# Post Removal Action Monitoring Report
# Amity – Blue Ridge Mine Complex
# Ochoco National Forest
# Crook County, Oregon

**August 2007**


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*Cover Photos: Johnson Creek adjacent to Amity Mine – May 25, 2004 (top); Johnson Creek – Spring 2006 (bottom).*

## TABLE OF CONTENTS



## TABLES



## FIGURES



## APPENDIX

## 1.0 INTRODUCTION

- The United States Department of Agriculture, Forest Service (Forest Service) retained Cascade Earth Sciences (CES) to perform a Removal Action (RA) at the Amity – Blue Ridge Mine Complex (Site).
- RA activities took place from June 18, 2004, through September 30, 2004, and June 20, 2005, through October 6, 2005.
- Post RA monitoring of the adjacent creeks was performed to evaluate the success of the RA.
- Figure 1 depicts the location of the Amity and Blue Ridge Mines in relation to the surrounding land and surface water features.

## 2.0 MONITORING ACTIVITIES

- CES established seven aquatic stations in Winter and Johnson Creeks in the spring of 2004 to determine baseline water and sediment quality, and benthic macroinvertebrate health and abundance prior to RA activities (see Figure 1).
- Photographs of each station are provided in Appendix A.
- CES established the following stations in Winter Creek:
  - WC-01 – upstream of the Blue Ridge Mine,
  - WC-02 – downstream of the marsh, and
  - WC-03 – above the confluence with Johnson Creek.
- CES established the following stations in Johnson Creek:
  - JC-01 – upgradient of the Amity Mine,
  - JC-02 – immediately downstream of the Amity Mine,
  - JC-03 – approximately 1 mile downstream of the Amity Mine, and
  - JC-04 – approximately 200 feet downstream of the confluence with Winter Creek.
- Monuments (rebar and aluminum caps), were installed and surveyed with a Trimble GPS.
- Each station was monitored twice each year (spring and fall) to compare results of the RA.
  - May 26, 2004 – Pre RA surface water, pore water, sediment, and benthic macroinvertebrate sampling and monitoring.
  - October 6, 2004 – Fall surface water, pore water, and sediment sampling and monitoring.
  - May 10, 2005 – Spring surface water, pore water, and sediment sampling and monitoring.
  - October 11, 2005 – Fall surface water, pore water, and sediment sampling and monitoring.
  - June 1, 2006 – Spring surface water, pore water, and sediment sampling and monitoring.
  - September 25, 2006 – Fall surface water, pore water, and sediment sampling and monitoring.
  - May 2007 – Spring surface water, pore water, sediment, and benthic macroinvertebrate sampling and monitoring.
- Based on results of previous investigations and discussions with the Forest Service, samples were analyzed for the following as the main contaminant of concern:
  - Total recoverable mercury and arsenic in surface water,
  - Dissolved mercury and arsenic in pore-water,
  - Total mercury and arsenic in sediment, and
  - Methyl mercury in sediment and pore water in the fall.
- Surface water samples were collected near depositional areas where water current is slower and there is greater retention time for the surface water to accumulate contaminants from sediment.
- Pore water samples were collected at all stations using an MHEPP-27 model drive point sampler following standard operating procedures.
- Invertebrate samples were collected at each Johnson Creek and Winter Creek station in spring 2004, prior to the commencement of RA activities at the Site, and in spring 2007, approximately three years after completion of the RA.
- Benthic invertebrate samples were collected according to the guidance document, *Stream Macroinvertebrate Protocol, Oregon Plan for Salmon and Watersheds* (ODEQ, 1998) and as outlined in the Work Plan (CES, 2003).
- ABA, Inc., of Corvallis, Oregon conducted identification of macroinvertebrates collected at the Site to the "lowest practical taxonomic level," typically genus and species levels.

## 3.0 MONITORING RESULTS

### 3.1 Surface Water

**Winter Creek:**

- CES collected a total of 16 surface water samples from the 3 Winter Creek aquatic stations from May 2004 through May 2007 (Table 1).
- Flows ranged from less than 1 gallon per minute (gpm) during fall events to 1,900 gpm (equal to 5 cubic feet per second [cfs]) in the spring of 2007.
- Concentrations of total recoverable mercury ranged from 0.001 micrograms per liter (µg/L) in WC-SW-1 (October 2004) to 0.1350 µg/L in WC-SW-2 (May 2005).
- With the exception of the October 2005 event, surface water samples collected from WC-02 and WC-03 exceeded the Oregon Department of Environmental Quality (ODEQ) freshwater acute criteria for aquatic life for mercury (0.012 µg/L). The background station (WC-01) did not exceed the criteria during the monitoring period.
- Arsenic was not detected above the method detection limit (MDL) in most of the surface water samples collected in Winter Creek. The MDL is the minimum concentration that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Two samples were detected at 0.2 µg/L, but were flagged because the concentrations were below the practical quantitation limit (PQL). The PQL is the lowest concentrations that can be accurately measured and reported by the given laboratory method and/or instrument.
- Over the three year monitoring period the following trends were observed:
  - WC-01 – concentrations of total recoverable mercury steadily decreased from 0.0117 µg/L to 0.0016 µg/L; total recoverable arsenic was consistently below the MDL.
  - WC-02 – concentrations of total recoverable mercury increased from 0.0468 µg/L to 0.23 µg/L; total recoverable arsenic was consistently below the MDL.
  - WC-03 – concentrations of total recoverable mercury decreased from 0.083 µg/L to 0.072 µg/L (based on only two samples due to lack of flows); total recoverable arsenic was consistently below the MDL.

**Johnson Creek:**

- CES collected a total of 25 surface water samples from May 2004 through May 2007 from the 4 Johnson Creek aquatic stations (Table 1).
- Flows ranged from ~1 gpm during fall events to 5,500 gpm (14.7 cfs) in spring 2007.
- Total recoverable mercury ranged from 0.0014 µg/L at JC-01 to 0.1020 µg/L also at JC-01.
- Samples from all stations in Johnson Creek consistently exceeded the ODEQ freshwater acute criteria for aquatic life for mercury of 0.012 µg/L.
- Arsenic was not detected above the MDL of 0.5 µg/L in any of the surface water samples.
- Over the three year monitoring period the following trends were observed:
  - JC-01 – concentrations of total recoverable mercury decreased slightly from 0.0139 µg/L to 0.0116 µg/L, with a high concentration detected in May 2005 (0.102 µg/L); total recoverable arsenic was constantly below the MDL.
  - JC-02 – concentrations of total recoverable mercury increased consistently from 0.0118 µg/L to 0.062 µg/L; total recoverable arsenic was constantly below the MDL.
  - JC-03 – concentrations of total recoverable mercury increased slightly from 0.0155 µg/L to 0.0188 µg/L, with a high concentration detected in May 2005 (0.091 µg/L); total recoverable arsenic was constantly below the MDL.
  - JC-04 – concentrations of total recoverable mercury increased slightly from 0.0148 µg/L to 0.0223 µg/L; total recoverable arsenic was constantly below the MDL.

## 3.2 Pore Water

**Winter Creek:**

- CES collected a total of 16 pore water samples from the 3 Winter Creek aquatic stations from May 2004 through May 2007 (Table 2).
- Dissolved mercury concentrations ranged from 0.0015 µg/L at WC- 01 to 0.0223 µg/L at WC-02. Only two pore water samples exceeded the ODEQ freshwater acute criteria for aquatic life for mercury (WC-02 – October 2005 and September 2006).
- Dissolved methyl mercury concentrations ranged from below the MDL of 0.00002 µg/L at WC-01 to 0.000459 µg/L at WC-02. There is no standard for methyl mercury in pore water; however, the ORNL surface water criteria of 0.0028 µg/L was not exceeded.
- Dissolved arsenic was not detected above the MDL in most of the surface water samples collected in Winter Creek. Two samples were detected at 0.2 µg/L and 0.6 µg/L, but were flagged because the concentrations were below the PQL.
- Over the three year monitoring period the following trends were observed:
  - WC-01 – concentrations of dissolved mercury steadily decreased from 0.0039 µg/L to 0.0016 µg/L, dissolved methyl mercury concentrations were relatively constant; and dissolved arsenic was consistently below the MDL and PQL.
  - WC-02 – concentrations of dissolved mercury increased slightly from 0.007 µg/L to 0.0097 µg/L, with higher concentrations detected in October 2005 and September 2006; dissolved methyl mercury concentrations were relatively constant; and dissolved arsenic was consistently below the MDL.
  - WC-03 – only two samples were analyzed for dissolved mercury due to lack of flows, results show a decrease in concentrations from 0.0094 µg/L to 0.0041 µg/L; one sample was analyzed for dissolved methyl mercury with the concentration below the PQL; and dissolved arsenic was consistently below the MDL.

**Johnson Creek:**

- CES collected a total of 25 pore water samples from May 2004 through May 2007 from the 4 Johnson Creek aquatic stations (Table 2).
- Dissolved mercury concentrations ranged from 0.0014 µg/L at JC-03 to 0.398 µg /L in JC-04. Only two pore water samples exceeded the ODEQ freshwater acute criteria for aquatic life for mercury (JC-02 in October 2005 and JC-03 in May 2004).
- Dissolved methyl mercury concentrations ranged from below the MDL of 0.00002 µg/L at JC-01 to 0.000264 µg/L in JC -03. There is no standard for methyl mercury in pore water; however, the ORNL surface water criteria of 0.0028 µg/L was not exceeded.
- Dissolved arsenic was not detected above the MDL in pore water samples from Johnson Creek.
- Over the three year monitoring period the following trends were observed:
  - JC-01 – concentrations of dissolved mercury increased slightly from 0.0015 µg/L to 0.0020 µg/L; dissolved methyl mercury concentrations were relatively constant and at or below the PQL and MDL; and dissolved arsenic was below the MDL.
  - JC-02 – concentrations of dissolved mercury decreased from 0.0116 µg/L to 0.0051 µg/L, with higher concentrations detected in October 2005; dissolved methyl mercury concentrations were relatively constant; and dissolved arsenic was below the MDL.
  - JC-03 – concentrations of dissolved mercury significantly decreased from 0.398 µg/L to 0.0043 µg/L; dissolved methyl mercury concentrations were relatively constant; and dissolved arsenic was below the MDL.
  - JC-04 – concentrations of dissolved mercury decreased slightly from 0.0068 µg/L to 0.0041 µg/L; dissolved methyl mercury concentrations decreased from 0.000109 µg/L to 0.000034 µg/L; and dissolved arsenic was below the MDL.

