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Remedial Investigation Report

Bolts Lake Area and Areas within OU-1 of Eagle Mine Site

September 15, 2006

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REPORT

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TABLE OF CONTENTS

EXECUTIVE SUMMARY ***ES-1***

DEFINITIONS ***DEF-1***

1.0 INTRODUCTION ***1***

1.1 PURPOSE OF REPORT ***1***

1.2 ACKNOWLEDGEMENTS ***2***

1.3 SITE SETTING ***3***
1.3.1 North Property Layout *3*
1.3.2 Local Geology *4*

1.4 EAGLE MINE SITE BACKGROUND SUMMARY ***6***
1.4.1 Historical Mining Activities *6*
1.4.2 Tailings Disposal History *6*
1.4.3 Regulatory Background *9*
1.4.4 Remediation Activities *12*

1.5 POST REMEDIATION CONDITIONS ***19***
1.5.1 Old Tailings Pile and Rex Flats *19*
1.5.2 Bolts Lake *26*
1.5.3 Consolidated Tailings Pile *27*
1.5.4 Maloit Park *30*
1.5.5 Roaster Pile 5 *31*
1.5.6 Highlands Area *31*

1.6 HISTORICAL AERIAL PHOTOGRAPHS ***32***

2.0 2005-2006 REMEDIAL INVESTIGATION ***40***

2.1 REMEDIAL INVESTIGATION OVERVIEW ***40***

2.2 SURFACE WATER INVESTIGATION ***43***
2.2.1 Surface Water Samples *43*
2.2.2 Surface Water Flow Measurements *46*

2.3 EAGLE RIVER SEDIMENT INVESTIGATION ***46***

2.4 SOIL INVESTIGATIONS ***49***
2.4.1 Background Samples *49*
2.4.2 Surface Soil Samples *52*

2.4.3 Tailing Slurry Pipeline Sediment Samples 54
2.4.4 Rock Chip Samples from Boulders 54
2.4.5 Subsurface Soil Samples 54
2.4.6 SPLP Soil Samples 56

2.5 GROUND WATER INVESTIGATION **57**
2.5.1 Well Installation 58
2.5.2 Well Development 62
2.5.3 Survey 63
2.5.4 Water Level Measurements 63
2.5.5 Water Sampling 63
2.5.5.1 Ground Water Sampling 64
2.5.5.2 Ground Water Seep Samples 65
2.5.5.3 Surface Water Diversion Trench Samples 67

2.6 BASELINE AIR QUALITY **67**
2.6.1 Sampling Activities 68
2.6.2 Sample Locations 70

2.7 GEOPHYSICAL SURVEY **71**
2.7.1 Geophysical Surveys 71
2.7.2 Test Pit Excavation Procedures 74

3.0 INVESTIGATION RESULTS **77**

3.1 SURFACE WATER **77**
3.1.1 Surface Water Concentrations 77
3.1.2 Surface Water Flow Measurements 87
3.1.3 Surface Water Load Calculations 89

3.2 EAGLE RIVER SEDIMENT **91**
3.2.1 Stream Sediment Concentrations 91

3.3 SOIL **93**
3.3.1 Soil Background Concentrations 93
3.3.2 Surface Soil Concentrations 96
3.3.3 Tailings Slurry Pipeline Sediment Samples 105
3.3.4 Rock Chip Samples from Boulders 106
3.3.5 Subsurface Soil Samples 107
3.3.6 SPLP Soil Samples 113
3.3.7 Fines Fraction Analysis 115

3.4 GROUND WATER **116**
3.4.1 Ground Water Elevations and Flow Directions 116
3.4.2 Metals Concentrations 125
3.4.3 Summary of Metals Concentrations 151

3.4.4 Hydrogeology 153

3.5 AIR ***156***
3.5.1 Data Recovery 157
3.5.2 Particulate Levels 158
3.5.3 Arsenic Levels 158
3.5.4 Cadmium Levels 159
3.5.5 Lead Levels 159

3.6 GEOPHYSICAL EVALUATION ***162***

4.0 NATURE AND EXTENT OF CONTAMINATION ***165***

4.1 SURFACE WATER ***165***

4.2 SOIL ***170***
4.2.1 Background and Screening Values 170
4.2.2 Extent 175
4.2.3 Tailings Slurry Pipeline Sediment Samples 191
4.2.4 Rock Chip Samples from Boulders 192
4.2.5 Subsurface Soil Samples 193
4.2.6 Extent of Impacted Soil 196

4.3 GROUND WATER, SEEPS, AND TRENCHES ***202***
4.3.1 Hydraulic Testing 213

4.4 AIR ***214***

5.0 CONTAMINANT FATE AND TRANSPORT ***215***

5.1 POTENTIAL ROUTES OF MIGRATION ***215***

5.2 SURFACE SOIL ***215***

5.3 SUBSURFACE SOIL ***220***

5.4 GROUND WATER ***220***
5.4.1 General Chemistry 220

5.5 SURFACE WATER ***230***

6.0 HUMAN HEALTH AND ENVIRONMENT EVALUATION ***231***

6.1 SOIL ***231***

6.2 GROUND WATER ***231***

6.3 SURFACE WATER *232*

7.0 CONCLUSIONS *233*

8.0 REFERENCES *237*

LIST OF TABLES *Page*

Table 1 *Summary of Eagle River Zinc Loading Data (Collected by Viacom) Near the OTP and Rex Flats* 26
Table 2 *Summary of Eagle River Zinc Loading Data (Collected by Viacom) Along the CTP and Cross Creek* 30
Table 3 *Key Field Tasks* 41
Table 4 *Summary of Surface Water Analytical Results* 78
Table 5 *Eagle River and Cross Creek Discharge Measurements* 88
Table 6 *Eagle River Discharge Measurements at Station E-12A* 89
Table 7 *Summary of Eagle River Sediment Analytical Results* 93
Table 8 *Summary of Background Soil Analytical Results* 94
Table 9 *Summary of the Minimum and Maximum Surface Soil Concentrations, by Area, of the Seven Primary Indicator Metals* 97
Table 10 *Summary of the Minimum and Maximum Surface Soil Concentrations, by Area, of the Expanded Analytes* 98
Table 11 *Summary of the Minimum and Maximum Subsurface Soil Concentrations, by Area, of the Seven Primary Indicator Metals* 109
Table 12 *Summary of the Minimum and Maximum Subsurface Soil Concentrations, by Area, of the Expanded Analytes* 110
Table 13 *Summary of Rex Flats Ground Water Analytical Data* 127
Table 14 *Summary of Rex Flats Seeps Analytical Data* 135
Table 15 *Summary of OTP Ground Water Analytical Data* 137
Table 16 *Summary of OTP Seeps/Trench Analytical Data* 145
Table 17 *Summary of Bolts Lake Ground Water Analytical Data* 147
Table 18 *Summary of the CTP Ground Water Analytical Data* 149
Table 19 *Particulate Levels* 158
Table 20 *Arsenic Levels* 158
Table 21 *Cadmium Levels* 159
Table 22 *Lead Levels* 159
Table 23 *Wind Speed* 161
Table 24 *Temperature* 162
Table 25 *Mean Hardness and Calculated Standards* 168
Table 26 *Site-Specific Background Concentrations* 171
Table 27 *Data Summary for the 7 Primary Metals - Surface Soil Samples* 172
Table 28 *Data Summary for the Expanded List of Analytes - Surface Soil Samples* 174
Table 29 *Comparison of Subsurface Soil Concentrations, to Site-Specific RGs - Seven Primary Indicator Metals* 192
Table 30 *Summary of Exceedances of CDPHE Ground Water Standards at the North Property* 201
Table 31 *Summary of Exceedances of Surface Water Standards at the North Property* 202
Table 32 *Potential Routes of Metal Transportation* 214
Table 33 *Comparison of Eagle River Sediment Concentrations* 217

LIST OF FIGURES *Page*

Figure 1 *North Property Boundary* 4
Figure 2 *Eagle River Monthly Streamflow -USGS Station 09064600 - Eagle River Sampling Location E12A-Select years and 1989 to 2004 mean streamflow* 18
Figure 3 *Water from the OTP draining into the historic Sump #3 area.* 20
Figure 4 *Viacom – Old Tailings Pile/Rex Flats Monitoring Well Locations from Newfields (Newfields, 2005)* 22
Figure 5 *Seep located on the north side of Rex Flats* 24
Figure 6 *CTP Monitoring Well Locations from Newfields (Newfields, 2005)* 28
Figure 7 *1939 Aerial Photograph* 32
Figure 8 *1974 Aerial Photograph* 34
Figure 9 *1985 Aerial Photograph* 36
Figure 10 *2004 Aerial Photograph* 38
Figure 11 *Surface Water Sampling Locations* 44
Figure 12 *Eagle River Sediment Sample Locations* 48
Figure 13 *Background Surface Soil Sample Locations* 50
Figure 14 *Background Soil Samples Relative to Topography* 51
Figure 15 *Surface Soil and Nearby Background Soil Sample Locations* 53
Figure 16 *Subsurface Soil Sample Locations* 55
Figure 17 *SPLP Soil Sample Locations* 57
Figure 18 *Ground Water, Seep, and Diversion Trench Sample Location Map* 59
Figure 19 *North Property Geology Map and Monitoring Well Locations* 61
Figure 20 *General Areas of Spring Water Ponding and Seeps* 66
Figure 21 *Air Sample Locations* 69
Figure 22 *Rex Flats – Geophysical Area Location Map* 73
Figure 23 *Test Pit Locations in Rex Flats – Geophysical Interpretation* 75
Figure 24 *Plastic sheeting used for excavated soil* 76
Figure 25 *Scrap wire and cable from Test Pit 2* 76
Figure 26 *Summary of Dissolved Zinc Concentrations in Surface Water* 82
Figure 27 *Summary of Zinc Concentrations in Surface Water of the Eagle River - October 2005* 83
Figure 28 *Summary of Dissolved Zinc Concentrations in Surface Water of the Eagle River Low Flow 2005 and 2006* 84
Figure 29 *Summary of Dissolved Zinc Concentrations in Surface Water of the Eagle River - High Flow 2006* 84
Figure 30 *Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River - March 22, 2006* 86
Figure 31 *Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River – April 19, 2006* 86
Figure 32 *Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River – May 23, 2006* 87
Figure 33 *Discharge at Eagle River Stations* 88
Figure 34 *Summary of Zinc Loading along Eagle River* 90
Figure 35 *Summary of Eagle River Sediment Analytical Results* 92
Figure 36 *Background Sample Locations with Metal Concentrations (mg/kg)* 96

Figure 37 *OTP Surface Soil Sample Locations and Nearby Background Locations* 101
Figure 38 *Rex Flats Surface Soil Sample Locations and Nearby Background Locations* 102
Figure 39 *Maloit Park Surface Soil Sample Locations and Nearby Background Locations* 103
Figure 40 *Roaster Pile #5 Surface Soil Sample Locations and Nearby Background Locations* 104
Figure 41 *Bolts Lake Surface Soil Sample Locations and Nearby Background Locations* 105
Figure 42 *Subsurface Soil Sample Locations* 108
Figure 43 *OTP –South-North- Cross Section* 111
Figure 44 *OTP –West-East Cross Section* 111
Figure 45 *Rex Flats South-North Cross Section* 112
Figure 46 *Rex Flats West-East Cross Section* 112
Figure 47 *Rex Flats, June 2006 Ground Water Contour Map* 117
Figure 48 *Rex Flats Area, Shallow and Deep Well Ground Water Elevations* 118
Figure 49 *OTP, Bolts Lake and CTP, June 2006 Ground Water Contour Map* 120
Figure 50 *Surface Contour Map* 121
Figure 51 *3D Perspective Looking North* 122
Figure 52 *OTP Area, Shallow and Deep Well Ground Water Elevations* 123
Figure 53 *3D Perspective Looking Northwest* 124
Figure 54 *CTP Area, Shallow and Deep Well Ground Water Elevations* 125
Figure 55 *Rex Flats, September 2005 Dissolved Manganese Map* 129
Figure 56 *Rex Flats, September 2005 Dissolved Zinc Map* 131
Figure 57 *Rex Flats, September 2005 Dissolved Cadmium Map* 132
Figure 58 *Expanded Dissolved Metal Ground Water Results – September 2005 and April 2006* 134
Figure 59 *Seep and Surface Water Diversion Trench Sampling Results* 136
Figure 60 *OTP, Bolts Lake and CTP, Dissolved Manganese September 2005* 140
Figure 61 *OTP, Bolts Lake and CTP, Dissolved Zinc September 2005* 142
Figure 62 *OTP, Bolts Lake and CTP, Dissolved Cadmium September 2005* 143
Figure 63 *Dissolved Manganese vs. Zinc, September 2005 - (Ground Water/Seeps/Diversion Trenches)* 152
Figure 64 *Dissolved Manganese vs. Zinc, April 2006 - (Ground Water/Seeps/Diversion Trenches)* 153
Figure 65 *Hydrologic Testing Summary Map* 154
Figure 66 *Battle Mountain North Particulate Levels – July 21 through November 18, 2005* 157
Figure 67 *Prevailing Wind Directions at the North Property – August 19 through November 21, 2005* 161
Figure 68 *Foundation block in Test Pit 1* 162
Figure 69 *Barbed wire by Test Pit 7* 163
Figure 70 *Test Pit after restoration and reseeding* 163
Figure 71 *Summary of Dissolved Zinc Concentrations in Surface Water of the Eagle River - Low Flow 2005 and 2006* 166

Figure 72 *Summary of Dissolved Zinc Concentrations in Surface Water of the Eagle River - High Flow 2006* 167
Figure 73 *Summary of Eagle River Water Quality Stations with Associated Surface Water Metals Exceedance* 169
Figure 74 *OTP –Impacted Area of Arsenic (greater than 40 mg/kg)* 176
Figure 75 *TP – Impacted Area of Lead (greater than 400 mg/kg)* 177
Figure 76 *OTP – Impacted Area of Manganese (greater than 1,800 mg/kg)* 178
Figure 77 *Rex Flats – Impacted Area of Arsenic (greater than 40 mg/kg)* 179
Figure 78 *Rex Flats – Impacted Area of Lead (greater than 400 mg/kg)* 180
Figure 79 *Rex Flats – Impacted Area of Manganese (greater than 1,800 mg/kg)* 181
Figure 80 *Maloit Park – Impacted Area of Arsenic (greater than 40 mg/kg)* 182
Figure 81 *Maloit Park – Impacted Area of Lead (greater than 400 mg/kg)* 183
Figure 82 *Maloit Park – Impacted Area of Manganese (greater than 1,800 mg/kg)* 184
Figure 83 *Bolts Lake – Impacted Area of Arsenic (greater than 40 mg/kg)* 185
Figure 84 *Bolts Lake – Impacted Area of Lead (greater than 400 mg/kg)* 186
Figure 85 *Bolts Lake – Impacted Area of Manganese (greater than 1,800 mg/kg)* 187
Figure 86 *Roaster Pile #5 – Impacted Area of Arsenic (greater than 40 mg/kg)* 188
Figure 87 *Roaster Pile #5 – Impacted Area of Lead (greater than 400 mg/kg)* 189
Figure 88 *Roaster Pile #5 – Impacted Area of Manganese (greater than 1,800 mg/kg)* 190
Figure 89 *Subsurface Soil Locations with Elevated Metal Concentrations* 193
Figure 90 *Bolts Lake – Summary of Extent Impacted Soil* 196
Figure 91 *Maloit Park - Summary of Extent Impacted Soil* 197
Figure 92 *OTP/Sump #3 – Summary of Extent Impacted Soil* 198
Figure 93 *Rex Flats – Summary of Extent Impacted Soil* 199
Figure 94 *Roaster Pile #5 – Summary of Extent Impacted Soil* 200
Figure 95 *April 2006 Dissolved Cadmium, Rex Flats -CDPHE Ground Water Standard Exceedance* 203
Figure 96 *April 2006 Dissolved Manganese, Rex Flats - CDPHE Ground Water Standard Exceedance* 204
Figure 97 *April 2006 Dissolved Zinc, Rex Flats - CDPHE Ground Water Standard Exceedance* 205
Figure 98 *April 2006 Dissolved Cadmium, OTP, Bolts Lake and CTP Areas - CDPHE Ground Water Standard Exceedance* 207
Figure 99 *April 2006 Dissolved Manganese, OTP, Bolts Lake and CTP Areas - CDPHE Ground Water Standard Exceedance* 208
Figure 100 *April 2006 Dissolved Zinc, OTP, Bolts Lake and CTP Areas - CDPHE Ground Water Standard Exceedance* 209
Figure 101 *Ponding water on the OTP* 211
Figure 102 *Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River – March 22, 2006* 215
Figure 103 *Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River – April 19, 2006* 216
Figure 104 *Seep in the OTP draining east toward the Eagle River* 223
Figure 105 *Seep in the OTP near Tigiwon Road* 223
Figure 106 *Rex Flats looking north* 225

Figure 107 *Ponded water beneath the Mine Water Transport Pipeline at Rex Flats.....227*

LIST OF APPENDICES

Appendix A *Viacom Well Graphs*
Appendix B *Historical Aerial Photographs*
Appendix C *Borehole Logs*
Appendix D *Waste Manifests*
Appendix E *Well Construction Information*
Appendix F *Well Development Summary*
Appendix G *Survey Report*
Appendix H *Water Level Measurements*
Appendix I *Monitoring Well Purge Forms*
Appendix J *Chain-Of-Custody Forms*
Appendix K *Database of Laboratory Analytical Results; and Ground Water Summary Tables*
Appendix L *Geophysical Test Surveys at the Rex Flats Area – Minturn, Colorado*
Appendix M *Log of Test Pits*
Appendix N *Eagle River Profiles – October 2005*
Appendix O *Figure of Eagle River Sediment Concentrations*
Appendix P *Tables of Analytical Results for Surface Water, Sediment, Boulders, and Soil*
Appendix Q *Rex Flats Ground Water Elevations*
Appendix R *Ground Water Elevation and Analytical Data Graphs*
Appendix S *OTP, Bolts Lake, and CTP Ground Water Elevations*
Appendix T *Rex Flats Dissolved Metal Concentration Maps*
Appendix U *OTP, Bolts Lake, and CTP Dissolved Metal Concentration Maps*
Appendix V *Slug Test Results*
Appendix W *Slug Test Data, Dames and Moore, 1991*
Appendix X *Pump Test Data*
Appendix Y *Air Quality Data Tables, Calibration and Audit Forms*
Appendix Z *Meteorological Data Tables*
Appendix AA *Surface Soil Areas of Impact*

LIST OF ATTACHMENTS

Attachment 1 *CTP Data Review Report*
Attachment 2 *Quality Assurance Project Plan Report*

EXECUTIVE SUMMARY

ERM has performed a Remedial Investigation of Ginn Battle North LLC's ("Ginn Battle North") property, located south of Minturn, Colorado ("North Property"), on behalf of Ginn Battle North. The North Property contains certain features of the Eagle Mine Superfund Site ("Eagle Mine Site"), such as the Consolidated Tailings Pile ("CTP"), Old (former) Tailings Pile ("OTP"), Rex Flats, and surrounding areas adjacent to features of the Eagle Mine Site, including Bolts Lake and the Highlands Area. The work was completed in accordance with the EPA/CDPHE-approved "Final Work Plan for Site Investigation of Bolts Lake and Eagle Mine Site OU-1 Development Areas, Battle Mountain North Development," dated July 6, 2005 ("Work Plan") , and the National Contingency Plan.

Mining and remediation features associated with the Eagle Mine Site that remain within the North Property include:

- CTP with its associated Water Treatment Plant ("WTP"), water extraction trenches, diversion trenches, surge ponds, outfall, sludge cell, and temporary cell,
- the mine water transport pipeline that is located on an elevated trestle between Rex Flats and the WTP,
- the tailings slurry pipeline located immediately south of the OTP that contains metals-laden sediment,
- the surface water diversions trenches located along the north and south portions of the OTP,
- scrap metal pieces within Rex Flats,
- large metals-stained boulders and tailings within the southern portions of Rex Flats and the OTP, and
- the ground water monitoring system.

The portion of the Eagle Mine Site within the North Property was previously remediated to reduce the effects of mine-related impacts to the Eagle River. The proposed reuse of the North Property as a residential and recreational community required additional investigation to evaluate the impacts of residual mine waste upon human health and the environment. The main purpose for the Remedial Investigation was to

determine the nature and extent of any remaining contamination in the soil, ground water, surface water, and air at the North Property.

The key field tasks as stated on page 34 of the Work Plan included the following:

- Review historic data collected from the CTP,
- Collect surface soil samples from the OTP, Rex Flats, Bolts Lake areas, Maloit Park, and Roaster Pile #5 areas, and collect subsurface soil samples within the OTP, Rex Flats, and Bolts Lake areas,
- Install new ground water monitoring wells and monitor the new and some existing Viacom wells for 8 months,
- Collect hydrogeologic data including water levels, slug tests, and an aquifer test,
- Collect samples of other media including air, surface water, surface water diversion trenches, seeps, boulders, and Tailings Slurry Pipeline sediment, and
- Perform a geophysical survey to evaluate potential subsurface anomalies at the Rex Flats and OTP areas.

Environmental samples from the Remedial Investigation were analyzed for a suite of primary metals indicative of the impacts from historical mining, including arsenic, cadmium, chromium, copper, lead, manganese, and zinc. Additionally, the Colorado Department of Public Health and Environment ("CDPHE") requested that a subset of the samples be analyzed for an expanded analyte list that included aluminum, antimony, barium, beryllium, calcium, cobalt, cyanide, iron, magnesium, mercury, nickel, potassium, selenium, silver, sodium, sulfate, thallium, and vanadium.

The findings from the Remedial Investigation are summarized below.

Soil

The majority of mine waste, predominantly mine tailings, was removed from the OTP, Rex Flats, Sump #3 area, Maloit Park, and Roaster Pile #5; however, localized portions of these areas contain residual amounts of waste that were not completely removed during the remediation activities performed by Viacom. These localized portions of waste contain

concentrations of mine-related metals (such as arsenic, lead, and manganese) at concentrations greater than risk-based remediation goals. Additionally, the surface and subsurface native soil within these areas contain elevated concentrations of metals due to the historic placement of mine waste at these locations. The mine waste that was removed from these areas was placed within the CTP, which also historically received mine waste.

The evaluation and estimation of the nature and extent of mine impact to soil was based on the Site-specific remediation goals ("RGs"). These were established based on background samples, EPA Region 9 Preliminary Remediation Goals ("PRGs"), and a Site-specific risk assessment. Based upon a review of all the above information, the OTP, Rex Flats, Sump #3 area, Roaster Pile #5, and areas of Maloit Park are considered to be impacted by waste residues from the historic disposal of mine wastes. A very localized area of Bolts Lake is also considered impacted where mine waste was used as road fill.

The impacted soil in these areas affects the surface water by erosion or overland flow into the Eagle River. Additionally, the remaining elevated metals at each area leach from the soil into the ground water, which then flows into the Eagle River. Residual impacted soil also contributes to metals concentrations of the Eagle River sediment.

Surface Water

Surface water quality is predominately evaluated by its zinc content, which is the primary concern identified by CDPHE due to its effect on the Eagle River trout population The existing zinc water quality standards were met during the summer and fall months of 2005, and exceeded during the spring runoff in March and April 2006. The zinc concentrations are generally higher in the Eagle River when it enters the North Property than when it exits the North Property. Each segment of the Eagle River within the North Property investigation has shown an increase in zinc concentration at least once during the 2005-2006 investigation. The localized increases in zinc concentrations are attributed to discharge to the river from seeps and ground water in these areas, and possibly surface water runoff.

It is noted that historically, cadmium was the primary cause of toxicity to the aquatic community in the Eagle River prior to 1994. However, remediation performed at the Site in 1994 resulted in a reduction in cadmium concentrations and rebounding of the aquatic community (CDPHE, 2005). Cadmium standards were exceeded during the Spring 2006 sampling events during this RI.

Additionally, copper exceeded the standards during the Spring 2006 sampling events, and lead was exceeded during the June 2005 sampling event. Arsenic, chromium, and manganese were not detected above the standards during the 2005 or 2006 sampling events. The existing surface water standards will change (be lowered) effective December 31, 2007.

Ground Water

Ground water beneath the OTP, Rex Flats, and historic Sump #3 area continues to be impacted by metals from the former placement of mine tailings materials in these areas prior to remediation. Specifically, dissolved cadmium, zinc, manganese, arsenic, iron, sulfate, and pH in these areas exceed the CDPHE ground water standards. Additionally, ground water in the OTP contains elevated dissolved arsenic, aluminum, beryllium, nickel, and thallium which exceeded CDPHE ground water standards. The use of ground water for domestic use in these areas is currently prohibited, as it has been in the past, due to these exceedances.

Ground water in the OTP, Rex Flats, and historic Sump #3 areas flows towards and into the Eagle River. The ground water contains elevated concentrations of metals and low pH. Dissolved ground water concentrations of cadmium, zinc, manganese, copper and lead exceed one of more of the CDPHE ground water standards or Eagle River surface water standards in these areas. Ground water levels generally rise in the spring and decrease in the summer and the fall. An increase in dissolved metals occurs in some of the ground water monitoring wells in the spring. This indicates that metals are mobilized in these areas either by: 1) an increase in ground water entering the Site; or 2) an increase in infiltration of surface water from snow melt.

The ground surfaces of the OTP and Rex Flats are wet during the spring snow melt with the OTP remaining wet for a longer period of time. Surface water run-on at the OTP is controlled by overflow from the Beaver Ponds, to the west of the OTP, and through leaking north and south surface water diversion ditches. Portions of the surface water diversion trenches were built near mine tailings and water leaking from these trenches interacts with these tailings forming acidic seeps that contain elevated metals. These seeps drain into the OTP and indirectly to the Eagle River, and infiltrate into the ground water, which flows into the Eagle River. Ground water in the northern portion of Rex Flats seeps along the south bank of the Eagle River. Water from these seeps contains elevated dissolved metals including zinc and manganese which exceed the Eagle River surface water standards.

Ground water beneath the CTP is impacted from the historic deposition of wet tailings at that location. A ground water collection structure and two ground water extraction trenches intercept impacted ground water at the CTP and return it to the WTP for metals removal and eventual discharge to the Eagle River. These trenches require periodic maintenance to maintain their effectiveness. Water has been observed seeping on the downstream side of the north ground water extraction trench in Maloit Park. No impact was evident from these seeps upon the water quality samples obtained in Cross Creek. Surface water collects seasonally in the temporary holding cell during periods of increased precipitation. Tears in the liner of the temporary holding cell are evident, and may enable surface water to infiltrate the underlying materials.

The analysis of ground water samples collected during this investigation from wells located downgradient of the CTP detected dissolved manganese and pH above the CDPHE ground water standard and dissolved manganese, copper, and zinc above Eagle River surface water standards. Analysis of ground water samples collected from Bolts Lake only detected dissolved manganese above the CDPHE ground water and surface water standards (one detection of copper was above the surface water standard).

Air Quality

Air quality monitoring was performed at the Site to establish a baseline of particulate matter in the air prior to any disturbance of the Site for additional remedial measures. The levels of PM10 (particulates smaller than 10 microns) measured at the North Property are below the Federal and Colorado annual standard for that parameter. Detectable levels of lead were only measured at Station AS-1 (north of Rex Flats on Tigiwon Road) and were all below the Colorado standard for that metal. The data indicate that even though soil with elevated metals concentrations is present at the North Property: 1) it is likely not present on Tigiwon Road, which generates the most dust due to vehicle use; and 2) there was insufficient metals-laden dust generated within the OTP, Rex Flats, and Maloit Park to impact air quality.

DEFINITIONS

The following terms, as used in this RI Report, shall have the definitions as set out in this section:

"Eagle Mine Superfund Site," "Eagle Mine Site," or "Site" shall mean the area impacted by past mining activities located along the Eagle River between the towns of Minturn and Red Cliff, in Eagle County, Colorado. The Eagle Mine Superfund Site is approximately 235 acres and includes the Eagle Mine workings and the town of Gilman, the Roaster Pile areas, the Waste Rock Piles, Rex Flats, the OTP, the CTP, Maloit Park, the water diversion components around the CTP, the water treatment plant ("WTP"), the tailing slurry lines and trestles, the mine seepage and collection systems, and the town of Belden.

"Eagle Mine" shall mean the mine located in the Gilman/Belden area that was operated from approximately 1916 to 1983 by the Empire Zinc Company, a subsidiary of the New Jersey Zinc Company, and/or Gulf & Western Industries, Inc. ("G&W") for lead-zinc and copper-silver ores. G&W subsequently changed its name to Paramount Communications, Inc. ("Paramount"), and Paramount merged into Viacom International, Inc. ("Viacom") in 1995.

"EPA Five-Year Review Report" shall mean the Five-Year Review Report of the Eagle Mine Site prepared by EPA in September 2000.

"1988 Consent Decree" or "CD" shall mean the Consent Decree entered between Gulf & Western Industries, Inc. and the State of Colorado in June 1988 to address remedial measures at the Eagle Mine Site.

"3-Party Consent Decree" shall mean the Partial Consent Decree entered between Viacom International, Inc. ("Viacom"), the State of Colorado, and EPA in August 1995 to address additional remedial measures at the Eagle Mine Site.

"Comprehensive Environmental Response, Compensation and Liability Act," "CERCLA," or "Superfund" (42 U.S.C. §§ 9601-9675 (2005)) shall mean the statute whose purpose is to respond to releases or substantial threats of releases of hazardous substances which may present an imminent and substantial danger to the public health or welfare.

"Consolidated Tailings Pile" or "CTP" shall mean the area where mine tailings were historically placed from about 1946 until 1977 and were consolidated at the Site in 1992. The CTP is located immediately south of Maloit Park, just west of the intersection of Two Elk Creek and the Eagle River.

"Maloit Park" shall mean the area situated at the north end of the North Property, along Cross Creek.

"Mine Water Transport Pipeline" shall mean the pipeline that rests on the wooden trestle and was historically used to transport tailings from the processing areas at Belden to the OTP and Rex Flats. The Mine Water Transport Pipeline currently carries mine water to the WTP, and traverses Rex Flats north to the WTP.

"National Contingency Plan" or "NCP" (40 C.F.R. Part 300 (2005)) shall mean the plan whose purpose is to implement CERCLA requirements and specify procedures, techniques, materials, equipment, and methods to be employed in identifying, removing, or remedying releases of hazardous substances.

"National Priorities List" or "NPL" shall mean the list of priority Sites of known or threatened releases of hazardous substances in the United States established pursuant to section 105 of CERCLA, 42 U.S.C. § 9605.

"North Property" shall mean property which is approximately 529 acres situated north of the town of Gilman and west of highway 24. The components of OU-1 of the Eagle Mine Site located within the North Property that are currently identified as principal sources of mine waste pollution are the Roaster Pile #5, Rex Flats, the OTP, the CTP, and Maloit Park. The approximate collective acreage of the portions of OU-1 situated within the North Property totals 150 acres. Roughly the western third of Maloit Park is located outside of the North Property boundary. The Highlands Area is situated west of the OTP and within the North Property, but is not currently identified in any EPA document as being part of the Eagle Mine Site. Bolts Lake is also situated within the North Property, south of the CTP and north of the OTP, and is also not currently identified in any EPA document as part of the Eagle Mine Site.

"Old Tailings Pile" or "OTP" shall mean the area where mine tailings were historically discharged by gravity flow for disposal from about 1929 to 1931 and again from 1941 to 1946. The OTP is located south of the CTP, and lies opposite and across the Eagle River from Rex Flats.

"Operable Unit 1" or "OU-1" shall mean the areas within the Eagle Mine Site identified as the principal sources of mine waste pollution that have impacted or may potentially impact the Eagle River and certain ground water resources with a focus on controlling transport of toxic metals from these various sources to the Eagle River and Site ground waters. Specifically, OU-1 includes the areas known as the Roaster Pile #5 area, the Waste Rock Piles, Rex Flats, the OTP, the CTP, Maloit Park, the water diversion components around the CTP, the WTP, the tailing slurry lines

and trestles, the mine seepage and collection systems, and the town of Belden. Portions of Waste Rock Piles, as defined below, are physically located within the town of Gilman.

"Operable Unit 2" or "OU-2" shall mean the areas within the Eagle Mine Site identified in EPA documents to evaluate the potential human health risks related to metals in the soil at the Site, including soil south of Minturn, the Maloit Park area and the town of Gilman. Impacted soils from the Maloit Park area were removed and subsequently replaced with clean fill.

"OU-1 Record of Decision" or "OU-1 ROD" shall mean the document prepared by EPA in March 1993 that represents the selected remedial action for OU-1.

"OU-2 Record of Decision" or "OU-2 ROD" shall mean the document prepared by EPA in September 1998 that represents the selected remedial action for OU-2.

"Remedial Action Plan" or "RAP" shall mean the plan appended to the 1988 Consent Decree, which outlined the specific requirements of remedial activities to be performed at the Eagle Mine Site.

"Rex Flats" shall mean the area where mine tailings were historically discharged by gravity flow for disposal from about 1929 to 1931 and again from 1941 to 1946. Rex Flats is located south of the CTP, and lies opposite and across the Eagle River from the OTP. Rex Flats is situated between the Denver & Rio Grande Railroad line and the Eagle River.

"Roaster Pile #5" shall mean the area where roaster wastes were historically disposed of situated south of Rex Flats near the southern end of the North Property and east of the Eagle River, just north of the intersection of Bishop Gulch and the Eagle River.

"Roaster Pile areas" shall mean the five roaster piles initially deposited at the Eagle Mine Site containing roaster wastes produced from the magnetic separation process, which were subsequently removed and consolidated to the CTP.

"Second Five-Year Review Report" shall mean the second Five-Year Review Report of the Eagle Mine Site prepared by the Colorado Department of Public Health and Environment (CDPHE) in September 2005.

"South Property" shall mean property which is approximately 97 acres situated immediately south of the North Property and west of Highway 24. The current OU-2 component situated within the South Property is the soil within the town of Gilman, and the current OU-1 component situated within the South Property includes portions of certain Waste Rock Piles. The South Property is owned by Ginn Battle South, LLC, and is not included as part of this RI Report. Additionally, the Waste Rock Piles are not owned by Ginn Battle North or Ginn Battle South. The approximate acreage of the Eagle Mine Site situated within the South Property is 50 acres, which includes the soil within Gilman.

"Sump #3" area shall mean the area formerly referred to as the "Sump 3 Area" which is situated north of the OTP area.

"Tailings Slurry Pipeline" shall refer to the pipeline which historically discharged tailings to the OTP. The Tailings Slurry Pipeline crosses the Eagle River just south of Rex Flats, and traverses the side of the hill which bounds the OTP to the south.

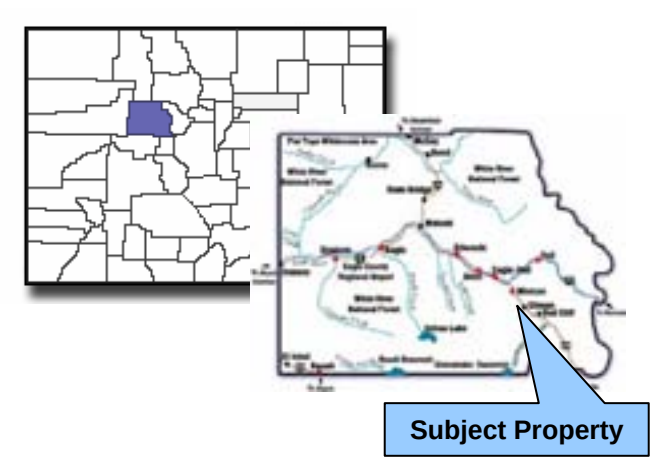
"Upgradient Ground Water Diversion Trench" or "UGDT" shall mean the trench located west of the CTP constructed to divert clean ground water that is entering the area from the west away from the CTP and into Maloit Park.

"Water Treatment Plant" or "WTP" shall mean the chemical water treatment plant operated and maintained by Viacom.

"Waste Rock Piles" shall mean those areas of disposal of waste rock from historic mining activities. Twelve waste rock piles have been individually identified within the Eagle Mine Site, and are labeled one ("WP-1") through twelve ("WP-12"). WP-8 is located near the northern edge of Gilman, while portions of WP-4, WP-5, WP-6, WP-7, and WP-11 are located on the western and southern edges of Gilman, on the slope leading down to the Eagle River.

1.0 *INTRODUCTION*

The subject property ("North Property") includes a portion of the Eagle Mine Site, which was designated as a Superfund Site and placed on the National Priorities List ("NPL") in 1986 by the Environmental Protection Agency ("EPA"), and surrounding areas adjacent to the Eagle Mine Site known as Bolts Lake and the Highlands Area. The Eagle Mine Site was listed on the NPL by the EPA due to the impacts of mining activities on the metals concentrations in the Eagle River. The Eagle Mine was the primary mine in the Battle Mountain mining district.



As described in the 2005 Second Five-Year Review (CDPHE, 2005), the Eagle Mine Site encompasses approximately 235 acres and includes the Eagle Mine workings, former town of Gilman, tailing piles, roaster piles, waste rock piles, Maloit Park, and other features associated with the Eagle Mine and remediation. The EPA divided the Eagle Mine Site into two Operable Units ("OU"): OU-1 includes the Eagle Mine Site except for the town of Gilman, and OU-2 is generally considered to be the town of Gilman. The North Property, as addressed herein, encompasses the northern portion of OU-1 that historically received the waste (tailings) from the ore beneficiation (crushing, grinding, washing, extraction) operations which occurred at Belden. Belden is not a part of the North Property.

1.1 *PURPOSE OF REPORT*

The purpose of this Remedial Investigation Report ("RI Report") is to document current conditions of the North Property prior to planned redevelopment of the area. Given the proposed reuse of the North Property as a residential and recreational community, the existing remedy is not sufficiently protective of human health and the environment. To address this new proposed property use, detailed investigations of the North Property were conducted in 2005 and 2006 ("Remedial Investigation"). The Remedial Investigation focused on soil, ground water, surface water, air, and the subsurface conditions in general to

assess the potential nature and extent, fate and transport, and impact to human health and the environment from remaining mine-related waste.

The Remedial Investigation was conducted by Environmental Resources Management ("ERM") on behalf of Ginn Battle North in 2005 and 2006, pursuant to the "Final Work Plan for Site Investigation of Bolts Lake and Eagle Mine Site OU-1 Development Areas, Battle Mountain North Development," dated July 6, 2005 ("Work Plan") (ERM, 2005) and approved by the U.S. Environmental Protection Agency ("EPA") and the Colorado Department of Public Health and Environment ("CDPHE"). The Work Plan was slightly amended twice during summer 2005, by request of and with approval by the agencies, once to address collecting additional surface soil samples near the perimeters of the North Property (step-out locations) ("Work Plan Addendum #1"), and once to address collecting sediment samples from the Eagle River stream bed ("Work Plan Addendum #2"). These additions were minor changes to the activities outlined in the Work Plan. A third addendum ("Work Plan Addendum #3") was submitted in May 2006 at the request of and for approval by the agencies, and was also voluntarily submitted for public comment. Under Work Plan Addendum #3, additional ground water, surface water, soil and sediment samples will be collected. The Work Plan and its Addendums are herein referred to as the "Work Plan."

This RI Report describes the activities performed and the results of the 2005 and 2006 field investigation. The Remedial Investigation data will also be incorporated into the Site-wide Risk Assessment and Feasibility Study.

1.2 ACKNOWLEDGEMENTS

ERM acknowledges several companies who prepared portions of this report. Specifically, Zonge Geosciences, Inc., who conducted the field work and prepared the report text regarding the geophysical survey at Rex Flats; Myers Environmental Services, Inc. and Asoian Associates LLC who conducted the field work and prepared the report text for the three air monitoring stations at the North Property Site. These companies conducted the work under the supervision of ERM and in accordance with the approved Work Plan. ERM appreciates their contribution to the Site investigation effort and to this report.

1.3 SITE SETTING

1.3.1 North Property Layout

The North Property includes the following areas: The Old Tailings Pile ("OTP"), Rex Flats, Maloit Park, Roaster Pile #5, and the Consolidated Tailings Pile ("CTP") areas, which were part of the Eagle Mine operations, and Bolts Lake and the Highlands Area which are located adjacent to features of the Eagle Mine Site, but were not part of the mine operations. These areas nonetheless impact the Site investigation due to their influence upon the surface water and ground water migration of contaminants. The North Property features are included in Figure 1.

As shown within Figure 1, the North Property includes: 1) the north and south surface water diversion trenches; 2) the Tailings Slurry Pipeline located immediately south of the OTP; 3) the Highlands Area located immediately west of the OTP; 4) Tigiwon Road, near the eastern edge of the OTP; 5) the Eagle River, which flows northward between the OTP and Rex Flats and which forms the boundary between the OTP and Rex Flats; 6) the Mine Water Transport Pipeline that is elevated onto a wooden trestle, which extends north-south through Rex Flats; 7) the CTP including the ground water extraction trenches, surface water diversion, ground water diversion, the Wastewater Treatment Plant ("WTP"); 8) Maloit Park, and 9) the Sump #3 area. It is noted that the Sump #3 area, as described in the Definitions portion of this RI Report, is not that same location as the Historical Sump #3 area that was in use prior to 1939, which was in the northeastern portion of the OTP between the Eagle River and Tigiwon Road.

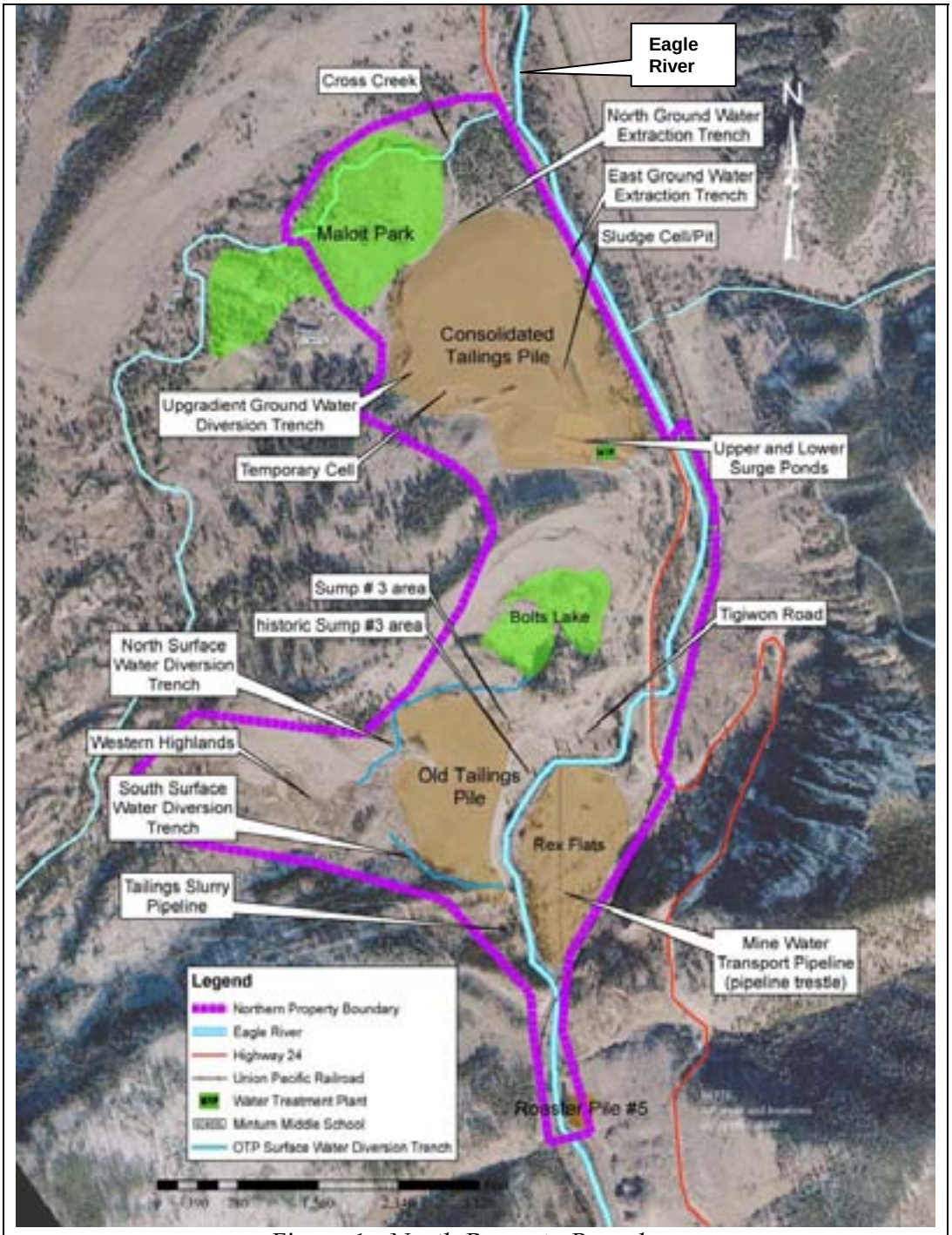


Figure 1 - North Property Boundary

1.3.2 *Local Geology*

Most of the tailings at the CTP and OTP were placed on glacial deposits of Pleistocene (Pinedale) age and Holocene/Pleistocene alluvium (D'Appolonia 1983, USGS, 1977), while most of the tailings placed at Rex Flats are underlain by Holocene/Pleistocene alluvium (USGS, 1977). According to past reports, the glacial deposits include "1) unsorted glacial

till (ground moraine) consisting of gravelly silt and sand with cobbles and occasional boulders, 2) glacial outwash comprised of sand and gravel, and 3) occasional beds of silt and clay of lacustrine origin" (Dames and Moore, 1997). Alluvium deposits include glacial sand and gravel with few fines (Dames and Moore 1986). The unit of black lacustrine silts is located in Maloit Park and near the north side of the CTP suggesting, "that the area was once the site of a glacial lake, probably formed when Cross Creek was temporarily dammed by terminal moraines" (Dames and Moore, 1997). The glacial and alluvial deposits at the CTP are underlain mostly by Leadville Dolomite (Dames and Moore, 1997), (D'Appolonia, 1983).

Leadville Dolomite (Lower Mississippian), Chaffee Group (Upper Devonian), Harding Sandstone (Middle Ordovician), Peerless Formation (Upper Cambrian), Sawatch Quartzite (Upper Cambrian), and Cross Creek Granite (Precambrian) outcrop in the North Property. The west portion of the OTP contains outcrops of Sawatch Quartzite and Peerless Formation. The Leadville Dolomite and Chaffee Group outcrop along the western portion of the ridge between the CTP and Bolts Lake. The east side, and especially the northeast, of Rex Flats contains Chaffee Group and Leadville Dolomite outcrops. The Leadville Dolomite, Peerless Formation, and Sawatch Quartzite dip about 10 and 17 degrees to the northeast (USGS, 1977).

As stated in a 1985 technical report by Dames and Moore (Dames and Moore, 1985), older periods of glaciation resulted in a low, broad complexly ridged moraine extending from south of the OTP northward beyond the confluence of Cross Creek and the Eagle River, and reaching eastward across US Highway 24 and the Eagle River. Younger glacial advances in Cross Creek were split by the bedrock hill between the OTP and CTP areas resulting in numerous moraine lobate ridges lying north and south of the hill and within the earlier glacial episode. The CTP was constructed on and within one or more of these younger lobate ridges of moraines.

Unconsolidated stream alluvium was deposited along all the major streams and occurs as lenses and discontinuous layers of fine sandy silts, silty clays, sandy gravels with silt and boulders and other various mixtures (Dames and Moore, 1985). A moraine borders the Eagle River and the east side of the CTP. In localized areas, near the existing east ground water extraction trench, the moraine was eroded by the river which reworked the glacial deposits and left behind sand and gravel with few fines (Dames and Moore, 1997), (USGS 1977).

1.4 EAGLE MINE SITE BACKGROUND SUMMARY

1.4.1 Historical Mining Activities

The history of the Eagle Mine Site, with respect to the OU-1 area, is summarized below (CDPHE, 2005), (E-Quest, 1991), (Warren and Pedersen, 2003), (USGS, 1978), (CH2M Hill, 1984), (EPA, 2000). The Eagle Mine is situated along the Eagle River near the towns of Gilman and Red Cliff, which are south of the North Property. Mining activities at the Eagle Mine began in 1879 and continued until 1984. The primary mined metals included zinc, gold, silver, lead, and copper.

During the early production history of these mines, the silver, lead, and gold ores were initially shipped to smelters in Leadville for processing. In about 1905, milling of zinc ore began in Belden. The zinc ore was initially processed using magnetic separation and roasting techniques, and later converted to floatation techniques. The tailings materials from these processes were placed within the Eagle Mine Site.

On December 30, 1977, the New Jersey Zinc Company announced permanent closure of zinc mining and milling activities at the Eagle Mine (the following day 153 employees were laid off). The underground mill, near Belden, was "partially dismantled and converted to a wastewater treatment plant for acid mine drainage" (CH2M Hill, 1984). Between 1977 and November 1981, intermittent mining continued primarily for silver ore with a reduced work force of about 40 people (Dames and Moore, 1985), (CH2M Hill, 1984) Because of the conversion of the underground mill, milling no longer took place and no tailings were generated (raw ore was transported off site for processing) after 1977 (CH2M Hill, 1984). After 1977, ore was sold to custom smelters (Dames and Moore, 1985).

From November 1981 to September, 1983, "the mine was on inactive status with a skeleton crew of 15 workers to operate the wastewater treatment facility and to carry out general maintenance" (D'Appolonia, 1983). In September, 1983, Glenn Miller purchased the mine from Gulf & Western and resold a portion of the Eagle Mine Site to Battle Mountain Corporation. For about 6 months, Mr. Miller "mined silver ore which was shipped to Leadville for processing" (Dames and Moore, 1985).

1.4.2 Tailings Disposal History

There are five areas within the North Property (OTP, Rex Flats, CTP, Roaster Pile #5, and Maloit Park) that received mine-related waste, according to past investigations and historical documentation. After the Eagle Mine was closed, it was estimated that about 7 million tons of tailings remained within the OTP (38 acres), New Tailings Pile ("NTP")

(69 acres), and Rex Flats (13.6 acres). Maloit Park was impacted due to releases from the CTP and was not historically used for tailings disposal. The tailings disposal history is discussed below.

The ore at the Eagle Mine was associated with gangue minerals (non-ore minerals) which included large amounts of pyrite (iron sulfide). When the mill was active, pyrite was separated from the ore and discarded as tailings. Because of inefficiencies in the ore extractive process of the mill, "some of the metals were also deposited in the tailings" (CH2M Hill, 1984). Reportedly, iron sulfide (sulfide) was deposited in these areas as mine tailings along with and including manganese-rich iron carbonate (siderite), zinc sulfide (sphalerite), lead sulfide (galena), and copper-iron sulfide (chalcopyrite). These minerals and others can also contain impurities including cadmium, arsenic, and chromium (Engineering Science, 1985).

Tailings disposal at the Eagle Mine dates back to at least 1914 when the United States Forest Service issued permits to the Eagle Mine "to dump tailings from a (roaster) mill in an 8 acre area above the Eagle River" to the west (now known as the Roaster Pile drainage) at Belden (CH2M Hill, 1984). The permit was reissued in 1917 (CH2M Hill, 1984). Roaster material was also placed in other areas around the Eagle Mine including Roaster Pile #5. In April, 1919, the roasters were dismantled (Dames and Moore, 1985). At this time, an underground mill was constructed in the Eagle River valley at Belden (USGS, 1978).

Construction of the pipeline to transport tailings from Belden to the OTP was started in 1928 and mine water and tailings were first discharged through the Mine Water Transport Pipeline and the Tailings Slurry Pipeline in April, 1929 (Steinmeier, 1969). Between April, 1929, and September, 1946, tailings were deposited through the pipelines to the OTP. In the mid-1950s, Rex Flats, an area across the river to the east of the OTP, also received mill tailings to "cover the vegetation and protect the [Mine Water Transport] pipeline" from fire hazards during the dry season (CH2M Hill, 1984).

In September, 1946, the OTP was almost full and construction of the NTP (currently known as the CTP) was started to the north of the OTP (Steinmeier, 1969). Prior to the construction of the NTP, the NTP area contained a lake with a dam to the north (Steinmeier, 1969). This dam is known as the pre-1939 dam. Reportedly, the "initial dam was (constructed) of compacted gravel fill. Since the entire area was underlain by a thick gravel bed there was no need for under drains or gravel beds to drain water from the interior of the dam" (USGS, 1978). At the NTP, coarse tailings material was dropped from the bottom of a 14-inch wood stave distribution pipeline to form a dike around about two-thirds of a

pond (on the east and north side) (Steinmeier, 1969). Since the tailings "are approximately 60 to 80 percent pyrite, a natural cementation takes place to forming a very stable dam" (Steinmeier, 1969). A tailings dike separated the NTP into the main tailings area or impoundment and an area to the south known as the Winter Pond (near the present day WTP) (Dames and Moore, 1997).

In September, 1950, a sewage treatment plant was constructed (presumably at Gilman) and the effluent was added to the tailings stream to the NTP. This effluent was reportedly chlorinated before joining the tailings stream (Steinmeier, 1969).

As of 1968, a total of approximately 4,900,000 tons of tailings were transported in the tailings pipeline; about 750,000 tons were deposited at the OTP and the remainder at the NTP (Steinmeier, 1969). In the 1960s, "approximately 400,000 tons of material from the OTP were reprocessed for the sulfur content and used in the manufacture of sulfuric acid" (CH2M Hill, 1984). After the Eagle Mine was closed, it was estimated that about 7 million tons of tailings remained in the OTP, NTP, and Rex Flats. The contents of the tailings were estimated to be:

- 2,940,000 tons of sulfur,
- 2,653,000 tons of iron,
- 105,000 tons of manganese,
- 42,000 tons of zinc,
- 18,200 tons of lead,
- 4,900 tons of copper,
- 5,390,000 troy ounces of silver, and
- 105,000 troy ounces of gold (CH2M Hill, 1984).

The NTP covered an area of about 69 acres, the OTP covered about 38 acres, and the tailings disposal area at Rex Flats covered about 13.6 acres (CH2M Hill, 1984). Both the NTP and OTP "were designed to seep to maintain their structural integrity. The mixing of surface water and ground water with the tailings, as well as the addition of treated mine water to the CTP, lead to the formation of acid seepage with high metal concentrations" (CH2M Hill, 1984).

Seepage from the NTP was historically documented north of the NTP towards Maloit Park, and also east to the Eagle River. Two ground water collection sumps, Sumps #1 and #2, were historically located just north (Sump #1) and east (Sump #2) of the NTP. A third sump, Sump #3, was originally located at the OTP between Tigiwon Road and the Eagle River, in an area known as the historic Sump #3 area or the OTP floodplain. This

historic Sump #3 area was moved to the current Sump #3 area which is located in the northeast corner of the OTP (Engineering Science, 1985).

The CTP background is discussed in ERM's CTP Data Review Report dated June 7, 2006, included as Attachment 1 and summarized here. References for the information summarized below can also be found in this report (Attachment 1). Prior to the construction of the CTP, this area contained a lake with a dam to the north. Underflow pipelines and risers were constructed prior to placing tailings in this area to decant liquid from the tailings in areas of the CTP.

In October, 1982, a riser pipe in the tailings pond collapsed (designed to decant clear water from the surface of the pond into the underdrain). This resulted in the discharging of large volumes of tailings pond water and tailings material through the underdrain beneath the CTP to Maloit Park and to Cross Creek for a week. The sumps, historic ground water sampling, and drainage at each area are discussed below (Engineering Science, 1985).

