonata				Gomphidae		0	59	22	55	65	169	0	0	9
125	Arthropoda	Insecta	Plecoptera	Chloroperlidae			Kathroperla		0	0	22	0	0	0	0	0	10
227	Arthropoda	Insecta	Plecoptera	Chloroperlidae			Paraperla		0	0	0	0	0	0	0	0	9
236	Arthropoda	Insecta	Plecoptera	Chloroperlidae			Sweltsa		14	71	66	49	22	0	78	4	47
196	Arthropoda	Insecta	Plecoptera	Nemouridae			Malenka		216	4	3286	1015	223	22	9	0	78
138	Arthropoda	Insecta	Plecoptera	Nemouridae			Zapada		634	130	216	31	22	0	372	3	43
80	Arthropoda	Insecta	Plecoptera	Peltoperlidae			Soliperla		0	1	22	0	0	0	0	0	0
103	Arthropoda	Insecta	Plecoptera	Peltoperlidae			Yoraperla		267	25	0	0	0	0	0	0	0
92	Arthropoda	Insecta	Plecoptera	Perlidae			Calineuria		85	65	45	178	44	0	0	1	82

165	Arthropoda	Insecta	Plecoptera	Perlidae			Doroneuria		0	0	0	0	0	0	89	0	0
67	Arthropoda	Insecta	Plecoptera	Perlidae			Hesperoperla		66	40	0	0	0	0	0	0	0
179	Arthropoda	Insecta	Trichoptera				Lepidostoma		7	135	0	159	79	71	35	0	52
155	Arthropoda	Insecta	Trichoptera				Polycentropodidae		0	4	0	0	16	18	0	15	0
30	Arthropoda	Insecta	Trichoptera				Rhyacophila		65	19	195	113	30	6	46	24	17
93	Arthropoda	Insecta	Trichoptera	Apataniidae			Apatania		0	5	0	0	0	0	0	0	0
68	Arthropoda	Insecta	Trichoptera	Brachycentridae			Amiocentrus		65	18	0	55	7	0	0	0	35
156	Arthropoda	Insecta	Trichoptera	Brachycentridae			Micrasema		259	47	519	31	0	0	0	0	17
144	Arthropoda	Insecta	Trichoptera	Hydropsychidae			Hydropsyche		209	35	714	204	223	22	121	36	62
234	Arthropoda	Insecta	Trichoptera	Hydropsychidae			Parapsyche		0	1	0	0	1	2	10	0	17
33	Arthropoda	Insecta	Trichoptera	Philopotamidae			Dolophilodes		0	0	0	0	0	0	0	0	1
201	Arthropoda	Insecta	Trichoptera	Philopotamidae			Wormaldia		22	0	0	0	0	0	73	0	0
37	Arthropoda	Insecta	Trichoptera	Sericostomatidae			Gumaga		0	4	0	0	0	0	0	0	0
160	Arthropoda	Insecta	Trichoptera	Uenoidae			Neophylax		0	5	0	0	0	0	0	0	0
104	Mollusca	Bivalvia	Veneroida				Pisidiidae		0	7	0	0	0	0	0	0	0
44	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae			Juga		0	268	0	0	0	0	0	0	0

Excel Worksheet Name	Worksheet Description
OE output	O/E (Observed/Expected) scores along with corresponding biological condition. Prior to O/E score computation, taxa are standardized to Operational Taxonomic Units (OTUs) and a fixed count of 300 individuals (unless otherwise requested).

The O/E model used for this analysis was the Oregon DEQ Predator 2005 (WCCP) model.
See additional documentation below and at http://www.usu.edu/buglab and http://www.cnr.usu.edu/wmc.

Description of the fields contained in the 'OE output' worksheet. A more detailed explanation of each metric is given at http://www.usu.edu/buglab

Column Name	Explanation	Predicted response to increasing perturbation	Calculation	Reference
OE	O/E (Observed/Expected) score based on a 0.5 probability of capture threshold.	Decrease	[Observed probability of caputre]/[Expected probability of capture]	WMC, Hawkins et al. 2000, Stoddard et al. 2006
Condition	Rating of "Good", "Fair", or "Poor" based on O/E score relative to the distribution of scores for reference sites. Samples with less than the required number of organisms are given an NA or "Null" rating because they did not meet model requirements.	A "Poor" rating should receive additional analysis or sampling before classifying the sites as impaired.	>Mean±2SD = "Poor", >Mean±1SD = "Fair", <Mean±1SD = "Good"	WMC, Hawkins et al. 2000, Stoddard et al. 2006
PassFail	This field indicates whether or not the site's habitat variables were within the range of experience of the model. A fail ("F") indicates the model had to extrapolate, rather than interpolate, to accommodate one or more of the habitat variables. O/E scores and condition ratings should be interpretted cautiosly if a site failed the model.	NA	NA	WMC