## 3.3 Sediment

**Winter Creek:**

- CES collected a total of 18 sediment samples from the 3 Winter Creek aquatic stations from May 2004 through May 2007 (Table 3).
- Total mercury concentrations ranged from below the MDL of 0.04 milligrams per kilogram (mg/kg) at WC-01 to 297 mg/kg in WC-02. Sediment from WC-02 exceeded the ODEQ freshwater sediment criteria for mercury (0.2 mg/kg) in all sampling events.
- Total arsenic was detected at concentrations ranging from below the MDL of 0.3 mg/kg at WC-02 to 2.4 mg/kg at also at WC-02, all well below the lowest criteria of 5.9 mg/kg.
- Methyl mercury concentrations ranged from 0.000011 nanograms per gram (ng/g) at WC-03 to 0.515 ng/g at WC-01. There is no comparison criteria for methyl mercury in sediment.
- Over the three year monitoring period the following trends were observed:
  - WC-01 – concentrations of total mercury significantly decreased from 0.19 mg/kg to below the MDL of 0.05 mg/kg; methyl mercury decreased from 0.515 ng/g to 0.1 ng/g; and total arsenic increased from 0.49 mg/kg to 1.8 mg/kg.
  - WC-02 – concentrations of total mercury significantly decreased from 13.5 mg/kg and 297 mg/kg (May and October 2004) to 12 mg/kg; methyl mercury slightly increased from 0.001593 ng/g to 0.004732 ng/g; and total arsenic increased from 1.03 mg/kg to 2.4 mg/kg.
  - WC-03 – concentrations of total mercury significantly decreased from 11.7 mg/kg to 0.14 mg/kg; methyl mercury increased from 0.000011 ng/g to 0.000416 ng/g, and total arsenic increased from 1.6 mg/kg to 1.9 mg/kg.

**Johnson Creek:**

- CES collected a total of 25 sediment samples from May 2004 through May 2007 from the 4 Johnson Creek aquatic stations (Table 3).
- Total mercury concentrations ranged from below the MDL of 0.05 mg/kg at JC-01 to 67.3 mg/kg in JC-03. Virtually all sediment samples exceeded the ODEQ sediment criteria of 0.2 mg/kg.
- Total arsenic was detected at concentrations ranging from below the MDL of 0.3 mg/kg at JC-01 and JC-02 to 3.1 mg/kg at JC-03, all well below the lowest regulatory criteria of 5.9 mg/kg.
- Methyl mercury concentrations ranged from 0.000033 ng/g at JC-01 to 0.002833 ng/g at JC-04. There is no comparison criteria for methyl mercury in sediment.
- Over the three year monitoring period the following trends were observed:
  - JC-01 – concentrations of total mercury increased from 0.22 mg/kg to 0.66 mg/kg; methyl mercury significantly increased from 0.000144 ng/g to 0.661 ng/g; and total arsenic increased from 0.36 mg/kg to 1.7 mg/kg.
  - JC-02 – concentrations of total mercury decreased from 2.43 mg/kg to 0.82 mg/kg; methyl mercury slightly increased from 0.00317 ng/g to 0.00433 ng/g; and total arsenic increased from 0.39 mg/kg to 1.7 mg/kg.
  - JC-03 – concentrations of total mercury decreased significantly from 67.3 mg/kg to 0.93 mg/kg; methyl mercury decreased from 0.000701 ng/g to 0.0001898 ng/g, and total arsenic increased from 0.3 mg/kg to 1.6 mg/kg.
  - JC-04 – concentrations of total mercury increased from 0.27 mg/kg to 0.41 mg/kg; methyl mercury increased slightly from 0.001331 ng/g to 0.002548 ng/g, and total arsenic increased from 0.81 mg/kg to 2.4 mg/kg.

## 3.4 Benthic Macroinvertebrate - Level III enumeration

### 3.4.1 Taxa Abundance

- Comparisons of the total taxa abundance identified in the spring 2004 and spring 2007 sampling events are shown in Table 4.
- In general, total taxa abundance increased from spring 2004 to 2007. A decrease was observed at station WC-01, along Winter Creek, upstream from the Blue Ridge Mine.
- Taxa abundance was greatest at stations JC-03, JC-04, and WC-02, which are located downstream from the Amity and Blue Ridge Mines (Figure 2).
- Taxa richness ranged from 15 to 39 distinct taxa in spring 2004 to 19 to 35 distinct taxa in spring 2007. Both ranges are considered low for a Pacific Northwest montane stream.

### 3.4.2 Ephemeroptera, Plecoptera, and Trichoptera Taxa and Diptera Abundance and Richness

- The Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) species were most abundant at stations JC-03, JC-04, and WC-02 (Figure 3). The EPT abundance at these stations consists of a significant portion of the overall invertebrate composition (Figure 4), over 90% of all invertebrates at stations JC-03 and WC-02 in spring 2004.
- Between spring 2004 and 2007, EPT abundance increased in stations JC-03 and JC-04; decreased in abundance in stations WC-01 and WC-02; and remained relatively similar in stations JC-01 and JC-02.
- The EPT species as a percentage of the overall invertebrate community composition decreased from spring 2004 to 2007 in each station on Johnson and Winter Creeks.
- Diptera (true flies) abundance was greatest at station WC-01. The lowest numbers of Diptera were observed at stations JC-02, JC-03, and WC-02; Diptera are known to be metal tolerant.
- Between spring 2004 and 2007, Dipetera abundance increased in stations JC-02, JC-03, JC-04, and WC-02; decreased in station WC-01; and remained stable in station JC-01.
- Diptera species as a percentage of the overall invertebrate community composition increased from spring 2004 to 2007 in stations JC-2, JC-3, JC-4, and WC-2 and decreased in stations JC-1 and WC-1.

### 3.4.3 Functional Feeding Groups

- Figure 5 demonstrates the composition of functional feeding groups at the Johnson and Winter Creek stations.
- The percentage of functional feeders representing intolerant taxa increased between spring 2004 and 2007 in all Johnson Creek stations, but decreased in the Winter Creek stations.
- The percentage of functional feeders representing tolerant species taxa decreased in all stations except WC-02 between spring 2004 and 2007.
- Stations JC-01, JC-03, and JC-04 contained higher percentages of functional feeding groups representing tolerant taxa in spring 2004. However, these data indicate the percentage of intolerant taxa were higher in those stations in spring 2007.

### 3.4.4 Percent Intolerant Taxa

- Percent intolerant taxa composition in spring 2004 indicated stations JC-01 and JC-02 contained high percentages of intolerant (cold water) biota. Percentages dropped significantly in downstream reaches of both creeks.
- Percent intolerant taxa composition in spring 2007 indicated stations JC-01, JC-04, and WC-02 contained higher percentages of intolerant biota.

### 3.4.5 Benthic Index of Biotic Biological Integrity

- The Benthic Index of Biological Integrity (BIBI) multimetric approach (modified Karr 1998) was used to evaluate stream habitat conditions upstream and downstream from the Site.
- The BIBI index combines various categories of data into a single number that indicates overall biological condition at a station.
- The BIBI scores calculated for the Site indicate low to moderate biological integrity at each station on Johnson and Winter Creeks in both sampling events (Table 5; Figures 6 and 7).
- Station JC-02 had the lowest biological integrity score of 26 during the spring 2004 field event. However, station JC-02 exhibited the highest score of 32 during the spring 2007 field event.
- Station WC-02 had the lowest overall score of 20 during the spring 2004 field event.
- Overall scores vary widely as exhibited in Figures 6 and 7. Station JC-04 had the most consistent scores between spring 2004 and 2007 of 24 and 26, respectively.

## 4.0 CONCLUSIONS

### 4.1 Surface Water

- Surface water samples collected from Winter Creek below the Blue Ridge Mine and all stations in Johnson Creek exceeded the ODEQ freshwater acute criteria for aquatic life for mercury.
- Over the three year monitoring period, the two background stations exhibited a slight decrease in mercury concentrations, while the downstream stations exhibited slight increases in mercury concentrations.
- There is a seasonal fluctuation of mercury concentration in surface water, with higher concentrations during periods of high flow. This is likely due to increased particulate entrainment during spring snowmelt and rain events.
- Arsenic was not detected above the MDL in most samples, and the PQL in two samples, and is, therefore, not a constituent of concern in surface water.

### 4.2 Pore Water

- Mercury in pore water from Winter and Johnson Creeks below the Site exceeded the ODEQ freshwater acute criteria for aquatic life.
- Over the three year monitoring period, sediment at all stations downstream from the Site (except WC-02 and JC-01) exhibited either a slight or significant decrease in dissolved mercury concentrations.
    - The most significant reduction was at JC-03, at which the dissolved mercury concentration decreased nearly two orders of magnitude from 0.398 mg/kg to 0.0043 mg/kg.
    - The slight increase in dissolved mercury concentrations at JC-01 may be attributed to influences from other upstream mining sources (i.e., Independence Mine).
- Methyl mercury concentrations over the three year monitoring period were relatively constant. There is no standard for methyl mercury in pore water; however, the ORNL surface water criteria of 0.0028 µg/L was not exceeded.
- Dissolved arsenic was not detected in pore water samples from Johnson Creek or Winter Creek and is, therefore, not a constituent of concern in pore water.
- There does not appear to be a seasonal fluctuation in concentrations of mercury in pore water.

### 4.3 Sediment

- Sediment samples collected from all stations in Winter Creek and Johnson Creek exceeded the ODEQ sediment criteria for mercury of 0.2 mg/kg.

- Over the three year monitoring period, there was a significantly decreased in the total mercury concentrations in sediment from the start to the end of the RA.
- Total arsenic appears to have slightly increased, although the concentrations are still below the lowest regulatory criteria.
- Overall, methyl mercury concentrations have increased over the three year period, with concentrations detected up to 0.015993 ng/g at WC-02 and 0.002833 ng/g at JC-04. However, there is no comparison standard for methyl mercury in sediment.
- There does not appear to be a significant seasonal fluctuation of metal concentrations in sediment.

### 4.4 Benthic Macroinvertebrates

- Positive indicators, such as increased overall abundance of benthic invertebrates and an increase in intolerant functional feeding group community composition between 2004 and 2007 may be related to an initial increase in habitat conditions following post-RA activities at the Site.
- Negative indicators, such as a reduction in the percentage of EPT species across nearly all stations between 2004 and 2007 may be associated with persistent elevated concentrations of mercury in pore water and sediment.
- Non-mining historic uses of the Site and surrounding properties, which have included logging and grazing, may have negatively impacted instream habitat conditions in Johnson and Winter Creeks and may have contributed to overall low biological integrity values.
- Instream habitat conditions (i.e., substrate type and size, percent cover, etc.), which were not assessed during this investigation, may also contribute to the low biological integrity scores developed for the Site.

## 5.0 RECOMMENDATIONS

- Overall mercury concentrations in pore water and sediment are decreasing after the RA.
  - The original source (i.e., wasterock and tailings at the Amity – Blue Ridge Mine Complex) is being controlled onsite, but the presence of elevated concentration of mercury in sediment will continue to be a source.
  - There are two viable methods to address the elevated mercury in the sediment; 1) allow the sediment to disperse and disseminate over time in conjunction with monitoring, or 2) spot removal using a portable dredge of areas with elevated sediment.
- CES recommends the following:
  - Conduct a detailed sediment sampling event in the fall of 2007 to better understand the concentrations and quantity of mercury-impacted sediment in Johnson and Winter Creek.
    - Two additional aquatic stations are recommended upstream from JC-01 to assess if other mines in the area are impacting the sediment in Johnson Creek.
    - In addition to the aquatic stations, 25 supplemental sediment samples will be collected and analyzed for total mercury.
    - The estimated cost for the detailed sediment sampling is $12,000.
  - Prepare an abbreviated Engineering Evaluation / Cost Analysis (EECA) following the detailed sediment sampling to assess the options for addressing the mercury-impacted sediment.
    - The EECA will be brief (two pages of text and two tables) and will include costs for the supplemental RA.
    - The estimated cost for the abbreviated EECA is $7,000.
  - Implement the supplemental RA to remove the mercury-impacted sediment in Johnson and Winter Creeks following completion of the EECA.
    - A pre-RA sampling event should be conducted to establish the baseline conditions; surface water, pore water, sediment, and fish tissue samples should be collected from the

aquatic stations and analyzed for mercury and methyl mercury. The estimated cost for the pre-RA sampling is $15,000.