1.4.3 Regulatory Background

The following regulatory history is summarized from EPA's 1993 OU-1 ROD (EPA, 1993) and the Second Five-Year Review (CDPHE, 2005). In 1983, the State of Colorado filed a Natural Resources Damages (NRD) lawsuit against Gulf & Western and the New Jersey Zinc Company for natural resource damages under the Superfund statute. In 1986, the State amended their complaint to seek injunctive relief against Gulf & Western. In 1986, the EPA placed the Eagle Mine Site on the National Priority List, making it a designated Superfund Site due to the "mine discharge (metals), uncontrolled mine waste piles and the close proximity of the population to the mine and associated features" (CDPHE, 2005). The EPA and the State entered into a Memorandum of Agreement (MOA) in 1986 which designated the State as "lead" agency for the Site Cleanup.

The State and Paramount (previously known as Gulf & Western) resolved their lawsuit in 1988 when the two parties entered into a Consent Decree ("CD")/Remedial Action Plan ("RAP"). This agreement included:

- Removal of tailings at the toes of the CTP,
- Removal of contaminated Maloit Park wetland soil
- Consolidation of the tailings at the CTP
- Capping and temporary ground water pumping at the CTP,
- CTP settling compliance objectives, and

- Long-term monitoring of surface water, ground water, vegetation, soils, CTP settlement, and CTP erosion.

Compliance standards were set for dissolved zinc concentrations in the Eagle River, for soils cleanup (lead and pH standards), and for revegetation criteria. The RAP also required:

- Temporary surface runoff and run-on control at Rex Flats, OTP, and CTP,
- Installation of an upgradient ground water diversion ditch and two ground water extraction trenches at the CTP,
- Removal of the historic pond on top of the CTP,
- Construction of a lined surge pond at the CTP, and
- Regrading and stabilizing the CTP.

In May, 1990, the CDPHE and Paramount amended the RAP and added:

- Construction of a chemical water treatment plant,
- Construction of a second lined surge pond,
- Expanded ground and surface water monitoring,
- Annual contaminant Eagle River metal loading reports, and
- Temporary sludge disposal at the CTP.

The EPA reviewed this CD/RAP and found it generally "environmentally acceptable," but expressed reservations about its ultimate success. Although significant progress was made, evidence of difficulties appeared in late-1989 and early 1990 when metals concentrations in the Eagle River were extremely high. On April 4, 1991, EPA issued a Notice of Violation ("NOV") to the CDPHE for alleged violations of Section 301 of the Clean Water Act by Paramount. This action was to compel additional clean-up actions at the Site. The CDPHE responded to the NOV on November 1, 1991. The CDPHE and Paramount agreed that Paramount would collect additional mine seepage and do additional work in the Roaster Pile area.

In the fall of 1990, the EPA announced it would conduct a Feasibility Study Addendum ("FSA"). It was called an "addendum" because it was being done "in addition" to, and consistent with, the large effort already underway. The FSA was released to the public in June, 1992. OU-1 and OU-2 were developed under the EPA's Feasibility Study Addendum. Areas of the Eagle Mine Site were included in OU-1 which focuses on the transport of metals to the Eagle River from Eagle Mine seepage, the

Roaster Piles, the Waste Rock Piles in the Gilman/Belden area, Rex Flats, the OTP, the CTP, and Maloit Park.

Additional remediation efforts were described in EPA's 1993 OU-1 ROD and included additions and modifications to the 1988 CD/RAP. These modifications included:

- Rapidly completing the cap on the CTP,
- Draining and capping the historic pond,
- Extracting and treating leachate/ground water from the CTP ground water extraction trenches,
- Constructing a new up-gradient ground water diversion structure, and
- Relocating the Minturn drinking water wells.

Other components of the OU-1 ROD also included:

- The continuing treatment of contaminated mine seepage and leachate/ground water from the CTP at the WTP until cleanup goals could be met,
- Dewatering the treated sludge and disposal of the dewatered sludge in on site lined cells on the CTP,
- Removing contaminated soils and sediments from the Maloit Park Wetlands,
- Controlling seepage from the CTP, and
- Rapidly adding topsoil and revegetating the tailings areas.

Based on data from 1990 through 1992, the EPA determined that about 40 to 60% of the increase in metals loadings in the Eagle River was from Eagle Mine seepage, about 10 to 30% was from non-point sources in the Belden area, about 2-3 % was from the Roaster Pile area, and about 15 to 40% of the increase in load was from the CTP area (primarily ground water). The Eagle River quality goals were set at 150 micrograms per Liter (µg/L) dissolved zinc below the mine and 250 µg/L dissolved zinc immediately above the confluence of the Eagle River with Cross Creek. The EPA believed that the critical time of year for meeting in-stream standards was during the low-flow period in late winter. The CDPHE has established specific standards for segments of the Eagle River and Cross Creek that transverse the Eagle Mine Site. These standards are further discussed in Section 4.1.

The contribution of metals loading for each major source area at the Eagle Mine Site is variable depending on seasonal impacts, storm events, snowmelt, and the inherent imprecision in measurement of stream flow volume. The original 1985 Remedial Investigation performed for the CDPHE by Engineering Science (Engineering Science, 1985) defined the major sources of contamination as well as the contaminants of potential concern. These original sources of contamination were redefined in EPA's 1993 OU-1 ROD and included:

- Eagle Mine Seepage,
- Waste Rock Piles/Belden Non-Point Sources,
- Roaster Pile Area,
- Rex Flats/Old Tailings Pile Areas,
- CTP, and
- Maloit Park.

For "consistency and convenience," the WTP was also presented as a source of contamination.

The CTP was considered to be a principal source of mine waste pollution impacting the Eagle River and certain ground water resources. In the area of the CTP, the environmental receptors included the potential future contamination of the Minturn drinking water wells and a residential well (located east of the CTP and called the "Piersen Well" (CDPHE, 2005) (EPA, 1993). The Minturn drinking water wells were later moved to a location "upgradient from any influence from CTP groundwater" and a water supply line to the Piersen Well was installed after 1988 (CDPHE, 2005).

1.4.4 Remediation Activities

Prior to Viacom's remediation effort, the OTP and Rex Flats areas were a significant source of metals loading to the Eagle River through surface runoff and ground water migration of metal-laden water.

The OU-1 remedy was constructed to "control the transport of metals from various sources to the Eagle River and to groundwater" (CDPHE, 2005). The OU-2 was established to "evaluate potential human health risks from soils in three areas: south of Minturn, Maloit Park, and Gilman" (CDPHE, 2005). Remediation activities at the OU-1 area have included: removal of tailing materials from the OTP, Rex Flats, Roaster Pile #5, and Maloit Park areas to the CTP; construction of the WTP and a lined sludge pond; capture and treatment of ground water; capping the

CTP; CTP erosion and settlement monitoring; ground and surface water monitoring; and revegetation of disturbed areas. Operation and maintenance of remediation systems at the OU-1 area of the Eagle Mine Site continues today, and is the responsibility of Viacom, the Potentially Responsible Party "PRP" at the Eagle Mine Site. Soil and ground water beneath areas on the North Property were not remediated and are potentially impacted by the former tailings placement.

The NTP is now referred to as the CTP and holds tailings originally placed in this area as well as tailings which were transported from other areas within the Eagle Mine Site during Viacom's remediation effort. The OTP is located on the west side of the Eagle River and contained tailings. Rex Flats is located on the east side of the Eagle River, adjacent to the OTP and also contained tailings. Although a small section of the access road to the lake does contain mine waste rocks, mine wastes were not placed in Bolts Lake. Roaster Pile #5 was located south of the OTP and Rex Flats on the east side of the Eagle River.

OTP and Rex Flats Remediation

In the summer of 1986, Dames and Moore performed subsurface exploration inside the tailings disposal areas, including the OTP, prior to remediation. The following description of the OTP is from this report:

> "The old tailings area consists of an older area of tailings deposition. It includes approximately 38 acres to the west of and adjacent to the Eagle River, along the Tigiwon Road. A containment dike up to 20 feet high runs along the east edge of the area, immediately parallel to Tigiwon Road. The old pond surface behind the dike is essentially flat. It has no defined area of ponding, although numerous puddles exist. Most of these puddles seem to occur where test pits were excavated and incompletely filled or have settled from a previous study. The tailings surface over most of the area is quite soft and often damp…… Near the south end of the area, rocky, colluvial fill material covers much of the surface and may overlie or be mixed with tailings in some areas. Drainage from the old tailings currently seeps to a collection sump northeast of the pond" (Dames and Moore, 1987).

This report indicates that the thickness of the tailings at the OTP ranged from about 1 to 24 feet thick prior to removal of these tailings to the CTP. The borehole logs from the OTP included in this report indicate that the water table within the tailings was between 4 and 10 feet below the top of the tailings (Dames and Moore, 1987). Other initial investigations at the OTP indicate that the water level difference between the tailings pile and historical Sump #3 area (between Tigiwon Road and the Eagle River) was

27 feet indicating that ground water movement from the OTP was steep to the west towards the river. During the initial investigations, seepage from the west bank of the Eagle River, near the OTP, was observed and the river samples confirmed "movement of contaminated ground water into the Eagle River at this point" (Engineering Science, 1985). A borehole installed in the OTP flood plain indicated that bedrock in this area, near the Eagle River, was at a depth of about 72 feet (Engineering Science, 1985).

The Rex Flats area historically received mine tailings from the Eagle Mine operations between 1946 and the mid-1950s in order to mitigate fire hazard caused by high vegetation beneath the Mine Water Transport Pipeline. The tailings disposal area at Rex Flats reportedly covered 13.6 acres (CH2M Hill, 1984).

In the summer of 1986, Dames and Moore performed subsurface exploration inside the tailings disposal areas, including Rex Flats, prior to remediation (Dames and Moore, 1987). The following description of Rex Flats is from this report:

> "Rex Flats, located between the Eagle River and Colorado State Highway 24 east of the Old Tailings Area, is covered in part by a strip of tailings deposited as overspill from the elevated portion of the wood stave slurry pipe used to transfer tailings from Eagle Mine to the New Tailings Area. The shape of the deposit is irregular, dependent on local topography, with frequent "islands" of trees and vegetation. This irregular character is due to the somewhat random spilling of very wet tailings, flowing along natural topographic lows, without any attempt at containment. It is likely that these deposits are very thin except in those areas immediately adjacent to the pipeline. No areas of ponding were observed. The surface of the tailing consists largely of fine sand" (Dames and Moore, 1987).

This report indicates that the thickness of the tailings at the Rex Flats ranged from about 1 to 4 feet thick in the areas tested prior to removal of these tailings to the CTP. Pictures located in the CDPHE files and reviewed by ERM indicate that the tailings beneath the pipeline were thicker than 4 feet prior to remediation. This report also indicates that the tailings appeared to be "dry to slightly moist."

The OTP, Maloit Park, and Rex Flats areas were remediated by Viacom and the tailings in these areas were removed and placed in the CTP. Prior to Viacom's remediation effort, the OTP and Rex Flats areas were a significant source of metals loading to the Eagle River through surface runoff and ground water migration of metal-laden water. Impacts to

Maloit Park were primarily from releases from the CTP underdrains directly in to Maloit Park and wind dispersion of tailings. Viacom began moving tailings from the OTP/Rex Flats areas in May 1989, and most of the remediation work was conducted between 1989 and 1992. During this time, about one million tons of tailings material and underlying soil were excavated from the OTP, and 150,000 tons were excavated from Rex Flats. Only portions of Maloit Park were impacted with tailings. Tailings were removed from the areas according to the requirements in the May 20, 1988 RAP, and placed in the CTP. Clean fill and lime were placed in areas where tailings had been removed. Residual impacts to the soil and ground water remain in both the Rex Flats and OTP areas. The criteria for the removal of contaminated material in these areas are summarized in the Second Five-Year Review (CDPHE, 2005).

During remediation activities, the underlying soil left in place at the OTP/Rex Flats areas were tested in some areas and exhibited low (acidic) pH values (as low as 2.6). In order to neutralize the soil left in place, hydrated lime was added to the soil to raise the pH of the top 6 to 12-inches of soil. Lime was added to raise the pH to the target level of 5 which was determined to be the average pH level from the natural soil samples surrounding the area. The remediation criteria are summarized in the Second Five-Year Review (CDPHE, 2005).

Approximately 845 tons of lime was applied to the OTP. Approximately 60,000 cubic yards of off site material was used to fill in areas of the OTP (Eagle, 1996) although clean backfill was not required by the CDs (CDPHE, 2005). Additional remediation (to support revegetation) of areas in the OTP was performed in June and July 1998. Monitoring in August 1998 indicated that these areas had come into compliance with the CDs (EPA, 2000).

North and south temporary surface water ditches were built to divert surface water around the OTP. Additionally, to drain surface water from the OTP area, a 30-inch diameter pipe and a 48-inch diameter pipe were installed under Tigiwon Road in the northeastern and southeastern corners of the OTP. In November 1990, Viacom was required by the EPA/CDPHE to construct three extraction wells in the OTP to attempt remediation of the ground water in this area. After the wells were installed, Viacom performed hydraulic testing (slug tests indicated a maximum recharge rate of one gallon per minute) on the three wells. Based on the slug test data, the EPA/CDPHE concluded that the collection of ground water may be impractical because of the low production potential from the extraction wells (EPA, 2000), (CDPHE, 2005). Therefore, "no active remediation of groundwater of the OTP and Rex Flats has occurred" (CDPHE, 2005).

CTP Remediation

Work on the CTP began in 1988 and the multilayer cap was completed in 1997. About 1,104,830 cubic yards of material was placed on the original tailings material at the CTP. Material from areas of the Eagle Mine Site including the OTP, Roaster Piles, Rex Flats, and Belden were placed in the CTP prior to capping.

After receiving the tailings and other wastes from the remedial activities completed at the Eagle Mine Site, the CTP was reshaped such that side slopes were 5:1. The entire pile was covered with a multi-layer cap, consisting of either a lower permeability zone (tailings slimes) or a geosynthetic clay liner; an erosion layer (24 inches); and a 12- to 24-inch growth layer (Dames & Moore, 1998), (EPA, 2000), (CDPHE, 2005).

Past reports indicate that the north and east ground water extraction trenches capture about 50 to 75% of the ground water near the trenches, respectively. Therefore, a portion of metals impacted ground water from the CTP is expected to flow past the trenches and into Maloit Park/Cross Creek and the Eagle River. The significance of this uncaptured ground water flow if any, appears to be minor, based upon ERM's sampling of surface water in Cross Creek and the Eagle River. Historical reports also indicate that the ground water trenches periodically become clogged with iron precipitate and the gravel in the ground water extraction trenches needs to be replaced periodically.

Water collected from these north and east ground water extraction trenches is delivered to the WTP, which is located on top of the CTP. The WTP was constructed in 1991 to treat water discharged from the mine seeps at Rock Creek (9%), the mine water draw down system (78%), and the CTP ground water collection system (13%). Treated water is discharged to the Eagle River pursuant to the limits specified in a discharge permit issued by the State.

The WTP, upper and lower surge ponds, and sludge pit will continue to treat ground water from the extraction trenches and from the Eagle Mine for an indefinite period of time. A cap was not placed on these areas or the temporary cell (about 6 acres). This temporary cell must remain open until the CDPHE determines that is no longer needed. The temporary cell contained about 2 to 3 feet of water in the spring of 2006, and the liner was torn in many areas.

There is also an upgradient diversion trench ("UGDT") at the CTP. The trench is a buried pipe intended to divert clean ground water around the CTP for eventual discharge into Maloit Park. Water from this trench has historically met Site-specific operational criteria for dissolved metals

(there was one period of exception in Spring 2000) (EPA, 2000). The UGDT typically flows in the spring of each year and there are no specific requirements/time limits identified in the CD on its operation (CDPHE, 2005).

Two lined ponds have been constructed on top of the CTP next to the WTP. One pond is a holding pond for water received prior to treatment and the other pond is a process water holding pond. Both ponds are lined with a synthetic liner. The WTP uses lime and soda ash to raise the water pH of the influent and a polymer is added to settle the solids out. The solids are collected and processed using a sludge press system installed in 1994. Acid is added to the effluent to neutralize the pH prior to discharging to the Eagle River. The treated water is discharged under the provisions of a Water Quality Control Division Permit (CDPS Permit Number CO-0042480) (CDPHE, 2005). Sludge from the WTP is dried and placed within a lined sludge cell located near the WTP. Approximately 5 cubic yards per day of sludge was reported as being generated by the WTP, as stated in the EPA Five-Year Review Report (EPA, 2000). The sludge is disposed of in the lined sludge cell located on the CTP. The design capacity of the sludge cell is 52,500 cubic yards ("cy") and the cell is about one-third full. The WTP generates about 800 to 1,600 cy of sludge per year and the empty portion of the cell will reportedly hold an additional 50 to 60 years of WTP sludge (CDPHE, 2005). The sludge generated by the WTP is not considered a hazardous waste.

Eagle River Monitoring

Surface water monitoring stations were established in 1985 at the outset of the remedial investigation of the Eagle Mine Superfund Site, corresponding closely with locations used by the U.S. Geological Survey (USGS) in studies prior to 1985. Water quality and discharge data are available from 1985 to the present.

Hydrologically, stream flow in the Eagle River and its tributaries is typical of most high-elevation watersheds in the region. Large seasonal fluctuations in discharge are apparent, which correlate to annual snow melt and accumulation cycles. During the winter months, when precipitation is captured as snow at higher altitudes and temperatures are normally below freezing, the Eagle River is at minimal flow. The winter base flow period is typically between November and March each year and streamflow averages from approximately 25 to 40 cubic feet per second ("cfs") cfs.

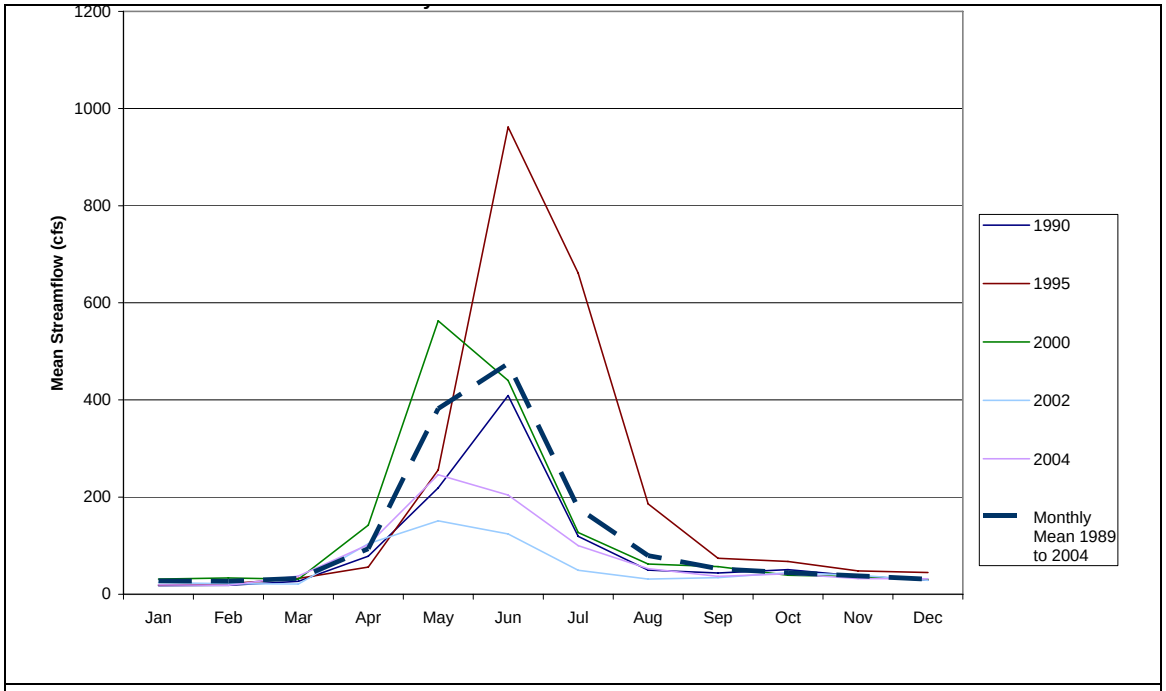


Figure 2 - Eagle River Monthly Streamflow
USGS Station 09064600 - Eagle River Sampling Location E12A
Select years and 1989 to 2004 mean streamflow

Hydrograph data indicate that streamflow remains relatively low during the early spring (March and April) when snowmelt from lower elevations, including areas of the North Property, is beginning to contribute to runoff entering the river. Regional snowmelt, which typically occurring in late April, May, and June, contribute to an order-of-magnitude increase in streamflow conditions. Peak flows during this time period typically average 800 cfs. As the accumulated snowpack is depleted beginning in late June and July, streamflow recedes to fall baseflow conditions throughout the autumn months.

1.5 POST REMEDIATION CONDITIONS

1.5.1 Old Tailings Pile and Rex Flats

Old Tailings Pile/Rex Flats

The ground water remedy at the OTP and Rex Flats included source removal and infiltration reduction (CDPHE, 2005). The ground water underlying the OTP and Rex Flats is impacted with elevated metal concentrations. The EPA Five-Year Review Report (EPA, 2000) concluded that although the metal levels have shown some improvement, the ground water will require additional testing before it could be used for unrestricted human consumption. Monitoring wells were installed in the OTP and Rex Flats areas between 1989 and 1990 to assess ground water quality in the area.

Portions of the ground water in the OTP and Rex Flats in 2002 were acidic with a pH ranging from about 2 to 7 as reported in the Eagle Mine Annual Reports, prepared for Viacom (Newfields, 2003, 2004, 2005). According to the EPA Five-Year Review Report (EPA, 2000), both arsenic and cadmium levels have been found above ground water standards in some monitoring wells in these areas, and ground water below the OTP should not be used for human consumption.

OTP

Ground water levels at the OTP have been measured since 1989 by Viacom. Graphs of Viacom's primary metal analytical results and water levels from the OTP wells over time are included in Appendix A. A review of these graphs indicates that water levels in the OTP are at a maximum from April to June and decrease in elevation until the following spring. The ground water elevation changes can range between 0.5 to 7 feet between April to June and September to December. The ground water elevations usually begin to rise in mid to late-February. The ground water flow is generally towards the Eagle River. Water ponds on the surface of the OTP between April and June due to the increase in ground water due to snow melt on the OTP and overflow on to the OTP from the Highlands Area located to the west. The depth to ground water at the OTP in 2002 varied from 3.3 feet to 8.42 feet below ground surface ("bgs") in April and from 6.74 feet to 13.25 feet bgs in September.

The north (Bolts Ditch) and south diversion trenches divert water around the OTP. The north diversion trench drains into Bolts Lake and the south diversion trench drains into the Eagle River through a culvert located beneath Tigiwon Road. Water that ponds on the OTP generally drains towards a swale on the west side of Tigiwon Road and follows this swale to a culvert located near the Sump #3 area. This water is diverted in a culvert crossing beneath Tigiwon Road, drains into the historic Sump #3 area, and then flows into the Eagle River (Figure 3).

Figure 3 - Water from the OTP draining into the historic Sump #3 area.

Ground water at the OTP has been monitored at about seven monitoring wells (OTP-MW-1 through OTP-MW-6 and OTP-MW-4D) from 1989 to the present by Viacom. These monitoring wells were sampled at least 2 to 4 times per year since 1990 and are shown on Figure 4. Between 1989 to present, most (OTP-MW-1/1R, OTP-MW-2, OTP-MW-3, OTP-MW-4S, and OTP-MW-4D) of the ground water monitoring wells contained elevated (above CDPHE ground water standards) concentrations of the primary metals including zinc, manganese, and cadmium. With regard to these primary metals, concentrations in most of these wells decrease significantly after about 1991/1992 just after removal of tailings at the OTP. Around mid-1998, the zinc and manganese concentrations in most of these wells dropped by an order-of-magnitude except at OTP-MW-4D

and OTP-MW-5. Concentrations in an upgradient background well, OTP-MW-6, remained for the most part, unchanged and the primary metals were not detected or were very low. OTP-MW-4D is screened 9 to 10 feet deeper than the other monitoring wells. The manganese and zinc concentrations at OTP-MW-4D started to decrease in 1998 and decreased by an order of magnitude by 2003. Sulfate, iron, and cadmium concentrations in these wells also decreased by at least an order of magnitude, except at OTP-MW-5.

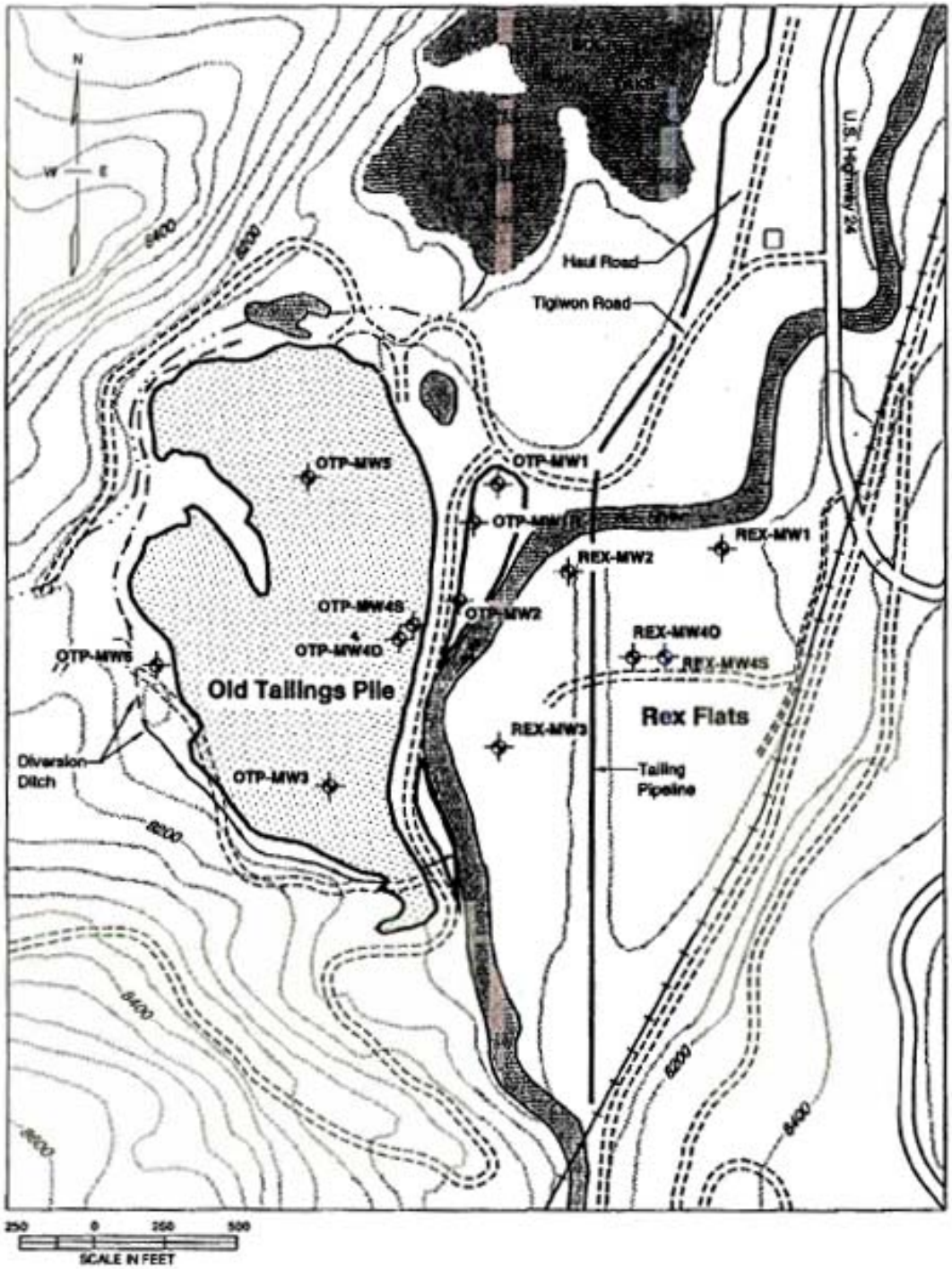


Figure 4 - Viacom – Old Tailings Pile/Rex Flats Monitoring Well Locations From Newfields (Newfields, 2005)

Analysis of ground water samples from OTP-MW-5, located in the north central portion of the OTP, detected elevated zinc and manganese. Since 1990, the manganese concentrations decrease but not an order of

magnitude like the other wells at the OTP. Additionally, the zinc, sulfate and iron concentrations detected in samples collected from OTP-MW-5 have remained relatively stable since 1990. Most of the time, the manganese and zinc concentrations in these wells increase with increasing water levels and decrease with decreasing water levels at the well. At well OTP-MW-5, this likely indicates that during the spring, when water levels are high, ground water moving to this well is impacted by an upgradient source.

In 2005, the CDPHE required Viacom to line the swale along Tigiwon Road, just north of where the south surface water diversion ditch intersects Tigiwon Road, with limestone gravel. The CDPHE observed a ground water seep emanating from the side of the swale in this area. This swale is located near the area which currently contains mine tailings mixed with large boulders.

Rex Flats

Ground water levels at Rex Flats have been measured since 1989 by Viacom. Graphs of Viacom's primary metal analytical results and water levels from the Rex Flats wells over time are included in Appendix A These graphs indicate that water levels in Rex Flats are at a maximum from April to June and decrease in elevation until the following spring. The ground water elevation changes can range between 0.5 to 5 feet between April to June and September to December. The ground water elevations usually begin to rise in mid to late-March. The ground water flow is generally to the north towards the Eagle River. Water has historically ponded below the northern portion of the Mine Water Transport Pipeline. A diversion swale was constructed to divert this water to the Eagle River.

Ground water at Rex Flats has been monitored at about five monitoring wells (REX-MW-1 through REX-MW-4S and 4D) from 1989 to the present by Viacom (Figure 4). These monitoring wells were sampled at least 2 to 4 times per year since 1989. Between 1989 to present, most (excluding REX-MW-3) of the ground water monitoring wells contained elevated, above CDPHE ground water standards, metal concentrations including zinc, manganese, cadmium, sulfate, and iron. Analysis of ground water samples collected from REX-MW-3, located to the west and cross-gradient of the area which historically contained tailings, detected very low concentrations of these metals (except for one sampling event in April of 1999 which is believed to be an outlier). Dissolved manganese and zinc in ground water samples from most of these wells decrease by about an order of magnitude from 1989 to the present. However, the concentrations of sulfate and iron in most of these wells have remained at similar concentrations from year to year. Laboratory analysis of ground

water samples collected from REX-MW-2, detected decreasing manganese and zinc concentration since 1989 until about April, 2002. Prior to this time, the higher manganese and zinc concentrations were detected during times of lower water levels in this well (in the fall). However, after April, 2002, higher manganese and zinc concentrations occur during times of higher water levels in the spring.

Prior to this investigation, conversations with the CDPHE indicated that at least one ground water seep existed in the northern portion of Rex Flats along the south side of the Eagle River. This seep is located near the historical staining in the Eagle River, north of Rex Flats (Figure 5).

Figure 5 - Seep located on the north side of Rex Flats

Reportedly, an existing surface water run-on ditch was located to the east along the northeastern portion of Rex Flats. Additionally, ditches were constructed just to the west of the Mine Water Transport Pipeline in the northern portion of Rex Flats to drain surface water which collects beneath and near the Mine Water Transport Pipeline to the Eagle River (Eagle, 1996A).

Eagle River Adjacent to OTP and Rex Flats

Surface water quality in the Eagle River associated with the OTP and Rex Flats areas was measured by Viacom at two surface water monitoring stations E11 and E12A. E11 is located upstream of the North Property and E12A is located north of Rex Flats. Prior to removal of tailings from the OTP and Rex Flats, dissolved zinc measured below this reach of river varied from 0.9 to as high as 2.1 milligrams per liter (mg/L) and zinc loading in this reach ranged from 95 to 245 pounds per day (lbs/day) with a high of 675 lbs/day during spring runoff (November to February, 1991). After removal of the tailings from these areas, data collected from 1997 through 2004 at this segment of the Eagle River indicate a decrease of zinc loading to the Eagle River (Table 1). The data collected from 1997 indicate zinc loading to the Eagle River of 7 to 42 lbs/day with the highest loads occurring in the spring (April). Data collected between 1999 and 2001 reported between 1 and 14 lbs/day of zinc loading. Data collected between 2002 and 2004 indicate loading less than 2 lbs/day along this segment of the river; however, the 2003 and 2004 data were only available from October, which, historically, has lower loads than the spring. The 2003 Eagle Mine Annual Report (Newfields, 2003) indicates zinc loading to the Eagle River from the OTP/Rex Flats area ranging from 0.4 to 1.3 lbs/day and concluded that the "increases in dissolved zinc load are likely from the OTP/Rex Flats ground water." However, the 2004 Eagle Mine Annual Report, prepared for Viacom (Newfields, 2005), indicates zinc loading to the Eagle River from the OTP/Rex Flats area at 1.9 lbs/day and concludes that the difference in "load is within measurement error."

Table 1 *Summary of Eagle River Zinc Loading Data (Collected by Viacom) Near the OTP and Rex Flats*

		OTP/Rex Flats Stream Sampling Stations		
Year	Month	E-11	E-12A	Zinc Loading
1997	March	292	312	20
	April	241	283	42
	September	36.9	51.8	14.9
	October	46.3	53.3	7
1999	March	105.1	113.6	8.5
	April	145.8	125.5	-20.3
	September	35.3	41.7	6.4
	October	43.1	44.8	1.7
2000	March	72.9	66.2	-6.7
	April	203.3	217.1	13.8
	September	21.1	26.1	5
	October	25.7	24.5	-1.2
2001	March	52.3	51.1	-1.2
	April	126	127	1
	September	21.9	25.3	3.4
	October	23.6	30.4	6.8
2002	March	40.8	38.8	-2
	April	124	118	-6
	September	12.2	12.6	0.4
	October	14.9	16.2	1.3
2003	October	20.3	18	-2.3
2004	October	17.3	19.2	1.9

Note: All results are in pounds per day (lbs/day). All results from the 2002 and 2004 Eagle Mine Annual Reports prepared for Viacom by Newfields and dated March 3, 2003 and March 1, 2005, respectively. A negative zinc loading value indicates a loss of zinc between the monitoring stations.

Some of the data are estimated.

1.5.2 Bolts Lake

Bolts Lake

Historic background information indicates that the Bolts Lake area did not receive mine tailings from the Eagle Mine operations. Bolts Lake is not included in the Eagle Mine Superfund Site. Historically, Bolts Lake was filled with water from Bolts Ditch which runs north of the OTP, through Arrow Lake to the beaver ponds to the west. From there, Bolts Ditch runs to Cross Creek through a series of beaver ponds. At Cross Creek, a sluice

controls the water released into Bolts Ditch. Bolts Ditch also collects surface water from the drainage basin just west of the OTP. ERM did not find any reports which document historic ground water conditions at Bolts Lake. Bolts Lake was drained in the 1990s when a portion of the eastern dam was excavated.

Prior to drainage of Bolts Lake, CDPHE conducted soil and surface water sampling within Bolts Lake in 1992 (CDPHE, 1992). Two soil samples and one surface water sample were collected. The samples were analyzed for arsenic, cadmium, lead, and zinc. The regulatory standard against which the samples were analyzed was EPA's 1983 standard for metals. The results of the soil sampling indicated the presence of lead and zinc, but at concentrations below the applicable EPA standard. Zinc was detected at 52 milligrams per kilogram ("mg/kg") in the first soil sample, and at 220 mg/kg in the second soil sample, as reported in the 1992 CDPHE report (CDPHE, 1992). These levels were both below the 1983 EPA standard for zinc of 500 mg/kg. Lead was detected in the second soil sample at 43 mg/kg, which is below the 1983 EPA standard for lead of 1,000 mg/kg. Arsenic and cadmium were not detected in either sample.

The surface water in Bolts Lake was sampled for these and other metals, and also general chemistry parameters. The summary report accompanying the analysis indicated that "relatively low concentrations" of manganese, sulfate and zinc were present in the surface water sample. CDPHE determined, therefore, that the soil and surface water analytical results met applicable standards (CDPHE, 1992).

1.5.3 Consolidated Tailings Pile

Consolidated Tailings Pile

Ground water impacts beneath the CTP have also diminished in many of the monitoring wells in the area. CTP ground water is monitored by collecting samples from extraction trenches located north and east of the CTP, and from the UGDT. Water samples taken from the north and east ground water extraction trenches indicate that the ground water contains dissolved concentrations of zinc ranging from 50 mg/L to 665 mg/L. Ground water samples taken from the UGDT indicate that the ground water contains zinc at below 0.5 mg/L as reported in the 2004 Eagle Mine Annual Report (Newfields, 2005).

Ground water monitoring and past modeling efforts indicate that the highest concentrations of the ground water plume are under the northeast part of the CTP. An analysis presented in Viacom's 1998 annual report indicated that there was no release of dissolved metals to the deeper aquifer underlying the CTP (EPA, 2000). Ground water data for twenty monitoring wells at the CTP are plotted and displayed in ERM's CTP Data Review Report and are included in Appendix A. Additionally, the ground water elevations are plotted on each graph. This data was collected by others including Viacom. The locations of these ground water monitoring wells are shown on Figure 6. These graphs include ground water sampling results for selected dissolved metals from monitoring wells in and around the CTP, the "DT" monitoring wells (located next to the UGDT), the east ground water extraction sump and ET-1 (downgradient of the east extraction trench), the north ground water extraction sump, NTP-MW-1 through NTP-MW-7, and the UGDT.

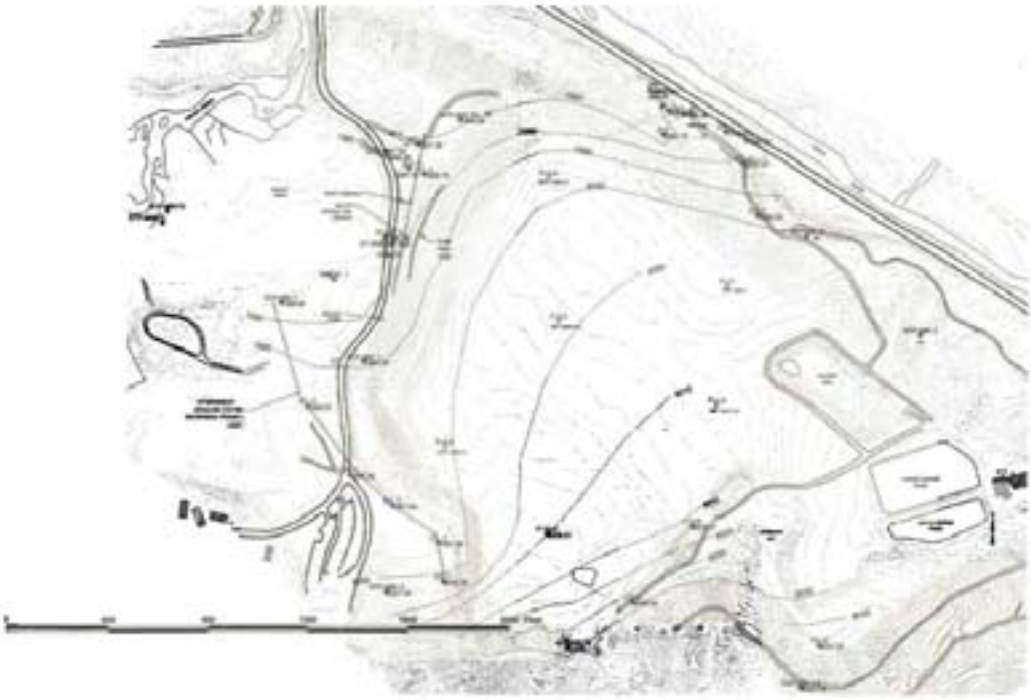


Figure 6 – CTP Monitoring Well Locations from Newfields (Newfields, 2005)

The data in these graphs indicate that generally, ground water samples collected from many monitoring wells at the CTP show a decrease in dissolved zinc and other dissolved metals from 1990 until today. The only monitoring wells which do not show this trend include ET-1, DAP-MW-4/4R (located behind the north ground water extraction trench), and NTP-MW-2 (south of the east ground water extraction trench). Additionally, laboratory analysis of samples from NTP-MW-5R shows elevated zinc

concentrations to the east of the north extraction trench. A few of these monitoring wells generally show lower dissolved metal concentrations when water levels in the well are high. Therefore, the concentrations in some of the monitoring wells are diluted during higher water elevations (predominantly in the spring).

Ground water levels at the CTP have been measured by Viacom since around 1989. This data indicate that most of the water levels in the CTP are at a maximum from April to June and decrease in elevation until the following spring. The ground water elevation increase in some ground water monitoring wells can be up to 10-feet. The ground water flow is generally to the north, northeast, and east.

A complete discussion of the CTP is included in ERM's CTP Data Review Report included as Attachment 1.

As a result of the reconfiguration of the CTP, which included installation of a cap and ground water collection trenches, the surface water loadings of zinc to the Eagle River have decreased from a high of approximately 395 lbs/day in 1991 to an average of 12 lbs/day in 1999 within Eagle River Segment 5 (EPA, 2000). Data from the Eagle Mine Annual Reports (Newfields, 2003, 2004, 2005) indicate that zinc loading between stream sampling locations along the CTP (E-13 and E-13B) ranged between about 2.4 and 67 lbs/day in 1997 and 1999 (Table 2). These reports also indicate that zinc loading to the Eagle River from 2000 through 2002 decreased and ranged between about 1.1 and 19 lbs/day in this area. More recent data collected in October of 2003 and 2004 by Viacom indicates that the zinc loading to the Eagle River along this segment has decreased further to below about 2 lbs/day (Table 2).

These reports also show a decrease in zinc loading to the Eagle River south of the CTP and Cross Creek (Table 2) (Newfields, 2003, 2004, 2005). The results of stream sampling locations E-13B and E-15, downstream of the CTP, indicate a decrease of zinc loading from about 11.5 to 28.1 in 1997 and 1999 to about 0 to 19.5 lbs/day in 2000 and 2001. Data collected along this segment of the Eagle River between 2002 and 2004 by Viacom indicate a further decrease in zinc loading of about 1.8 to 5 lbs/day. Additionally, Viacom's 2002 to 2004 stream sampling data collected at Cross Creek (T-18) suggest that zinc loading to this segment of the river is dominantly from Cross Creek (1.2 to 6 lbs/day).

The WTP is authorized to discharge up to 5 lbs/day total zinc to the Eagle River. However, according to the Eagle Mine Annual Reports (Newfields, 2003, 2004, 2005), the actual zinc loading from the WTP is negligible (EPA, 2000). The discharge permit for the WTP allows a 30-day average of 750 µg/L zinc with a daily maximum of 1,500 µg/L (CDPHE, 2005). In

samples collected from the WTP discharge from October 2000 through May 2005, the total zinc average of all 30-day average measurements was 60 µg/L and the maximum daily sample was 197 µg/L. Additionally, the total cadmium average and maximum was well below the effluent limits. The copper average and maximum was closer to the effluent limits (CDPHE, 2005).

Table 2 Summary of Eagle River Zinc Loading Data (Collected by Viacom) Along the CTP and Cross Creek

		CTP Stream Sampling Locations			Downstream of Cross Creek and the CTP Sampling Locations			Cross Creek Sampling Location
Year	Month	E-13	E-13B	Zinc Loading	E-13B	E-15	Zinc Loading	T-18
1997	March	342	409	67	409	434	25	17
	September	51.3	68.2	16.9	68.2	62.7	-5.5	4.2
	October	50.7	73.3	22.6	73.3	68.7	-4.6	6.4
1999	March	145.2	185.1	39.9	185.1	213.2	28.1	3.8
	April	134.2	129.3	-4.9	129.3	140.8	11.5	3
	September	57.2	60.7	3.5	60.7	58.1	-2.6	1.2
	October	44.7	47.1	2.4	47.1	45.2	-1.9	0.9
2000	March	92.1	93.2	1.1	93.2	93.2	0	4.9
	April	258	277	19	277	284	7	3.7
	September	30.3	36.3	6	36.3	39	2.7	1.1
	October	21.2	26	4.8	26	20.9	-5.1	1.6
2001	March	61.5	61.1	-0.4	61.1	80.2	19.1	13
	April	138	155	17	155	133	-22	2.8
	September	23.2	25.5	2.3	25.5	31.1	5.6	1.5
	October	30	26.9	-3.1	26.9	23	-3.9	1.3
2002	March	33.5	43.2	9.7	43.2	43	-0.2	6
	April	111	105	-6	105	103	-2	2.7
	September	11.4	10.5	-0.9	10.5	12.4	1.9	2.25
	October	14.9	16.6	1.7	16.6	15.4	-1.2	1.2
2003	October	18.7	18.6	-0.1	18.6	23.6	5	2.8
2004	October	18.7	20.1	1.4	20.1	21.9	1.8	2.2

Note: All results are in pounds per day (lbs/day).
A negative zinc loading value indicates a loss of zinc between the monitoring stations.
Some of the data are estimated
na = not available

1.5.4 Maloit Park

Maloit Park

As discussed above, Maloit Park was impacted by activities at the CTP, including seeps from the former NTP (now the CTP) to Maloit Park and a discharge of large volumes of tailings pond water and tailings material as a result of a collapsed riser pipe. As a result, portions of the wetlands were contaminated with visible tailings and some soils contained metals. Soil and tailings were removed and placed into the CTP, and uncontaminated soil was placed at Maloit Park. Also as stated above, the ground water extraction trenches for the CTP reports indicate that both

the north and east ground water extraction trenches are not 100 percent effective and a portion of metals impacted ground water from the CTP flows past the trenches and into Maloit Park/Cross Creek and the Eagle River. During the spring of 2006, orange stained surface water was observed to be ponded within Maloit Park. Ground water monitoring wells are located within Maloit Park near Cross Creek; however, these wells are apparently no longer monitored (Newfields, 2005).

As previously mentioned, those areas of Maloit Park which contained elevated metal levels were removed and replaced with clean soil. The excavated areas were then revegetated with native plant species. The EPA Five-Year Review Report (EPA, 2000) concludes, through visual inspection, that the cleanup was successful and recommends only continued monitoring of the vegetation status.

1.5.5 Roaster Pile 5

Zinc was initially processed at Belden using a roaster and magnetic separation process. The resulting waste roaster material was placed onto five separate areas of the Eagle Mine Site, one of which was Roaster Pile 5. Roaster Pile 5 is within the southern-most portion of the North Property and encompasses approximately 0.5 acres. Roaster material was removed from this area and placed into the CTP, as required by the 1988 Consent Decree with Gulf+Western and Remediation Plan. Currently, the area is lightly vegetated, and areas of orange stained soil and gravel remain on the ground surface.

1.5.6 Highlands Area

The Highlands Area is located adjacent to the OTP to the west and is topographically higher than the OTP. Features of the Highlands Area include ponded water, beaver dams, with wetlands vegetation, and aspen and pine forests. Surface water which supports these wetlands and ponds is supplied to the area by a flume which diverts water from Cross Creek, and ground water which seeps from the south side of the area. Since tailings and waste rock from the Eagle Mine Site were not placed in this area, background samples for the 2005 and 2006 investigation were collected from this area. Remediation features for the Eagle Mine OU-1 are located in the Highlands Area and include the Bolts Lake surface water diversion feature and additional surface water berms intended to divert flow around the OTP. Even with these features in place, surface water flows from the Highlands Area onto the OTP during the spring snow melt and runoff as observed during the Site investigation and indicated by water-stained rock outcrops.

1.6 HISTORICAL AERIAL PHOTOGRAPHS

Historical aerial photographs were used to document pre-and post-mine waste conditions, as discussed in the above sections. The historical aerial photographs from 1939, 1974, 1985, and 2004 are shown below and included for these years and others in Appendix B). The visual observations made from these photographs are summarized below.

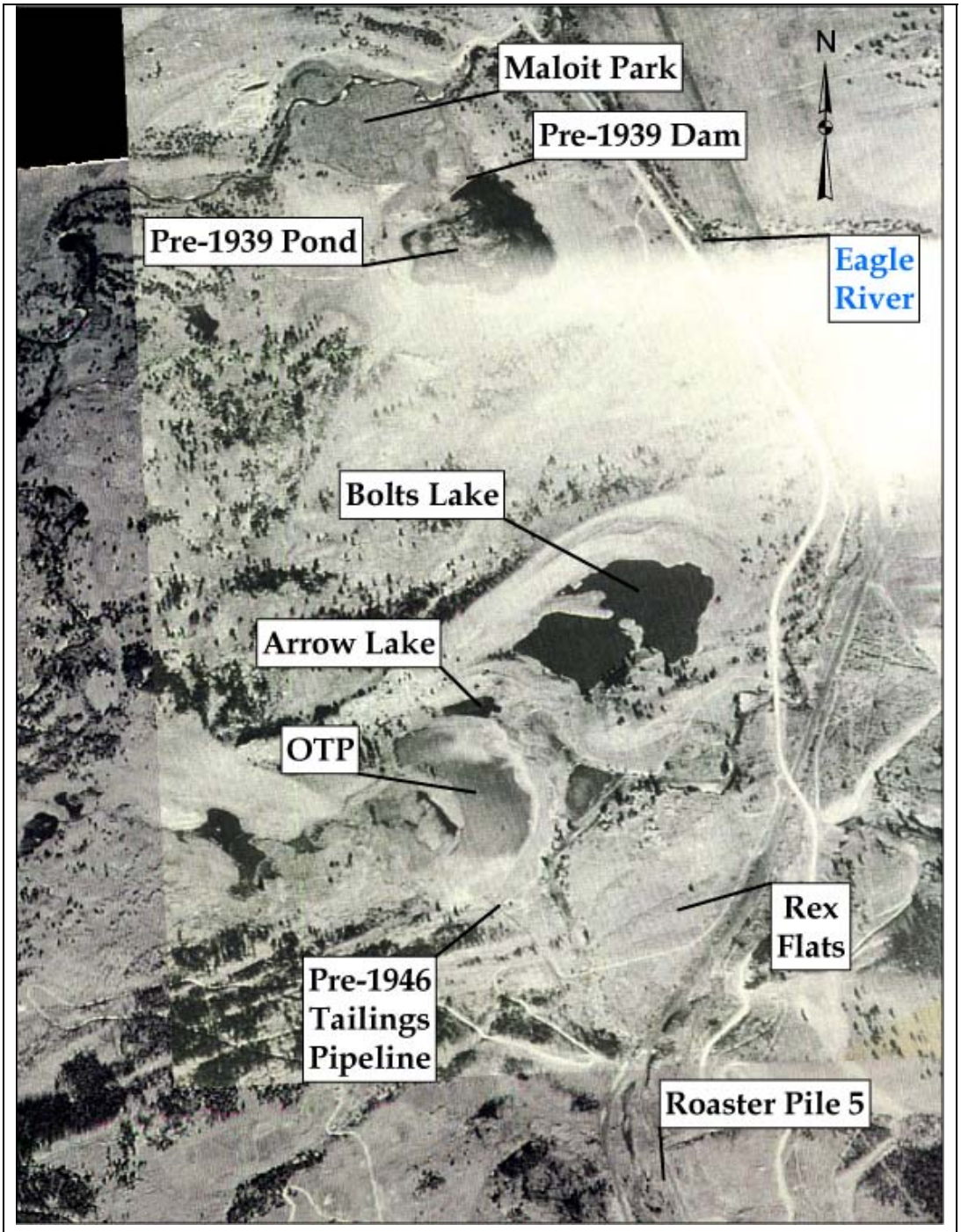


Figure 7 – 1939 Aerial Photograph

1939 Aerial Photograph (Figure 7): The following observations were made from the 1939 aerial photograph:

- The NTP/CTP, Bolts Lake and Rex Flats appear natural and have no indication of impacts due to tailings disposal from the Eagle Mine.

- The NTP/CTP area contains a lake with a dam to the north and Bolts Lake is filled with water.

- The OTP is a tailings pond and the reportedly original location of Sump #3. It is located next to the Eagle River just east of the OTP, and appears to be filled with water. Also the area of the current Sump #3 area contains water.

- The location of the tailings pipeline to the OTP is visible to the south of the OTP.

- The beaver ponds west of the OTP appear to be filled with water.

- Arrow Lake, located immediately north of the OTP, appears to be filled with water.

- The area of Maloit Park is vegetated; there is no indication of tailings material.

- Bolts Lake is surrounded by vegetation; the lake appears to be filled with water; there is no indication of tailings material.

- An east-west roadway is located in the southern portion of Rex Flats; and there is no indication of the Mine Water Transport Pipeline that currently extends across Rex Flats.

- Roadways are located along the south side of the OTP.

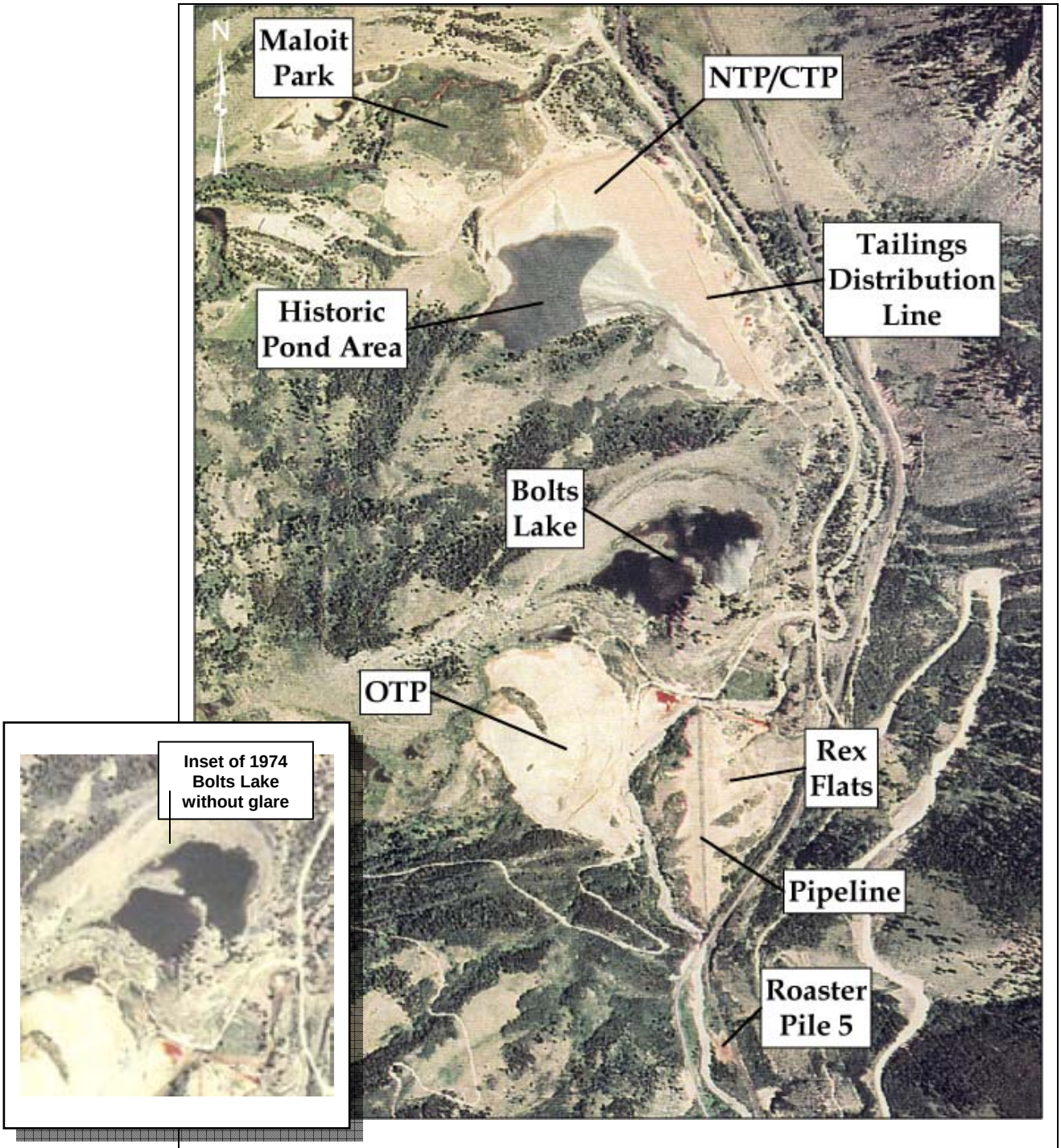


Figure 8 – 1974 Aerial Photograph

1974 Aerial Photograph (Figure 8): The following observations were made from the 1974 aerial photograph:

- A portion of Maloit Park contains lighter-colored soil indicative of tailings.