Analysis methods

We used the Oregon Department of Environmental Quality observed/expected (O/E) index, aka "Predator", to assess biological condition of sampled sites (Hubler, 2008). O/E models compare the macroinvertebrate taxa observed at sites of unknown biological condition (i.e., 'test sites') to the assemblages expected to be found in the absence of anthropogenic stressors (see Hawkins et al. 2000 for details). The Predator O/E model for the Western Cordillera and Columbia Plateau ecoregion is based on 167 reference sites grouped into 5 distinct classes based on the similarity of macroinvertebrate assemblage composition among sites following the standard methods of Hawkins et al. (2000) and described in detail within the EMAP-West statistical summary (Stoddard et al. 2006). The expected class membership and subsequent reference macroinvertebrate assemblage (E) for comparison to test sites is predicted by linear discriminant function models using outlet elevation, mean annual maximum air temperature, mean annual precipitation, and location in western or eastern Oregon. Prior to computing O/E scores, data for all test sites was standardized to the operational taxonomic units used to derive the Predator O/E model (Hubler, 2008) and re-sampled to a 300 fixed-count. Following the recommendations of Hawkins et al. (2000), O/E scores were calculated for taxa having a probability of capture $\geq$ 0.5 to increase the precision of O/E estimates and subsequent model sensitivity to stressors. Biological condition was subsequently assessed based on the precision of the reference site data set used to develop the Predator WCCP O/E model (mean =1.01, standard deviation (SD) = 0.15), with test sites scoring less than one SD below the mean of reference sites in "Good" biological condition (i.e. comparable to reference conditions); sites scoring between one SD and two SD in "Fair" biological condition; and sites scoring more than two SD below the mean of reference sites in "Poor" biological condition. For the Predator O/E model, the minimum count required for assinging an O/E score and biological condition rating is 200 individuals. Samples with less than 200 individuals were not given a condition rating.

REFERENCES

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Hubler, S. 2008. PREDATOR: Development and use of RIVPACS-type macroinvertebrate models to assess the biotic condition of wadeable Oregon streams. Oregon Department of Environmental Quality. Report: DEQ08-LAB-0048-TR.

Stoddard, J. L., D. V. Peck, A. R. Olsen, D. P. Larsen, J. Van Sickle, C. P. Hawkins, R. M. Hughes, T. R. Whittier, G. Lomincky, A. T. Herlihy, and P.R. Kaufmann. 2006. Environmental Monitoring and Assessment Program (EMAP): western streams and rivers statistical summary. EPA 620/R-05/006. US Environmental Protection Agency, Washington, DC.

Sampleid	Station (NAMC)	Station (Customer)	Stream	County	State	Latitude
150886	MDLCKBK-01	M7.9	Middle Creek at Buck Creek, Mile 7.9	Douglas	OR	42.837
150887	UPMARTIN-01	Martin Creek Ref	Upper Martin Creek, Reference site	Douglas	OR	42.83
150888	MDLCK-3.1	M3.1	Middle Creek, Mile 3.1, below confluence	Douglas	OR	42.847
150889	MDLCK-3	M3.0	Middle Creek, Mile 3 above confluence of South Fork	Douglas	OR	42.847
150890	MIDCRMID	M2.0	Middle Creek	Douglas	OR	42.853477
150891	MIDBEN	M1.2	Middle Bench	Douglas	OR	42.855987
150892	SFREF1	SFREF1	South Fk Middle Creek Ref (Trib)	Douglas	OR	42.831628
150893	SF1.0	SF1.0	South Fork Middle Creek	Douglas	OR	42.836969
150894	SF3.0	SF3.0	South Fork Middle Creek	Douglas	OR	42.833905

Longitude	Collection Date	Habitat Sampled	Collection Method	Field Notes	Lab Notes	Area sampled(m^2)	Field Split	Lab Split
-123.505	9/11/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	18.75
-123.488	9/11/2013	Targeted Riffle	Surber net	uncontaminated from mine site	NULL	0.74	100	37.5
-123.437	9/11/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	6.25
-123.434	9/11/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	17.19
-123.4165	9/11/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	18.75
-123.4047	9/12/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	68.75
-123.3727	9/12/2013	Targeted Riffle	Surber net	uncontaminated by mine runoff	NULL	0.74	100	15.63
-123.3807	9/12/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	100
-123.4124	9/12/2013	Targeted Riffle	Surber net	NULL	NULL	0.74	100	15.63

# of SubSampled Organisms	# of Resampled Individuals	OTU_ Richness	OE	Condition	PassFail
707	300	26	0.7762	Fair	P
728	300	35	1.1766	Good	P
668	300	23	0.9037	Good	P
665	300	21	0.7105	Fair	P
652	300	21	0.5892	Poor	P
734	300	16	0.4635	Poor	P
606	300	25	0.6662	Poor	P
452	300	22	0.7305	Fair	P
661	300	22	0.6539	Poor	P