- Following the pre-RA sampling event, sediment should be removed as recommended in the EECA. CES assumes 10 cubic yards of mercury-impacted sediment will be removed using a portable dredge, transported to the smaller Blue Ridge Mine repository and covered with surrounding cover soil. The estimated cost for the RA is between $15,000 and $25,000, depending on the quantities and access.

- Following completion of the RA, three years of semi-annual sampling and monitoring should be performed to evaluate the success of the RA.
  - Surface water, pore water, and sediment samples should be collected from the aquatic stations and analyzed for mercury and methyl mercury.
  - The final sampling event would include fish tissue sampling from the same stations as the pre-RA sampling event.
  - The estimated cost for the post-RA sampling and monitoring is $75,000.

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## TABLES

**Table 1. Surface Water Analytical Results**
**Amity - Blue Ridge Mine Complex, Ochoco National Forest, Crook County, Oregon**

| Sample ID | Sample Date | 1631 Mercury - ACZ | Arsenic Total - ACZ | Flow Rate | Temperature (Field) | pH (Field) | Conductivity (Field) | Dissolved Oxygen (Field) | Oxygen Reduction Potential (Field) |
|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | gpm | °C | su | µS | mg/L | mV |
| WC-SW-1 | May 26, 2004 | 0.0117 | 0.2B | 575 | 7.9 | 7.45 | 120 | 12.5 | 149 |
| | October 6, 2004 | 0.0010 | <0.5 | 2 | 6.4 | 7.5 | 295 | 8.55 | 277 |
| | May 10, 2005 | 0.0033 | <0.5 | 280 | 6.6 | 7.9 | 146 | 9.34 | 204 |
| | October 11, 2005 | 0.0012 | <0.5 | 4.5 | 6.8 | 7.3 | 259 | 7.7 | 78.4 |
| | June 1, 2006 | 0.0020 | <0.5 | 320 | 7.2 | 7.6 | 130 | 8.3 | 94 |
| | September 25, 2006 | 0.0012 | <0.5 | 4 | 9.5 | 7.5 | 233 | 9.2 | 113 |
| | May 9, 2007 | 0.0016 | <0.5 | 650 | 8.91 | 7.7 | 147 | 10.4 | 162 |
| WC-SW-2 | May 26, 2004 | **0.0468** | 0.2B | 1,616 | 8.2 | 7.63 | 130 | 12.8 | 173 |
| | October 5, 2004 | 0.0070 | <0.5 | Pool, no flow | 9.04 | 6.6 | 296 | 4.96 | 279 |
| | May 10, 2005 | **0.1350** | <0.5 | 765 | 8.74 | 7.7 | 16.5 | 8.7 | 144 |
| | October 11, 2005 | **0.0167** | <0.5 | 0.25 (dry at pool) | 7.4 | 7.5 | 221 | 2.5 | 103 |
| | June 1, 2006 | **0.0530** | <0.5 | 800 | 8.3 | 7.51 | 150 | 8.5 | 124 |
| | September 25, 2006 | **0.0164** | <0.5 | 0.75 | 8.2 | 6.81 | 217 | 8.2 | 144 |
| | May 9, 2007 | **0.2300** | <0.5 | 580 | 11.54 | 7.9 | 164 | 7.8 | 172 |
| WC-SW-3 | May 31, 2006 | **0.083** | <0.5 | 430 | 11 | 7.1 | 157 | 7.7 | 117 |
| | September 25, 2006 | NC | NC | NM | NM | NM | NM | NM | NM |
| | May 8, 2007 | **0.0720** | <0.5 | 1,900 | 12.7 | 8.1 | 126 | 7.4 | 180 |
| JC-SW-1 | May 25, 2004 | **0.0139** | <1.0 | 3,660 | 8.2 | 7.2 | 90 | 12.6 | 152 |
| | October 5, 2004 | 0.0019 | <0.5 | 3 | 6.3 | 7.3 | 203 | 7.9 | 177 |
| | May 11, 2005 | **0.1020** | <0.5 | 1,480 | 6.4 | 7.7 | 117 | 9.78 | 167 |
| | October 12, 2005 | 0.0017 | <0.5 | 3 | 4.6 | 7.9 | 184 | 7.1 | 94 |
| | June 1, 2006 | **0.0204** | <0.5 | 2,155 | 8.1 | 7.5 | 86 | 9.1 | 62 |
| | September 26, 2006 | 0.0014 | <0.5 | 5 | 3.9 | 7.22 | 161 | 10.4 | NM |
| | May 8, 2007 | 0.01160 | <0.5 | 1,500 | 8.84 | 8.0 | 108 | 9.3 | 170 |
| JC-SW-2 | May 25, 2004 | 0.0118 | <1.0 | 5,100 | 7.3 | 7.34 | 90 | 13.9 | 153 |
| | October 5, 2004 | 0.0085 | <0.5 | 3 | 8.13 | 7.4 | 300 | 8.4 | 248 |
| | May 11, 2005 | **0.0870** | <0.5 | 2,625 | 6.39 | 7.6 | 111 | 10.09 | 178 |
| | October 11, 2005 | **0.0670** | <0.5 | 1.1 | 8.1 | 7.9 | 254 | 7.7 | 72 |
| | June 1, 2006 | **0.0720** | <0.5 | 2,600 | 8.7 | 7.45 | 86 | 9 | 79 |
| | September 26, 2006 | **0.0610** | <0.5 | 5 | 4.4 | 7.3 | 284 | 10.1 | NM |
| | May 8, 2007 | **0.0620** | <0.5 | 2,250 | 9.03 | 8.2 | 108 | 9.7 | 45 |
| JC-SW-3 | May 25, 2004 | **0.0155** | <1.0 | 4,580 | 5.3 | 7.29 | 90 | 13.1 | 175 |
| | October 5, 2004 | 0.0032 | <0.5 | 3 | 13.6 | 7.3 | 259 | 7.35 | 246 |
| | May 11, 2005 | **0.0910** | <0.5 | 2380 | 4.88 | 7.4 | 115 | 10.35 | 202 |
| | October 11, 2005 | 0.0075 | <0.5 | 1 | 8.9 | 7.3 | 246 | 7 | 50 |
| | June 1, 2006 | **0.0600** | <0.5 | 4,020 | 7.7 | 7.11 | 94 | 10.2 | 82 |
| | September 25, 2006 | 0.0065 | <0.5 | 4 | 8.7 | 7.11 | 216 | 7.1 | 67 |
| | May 8, 2007 | **0.0188** | <0.5 | 2,600 | 8.1 | 7.8 | 110 | 7.9 | 163 |
| JC-SW-4 | May 25, 2004 | **0.0148** | <1.0 | 2,750 | 11.4 | 7.16 | 110 | 10.3 | 168 |
| | October 5, 2004 | NC | NC | NM | NM | NM | NM | NM | NM |
| | May 10, 2005 | **0.0230** | <0.5 | 1,620 | 11.92 | 7.3 | 13.6 | 7.8 | 236 |
| | October 11, 2005 | NC | NC | NM | NM | NM | NM | NM | NM |
| | May 31, 2006 | **0.0202** | <0.5 | 4,240 | 12.5 | 6.96 | 107 | 7.6 | 123 |
| | September 26, 2006 | NC | NC | NM | NM | NM | NM | NM | NM |
| | May 8, 2007 | **0.0223** | <0.5 | 2,770 | 7.4 | 7.38 | 124 | 7.9 | 204 |
| **Comparison Standards** | | | | | | | | | |
| Oregon - Aquatic Life | | 0.012 | 150 | -- | -- | -- | -- | -- | -- |
| Oregon - Ecological Screening Level Values | | 0.77 | NS | -- | -- | -- | -- | -- | -- |
| EPA - Aquatic Life (CCC) | | 0.77 | 150 | -- | -- | -- | -- | -- | -- |
| ORNL - Surface Water PRGs | | 1.3 | NS | -- | -- | -- | -- | -- | -- |

NOTES:

Analysis performed by ACZ Laboratories Steamboat Springs, Colorado and Brooks Rand Lab, Seattle, Washington.

µg/L = micrograms per liter; gpm = gallons per minute; °C = degrees celsius; su = standard units µS = micro siemans; mg/L = milligrams per liter; mV = millivolts; WC = Winter Creek; < value = analyte not detected above method detection limit (MDL); JC = Johnson Creek; NM = not measured; B = analyte detected between MDL and Practical Quantification Limit (PQL); NC = not collected; NS = no standard.

Bold = exceeds the lowest comparison standard

**Table 2. Pore Water Analytical Results**
**Amity - Blue Ridge Mine Complex, Ochoco National Forest, Crook County, Oregon**