- The NTP/CTP area contains tailings on top of, to the south of, and to the west of the original lake. The tailings pipeline is located on top and along the eastern side of the CTP within the tailings-like material. A few small areas of orange color are present along the eastern edge of the CTP. A pond is along the west side of the CTP. Drainage from the tailings pipeline on top of the CTP/NTP is evident.

- Bolts Lake appears as it did in 1939. The tailings pipeline is located just east of Bolts Lake.

- The majority of Rex Flats contains tailings material, and the Mine Water Transport Pipeline extends north-south through Rex Flats. Orange staining is present along the northern edge of Rex Flats next to the Eagle River. The Eagle River is stained orange north of Rex Flats. Vegetation is present along the western side of Rex Flats near the Eagle River.

- Arrow Lake is filled with water and is located to the north of the OTP. The beaver ponds west of the OTP are filled with water. Roadways are located along the south side of the OTP. Tailings (light-colored soil) are located within the OTP. Vegetation is present along the west, southwest, north and south sides of the OTP. Orange staining is present within the old Sump #3 area in the northeastern portion of the OTP, current Sump #3 area, northern, and northwestern portions of the OTP. The Eagle River is stained orange along the eastern boundary of the OTP.

- Roaster Pile #5 is stained orange.

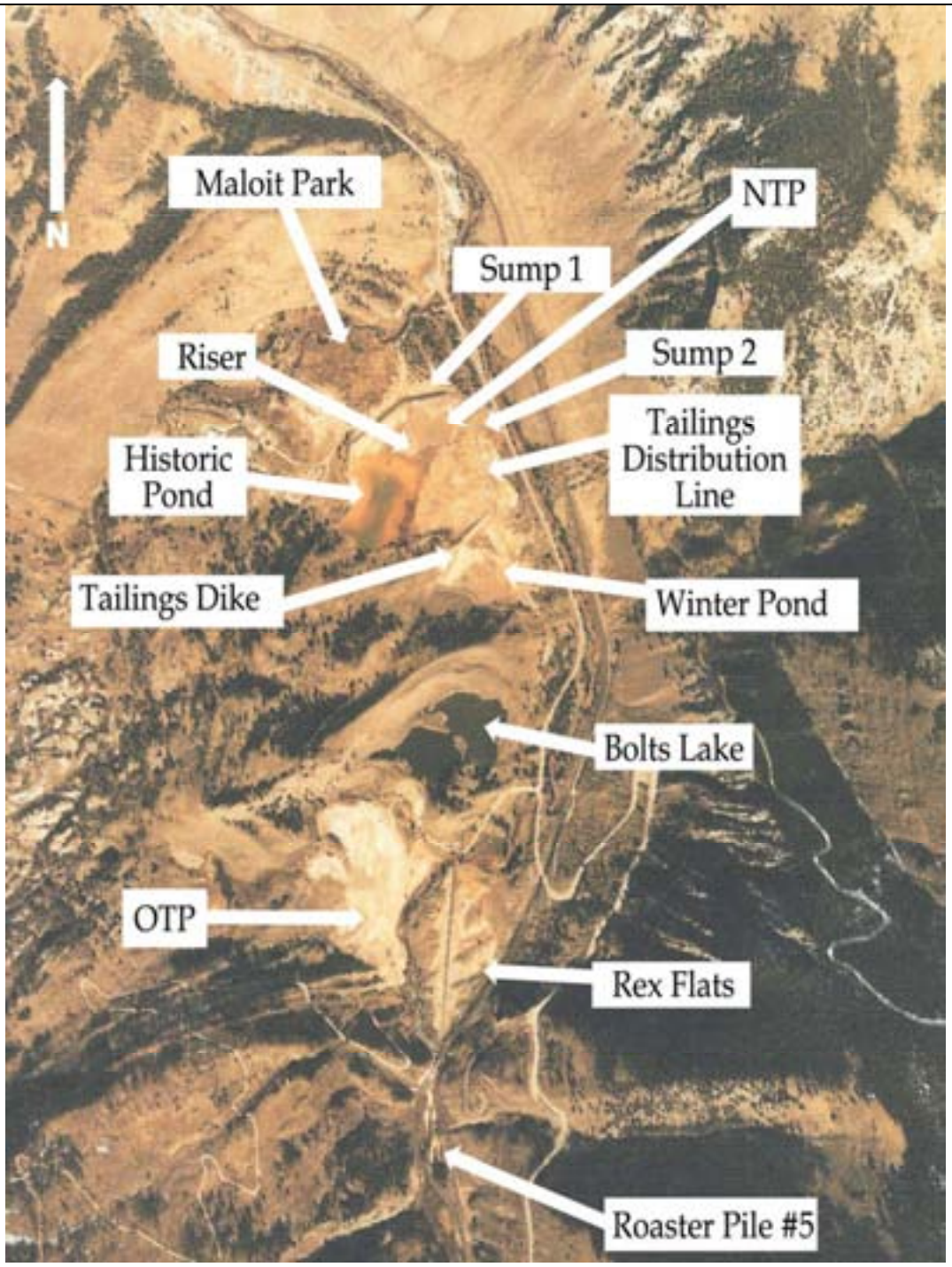


Figure 9 – 1985 Aerial Photograph

1985 Aerial Photograph (Figure 9): The following observations were made from the 1985 aerial photograph:

- Maloit Park appears to have several areas of light orange staining probably due to ground water seeps.

- The CTP appears similar to the 1974 photograph, except 1) the tailings pond on the western side appears larger and is a strong orange color, 2) there appear to be more tailings within the southern portion of the CTP, 3) the tailings dam separates the north tailings area and winter pond area is evident, 4) the northern portion of the tailings pipeline is gone, 5) there is ponded orange water in the winter pond area, 6) there is obvious orange staining near the Sump #2 area on the eastern portion of the CTP, 7) three decant (underdrains) drains and discharge is evident at the CTP/NTP (due to the better aerial resolution), and 8) orange staining is observed in the Eagle River east of the NTP/CTP. This staining seems more prominent just east of Sump #2.

- Bolts Lake appears as it did in the 1939 photograph.

- Rex Flats appears similar to the 1974 photograph, except 1) the area of tailings appears to be less to the east, and 2) the area of strong orange color is larger than observed in the 1974 photograph, and is more evident in the north northeast portions of Rex Flats, and 3) staining in the Eagle River is evident.

- The OTP appears similar to the 1974 photograph, except 1) Arrow Lake to the north is dry, 2) Sump #3 is filled with water, 3) staining along the eastern portion of the OTP in the Eagle River is apparent, and 4) Tigiwon Road is located at the OTP.

- Roaster Pile #5 is stained orange as it was in 1974.

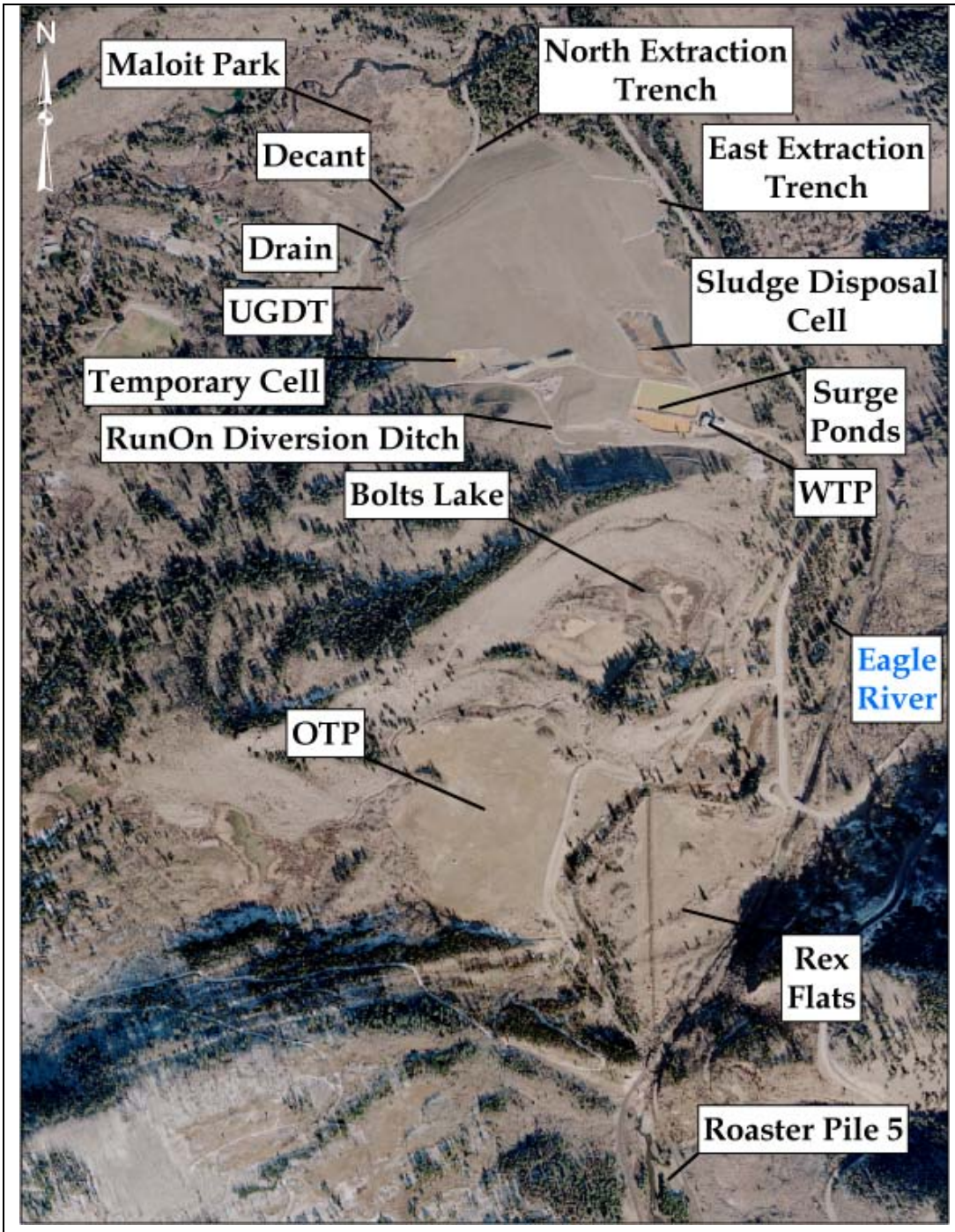


Figure 10 – 2004 Aerial Photograph

2004 Aerial Photograph (Figure 10): The following observations were made from the 2004 aerial photograph:

- The majority of the CTP appears to have a graded surface, with no indications of tailings at the surface. The upper and lower surge ponds are located on the southern edge of the CTP. The sludge cell is located just north of the surge ponds. The WTP is located to the east of the surge ponds, the temporary cell is located in the west/central portion of the CTP. Several surface water trenches are evident. The historic pond on the western side of the CTP is not evident. The Eagle River east of the CTP is not stained orange like the 1985 aerial.

- Bolts Lake is dry.

- Tailings are not readily apparent on Rex Flats. The Mine Water Transport Pipeline remains on site. Portions of the Eagle River north of Rex Flats are stained light orange.

- The majority of the OTP has a uniform surface without indications of tailings at the surface. Similar to the previous photographs, vegetation is present to the west, southwest and south of the OTP. The eastern portion of the OTP along the Eagle River does not appear to be stained.

- The Roaster Pile #5 area does not appear stained.

2.0 2005-2006 REMEDIAL INVESTIGATION

The field activities included collecting surface and subsurface soil samples; installing and sampling ground water wells; sampling seeps; sampling surface water diversion trenches; sampling surface water and stream sediments; conducting a geophysical survey and verifying results with test pits; collecting hydrologic data; and collecting air samples.

2.1 REMEDIAL INVESTIGATION OVERVIEW

As part of the Work Plan, Region VIII of the EPA, in which the Eagle Mine Site is located, and the CDPHE have approved the following metals of concern for this Remedial Investigation: arsenic, cadmium, chromium, copper, lead, manganese and zinc. These metals are referred to herein as the "primary indicator metals." Soil and water samples were tested for the primary indicator metals and pH. Additionally, in order to facilitate the performance of a risk evaluation at areas of the Eagle Mine Site situated within the North Property, CDPHE has requested an expanded analytes list be performed on a subset (50%) of all soil samples (up to 10 samples per area) tested for specified areas. This expanded analyte list includes portions of EPA's Target Analyte List, specifically: aluminum, antimony, barium, beryllium, calcium, cobalt, cyanide, iron, magnesium, mercury, nickel, potassium, selenium, silver, sodium, thallium and vanadium. Additionally, sulfate, which can also indicate areas requiring special management, were included in the laboratory analyses for the expanded analyte list for select media. This expanded analyte list is referred to herein as the "expanded analytes."

ERM has completed a comprehensive Site-wide risk assessment (June 2006) to determine if the primary indicator metals used by Viacom and the regulatory agencies to remediation and monitor the Site were appropriate. The Risk Assessment and the results of this Site investigation confirm that the primary indicator metals are indeed the metals which are most indicative of impacts from the Eagle Mine upon the environment.

Coal tar creosotes and pine oils were historically used as reagents in the treatment of ores at many sites (Gaudin, 1982). Therefore, ERM analyzed select soil and ground water samples at the OTP and Rex Flats areas for the presence of volatile organic compounds ("VOCs") (Method 8260B) and semi-volatile organic compounds ("SVOCs"). The SVOCs were tested using Method 8270C, which has the ability to detect the presence of polynuclear aromatic hydrocarbons such as creosote.

The data collection tasks as established in the Work Plan were developed to be consistent with the National Contingency Plan ("NCP"), and to collect the necessary information to ultimately accomplish the following goals:

1. Document current baseline environmental conditions at the North Property;

2. Assess the risk posed by the contamination on the North Property to human health and the environment, taking into account the final reuse of the North Property;

3. Identify and evaluate the appropriate remedial alternatives to address the assessed risk; and

4. Partially delist the areas of the Eagle Mine Site situated within the North Property if all appropriate response actions have been taken.

Table 3 lists the key field tasks as stated in the Work Plan, and their status and deviations.

Table 3 ***Key Field Tasks***

Task	*2005 Field Season*	*2006 Field Season*
Perform a geophysical survey to evaluate potential subsurface anomalies at the Rex Flats and OTP areas.	Conducted geophysical survey at Rex Flats, which, based on past Site use, was assessed to have the most potential for subsurface anomalies. Tested effectiveness of the survey by digging test pits within identified anomalies. Found surficial metal and near surface rebar in concrete; but no drums, underground tanks, or other metallic environmental concerns.	Task completed. OTP will not be surveyed due to prior remediation to the depth of natural soils.
Collect surface soil samples on a grid pattern at the OTP, Rex Flats, and Bolts Lake areas.	Completed. More samples were collected than anticipated in the Work Plan. Additional samples were collected to investigate areas of concern identified during the field survey.	Under Work Plan Addendum #3 additional surface soil sampling at OTP and Rex Flats were collected. This task is completed.
Collect soil samples from Maloit Park and Roaster Pile #5 areas.	Completed. More samples were collected than anticipated in the Work Plan. Additional samples were collected to investigate areas of concern identified during the field survey.	Under Work Plan Addendum #3 additional surface soil sampling at Maloit Park were collected. This task is completed.

Task	*2005 Field Season*	*2006 Field Season*
Drill shallow soil borings at pre-determined locations.	Per the Work Plan, Geoprobe® soil borings were drilled within the OTP and Rex Flats areas, and tests pits were dug within Bolts Lake. Fewer locations were drilled than anticipated due to inaccessible locations such as heavily forested and/or steep terrain, and some locations were moved slightly due to these conditions. Also, borings were drilled shallower than anticipated due to rig refusal on boulders (weathered boulders were drilled through) or bedrock. As a result, fewer samples were collected than anticipated in the Work Plan.	Task completed.
Install ground water monitoring wells at pre-determined locations and monitor most of the new and some existing Viacom wells for 8 months.	Sixteen wells were installed in 2005 and ground water was sampled from specified new and existing wells (one additional well was installed in 2006). Most of the wells were sampled in August, September and October of 2005. Several wells were not completed until September and therefore were not sampled in August of 2005. An attempt was made to drill CTP-MW-3, however, due to drilling difficulties, this well was not installed until 2006.	Task completed. The ground water wells were sampled in March, April, May, June and July of 2006. CTP-MW-3 was installed in May 2006 and was sampled in June and July of 2006.
Collect hydrogeologic data.	Slug tests were conducted at the newly installed wells at the Rex Flats, OTP, CTP, and Bolts Lake areas. Slug tests could not be performed on a few wells because the wells did not contain enough water. Also, a pump test was conducted at Bolts Lake. In situ data loggers were placed in six of the new wells.	Task completed. Slug tests were attempted at the wells which did not contain enough water in 2005. Only one of those wells contained enough water to collect slug test data. The water level data loggers were removed from the wells in July of 2006.

Task	*2005 Field Season*	*2006 Field Season*
Collect samples of other media including air, surface water, surface water diversion trenches, seeps, boulders, and Tailings Slurry Pipeline.	Air – Collected baseline measurements from areas of Rex Flats, OTP, and CTP. Surface Water – Collected surface water samples and flow measurements as specified in the Work Plan. Additionally, collected sediment samples. Boulders – Collected rock chip samples from the Site boulders as specified in the Work Plan. Tailings Slurry Pipeline – Fewer samples collected due to shorter length of pipeline than anticipated (1 sample per 100 feet of pipeline). OTP Surface Water Diversion Trenches – A sample from each surface water diversion trench was collected once in September 2005 and April 2006. Seeps – Two ground water seeps in the Rex Flats were sampled in September 2005 and April 2006. One ground water seep was sampled at the OTP in September 2005 and two were sampled in April 2006. Two seeps were not visible in September 2005.	Air – Task completed. Surface Water – Under Work Plan Addendum #3 additional surface water sampling was conducted in 2006, and Additional sediment samples were collected upstream of the Site. This task is completed. Boulders – Task completed. Tailings Slurry Pipeline – Task completed. OTP Surface Water Diversion Trenches – Task completed. Seeps – Task completed.
Submit samples for laboratory analysis. (Chain of custody forms for the samples are within Appendix J.)	Samples submitted. Some samples missed the analytical holding times, and those sample locations and intervals were re-sampled and analyzed. Some sample names differed slightly from Work Plan naming convention and are identifiable. A few sample names were repeated; but are unique in their location and date/times of collection and are identifiable.	Under Work Plan Addendum #3 additional ground water, surface water, soil, and sediment samples were collected and submitted for laboratory analysis . This task is completed.

Work was conducted in accordance with the Work Plan, and the Quality Assurance Project Plan ("QAPP") evaluated the representativeness of the data that was collected (Attachment 2).

2.2 *SURFACE WATER INVESTIGATION*

2.2.1 *Surface Water Samples*

This RI Report discusses samples that were collected from the Eagle River at the locations illustrated in Figure 11. Surface water samples collected during this investigation were analyzed for the primary indicator metals. These metals have been determined by previous studies to be most indicative of the mining impacts upon surface water.

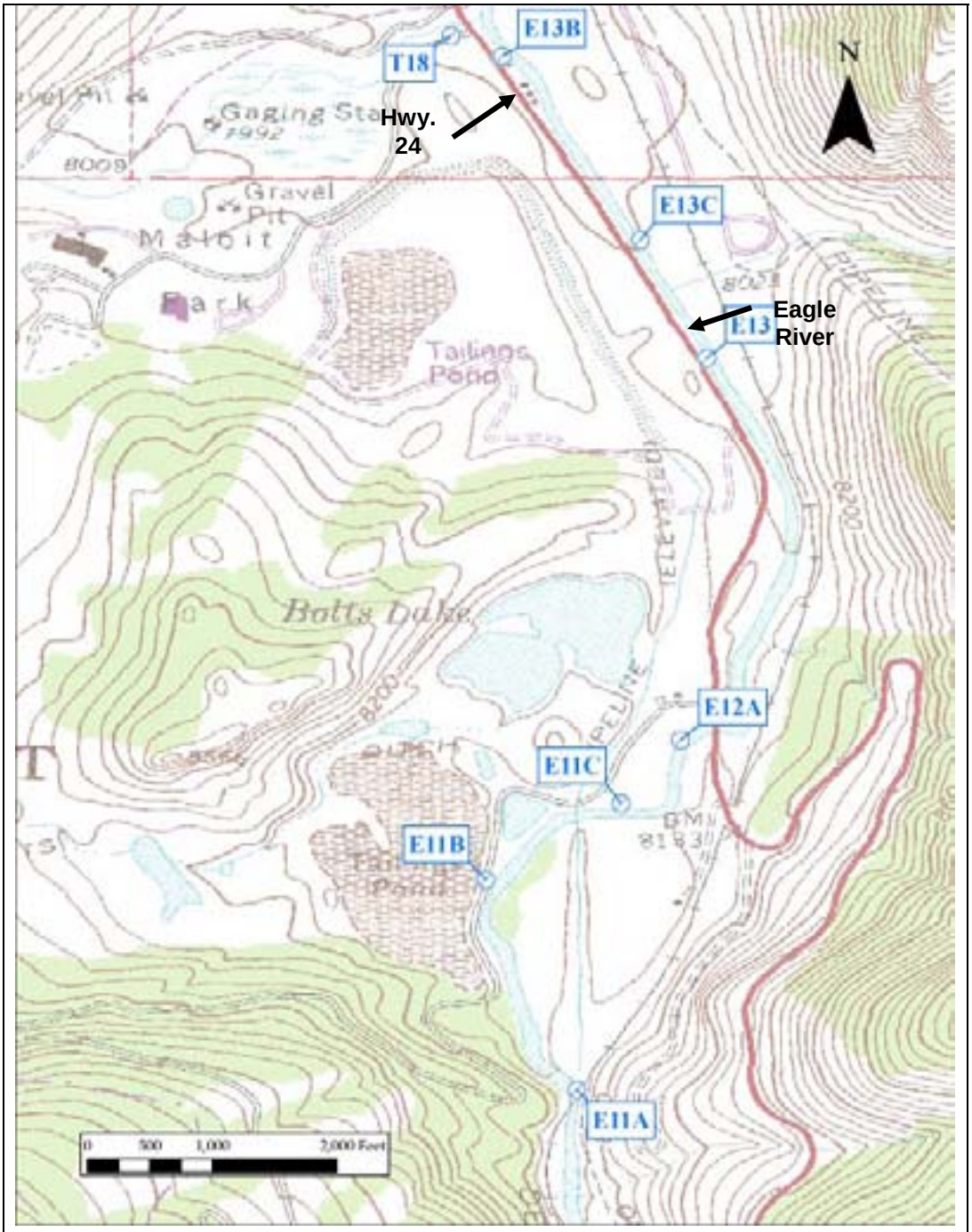


Figure 11 - Surface Water Sampling Locations

A total of 8 stream stations were sampled as part of this investigation. Four new stream stations were established along the Eagle River, and these new stations were used in conjunction with three existing stations along the river as well as one existing station along Cross Creek. The stream stations are located to assess the quality of water entering, traveling through, and exiting the investigated areas. Background samples were not collected for the surface water samples. Surface water

upstream of the North Property is impacted by historic mining activities, and therefore does not represent "background" conditions. Instead, a surface water sample location was established near the upstream portion of the investigation area (E-11A) to document water quality entering the North Property.

Overall, surface water samples were collected monthly from June through October 2005; weekly from March through April 2006; and monthly for the May 2006 sampling event. These samples represent water quality conditions throughout the year, except for the winter months when the Eagle River is covered with ice and snow.

The samples that were collected monthly from June through October 2005 were analyzed for the primary metals of dissolved arsenic, cadmium, chromium, copper, lead, manganese, and zinc. For each sampling event, one sample was collected from each sample station, and a field duplicate was collected from station E-11C. The samples were collected as follows from July through October. With the exception of station E-11A, six water samples were collected at each station from the cross section of the stream at approximately equally spaced intervals, beginning and ending about 5 feet from the stream banks. The samples for each stream station were composited into one sample that was field filtered, preserved with nitric acid (HNO3), and placed on ice. During the June sampling event, the stream stations were flowing at about 200 cfs or greater and therefore not accessible. Subsequently for the June sampling event, two water samples were collected per stream station, and those samples were collected from approximately 5 feet from each bank. The samples were then prepared as described above. Stream station E-11A was never safely accessible due to rapids, and therefore station E-11A was sampled for each sampling event by retrieving a single grab sample using a bucket tied to a rope and thrown out to midstream.

During the March and April 2006 sampling events, samples were collected weekly for select parameters as follows:

- Week 1 - Dissolved hardness, zinc, cadmium, copper
- Week 2 - Dissolved hardness and zinc
- Week 3 - Dissolved hardness, arsenic, cadmium, chromium, copper, lead, manganese, zinc; and total arsenic, cadmium, chromium, copper, lead, manganese, zinc
- Week 4 - Dissolved hardness and zinc

Due to very limited access because of snow and ice, and/or high stream flow during the March, April, and May sampling events, a cross section of the stream station was not sampled. Instead, one sample was collected from each station, typically from one of the banks. The exception was sample location E-11A, which was collected from the middle of the stream from the Union Pacific Bridge which crosses the Eagle River.

2.2.2 *Surface Water Flow Measurements*

Stream flow was measured at 7 of the 8 stream stations on a monthly basis from July through October 2005. The stream stations were not accessible in June 2005 and March, April, and May 2006 due to high flows (approximately greater than 200 cfs). As stated above, station E-11A was never safely accessible due to rapids.

The mid-section method of collecting flow measurements was used at the stream stations and included partitioning the channel into approximately 20 points, and then measuring depth and velocity of the channel at those points. Depths were measured with a top setting measuring rod, and velocity was measured with a Price AA-type current meter.

Velocity was measured using the six-tenths method (measured at 0.6 of the depth from the water surface). A measuring tape was extended across the river perpendicular to the flow and tied off. Depth and velocity readings were taken at 1.5 to 2 foot intervals depending on uniformity of the river bottom. Interval location, depth, and velocity data was recorded on an AquaCalc Pro Stream Flow Computer manufactured by JBS Instruments.

Several factors affect the accuracy of the discharge measurements. These factors include the stream profile, the number of measurements taken within a cross section, and other factors such as boulders, wind, and operation of the measuring equipment. To reduce potential error, the number of measurement stations within a cross section were 30 to 40 per cross section. One Eagle River station (E-13) exhibited very turbulent conditions due to large boulders in the riverbed at that location. This turbulent station may have more variance in the measurements than the other stations.

2.3 *EAGLE RIVER SEDIMENT INVESTIGATION*

Sediment sample locations are shown on Figure 12 and were selected based on the analytical results of the surface water samples and included: 1) three sediment sample locations between stream stations E-11B and E-11C due to an increase of zinc in the downstream water sample (E-11C); 2)

two sediment samples between stream stations E-13 and E-13C to evaluate conditions both upstream and downstream of the area of the WTP discharge and Two Elk Creek confluence; and 3) one sediment sample between E-13C and E13B due to a slight increase in zinc concentrations between those two points. Additionally, four samples were collected upstream of the North Property, including: 1) one sample immediately downstream of Rock Creek to evaluate potential impact from the Belden and Gilman mining area; and 2) three locations between Red Cliff and Belden to evaluate background stream sediment conditions.

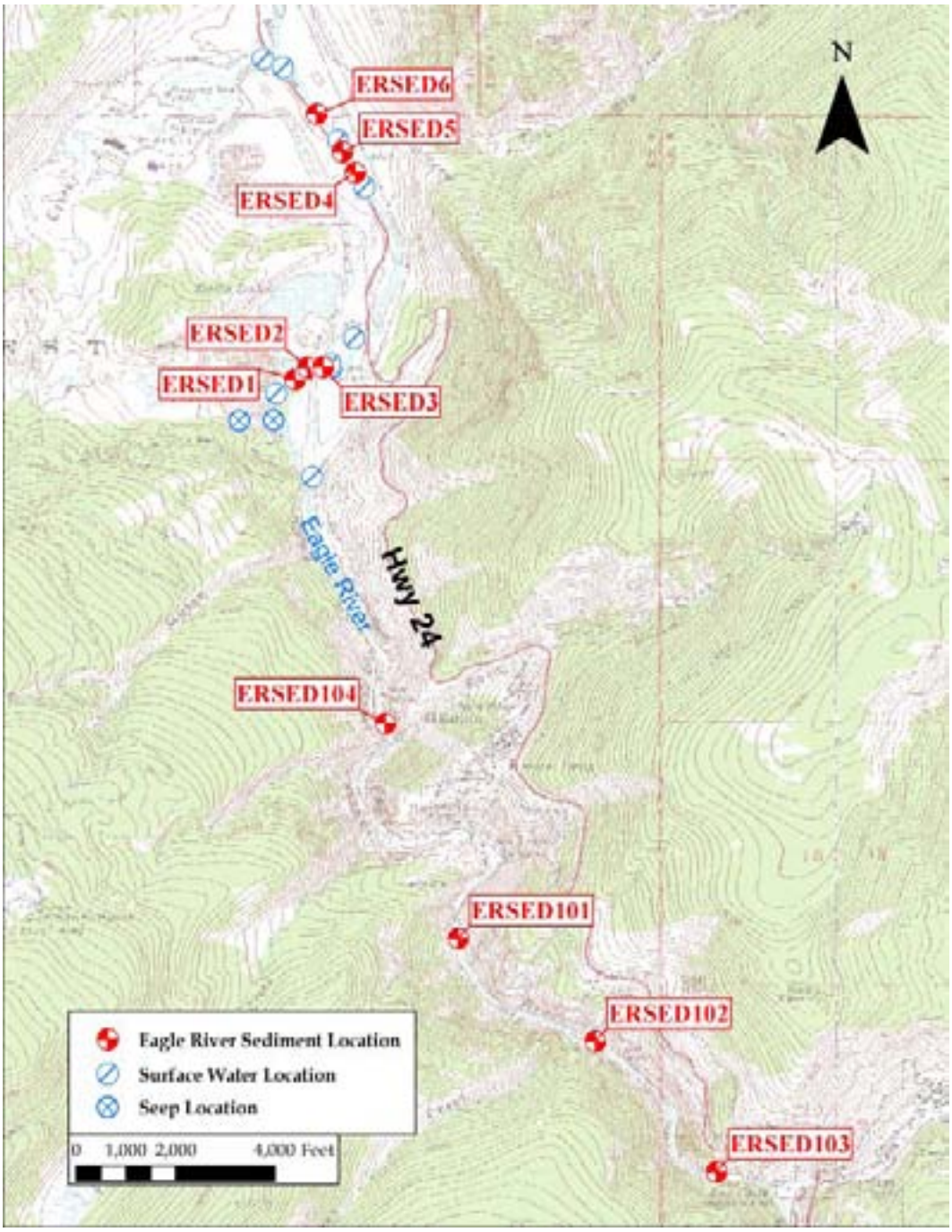


Figure 12 - Eagle River Sediment Sample Locations

One composite sample was collected from each sample location. For eight of the ten locations, the composite was collected from: 1) approximately 2 to 5 feet instream from each bank; and 2) the approximate center of the stream. At the two southern-most locations (nearest to Red Cliff), samples could not be retrieved from the center of the river due to the rocky stream bottom and subsequent lack of sediment. At those two locations, the samples were composited from the instream, bank samples. At each

location the sediment was sampled from 0 to 2 inches deep. A total of ten locations were sampled, and those samples were analyzed for the primary metals.

2.4 *SOIL INVESTIGATIONS*

Numerous soil samples were collected from the OTP and adjacent Sump #3, Rex Flats, Roaster Pile #5, Bolts Lake, Maloit Park areas, and in the general vicinity of the CTP. These features are illustrated in Figure 1 of Section 1.3.1.

All the samples collected during this investigation were analyzed for the primary indicator metals (arsenic, cadmium, chromium, copper, lead, manganese and zinc). A subset of these samples was also analyzed for an extended list of analytes. These additional metals were analyzed for the Site-wide Risk Assessment, to determine if metals other than the primary indicator metals were representative of impacts from the Eagle Mine. The expanded analytes list included: aluminum, antimony, barium, beryllium, calcium, cobalt, cyanide, iron, magnesium, mercury, nickel, potassium, selenium, silver, sodium, thallium and vanadium. Additionally, sulfate, which can also indicate areas requiring special management, was included in the laboratory analyses for the expanded analytes list in some media.

2.4.1 *Background Samples*

Background soil and one rock sample chipped from an outcrop were collected from the areas adjacent to the Eagle Mine Site with no recorded or evident impacts by historic mining activities (Figure 13). The background rock chip sample was collected from a rock outcrop located near Red Cliff. The 20 background soil samples were collected from 0 to 6 inches bgs in non-impacted soil and included the following areas:

1) hillsides east and southeast of Rex Flats (3 samples);
2) hillsides west and southwest of the OTP (8 samples);
3) Eagle River valley east of Bolts Lake (1 sample);
4) Eagle River valley east of the CTP (4 samples);
5) north of the CTP (1 sample);
6) southwest of Maloit Park (1 sample); and
7) hillside west of Bolts Lake (2 samples).

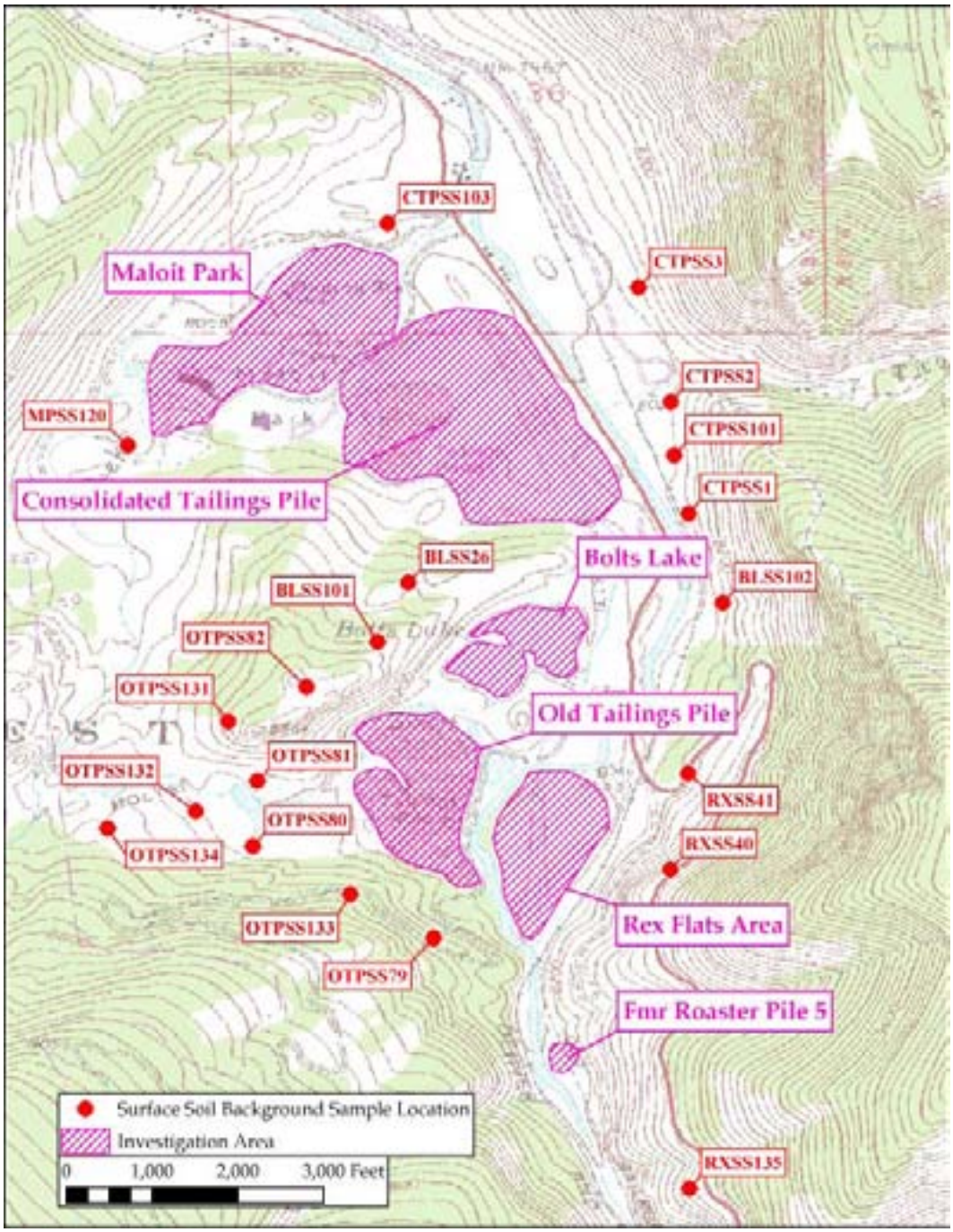


Figure 13 - Background Surface Soil Sample Locations

Figure 14 shows the background soil samples relative to topography using a 3-dimensional presentation.

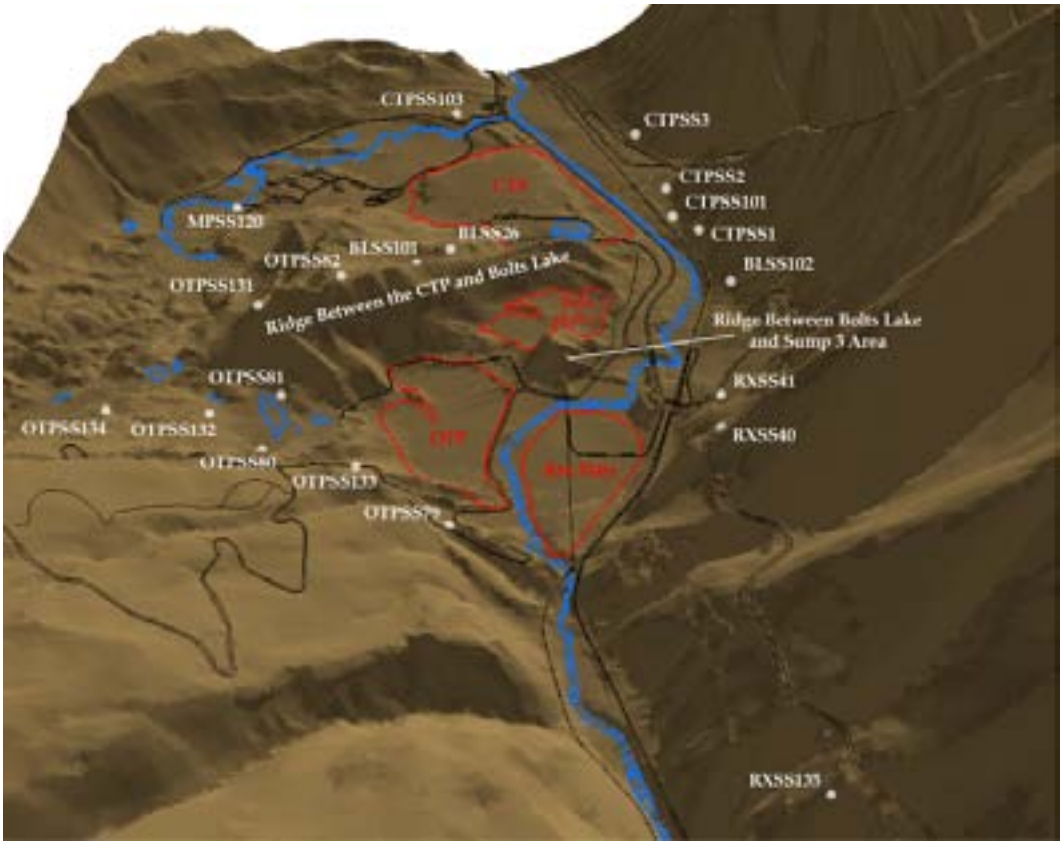


Figure 14 - Background Soil Samples Relative to Topography

As anticipated in the Work Plan, background soil samples could not be obtained closer to the investigated areas due to the steepness of the Eagle River valley walls and due to the continuation of the Eagle Mine Site to the south of the investigated areas. As shown on the topographic map, the background samples are located outside of the known former mine tailings areas.

With the exception of sample CTP-SS-3, the background sample locations are representative of the investigated areas. Sample CTP-SS-3 is located proximate to a shooting range, and the lead concentrations are likely impacted by that potential source. Therefore, the data from CTP-SS-3 were not included in background comparisons or calculations during the soil evaluation discussed in Section 4.2.1.

The soil samples and the rock chip sample collected from the rock outcrop were analyzed for the primary metals and pH. Additionally, 5 of the background soil samples were analyzed for the extended list of analytes.

2.4.2 *Surface Soil Samples*

Surface soil samples were collected, typically from 0 to 6 inches deep, from predetermined locations per the Work Plan at the OTP, Sump #3, Rex Flats, Bolts Lake, Roaster Pile #5, Maloit Park, and at the background locations (Figure 15, below). Except for the background samples, the sampling program was designed to collect the most tailings-like soil, based on visual observations, from each predetermined location. This was accomplished by going to the predetermined sample location, then with the use of a measuring tape, searching a 50-foot radius around the sample location. If within that radius the field team visually observed soil that was yellow, orange, or red-stained and/or fine-grained and loess-like, then that soil was sampled because it had the characteristics of tailings material.

In addition to these predetermined samples, step-out samples were collected from the perimeters of the OTP, Rex Flats, and Maloit Park areas to better define the areas of higher metals concentrations. The areas of the step-outs were based on the initial analytical results. To assess the need for and the location of a step-out, the initial analytical results were compared to: 1) EPA Region 9 residential preliminary remediation goals ("PRGs") for the metals of cadmium, chromium, copper, lead, manganese and zinc; and 2) background soil analytical results for arsenic, which are higher than the PRGs. A few "opportunity" samples were collected from within the OTP, Rex Flats, and Maloit Park. These samples were occasionally collected when potentially-impacted soil was observed outside of the 50-foot radius. Also, several additional soil samples were collected from areas adjacent to some of the boulders from which the rock chip samples were collected.

In addition to the standard analyses of the primary indicator metals, some soil samples were analyzed by the Synthetic Precipitation Leaching Procedure ("SPLP") to evaluate potential impact to ground water from leaching of metals in soils. Plus, at some of the sample locations, additional soil sample volume was collected so that the laboratory could sieve the fines fractions of the sample (minus 60 mesh sieve, 250 micrometers) for analysis of the primary metals within the fines fraction.

A subset of the samples was submitted for the extended list of analytes.

As described in the QAPP (Attachment 2), some of the locations were resampled for the extended list of analytes due to missed holding times.

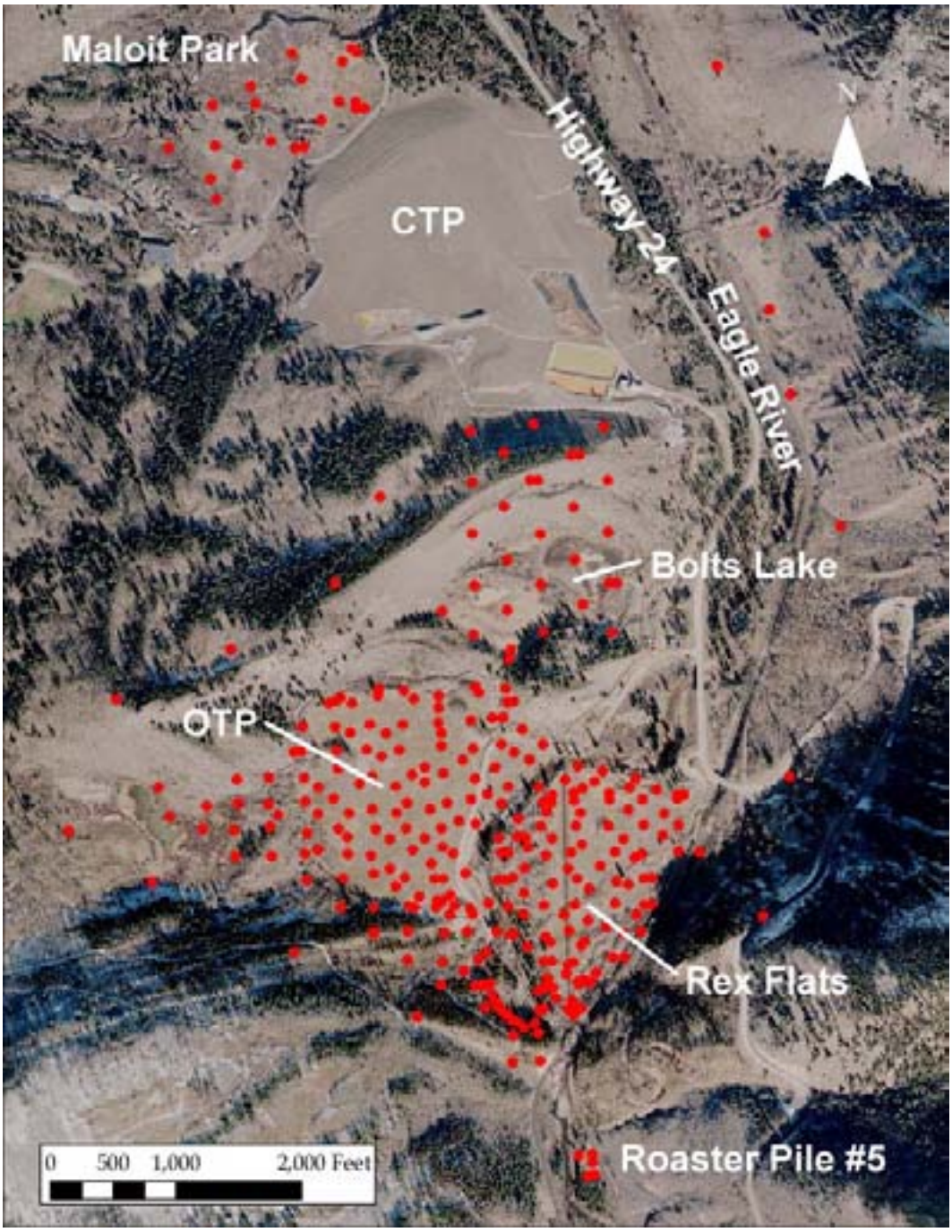


Figure 15 - Surface Soil and Nearby Background Soil Sample Locations

In accordance with the Work Plan, some of the surface soil locations were dug with a hand auger to collect slightly deeper samples for laboratory analyses. These areas included: 1) the boulder areas that are located within the southern portions of the OTP and Rex Flats, and 2) several locations within Bolts Lake that were selected based on detected concentrations of primary metals in the area.

2.4.3 *Tailing Slurry Pipeline Sediment Samples*

Sediment was collected from within the Tailings Slurry Pipeline area. Samples were collected for analyses of the primary indicator metals; and cyanide and mercury.

2.4.4 *Rock Chip Samples from Boulders*

Other surficial types of samples were collected including rock chip samples from stained boulders with the OTP and Rex Flats. Specifically, the rock chip samples were collected from large boulders that were located in the southern portions of the OTP and Rex Flats. The samples were collected by hammering at the boulders to collect chips of the discolored material coating the boulders. Samples were collected for analyses of the primary indicator metals.

2.4.5 *Subsurface Soil Samples*

Four test pit locations were excavated within Bolts Lake (Figure 16), and samples for laboratory analyses were collected at depths assigned in the Work Plan. Per the Work Plan, soil samples for laboratory analyses from the even numbered test pits were collected from approximately 2, 6, 10, and 14-feet below ground surface. The odd numbered test pits were sampled at approximately 3, 7, 11, and 15-feet deep. Depths of the test pits extended to as deep as 18 feet.

Soil boring locations were drilled with a Geoprobe® rig at the OTP, Rex Flats, and Sump #3 areas as prescribed in the Work Plan. The anticipated depths of the borings were 15 feet, except for five borings in the Rex Flats area and five in the OTP area, which were anticipated to be 25 feet deep. Five of the predetermined locations were not accessed due to steepness of the terrain, large boulders on the ground surface, and/or heavily forested areas. At 10 locations, the desired depth was not reached due to rock/boulders in the subsurface. At these locations, per the Work Plan, three attempts were made in the general area of the location in an effort to reach the desired depth. The QAPP describes the depth and sample variations in detail; it also contains copies of the field books, which describes the step-out attempts.

Figure 16, below, shows the locations of the test pits and soil boring holes, and soil boring logs are included in Appendix C. Figure 16 also shows the hand auger locations, discussed in Section 2.5, where deeper (approximately greater than 0.5 feet) soil samples were collected. Additionally, the map shows the soil boring locations that were drilled, but not sampled, because the sample depth could not be reached due to rig refusal on boulders/rock.

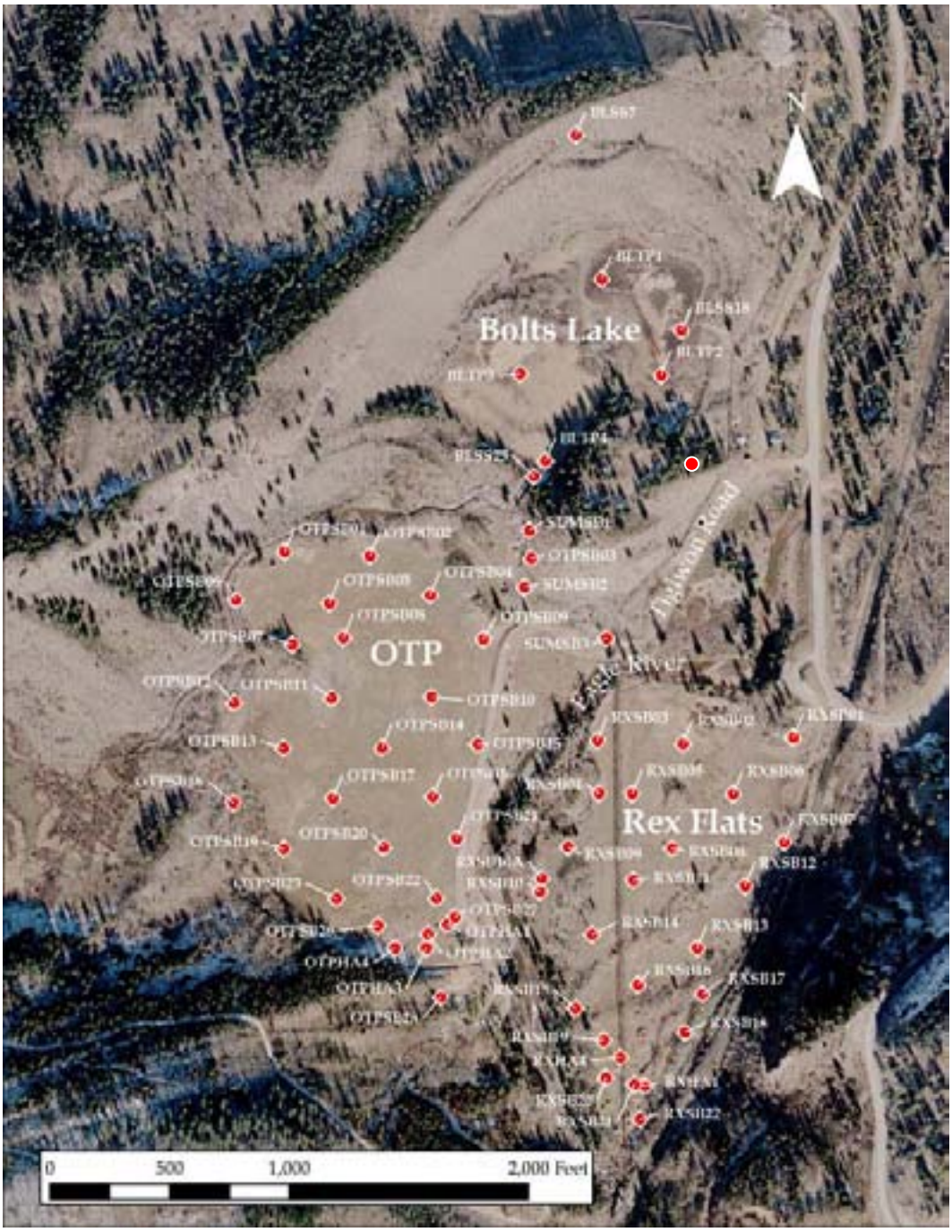


Figure 16 - Subsurface Soil Sample Locations

Continuous soil core/samples were collected from the Geoprobe® borings and test pits and visually inspected by the field geologist to identify lithology and stratigraphy. The soil samples were screened with a field photoionization detector ("PID") equipped with a 10.6 electron volt lamp. Elevated PID readings, defined as 15 parts per million ("ppm") or greater above background, were observed at locations OTP-SB-19 and RX-SB-10. The PID readings at these two locations were: 1) 315 to greater than 2,000

ppm from 10 to 12 feet deep; and 2) 37 ppm from 0 to 0.5 feet deep (a surface soil sample), respectively. Soil samples for organic analyses were placed directly into sample jars and submitted for analyses of VOCs and SVOCs. No other elevated readings were encountered during the investigation.

Samples were collected from multiple depths at many of the subsurface soil locations for laboratory analyses. The depths of the soil samples for laboratory analyses varied, which was intended in the Work Plan. Except for the Sump #3 area, the sample depths of the even-numbered borings were staggered from the odd-numbered borings to obtain analytical data from the entire soil horizon and not just specific layers. For each sampled interval, the soil was placed in a disposable, lock-tight, plastic bag; mixed; placed into sample jars; and preserved with ice. The samples were then submitted for analyses of the primary metals. A subset of the samples was submitted for analyses of the extended list of analytes. As described in the QAPP (Attachment 2), some of the locations were re-sampled for the extended list of analytes due to missed holding times.

2.4.6 *SPLP Soil Samples*

In accordance with the Work Plan, 10 samples collected from the OTP, Rex Flats and CTP areas were analyzed by SPLP to evaluate the potential for leaching of the primary metals. These samples were collected from the subsurface and surface soil. Additional SPLP samples (20) were collected from the surface soil of the OTP and Rex Flats to further evaluate the potential for leaching. The following map (Figure 17) shows the locations and depths of the SPLP samples.