| Sample I.D. | Sample Date | Methyl Mercury - Brooks Rand | Total Mercury - ACZ | Arsenic Total-ACZ | Temperature (Field) | pH (Field) | Conductivity (Field) | Dissolved Oxygen (Field) | Oxygen Reduction Potential (Field) |
|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | °C | su | µS | mg/L | mV |
| WC-PW-1 | May 26, 2004 | <0.00004 | 0.0039 | 0.2B | 10.3 | 6.92 | 140 | 6.5 | -11 |
| | October 5, 2004 | 0.00026 B | 0.0015 | <0.5 | 16 | 7.45 | 285 | 6.4 | 248 |
| | May 10, 2005 | NA | 0.0017 | <0.5 | 6.35 | 7.6 | 152 | 6.01 | 203 |
| | October 11, 2005 | 0.000053 | 0.0004 B | <0.5 | 6.9 | 7.7 | 269 | 6.1 | -35.8 |
| | June 1, 2006 | NA | 0.0020 | <0.5 | 10 | 7.07 | 134 | 5.1 | 85.3 |
| | September 25, 2006 | <0.00002 | 0.0018 | 0.6B | 8.6 | 7.1 | 215 | 5.8 | 102 |
| | May 9, 2007 | <0.00002 | 0.0016 | <0.5 | 11.4 | 7.6 | 146 | 10.9 | 186 |
| WC-PW-2 | May 26, 2004 | 0.000151 | 0.0070 | <0.2 | 12.3 | 7.41 | 130 | 11.1 | 155 |
| | October 5, 2004 | 0.000386 | 0.0029 | <0.5 | 11.2 | 6.65 | 285 | 2.9 | 202 |
| | May 10, 2005 | NA | 0.0104 | <1 | 8.2 | 7.3 | 173 | 3.91 | 172 |
| | October 11, 2005 | 0.000257 | 0.0141 | <0.5 | 7.8 | 7.3 | 220 | 1.8 | 150 |
| | June 1, 2006 | NA | 0.0099 | <0.5 | 9.2 | 7.05 | 151 | 5.8 | 110 |
| | September 25, 2006 | 0.000459 | 0.0223 | <0.5 | 10.4 | 7.12 | 232 | 4.6 | 113 |
| | May 9, 2007 | 0.000179 | 0.0097 | <0.5 | 13.2 | 8 | 162 | 10.5 | 208 |
| WC-PW-3 | May 31, 2006 | NA | 0.0094 | <0.5 | 11.7 | 7 | 154 | 3.4 | 185 |
| | September 25, 2006 | NC | NC | NC | NM | NM | NM | NM | NM |
| | May 8, 2007 | 0.00003 B | 0.0041 | <0.5 | 12.73 | 8.1 | 126 | 8.6 | 180 |
| JC-PW-1 | May 25, 2004 | <0.00004 | 0.0015 | <1.0 | 10.4 | 6.7 | 90 | 10.1 | 158 |
| | October 6, 2005 | 0.000122 | 0.0018 | <0.5 | 6.7 | 7.24 | 204 | 7.42 | 212 |
| | May 11, 2005 | NA | 0.0020 | <0.5 | 8.74 | 7.1 | 141 | 4.51 | 152 |
| | October 12, 2005 | 0.000020 | 0.0014 | <0.5 | 4.7 | 7.3 | 185 | 0 | 96.1 |
| | June 1, 2006 | NA | 0.0030 | <0.5 | 8.2 | 6.6 | 118 | 3.2 | 101 |
| | September 26, 2006 | 0.000034 | 0.0016 | <0.5 | 5.1 | 7.4 | 157 | 3.9 | NM |
| | May 8, 2007 | 0.000025 B | 0.0020 | <0.5 | 12.0 | 8.0 | 102 | 7.2 | 77 |
| JC-PW-2 | May 25, 2004 | 0.000048 B | 0.0116 | <1.0 | 13 | 6.8 | 490 | 9.2 | 129 |
| | October 5, 2004 | <0.00002 | 0.0020 | <0.5 | 12.5 | 6.85 | 569 | 6.17 | 266 |
| | May 11, 2005 | NA | 0.0082 | <1.0 | 6.67 | 7 | 785 | 6.57 | 170 |
| | October 11, 2005 | 0.000040 | 0.0740 | <0.5 | 8.2 | 7.3 | 590 | 2.8 | 71.4 |
| | June 1, 2006 | NA | 0.0030 | <0.5 | 8.1 | 6.7 | 737 | 2.2 | 108 |
| | September 26, 2006 | 0.000190 | 0.0055 | <0.5 | 5.9 | 7.3 | 294 | 4.8 | 82 |
| | May 8, 2007 | <0.000020 | 0.0051 | <0.5 | 11.8 | 7.4 | 273 | 7.8 | 105 |
| JC-PW-3 | May 25, 2004 | 0.000138 | 0.3980 | <1.0 | 9.1 | 6.55 | 100 | 8.4 | 140 |
| | October 5, 2004 | 0.000264 | 0.0014 | <0.5 | 14.3 | 6.86 | 0.244 | 4.1 | 161 |
| | May 11, 2005 | NA | 0.0057 | <1.0 | 7 | 7.5 | 115 | 6.07 | 184 |
| | October 11, 2005 | 0.000210 | 0.0064 | <0.5 | 8.5 | 7.34 | 203 | 1.8 | 96.7 |
| | June 1, 2006 | NA | 0.0068 | <0.5 | 8.3 | 6.74 | 111 | 3 | 102 |
| | September 25, 2006 | 0.000237 | 0.0042 | <0.5 | 10.1 | 7 | 220 | 2.7 | 110 |
| | May 8, 2007 | 0.000120 | 0.0043 | <0.5 | 15 | 8.3 | 64 | 2.0 | 90 |
| JC-PW-4 | May 24, 2004 | 0.000109 | 0.0068 | <1.0 | 11 | 6.41 | 130 | 8.6 | 89 |
| | October 5, 2004 | NC | NC | NC | NM | NM | NM | NM | NM |
| | May 10, 2005 | NA | 0.0030 | <1.0 | 8.74 | 6.9 | 138 | 1.67 | 184 |
| | October 11, 2005 | NC | NC | NC | NM | NM | NM | NM | NM |
| | May 31, 2006 | NA | 0.0026 | <0.5 | 12 | 6.75 | 120 | 1.3 | 139 |
| | September 26, 2006 | NC | NC | NC | NM | NM | NM | NM | NM |
| | May 8, 2007 | 0.000034 | 0.0041 | <0.5 | 11.4 | 7.6 | 127 | 4.4 | 51.5 |
| **Comparison Standards** | | | | | | | | | |
| Oregon - Aquatic Life | | NS | 0.012 | 150 | -- | -- | -- | -- | -- |
| Oregon - Ecological Screening Level Values | | NS | 0.77 | NS | -- | -- | -- | -- | -- |
| EPA - Aquatic Life (CCC) | | NS | 0.77 | 150 | -- | -- | -- | -- | -- |
| ORNL - Surface Water PRGs | | 0.0028 | 1.3 | NS | -- | -- | -- | -- | -- |

NOTES.

Analyses performed by ACZ Laboratories Steamboat Springs, Colorado and Brooks Rand Lab, Seattle, Washington.

µg/L = micrograms per liter; °C = degrees celsius; su = standard units; µS = micro siemens; mg/L = milligrams per liter; mV = millivolts; WC = Water Creek, < value = analyte not detected above method detection limit (MDL); B = analyte detected between MDL and Practical Quantification Limit (PQL) and value is estimate; NA = not analyzed; NC = not collected; NM = not measured; NS = no standard.

Bold = exceeds the lowest comparison standard

**Table 3. Sediment Analytical Results**
**Amity - Blue Ridge Mine Complex, Ochoco National Forest, Crook County, Oregon**

| Sample ID | Sample Date | Methyl Mercury - Brooks Rand | Mercury Total - ACZ | Arsenic Total - ACZ |
|---|---|---|---|---|
| | | ng/g | mg/kg | |
| WC-SS-1 | May 26, 2004 | 0.515 | 0.19B | 0.49 |
| | October 6, 2004 | 0.108 | <0.04 | 0.4B |
| | May 10, 2005 | NA | <0.09 | 1.1 |
| | October 11, 2005 | 0.108 | 0.133 | 1.0 |
| | June 1, 2006 | NA | <0.05 | 0.9B |
| | September 25, 2006 | 0.081 | 0.05 B | 1.3 |
| | May 9, 2007 | 0.1 | < 0.05 | 1.8 |
| WC-SS-2 | May 26, 2004 | 0.001593 | 13.5 | 1.03 |
| | October 5, 2004 | 0.008121 | 297 | <0.3 |
| | May 10, 2005 | NA | 9.9 | 1.4 |
| | October 11, 2005 | 0.015933 | 2.25 | 1.5 |
| | June 1, 2006 | NA | 2.93 | 1.2 |
| | September 25, 2006 | 0.001298 | 6.80 | 2.1 |
| | May 9, 2007 | 0.004732 | 12.0 | 2.4 |
| WC-SS-3 | May 12, 2005 | 0.000011 | 11.7 | 1.60 |
| | October 11, 2005 | Dry | 0.06 B | 1.7 |
| | May 31, 2006 | NA | 5.20 | 1.5 |
| | September 26, 2006 | NC | NC | NC |
| | May 8, 2007 | 0.000416 | 0.14 B | 1.9 |
| JC-SS-1 | May 25, 2004 | 0.000144 | 0.22 | 0.36 |
| | October 5, 2004 | 0.00045 | 0.42 | <0.3 |
| | May 11, 2005 | NA | 0.25 | 0.9 |
| | October 11, 2005 | 0.000033 | 0.07B | 1.0 |
| | June 1, 2006 | NA | <0.06 | 1.0B |
| | September 26, 2006 | 0.11 | <0.05 | 1.3 |
| | May 8, 2007 | 0.661 | 0.66 | 1.7 |
| JC-SS-2 | May 25, 2004 | 0.000317 | 2.43 | 0.39 |
| | October 5, 2004 | 0.001657 | 4.87 | <0.3 |
| | May 11, 2005 | NA | 0.98 | 1.2 |
| | October 11, 2005 | 0.000365 | 8.30 | 1.2 |
| | June 1, 2006 | NA | 0.55 | 1.1 |
| | September 26, 2006 | 0.000513 | 0.40 | 1.6 |
| | May 8, 2007 | 0.000433 | 0.82 | 1.7 |
| JC-SS-3 | May 25, 2004 | 0.000701 | 67.3 | 0.30B |
| | October 5, 2004 | 0.001929 | 3.80 | 3.1 |
| | May 11, 2005 | NA | 0.36 | 0.8 |
| | October 11, 2005 | 0.000948 | 0.66 | 1.1 |
| | June 1, 2006 * | NC | NC | NC |
| | September 26, 2006 | 0.000122 | 0.09 B | 1.5 |
| | May 8, 2007 | 0.001898 | 0.93 | 1.6 |
| JC-SS-4 | May 24, 2004 | 0.001331 | 0.27 | 0.81 |
| | October 5, 2004 | NC | NC | NC |
| | May 10, 2005 | NA | 0.70 | 1.4 |
| | October 11, 2005 | 0.002833 | 1.190 | 1.4 |
| | June 1, 2006 | NA | 0.29 | 1.3 |
| | September 26, 2006 | NC | NC | NC |
| | May 8, 2007 | 0.002548 | 0.41 | 2.4 |
| **Comparison Standards** | | | | |
| OR - Freshwater | | NS | 0.2 | 6 (As III) |
| EPA - Freshwater TEL | | NS | 0.17 | 5.9 |
| EPA - Freshwater PEL | | NS | 0.486 | 17 |
| ORNL - Freshwater | | NS | 0.7 | 42 |

NOTES:

Analysis performed by ACZ Laboratories Steamboat Springs, Colorado and Brooks Rand Lab, Seattle, Washington.

ng/g = nanogram per gram; mg/kg = milligrams per kilogram; WC = Winter Creek; B = analyte detected between method detection limit (MDL) and practical quantification limit (PQL); < value = analyte not detected above method detection limit (MDL); NA = not analyzed; NC = not collected; JC = Johnson Creek.

*Sample jar broke during transport and was not salvagable for analysis.

Bold = exceeds the lowest comparison standard

**Table 4. Comparison of Taxa Abundance-May 2004 and May 2007**
**Amity - Blue Ridge Mine Complex, Ochoco National Forest, Crook County, Oregon**

| Station | Date | Taxon | | | | | | | EPT Abundance | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Non Insects | Ephemeroptera | Plecoptera | Trichoptera | Coleoptera | Diptera | Chironomidae | | |
| JC-01 | 5/25/04 | 0 | 23 | 11 | 3 | 8 | 12 | 9 | 37 | 66 |
| | 5/8/07 | 18 | 18 | 9 | 3 | 5 | 11 | 14 | 30 | 77 |
| JC-02 | 5/25/04 | 1 | 7 | 8 | 9 | 1 | 9 | 5 | 24 | 42 |
| | 5/8/07 | 20 | 12 | 5 | 5 | 4 | 23 | 20 | 22 | 90 |
| JC-03 | 5/25/04 | 1 | 124 | 43 | 26 | 3 | 5 | 7 | 193 | 209 |
| | 5/8/07 | 9 | 196 | 105 | 5 | 4 | 27 | 36 | 306 | 383 |
| JC-04 | 5/24/04 | 4 | 96 | 1 | 5 | 0 | 4 | 5 | 102 | 116 |
| | 5/8/07 | 85 | 135 | 77 | 15 | 0 | 36 | 23 | 227 | 371 |
| WC-01 | 5/26/04 | 36 | 31 | 27 | 18 | 12 | 99 | 22 | 76 | 244 |
| | 5/9/07 | 31 | 11 | 3 | 19 | 5 | 41 | 39 | 33 | 149 |
| WC-02 | 5/26/04 | 11 | 216 | 7 | 8 | 0 | 0 | 11 | 231 | 252 |
| | 5/9/07 | 32 | 113 | 32 | 19 | 0 | 20 | 107 | 164 | 324 |

NOTES:

Chironomidae is a family of true flies within the order Diptera.

EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These are generally considered to be pollution-intolerant taxa, which will typically decrease in abundance with decreased water quality.

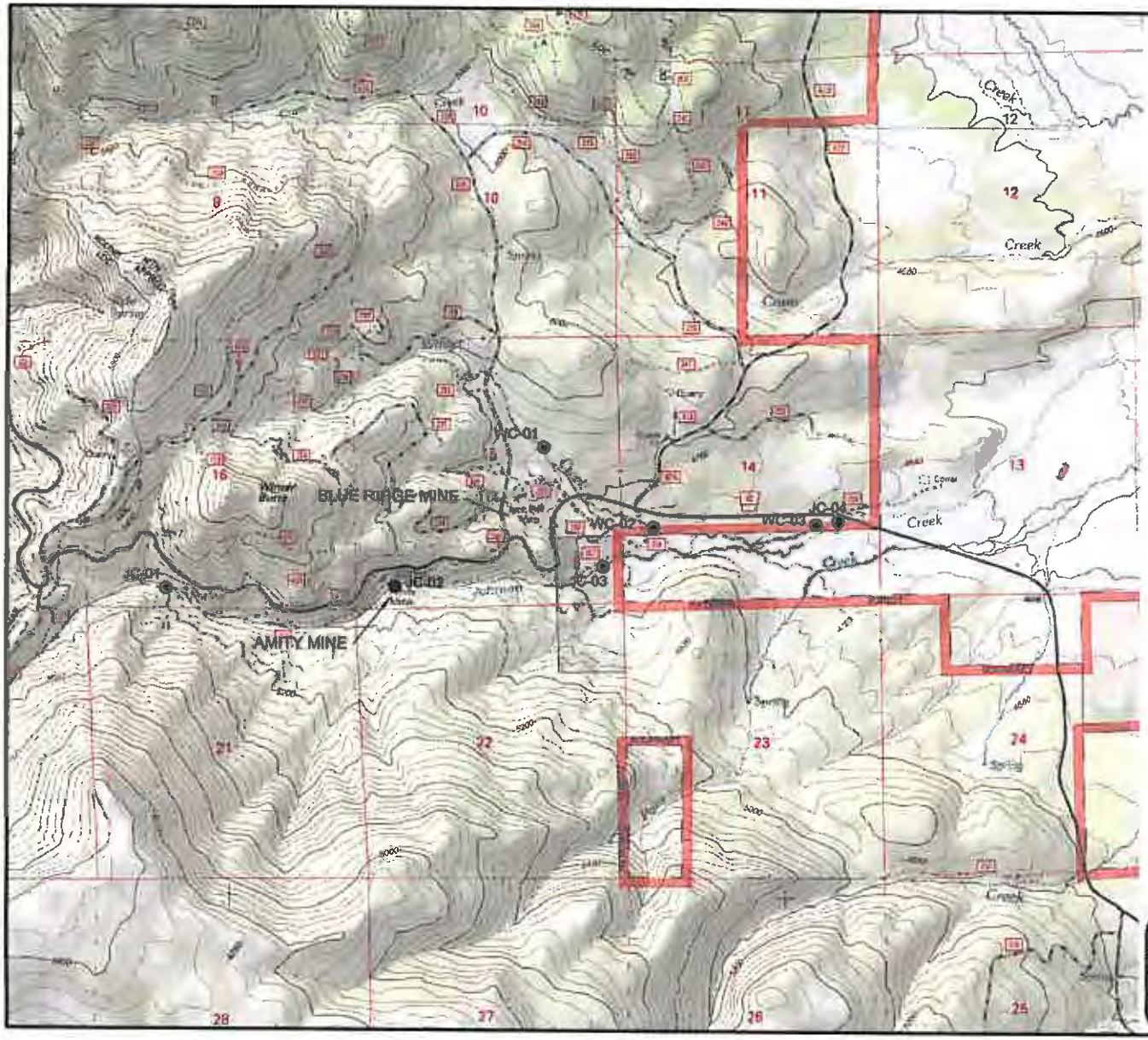
**Table 5. Benthic Invertebrate Index of Biological Integrity Scores, Spring 2004 and 2007**
**Amity - Blue Ridge Mine Complex, Ochoco National Forest, Crook County, Oregon**

| Station | Benthic Invertebrate Index of Biological Integrity (BIBI) Index | | | | |
|---|---|---|---|---|---|
| | Biological Condition Category | | | | |
| | Low Biological Integrity | Medium Biological Integrity | High Biological Integrity | Total Score (Spring 2004) | Total Score (Spring 2007) |
| JC-01 | 25 | 40 | 50 | 28 | 22 |
| JC-02 | 25 | 40 | 50 | 26 | 32 |
| JC-03 | 25 | 40 | 50 | 32 | 26 |
| JC-04 | 25 | 40 | 50 | 26 | 24 |
| WC-01 | 25 | 40 | 50 | 34 | 28 |
| WC-02 | 25 | 40 | 50 | 20 | 32 |

NOTE:

BIBI scores were calculated by Robert Wissman, Aquatic Biology Associates, Inc., Corvallis, Oregon.

## FIGURES




N

SCALE 1 INCH = 2,000 FEET

1 1/2 0 1 MILE

CONTOUR INTERVAL = 40 FEET

## EXPLANATION

WC-01 ● Aquatic Station Location and ID

WC Winter Creek

JC Johnson Creek

(SOURCE: NATIONAL GEOGRAPHIC TOPO MAPS OF WASHINGTON ON CD-ROM, 2000)

Figure 1. Aquatic Monitoring Stations

| | |
|---|---|
| PROJECT No. 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/18/07 | |
| DRAWING No. 2323026-004F1 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
| REVISION | CASCADE EARTH SCIENCES A Valmont Industries Company |

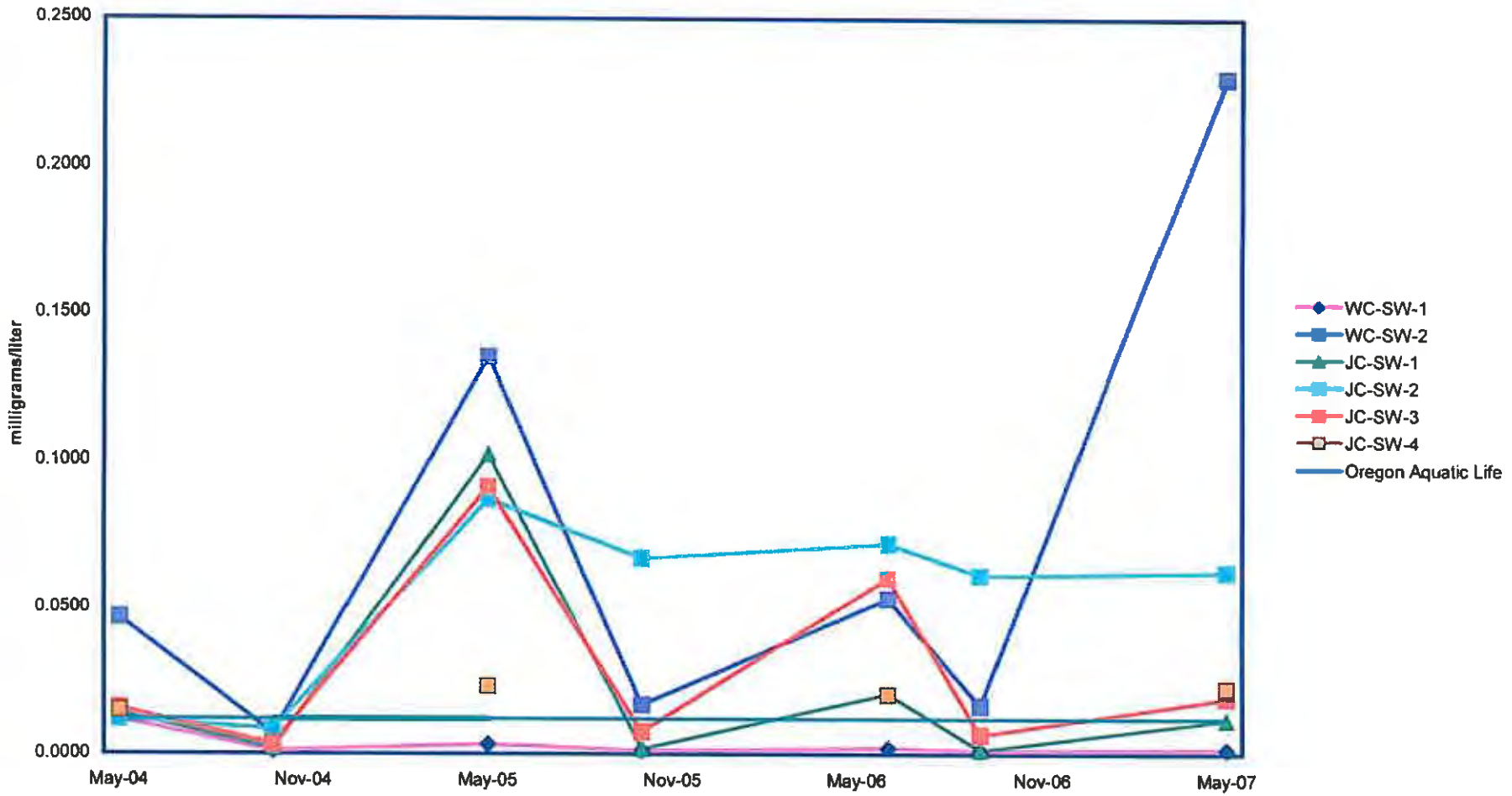



Figure 2. Mercury in Surface Water

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F2 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
| REVISED: | CES CASCADE EARTH SCIENCES A Valmont Industries Company |