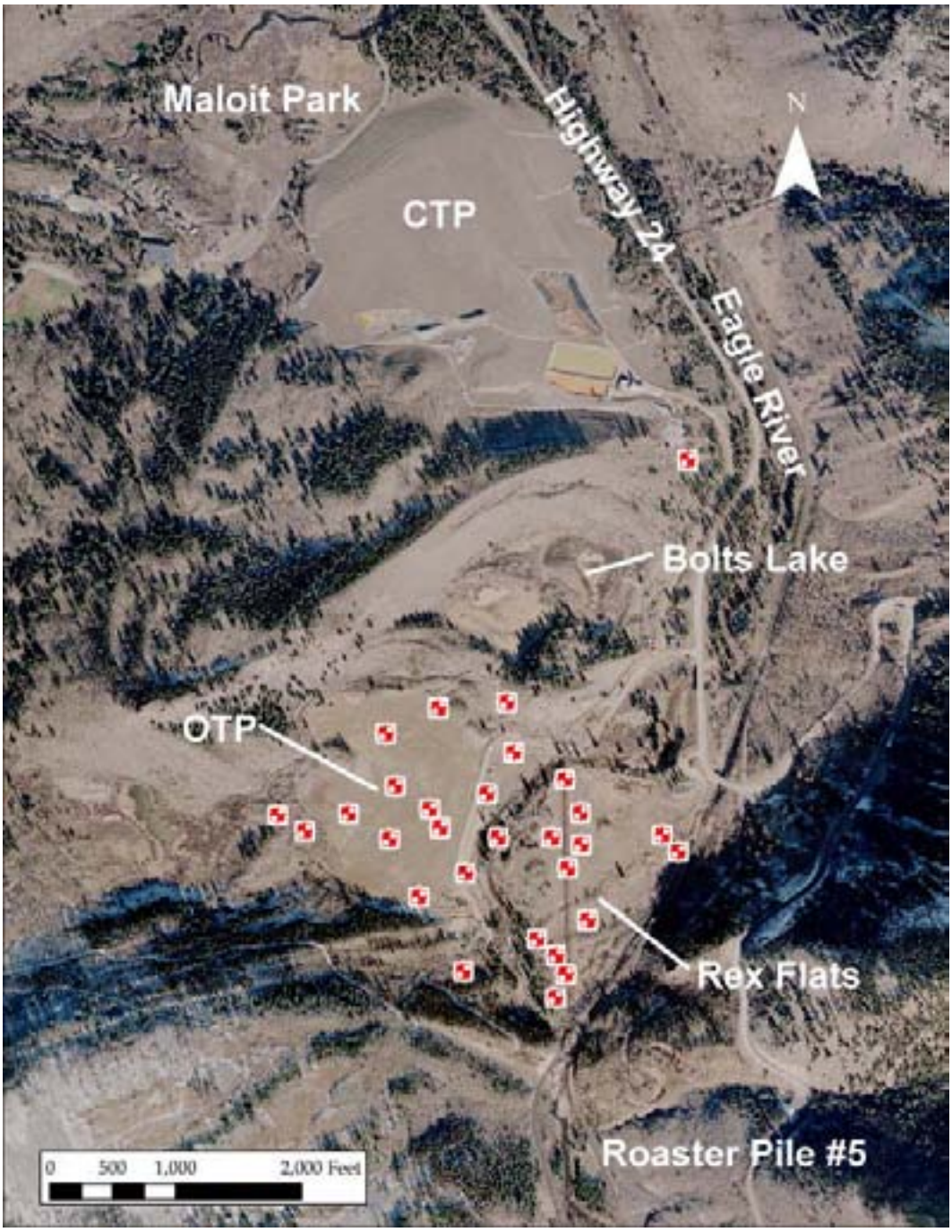


Figure 17 - SPLP Soil Sample Locations

2.5 *GROUND WATER INVESTIGATION*

This section summarizes the ground water investigative field activities during this investigation from the OTP and adjacent Sump #3, Rex Flats, Bolts Lake, and in the general vicinity of the CTP. These features are illustrated in Figure 1. At least 50 ground water monitoring wells were

historically installed and sampled since 1989 in the OTP, Rex Flats, and the CTP areas. Currently, and since at least 2000, Viacom's ground water monitoring network is made up of at least 28 ground water monitoring points in these areas (Newfields, 2005). These wells continue to be part of Viacom's ongoing ground water monitoring program and approval to sample some of these wells for this investigation was obtained from Viacom.

The 2005/2006 field activities included installing ground water wells; sampling the new ground water wells and several existing Viacom ground water wells; surveying; collecting depth to ground water measurements;, sampling existing surface water diversion trenches; sampling existing seeps; slug testing; pump testing; investigation-derived waste ("IDW") management; and installing pressure transducers for continuous ground water level measurements in select wells. Additional field work included the collection of Eagle River elevations in May, June and July of 2006.

The ground water well installation and sampling during this investigation were conducted from July of 2005 through July of 2006. The following sections summarize the field investigation activities and the results for the:

- Ground water well installation, development and surveying,
- Depth to ground water measurements,
- Ground water, seep and surface water diversion trench samples, and
- Hydraulic (aquifer) testing.

2.5.1 Well Installation

Seventeen new ground water monitoring wells were installed in the North Property. Sixteen new ground water monitoring wells were installed between July and September, 2005 in the OTP, Rex Flats, Bolts Lake, and Sump #3 areas, and near the CTP. One monitoring well, CTP-MW-3, located on the ridge between the CTP and Bolts Lake, was installed in May 2006 due to drilling difficulties in 2005. The new wells were installed using an air rotary rig provided by Spectrum Drilling Services located in Sedalia, Colorado. Prior to drilling, the locations of utilities were cleared with the Utility Notification Center of Colorado. The locations of the ground water monitoring wells are shown in Figure 18.

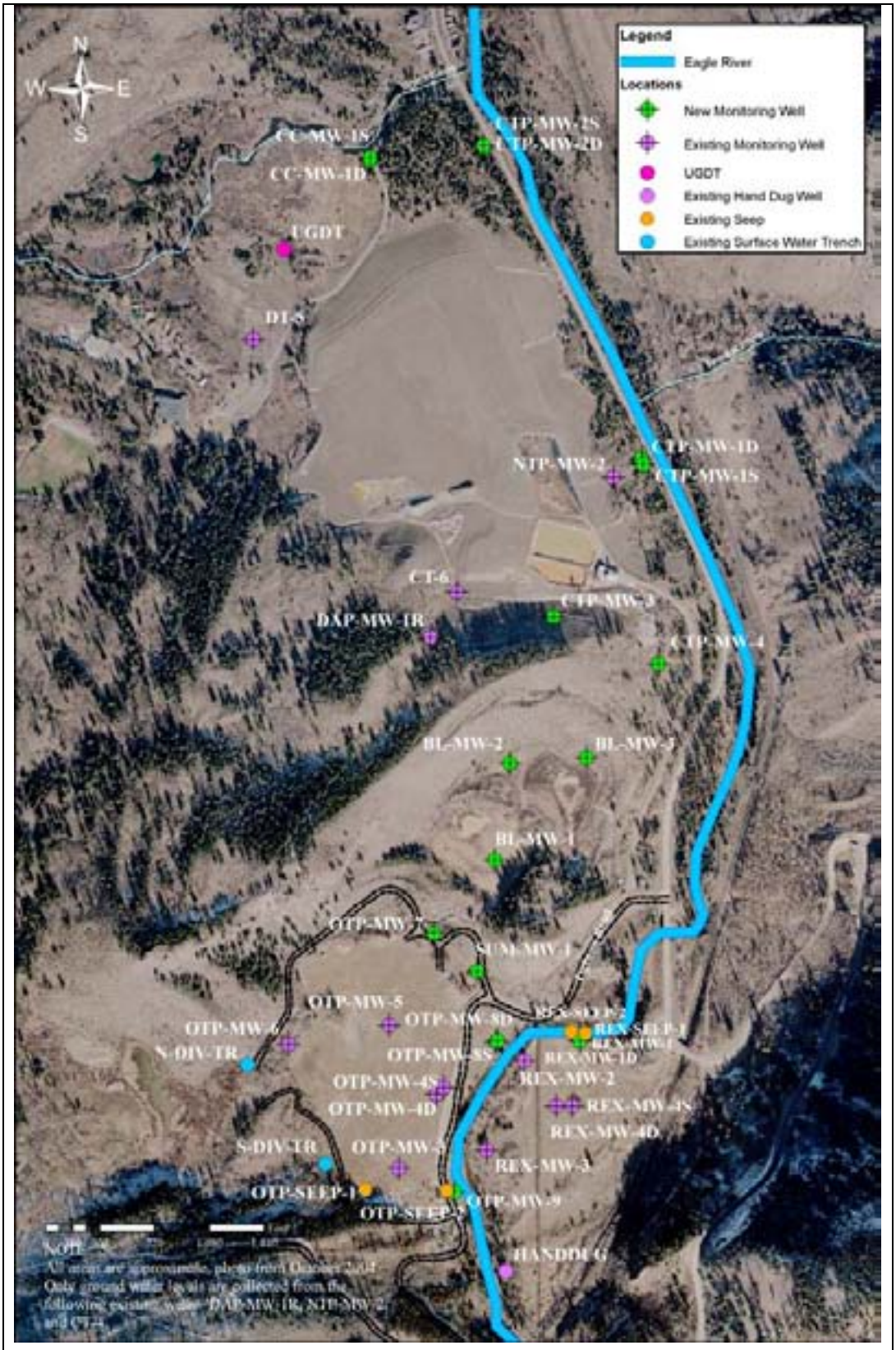


Figure 18 – Ground Water, Seep, and Diversion Trench Sample Location Map

Note: ***All areas are approximate; photo from October 2004.***

During drilling, an on site ERM field geologist described the geology and recorded drilling observations on borehole logs. The borehole logs are included as Appendix C. All of the new wells were installed in either the Holocene/Pleistocene alluvium or the Pinedale age glacial drift (Figure 19). The observed lithologies are briefly described below:

- Bolts Lake area (BL-MW-1 through BL-MW-3) – dominantly sand (very fine to medium) with minor clayey silt, silt, gravel, and coarse sand.

- Cross Creek area (CC-MW-1S and -1D) – dominantly sand (fine to coarse) with varying amounts of gravel, cobbles, and boulders.

- CTP area (CTP-MW-1S and -1D, CTP-MW-2S and -2D, CTP-MW-3, CTP-MW-4) – dominantly sand (fine to coarse) with varying amounts of gravel, cobbles, and boulders. Minor silty clay and silt.

- OTP area (OTP-MW-8S and -8D, OTP-MW-9) – dominantly sand (coarse to fine) with varying amounts of gravel and cobbles and minor silt near the surface.

- Rex Flats area (REX-MW-1D) – dominantly sand (very coarse to fine) with varying amounts of gravel, cobbles, and boulders.

- Sump #3 area (OTP-MW-7, SUM-MW-1) – dominantly sand (medium to coarse) with varying amounts of gravel and mostly silt between the ground surface to about 4 to 9 feet below existing grade.

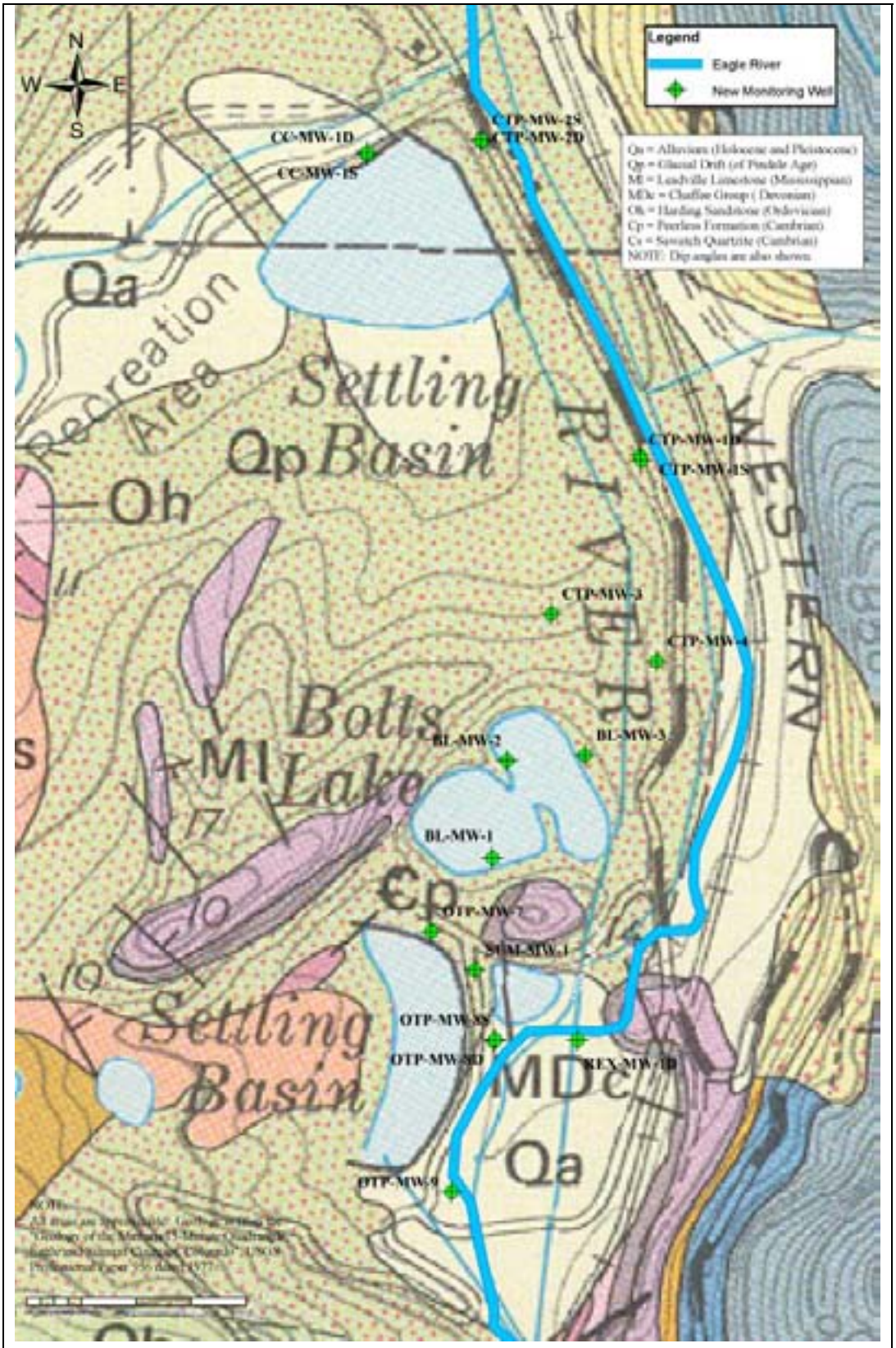


Figure 19 – North Property Geology Map and Monitoring Well Locations

Notes: ***All areas are approximate; geology is from the "Minturn 15-Minute Quadrangle, Eagle and Summit Counties, Colorado," USGS Professional Paper 956, dated 1977 (USGS, 1977).***

Most of the new monitoring wells installed at the OTP, CTP, and Rex Flats areas were adjacent to either the Eagle River or Cross Creek. Therefore, most of the lithologies described above are fluvial deposits associated with these rivers. Lithologies in these areas will differ depending on the proximity to these rivers.

All of the new monitoring wells were constructed with 2-inch diameter PVC with 5 to 10-feet of 0.010 slot PVC screen and PVC riser pipe to the surface. A filter pack consisting of 10-20 silica sand was placed at least one-foot above the top of the screen. As the filter pack was placed, continuous depths were measured to minimize bridging of the filter pack. In some wells, the 10-20 silica sand was also used to backfill the borehole prior to completing the monitoring well. At least 1-foot of bentonite pellets or chips was placed above the filter pack. A 5-percent (by weight) bentonite-cement grout was mixed at the surface and tremmied in the annular space to the surface. Most of the wells were completed as stick-up wells with a concrete pad, steel protective casing, and locking cover with a seal. However, two wells were completed as flush mounted wells (CC-MW-1S and CC-MW-1D) to avoid damage by snow plows. All of the equipment associated with the monitoring well installation was decontaminated between each well. All soil cuttings and decontamination water associated with the well installation were containerized in labeled 55-gallon drums and transported to a state-approved landfill and water treatment facility. The waste manifests are included as Appendix D. A table summarizing the well construction is included as Appendix E.

2.5.2 *Well Development*

The wells were developed using a bailer, surge block, and pump at least 24 hours after the well was constructed. Approximately ten borehole volumes of water were removed from each new monitoring well, in between bailing and surging, and parameters were collected prior to sampling each well. The wells were surged with a 2-inch surge block and were bailed when significant sediment was detected on the bottom of the well. Only BL-MW-3 was bailed dry several times during development. CTP-MW-3 and CTP-MW-4 were developed with a Grundfos® pump. A table summarizing the well development is included in Appendix F. All of the equipment associated with the well development was decontaminated between each well. All of the purge and decontamination water associated with the well development was containerized in labeled 55-gallon drums and transported to a state-approved water treatment facility. The waste manifests are included as Appendix D.

2.5.3 *Survey*

The new monitoring wells were surveyed by a registered land surveyor (Peak Land Consultants located in Vail, Colorado). The new monitoring wells were surveyed in Colorado State Plane coordinates. Additionally, elevations were surveyed in relation to North American Vertical Datum 1988. Elevations of the existing Viacom wells sampled during this investigation were also tied into the survey. The survey information for the new monitoring wells is included in Appendix G. Additionally, three steel-reinforcement bars (rebar) were placed in the Eagle River and surveyed to allow for measurement of the elevation of the Eagle River. The Eagle River elevations were collected by ERM using a level transit. Seeps, surface water diversion trench, and the hand dug well sample locations were surveyed using a handheld global positioning system ("GPS").

2.5.4 *Water Level Measurements*

Water level measurements were collected manually in 16 new wells and 15 existing wells during each sampling event. Water level measurements were also collected from three additional existing wells (CT-6, DAP-MW-1R, and NTP-MW-2) to evaluate ground water flow directions in the area near the southern portion of the CTP. The water level measurements were collected on the same day to provide a snapshot of the water table surface during each sampling event. Eagle River water levels were also collected in May, June and July of 2006. The water level measurements for all wells measured by ERM are summarized in Appendix H.

Submersible water level data loggers were installed in six new monitoring wells (OTP-MW-8S, OTP-MW-8D, BL-MW-2, CTP-MW-1D, CTP-MW-2S, and CTP-MW-2D) in October, 2005. These data loggers collected water levels two times per day until July of 2006. The water level graphs from the data loggers are included in Appendix H.

2.5.5 *Water Sampling*

Ground water, seep, and surface water diversion trench samples were collected between August of 2005 and July of 2006. The sampling locations are shown in Figure 18. The ground water, seep, and diversion trench samples collected during this investigation were analyzed for dissolved arsenic, cadmium, chromium, copper, lead, manganese, and zinc ("primary indicator metals") Six wells were sampled twice, during September of 2005 and April of 2006, for laboratory analysis of the "expanded analyte list" which includes aluminum, antimony, barium, beryllium, calcium, cobalt, iron, magnesium, nickel, potassium, selenium, silver, sodium, thallium, vanadium, sulfate, and cyanide. Additionally,

VOCs and SVOCs were analyzed. These six wells were also sampled for mercury in May of 2006 and July of 2006. The six wells were also sampled for total concentrations of the primary indicator metals from March through July of 2006. The sample collection is discussed in the following sections.

2.5.5.1 Ground Water Sampling

Ground water samples were obtained during the sampling events in 2005 and 2006 from the 15 new monitoring wells and 12 existing monitoring wells. Ground water samples were not collected from 5 of the new monitoring wells in August, 2005, because these wells were not installed until September, 2005. Ground water samples were collected from two of the new monitoring wells, CTP-MW-3 and CTP-MW-4, at least twice during this investigation. Duplicate and matrix spike ground water samples were also collected and were evaluated in the QAPP (Attachment 2).

Ground water samples were obtained using a low flow purge method and a sample was collected after successive field parameter measurements were within 10-percent. In monitoring wells where the low flow purge method could not be employed due to drawdown or insufficient water in the well, samples were collected after three well casing volumes were purged or until the well went dry. In existing wells which contain two screen intervals (OTP-MW-3, REX-MW-2, and REX-MW-3), the low flow sampling inlet was placed in the middle of the upper screen. All samples for dissolved metals analysis were field filtered through a disposable 0.45 micron filter. Disposable tubing was used at each well. Field purge forms are included as Appendix I. All purge water was placed in labeled 55-gallon drums and was transported to a state-approved disposal facility. The waste manifests are included in Appendix D.

Six wells (CTP-MW-1S, CTP-MW-2S, REX-MW-1, REX-MW-4S, OTP-MW-3, and OTP-MW-5), were sampled in September, 2005 and April 2006, for the expanded analyte list plus VOCs and SVOCs in conjunction with the sampling for the analysis of the primary indicator metals list. As described above, the six wells were also sampled for mercury in May and July of 2006. Additionally, ground water samples collected from well OTP-MW-6 in October of 2005 and April of 2006 were also analyzed for the expanded analyte list plus VOCs and SVOCs. In order to obtain the lower reporting limits, the October, 2005 ground water samples from these wells were analyzed for beryllium and thallium by a different laboratory method as described below.

All ground water samples were collected in laboratory supplied containers, labeled, and recorded on the chain-of-custody. The chain-of-

custody forms are included in Appendix J. The samples were kept in a cooler with ice and sent to Severn Trent Laboratory ("STL") located in Denver, Colorado. All ground water samples were analyzed for the primary indicator metals (dissolved) by analytical method SW 846 6020B. All the ground water samples collected for the expanded analyte list plus VOCs and SVOCs were analyzed by methods SW 846 Method 8260B (VOCs), SW 846 Method 8270C (SVOCs), SW 846 Method 6020B (dissolved expanded metals), Method SW7470 (mercury), 4500-CN-I (free cyanide), and MCAWW 300.0A (sulfate). In order to obtain a lower laboratory reporting limit, the expanded analyte ground water samples were also analyzed by SW 846 6010B for dissolved beryllium and thallium.

The laboratory analytical results are included in a database included in Appendix K. Summary tables of the laboratory results for the primary indicator metals, the expanded analyte list, and VOCs and SVOCs are also included in Appendix K. The summary result tables include a comparison to the CDPHE ground water standards including the human health and drinking water standards (CDPHE WQCD, 2005) and the segment-specific surface water standards established by the CDPHE for the Eagle River.

2.5.5.2 Ground Water Seep Samples

During this investigation, water samples were collected in August and September of 2005 and April of 2006 from three ground water seeps within the OTP and Rex Flats areas. Two seeps were observed on the north side of Rex Flats (Rex-Seep-1 and Rex-Seep-2) (Figure 18) and were sampled in August and September, 2005. One seep was observed in the OTP (OTP-Seep-1) and sampled in August of 2005 and April of 2006 (Figure 18). Another seep was observed in the OTP (OTP-Seep-2) in the spring of 2006 and was sampled in April of 2006. ERM observed ponded water and seeps in the spring of 2006. These observations are shown in Figure 20.

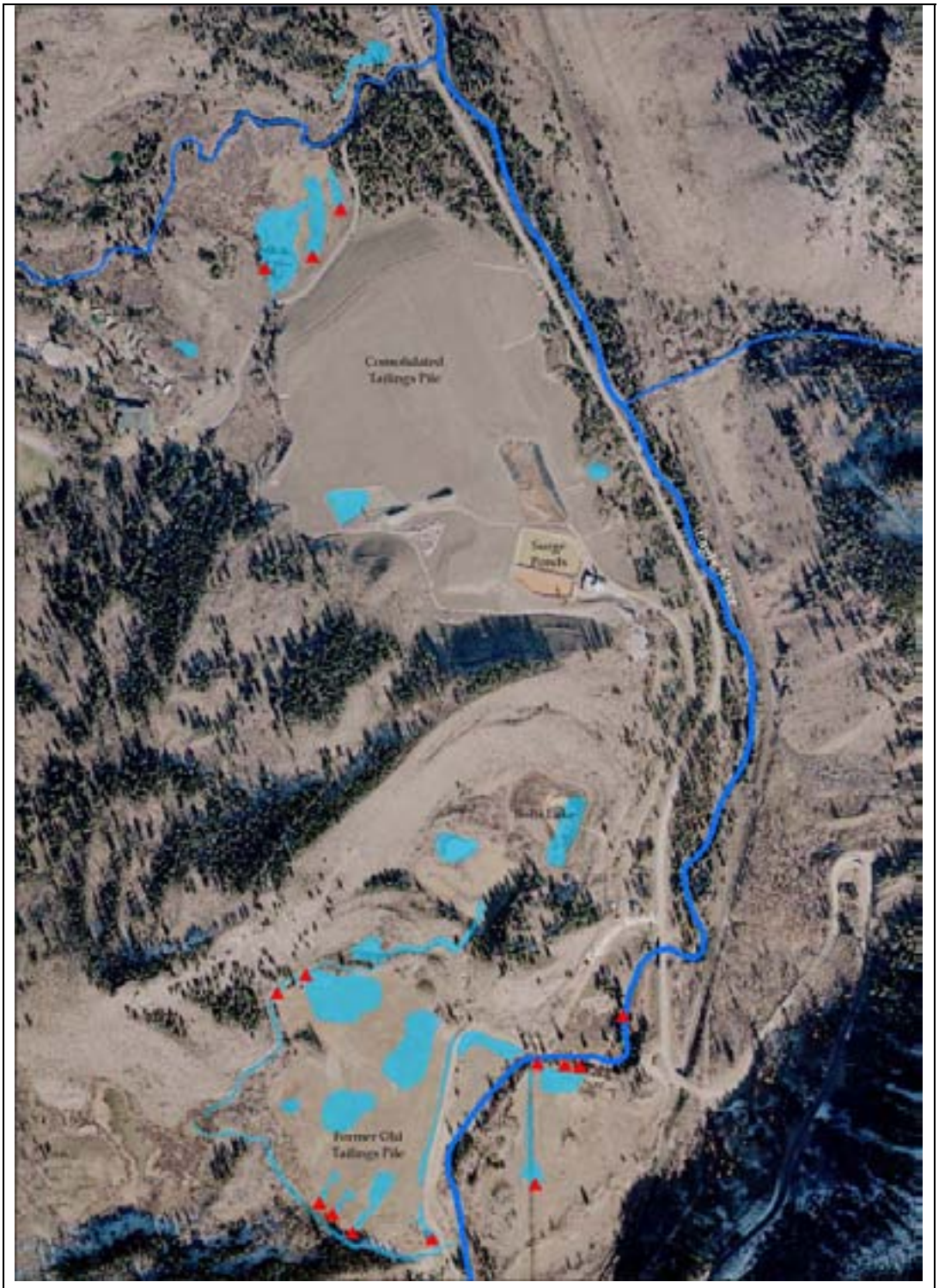


Figure 20 – General Areas of Spring Water Ponding and Seeps

The seep samples were collected with a peristaltic pump. The sampling tube was lowered into the seep and field parameters were collected prior to sample collection (Appendix I). The sampling tube was lowered in a gentle manner to avoid disturbing the substrate around the seep. Seep

samples were field filtered using a 0.45 micron disposable filter. New disposable tubing was used at each sample location.

The samples were collected in laboratory supplied containers, labeled, and recorded on the chain-of-custody. The chain-of-custody forms are included in Appendix J. The samples were kept in a cooler with ice and sent to STL and analyzed for the primary indicator metals (dissolved) by analytical method SW 846 6020B. The laboratory data are included in Appendix K and summarized in tables in Appendix K.

2.5.5.3 Surface Water Diversion Trench Samples

Surface water samples were collected from the north and south diversion trenches adjacent to the OTP in August and September of 2005 and April of 2006. The samples were collected with a peristaltic pump. The sampling tube was lowered into the trench and field parameters were collected prior to sample collection (Appendix I). The sampling tube was lowered in a gentle manner to avoid disturbing the substrate of the trench. The samples were field filtered using a 0.45 micron disposable filter. Disposable tubing was used at each sample location.

The samples were collected in laboratory supplied containers, labeled, and recorded on the chain-of-custody. The chain-of-custody forms are included in Appendix J. The samples were kept in a cooler with ice, sent to STL and analyzed for the primary indicator metals (dissolved) by analytical method SW 846 6020B. The laboratory data are included in Appendix K and summarized in Appendix K.

2.6 BASELINE AIR QUALITY

Redevelopment of the North Property currently contemplates a proposed real-estate development project. By necessity, the construction activities will involve grading, earthwork, materials handling activities, and construction activities that in general are a potential source of air pollution. In addition to tailpipe emissions and vehicle exhaust, the primary air pollutant associated with this type of construction activity is dust and particulate matter. Due to historic mining activities in the area, the primary concern for this project is the dust that may be generated from earth moving activities during construction and the possibility that arsenic, cadmium, and lead may be contained in that dust. Therefore, Ginn Battle North initiated and conducted an air quality monitoring program, in accordance with the Work Plan, to establish baseline (existing) air quality levels at the North Property before any construction activities have begun. The air quality data collected includes PM_{10} (particles less than ten microns in diameter), total suspended particulate

matter ("TSP"), arsenic, cadmium, and lead, and the meteorological parameters of wind speed, wind direction, temperature, and atmospheric stability.

2.6.1 *Sampling Activities*

The baseline air quality data was collected between July 21, 2005 and November 18, 2005. The meteorological data collection began on August 19, 2005. Meteorological data was collected through November 21, 2005.

Air quality sampling was conducted on a one in every six-day schedule. This sampling schedule resulted in data being collected in accordance with the one in every six-day federal and Colorado sampling schedule. The air quality samples were 24-hour samples and were collected from midnight to midnight of the sampling day. Meteorological data was collected on a continuous basis.

Dust levels and particulate matter were sampled by air monitoring equipment at three locations at the North Property (see Figure 21). The air monitoring equipment collected dust on filters used to determine particulate levels in the air. The filters were also analyzed to determine the presence and levels of arsenic, cadmium, and lead in the dust. In addition to the air quality data, wind speed, wind direction, temperature, and atmospheric stability data were also recorded at the North Property. The meteorological data collected during the reporting period is also presented in this report.

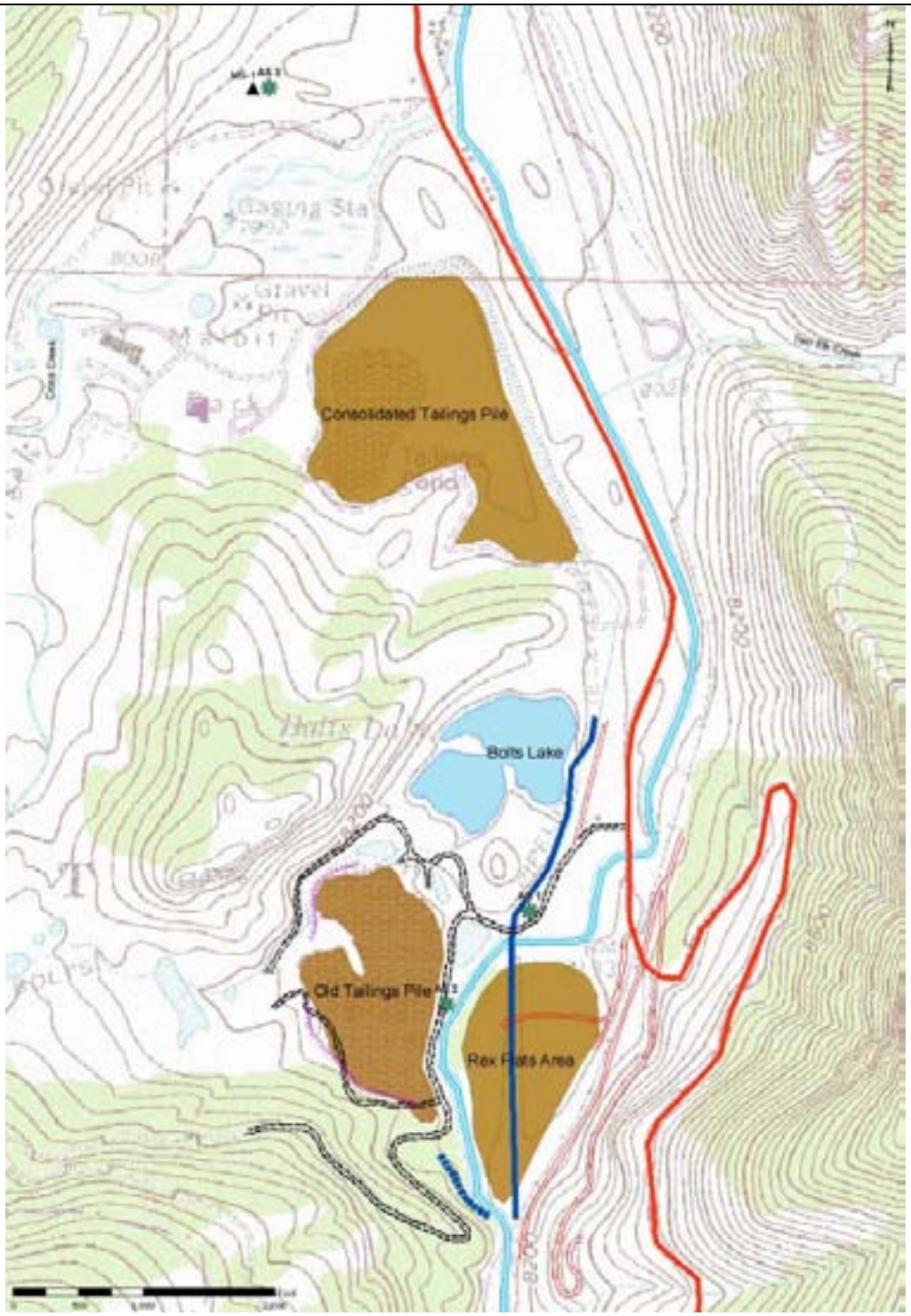


Figure 21 – Air Sample Locations

PM_{10} and TSP were collected at all three monitoring locations. The applicable particulate standards are the state and federal PM_{10} standards. TSP data were collected because the current lead standard is based on

TSP. Although there are neither federal nor Colorado standards for arsenic or cadmium, these metals were also analyzed on the TSP samples.

2.6.2 *Sample Locations*

A total of three sampling locations were used to evaluate pollutant levels at the North Property, Stations AS-1, AS-2, and AS-3 (see Figure 121). These stations were chosen because they are representative of the North Property and were approved by the Air Pollution Control Division ("APCD"), a division of CDPHE. Meteorological parameters were recorded at Station MS-1, next to air quality monitoring Station AS-3. The meteorological data was collected to aid in the assessment of the air quality data, especially as it may relate to the potential contribution of the project to pollutant levels.

Station AS-1

Station AS-1 is located approximately 20 feet to the north of Tigiwon Road near the Mine Water Transport Pipeline at an elevation of approximately 8,120 feet above mean sea level ("amsl"). The Universal Transverse Mercator ("UTM") coordinates, in meters, for the station are 379,378m E and 4,379,134m N. Electric power to operate the samplers was provided by a propane-fired generator located at the station.

This station is situated in an area covered with grasses, small conifers, and aspen trees. No man made sources of pollution were observed in the vicinity, with the exception of Tigiwon Road, a dirt road, and Colorado Highway 24 which is located approximately 1,200 feet to the east. Tigiwon Road is a primary access point to the National Forest and the Holy Cross Wilderness for outdoor enthusiasts and during the summer months can be quite busy. During dry periods dust plumes have be seen rising from cars as they travel on the road.

Station AS-2

Station AS-2 is located approximately 150 feet to the west of Tigiwon Road on the OTP and 2,000 feet west of Highway 24 past Station AS-1. The station is located at an elevation of approximately 8,100 feet amsl. The UTM coordinates for the station are 379,154m E and 4,379,065m N. This station was also powered by a propane-fired generator until utility line power was installed in late October.

This station is situated in an area covered with grasses. No man made sources of pollution were observed in the vicinity, again with the exception of Tigiwon Road.

Station AS-3

Station AS-3 is located approximately 1,500 feet east of Highway 24 and about 100 feet north of the dirt road leading to the town of Minturn's water treatment plant. The UTM coordinates for the station are 378,993m E and 4,380,963m N and the station is located at an elevation of approximately 8,040 feet amsl. Utility line power was available at station AS-3, allowing sampling to begin on July 27, 2005.

This station is situated in an area more wooded than either Station AS-1 or AS-2. A commercial facility specializing in auto detailing and carpet cleaning is located on the northwest corner of Highway 24 and the access road to the Minturn water treatment plant. In addition, during the sampling period, final construction and landscaping activities were being conducted at a small housing development on the east side of Highway 24 at the intersection with the access road to the Minturn water treatment plant. No other man made sources of pollution are located in the vicinity of the station.

2.7 GEOPHYSICAL SURVEY

The Remedial Investigation activities included performance of a geophysical survey at the Rex Flats area to evaluate if buried metallic objects were present. Rex Flats was selected to test the applicability of geophysics due to its proximity to the Union Pacific rail line and Highway 24, which historically could have been used to transport large waste objects from the Eagle Mine. Detection of large magnetic anomalies could be an indicator of buried tanks, drums or transformers, which would present new environmental concerns at the North Property.

2.7.1 Geophysical Surveys

Test geophysical surveys were performed at the Rex Flats area on June 22, 2005. The purpose of the test surveys was to select the most appropriate method to identify geophysical anomalies in the subsurface. Tests were performed using seismic refraction instrumentation, EM-61 high resolution metal detectors, and an EM-31 terrain conductivity meter. The test surveys encountered interferences with the metallic properties of the naturally occurring rocks in the area, and ERM concluded that the EM-61 metal detector was the recommended instrument for the geophysical surveys. A copy of the Geophysical test survey report is included as Appendix L.

A geophysical survey using the EM-61 high resolution metal detector was performed at the Rex Flats area on July 12, 2005. The EM-61 survey of the Rex Flats area identified approximately five areas of significant magnetic

anomaly. These areas were considered significant because of their increased areal extent, which was generally greater than 10 feet in size. A copy of the Geophysical Survey Report at Rex Flats is included as Appendix L. The five areas of concern at Rex Flats are shown on Figure 22.

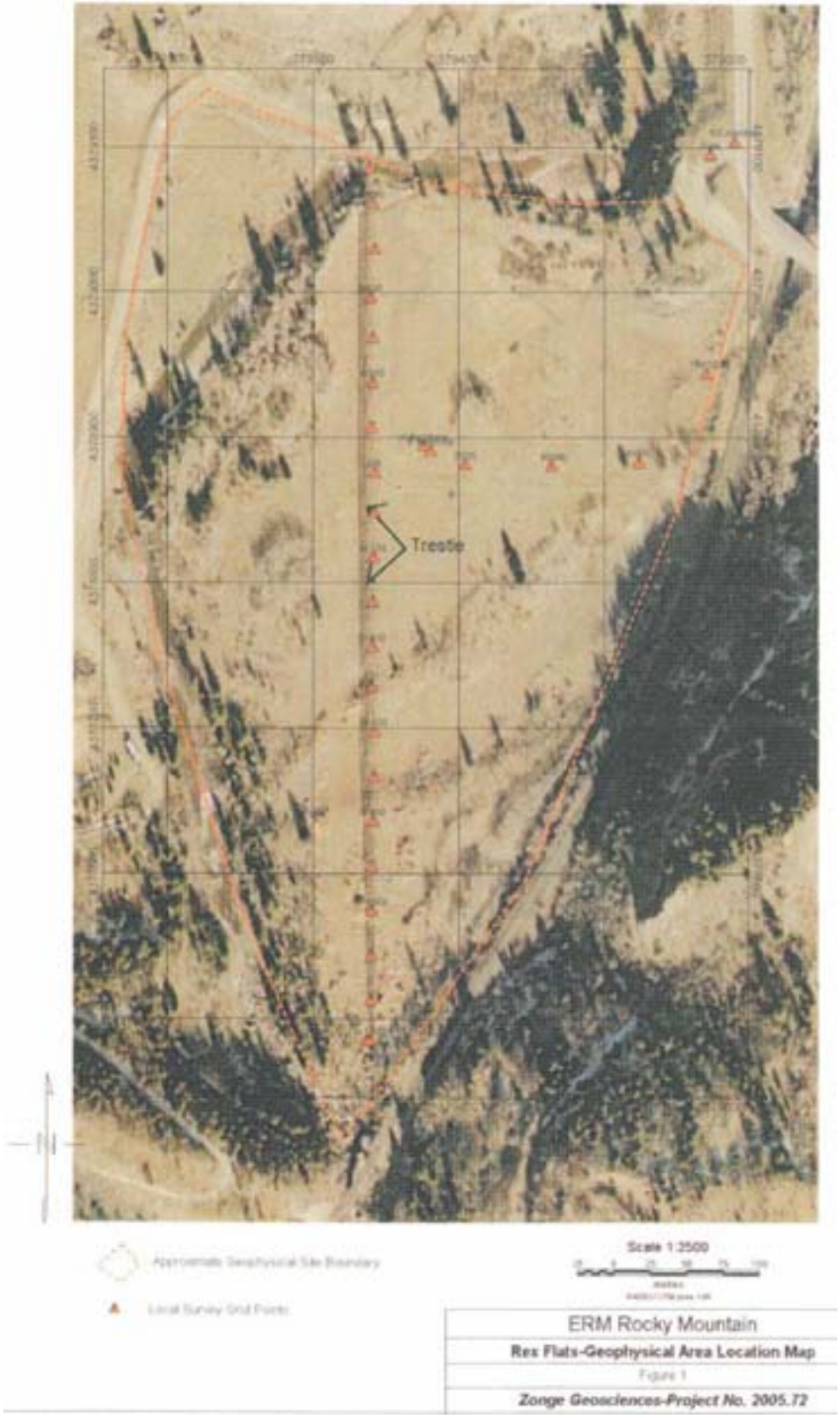


Figure 22 Rex Flats – Geophysical Area Location Map

2.7.2 *Test Pit Excavation Procedures*

Seven test pits were excavated at the five primary areas where the EM-61 survey indicated magnetic anomalies (Figure 23). Additionally, another test pit was excavated in an area with a minor magnetic detection, for a total of eight test pits. The test pits were completed on September 29, 2005 at each location to identify the source of the magnetic detection. The test pits were excavated with a backhoe, and excavated soil was placed on plastic sheeting (Figures 24 and 25) to reduce the impact to the surrounding vegetation.

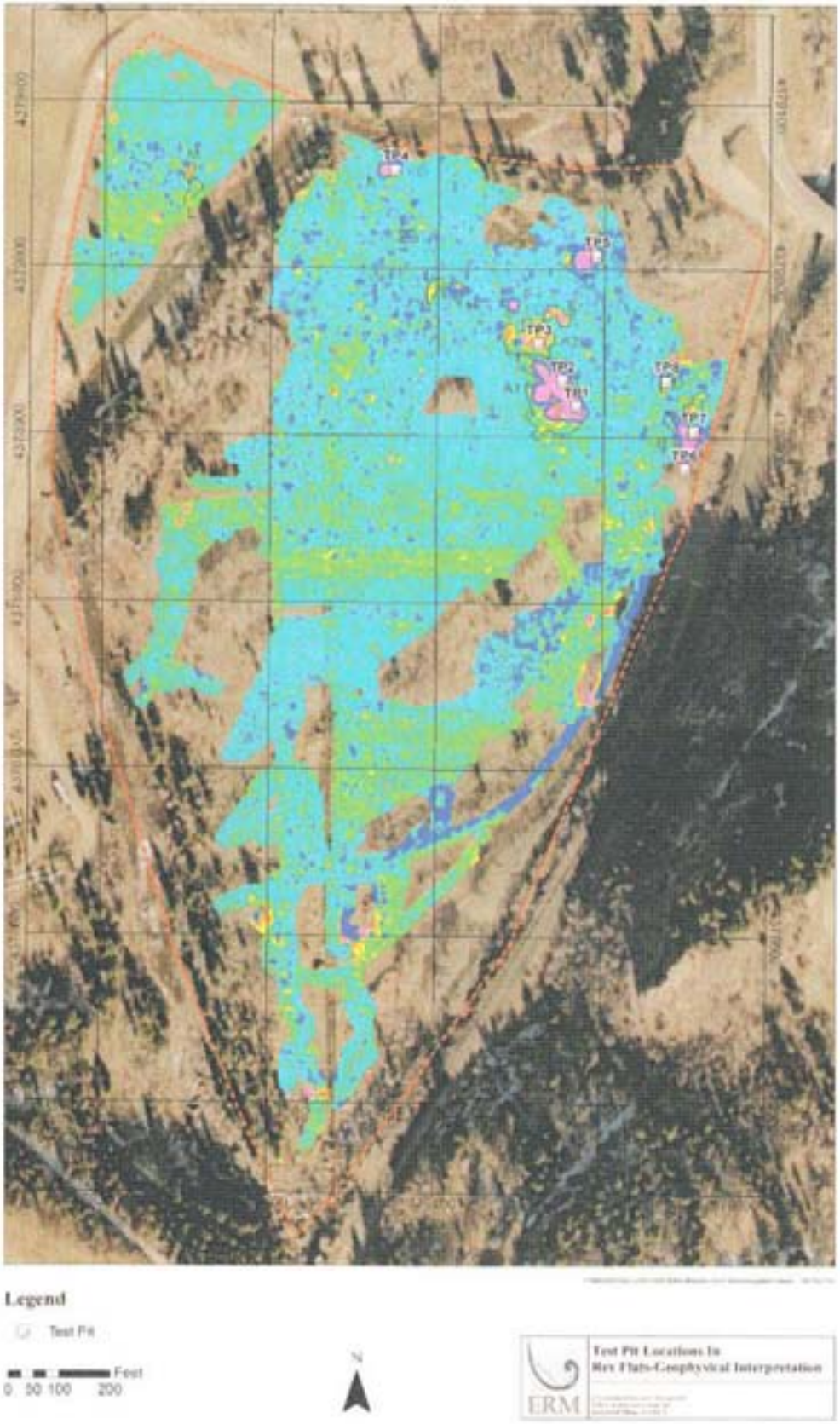


Figure 23 Test Pit Locations in Rex Flats – Geophysical Interpretation

Figure 24 Plastic sheeting used for excavated soil

Materials excavated were screened visually for the presence of metallic objects, and a PID was present to measure organic vapors where discoloration was observed. Soil sampling jars were also available to obtain samples of impacted soil for laboratory analysis, as warranted. The test pits were excavated until either natural soil or metallic objects were encountered, whichever occurred first. The test pits were logged by a Professional Geologist. The locations of the test pits are presented on Figure 23, and the logs are recorded in Appendix M.

Figure 25 Scrap wire and cable from Test Pit 2

Upon completion of each test pit, the excavated materials were removed from the plastic sheeting and placed back into the excavation. To the extent possible, clumps of vegetation that could be salvaged were replanted. The test pit area was raked to a smooth surface and organic soil and mulch were placed on top of the disturbed areas. The area was reseeded with the seed mix specified by EPA and CDPHE to revegetate Rex Flats pursuant to the approved Eagle Mine Site remedy, and cover soil was raked on top.

3.0 INVESTIGATION RESULTS

The results of the field investigation are presented in the following sections, which discuss the surface water, Eagle River sediment, soil, ground water, air, and geophysical testing.

3.1 SURFACE WATER

Surface water samples were collected from the eight Remedial Investigation sample stations from June through October 2005 and March through May 2006. Additionally, flow measurements were collected from July through October 2005.

Zinc was chosen for the overall evaluation to illustrate metals levels in the Eagle River because it was consistently detected in the river water samples and also because it is an analyte of primary concern to EPA and CDPHE.

It is noted that historically cadmium concentrations exceeded acutely toxic levels for trout (CDPHE, 2005). Specifically, in 1990, monitoring of surface water in the Eagle River from Belden to below Minturn detected dissolved cadmium concentrations that exceeded the acutely toxic level for acclimated young brown trout. Additionally in 1993 the acute cadmium concentration was exceeded at Belden. The CDPHE report noted that because of remediation at the Site performed in 1994, the cadmium acutely toxic levels were not exceeded from 1994 through 2004.

3.1.1 Surface Water Concentrations

Table 4 summarizes the analytical data, and Figure 26 illustrates the zinc concentrations.

Table 4 Summary of Surface Water Analytical Results

Sample Location	Sample Date	As (Diss)	As (Total)	Cd (Diss)	Cd (Total)	Cr (Diss)	Cr (Total)	Cu (Diss)	Cu (Total)	Pb (Diss)	Pb (Total)	Mn (Diss)	Mn (Total)	Zn (Diss)	Zn (Total)	Hard
E11A	6/28/2005	< 5	--	< 1	--	< 2	--	< 2	--	2.1	--	25	--	49	--	--
E11A	7/29/2005	< 5	--	< 1	--	< 2	--	2.3	--	< 1	--	39	--	64	--	--
E11A	8/25/2005	< 5	--	< 1	--	< 2	--	2.4	--	< 1	--	54	--	110	--	--
E11A	9/22/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	48	--	73	--	--
E11A	10/25/2005	< 5	--	< 1	--	< 2	--	2.3	--	< 1	--	55	--	86	--	--
E11A	3/9/2006	--	--	2.7	--	--	--	13	--	--	--	--	--	900	--	85
E11A	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	460	--	80
E11A	3/22/2006	< 5	< 5	1.5	1.7	< 2	< 2	6.6	11	< 1	2.0	210	220	440	500	82
E11A	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	560	--	79
E11A	4/5/2006	--	--	2.0	--	--	--	10.0	--	--	--	--	--	540	--	86
E11A	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	350	--	79
E11A	4/19/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	14.0	18	< 1	1.8	120	130	230	260	67
E11A	4/26/2006	--	--	--	--	--	--	--	--	--	--	--	--	180	--	67
E11A	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	3.0	4.9	< 1	8.4	42	130	24	54	40
E11B	6/28/2005	< 5	--	< 1	--	< 2	--	2.2	--	2.8	--	25	--	41	--	--
E11B	7/29/2005	< 5	--	< 1	--	< 2	--	2.1	--	< 1	--	40	--	58	--	--
E11B	8/25/2005	< 5	--	< 1	--	< 2	--	2.2	--	< 1	--	51	--	99	--	--
E11B	9/22/2005	< 5	--	< 1	--	< 2	--	2.0 J*	--	< 1	--	45	--	66	--	--
E11B	10/25/2005	< 5	--	< 1	--	4.4/ND	--	2.2	--	< 1	--	53	--	77	--	--
E11B	3/9/2006	--	--	2.5	--	--	--	11	--	--	--	--	--	750	--	84
E11B	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	440	--	80
E11B	3/22/2006	< 5	< 5	1.4	1.7	< 2	< 2	5.7	11	< 1	2.2	200	220	410	490	85
E11B	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	560	--	82
E11B	4/5/2006	--	--	2.1	--	--	--	10.0	--	--	--	--	--	540	--	85
E11B	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	370	--	78
E11B	4/19/2006	< 5	< 5	1.0	1.2	< 2	< 2	14.0	18	1.7	3.5	140	160	250	290	70
E11B	4/26/2006	--	--	--	--	--	--	--	--	--	--	--	--	170	--	70
E11B	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	3.7	5.9	< 1	9.9	42	150	26	59	40
E11C	6/28/2005	< 5	--	< 1	--	< 2	--	< 2	--	3.2	--	49	--	41	--	--
E11C	7/29/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	160	--	78	--	--
E11C	8/25/2005	< 5	--	< 1	--	< 2	--	2.0	--	< 1	--	180	--	110	--	--
E11C	9/22/2005	< 5	--	< 1	--	< 2	--	2.1 J*	--	< 1	--	95	--	74	--	--
E11C	10/25/2005	< 5	< 5	< 1	--	< 2	--	2.3	--	< 1	--	120	--	86	--	--
E11C	3/9/2006	--	--	2.2	--	--	--	7.4	--	--	--	--	--	690	--	86
E11C	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	460	--	80
E11C	3/22/2006	< 5	< 5	1.2	1.6	< 2	< 2	3.1	10	< 1	1.9	450	460	400	520	89
E11C	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	540	--	83
E11C	4/5/2006	--	--	1.9	--	--	--	9.0	--	--	--	--	--	510	--	86
E11C	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	380	--	81
E11C	4/19/2006	< 5	< 5	< 1	1.0	< 2	< 2	13.0	17	< 1	2.4	170	190	240	270	70
E11C	4/26/2006	--	--	--	--	--	--	--	--	--	--	--	--	170	--	67
E11C	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	3.1	5.1	< 1	8.6	43	130	24	55	46

Sample Location	Sample Date	As (Diss)	As (Total)	Cd (Diss)	Cd (Total)	Cr (Diss)	Cr (Total)	Cu (Diss)	Cu (Total)	Pb (Diss)	Pb (Total)	Mn (Diss)	Mn (Total)	Zn (Diss)	Zn (Total)	Hard
E11C FD	6/28/2005	< 5	--	< 1	--	< 2	--	< 2	--	1.7	--	48	--	39	--	--
E11C FD	7/29/2005	< 5	--	< 1	--	< 2	--	2.0	--	< 1	--	160	--	81	--	--
E11C FD	8/25/2005	< 5	--	< 1	--	< 2	--	2.0	--	< 1	--	170	--	110	--	--
E11C FD	9/22/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	87	--	71	--	--
E11C FD	10/25/2005	< 5	--	< 1	--	< 2	--	2.3	--	< 1	--	120	--	84	--	--
E11C FD	3/9/2006	--	--	2.2	--	--	--	6.4	--	--	--	--	--	710	--	90
E11C FD	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	440	--	84
E11C FD	3/22/2006	< 5	< 5	1.2	1.6	< 2	< 2	3.7	10	< 1	1.8	450	450	410	510	89
E11C FD	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	560	--	86
E11C FD	4/5/2006	--	--	2.0	--	--	--	9.9	--	--	--	--	--	560	--	90
E11C FD	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	400	--	74
E11C FD	4/19/2006	< 5	< 5	< 1	1.1	< 2	< 2	13.0	18	< 1	2.8	180	200	240	290	70
E11C FD	4/26/2006	--	--	--	--	--	--	--	--	--	--	--	--	170	--	70
E11C FD	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	2.8	4.7	< 1	7.4	44	110	26	49	40
E12A	6/28/2005	< 5	--	< 1	--	< 2	--	< 2	--	1.9	--	42	--	38	--	--
E12A	7/29/2005	< 5	--	< 1	--	< 2	--	2.0	--	< 1	--	97	--	61	--	--
E12A	8/25/2005	< 5	--	< 1	--	< 2	--	2.4	--	< 1	--	150	--	100	--	--
E12A	9/22/2005	< 5	--	< 1	--	< 2	--	2.0 J*	--	< 1	--	140	--	74	--	--
E12A	10/25/2005	< 5	--	< 1	--	< 2	--	2.3	--	< 1	--	120	--	84	--	--
E12A	3/9/2006	--	--	2.2	--	--	--	8.3	--	--	--	--	--	720	--	90
E12A	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	440	--	88
E12A	3/22/2006	< 5	< 5	1.2	1.7	< 2	< 2	3.1	11	< 1	1.9	480	520	400	520	90
E12A	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	560	--	92
E12A	4/5/2006	--	--	1.9	--	--	--	9.4	--	--	--	--	--	550	--	87
E12A	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	350	--	73
E12A	4/19/2006	< 5	< 5	< 1	1.2	< 2	< 2	15.0	19	< 1	9.6	150	210	220	300	71
E12A	4/26/2006	--	--	--	--	--	--	--	--	--	--	--	--	170	--	70
E12A	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	3.4	5.5	< 1	10	47	160	25	61	43
E13	6/28/2005	< 5	--	< 1	--	< 2	--	< 2	--	1.8	--	45	--	39	--	--
E13	7/29/2005	< 5	--	< 1	--	< 2	--	2.2	--	< 1	--	86	--	55	--	--
E13	8/25/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	120	--	78	--	--
E13	9/22/2005	< 5	--	< 1	--	< 2	--	2.0 J*	--	< 1	--	110	--	65	--	--
E13	10/25/2005	< 5	--	< 1	--	< 2	--	2.1	--	< 1	--	120	--	73	--	--
E13	3/9/2006	--	--	2.2	--	--	--	8.4	--	--	--	--	--	690	--	85
E13	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	460	--	84
E13	3/22/2006	< 5	< 5	1.2	1.6	< 2	< 2	4.4	11	< 1	2.1	350	370	400	510	89
E13	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	530	--	87
E13	4/5/2006	--	--	1.8	--	--	--	8.4	--	--	--	--	--	500	--	90
E13	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	390	--	78
E13	4/19/2006	< 5	< 5	< 1	1.1	< 2	< 2	15.0	19	< 1	5.7	150	220	220	300	70
E13	4/26/2006	--	--	--	--	--	--	--	--	--	--	--	--	180	--	66
E13	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	3.2	5.6	< 1	11	48	160	28	65	40

Sample Location	Sample Date	As (Diss)	As (Total)	Cd (Diss)	Cd (Total)	Cr (Diss)	Cr (Total)	Cu (Diss)	Cu (Total)	Pb (Diss)	Pb (Total)	Mn (Diss)	Mn (Total)	Zn (Diss)	Zn (Total)	Hard
E13B	6/28/2005	< 5	--	< 1	--	< 2	--	< 2	--	1.7	--	41	--	32	--	--
E13B	7/29/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	86	--	48	--	--
E13B	8/25/2005	< 5	--	< 1	--	< 2	--	2.2	--	< 1	--	130	--	69	--	--
E13B	9/22/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	130	--	58	--	--
E13B	10/25/2005	< 5	--	< 1	--	< 2	--	2.2	--	< 1	--	200	--	71	--	--
E13B	3/9/2006	--	--	1.9	--	--	--	6.0	--	--	--	--	--	630	--	120
E13B	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	440	--	110
E13B	3/22/2006	< 5	< 5	1.1	1.5	< 2	< 2	3.4	9.8	< 1	1.8	420	430	370	480	130
E13B	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	470	--	120
E13B	4/5/2006	--	--	1.6	--	--	--	7.8	--	--	--	--	--	490	--	110
E13B	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	370	--	94
E13B	4/19/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	13.0	15	< 1	2.1	180	210	230	260	82
E13B	4/26/2006	--	--	--	--			--	--	--	--	--	--	160	--	78
E13B	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	2.2	3.1	5.5	< 1	8.8	51	150	26	62	44
E13C	6/28/2005	< 5	--	< 1	--	< 2	--	< 2	--	1.3	--	31	--	27	--	--
E13C	7/29/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	74	--	46	--	--
E13C	8/25/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	110	--	65	--	--
E13C	9/22/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	110	--	55	--	--
E13C	10/25/2005	< 5	--	< 1	--	< 2	--	2.0	--	< 1	--	160	--	66	--	--
E13C	3/9/2006	--	--	1.9	--	--	--	6.3	--	--	--	--	--	600	--	110
E13C	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	410	--	110
E13C	3/22/2006	< 5	< 5	1.2	1.5	< 2	< 2	3.7	10	< 1	1.8	330	340	360	460	120
E13C	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	470	--	110
E13C	4/5/2006	--	--	1.7	--	--	--	7.5	--	--	--	--	--	480	--	100
E13C	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	350	--	85
E13C	4/19/2006	< 5	< 5	< 1	1.0	< 2	< 2	13.0	16	< 1	2.2	150	180	220	270	77
E13C	4/26/2006	--	--	--	--	--	--	--	--	--	--	--	--	170	--	74
E13C	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	3.9	5.2	< 1	9.1	47	140	26	60	44

Sample Location	Sample Date	As (Diss)	As (Total)	Cd (Diss)	Cd (Total)	Cr (Diss)	Cr (Total)	Cu (Diss)	Cu (Total)	Pb (Diss)	Pb (Total)	Mn (Diss)	Mn (Total)	Zn (Diss)	Zn (Total)	Hard
T18	6/28/2005	< 5	--	< 1	--	< 2	--	3.7	--	1.7	--	21	--	< 10	--	--
T18	7/29/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	31	--	< 10	--	--
T18	8/25/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	77	--	12	--	--
T18	9/22/2005	< 5	--	< 1	--	< 2	--	< 2	--	< 1	--	82	--	13	--	--
T18	10/25/2005	< 5	--	< 1	--	< 2	--	2.8	--	< 1	--	58	--	13	--	--
T18	3/9/2006	--	--	< 1	--	--	--	2.1	--	--	--	--	--	66	--	38
T18	3/15/2006	--	--	--	--	--	--	--	--	--	--	--	--	84	--	40
T18	3/22/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	< 2	< 2	< 1	< 1	400	400	82	80	41
T18	3/29/2006	--	--	--	--	--	--	--	--	--	--	--	--	110	--	45
T18	4/5/2006	--	--	< 1	--	--	--	2.8	--	--	--	--	--	100	--	53
T18	4/12/2006	--	--	--	--	--	--	--	--	--	--	--	--	35	--	29
T18	4/19/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	2.9	3.4	< 1	< 1	120	120	18	19	22
T18	4/26/2006	--	--	--	--	--	--	--	--	--	--		--	16	--	19
T18	5/23/2006	< 5	< 5	< 1	< 1.0	< 2	< 2	4.2	6.4	< 1	< 1	26	50	< 10	< 10	48

Notes:
As - Arsenic
Cd - Cadmium
Cr - Chromium
Cu - Copper
Pb - Lead
Mn - Manganese
Zn - Zinc
Hard - Hardness in Water
Diss - Dissolved
Metals concentrations reported in micrograms per liter (µg/l)
Hardness in Water concentrations reported in milligrams per liter (mg/l)
Analyses are for dissolved metals (Diss) and Total, as noted above
Data Validation Qualifiers: J* - Results are estimated high
FD = Field Duplicate
ND - Not detected when re-analyzed by laboratory
-- Not Analyzed

A review of Figure 26 shows the seasonal fluctuations in dissolved zinc concentrations in the Eagle River and its tributary, Cross Creek, from June 2005 through May 2006. These fluctuations are expected based on the seasonal change in streamflow discharge due to the snowmelt cycle. The zinc data show that concentrations are highest during the March and April sampling events, which coincide with the localized spring snowmelt, and generally decrease from March through May. Concentrations of zinc are lowest during the summer and fall months, and generally increase from summer to fall as flow in the river decreases.