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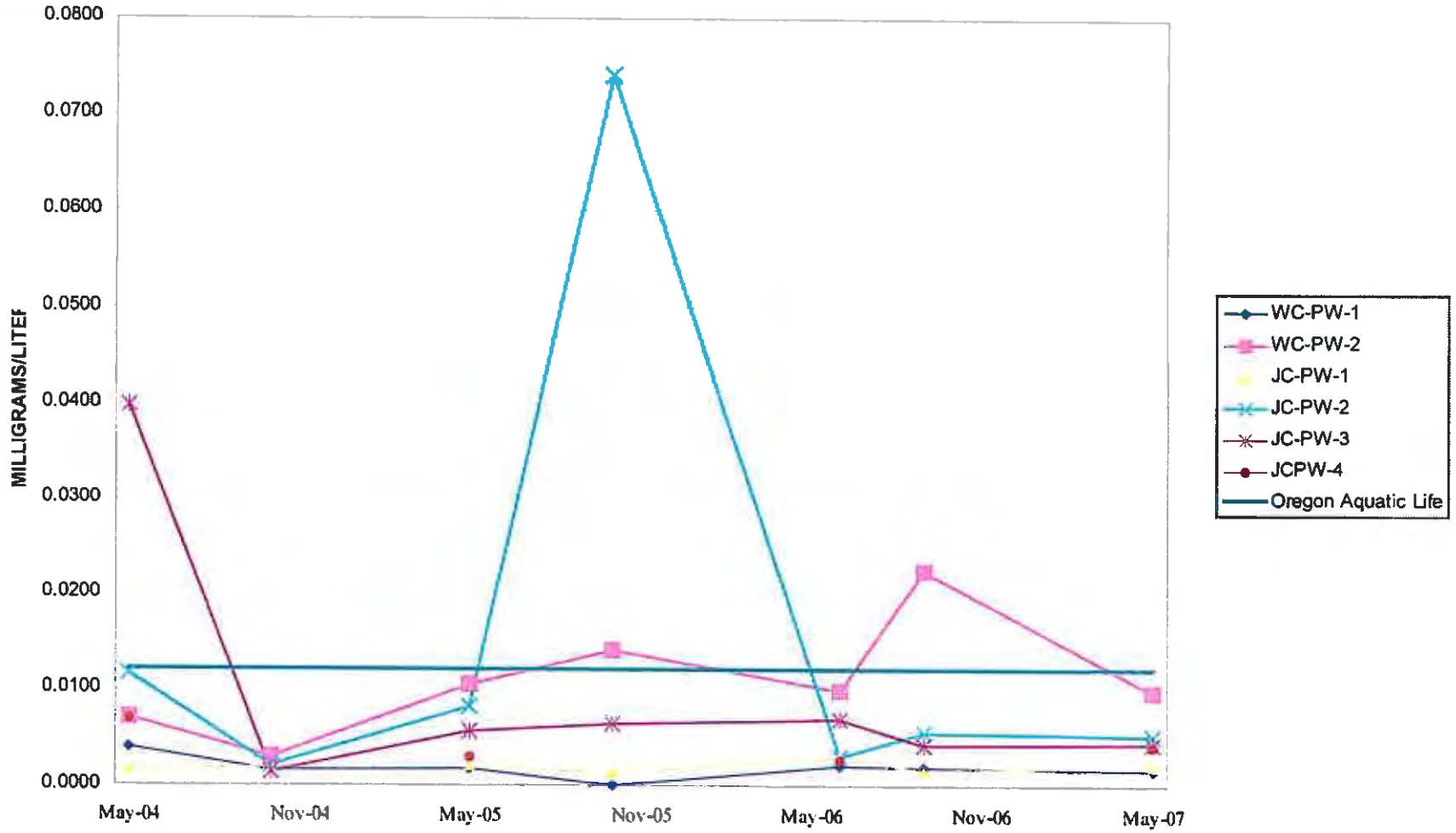


Figure 3. Mercury in Pore Water

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - **Blue** Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F3 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
| REVISED: | CASCADE EARTH SCIENCES A Valmont Industries Company |

Kathy 7/ 11:41 PM 2323026-004F3.dwg

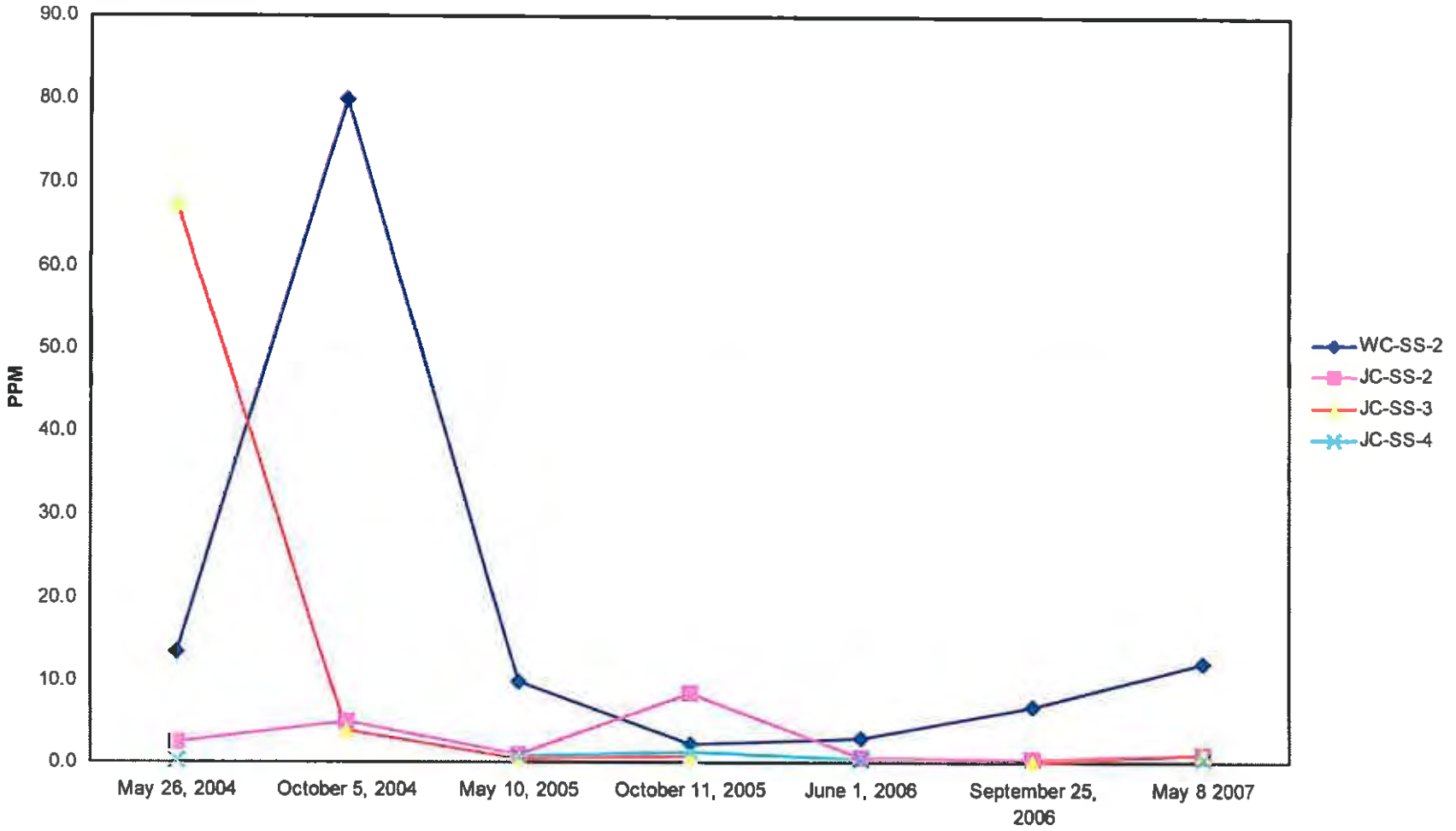


Figure 4. Mercury in Sediment

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F4 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
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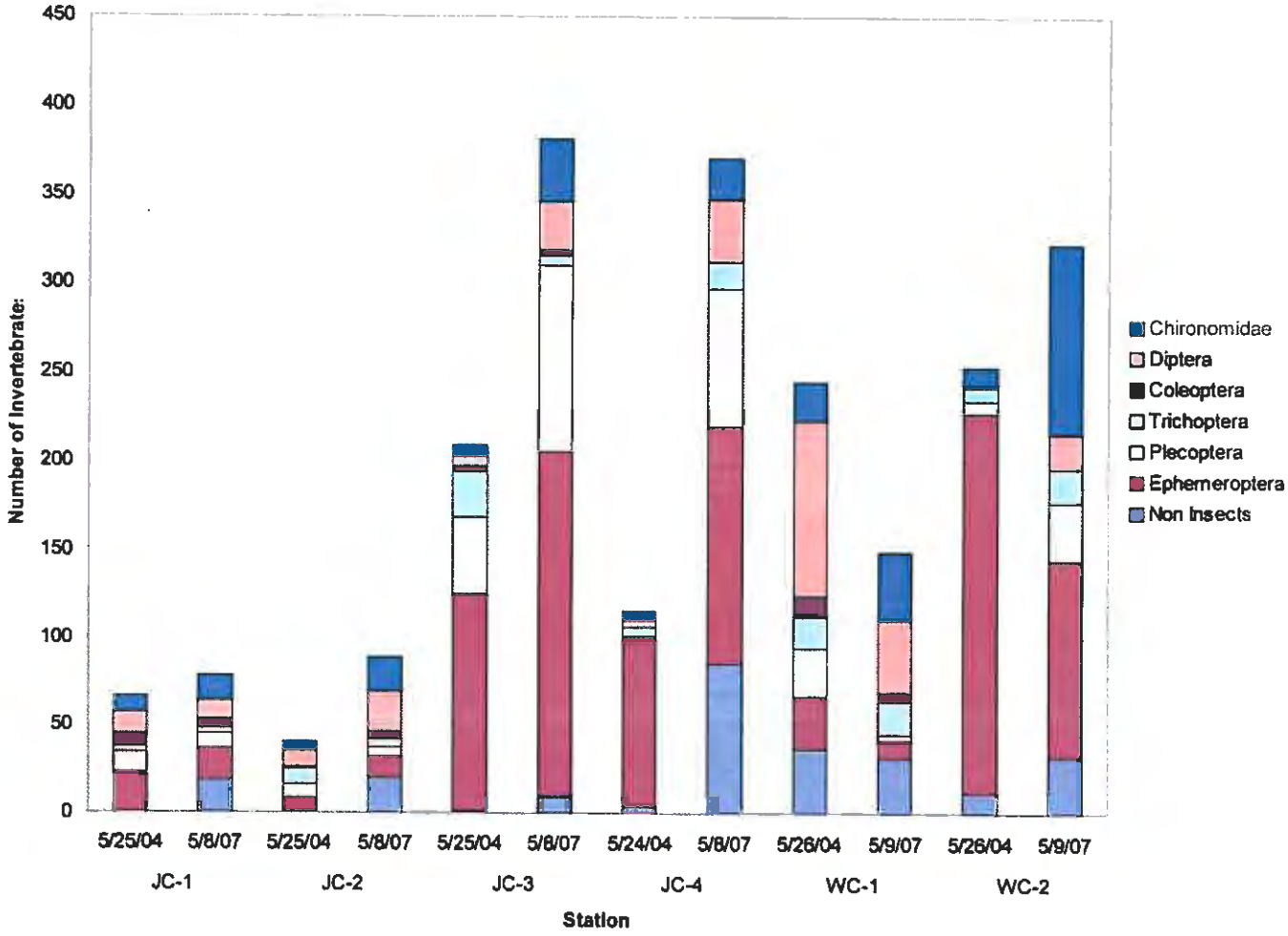


Figure 5. Invertebrate Abundance

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F5 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
| REVISED: | CES CASCADE EARTH SCIENCES A Valmont Industries Company |

Kathy 7/1 11:45 PM 2323026-004F5.dwg

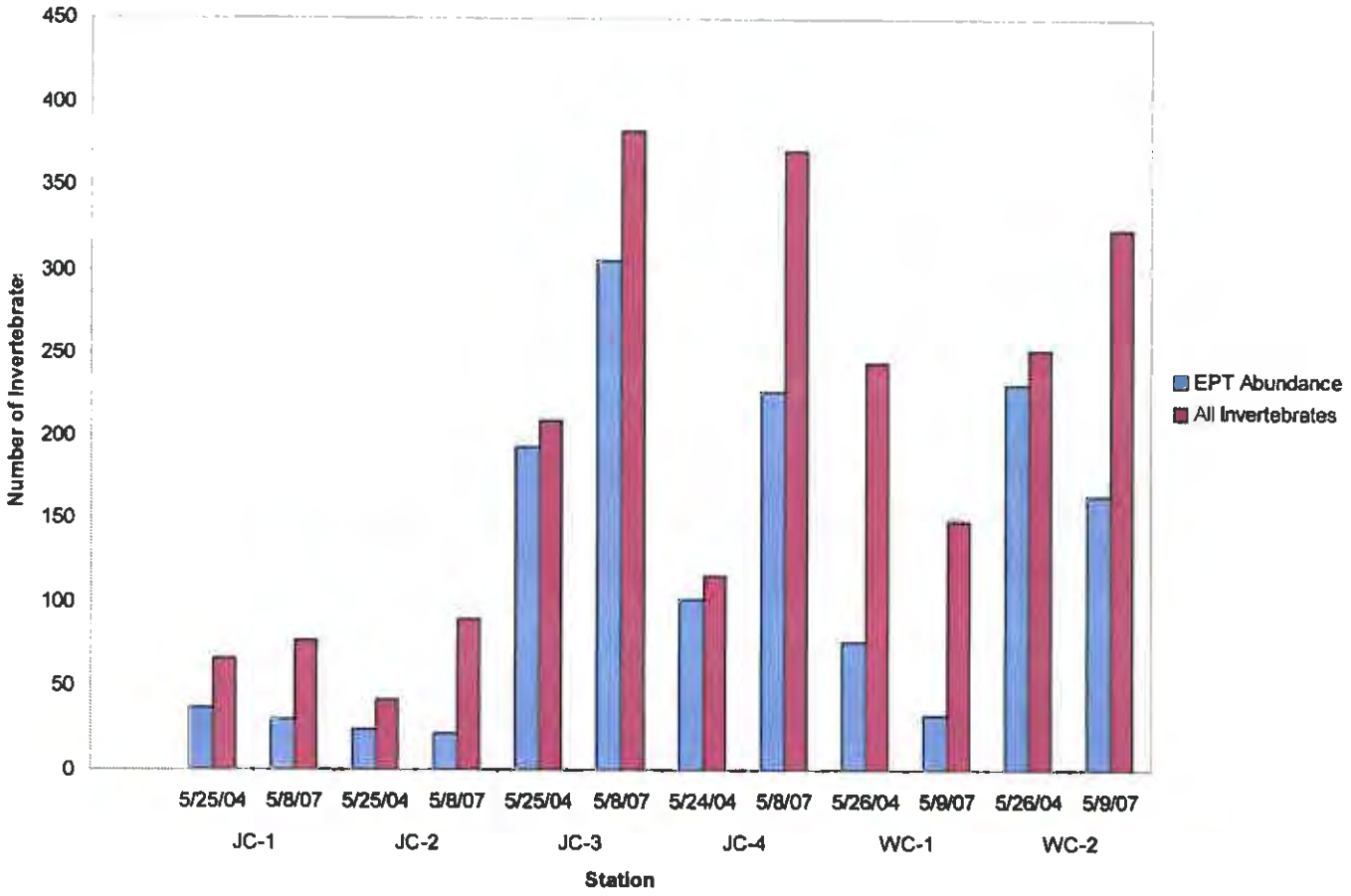


Figure 6. EPT Abundance

NOTE: EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These are generally considered to be pollution-intolerant taxa, which will typically decrease in abundance with decreased water quality.

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F6 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
| REVISED: | CASCADE EARTH SCIENCES A Valmont Industries Company |

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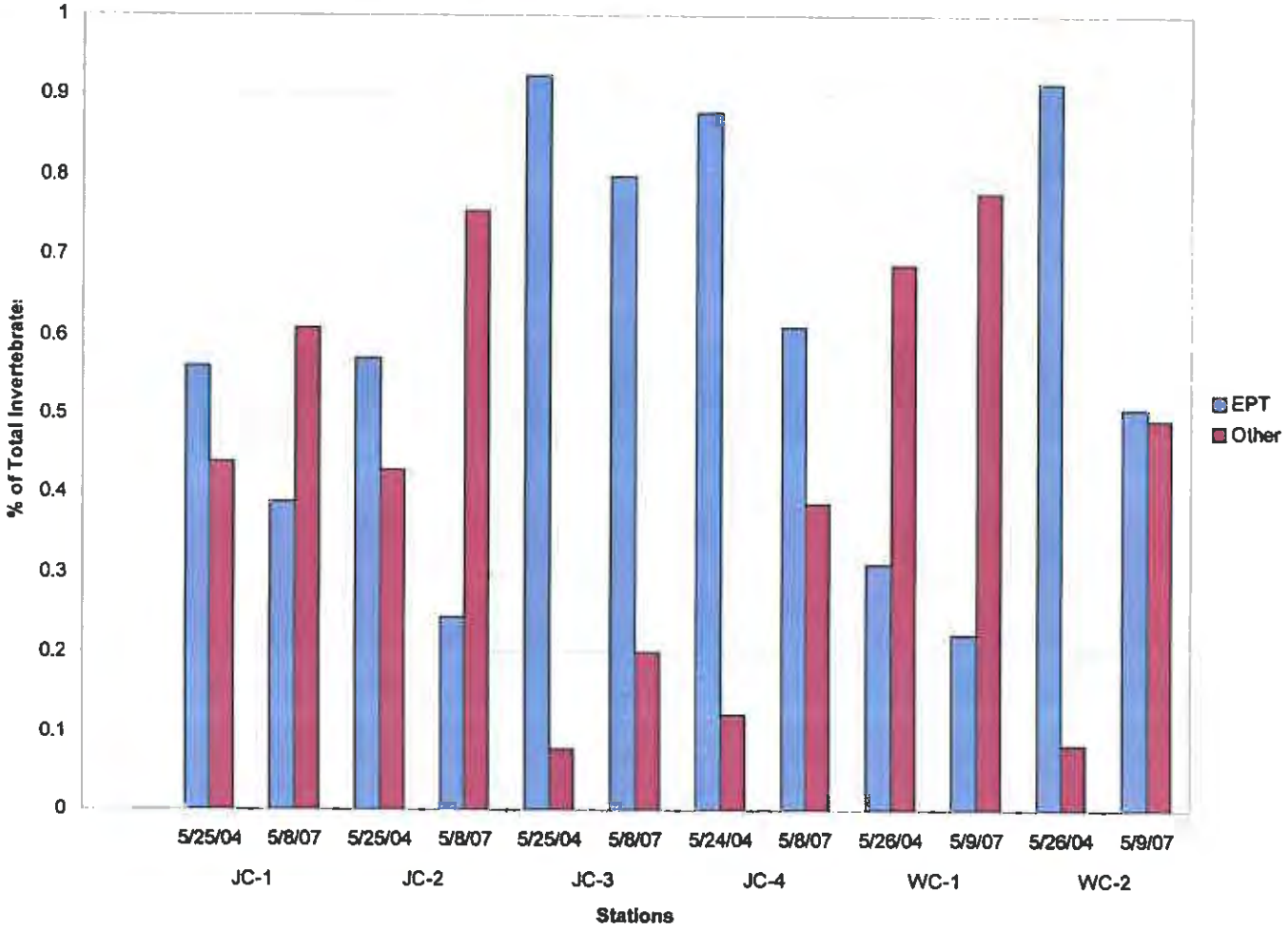


Figure 7. Community Composition

NOTE: EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These are generally considered to be pollution-intolerant taxa, which will typically decrease in abundance with decreased water quality.

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F7 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
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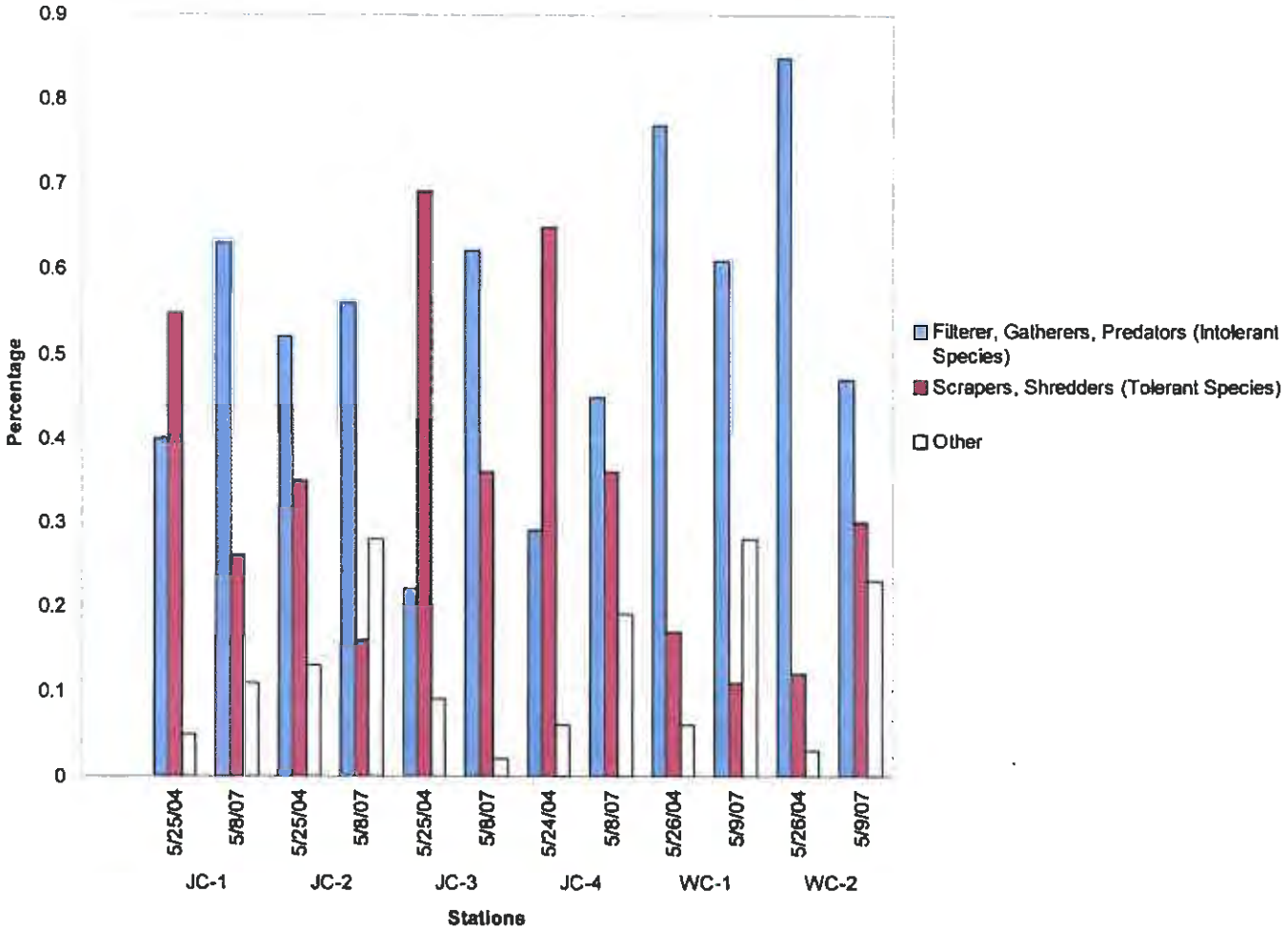