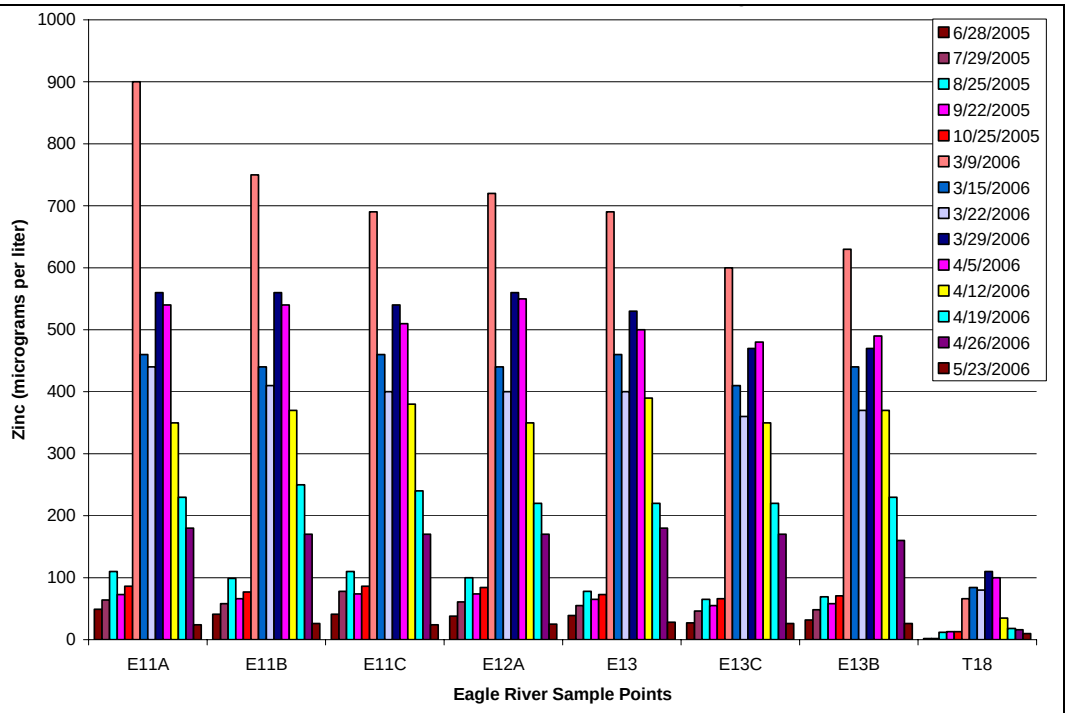


Figure 26 – Summary of Dissolved Zinc Concentrations in Surface Water

The 2005 and 2006 data mostly show that zinc is detected at a higher concentration in the surface water when it enters the investigation area (station E-11A) than when it leaves the investigation area (station E-13B), as is evident from the October 2005 data (Figure 27). The exceptions were for the April 12, April 19, and May 23, 2006 sampling events when the concentration of zinc entering the Site were either slightly lower or equal to the zinc concentrations leaving the Site.

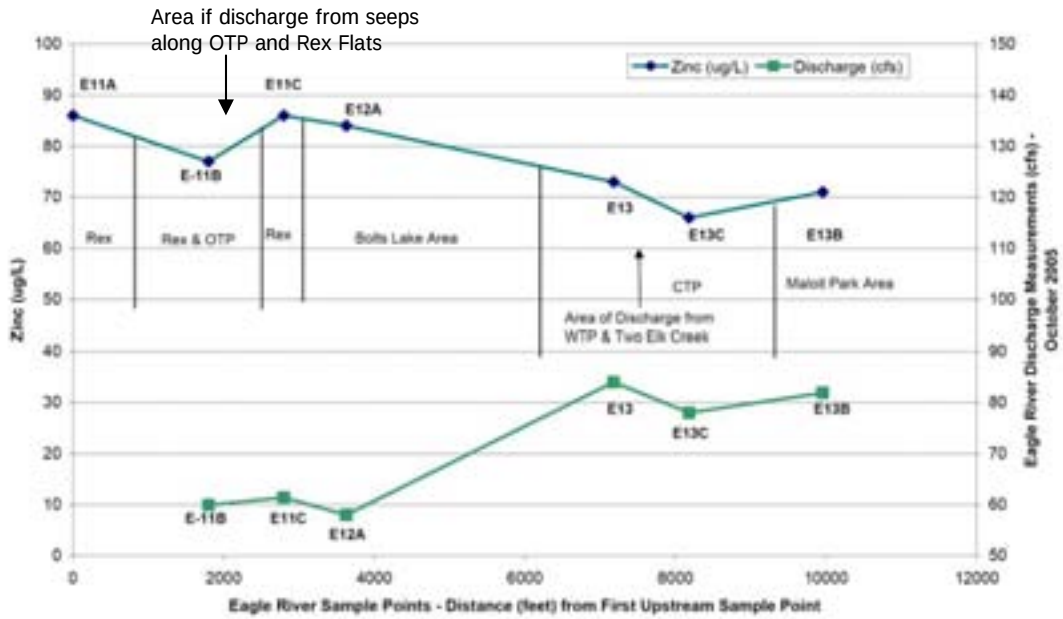


Figure 27
Summary of Zinc Concentrations in Surface Water of the Eagle River - October 2005

As seen in Figures 28 and 29 below, each segment of the Eagle River has shown an increase in zinc concentrations at least once during the 2005-2006 investigation. The most consistent increases in zinc concentrations were observed between stations: 1) E-13C and E-13B, which is adjacent to the northeastern portion of the CTP and northward; 2) E-11B and E-11C, which encompasses the northern portion of Rex Flats and northeastern portion of the OTP; and 3) E-11C and E-12A, which is north of Rex Flats.

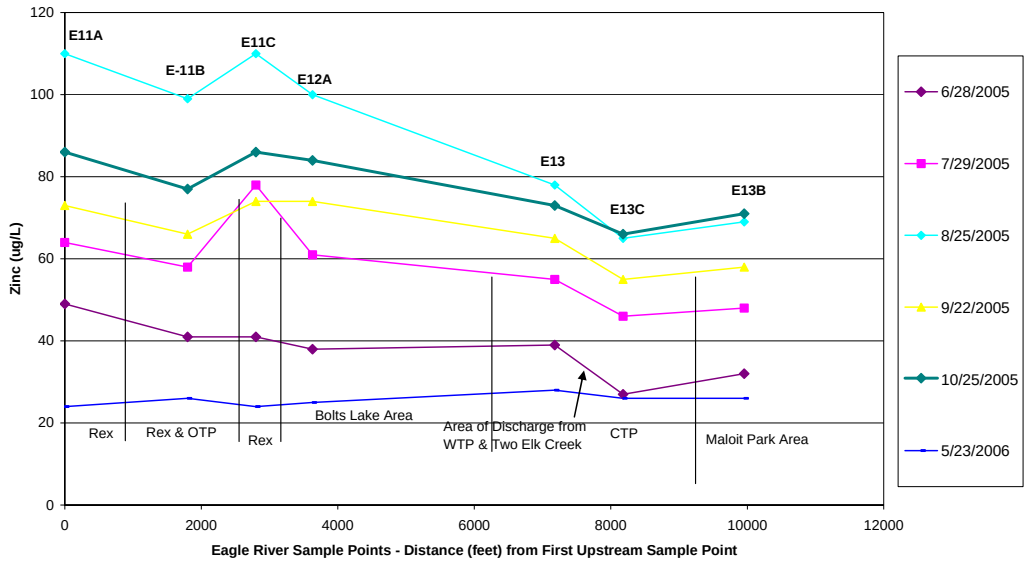


Figure 28
Summary of Dissolved Zinc Concentrations in Surface Water of the Eagle River Low Flow 2005 and 2006

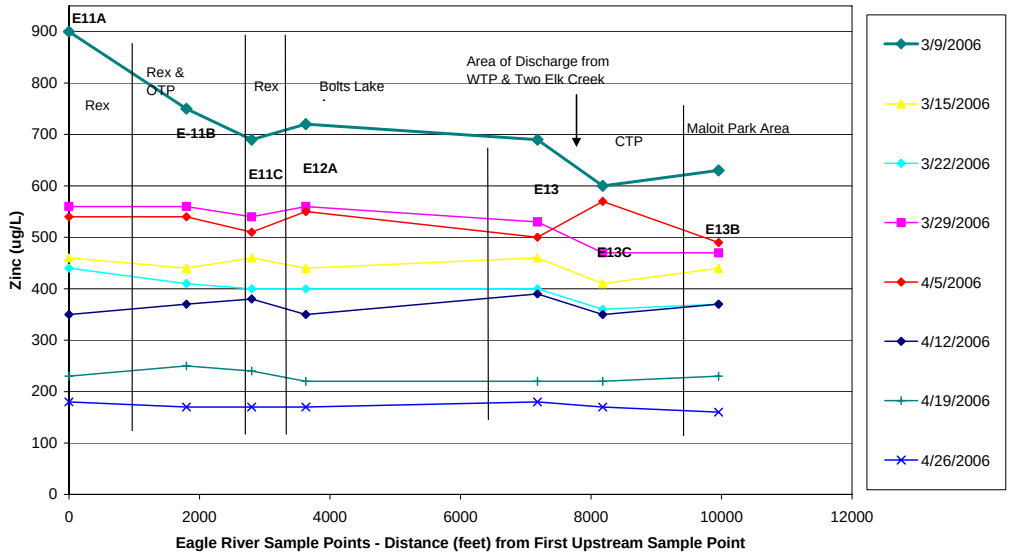


Figure 29
Summary of Dissolved Zinc Concentrations in Surface Water of the Eagle River High Flow 2006

Between stations E-13C and E-13B is the northern portion of the CTP, which includes a ground water interceptor trench between the CTP and the Eagle River. There are no observable seeps in this area. Ground water flows from the CTP to the Eagle River in this area. It is noted that the WTP discharges to the Eagle River upstream of station E-13C. The NPDES permit for the water treatment plant established effluent limits for zinc of 750 µg/L (30-day average measurement) and 1,500 µg/L (maximum daily sample) (CDPHE, 2005). The Eagle River zinc data do not indicate a negative impact due to discharge from the WTP.

Between stations E-11B and E-12A, ground water, seeps, and surface water runoff from the OTP flow into the Eagle River along the eastern edge of the OTP and the northern edge of Rex Flats. The seeps from the northern edge of Rex Flats were sampled as discussed in Section 3.4 and contained detectable concentrations of copper, lead, manganese, and zinc. Zinc concentrations varied from 82 µg/L to 12,000 µg/L. Measured pH varied from 5.01 to 6.64.

A review of the reported dissolved concentrations for the other primary indicator metals indicates that most are present within the Eagle River surface water as noted in Table 4. Specifically, dissolved manganese was reported consistently above the laboratory analytical limit throughout the year at the seven Eagle River sampling locations. Copper was typically detected above the laboratory analytical limit. Lead and cadmium were occasionally detected above laboratory analytical limits. Arsenic was not detected, and chromium was detected once.

During the 2005 sampling events, the samples were only analyzed for the dissolved metals. Beginning in 2006, some of the samples were also analyzed for the total metals, as specified in the third work plan addendum. Specifically, the samples collected during the March 22, April 26, and May 23, 2006 sampling events were analyzed for both the dissolved and total concentrations of the primary indicator metals. Using the zinc concentrations for comparison (Figures 30, 31 and 32), the following observations were made: 1) the total and dissolved concentrations generally mimic each other from upstream to downstream; and 2) similar to the dissolved concentrations, the total concentrations decreased from March through May.

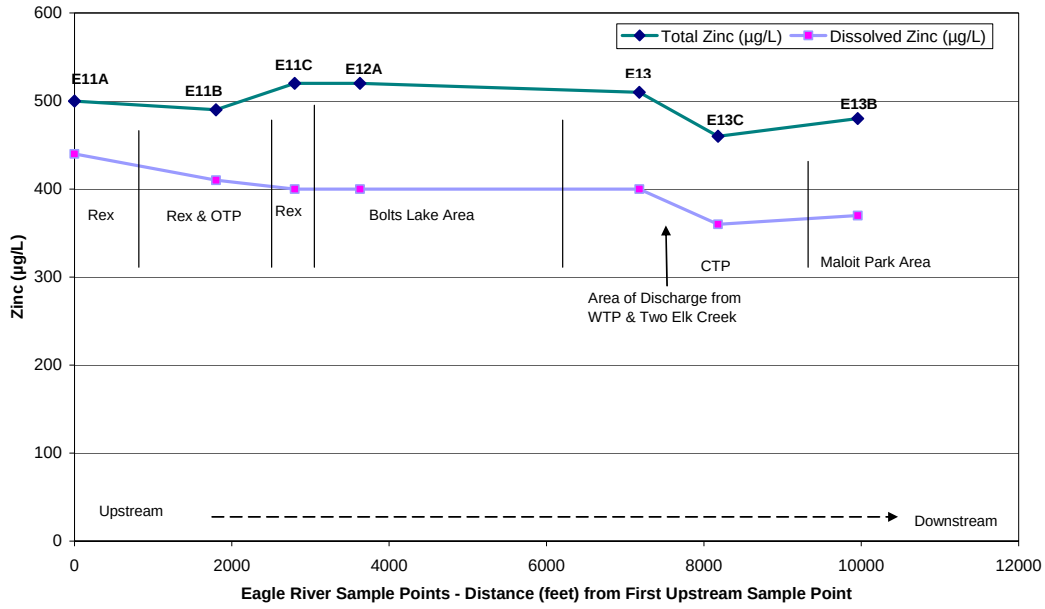


Figure 30 – Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River - March 22, 2006

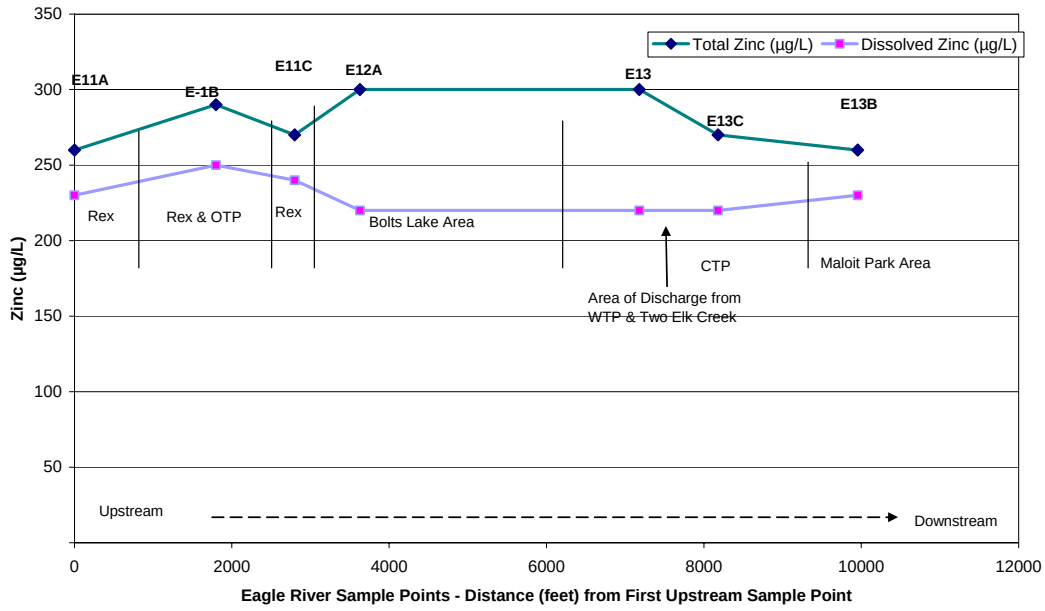


Figure 31 – Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River – April 19, 2006

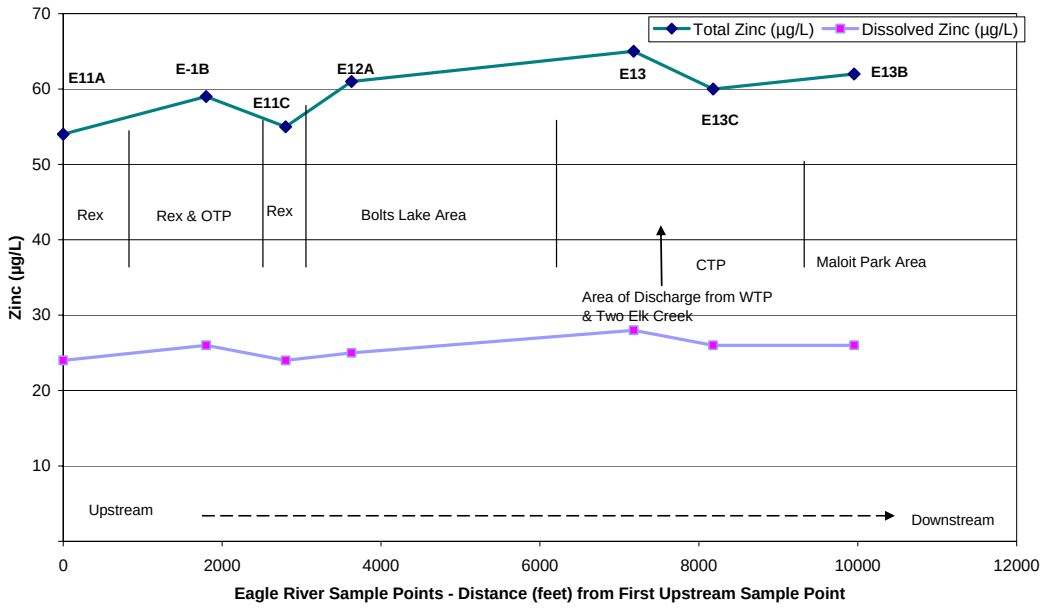


Figure 32 – Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River – May 23, 2006

Two variations are noted in the upstream to downstream total and dissolved concentrations.

- During the March 22, 2006 sampling event, dissolved zinc concentrations decreased between stations E-11B and E-11C whereas total concentrations increased within this area, possibly due to sediment entering the river.

- During the April 19, 2006 sampling event: 1) dissolved zinc concentrations decreased between stations E-11C and E-12A whereas total concentrations increased, possibly due to sediment entering the river; and 2) dissolved concentrations increased generally between stations E13/E13C and E13B whereas total concentrations decreased, possibly due to more-impacted ground water entering the river.

3.1.2 *Surface Water Flow Measurements*

The discharge measurements were collected when the river was accessible, which was during the months of July through October of 2005 (Table 5 and Figure 33). The measurements are from 6 stations along the Eagle River (E-11B, E-11C, E-12A, E-13, E-13C, E-13B) and 1 station along

Cross Creek (T-18). Station E-11A along the Eagle River was not accessible due to rapids. The October 2005 configurations of the stream channel at the sample locations are provided in Appendix N.

Table 5 Eagle River and Cross Creek Discharge Measurements

	Discharge (cfs)			
Station ID	*29-Jul-05*	*25-Aug-05*	*22-Sep-05*	*25-Oct-05*
E-11B	80.6	46.1	47.6	59.9
E-11C	78.3	42.2	41.4	61.4
E-12A	82.8	43.1	43.5	58.0
E-13	92.4	58.9	58.7	84.0
E-13C	92.9	56.5	55.9	78.0
E-13B	95.2	54.2	42.9	81.9
T-18	61.8	22.2	26.2	31.8

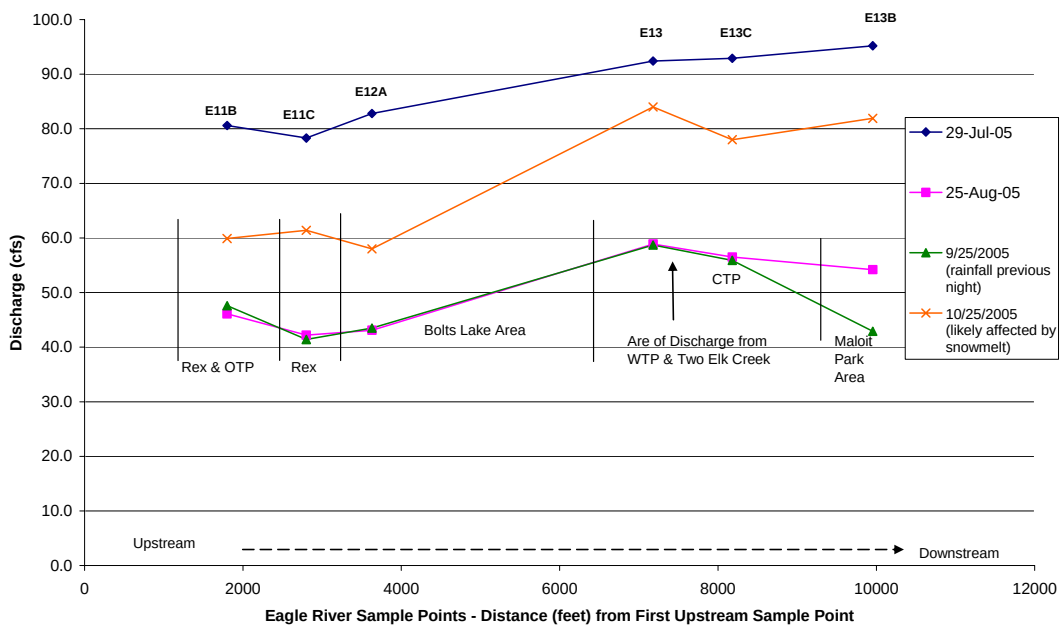


Figure 33
Discharge at Eagle River Stations

A review of the stream discharge data shows that discharge generally decreases downstream of station E-13 during the August, September, and October 2005 sampling events. However, an increase was expected due to discharge from Two Elk Creek and the WTP to the Eagle River downstream of station E-13. This discrepancy may be due to the

turbulent conditions at station E-13 and downstream, as discussed in Section 2.1.2 of this report.

To evaluate the measurements collected during this investigation, the discharge measurements collected by ERM at sampling station E-12A were compared to the discharge measurements collected by the USGS stream gauging station (USGS Station 09064600 Eagle River near Minturn, Colorado) (Table 6). Although referred to as different names, this is a single station. The ERM-collected data correlates well to the USGS stream gauging station data, and the discharge measurements appropriately represent Site conditions.

Table 6 Eagle River Discharge Measurements at Station E-12A

Measurement Date	*USGS Station 09064600 (cfs)*	*Eagle River Sampling Station E-12A (cfs)*
7/29/2005	84	82.8
8/25/2005	45	43.1
9/22/2005	40	43.5
10/25/2005	59	58.0

cfs - cubic feet per second

*http://waterdata.usgs.gov/co/nwis/uv/?site_no09064600&PARAmeter_cd=00065,00060

3.1.3 Surface Water Load Calculations

For the fall months, when the Eagle River was accessible and discharge measurements could be collected, zinc load at the North Property river stations were calculated (with the exception of E-11A, which was never accessible due to rapids). Although an evaluation of zinc load in the river during the early spring (March and April) when the zinc concentrations are higher and seeps and overland flow are contributing to the load in the river would be beneficial, the high water in the river prevents access to collect discharge measurements.

Load was calculated at the North Property sampling stations and is shown on Figure 34. Load appeared to be highest in July and October and lowest in September. The September decrease may have been a result of dilution due to a rain storm that occurred prior to the sampling event.

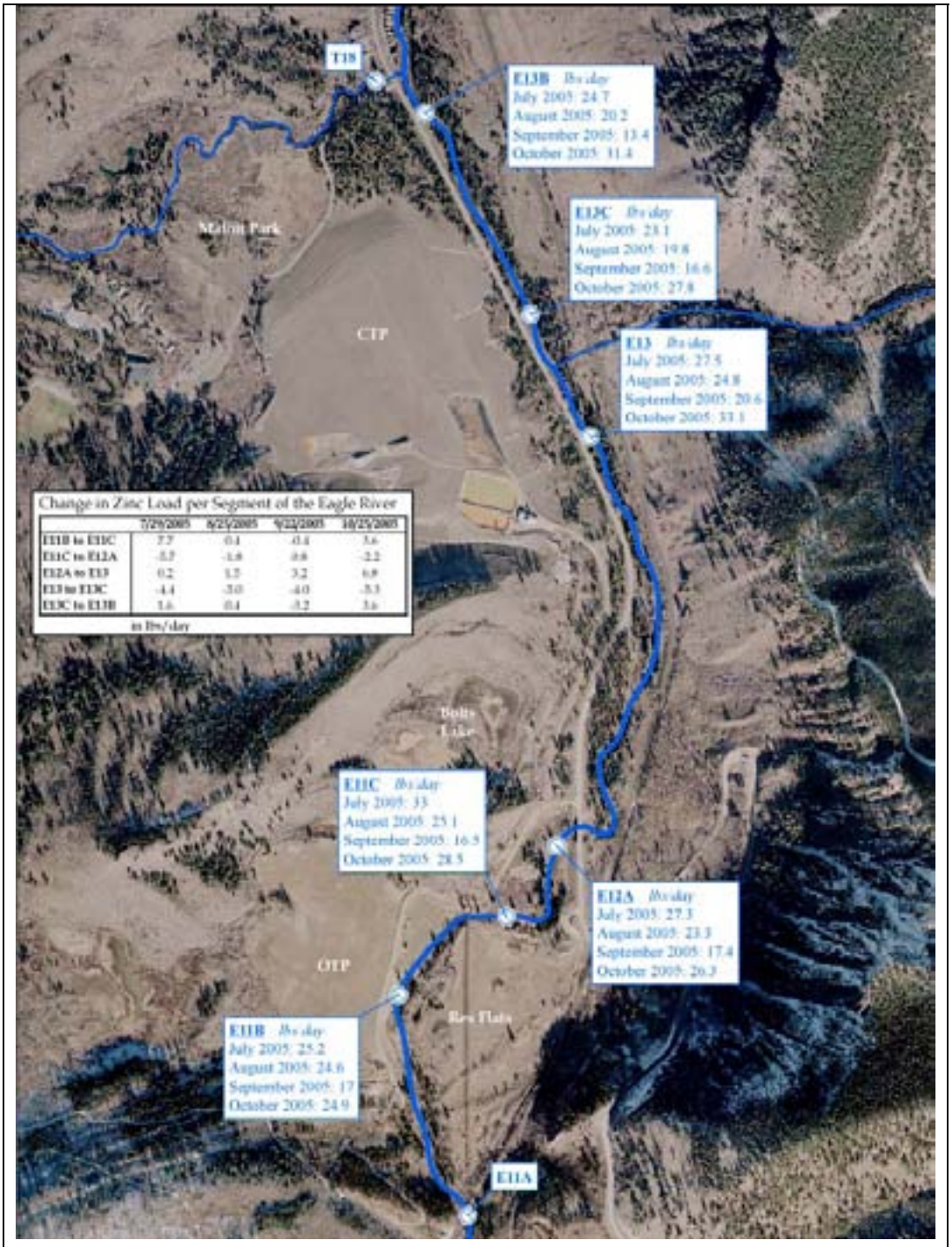


Figure 34 - Summary of Zinc Loading along Eagle River

The change in load between sampling stations (i.e., the zinc loading to the Eagle River) is also shown on Figure 34. The loading to the Eagle River is a dynamic process. Positive loading of zinc (i.e., net gain of zinc in the river) generally occurs in the following reaches of the Eagle River:

- E-11B to E-11C – the northern area of OTP and Rex Flats;

- E-12A to E-13 – the area of Bolts Lake and the southern portion of the CTP; and

- E-13C to E-13B – the northern portion of the CTP.

Negative loading (i.e., net loss of zinc in the river) to the Eagle River generally occurs in the following reaches:

- E-11C to E-12A – the northeastern area of Rex Flats and northward; and

- E-13 to E-13C – the central CTP area including influent from Two Elk Creek and the WTP.

Because the loading calculations are shown for the summer and fall months when the contribution to Eagle River discharge from seeps and overland flow are minimal, contributions to and from ground water appear to be the reason for the changes in load at each reach. This data indicate that the surface water of the Eagle River is in constant flux with the ground water at the Site.

3.2 EAGLE RIVER SEDIMENT

3.2.1 Stream Sediment Concentrations

Stream sediment samples were collected to assess metals concentrations, specifically zinc, in the Eagle River. Six locations were sampled from within the boundaries of the North Property and included: 1) the areas between surface water sample stations where the zinc surface water concentrations increased (between E-11B and E-11C, and between E-13B and E-13C), and 2) upstream and downstream of the WTP discharge/Two Elk Creek confluence with the Eagle River. An additional four locations were sampled upstream of the North Property to assess sediment quality, a) immediately downstream of Belden and Gilman, and b) upstream of Belden. These sediment sample locations and corresponding metal concentrations are shown in Figure 35 and Table 7 below. A full-scale version of Figure 35 is also presented within Appendix O of this report.

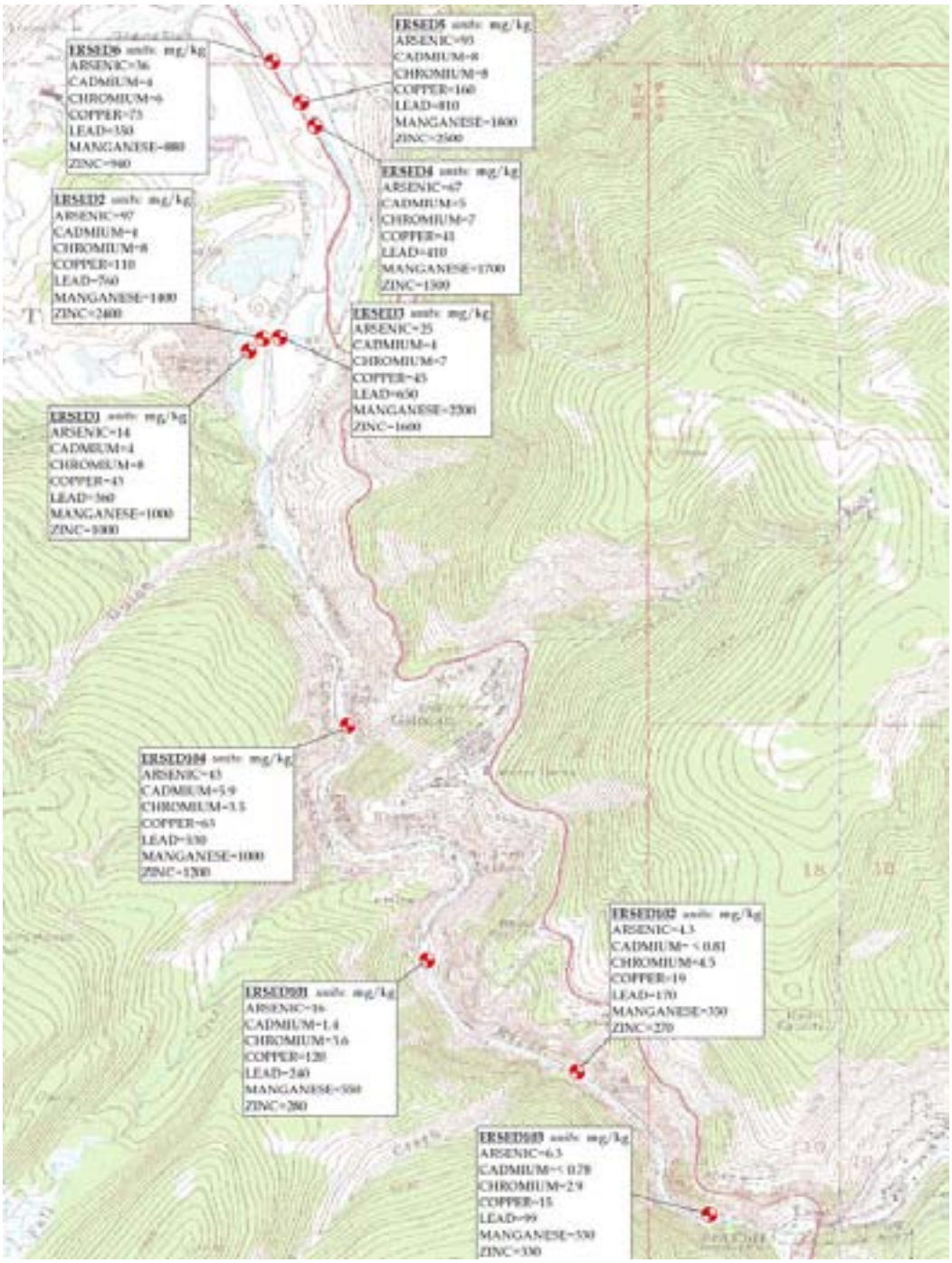


Figure 35 - Summary of Eagle River Sediment Analytical Results

Table 7 Summary of Eagle River Sediment Analytical Results

Sample Location	Sample Date	As	Cd	Cr	Cu	Pb	Mn	Zn
ERSED1	10/19/2005	14	3.5	8.5	43	360	1000	1000
ERSED2	10/19/2005	97	3.9	7.7	110	760	1400	2400
ERSED3	10/19/2005	25	3.6	7.0	45	650	2200	1600
ERSED4	10/19/2005	67	4.9	7.3	41	410	1700	1500
ERSED5	10/19/2005	93	8.1	8.4	160	810	1800	2500
ERSED6	10/19/2005	36	3.5	5.9	73	350	880	940
ERSED101	7/20/2006	16	1.4	3.6	120	240	550	280
ERSED102	7/20/2006	4.3	< 0.81 J	4.5	19	170	350	270
ERSED103	7/20/2006	6.3	< 0.78 J	2.9	15	99	330	330
ERSED104	7/20/2006	43	5.9	3.5	63	530	1000	1200

Notes:
Concentrations reported in milligrams per kilogram (mg/kg)
< = less than
As = Arsenic
Cd = Cadmium
Cr = Chromium
Cu = Copper
Pb = Lead
Mn = Manganese
Zn = Zinc
J = Estimated value

The zinc concentrations as seen on Figure 35 range from 940 to 2,500 mg/kg within the North Property. The two highest zinc concentrations are from two areas: 1) due north of Rex Flats (2,400 mg/kg, ER-Sed-2), and 2) immediately downstream of the discharge from the water treatment plant and Two Elk Creek (2,500 mg/kg, ER-Sed-5).

The zinc concentrations immediately downstream of Rock Creek is 1,200 mg/kg. The range in zinc concentrations between Belden and Red Cliff is 270 mg/kg to 330 mg/kg.

3.3 SOIL

Soil sampling under the Work Plan is completed, and the investigation results for soil are presented herein. The method to establish the background values incorporated input from EPA and CDPHE and is discussed below.

3.3.1 Soil Background Concentrations

Background samples were analyzed for the primary metals because they are most representative of potential impact due to mining activities and the tailings that were historically placed within the investigated area. In

the Work Plan, the primary indicator metals were identified as arsenic, cadmium, chromium, copper, lead, manganese, and zinc. For the Remedial Investigation, background soil samples were collected outside the known areas of impact. Twenty background soil samples were collected in surface soil (zero to six inches) and were analyzed for the seven indicator metals. The 20 background samples collected include:

BL-SS-26	BL-SS-101
CTP-SS-1	BL-SS-102
CTP-SS-2	CTP-SS-101
CTP-SS-3	CTP-SS-103
OTP-SS-79	OTP-SS-131
OTP-SS-80	OTP-22-132
OTP-SS-81	OTP-SS-133
OTP-SS-82	OTP-SS-134
RX-SS-40	RX-SS-135
RX-SS-41	MP-SS-120

Table 8 below provides the reported concentrations for the background soil samples. Sample results are presented in Appendix P. As noted previously, the lead concentration in sample CTP-SS-3 is likely impacted by a nearby shooting range.

Table 8 Summary of Background Soil Analytical Results

Sample Location	*Sample Date*	*As*	*Cd*	*Cr*	*Cu*	*Pb*	*Mn*	*Zn*
BLSS101	5/25/2006	11	1.0	13	6.8	20	260	210
BLSS102	5/25/2006	9.0	1.0	17	15	40	280	200
BLSS26	7/13/2005	43	5.5	14	23	170	630	810
CTPSS1	7/21/2005	0.67	< 0.1	19	3.2	4.3	83	24
CTPSS101	5/25/2006	4.8	0.69	16	16	45	470	130
CTPSS103	5/25/2006	12	1.3	14	8.4	40	650	200
CTPSS2	7/21/2005	8.1	0.84	19	17	31	510	160
CTPSS3	7/21/2005	6.9	0.68	22	38	2300	350	140
MPSS120	5/25/2006	8.0	1.2	17	16	39	670	200
OTPSS131	5/25/2006	7.3	1.0	10	8.2	30	160	170
OTPSS132	5/25/2006	4.8	0.58	18	18	23	500	110
OTPSS133	5/25/2006	9.4	0.52	16	8.5	23	370	110
OTPSS134	5/25/2006	2.9	0.31	15	11	18	350	87
OTPSS79	7/12/2005	24	2.8	20	18	74	390	430

Sample Location	*Sample Date*	*As*	*Cd*	*Cr*	*Cu*	*Pb*	*Mn*	*Zn*
OTPSS80	7/8/2005	6.2	0.91	22	25	32	790	180
OTPSS81	7/8/2005	10	1.6	13	17	47	410	290
OTPSS82	7/13/2005	18	2.4	20	19	68	1300	380
RXSS135	5/25/2006	48	3.9	12	23	100	900	920
RXSS40	7/20/2005	5.5	< 0.2	16	19	19	290	65
RXSS41	7/20/2005	2.0	< 0.2	17	7.2	9.7	290	45

Concentrations reported in milligrams per kilogram (mg/kg)
< = less than
As = Arsenic
Cd = Cadmium
Cr = Chromium
Cu = Copper
Pb = Lead
Mn = Manganese
Zn = Zinc
Concentrations reported in milligrams per kilogram (mg/kg)

Figure 36 summarizes the primary metal concentrations in the background samples.

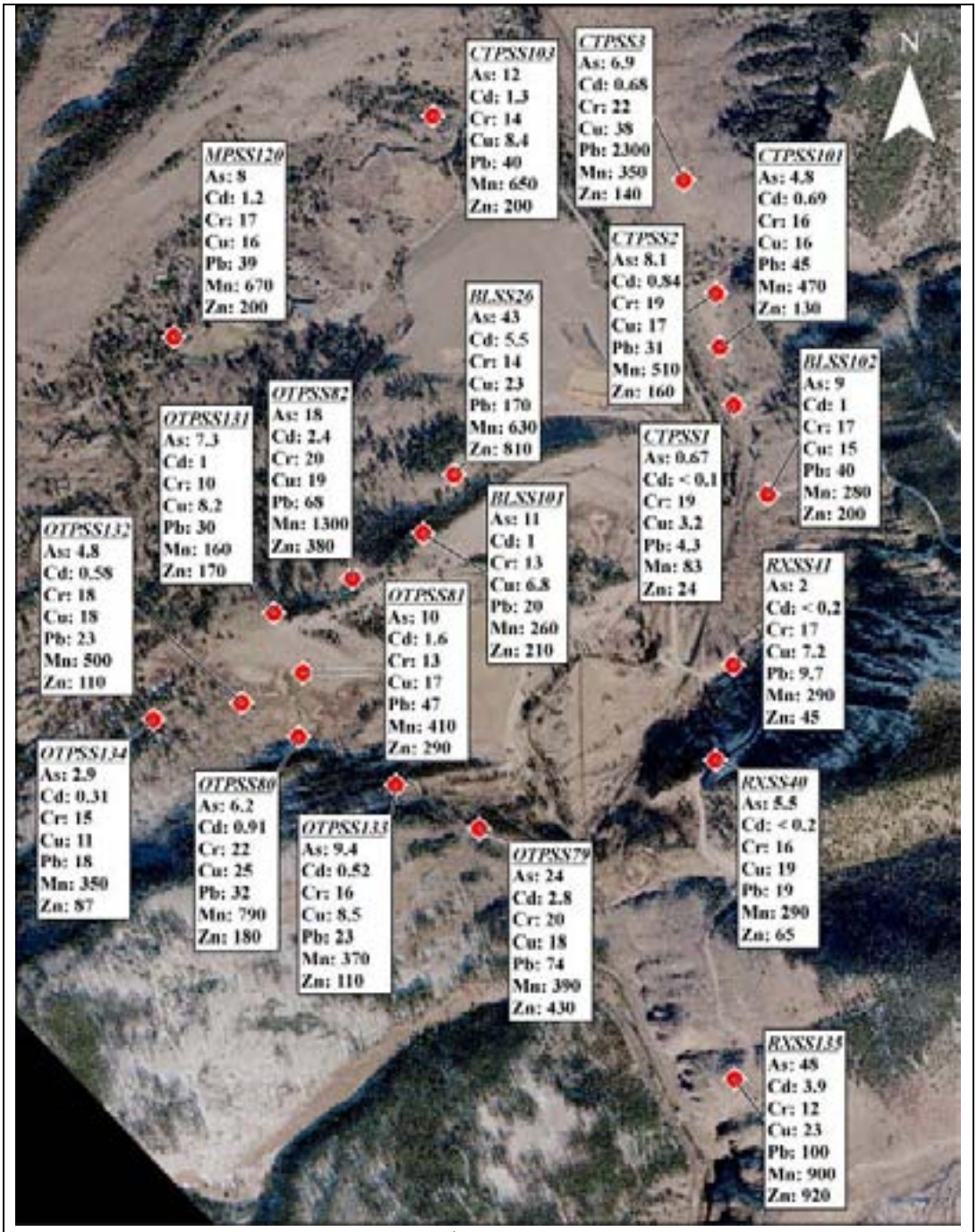


Figure 36
Background Sample Locations with Metal Concentrations (mg/kg)

Note: < = less than

3.3.2 *Surface Soil Concentrations*

Tables of the surface soil analytical results are presented in Appendix P. The results of the seven primary indicator metals (arsenic, cadmium,

chromium, copper, lead, manganese, and zinc) are briefly presented below and summarized in Table 9. Similarly, the results of the expanded list of analytes are presented in Table 10.

Table 9 ***Summary of the Minimum and Maximum Surface Soil Concentrations, by Area, of the Seven Primary Indicator Metals***

Metal (mg/kg)		*Background**	*Bolts Lake*	*Maloit Park*	*Roaster Pile 5*	*OTP/ Sump 3*	*Rex Flats*
Arsenic	min	0.67	2.7	2.3	14	0.85	1.9
	max	48	57	1,400	230	1,000	2,700
Cadmium	min	<0.1	0.12	0.12	0.27	<0.1	<0.1
	max	5.5	6.3	26	9.5	9.9	16
Chromium	min	10	8.7	7.9	7.4	5.1	<2.3
	max	22	21	36	13	62	36
Copper	min	3.2	4.3	13	13	6.9	8.2
	max	25	73	1,300	92	320	850
Lead	min	4.3	7.4	8.5	98	2.4	9.6
	max	170	150	7,100	1,800	4,500	14,000
Manganese	min	83	75	170	240	40	22
	max	1300	980	9,800	2,100	5,000	6,200
Zinc	min	24	44	53	110	29	46
	max	920	890	7,700	2,200	4,600	3,300

*Excludes location CTP-SS-3 due to proximity to shooting range

Comparison of the data for the seven primary metals shows that:

- the seven primary metals were detected at the background locations and within each of the investigated areas;
- the highest concentrations of arsenic and lead were detected at Rex Flats;
- the highest concentrations of cadmium, copper, manganese, and zinc were detected at Maloit Park; and
- the highest concentrations of chromium were detected at the OTP.

Table 10 Summary of the Minimum and Maximum Surface Soil Concentrations, by Area, of the Expanded Analytes

Metal (mg/kg)		*Background (4 Site samples)**	*Bolts Lake*	*Maloit Park*	*Roaster Pile 5*	*OTP/ Sump 3*	*Rex Flats*
Aluminum	min	8,800	6,200	5,200	5,900	2,500	1,800
	max	24,000	10,000	30,000	9,800	19,000	22,000
Antimony	min	<1.1	<1.3	<1	<1.1	<1.1	<1.1
	max	41	51	12	<1.3	8.1	11
Barium	min	140	120	45	120	66	100
	max	440	540	350	270	340	410
Beryllium	min	<0.59	<0.63	<0.52	<0.57	<0.53	<0.56
	max	6.5	7.9	1.4	0.65	1.2	1.4
Calcium	min	4,900	1,200	1,700	2,100	320	400
	max	79,000	59,000	83,000	12,000	33,000	40,000
Cobalt	min	8.1	2.4	2.2	4.6	1.8	2.2
	max	55	68	20	6.8	11	13
Cyanide (free)	min	<0.55	<0.63	<0.52	<0.55	<0.53	<0.55
	max	<0.62	<0.72	2.7	<0.63	36	0.85
Iron	min	16,000	31,000	11,000	25,000	14,000	14,000
	max	160,000	170,000	250,000	87,000	170,000	260,000
Magnesium	min	3,800	1,500	330	2,800	720	540
	max	14,000	9,000	17,000	8,600	5,700	16,000
Mercury	min	<0.036	<0.041	<0.034	<0.038	<0.035	<0.036
	max	0.046	0.048	1.2	0.072	1	2.7
Nickel	min	11	5.5	7.5	12	<4.6	5
	max	57	71	30	15	22	31
Potassium	min	2,800	2,100	1,600	1,800	1,400	1,500
	max	11,000	13,000	7,300	4,700	4,200	6,400
Selenium	min	<1.4	<1.6	<1.4	<1.4	<1.4	<1.4
	max	210	100	2.2	<1.6	<8	1.7
Silver	min	<1.1	<1.3	<1	<1.1	<1.1	<1.1
	max	21	21	40	2.8	44	52
Sodium	min	<590	<630	<520	<550	<530	<550
	max	7,000	8,600	<2700	<630	<670	680
Sulfate	min	<55	<64	<52	120	<53	110
	max	78	430	29,000	4,200	25,000	42,000
Thallium	min	<1.3	<1.5	<1.2	<1.3	<1.3	<1.3
	max	210	260	12	<1.5	14	18
Vanadium	min	17	31	5.3	12	20	14
	max	89	110	49	30	59	41

*Excludes location CTP-SS-3 due to proximity to shooting range

Comparison of the data from the 18 analytes of the expanded list shows that:

- 16 of the 18 analytes were detected in the background samples, the exceptions were cyanide and mercury;
- the highest concentrations of aluminum, calcium, and magnesium were detected at Maloit Park;
- the highest concentrations of antimony, barium, beryllium, cobalt, nickel, potassium, sodium, thallium, and vanadium were detected at Bolts Lake;
- the highest concentrations of cyanide were detected at the OTP;
- the highest concentrations of iron, mercury, silver, and sulfate were detected at Rex Flats; and
- the highest concentration of selenium was within a background sample.

The expanded analytes list includes portions of EPA's Target Analyte List, which was derived from EPA's non Site-specific priority pollutant list. These analytes are not necessarily indicative of mine waste, or mine waste from the Eagle Mine Site. Of note is Bolts Lake, which contains the highest concentrations of many of these additional analytes. A potential cause of these comparatively higher concentrations is that, unlike the remainder of the Site, Bolts Lake is a lake bed within which these analytes have concentrated by annual runoff and water evaporation.

Bolts Lake did not receive waste from the Eagle Mine, and is not part of the Superfund Site as determined by the EPA and CDPHE. As noted, there is one isolated area at the extreme south end of Bolts Lake where a drum and a small amount of tailings has been placed as road fill.

Most indicative that Bolts Lake is otherwise not impacted by mine tailings is the types of elevated analytes found at Bolts Lake versus the types of elevated analytes found at the mine tailings impacted areas of OTP, Rex Flats, and Maloit Park. For example, OTP, Rex Flats, and Maloit Park contain elevated concentrations of arsenic, lead, and manganese; they have low to non-detect concentrations of antimony, thallium, and vanadium. Whereas (except for the roadfill area, which has slightly elevated arsenic at sample location BL-SS-25) Bolts Lake contains low concentrations of arsenic, lead, and manganese; it has elevated concentrations of antimony, thallium, and vanadium. If Bolts Lake was

impacted by mine tailings, it would have a similar suite of metals; and elevated thallium and vanadium would be observed at the OTP, Rex Flats, and Maloit Park.

Elevated iron concentrations are detected throughout the area: background up to 160,000 mg/kg; Bolts up to 170,000 mg/kg; and at the OTP, Rex Flats, and Maloit Park up to 260,000 mg/kg. The iron concentrations detected at Bolts Lake are similar to background concentrations.

To summarize, 1) the types of elevated analytes detected at Bolts Lake are not indicative of mine tailings, as compared to the results of the mine tailings area; and 2) the elevated analytes detected at Bolts Lake are similar in concentrations to the background samples.

The following maps show the surface soil sample locations and nearby background locations for each area of investigation on the North Parcel.