Figure 8. Functional Feeding Groups

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F8 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
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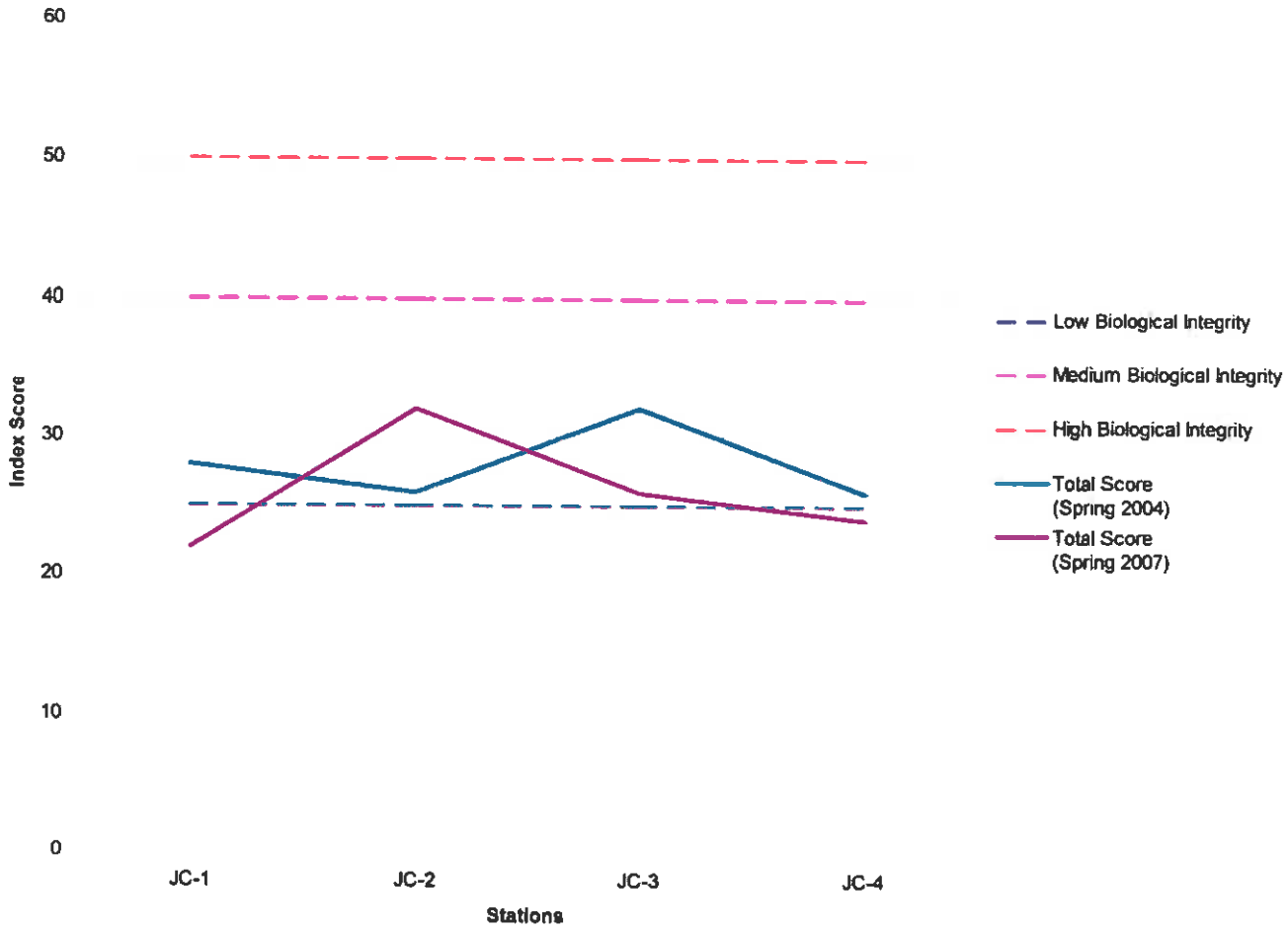


Figure 9. Benthic Index of Biological Integrity - Johnson Creek

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F9 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
| REVISED: | CES CASCADE EARTH SCIENCES A Valmont Industries Company |

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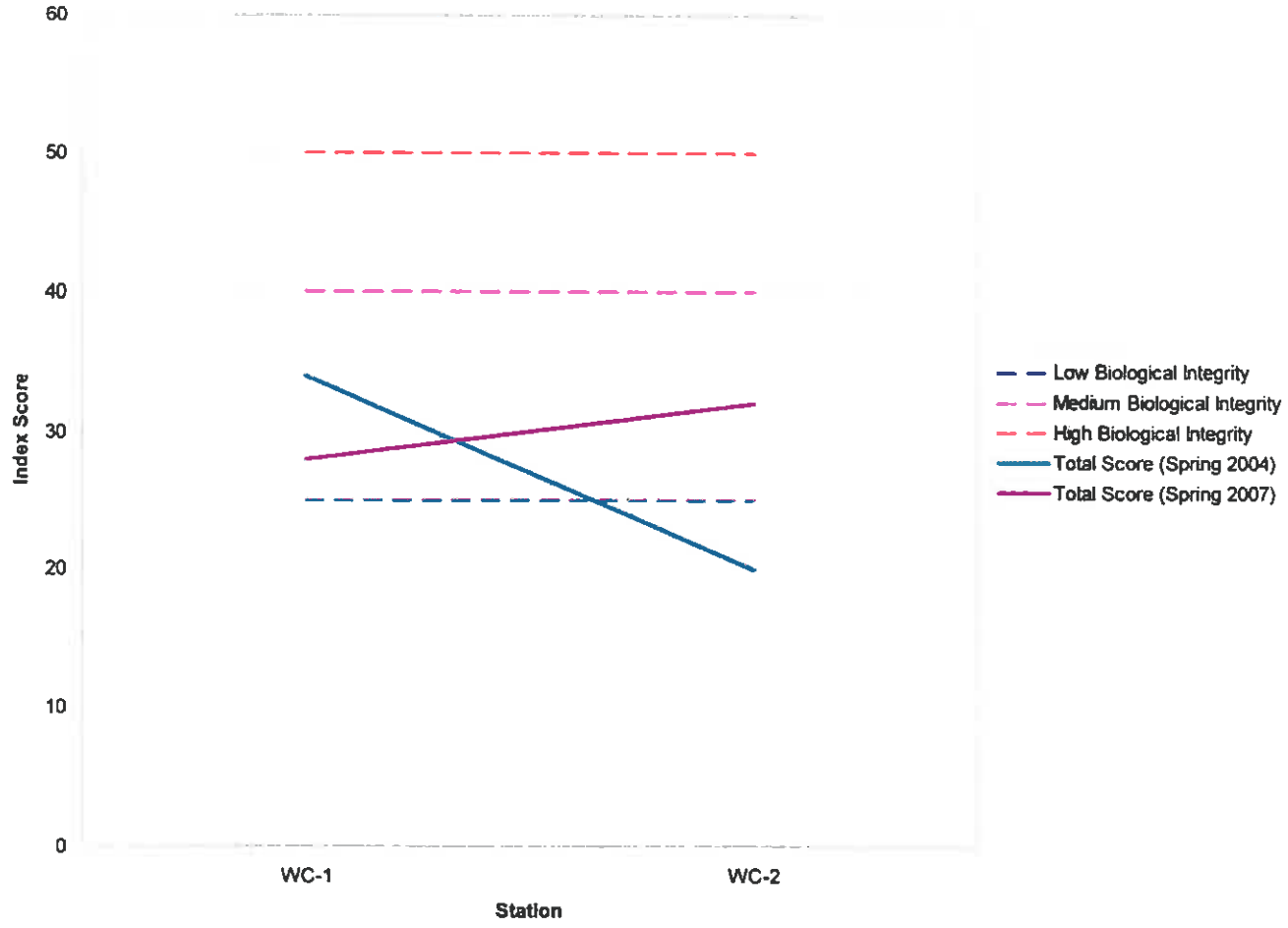


Figure 10. Benthic Index of Biological Integrity - Winter Creek

| | |
|---|---|
| PROJECT NUMBER: 2323026-004 | Amity - Blue Ridge Mines Removal Action |
| DATE: 07/10/07 | |
| DWG BY: 3kac / DWG NO: 2323026-004F10 | Ochoco National Forest Prineville, Oregon |
| PROJECT MANAGER: DGW | |
| REVISED: | CES CASCADE EARTH SCIENCES A Valmont Industries Company |

Kathy 7/11/2007 12:02 AM 2323026-004F10.dwg

## APPENDICES

**Appendix A. Aquatic Station Photographs**

**Appendix A.**

**Aquatic Station Photographs:**

## Appendix A. Aquatic Station Photographs

**Photograph 1.** Looking north at WC-01 in fall 2004. (Photograph CES)

**Photograph 2.** Looking north at WC-01 in spring 2007. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 3.** Looking south at WC-01 in spring 2006. (Photograph CES)

**Photograph 4.** Looking west at WC-02 in fall 2004. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 5.** Looking west at WC-02 in spring 2007. (Photograph CES)

**Photograph 6.** Looking west at WC-02 in spring 2004. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 7.** Looking east at WC-02 in fall 2004. (Photograph CES)

**Photograph 8.** Looking east at WC-02 in spring 2007. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 9.** Looking west at JC-01 in fall 2004. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 10.** Looking west at JC-01 in spring 2004. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 11.** Looking north at JC-02 in fall 2004. (Photograph CES)

**Photograph 12.** Looking east at JC-02 in spring 2007. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 13.** Looking east at JC-03 in fall 2004. (Photograph CES)

**Photograph 14.** Looking west at JC-03 in spring 2006. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 15.** Looking south at JC-04 in fall 2004. (Photograph CES)

**Photograph 16.** Looking south at JC-04 in spring 2006. (Photograph CES)

## Appendix A. Aquatic Station Photographs

**Photograph 17.** Looking north at JC-04 in spring 2006. (Photograph CES)