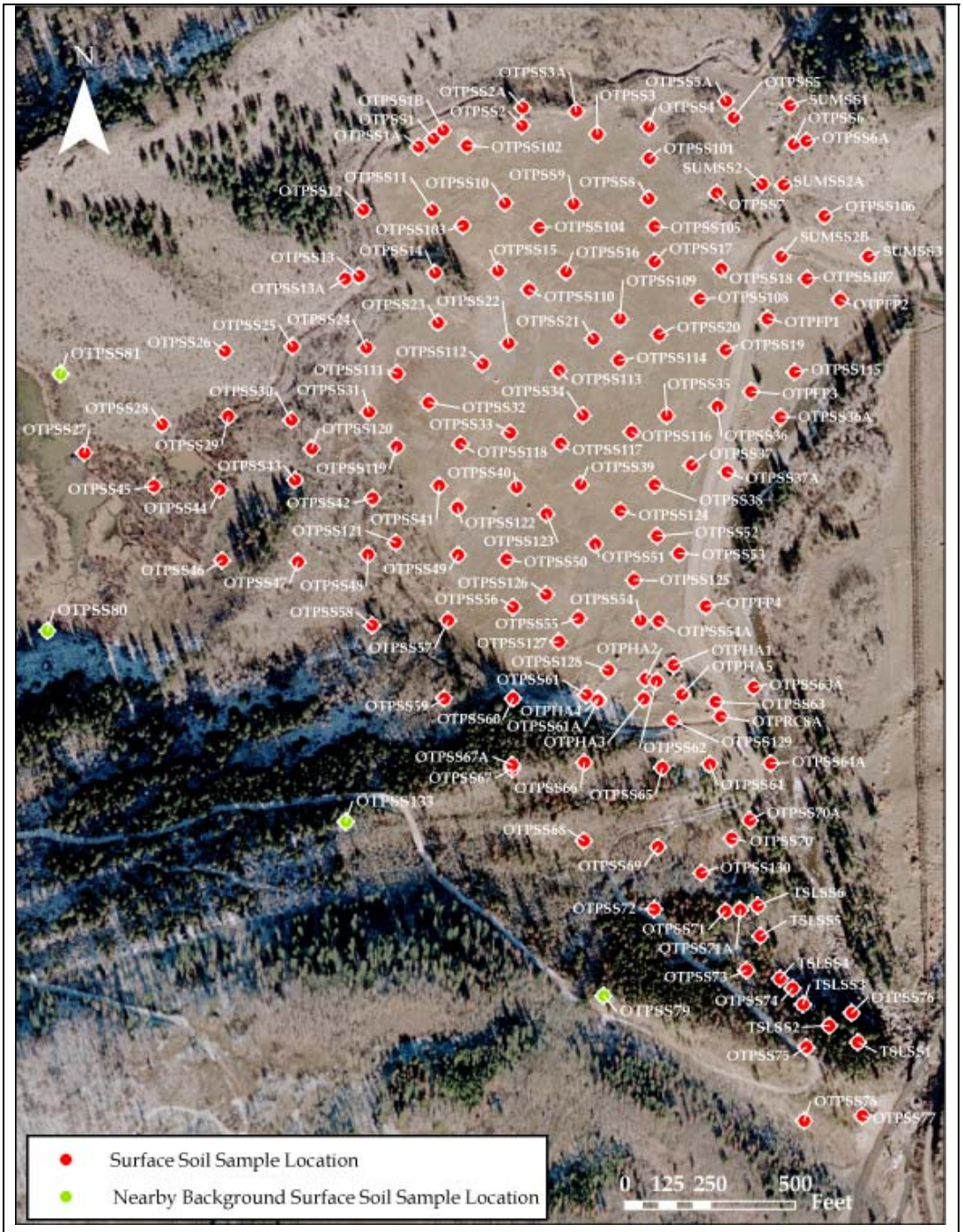


Figure 37
OTP Surface Soil Sample Locations and Nearby Background Locations

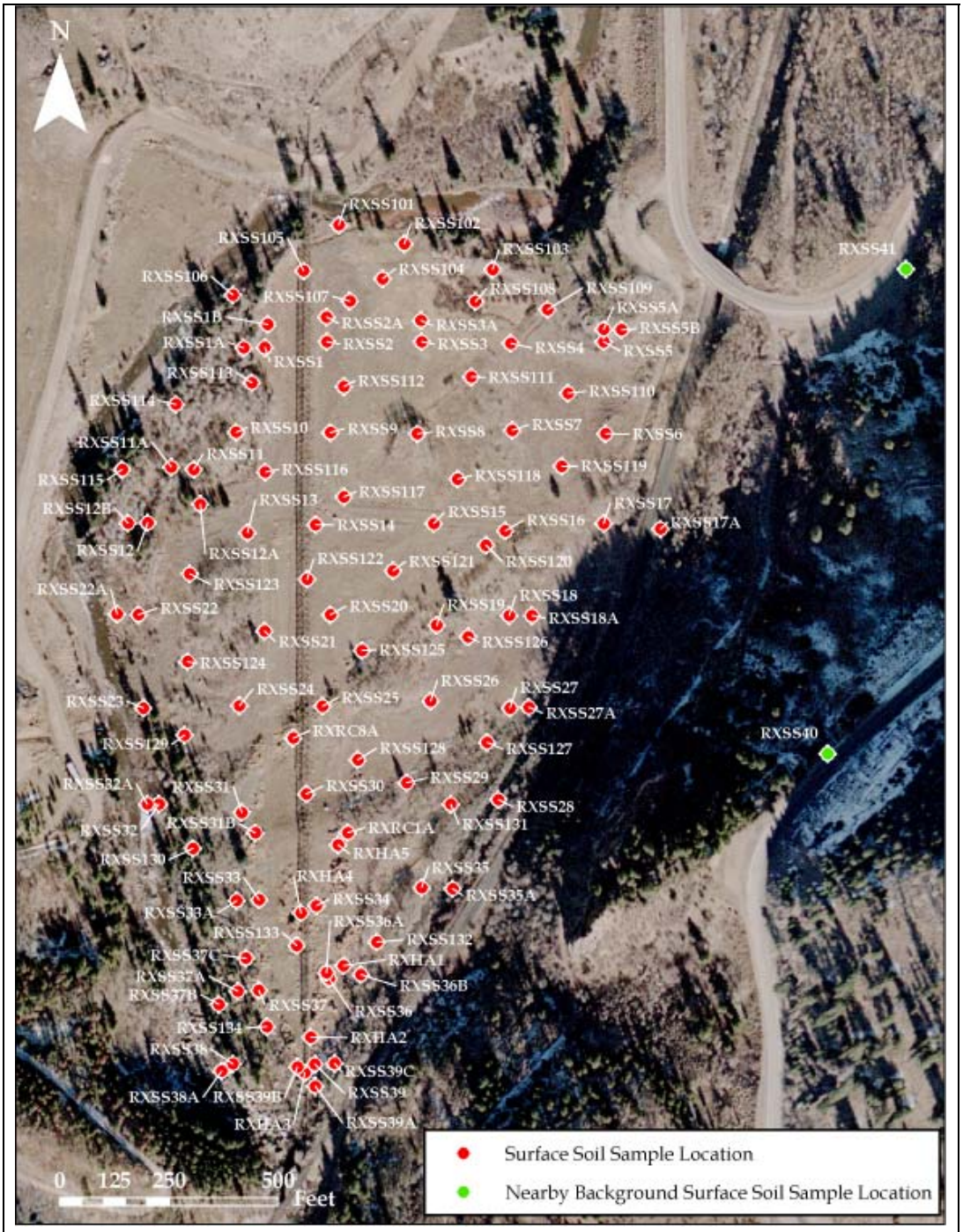


Figure 38
Rex Flats Surface Soil Sample Locations and Nearby Background Locations

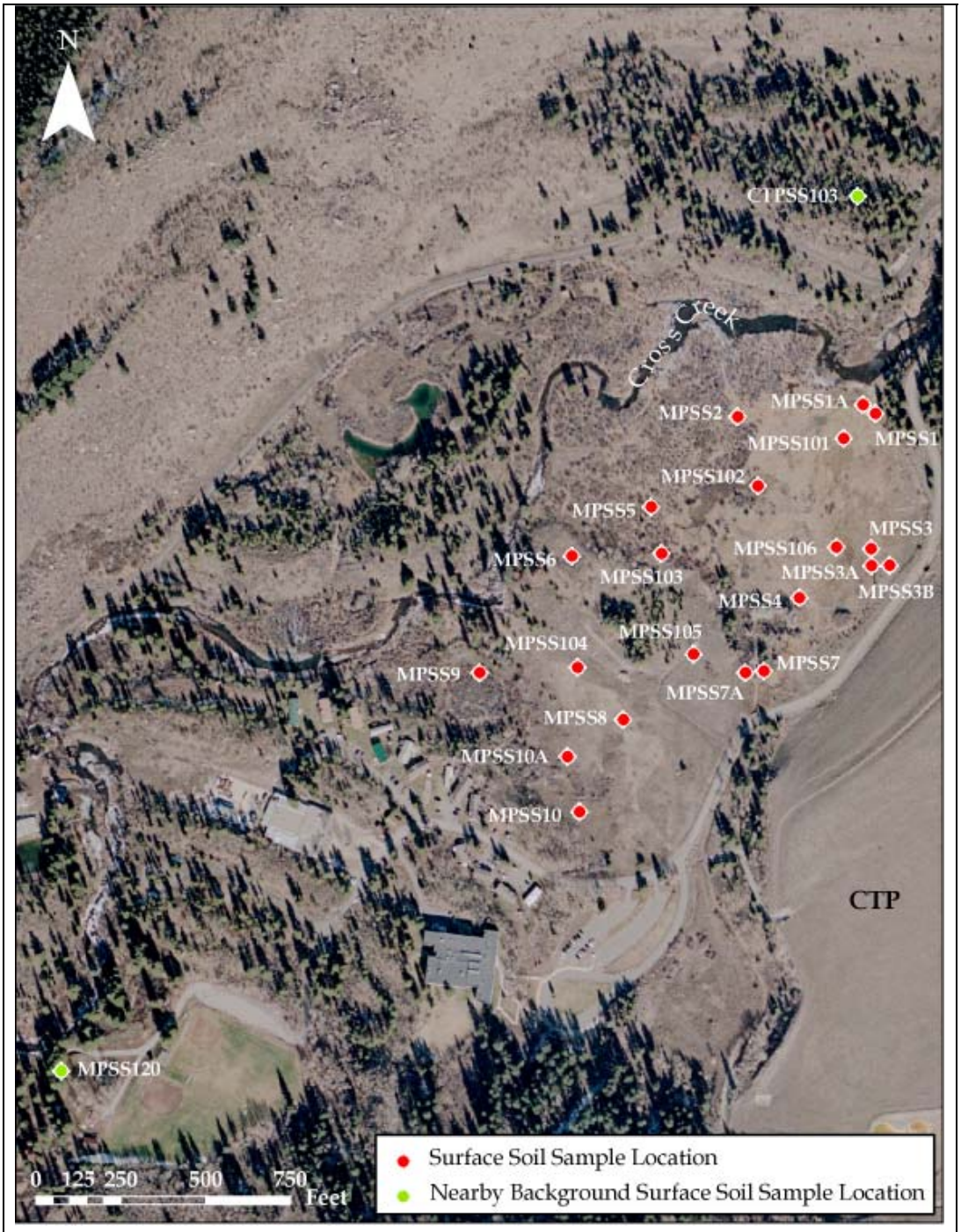


Figure 39
Maloit Park Surface Soil Sample Locations and Nearby Background Locations

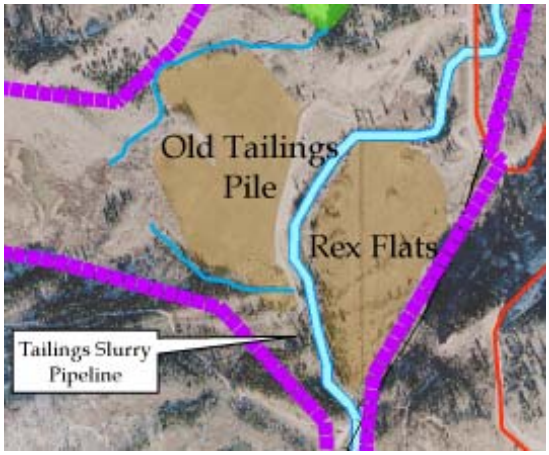
Figure 40
Roaster Pile #5 Surface Soil Sample Locations and Nearby Background Locations

Figure 41
Bolts Lake Surface Soil Sample Locations and Nearby Background Locations

3.3.3 *Tailings Slurry Pipeline Sediment Samples*

Four samples of the sediment within the Tailings Slurry Pipeline area were collected and analyzed for the primary metals, as well as mercury and cyanide. As seen in the table within Appendix P, each of these

constituents was detected in at least one of the samples. The range of concentrations was as follows:



- arsenic, 39 to 3,100 mg/kg;
- cadmium, less than 2.5 to 1.8 mg/kg;
- chromium, 3.5 to 5.8 mg/kg;
- copper 84 to 810 mg/kg;
- cyanide, 0.93 to 97 mg/kg;
- lead, 250 to 5,300 mg/kg;
- manganese, 270 to 920 mg/kg;
- mercury, 0.31 to 88 mg/kg; and
- zinc, 550 to 2,200 mg/kg.

3.3.4 *Rock Chip Samples from Boulders*

Sixteen rock chip samples from boulders were collected from Rex Flats and the OTP for analysis of the seven primary metals. The on site boulders sampled during this investigation were historically buried within the former tailings as evidenced by their discoloration, weathering, and sulfur odor. As seen in the table within Appendix P, each of these constituents was detected in at least one of the samples. The range of concentrations was as follows:

- arsenic, less than 0.6 to 1,500 mg/kg;
- cadmium, less than 0.1 to 15 mg/kg;
- chromium, 1.9 to 34 mg/kg;
- copper 0.3 to 720 mg/kg;
- lead, 2.4 to 1,400 mg/kg;
- manganese, 15 to 2,900 mg/kg; and
- zinc, 7.3 to 2,400 mg/kg.

3.3.5 *Subsurface Soil Samples*

The subsurface locations for each area (Bolts Lake, OTP/Sump #3 and Rex Flats) are presented in Figure 42. Soil borings or test pits were not installed at Maloit Park or Roaster Pile #5. Tables 11 and 12 show the range in concentration per area. The concentrations are graphically shown in Figures 43 to 46 as west-east and north-south subsurface cross sections through the OTP and Rex Flats. These cross sections show the sample locations, depth, associated concentrations for arsenic, lead, manganese and zinc, and the concentrations for the nearest surface soil sample. Additionally, Appendix P contains tables that illustrate the soil boring analytical data and data from the nearest surface soil sample, so that concentrations versus depths may be evaluated. In general, subsurface concentrations are lower than the surface soil concentrations.

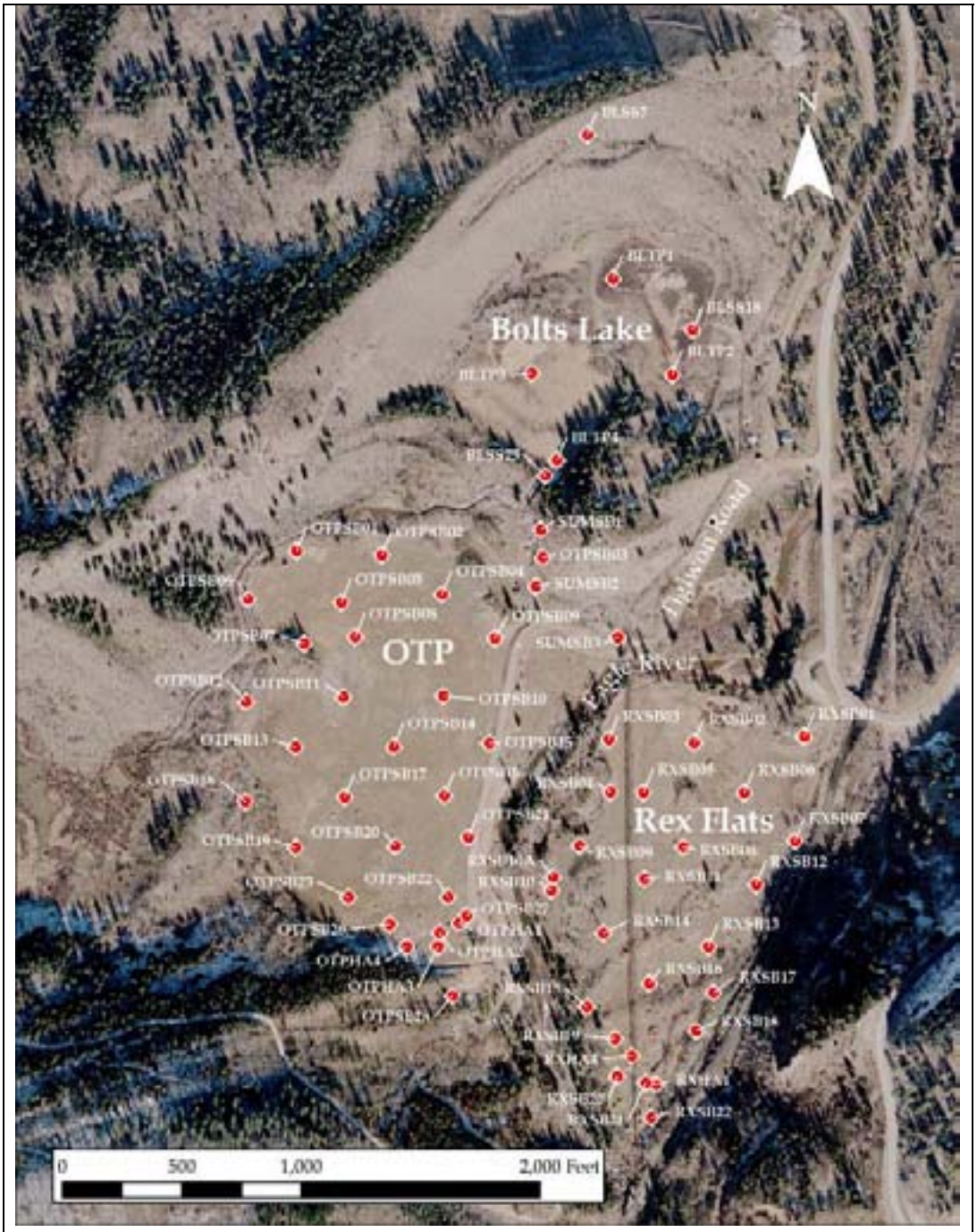


Figure 42
Subsurface Soil Sample Locations

Table 11 ***Summary of the Minimum and Maximum Subsurface Soil Concentrations, by Area, of the Seven Primary Indicator Metals***

Metal (mg/kg)		*Bolts Lake*	*OTP/Sump 3*	*Rex Flats*
Arsenic	min	<1.3	0.65	<0.63
	max	25	220	1000
Cadmium	min	<0.21	<0.1	<0.1
	max	2.3	2	2.1
Chromium	min	8.1	5.8	6.7
	max	36	92	31
Copper	min	5.6	6.5	5.5
	max	23	74	250
Lead	min	2.8	1.7	2.4
	max	70	230	2400
Manganese	min	57	25	73
	max	940	2200	1200
Zinc	min	14	12	20
	max	460	1000	940

Table 12 ***Summary of the Minimum and Maximum Subsurface Soil Concentrations, by Area, of the Expanded Analytes***

Metal (mg/kg)		*Bolts Lake***	*OTP/ Sump 3*	*Rex Flats*
Aluminum	min	4,500	3,600	87
	max	4,500	14,000	13,000
Antimony	min	<1	<1	<1
	max	<1	<1.3	2.8
Barium	min	32	31	<1.3
	max	32	170	390
Beryllium	min	<0.52	<0.51	<0.52
	max	<0.52	3.4	1
Calcium	min	1,300	1,200	24
	max	1,300	9,300	12,000
Cobalt	min	2.6	2.6	<1.3
	max	2.6	14	8.8
Cyanide (free)	min	<0.52	<0.51	<0.52
	max	<0.52	<0.67	1
Iron	min	8,600	10,000	430
	max	8,600	40,000	140,000
Magnesium	min	1,600	1,700	34
	max	1,600	9,300	6,700
Mercury	min	<0.034	<0.034	<0.034
	max	<0.034	<0.044	0.38
Nickel	min	6.1	6.5	<5.1
	max	6.1	24	19
Potassium	min	1,300	1,400	<330
	max	1,300	6,700	5,600
Selenium	min	<1.3	<1.3	<1.3
	max	<1.3	<1.8	<1.9
Silver	min	<1	<1	<1
	max	<1	1.1	28
Sodium	min	<520	<510	<520
	max	<520	<670	<720
Sulfate	min	<52	<51	<52
	max	<52	20,000	15,000
Thallium	min	<1.2	<1.2	<1.2
	max	<1.2	1.7	6.9
Vanadium	min	12	14	<2.5
	max	12	58	40

** only one sample from Bolts Lake

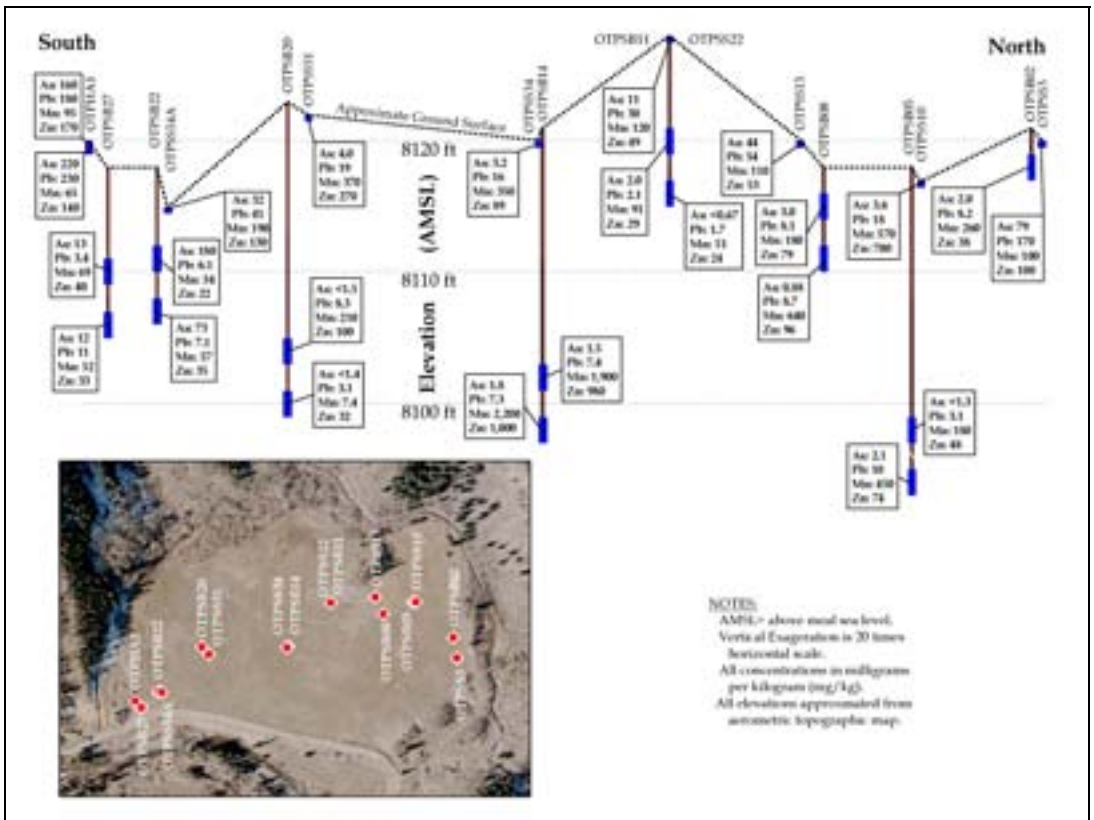


Figure 43 - OTP –South-North- Cross Section

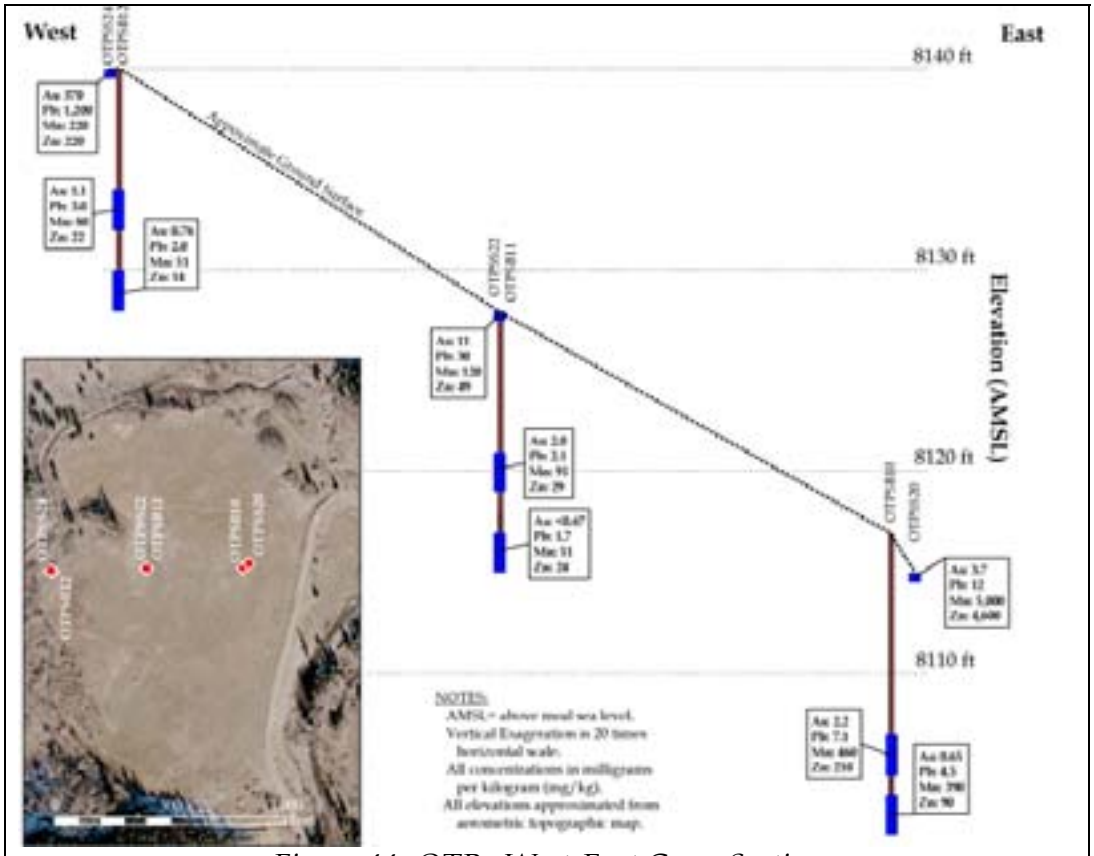


Figure 44- OTP –West-East Cross Section

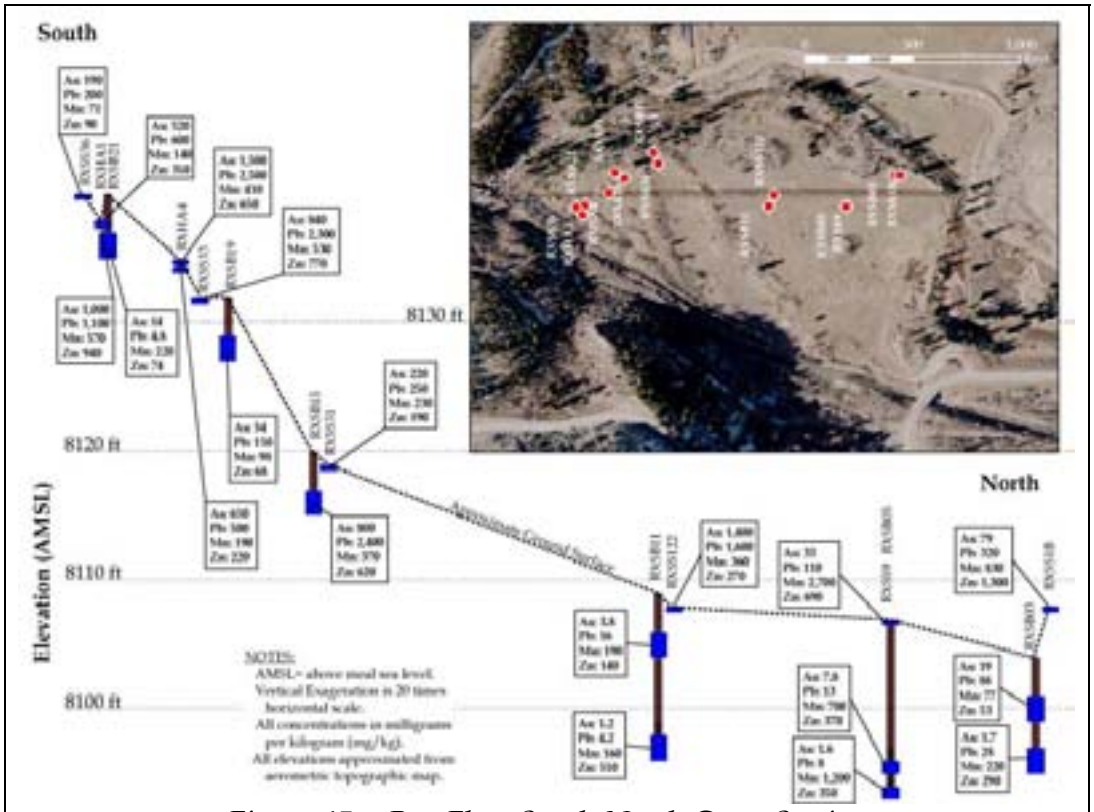


Figure 45 - Rex Flats South-North Cross Section

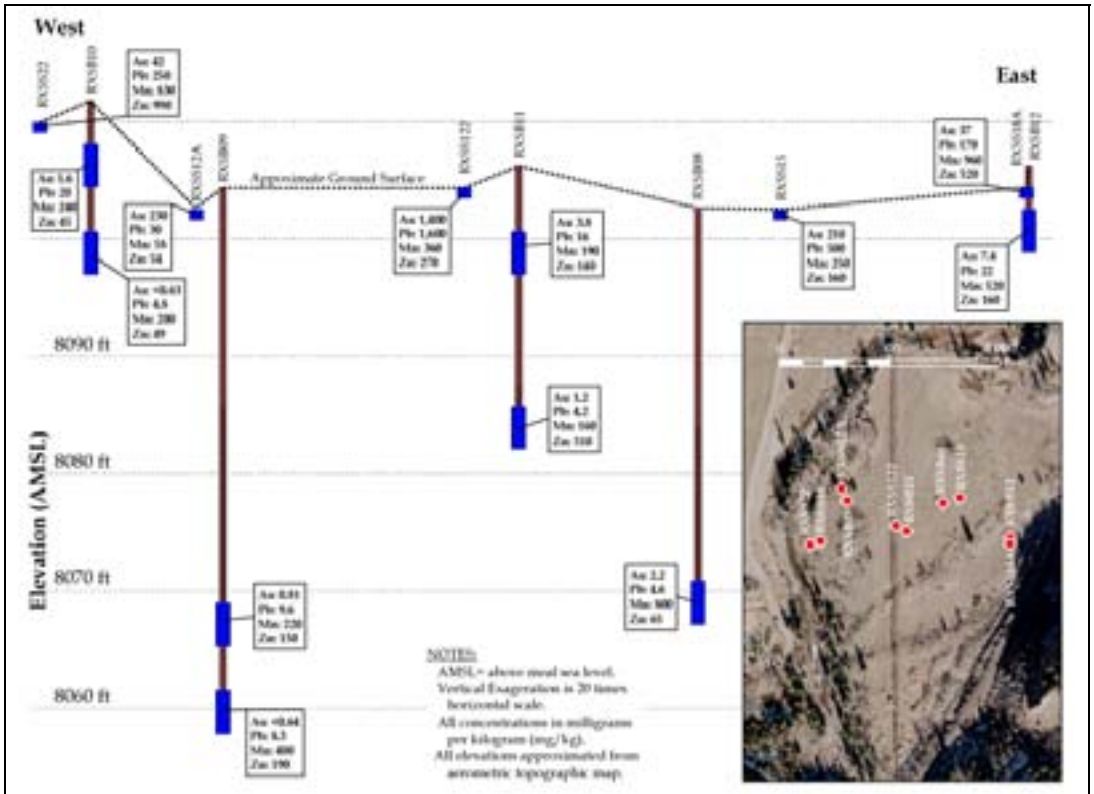


Figure 46 - Rex Flats West-East Cross Section

In addition to the samples collected and analyzed for the metals and expanded analytes list, several soil samples were collected for analyses of VOCs.

As directed by the Work Plan, the soil cores from each boring were screened with a field PID as discussed in Section 2.4.3. At location RXSB-10 within Rex Flats, an elevated PID reading of 37 ppm was observed for the sample interval from surface to 6 inches bgs. The soil core below six inches had background PID readings. The 0 to 6 inches interval was analyzed for VOCs and SVOCs. Of those analyses, the volatile constituent of 4-isopropyltoluene was detected at 59 micrograms per kilogram ("µg/kg"). The step-out location, which was attempted due to rig refusal before reaching the planned depth at the initial location, had a PID reading of 0.7 ppm for the 0 to 6 inches interval. The step out location was within 50 feet of the original location. The extent of isopropyltoluene impact is limited horizontally by the step out location and other nearby soil borings (RX-SB-9 and RX-SB-4), and it is limited vertically by the underlying background PID readings. The occurrence of this volatile substance in surface soil (0 to 6 inches) in unusual because volatile constituents typically volatilize (evaporate) quickly when exposed to air. The occurrence of 4-isopropyltoluene may not be related to historic mining activities; instead, it may be the result of a small quantity of recently discarded or spilled material.

Similar to Rex Flats, one soil boring encountered elevated PID readings. A reading exceeding 2,000 ppm was detected at soil boring OTP-SB-19 within the OTP from 10 to 12 feet deep. Seven step-out locations were drilled due to auger refusal in an effort to reach the planned depth. None of these other locations had elevated PID readings. The sample was analyzed for VOCs and SVOCs, and none were detected by the laboratory. The elevated PID may have been due to a very isolated occurrence of a very volatile substance.

3.3.6 SPLP Soil Samples

Thirty soil samples were analyzed by the SPLP method for the seven primary metals. These analyses were conducted to assess scenarios such as rainwater and/or irrigation water moving through the unsaturated soil, and the resulting concentrations of metals that could be found in the leachate water. As seen in Appendix P, many of the analytical results from this leaching procedure were below the analytical detection limits. Additionally, the SPLP (leachable) metals results were compared to the non-SPLP (total) metals results and compared to pH to assess if a statistical correlation was evident. A correlation was not observed. In evaluating the data, it is noted that the detection limits for the total metals and the SPLP analyses varied among the samples due to different

analytical methods (one method was used for 2005 SPLP data and another method, with potentially lower detection limits, was used for 2006 SPLP samples) and due to matrix interference, which is common for soil samples. Also, not all samples were analyzed for the same suite of analyses: 30 samples were analyzed for SPLP metals, 27 of these samples were also analyzed for pH and for the total metals. The pH of these samples ranged from 2.3 to 8.4.

The data show primarily that there does not appear to be a correlation between concentration, pH, and leachability of the metals in soil at the Site, with the exception of zinc. Additionally, the data show:

a) arsenic does not tend to leach (1 in 30 samples).

b) cadmium does not tend to leach at this Site (0 in 30 samples).

c) chromium minimally leaches (4 in 30 samples).

d) copper somewhat leaches (10 in 30 samples).

e) lead somewhat leaches (12 in 30 samples).

f) manganese leaches from soil at the Site (24 in 30 samples).

g) zinc minimally leaches (6 in 30 samples). A low pH typically (but not always) indicated that SPLP zinc would be detected.

Metals naturally leach from soil, and at this Site, manganese, lead, and copper are the most easily leached, whereas zinc and chromium are minimally leached, and cadmium and arsenic are not expected to readily leach.

The SPLP analytical data were compared to ground water and surface water standards, as follows.

- The SPLP concentrations of arsenic were compared to the ground water standard of 0.05 mg/L and surface water standard of 0.05 mg/L for arsenic. The one SPLP sample with detected arsenic (0.16mg/L) exceeded these standards.

- Although SPLP cadmium concentrations were not detected in the samples, most of the detection limits were greater than the ground water standard of 0.005 mg/L and surface water variable standards of 0.00118 to 0.00225 mg/L for cadmium.

- The detected SPLP concentrations of chromium were less than the ground water standard of 0.1 mg/L, but greater than the surface water standard of 0.011 mg/L.

- The SPLP concentrations of copper were compared to the ground water standard of 1 mg/L and surface water variable standards of 0.00427 to 0.00903 mg/L for copper. The detected SPLP concentrations were less than the ground water standard, but greater than the surface water standards.

- Five of the detected SPLP lead concentrations exceeded the ground water standard of 0.05 mg/L, and 11 samples exceeded the variable surface water standards of 0.00097 to 0.00254 mg/L.

- Eighteen of the detected SPLP manganese concentrations exceeded the ground water standard of 0.05 mg/L, and three of the samples exceeded the variable surface water standards of 1.231 to 1.655 mg/L.

- The detected SPLP zinc concentrations were less than the ground water standard of 5 mg/L, but greater than the lowest surface water standards, which vary from 0.116 to 0.41 mg/L.

3.3.7 Fines Fraction Analysis

For 70 surface soil samples, the seven primary metals were analyzed twice: a) once from the total volume of soil collected from a sample location, and b) a second time from the fines only fraction of that sample. These two analyses were conducted to assess whether the fines fraction of a soil sample contained a disproportionate concentration of the metals as compared to the total soil sample. These samples were collected from the OTP, Rex Flats, and Maloit Park, and the comparisons of the total to fines fractions metals concentrations (Appendix P) are discussed below.

The data show that the metals concentrations in the fine fraction are typically, but not always, greater than the concentrations in the total sample. This is not unexpected considering the criteria used to select the surface soil samples. As specified in the Work Plan, the sample selection was biased towards collecting tailings-like materials. This was accomplished by the field team: a) approaching the pre-selected sample grid point, b) then surveying the ground within a 50-foot radius of the pre-selected grid point for indications of tailings-like material (very fine grained soil and/or yellow to orange color soil), and c) sampling from the area with the greatest visual indication of tailings like material. Also, samples in addition to the prescribed work plan locations were collected from areas exhibiting tailings-like material.

To evaluate the gradations of the fines fraction, 10 samples that were analyzed for the total and fines were also analyzed for grain size. The

geotechnical laboratory was able to break out the fines fraction using a number 50 sieve, which is equivalent to 300 micrometers, and is more conservative than the number 60 sieve (250 micrometers) (Appendix P). These samples were selected to represent a range of arsenic values and encompassed Maloit Park, the OTP, and Rex Flats. The samples and results are summarized in Appendix P. The data show that the samples are biased towards tailings-like material, and that the overall average of the fines fraction is 52%. This fines fraction represents that portion of the sample that is in the range of a fine sand or smaller (silt and clay).

3.4 GROUND WATER

This section discusses the ground water, seep, and surface water diversion trench laboratory results to date. The ground water table and ground water flow directions are also evaluated below.

3.4.1 Ground Water Elevations and Flow Directions

Based on the past water elevation data collected by Viacom, and data collected during this investigation, ground water elevations in the OTP and Rex Flats areas generally increase in the spring (April through June) during the snow melt and decrease until the next spring. Due to its location with respect to the Eagle River (east of the river), ground water flow data from the Rex Flats area was evaluated separately in this report from the areas west of the Eagle River (OTP, Bolts Lake, and CTP). The Eagle River is likely a divide between the OTP and Rex Flats with respect to ground water flow. These areas are discussed below.

Rex Flats

The ground water elevations at Rex Flats for each month are plotted along with the ground water surface contours on figures in Appendix Q. Generally, the ground water flow directions were similar during this investigation for all 8 months. Figure 47 shows the ground water surface map for June, 2006. The dominant ground water flow direction in the Rex Flats surficial aquifer is to the north. The northerly ground water flow direction was consistent during this investigation. This northerly ground water flow direction parallels the Eagle River flow direction until the river bends to the east along the north end of Rex Flats. At the northern portion of Rex Flats, the ground water table is intercepted by the Eagle River, as evidenced by seeps on the river bank.

Figure 47 – Rex Flats, June 2006 Ground Water Contour Map

Notes: ***All areas are approximate; aerial photo date October 2004. Hand Dug well data is approximate. Contour interval = 1 foot. Blue arrow shows ground water flow direction. All data in feet above mean sea level. Due to their similarities, deep and shallow wells were both used to generate the contours.***

Generally, ground water elevations in all of the wells increase between March and April and decline for the rest of the year. The ground water elevations in the shallow and deep Rex Flats wells are plotted versus time in Figure 48. The ground water elevations measured in REX-MW-4S (shallow), and REX-MW-4D (deep) are similar throughout the year. The ground water elevations measured in REX-MW-1 (shallow) were lower in elevation than in the deep well REX-MW-1D throughout this investigation. This indicates that an upward ground water gradient exists in this area throughout the year. Elevations of the Eagle River measured in 2006 were lower than the ground water elevations in REX-MW-1 and -1D during this time period (Figure 48). The upward ground water gradient in those wells, which are located within 30 feet of the Eagle River, and the lower river elevation indicate that the Eagle River is gaining in this area during the spring and summer.

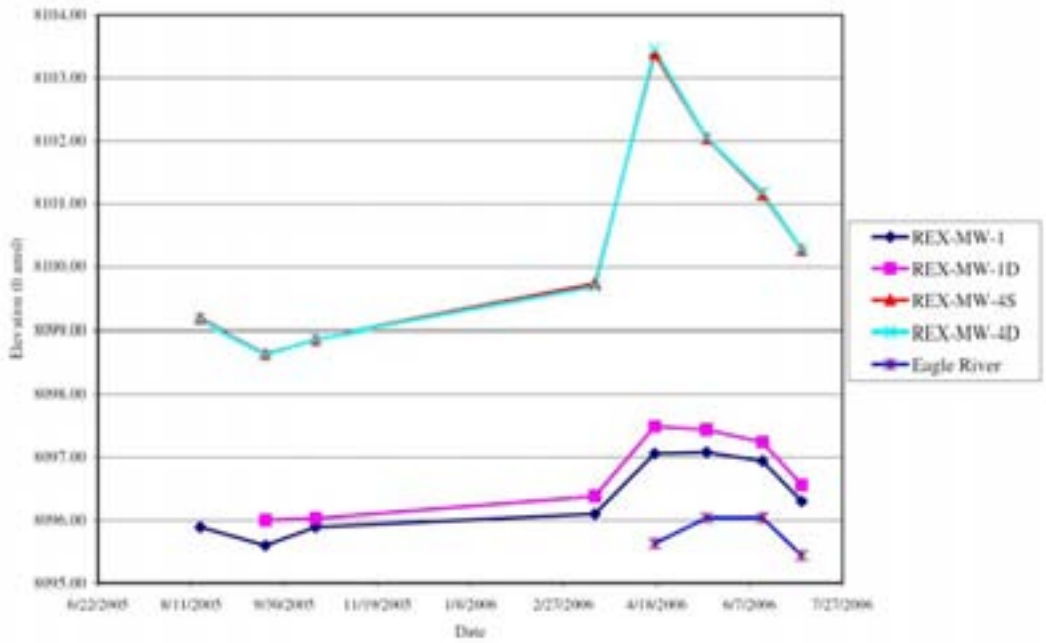


Figure 48 – Rex Flats Area, Shallow and Deep Well Ground Water Elevations

Ground water gradients in Rex Flats are generally steeper in the southern portion of Rex Flats and become less steep in the north portion near the Eagle River. This is likely due to the ground surface elevation change from higher elevations on the south end of Rex Flats to lower elevations in the north. The ground water elevations are plotted versus time for each well in the graphs provided in Appendix R. Ground water elevations collected by Viacom in the past at the existing wells are also included in Appendix R. The difference in ground water gradients between REX-MW-4S, in the north-central portion of Rex Flats, and REX-MW-1, in the

north portion of Rex Flats, ranges from 0.005 in the fall to about 0.01 in the spring. The difference in ground water elevation between these two wells ranges from 2.98 to 6.33 feet, respectively.

West of the Eagle River (OTP, Bolts Lake, and CTP Areas)

The ground water elevations for these monitoring wells are plotted versus time for each well in the graphs provided in Appendix R. The ground water elevations and flow for each area are discussed below.

OTP and Sump #3 Areas

The ground water elevations for August through October 2005 and March through July of 2006 are plotted along with the ground water surface contours on figures in Appendix S. The ground water surface maps were similar during this investigation and the June 2006 ground water contours are included on Figure 49. The dominant ground water flow direction in the surficial aquifer at the OTP follows the surface topography to the east towards the Eagle River. Ground water flow direction in the surficial aquifer near the Sump #3 area (SUM-MW-1 and OTP-MW-7) is to the southeast towards the Eagle River. A small ground water flow component from the Sump #3 area to Bolts Lake exists in April of 2006. The surficial ground water flow in this area is directed to the southeast due to the presence of bedrock outcrops on a large (150 feet above Bolts Lake) ridge to the east of the Sump #3 area and the surface topography which slopes towards the Eagle River to the southeast in this area. The surface topography is shown in Figure 50. Additionally, a three-dimensional perspective drawing is shown to illustrate the locations of large hills at the Site in Figure 51.

Figure 49 – OTP, Bolts Lake and CTP, June 2006 Ground Water Contour Map

Notes: All areas are approximate; aerial photo date October 2004. All data in feet above mean sea level. Only shallow wells were used for contouring. Contour interval = 5 feet. Arrows show general ground water flow direction.

Figure 50 – Surface Contour Map

Notes: ***All areas are approximate; aerial photo date October 2004.***

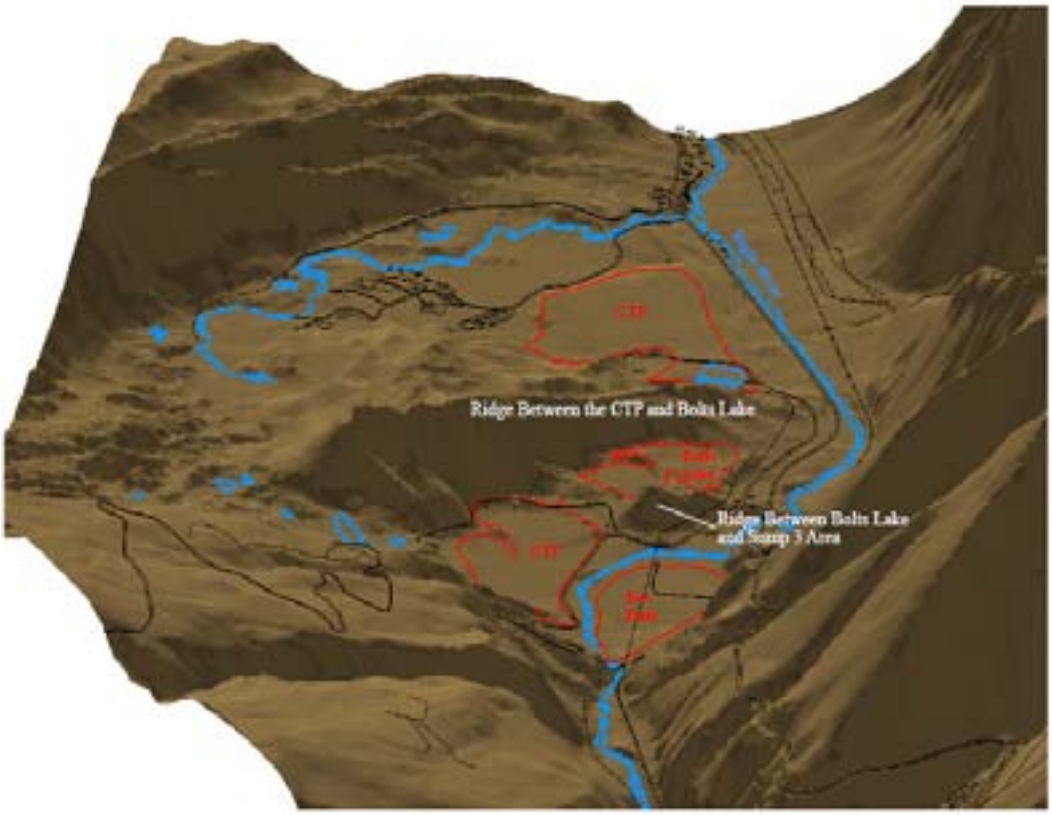


Figure 51 - 3D Perspective Looking North

Generally, ground water elevations in the monitoring wells in the OTP decreased from August to October 2005, increased in the spring of 2006, and started decreasing in the summer. The ground water elevations in the shallow and deep OTP wells are plotted versus time in Figure 52. The ground water elevations measured in OTP-MW-4S (shallow) are consistently at least 8 feet higher than the water levels in OTP-MW-4D (deep). This is due to a downward vertical ground water gradient in this area and because OTP-MW-4S is screened in a clayey interval while OTP-MW-4D is screened in silty sands and gravels. The ground water elevations in OTP-MW-8S (shallow) are slightly higher than OTP-MW-8D (deep) in the fall (September and October) and the elevations are higher in the deep well in the spring and summer. These differences indicate a small downward ground water gradient in this area during the fall and upward gradient in the spring and summer. Surface water elevations measured during the spring near these wells indicate that the ground water elevations in both OTP-MW-8S and -8D are higher than the Eagle River. This indicates that ground water near these wells is flowing to the Eagle River during the spring and summer.

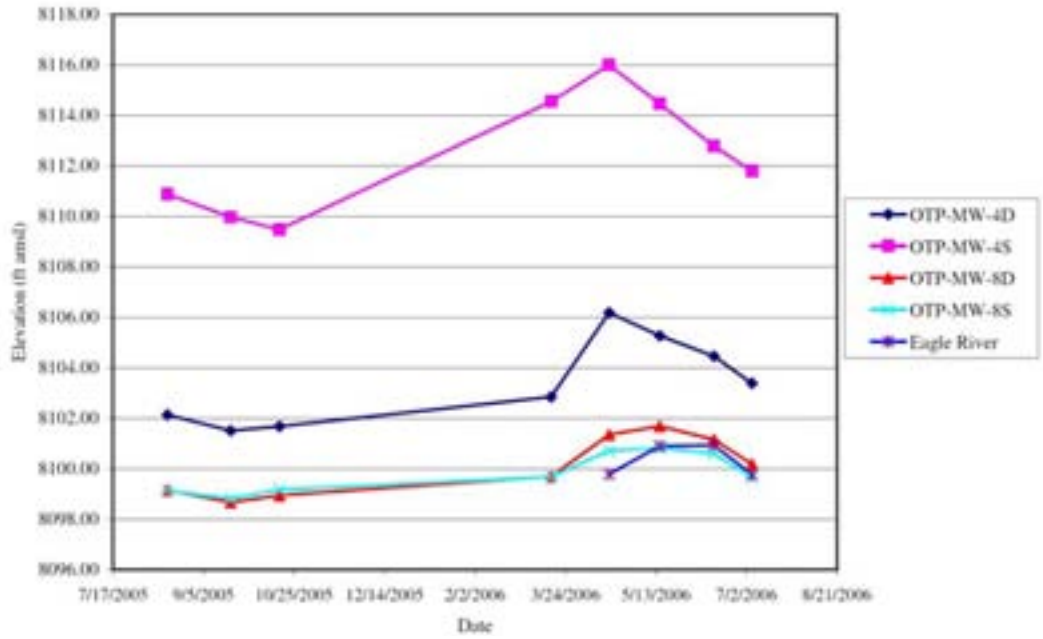


Figure 52 – OTP Area, Shallow and Deep Well Ground Water Elevations

Bolts Lake

Ground water elevations in the Bolts Lake wells trend downward from the fall and generally increase between April and June. Portions of the ground water in Bolts Lake flow to the east-northeast towards the Eagle River (Figure 49). Based on the June and July 2006 ground water contour maps, which include data from CTP-MW-3, a component of the ground water in the surficial aquifer within the western portion of Bolts Lake flows beneath this ridge to the CTP. The June of 2006 water level contours were draped over the three-dimensional perspective drawing to show the ground surface topography relative to the ground water flow directions. This drawing is included as Figure 53.

Figure 53 - 3D Perspective Looking Northwest

CTP

Ground water elevations in the surficial aquifer near the Eagle River to the east of the CTP, as measured in the new monitoring wells, indicate that the flow direction is generally to the north/northeast and parallels the Eagle River flow direction (Figure 49). North of the CTP, the ground water flows to the northeast towards the Eagle River. Surficial ground water flow between CTP-MW-1S and CTP-MW-2S could be affected by Viacom's eastern ground water extraction trench located near the toe of the CTP slope. Additionally, ground water flow directions north of the CTP are probably affected by Viacom's northern ground water extraction trench.

The ground water elevations monitored during this investigation generally decreased in the fall (August through October of 2005), increased in the spring and declined in the summer. The ground water elevations in the shallow and deep CTP wells and wells near Cross Creek are plotted versus time in Figure 54. The ground water elevations measured in CTP-MW-1S (shallow) and CTP-MW-1D (deep) are similar and indicate a downward gradient in March of 2006 only. The water levels in CTP-MW-1S almost dropped below the total depth of that well in March of 2006. The ground water elevations measured in CTP-MW-2S

and -2D show a downward vertical gradient throughout the year; the ground water elevations in the shallow well (CTP-MW-2S) are higher than the deeper well. The monitoring wells near Cross Creek CC-MW-1S (shallow) and CC-MW-1D (deep) do not indicate an upward or downward gradient at this time. The water levels in these two wells were similar throughout the year.

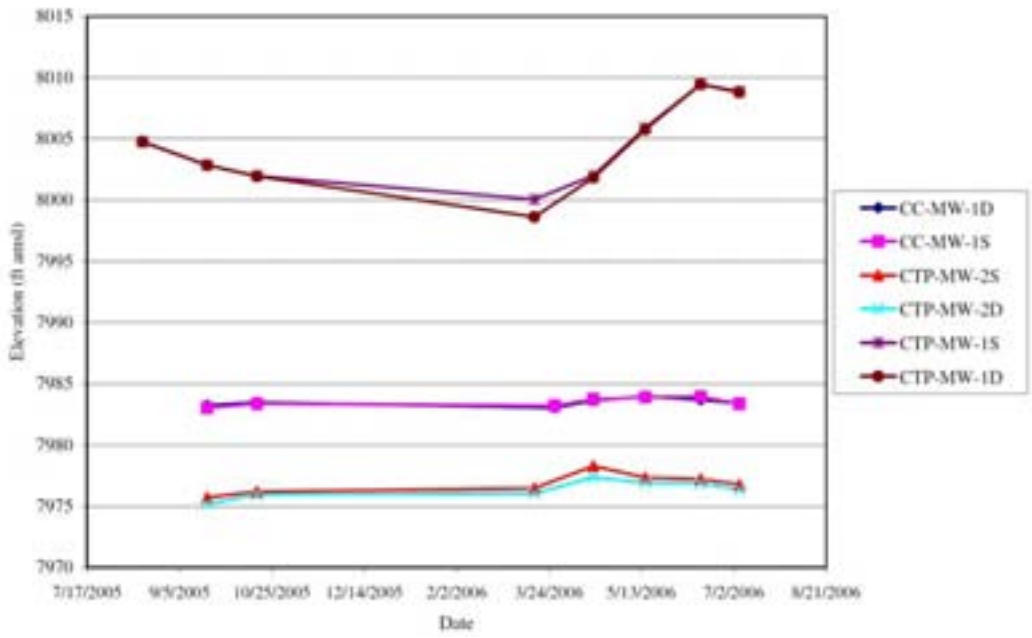


Figure 54 – CTP Area, Shallow and Deep Well Ground Water Elevations

3.4.2 *Metals Concentrations*

In order to determine areas of significant elevated metal concentrations, the analytical results were compared to CDPHE domestic water supply human health standards (CDPHE WQCD, 2005). In the absence of a CDPHE ground water supply human health standard, the results were compared to the CDPHE domestic water supply drinking water standard. Both of these standards are referred to herein as the CDPHE ground water standards and both are shown on the tables presented in this section.

The laboratory results were also compared to the segment-specific surface water standards to determine the potential for the ground water to affect the Eagle River. It is important to note that the surface water standards for all the primary metals, excluding manganese and arsenic, are at least one order of magnitude lower than the CDPHE ground water standards. Consequently, metals concentrations in ground water that do not exceed the CDPHE ground water standards could exceed surface water standards. Generally, if the detected metal concentrations exceeded the

CDPHE ground water standards, the surface water standard was exceeded, except for manganese. The ground water analytical results for each event are discussed in the following subsections.

The analytical results for the dissolved primary indicator metals are summarized in Appendix K and are plotted versus time for each well in graphs included in Appendix R. Also, the dissolved manganese, zinc, and cadmium results are shown on figures in Appendix K (Rex Flats) and Appendix U (west of the Eagle River). The expanded analyte list, plus VOCs and SVOCs, analytical results are summarized in Appendix K.

Rex Flats

Of the seven primary indicator metals, dissolved manganese, zinc, and cadmium were detected at Rex Flats above CDPHE ground water standards and surface water standards. Dissolved copper concentrations exceeded the surface water standards only. Generally, the total concentrations are similar to the dissolved concentrations and therefore the metals were present in the dissolved form (Table 13). Dissolved arsenic was detected in one well, the existing hand dug well, but the concentration did not exceed CDPHE ground water standards (Table 13). The field pH measurements also exceeded CDPHE ground water standards in some of the monitoring wells.

Table 13 Summary of Rex Flats Ground Water Analytical Data

	Location	Sample Date	Total/Dissolved	pH	Arsenic	Calcium	Chromium	Copper	Lead	Manganese	Zinc
					Dissolved Metals (milligrams per liter)						
Rex Flats	HANDDUG (existing)	8/24/2005	D	6.76	0.011	< 0.001	< 0.002	< 0.002	< 0.001	0.17	0.016
		9/21/2005	D	6.81	0.0092	< 0.001	< 0.002	< 0.002	< 0.001	0.19	< 0.01
		10/26/2005	D	6.75	0.049	< 0.001	< 0.002	< 0.002	< 0.001	0.57	< 0.01
		4/21/2006	D	6.73	< 0.005	0.0016	< 0.002	0.0073	< 0.001	0.01	0.33
		5/16/2006	D	6.38	< 0.005	< 0.001	< 0.002	0.0034	< 0.001	0.49	0.15
		6/15/2006	D	5.9	< 0.005	< 0.001	< 0.002	0.0034	< 0.001	0.33	0.15
		7/11/2006	D	6.66	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.041	0.053
	REX-MW-1 (existing)	8/19/2005	D	6.88	< 0.005	< 0.001	< 0.002	0.0043	< 0.001	14	0.33
		9/21/2005	D	6.29	< 0.005	< 0.001	< 0.002	0.0045 J+	< 0.001	14	0.36
		9/29/2005	D	6.91	< 0.005	< 0.001	< 0.002	0.0078	< 0.002	13	0.4
		10/24/2005	D	6.41	< 0.005	< 0.001	< 0.002	0.0066	< 0.001	12	0.27
		3/23/2006	D	6.46	< 0.005	< 0.001	< 0.002	0.0055	< 0.001	9.8	0.22
			T	6.46	< 0.005	< 0.001	< 0.002	0.0055	< 0.001	8.9	0.22
		4/27/2006	D	6.52	< 0.005	< 0.001	< 0.002	0.0027	< 0.001	8.8	0.053
			T	6.52	< 0.005	< 0.001	< 0.002	0.0047	< 0.001	9.8	0.052
		5/22/2006	D	6.58	< 0.005	< 0.001	< 0.002	0.0068	< 0.001	8.7	0.078
			T	6.58	< 0.005	< 0.001	< 0.002	0.0064	< 0.001	7.4	0.071
		6/16/2006	D	6.69	< 0.005	< 0.001	< 0.002	0.0036	< 0.001	7.6	0.17
			T	6.69	< 0.005	< 0.001	< 0.002	0.0032	< 0.001	7.6	0.15
		7/10/2006	D	6.53	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	7.8	0.15
			T	6.53	< 0.005	< 0.001 L	< 0.002	0.0051	< 0.001	7.7	0.15
	REX-MW-1D	9/30/2005	D	6.43	< 0.005	0.0093	< 0.002	0.0027	< 0.001	120	31
		10/24/2005	D	6.67	< 0.005	0.011	< 0.002	0.011	< 0.001	180	36
		3/23/2006	D	5.59	< 0.005	0.013	< 0.002	0.013	< 0.001	220	44
		4/27/2006	D	5.51	< 0.005	0.016	< 0.002	0.0096	< 0.001	230	46
		5/22/2006	D	5.51	< 0.005	0.017	< 0.002	0.016	< 0.001	230	45
		6/16/2006	D	5.66	< 0.005	0.016	< 0.002	0.0084	< 0.001	240	50
		7/10/2006	D	5.29	< 0.005	0.025	< 0.002	0.0084	< 0.001	420	82
	REX-MW-2 (existing)	8/24/2005	D	6.47	< 0.005	0.0054	< 0.002	0.003	< 0.001	27	6.6
		9/21/2005	D	5.99	< 0.005	0.0062	< 0.002	0.0029 J+	< 0.001	28	7.2
		10/24/2005	D	6.69	< 0.005	0.0029	< 0.002	< 0.002	< 0.001	12	1.7
		3/23/2006	D	6.2	< 0.005	0.0027	< 0.002	< 0.002	< 0.001	12	1.7
		4/21/2006	D	5.08	< 0.005	0.072	< 0.002	0.032	< 0.001	310	96
		5/16/2006	D	5.48	< 0.005	0.053	< 0.002	0.023	< 0.001	300	97
		6/16/2006	D	6.13	< 0.005	0.011	< 0.002	0.0046	< 0.001	96	19
		7/10/2006	D	6.05	< 0.005	0.0063	< 0.002	0.0026	< 0.001	29	7.3
	REX-MW-3 (existing)	8/24/2005	D	6.8	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.0034	< 0.01
		9/21/2005	D	6.78	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	< 0.001	< 0.01
		10/26/2005	D	6.87	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	< 0.001	< 0.01
		3/23/2006	D	6.11	< 0.005	< 0.001	< 0.002	< 0.001	< 0.001	< 0.001	< 0.01
		4/25/2006	D	6.58	< 0.005	< 0.001	< 0.002	0.0022	< 0.001	< 0.001	0.012
		5/22/2006	D	7.02	< 0.005	< 0.001	< 0.002	0.002	< 0.001	< 0.001	0.014
			T	7.02	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	< 0.001	< 0.01
		6/16/2006	D	6.88	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.002	< 0.01
		7/11/2006	D	6.24	< 0.005	< 0.001	< 0.002	0.002	< 0.001	< 0.001	0.012
	REX-MW-4D (existing)	8/19/2005	D	7.18	< 0.005	< 0.001	< 0.002	0.0032	< 0.001	8.7	0.036
		9/21/2005	D	6.75	< 0.005	< 0.001	< 0.002	0.0039 J+	< 0.001	9.6	0.029
		10/24/2005	D	7.04	< 0.005	< 0.001	< 0.002	0.0058	< 0.001	5.3	0.026
		3/23/2006	D	6.98	< 0.005	< 0.001	< 0.002	0.0044	< 0.001	2.8	0.019
		4/21/2006	D	6.99	< 0.005	< 0.001	< 0.002	0.0053	< 0.001	4.7	0.023
		5/16/2006	D	7.06	< 0.005	< 0.001	< 0.002	0.0031	< 0.001	5.5	0.022
		6/15/2006	D	6.82	< 0.005	< 0.001	< 0.002	0.0027	< 0.001	4.6	0.024
		7/10/2006	D	6.88	< 0.005	< 0.001	< 0.002	0.0036	< 0.001	4.6	0.026

				Dissolved Metals (milligrams per liter)						
Location	Sample Date	Total/Dissolved	pH*	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Zinc
RX-MW-4S (existing)	6/19/2005	D	6.5	< 0.005	0.057	< 0.002	0.028	< 0.001	34	8.5
	9/21/2005	D	5.99	< 0.005	0.061	< 0.002	0.02	< 0.001	37	9.3
	10/24/2005	D	6.29	< 0.005	0.062	< 0.002	0.069	< 0.001	31	10
	5/23/2006	D	4.29	< 0.005	0.046	< 0.002	0.19	< 0.001	12	6.4
		T	4.29	< 0.005	0.049	< 0.002	0.2	< 0.001	12	6.2
	4/21/2006	D	5.04	< 0.005	0.06	< 0.002	0.12	< 0.001	27	9.1
		T	5.04	< 0.005	0.058	< 0.002	0.12	< 0.001	27	8.6
	5/16/2006	D	6.08	< 0.005	0.053	< 0.002	0.043	< 0.001	36	8.9
		T	6.08	< 0.005	0.05	< 0.002	0.041	< 0.001	35	8.2
	6/15/2006	D	6.03	< 0.005	0.045	< 0.002	0.013	< 0.001	35	8.5
		T	6.03	< 0.005	0.042	< 0.002	0.013	< 0.001	38	9.2
	7/10/2006	D	6.6	< 0.005	0.056	< 0.002	0.013	< 0.001	37	9.3
		T	6.6	< 0.005	0.06 L	< 0.002	0.016	< 0.001	36	9.6
CDPHE Domestic Water Supply Standard										
Human Health Standard (enforceable)			na	0.05	0.005	0.1	na	0.05	na	na
Drinking Water Standard (not enforceable)			6.5-8.5	na	na	na	1.0	na	0.05	5.0
Chronic Eagle River Standards										
CDPHE Chronic Standards (Not Eagle River Segment Specific)			na	0.05	na	0.011	na	na	na	na
Calculated March to April Chronic Standards										
Segment 5a (OTP and Rex Flats)			na	na	0.00195	na	0.00764	0.00205	1.590	na
Segment 5b (Bolts Lake and the CTP)			na	na	0.00225	na	0.00903	0.00254	1.653	na
Segment 7b (Cross Creek)			na	na	0.00122	na	0.00444	0.00102	1.258	na
Calculated May to February Chronic Standards										
Segment 5a			na	na	0.00118	na	0.00427	0.00097	1.236	na
Segment 5b			na	na	0.00120	na	0.00435	0.00099	1.249	na
Segment 7b			na	na	0.00130	na	0.00478	0.00112	1.292	na
CDPHE Segment Specific Chronic Standards for Zinc										
March 1 through April 30										
Segment 5a			na	na	na	na	na	na	na	0.410
Segment 5b			na	na	na	na	na	na	na	0.310
Segment 7b			na	na	na	na	na	na	na	0.193
May 1 through February 29										
Segment 5a			na	na	na	na	na	na	na	0.166
Segment 5b			na	na	na	na	na	na	na	0.123
Segment 7b			na	na	na	na	na	na	na	0.116

NOTES: All results are dissolved and are in milligrams per liter (mg/L).

Segment 5a of the Eagle River is adjacent to the OTP and Rex Flats, therefore the ground water concentrations from the OTP and Rex Flats were compared to these standards.

Segment 5b of the Eagle River is adjacent to the CTP, therefore the ground water concentrations from the CTP ground water wells were compared to these standards.

Segment 7b of Cross Creek near the Cross Creek ground water wells (CC-MW-19, 215-F, and UGDT) – these standards were compared to the ground water concentrations from these locations.

= exceeds CDPHE human health or drinking water standard

= exceeds an Eagle River standard

= exceeds the Eagle River standard and the CDPHE human health or drinking water standard.

* Field pH, lab measurement prior to sampling

< = not detected above laboratory reporting limits, corresponding value is the reporting limit

CDPHE = Colorado Department of Public Health and the Environment

CTP = Consolidated Tailings Pile

D = dissolved, field filtered

existing = existing Vitrum ground water well

J= = estimated high

L = Initial dilution of a duplicate in the analytical batch indicates that physical and chemical interferences are present

na = not available

OTP = Old Tailings Pile

T = total

UGDT = upgradient ground water diversion trench

The dissolved manganese concentrations for Rex Flats for each sampling date are shown on figures in Appendix T. These manganese concentrations changed slightly (same order of magnitude) over these months except in RX-MW-2. The September 2005 dissolved manganese concentrations are shown in Figure 55 and are generally representative of these months.

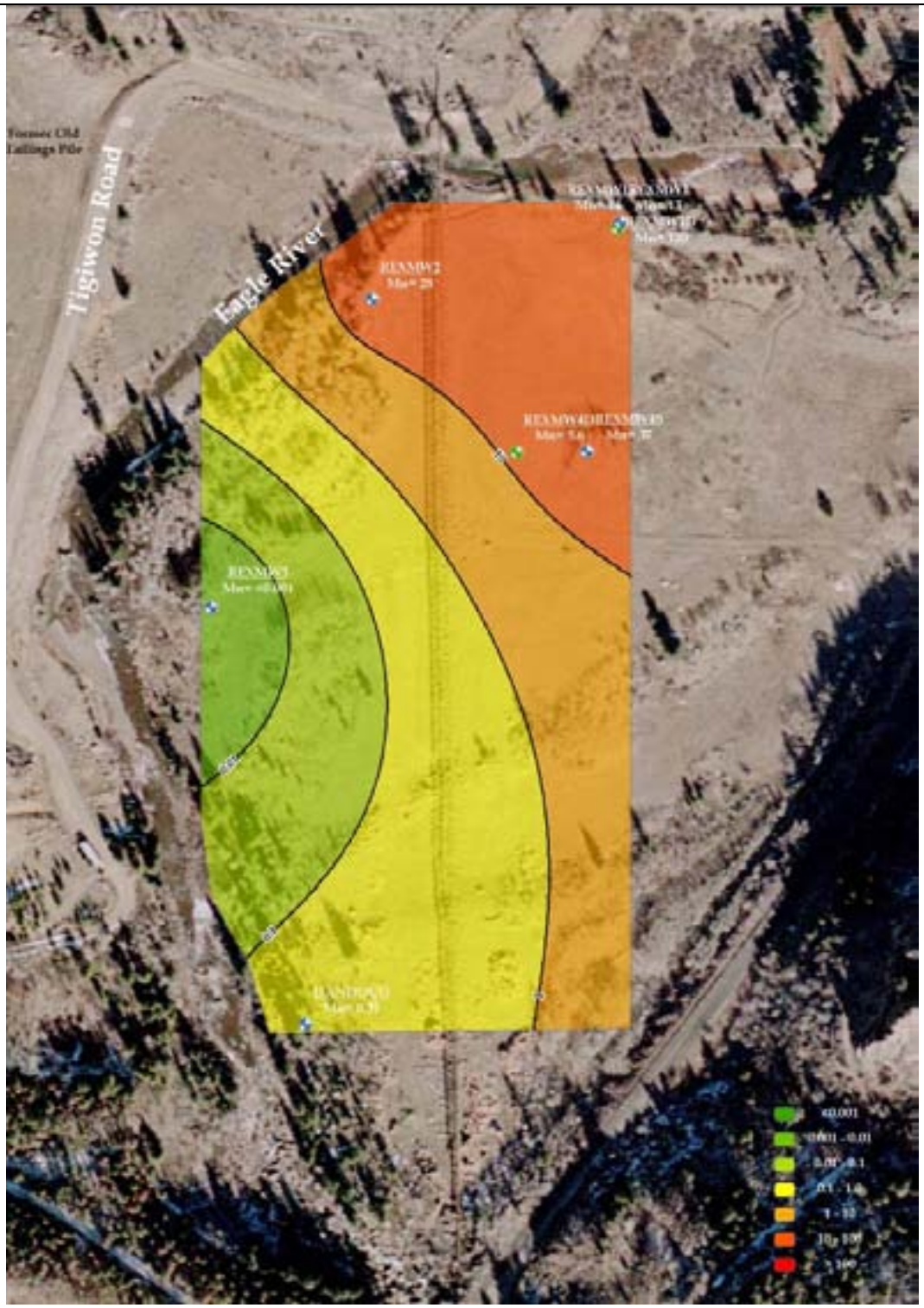


Figure 55 – Rex Flats, September 2005 Dissolved Manganese Map

Notes: ***All areas are approximate; aerial photo date October 2004. All data in milligrams per liter (mg/L) dissolved. Only shallow wells were used for contouring. Contour interval = 5 feet. U = not detected above laboratory reporting limit shown.***

The dissolved zinc and cadmium concentrations for Rex Flats detected during this investigation are shown on figures in Appendix T. These concentrations changed slightly (within an order of magnitude) over these months. The cadmium and zinc concentrations increased by an order of magnitude in samples collected from REX-MW-2 in the spring (April and May, 2006). The ground water elevation in this well increased at this time. The increase in concentrations in REX-MW-2 is likely due to drainage from a seep located to the south which passes adjacent to this well and flows during this time. The September 2005 dissolved zinc and cadmium concentrations are shown in Figure 56 and Figure 57 and are generally representative of concentrations detected during this investigation. Concentrations of dissolved copper exceeded the surface water standards in all the Rex Flats monitoring wells, excluding REX-MW-3 and the Hand Dug well, as shown in Table 13.

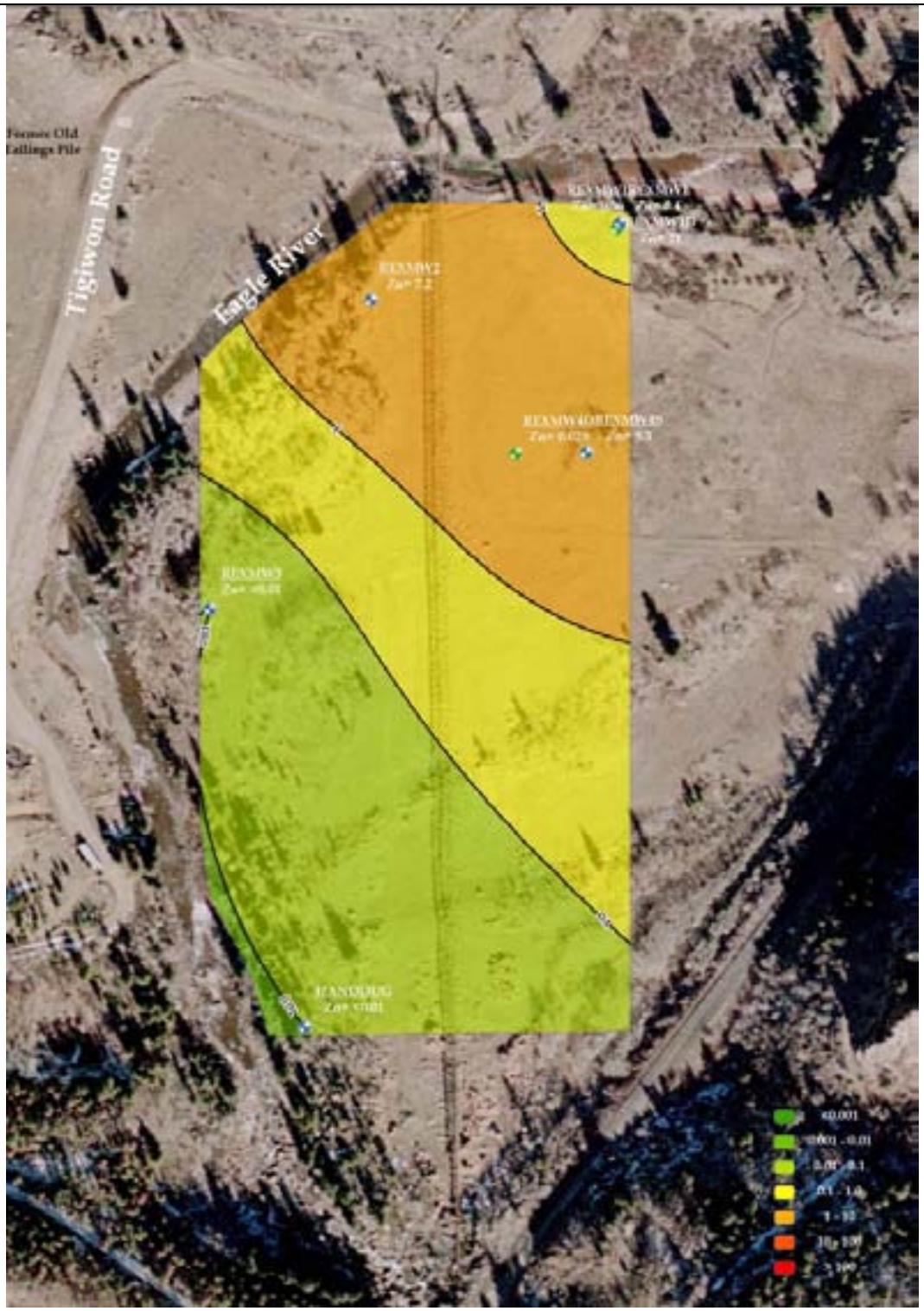


Figure 56 – Rex Flats, September 2005 Dissolved Zinc Map

Notes: ***All areas are approximate; aerial photo date October 2004. All data in milligrams per liter (mg/L) dissolved. Only shallow wells were used for contouring. Contour interval = 5 feet. U = not detected above laboratory reporting limit shown.***

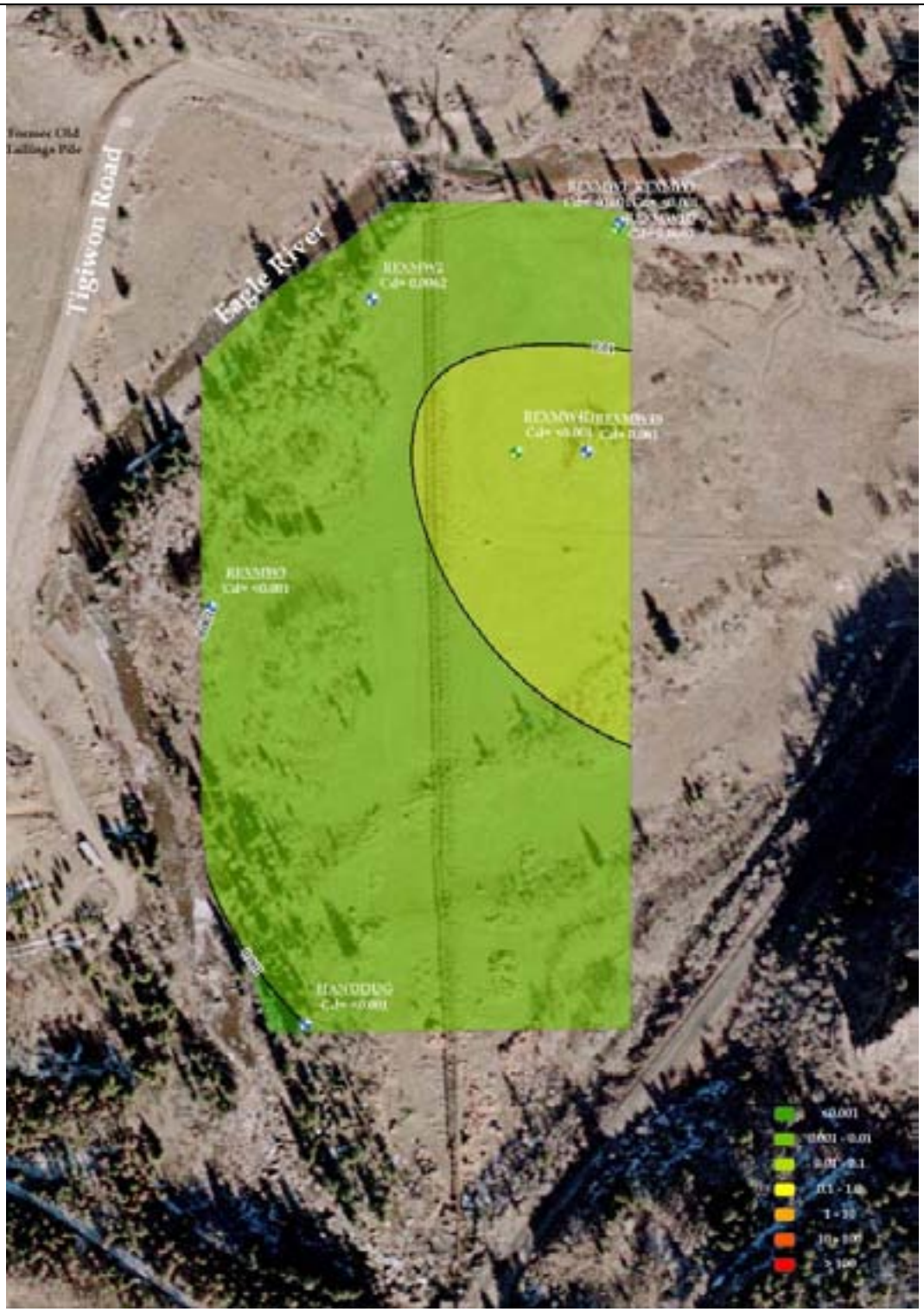


Figure 57 – Rex Flats, September 2005 Dissolved Cadmium Map

Notes: ***All areas are approximate; aerial photo date October 2004. All data in milligrams per liter (mg/L) dissolved. Only shallow wells were used for contouring. Contour interval = 5 feet. U = not detected above laboratory reporting limit shown.***

Laboratory analysis of ground water samples collected from REX-MW-1 and REX-MW-4S for the expanded analyte list detected elevated dissolved iron and sulfate above CDPHE ground water standards. The concentration of dissolved aluminum in REX-MW-4S during the spring exceeded the CDPHE ground water standard. The expanded analyte list laboratory results are summarized in Figure 58.

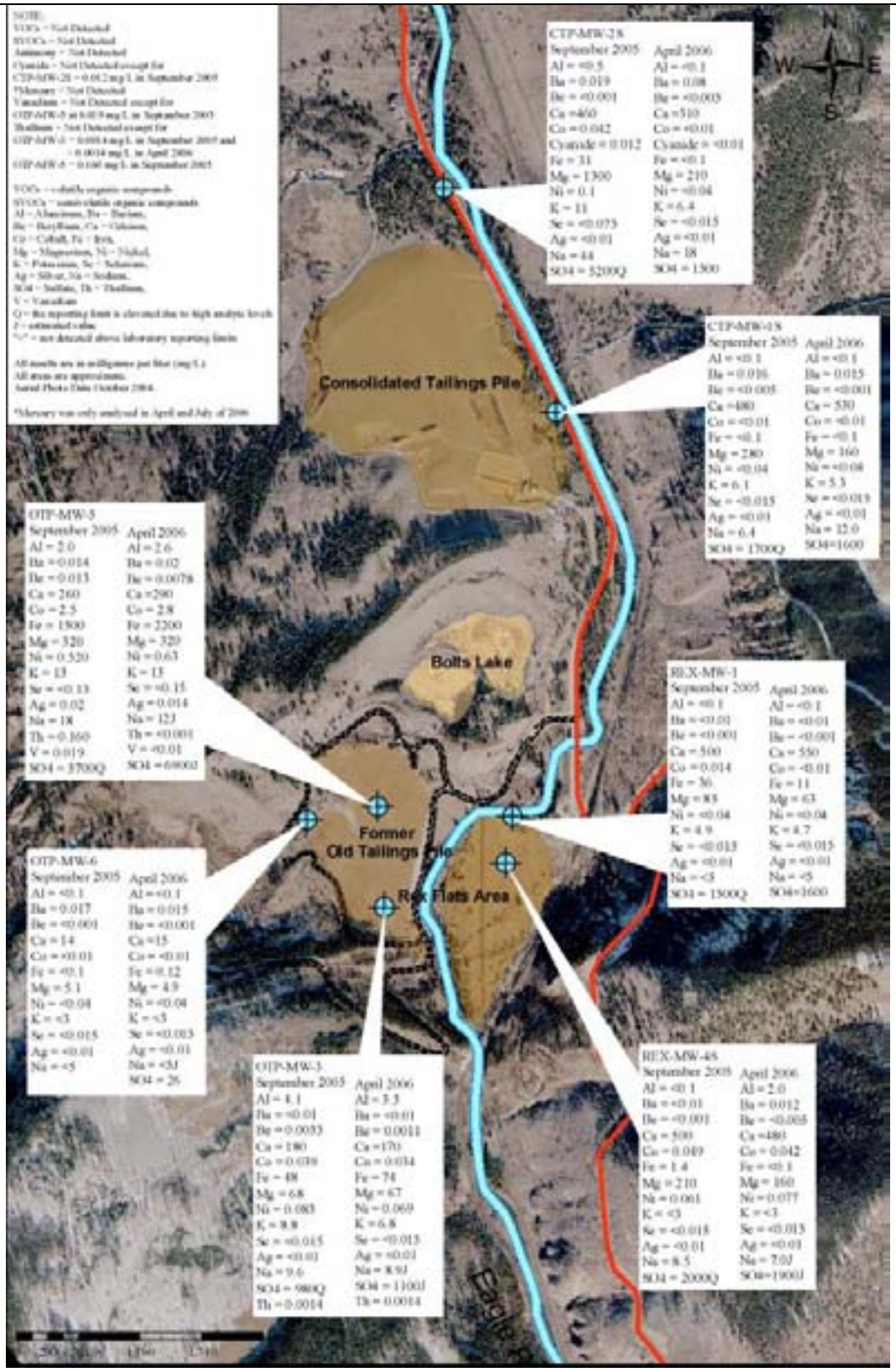


Figure 58 – Expanded Dissolved Metal Ground Water Results – September 2005 and April 2006

Notes: ***All areas are approximate; aerial photo date October 2004. All results are in milligrams per liter (mg/L). Q = the reporting level is elevated due to high analyte levels. SVOCs = semi volatile organic compounds. U = not detected above laboratory reporting limits. VOCs = volatile organic compounds.***

Dissolved metals concentrations in the shallow and deep wells in Rex Flats vary by location (Appendix T). Higher concentrations of dissolved zinc, manganese, and cadmium were detected in REX-MW-1D (deep) compared to REX-MW-1 (shallow), while higher concentrations of dissolved zinc, manganese, and cadmium were detected in REX-MW-4S (shallow) versus REX-MW-4D (deep).

Laboratory analysis of seep samples Rex-Seep-1 and -2 collected along the Eagle River on the north side of Rex Flats detected dissolved manganese and zinc (once in April of 2006) above the CDPHE ground water standard (Table 14). Dissolved concentrations of copper, lead, manganese and zinc exceeded the surface water standards. Field pH measurements collected from the REX-SEEP-2 in April 2006 was the lowest observed at Rex Flats. The seep sampling results are summarized on Figure 59.

Table 14 Summary of Rex Flats Seeps Analytical Data

	Location	Sample Date	Sample ID	Total/Dissolved	pH	Dissolved Oxygen	Specific Conductivity	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Zinc
								(dissolved metals milligrams per liter)						
Rex Flats Seeps	REX-SEEP-1	6-19-2005	REX-SEEP-1-061905-N	D	6.64			[illegible]	[illegible]	[illegible]	0.0024	[illegible]	14	0.11
		9-21-2005	REX-SEEP-1-092105-N	D	8.4			[illegible]	[illegible]	[illegible]	0.002[illegible]	[illegible]	15	0.082
		4-27-2006	REX-SEEP-1-0406-N	D	5.99			[illegible]	[illegible]	[illegible]	0.0084	[illegible]	1.8	0.44
	REX-SEEP-2	6-19-2005	REX-SEEP-2-061905-N	D	6.21			[illegible]	[illegible]	[illegible]	0.002[illegible]	[illegible]	33	4.9
		9-21-2005	REX-SEEP-2-092105-N	D	9.63			[illegible]	[illegible]	[illegible]	0.0026	[illegible]	39	2.6
		4-27-2006	REX-SEEP2040-N	D	9.05			[illegible]	[illegible]	[illegible]	0.002[illegible]	[illegible]	50	12
	CDPHE Domestic Water Supply Standard													
	Human Health Standard (ug/l)				na			0.05	0.005	0.1	na	0.05	na	na
	Drinking Water Standard (not enforceable)				6.5-8.5			na	na	na	1.3	na	0.05	5.0
	Chronic Eagle River Standards													
	CDPHE Chronic Standards (Not Eagle River Segment Specific)				na			0.05	na	0.011	na	na	na	na
	Calculated March to April Chronic Standards													
	Segment 5a (OU9 and Rex Flats)				na			na	[illegible]	na	[illegible]	[illegible]	1.770	na
	Segment 5b (Belly Lake and the CTP)				na			na	[illegible]	na	[illegible]	[illegible]	1.277	na
	Segment 5c (Cow Creek)				na			na	[illegible]	na	[illegible]	[illegible]	1.279	na
	Calculated May to February Chronic Standards													
	Segment 5a				na			na	[illegible]	na	[illegible]	[illegible]	1.770	na
	Segment 5b				na			na	[illegible]	na	[illegible]	[illegible]	1.147	na
	Segment 5c				na			na	[illegible]	na	[illegible]	[illegible]	1.292	na
	CDPHE Segment Specific Chronic Standards for Zinc													
	March 1 through April 30													
	Segment 5a				na			na	na	na	na	na	na	0.410
	Segment 5b				na			na	na	na	na	na	na	0.310
	Segment 5c				na			na	na	na	na	na	na	0.135
	May 1 through February 29													
	Segment 5a				na			na	na	na	na	na	na	0.350
	Segment 5b				na			na	na	na	na	na	na	0.270
	Segment 5c				na			na	na	na	na	na	na	0.116

NOTES: All results are dissolved and are in milligrams per liter (mg/L).

Segment 5a of the Eagle River is adjacent to the OU9 and Rex Flats. Therefore the ground water concentrations from the OU9 and Rex Flats were compared to these standards.

Segment 5b of the Eagle River is adjacent to the CTP. Therefore the ground water concentrations from the CTP ground water wells were compared to these standards.

Segment 5c of Cow Creek and the Cow Creek ground water wells (CO-MW-01, DO-1, and COD2) -- these standards were compared to the ground water concentrations from these locations.

= exceeds CDPHE human health or drinking water standard

= exceeds an Eagle River standard

= exceeds the Eagle River standard and the CDPHE human health or drinking water standard

* Field pH, low measurement prior to sampling

< = not detected above laboratory reporting limits, corresponding value is the reporting limit

CDPHE = Colorado Department of Public Health and the Environment

CTP = Consolidated Tailings Pile

D = dissolved, field filtered

existing = existing Chronic ground water well

J = estimated high

L = based division of a diagnostic in the analytical book indicates that physical and chemical interferences are present

na = not available

OU9 = Old Tailings Pile

T = total

YSZ01 = upgradient ground water downstream transit

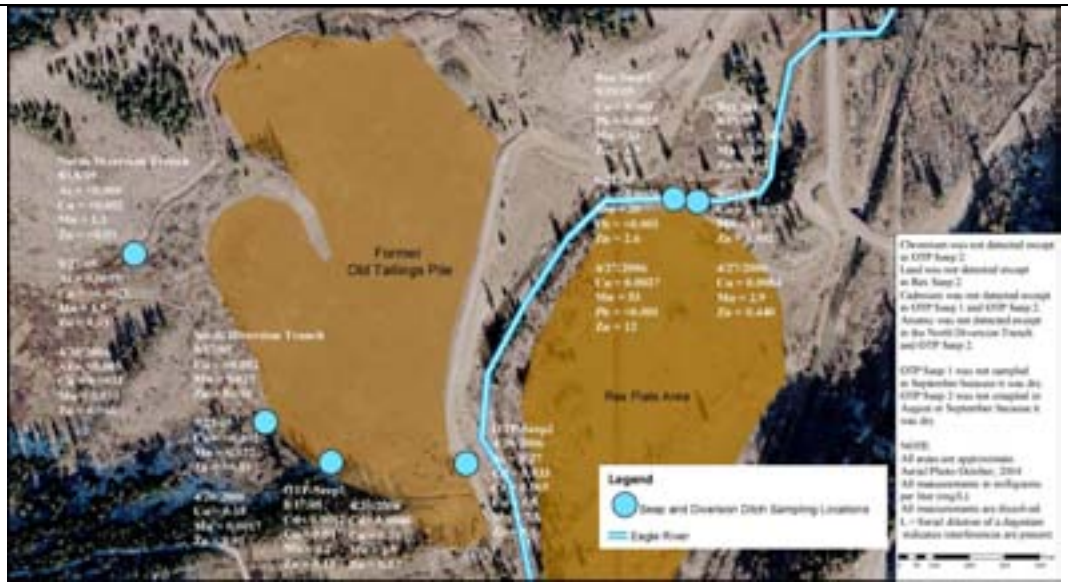


Figure 59 – Seep and Surface Water Diversion Trench Sampling Results

Notes: ***All areas are approximate; aerial photo date October 2004. All results are in milligrams per liter (mg/L) dissolved. L = serial dilution of a digestate indicates interferences are present. U = not detected above laboratory reporting limit shown.***

West of the Eagle River (OTP, Bolts Lake and CTP)

OTP

Ground water concentrations of cadmium, manganese, zinc, arsenic (one well), and pH were higher than the CDPHE ground water standards. Ground water concentrations of cadmium, copper, lead, manganese, and zinc exceeded the surface water standards. An analysis of the total and dissolved concentrations indicates that most of the total concentrations are accounted for in the dissolved result. The detected metals concentrations in ground water samples collected between August and October 2005, varied slightly and generally were within an order of magnitude. Some of the metals concentrations in the OTP monitoring wells decreased in the spring. The results are summarized in Table 15.

Table 15 Summary of OTP Ground Water Analytical Data

	Location	Sample Date	Total/Dissolved	pH	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Zinc
					Dissolved Metals (milligrams per liter)						
OTP	OTP-MW-3 (existing)	6/17/2005	D	3.96	< 0.005	0.14	< 0.002	0.32	0.0017	33	46
		9/23/2005	D	3.96	< 0.005	0.14	< 0.002	0.37	0.0063	32	42
		10/18/2005	D	3.78	< 0.005	0.047	< 0.002	0.62	0.0018	9.7	14
		3/20/2006	D	5.13	< 0.005	0.13	< 0.002	0.23	< 0.001	27	38
			T	5.13	< 0.005	0.12	< 0.002	0.23	< 0.001	25	36
		4/20/2006	D	4.07	< 0.005	0.1	< 0.002	0.19	< 0.001	34	48
			T	4.07	< 0.005	0.098	< 0.002	0.21	< 0.001	34	49
		5/16/2006	D	4.48	< 0.005	0.061	< 0.002	0.32	< 0.001	14	20
			T	4.48	< 0.005	0.065	< 0.002	0.35	< 0.001	15	21
		6/21/2006	D	4.04	< 0.005	0.12	< 0.002	0.24	< 0.001	31	45
			T	4.04	< 0.005	0.14	< 0.002	0.24	< 0.001	30	47
		7/12/2006	D	3.91	< 0.005	0.14	< 0.002	0.21	< 0.001	29	42
			T	3.91	< 0.005	0.14 L	< 0.002	0.25	< 0.001	29	44
	OTP-MW-4D (existing)	6/17/2005	D	5.26	0.0064	0.0021	< 0.002	0.015	0.0011	480	320
		9/29/2005	D	5.3	0.0067	0.0015	< 0.002	0.039	< 0.002	700	480
		10/20/2005	D	5.27	0.006	< 0.001	< 0.002	0.014	0.001	860	390
		3/20/2006	D	5.19	0.0056	< 0.001	< 0.002	0.014	< 0.001	930	440
		4/19/2006	D	5.45	< 0.01	< 0.002	< 0.004	0.051	< 0.002	1400	540
		5/18/2006	D	5.62	< 0.025	< 0.001	< 0.01	0.073	< 0.001	1100	490
		6/21/2006	D	5.43	0.0077	< 0.001	< 0.002	0.014	< 0.001	1200	480
		7/11/2006	D	5.32	< 0.005	< 0.001	< 0.002	0.018	< 0.001	560	320
	OTP-MW-4S (existing)	6/17/2005	D	5.07	0.11	0.19	< 0.002	0.0071	< 0.001	28	33
		9/27/2005	D	5.22	0.091	0.19	< 0.002	0.0052 L	< 0.001	25	27
		10/20/2005	D	5.2	0.1	0.15	< 0.002	0.0048	0.0019	24	26
		3/20/2006	D	5.18	0.041	0.39	< 0.002	0.004	< 0.001	41	51
		4/19/2006	D	5.38	0.033	0.24	< 0.002	0.0059	< 0.001	30	33
		5/18/2006	D	5.65	0.042	0.27	< 0.002	0.0049	< 0.001	28	32
		6/21/2006	D	5.27	0.039	0.19	< 0.002	0.0051	< 0.001	25	28
		7/11/2006	D	4.99	0.049	0.21	< 0.002	0.0033	< 0.001	23	26
	OTP-MW-5 (existing)	6/16/2005	D	6.97	0.0056	0.0070	< 0.002	0.01	< 0.001	420	91
		9/23/2005	D	5.49	< 0.01	0.011	< 0.004	0.013	< 0.002	380	83
		10/18/2005	D	5.67	0.006	0.0078	< 0.002	0.01	0.0017	350	85
		3/20/2006	D	5.34	< 0.005	0.0069	< 0.002	0.009	< 0.001	410	110
			T	5.34	0.0056	0.0077	0.002	0.012	< 0.001	410	98
		4/20/2006	D	5.42	0.0055	0.0050	< 0.002	0.028	< 0.001	450	87
			T	5.42	0.0053	0.0062	0.0026	0.024	< 0.001	440	93
		5/17/2006	D	5.99	< 0.025	0.0053	< 0.01	0.04	< 0.001	420	99
			T	5.99	< 0.025	0.0051	< 0.01	0.042	< 0.001	440	100
		6/20/2006	D	5.89	0.006	0.0036	< 0.002	0.0070	< 0.001	410	87
			T	5.89	0.0056	0.0039	< 0.002	0.011	< 0.001	390	94
		7/13/2006	D	5.63	< 0.01	0.0034	< 0.004	0.021	< 0.002	390	82
			T	5.63	< 0.01	0.0034 L	< 0.004	0.018	< 0.002	400	91
	OTP-MW-6 (existing)	6/17/2005	D	6.11	< 0.005	< 0.001	< 0.002	0.0052	< 0.001	0.054	< 0.01
		9/23/2005	D	6.51	< 0.005	< 0.001	< 0.002	0.0068	< 0.001	0.0028	< 0.01
		10/18/2005	D	6.41	< 0.005	< 0.001	< 0.002	0.007	< 0.001	0.0047	< 0.01
		3/20/2006	D	6.39	< 0.005	< 0.001	< 0.002	0.0048	< 0.001	< 0.001	< 0.01
		4/20/2006	D	6.3	< 0.005	< 0.001	< 0.002	0.0041	< 0.001	< 0.001	< 0.01
		5/16/2006	D	6.59	< 0.005	< 0.001	< 0.002	0.0082	< 0.001	< 0.001	0.013
		6/20/2006	D	6.43	< 0.005	< 0.001	< 0.002	0.0072	< 0.001	0.0015	0.013
		7/12/2006	D	5.9	< 0.005	< 0.001	< 0.002	0.0064	< 0.001	0.002	0.012
	OTP-MW-7	6/17/2005	D	7.04	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.0082	0.011
		9/23/2005	D	6.99	< 0.005	< 0.001	< 0.002	0.0022 L	< 0.001	0.0026	0.011
		10/20/2005	D	6.96	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.012	0.015
		3/20/2006	D	6.76	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.001	< 0.01
		4/20/2006	D	6.61	< 0.005	< 0.001	< 0.002	0.0027	< 0.001	0.0028	0.011
		5/19/2006	D	7.17	< 0.005	< 0.001	< 0.002	0.0048	< 0.001	0.0018	< 0.01
		6/16/2006	D	6.84	< 0.005	< 0.001	< 0.002	0.0034	< 0.001	0.004	< 0.01
		7/13/2006	D	6.51	< 0.005	< 0.001	< 0.002	0.0026	< 0.001	0.015	0.015

				Dissolved Metals (milligrams per liter)						
Location	Sample Date	Total/Dissolved	pH*	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Zinc
OTP-MW-4D	8/18/2005	D	6.32	< 0.005	0.0075	< 0.002	0.005	< 0.001	96	14
	9/27/2005	D	5.99	< 0.005	0.0041	< 0.002	0.0049 L	< 0.001	82	10
	10/18/2005	D	6.27	< 0.005	0.0029	< 0.002	0.0058	< 0.001	78	8.9
	3/21/2006	D	5.93	< 0.005	0.0059	< 0.002	0.0063	< 0.001	79	10
	4/25/2006	D	6.08	< 0.005	0.0095	< 0.002	0.0064	< 0.001	110	16
	5/18/2006	D	6.51	< 0.005	0.011	< 0.002	0.0092	< 0.001	120	17
	6/19/2006	D	5.97	< 0.005	0.0098	< 0.002	0.0043	< 0.001	97	15
	7/12/2006	D	6.08	< 0.005	0.011	< 0.002	0.0087	< 0.001	120	19
OTP-MW-4S	8/18/2005	D	4.67	< 0.005	0.059	0.0049	0.53	0.0056	29	23
	9/27/2005	D	4.12	< 0.005	0.026	0.0028	0.21 L	0.0028	16	11
	10/18/2005	D	4.27	< 0.005	0.047	0.005	0.23	0.011	29	21
	3/21/2006	D	3.59	< 0.005	0.042	0.0041	0.27	0.0024	55	29
	4/25/2006	D	3.94	< 0.005	0.032	0.0032	0.21	0.0028	59	30
	5/18/2006	D	4.42	< 0.005	0.02	0.003	0.19	0.0031	58	27
	6/19/2006	D	3.63	< 0.005	0.044	0.0064	0.36	0.0029	42	32
	7/12/2006	D	3.84	< 0.005	0.06	0.0075	0.45	0.0056	54	31
OTP-MW-9	8/18/2005	D	3.7	< 0.005	0.036	0.0033	0.16	0.0019	4.6	3.6
	9/27/2005	D	3.51	< 0.005	0.04	0.0044	0.34 L	0.011	6.4	5.2
	10/18/2005	D	3.68	< 0.005	0.043	0.0054	0.33	0.014	5.8	4.7
	3/20/2006	D	4.15	< 0.005	0.042	0.0055	0.28	0.0019	7.3	5.2
	4/18/2006	D	3.92	< 0.005	0.03	0.0031	0.13	< 0.001	9.6	4.2
	5/18/2006	D	3.32	< 0.005	0.037	0.0035	0.16	< 0.001	5.5	3.5
	6/21/2006	D	3.12	< 0.005	0.029	0.0038	0.14	< 0.001	4.2	2.5
	7/6/2006	D	3.01	< 0.005	0.024	0.0027	0.12	< 0.001	3.4	2.2
SUM-MW-1	8/17/2005	D	6.82	< 0.005	< 0.001	< 0.002	0.0028	< 0.001	0.39	0.078
	9/27/2005	D	7.05	< 0.005	< 0.001	< 0.002	0.0031 L	< 0.001	1.1	0.051
	10/20/2005	D	7.03	< 0.005	< 0.001	< 0.002	0.0049	< 0.001	1.3	0.064
	3/21/2006	D	6.82	< 0.005	< 0.001	< 0.002	0.0027	< 0.001	2.6	0.031
	4/19/2006	D	7.31	< 0.005	< 0.001	< 0.002	0.0058	< 0.001	4.8	0.025
	5/17/2006	D	7.6	< 0.005	< 0.001	< 0.002	0.0056	< 0.001	4.7	0.016
	6/21/2006	D	7.18	< 0.005	< 0.001	< 0.002	0.0024	< 0.001	2.7	0.031
	7/13/2006	D	7.15	< 0.005	< 0.001	< 0.002	0.0043	< 0.001	2.2	0.061
CDPHE Domestic Water Supply Standard										
Human Health Standard (unforeable)			na	0.05	0.005	0.1	na	0.05	na	na
Drinking Water Standard (not enforceable)			6.5-8.5	na	na	na	1.0	na	0.05	5.0
Chronic Eagle River Standards										
CDPHE Chronic Standards (Not Eagle River Segment Specific)			na	0.05	na	0.011	na	na	na	na
Calculated March to April Chronic Standards										
Segment 5a (OTP and Rex Pits)			na	na	0.00195	na	0.00764	0.00209	1.550	na
Segment 5b (Belts Lake and the CTP)			na	na	0.00225	na	0.00903	0.00254	1.655	na
Segment 5b (Cross Creek)			na	na	0.00122	na	0.00444	0.00102	1.255	na
Calculated May to February Chronic Standards										
Segment 5a			na	na	0.00118	na	0.00427	0.00097	1.236	na
Segment 5b			na	na	0.00120	na	0.00435	0.00099	1.245	na
Segment 5b			na	na	0.00130	na	0.00476	0.00112	1.292	na
CDPHE Segment Specific Chronic Standards for Zinc										
March 1 through April 30										
Segment 5a			na	na	na	na	na	na	na	0.410
Segment 5b			na	na	na	na	na	na	na	0.310
Segment 5b			na	na	na	na	na	na	na	0.193
May 1 through February 29										
Segment 5a			na	na	na	na	na	na	na	0.360
Segment 5b			na	na	na	na	na	na	na	0.125
Segment 5b			na	na	na	na	na	na	na	0.116

NOTES: All results are dissolved and are in milligrams per liter (mg/L).

Segment 5a of the Eagle River is adjacent to the OTP and Rex Pits, therefore the ground water concentrations from the OTP and Rex Pits were compared to these standards.

Segment 5b of the Eagle River is adjacent to the CTP, therefore the ground water concentrations from the CTP ground water wells were compared to these standards.

Segment 5b of Cross Creek near the Cross Creek ground water wells (CC-MW-1A, DS-8, and USDT) -- these standards were compared to the ground water concentrations from these locations.

= exceeds CDPHE human health or drinking water standard

= exceeds an Eagle River standard

= exceeds the Eagle River standard and the CDPHE human health or drinking water standard

* Field pH, lab measurement prior to sampling

< = not detected above laboratory reporting limits, corresponding value is the reporting limit

CDPHE = Colorado Department of Public Health and the Environment

CTP = Consolidated Tailings Pile

D = dissolved, field filtered

existing = existing Vacuum ground water well

J= = estimated high

L = barrel dilution of a dispersion in the analytical batch indicates that physical and chemical interferences are present

na = not available

OTP = Old Tailings Pile

T = total

USDT = upgradient ground water diversion trench

The dissolved manganese concentrations for the OTP during this investigation are shown on figures in Appendix U. The manganese concentrations in most of the monitoring wells over this investigation were similar or at least within the same order of magnitude. Higher manganese concentrations were observed in a few of the monitoring wells in the spring (CTP-MW-2S, BL-MW-3, and OTP-MW-9). However, generally the distribution of higher concentrations was similar from month to month. The September 2005 dissolved manganese concentrations are shown in Figure 60 and are generally representative of these months.

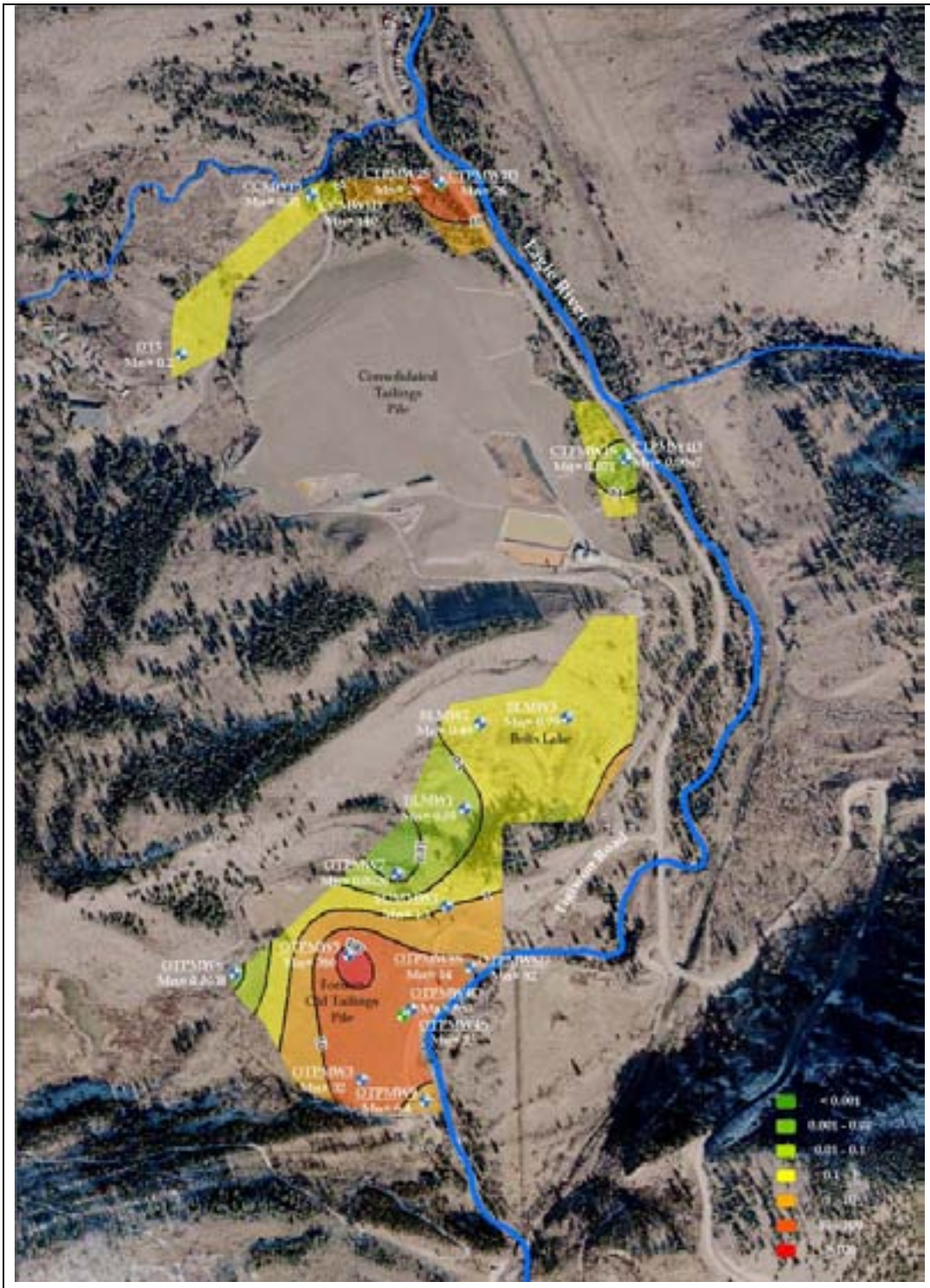


Figure 60 – OTP, Bolts Lake and CTP, Dissolved Manganese September 2005

Notes: ***All areas are approximate; aerial photo date October 2004. All data in milligrams per liter (mg/L) dissolved. Only shallow wells were used for contouring. Some concentrations inferred between monitoring well sampling locations. Contour interval = Log (0.001, 0.01, 0.1, etc.). U = not detected above laboratory reporting limit shown.***

Dissolved zinc concentrations were detected above the laboratory reporting limits in all of the OTP wells. Zinc concentrations exceeded the CDPHE ground water standard of 5 mg/L and the surface water standards in all of these wells except for OTP-MW-6, OTP-MW-7, and SUM-MW-1. Zinc concentrations in CTP-MW-2S increased in June and July of 2006. Dissolved cadmium was detected in most of the OTP monitoring wells. Most of the dissolved cadmium concentrations exceeded either the surface water standards or the CDPHE ground water standard of 0.005 mg/L. Lower field pH (below 5) was observed in OTP-MW-9, OTP-MW-3, and OTP-MW-8S. The dissolved zinc and cadmium concentrations for the OTP during this investigation are shown on figures in Appendix U. The September 2005 dissolved zinc and cadmium concentrations are shown in Figures 61 and Figure 62, respectively, and are generally representative of these months.

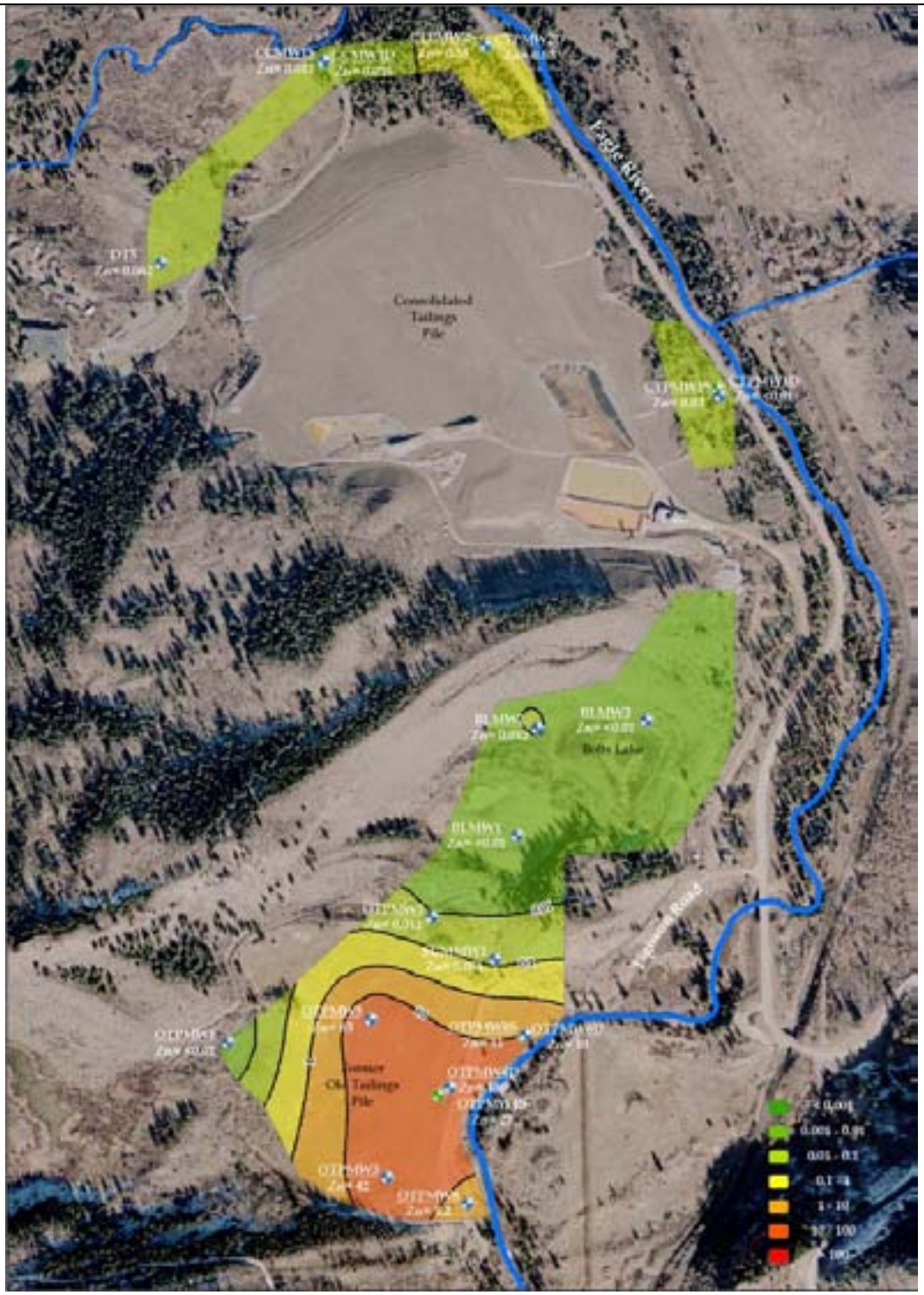


Figure 61 – OTP, Bolts Lake and CTP, Dissolved Zinc September 2005

Notes: ***All areas are approximate; aerial photo date October 2004. All data in milligrams per liter (mg/L) dissolved. Only shallow wells were used for contouring. Some concentrations inferred between monitoring well sampling locations. Contour interval = Log (0.001, 0.01, 0.1, etc.). U = not detected above laboratory reporting limit shown.***

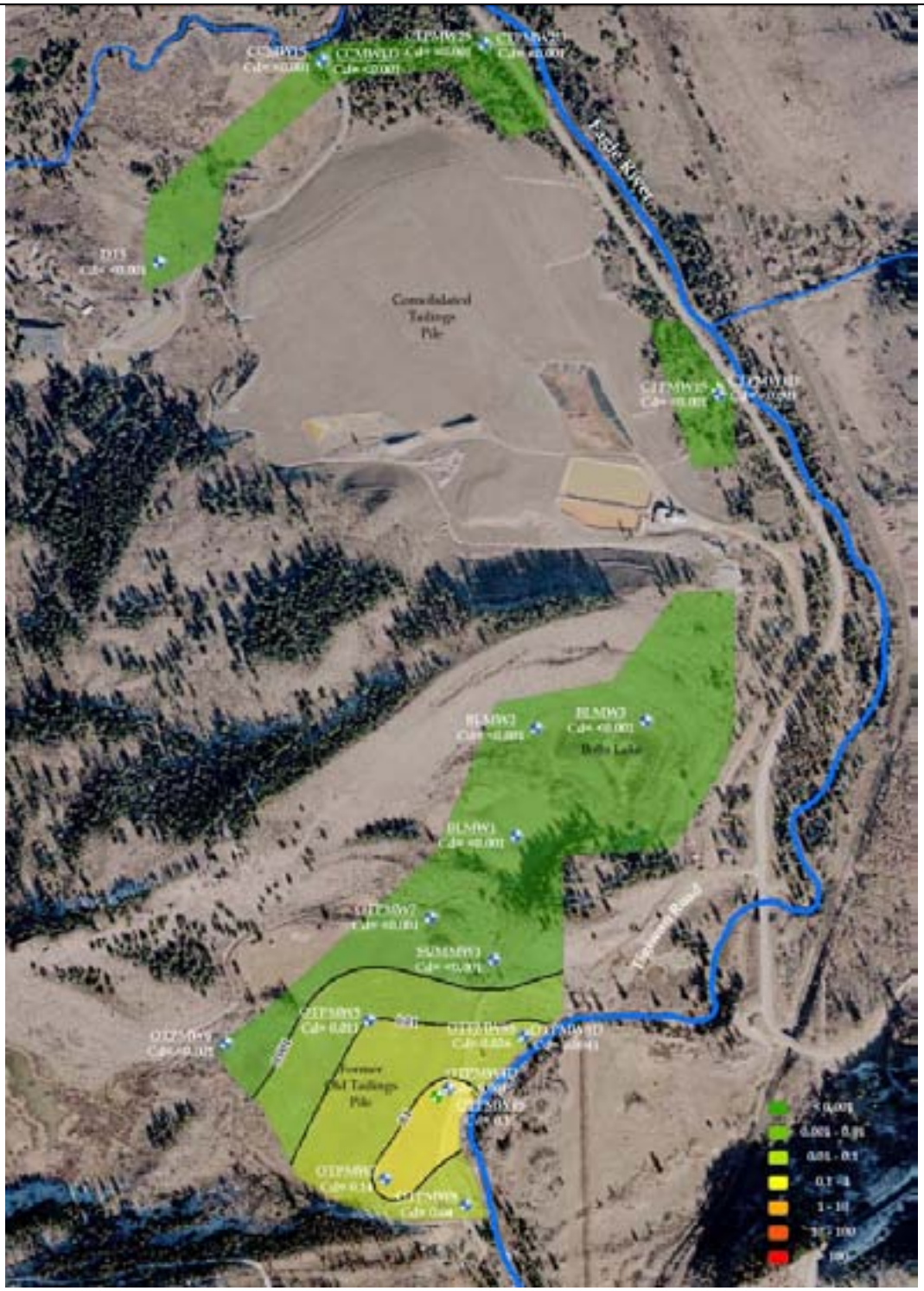


Figure 62 – OTP, Bolts Lake and CTP, Dissolved Cadmium September 2005

Notes: ***All areas are approximate; aerial photo date October 2004. All data in milligrams per liter (mg/L) (dissolved). Only shallow wells were used for contouring. Some concentrations inferred between monitoring well sampling locations. Contour interval = Log (0.001, 0.01, 0.1, etc.). U = not detected above laboratory reporting limit shown.***

Laboratory analysis of ground water samples collected from OTP-MW-3 and OTP-MW-5 for the expanded analyte list detected dissolved aluminum, iron and sulfate above CDPHE ground water standards. Additionally, analysis of the ground water sample from OTP-MW-5 detected dissolved beryllium, nickel, and thallium above the CDPHE ground water standard. Dissolved barium, calcium, cobalt, magnesium, potassium, sodium, and vanadium were detected above the laboratory reporting limits but did not exceed CDPHE ground water standards or a standard was unavailable. The expanded analyte list laboratory results are summarized in Figure 58.

Dissolved metals concentrations in the shallow and deep wells at the OTP vary as discussed below (Appendix R). Higher concentrations of dissolved zinc and manganese were detected in OTP-MW-4D (deep) compared to OTP-MW-4S (shallow) while higher concentrations of dissolved arsenic and cadmium were detected in OTP-MW-4S when compared to OTP-MW-4D. Higher concentrations of dissolved manganese were detected in OTP-MW-8D (deep) than OTP-MW-8S (shallow) while higher concentrations of dissolved zinc were detected in OTP-MW-8S when compared to OTP-MW-8D. Higher concentrations of cadmium, chromium, and lead were also detected in OTP-MW-8S when compared to OTP-MW-8D.

Laboratory analysis of the seep samples OTP-SEEP-1 and OTP-SEEP-2, collected in the south portion of the OTP, the dissolved manganese and zinc concentrations and pH in exceedance of the CDPHE ground water standard. The concentrations of arsenic, cadmium, and copper in the sample collected from OTP-SEEP-2 exceeded the CDPHE ground water standards. Additionally, the cadmium and copper concentrations, as well as the chromium concentration detected in OTP-SEEP-2, exceeded the surface water standards. The seep sample results are shown on Figure 59 and summarized in Table 16.

Table 16 Summary of OTP Seeps/Trench Analytical Data

	Location	Sample Date	Total/Dissolved	pH*	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Zinc
					Dissolved Metals (milligrams per liter)						
OTP Surface Water Diversion Trenches and Seeps (existing)	North OTP Surface Water Diversion Trench	8/18/2005	D	6.72	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	1.3	< 0.01
		9/27/2005	D	5.06	0.0057	< 0.001	< 0.002	< 0.002 L	< 0.001	1.9	0.01
		4/20/2006	D	6.19	< 0.005	< 0.001	< 0.002	0.0053	< 0.001	0.021	0.006
	South OTP Surface Water Diversion Trench	8/17/2005	D	6.13	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.027	0.016
		9/23/2005	D	6.72	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.072	< 0.01
		4/20/2006	D	5.31	< 0.005	< 0.001	< 0.002	0.18	< 0.001	0.0017	0.01
	OTP-SEEP-1	8/17/2005	D	4.39	< 0.005	0.0012	< 0.002	0.01	< 0.001	0.2	0.12
		4/20/2006	D	3.99	< 0.005	0.0046	< 0.002	0.1	< 0.001	1	0.57
	OTP-SEEP-2	4/20/2006	D	2.97	0.27	0.033	0.005	1.8	< 0.001	7.3	0.5
	CDPHE Domestic Water Supply Standard										
	Human Health Standard (ambient)			na	0.05	0.005	0.1	na	0.05	na	na
	Drinking Water Standard (not enforceable)			6.5-8.5	na	na	na	1.0	na	0.05	5.0
	Chronic Eagle River Standards										
	CDPHE Chronic Standards (Not Eagle River Segment Specific)			na	0.05	na	0.011	na	na	na	na
	Calculated March to April Chronic Standards										
	Segment 5a (OTP and Rex Flats)			na	na	0.00197	na	0.00764	0.00207	1.570	na
	Segment 5b (Belle Lake and the CTP)			na	na	0.00225	na	0.00993	0.00274	1.655	na
	Segment 7b (Cross Creek)			na	na	0.00122	na	0.00444	0.00102	1.255	na
	Calculated May to February Chronic Standards										
	Segment 5a			na	na	0.00118	na	0.00427	0.00097	1.236	na
	Segment 5b			na	na	0.00170	na	0.00455	0.00099	1.245	na
	Segment 7b			na	na	0.00130	na	0.00478	0.00112	1.292	na
	CDPHE Segment Specific Chronic Standards for Zinc										
	March 1 through April 30										
	Segment 5a			na	na	na	na	na	na	na	0.410
	Segment 5b			na	na	na	na	na	na	na	0.310
	Segment 7b			na	na	na	na	na	na	na	0.193
	May 1 through February 29										
	Segment 5a			na	na	na	na	na	na	na	0.166
	Segment 5b			na	na	na	na	na	na	na	0.123
	Segment 7b			na	na	na	na	na	na	na	0.156

NOTES: All results are dissolved and are in milligrams per liter (mg/L).

Segment 5a of the Eagle River is adjacent to the OTP and Rex Flats, therefore the ground water concentrations from the OTP and Rex Flats were compared to these standards.

Segment 5b of the Eagle River is adjacent to the CTP, therefore the ground water concentrations from the CTP ground water wells were compared to these standards.

Segment 7b of Cross Creek near the Cross Creek ground water wells (CC-MW-1A, 2D-S, and CSEEP) – these standards were compared to the ground water concentrations from these locations.

= exceeds CDPHE human health or drinking water standard

= exceeds an Eagle River standard

= exceeds the Eagle River standard and the CDPHE human health or drinking water standard

* Field pH, but measurement prior to sampling

< = not detected above laboratory reporting limits, corresponding value is the reporting limit

CDPHE = Colorado Department of Public Health and the Environment

CTP = Consolidated Tailings Pile

D = dissolved, field filtered

existing = existing Vicom ground water well

2> = estimated high

L = Serial dilution of a duplicate in the analytical batch indicates that physical and chemical interferences are present

na = not available

OTP = Old Tailings Pile

T = total

VSEEP = upgradient ground water diversion trench

Analysis of the north and south diversion trench samples detected dissolved manganese and pH in exceedance of the CDPHE ground water standard. The manganese concentrations detected in the north diversion trench in August and September, 2005, and the copper concentration detected in the south diversion trench in April, 2006, exceeded the surface water standards. The diversion trench sample results are summarized in Table 16 and are shown on Figure 59.

Bolts Lake

Of the seven primary indicator metals, dissolved manganese was the only constituent detected above the CDPHE ground water standard at Bolts Lake (Table 17).

Table 17 Summary of Bolts Lake Ground Water Analytical Data

	Location	Sample Date	Field/Dissolved	pH*	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Zinc
					Dissolved Metals (milligrams per liter)						
Bolts Lake	BL-MW-1	8/18/2005	D	7.43	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.18	< 0.01
		9/26/2005	D	7.15	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.05	< 0.01
		10/21/2005	D	6.85	< 0.005	< 0.001	< 0.002	0.002	< 0.001	0.027	< 0.01
		3/21/2006	D	7.21	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.072	< 0.01
		4/26/2006	D	6.91	< 0.005	< 0.001	< 0.002	0.0013	< 0.001	0.086	< 0.01
		5/17/2006	D	7.31	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.068	< 0.01
		6/21/2006	D	6.99	< 0.005	< 0.001	< 0.002	0.0021	< 0.001	0.054	< 0.01
		7/10/2006	D	6.85	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.023	< 0.01
	BL-MW-2	8/18/2005	D	7.51	0.0079	< 0.001	< 0.002	< 0.002	< 0.001	0.640	0.014
		9/26/2005	D	7.53	0.014	< 0.001	< 0.002	< 0.002 J	< 0.001	0.460	0.012
		10/21/2005	D	7.41	0.015	< 0.001	< 0.002	< 0.002	< 0.001	0.480	0.017
		3/21/2006	D	7.11	0.018	< 0.001	< 0.002	< 0.002	< 0.001	0.510	< 0.01
		4/26/2006	D	7.44	0.019	< 0.001	< 0.002	< 0.002	< 0.001	0.520	0.012
		5/17/2006	D	7.46	0.021	< 0.001	< 0.002	< 0.002	< 0.001	0.580	0.013
		6/22/2006	D	7.1	0.019	< 0.001	< 0.002	< 0.002	< 0.001	0.560	0.012
		7/11/2006	D	7.17	0.021	< 0.001	< 0.002	< 0.002	< 0.001	0.57	0.017
	BL-MW-3	8/19/2005	D	7.67	< 0.005	< 0.001	< 0.002	0.0038	< 0.001	0.86	0.011
		9/27/2005	D	6.77	< 0.005	< 0.001	< 0.002	0.0041 J	< 0.001	0.79	< 0.01
		10/26/2005	D	7.45	< 0.005	< 0.001	< 0.002	0.0033	< 0.001	0.40	< 0.01
		3/28/2006	D	7.22	< 0.005	< 0.001	< 0.002	0.0038	< 0.001	0.086	< 0.01
		4/26/2006	D	7.03	< 0.005	< 0.001	< 0.002	0.0048	< 0.001	0.25	0.027
		5/17/2006	D	7.38	< 0.005	< 0.001	< 0.002	0.0084	< 0.001	1.40	0.027
		6/22/2006	D	6.85	< 0.005	< 0.001	< 0.002	0.0041	< 0.001	2.40	0.02
		7/11/2006	D	6.97	< 0.005	< 0.001	< 0.002	0.0035	< 0.001	2	0.012
	CDPHE Domestic Water Supply Standard										
	Human Health Standard (enforceable)			na	0.05	0.005	0.1	na	0.05	na	na
	Drinking Water Standard (not enforceable)			6.5-8.5	na	na	na	1.0	na	0.05	5.0
	Chronic Eagle River Standards										
	CDPHE Chronic Standards (Not Eagle River Segment Specific)			na	0.05	na	0.011	na	na	na	na
	Calculated March to April Chronic Standards										
	Segment 5a (OTP and Bun Flats)			na	na	0.00195	na	0.00764	0.00205	1.550	na
	Segment 5b (Bolts Lake and the CTP)			na	na	0.00225	na	0.00905	0.00254	1.655	na
	Segment 7b (Cross Creek)			na	na	0.00122	na	0.00444	0.00102	1.255	na
	Calculated May to February Chronic Standards										
	Segment 5a			na	na	0.00118	na	0.00427	0.00097	1.256	na
	Segment 5b			na	na	0.00120	na	0.00435	0.00099	1.245	na
	Segment 7b			na	na	0.00150	na	0.00476	0.00112	1.292	na
	CDPHE Segment Specific Chronic Standards for Zinc										
	March 1 through April 30										
	Segment 5a			na	na	na	na	na	na	na	0.410
	Segment 5b			na	na	na	na	na	na	na	0.310
	Segment 7b			na	na	na	na	na	na	na	0.195
	May 1 through February 29										
	Segment 5a			na	na	na	na	na	na	na	0.106
	Segment 5b			na	na	na	na	na	na	na	0.123
	Segment 7b			na	na	na	na	na	na	na	0.116

NOTES: All results are dissolved and are in milligrams per liter (mg/L).

Segment 5a of the Eagle River is adjacent to the OTP and Bun Flats, therefore the ground water concentrations from the OTP and Bun Flats were compared to these standards.

Segment 5b of the Eagle River is adjacent to the CTP, therefore the ground water concentrations from the CTP ground water wells were compared to these standards.

Segment 7b of Cross Creek near the Cross Creek ground water wells (CC-MW-1A, DT-5, and UGDT) – these standards were compared to the ground water concentrations from these locations.

= exceeds CDPHE human health or drinking water standard

= exceeds an Eagle River standard.

= exceeds the Eagle River standard and the CDPHE human health or drinking water standard

* Field pH, last measurement prior to sampling

< = not detected above laboratory reporting limits, corresponding value is the reporting limit

CDPHE = Colorado Department of Public Health and the Environment

CTP = Consolidated Tailings File

D = dissolved, field filtered

existing = existing Chronic ground water well

J= = estimated high

L = Serial dilution of a dependent in the analytical batch indicates that physical and chemical interferences are present

na = not available

OTP = Old Tailings File

T = total

UGDT = upgradient ground water diversion trench

Dissolved manganese was detected above the CDPHE ground water standard of 0.05 mg/L in all three wells (BL-MW-1 through BL-MW-3). The dissolved concentrations of manganese and copper in BL-MW-3 exceeded the surface water standards. The dissolved manganese, zinc, and cadmium concentrations for Bolts Lake during this investigation are shown on figures in Appendix U. The detected metals concentrations in ground water samples collected during this investigation varied slightly and generally were within an order of magnitude from month to month. The only exception is the manganese concentrations in BL-MW-3, which increased by an order of magnitude between May and July, 2006. The September 2005 dissolved concentrations for the metals are shown in Figures 60, 61 and 62.

CTP

Of the seven primary indicator metals, six were detected above the laboratory reporting limit at the CTP (Table 18). The detected ground water concentrations of manganese and the pH measurements in some of these wells exceeded the CDPHE ground water standards. Additionally, the concentrations of copper, manganese, and zinc in some of these wells was above the surface water standards. An analysis of most of the total and dissolved concentrations indicates that most of the total concentrations are accounted for in the dissolved result.

Table 18 Summary of the CTP Ground Water Analytical Data

	Location	Sample Date	Total/Dissolved	pH	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Zinc
					Dissolved Metals (milligrams per liter)						
CTP	CC-MW-1D	9/30/2005	D	6.69	0.023	< 0.001	< 0.002	0.0043	< 0.001	140	0.035
		10/26/2005	D	6.31	0.023	< 0.001	< 0.002	0.0054	< 0.001	130	0.012
		3/27/2006	D	6.41	0.027	< 0.001	< 0.002	0.0057	< 0.001	120	0.092
		4/18/2006	D	6.59	0.041	< 0.001	< 0.002	0.017	< 0.001	130	0.019
		5/23/2006	D	6.75	0.047	< 0.001	< 0.002	0.013	< 0.001	110	0.016
		6/29/2006	D	6.55	0.038	< 0.001	< 0.002	0.0046	< 0.001	120	0.024
		7/7/2006	D	6.35	0.041	< 0.04	< 0.002	0.0045	< 0.001	130	0.021
	CC-MW-1S	9/30/2005	D	6.84	< 0.005	< 0.001	< 0.002	0.003	< 0.001	0.35	0.011
		10/26/2005	D	6.66	< 0.005	< 0.001	< 0.002	0.0032	< 0.001	0.057	0.013
		3/27/2006	D	6.59	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.0094	< 0.01
		4/18/2006	D	6.61	< 0.005	< 0.001	< 0.002	0.0036	< 0.001	0.0064	< 0.01
		5/23/2006	D	6.8	< 0.005	< 0.001	< 0.002	0.0046	< 0.001	0.012	< 0.01
		6/29/2006	D	6.8	< 0.005	< 0.001	< 0.002	0.002	< 0.001	0.0056	< 0.01
		7/7/2006	D	6.4	< 0.005	< 0.001	< 0.002	0.0033	< 0.001	0.0052	0.015
	CTP-MW-1D	8/23/2005	D	6.83	< 0.005	< 0.001	< 0.002	0.0086	< 0.001	0.0059	0.013
		9/28/2005	D	6.89	< 0.005	< 0.001	< 0.002	0.0084	< 0.001	0.0057	< 0.01
		10/26/2005	D	6.77	< 0.005	< 0.001	< 0.002	0.0052	< 0.001	0.0042	< 0.01
		3/30/2006	D	6.8	< 0.005	< 0.001	< 0.002	0.0052	< 0.001	0.015	0.012
		4/26/2006	D	6.91	< 0.005	< 0.001	< 0.002	0.0056	< 0.001	0.0032	< 0.01
		5/22/2006	D	7.04	< 0.005	< 0.001	< 0.002	0.0052	< 0.001	0.009	< 0.01
		6/22/2006	D	6.85	< 0.005	< 0.001	< 0.002	0.0044	< 0.001	0.0036	0.013
		7/6/2006	D	7.2	< 0.005	< 0.001	< 0.002	0.0073	< 0.001	0.0042	0.029
	CTP-MW-1S	8/23/2005	D	6.55	< 0.005	< 0.001	< 0.002	0.0097	< 0.001	0.16	0.042
		9/28/2005	D	6.61	< 0.005	< 0.001	< 0.002	0.0088	< 0.001	0.071	0.03
		10/26/2005	D	6.32	< 0.005	< 0.001	< 0.002	0.0094	< 0.001	0.018	0.016
		4/26/2006	D	6.45	< 0.005	< 0.001	< 0.002	0.0053	< 0.001	0.017	0.078
			T	6.45	< 0.005	< 0.001	< 0.002	0.0053	< 0.001	0.022	0.082
		5/22/2006	D	6.69	< 0.005	< 0.001	< 0.002	0.0085	< 0.001	0.019	0.11
			T	6.69	< 0.005	< 0.001	0.012	0.016	0.0046	0.21	0.15
		6/22/2006	D	6.41	< 0.005	< 0.001	< 0.002	0.0055	< 0.001	0.044	0.12
			T	6.41	< 0.005	< 0.001	0.0029	0.0046	< 0.001	0.077	0.13
		7/6/2006	D	6.65	< 0.005	< 0.001	< 0.0005	0.0045	< 0.001	0.046	0.14
			T	6.65	< 0.005	< 0.001	0.0021	0.0045	< 0.001	0.062	0.13
	CTP-MW-2D	9/29/2005	D	6.92	< 0.005	< 0.001	< 0.002	0.028	< 0.002	28	0.83
		10/25/2005	D	6.5	< 0.005	< 0.001	< 0.002	0.018	< 0.001	23	0.64
		3/24/2006	D	6.33	< 0.005	< 0.001	< 0.002	0.017	< 0.001	22	0.56
		4/18/2006	D	6.42	< 0.005	< 0.001	< 0.002	0.028	< 0.001	24	0.78
		5/16/2006	D	6.45	< 0.005	< 0.001	< 0.002	0.015	< 0.001	23	0.61
		6/19/2006	D	6.37	< 0.005	< 0.001	< 0.002	0.011	< 0.001	23	0.57
		7/7/2006	D	7.06	< 0.005	< 0.001	< 0.002	0.011	< 0.001	23	0.57
	CTP-MW-2S	9/29/2005	D	7.01	< 0.005	< 0.001	< 0.002	0.027	< 0.002	29	0.55
		10/25/2005	D	6.93	< 0.005	< 0.001	< 0.002	0.016	< 0.001	32	0.63
		3/24/2006	D	6.76	< 0.005	< 0.001	< 0.002	0.0061	< 0.001	4.1	0.1
			T	6.76	< 0.005	< 0.001	< 0.002	0.0071	< 0.001	0.34	0.017
		4/18/2006	D	6.93	< 0.005	< 0.001	< 0.002	0.0087	< 0.001	0.034	< 0.01
			T	6.93	< 0.005	< 0.001	< 0.002	0.011	< 0.001	0.32	0.04
		5/16/2006	D	6.77	< 0.005	< 0.001	< 0.002	0.02	< 0.001	19	0.52
			T	6.77	< 0.005	< 0.001	< 0.002	0.014	< 0.001	22	0.59
		6/19/2006	D	6.26	< 0.005	< 0.001	< 0.002	0.012	< 0.001	47	1.3
			T	6.26	< 0.005	< 0.001	< 0.002	0.017	< 0.001	46	1.4
		7/7/2006	D	6.95	< 0.005	< 0.001	< 0.002	0.01	< 0.001	50	1.6
			T	6.95	< 0.005	< 0.001	< 0.002	0.013	< 0.001	52	1.7
	CTP-MW-3	6/19/2006	D	7.31	< 0.005	< 0.001	< 0.002	0.0021	< 0.001	0.041	0.02
		7/6/2006	D	7.22	< 0.021	< 0.001	< 0.002	0.0021	< 0.001	0.024	< 0.002
	CTP-MW-4	8/23/2005	D	7.21	< 0.005	< 0.001	0.0021	< 0.002	< 0.001	0.014	< 0.01
		6/15/2006	D	7.1	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.0027	< 0.01
		7/6/2006	D	7.12	< 0.005	< 0.001	0.0031	0.0025	< 0.001	0.0017	0.01

				Dissolved Metals (milligrams per liter)						
Location	Sample Date	Total/Dissolved	pH*	Arsenic	Calcium	Chromium	Copper	Lead	Manganese	Zinc
DT-5 (existing)	8/25/2005	D	6.66	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.0091	0.046
	9/26/2005	D	7.07	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.2	0.082
	10/26/2005	D	6.89	< 0.005	< 0.001	< 0.002	0.0021	< 0.001	0.028	0.057
	3/30/2006	D	6.77	< 0.005	< 0.001	< 0.002	0.0024	< 0.001	2.1	0.27
UGDT (existing)	4/27/2006	D	6.46	< 0.005	0.0043	< 0.002	0.0025	< 0.001	1.4	0.43
	5/19/2006	D	6.97	< 0.005	< 0.001	< 0.002	0.0035	< 0.001	0.067	0.08
	6/20/2006	D	6.81	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.0038	0.036
	7/12/2006	D	6.66	< 0.005	< 0.001	< 0.002	< 0.002	< 0.001	0.0012	0.041
CDPHE Domestic Water Supply Standard										
Human Health Standard (enforceable)			na	0.05	0.005	0.1	na	0.05	na	na
Drinking Water Standard (not enforceable)			6.5-8.5	na	na	na	1.0	na	0.05	5.0
Chronic Eagle River Standards										
CDPHE Chronic Standards (Not Eagle River Segment Specific)			na	0.05	na	0.011	na	na	na	na
Calculated March to April Chronic Standards										
Segment 5a (OTP and Box Flats)			na	na	0.00195	na	0.00764	0.00269	1.550	na
Segment 5b (Bells Lake and the CTP)			na	na	0.00225	na	0.00903	0.00254	1.655	na
Segment 7b (Cross Creek)			na	na	0.00122	na	0.00444	0.00102	1.255	na
Calculated May to February Chronic Standards										
Segment 5a			na	na	0.00118	na	0.00427	0.00097	1.256	na
Segment 5b			na	na	0.00120	na	0.00435	0.00099	1.245	na
Segment 7b			na	na	0.00130	na	0.00478	0.00112	1.292	na
CDPHE Segment Specific Chronic Standards for Zinc										
March 1 through April 30										
Segment 5a			na	na	na	na	na	na	na	0.410
Segment 5b			na	na	na	na	na	na	na	0.310
Segment 7b			na	na	na	na	na	na	na	0.193
May 1 through February 29										
Segment 5a			na	na	na	na	na	na	na	0.306
Segment 5b			na	na	na	na	na	na	na	0.123
Segment 7b			na	na	na	na	na	na	na	0.116

NOTES: All results are dissolved and are in milligrams per liter (mg/L).

Segment 5a of the Eagle River is adjacent to the OTP and Box Flats, therefore the ground water concentrations from the OTP and Box Flats were compared to these standards.

Segment 5b of the Eagle River is adjacent to the CTP, therefore the ground water concentrations from the CTP ground water wells were compared to these standards.

Segment 7b of Cross Creek uses the Cross Creek ground water wells (CC-MW-1S, DT-5, and UGDT) - these standards were compared to the ground water concentrations from these locations.

= exceeds CDPHE human health or drinking water standard

= exceeds an Eagle River standard

= exceeds the Eagle River standard and the CDPHE human health or drinking water standard.

* Field pH, last measurement prior to sampling

< = not detected above laboratory reporting limits, corresponding value is the reporting limit

CDPHE = Colorado Department of Public Health and the Environment

CTP = Consolidated Tailings Pile

D = dissolved, field filtered

existing = existing Vincent ground water well

I> = estimated high

L = lateral dilution of a deposition in the analytical batch indicates that physical and chemical interferences are present

na = not available

OTP = Old Tailings Pile

T = total

UGDT = upgradient ground water diversion trench

Dissolved manganese concentrations exceeded the CDPHE ground water standard of 0.05 mg/L at CC-MW-1S, CC-MW-1D, CTP-MW-1S (August and September 2005), CTP-MW-2S, CTP-MW-2D, DT-5, and from the UGDT. The manganese concentrations in these wells also exceeded the surface water quality standard for manganese. The dissolved manganese concentrations were highest at CC-MW-1D, CTP-MW-2S, and CTP-MW-2D. The dissolved manganese concentrations for the CTP during this investigation are shown on figures in Appendix U. These concentrations changed slightly during this investigation; most were within an order of magnitude. The September 2005 dissolved manganese concentrations are shown in Figure 60.

Dissolved zinc concentrations in some monitoring wells (CTP-MW-1S, -2D, -2S, DT-5, and the UGDT) exceeded the surface water standards. The highest concentrations were detected in CTP-MW-2S, -2D,and the spring samples from the UGDT. Dissolved zinc concentrations for the CTP during this investigation are shown in Appendix T. These concentrations changed within an order of magnitude during this investigation. The September 2005 dissolved zinc concentrations are shown in Figure 61.

Laboratory analysis of ground water samples collected from CTP-MW-1S and CTP-MW-2S for the expanded analyte list detected elevated sulfate above CDPHE ground water standards. Additionally, analysis of the ground water sample from CTP-MW-2S detected dissolved iron above the CDPHE ground water standard and nickel at the standard. The expanded analyte list analytical results are summarized in Figure 58.

Dissolved concentrations in the shallow and deep wells at the CTP vary (Appendix R) by location. Higher concentrations of dissolved manganese were detected in well CC-MW-1D (deep) compared to CC-MW-1S (shallow) while their dissolved zinc concentrations were similar. Low arsenic concentrations were observed in well CC-MW-1D and were not detected above the laboratory reporting limit in the samples collected from CC-MW-1S. Dissolved manganese and zinc concentrations were higher in well CTP-MW-1S (shallow) than in CTP-MW-1D. Dissolved manganese and zinc concentrations were similar in wells CTP-MW-2S and 2D.

3.4.3 Summary of Metals Concentrations

Generally, laboratory analysis of ground water samples for the primary indicator metals detected elevated concentrations of dissolved manganese, zinc, and cadmium which exceeded both the CDPHE ground water and surface water standards. Low concentrations of dissolved arsenic were detected above the CDPHE ground water standards in one well in the OTP (OTP-MW-4S) and many samples exceeded the CDPHE ground water standard for pH. Dissolved copper detected in the OTP, CTP, and Rex Flats, and dissolved lead concentrations detected in the OTP, exceeded the surface water standards.

Analysis of ground water samples for the expanded analyte list detected concentrations of dissolved iron and total sulfate in the OTP, Rex Flats, and CTP that exceeded the CDPHE ground water standards. Dissolved aluminum concentrations in the OTP and one well in Rex Flats exceeded the CDPHE ground water standards. Additionally, dissolved concentrations of beryllium, nickel, and thallium exceeded the CDPHE ground water standards in one well located in the OTP (OTP-MW-5).

Generally, greater concentrations of three dissolved metals (manganese, zinc, and cadmium) exceeding the CDPHE ground water standards were detected in the same monitoring wells. Where detections of dissolved zinc were elevated, dissolved manganese was also detected. However, small increases in dissolved manganese concentrations were not always associated with elevated dissolved zinc concentrations. When concentrations of dissolved manganese exceeded about 1 milligram per liter (mg/L), it was generally associated with increased dissolved zinc concentrations. Figures 63 and 64 show this trend for September, 2006 and April, 2006 on a log-log plot and include the labeled CDPHE ground water and surface water standards. These graphs show that laboratory analysis of ground water samples collected from the OTP and the northern portion of Rex Flats display the highest concentrations of dissolved zinc and manganese detected during this investigation to date. Several OTP monitoring wells also display the highest dissolved cadmium concentrations detected on the North Property and occur where the highest dissolved manganese and zinc concentrations were detected (Figures 63 and 64). Concentrations of dissolved zinc and manganese downgradient of the CTP, in wells CTP-MW-2D and CTP-MW-2S, exceeded the surface water standards.

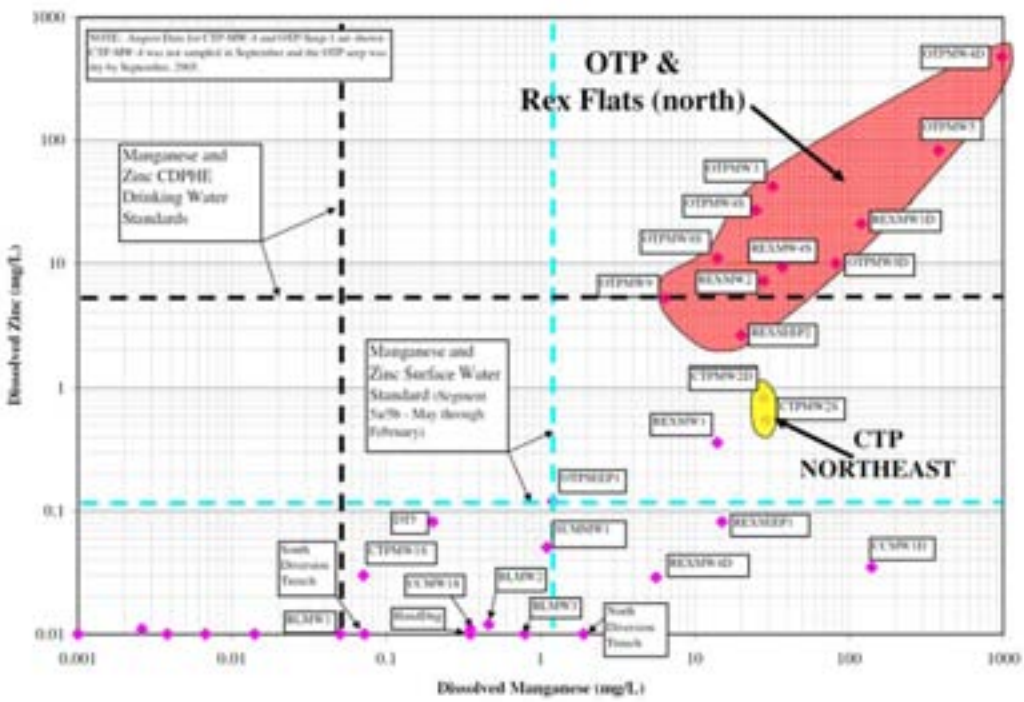


Figure 63 - Dissolved Manganese vs. Zinc, September 2005 (Ground Water/Seeps/Diversion Trenches)

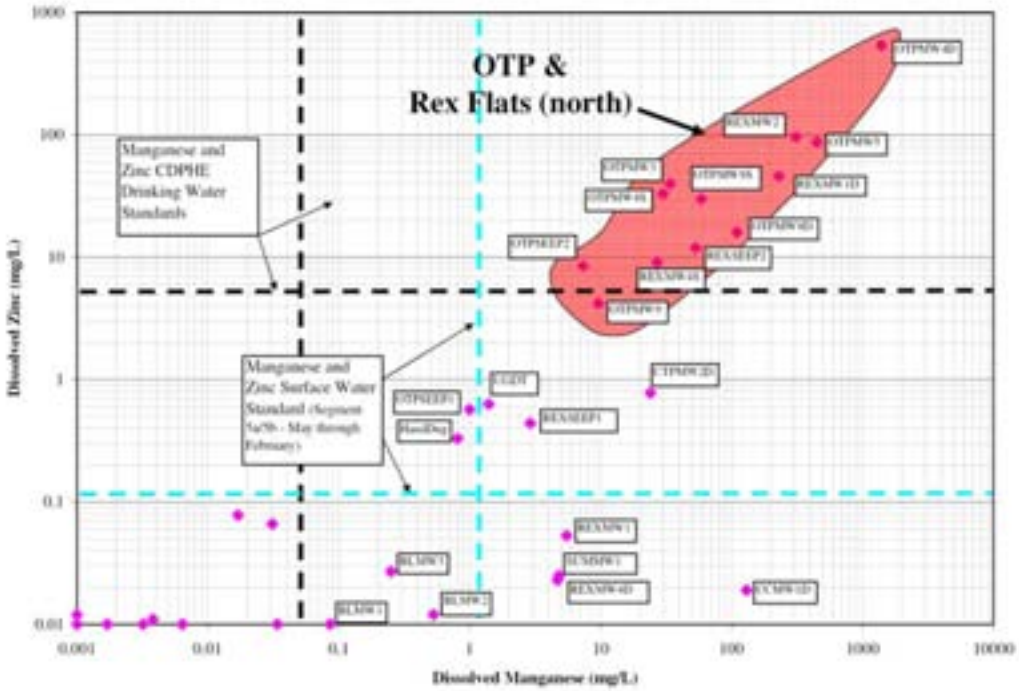


Figure 64 – Dissolved Manganese vs. Zinc, April 2006 (Ground Water/Seeps/Diversion Trenches)

All of the elevated primary indicator metal concentrations detected in the wells in the OTP and northern portion of Rex Flats are located downgradient of or in areas of known historic tailings deposition and removal. Generally, the concentrations of dissolved zinc and manganese in some of the existing OTP and Rex Flats monitoring wells have decreased by one to two orders of magnitude since the removal of tailings in these areas by Viacom.

3.4.4 *Hydrogeology*

<u>Slug Test Analysis Results</u>

The results and analyses of the slug tests of the monitoring wells at the North Property are included in Appendix V. The results of the slug tests are also summarized in a table in Appendix V and are shown on Figure 65. Based on the data obtained from the slug tests in this investigation, measured hydraulic conductivities near the Eagle River range in the OTP/Rex Flats area from about 1.54 to 23.66 feet per day, Sump #3 area from about 9.59 to 56.42 feet per day, Bolts Lake area from 14.61 to 44.93 feet/day, CTP area from 1.36 to 88 feet/day, Cross Creek area at about 0.68 feet/day, and on the eastern portion of the ridge between the CTP and Bolts Lake at about 167 feet/day.

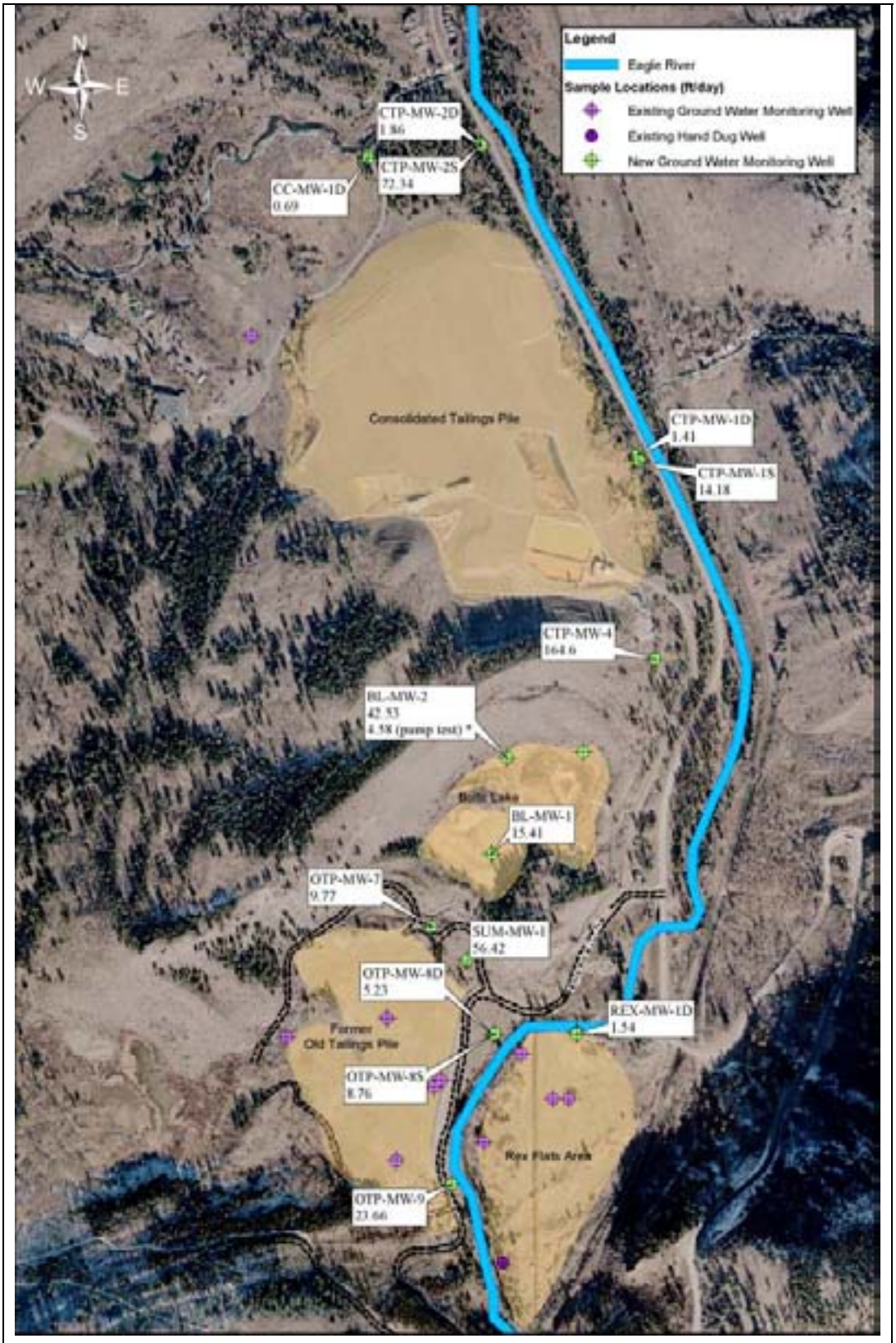


Figure 65 – Hydrologic Testing Summary Map

Notes: ***All areas are approximate; aerial photo date October 2004. *Pump test estimated hydraulic conductivity may be as much as one order of magnitude lower (see text).***
All data is from slug testing in feet per day (average) unless otherwise noted.

The lithology of the screened interval at each well is included in Appendix V. Most of new wells were installed in fine to coarse sands and gravels near the Eagle River. Therefore, these measured slug test hydraulic conductivities are only representative of conditions near the river (sand and gravel) and probably do not represent finer grained formations known to exist in the OTP and other areas at the North Property (Dames and Moore, 1991).

The highest hydraulic conductivity, at CTP-MW-4 (169 ft/day), was measured in a monitoring well screened in moraine material (on the eastern portion of the ridge between Bolts Lake and the CTP) composed of fine to coarse sand and gravel with 3-foot boulders. This anomalously high measured hydraulic conductivity is probably localized and only represents coarse grained material located on the far east nose of the ridge between Bolts Lake and the CTP.

In general, the hydraulic conductivities measured during this investigation were similar to hydraulic conductivities measured in previous investigations in similar areas. Dames and Moore (Dames and Moore, 1991) measured hydraulic conductivities from slug test data that ranged from about 0.17 to 3.40 feet/day using "fair" to "good" slug test model fitted data. The Dames and Moore data is included as Appendix W. The highest hydraulic conductivity measured during their investigation was about 26.69 feet/day in the OTP near the Eagle River. However, the slug test model used to estimate this hydraulic conductivity matched the data poorly. A lower hydraulic conductivity was measured at OTP-MW-5, located in the north-central portion of the OTP, at 0.64 feet/day. Additionally, lower conductivities were measured in wells XW1 and XW4 (generally at the OTP, exact location unknown) ranging from 0.17 to 0.42 feet/day (Dames and Moore, 1991).

Constant-Discharge Test Results

The drawdown in water levels recorded in the pumping well, BL-MW-02, during the constant-discharge test ("flow test") is shown in Appendix X. A maximum drawdown of approximately 4.4 feet was observed in the pumping well during the flow test. No significant drawdown was observed in the two observation wells, BL-MW-01 and BL-MW-03, during the test.

The results and analysis of the water level drawdown data from the constant-discharge test of BL-MW-02 are included in Appendix X and summarized in Figure 65**.** The estimated hydraulic conductivity for the surficial aquifer in the Bolts Lake area from this test is 4.58 feet/day. This estimated conductivity may be as much as an order of magnitude lower than the actual conductivity due to the head losses that typically occur in

pumping wells due to well-bore skin, turbulence, and other non-ideal flow conditions (Fetter, 1994).

3.5 *AIR*

Air quality data was collected by Myers Environmental Services, Inc., and Asoian Associates LLC, as contractors to ERM. Collection of the air quality data began on July 21, 2005 at Stations AS-1 and AS-2. Sampling at Station AS-3 began on July 27, 2005. The data presented here were collected through November 18, 2005. PM_{10} and TSP samples were collected at each of the stations. The TSP samples were also analyzed for arsenic, cadmium, and lead content.

A summary graph of the particulate data is presented in Figure 66. Figure 66 contains six line graphs; one for each of the samplers PM_{10}-1, TSP-1, PM_{10}-2, TSP-2, PM_{10}-3, and TSP-3 for the period July 21 through November 18, 2005. These summaries provide a quick overview and comparison of pollutant levels from sample day to sample day and from station to station. The detailed data tables from which Figure 66 was developed are provided in Appendix Y. These tables include information on sample run times, temperature, pressure, and residue weights for each filter for each pollutant, as well as other pertinent information used to determine the ambient pollutant levels presented in this report. A summary graph was not prepared for arsenic, cadmium, and lead because the majority of the samples were below the applicable detection limit. All of the air quality data presented in this report is in units of micrograms.

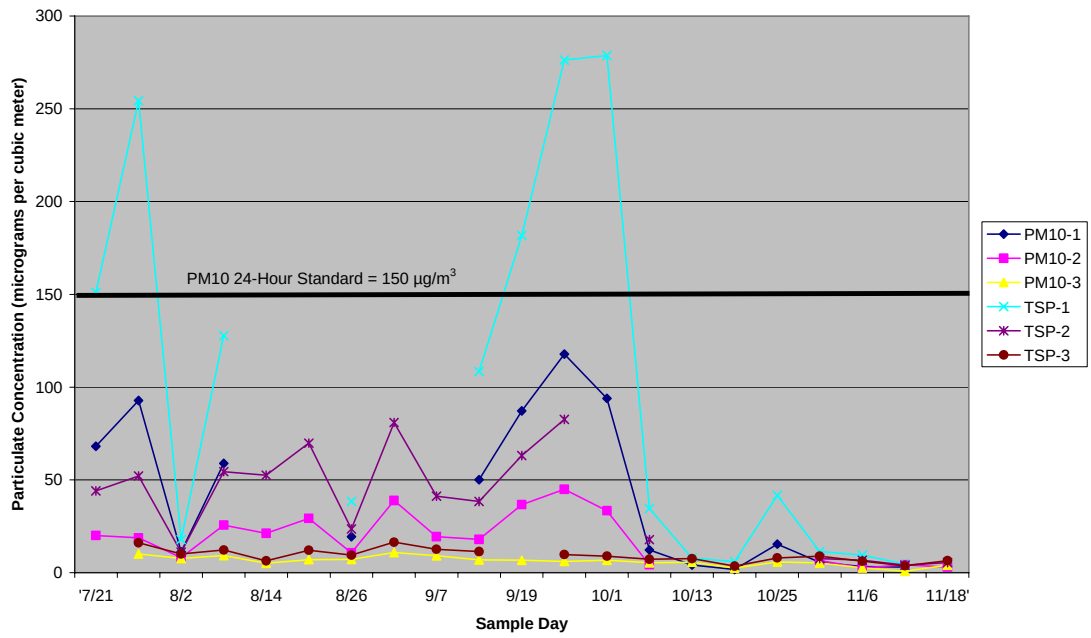


Figure 66 – Battle Mountain North Particulate Levels – July 21 through November 18, 2005

3.5.1 *Data Recovery*

The overall data recovery rate from the program was 85 percent. The individual data recovery rates for each of the samplers are presented below.

- Station AS-1 – 71 % (PM_{10})
- Station AS-1 – 76 % (TSP)
- Station AS-2 – 86% (PM_{10})
- Station AS-2 – 81 % (TSP)
- Station AS-3 – 100 % (PM_{10})
- Station AS-3 – 95 % (TSP)

In all cases the data loss at Stations AS-1 and AS-2 were a direct or indirect result of generator malfunctions. The loss of data at Station AS-3 TSP on September 19, 2005 was a result of an unknown malfunction that resulted in an insufficient run time.

3.5.2 *Particulate Levels*

The particulate levels for July, August, September, October, and November 2005 are summarized in Figure 66. The maximum 24-hour average particulate levels for each month and each station and the period average are presented in Table 19 below.

Table 19 Particulate Levels

Station	*July*	*August*	*September*	*October*	*November*	*Period Average*
AS-1 (PM_{10})	92.8	58.9	117.7	93.9	3.3	40.3
AS-1 (TSP)	188.9	93.8	199.1	201.3	6.6	31.3
AS-2 (PM_{10})	20.0	29.3	44.9	33.4	4.2	19.2
AS-2 (TSP)	43.4	60.4	78.2	14.6	5.0	22.1
AS-3 (PM_{10})	10.0	9.2	10.8	6.7	4.0	6.2
AS-3 (TSP)	13.0	9.8	13.1	7.2	4.8	6.8

The PM_{10} levels can be compared to the Colorado and federal 24-Hour PM_{10} Standard of 150 micrograms per cubic meter ("$\mu g/m^3$"). The 24-Hour PM_{10} standard was not exceeded during the sampling period. Although a full year of data was not collected, comparing period average values to the Colorado and federal annual PM_{10} Standard of 50 $\mu g/m^3$ indicates that the period averages were all below the annual standard. There is no TSP standard. The quarterly average for PM_{10} is an arithmetic average and the quarterly average for TSP is a geometric mean.

3.5.3 *Arsenic Levels*

All of the samples were found to be below the laboratory detection limit for arsenic of 36 micrograms per filter as shown in Table 20.

Table 20 Arsenic Levels

Station	*July*	*August*	*September*	*October*	*November*	*Period Average*
AS-1 (TSP)	BD	BD	BD	BD	BD	NA
AS-2 (TSP)	BD	BD	BD	BD	BD	NA
AS-3 (TSP)	BD	BD	BD	BD	BD	NA

BD: Below laboratory detection limits.
NA: Not applicable due to lack of detectable concentrations.

3.5.4 *Cadmium Levels*

All of the samples were found to be below the laboratory detection limit for cadmium of 2.4 micrograms per filter as shown in Table 21.

Table 21 Cadmium Levels

Station	*July*	*August*	*September*	*October*	*November*	*Period Average*
AS-1 (TSP)	BD	BD	BD	BD	BD	NA
AS-2 (TSP)	BD	BD	BD	BD	BD	NA
AS-3 (TSP)	BD	BD	BD	BD	BD	NA

BD: Below laboratory detection limits.
NA: Not applicable due to lack of detectable concentrations.

3.5.5 *Lead Levels*

The monthly averages of the 24-hour average lead levels for each month and each station and the quarterly average for each station are presented in Table 22.

Table 22 Lead Levels

Station	*July*	*August*	*September*	*October*	*November*	*Period Average*
AS-1 (TSP)	0.01	BD	0.02	0.01	BD	NA
AS-2 (TSP)	BD	BD	BD	BD	BD	NA
AS-3 (TSP)	BD	BD	BD	BD	BD	NA

BD: Below laboratory detection limits.
NA: Not applicable due to lack of detectable concentrations.

Monthly average lead levels are only presented when at least one sample day during the month had lead levels above the detection limit of 24 micrograms per filter. The monthly average was calculated using one half the detection limit, 12 micrograms per filter, for days during the month that had lead levels below the detection limit. The monthly average lead levels are arithmetic averages. Detectable lead levels were only found at Station AS-1 and all monthly averages that were able to be calculated are below the Colorado Standard of 1.5 $\mu g/m^3$ for a one-month average. Due to the lack of detectable lead levels it is inappropriate to try and make a comparison to the federal standard, which is a quarterly average of 1.5 $\mu g/m^3$.

Meteorological Data

Collection of the meteorological data began on August 19, 2005. The data presented here were collected during the period August 19 through November 21, 2005. The meteorological data is collected at Station MS-1. It is co-located with air quality Station AS-1 and is located at UTM coordinates 378,993m E and 4,379,963m N at an elevation of approximately 8,040 feet amsl. Wind speed and wind direction were collected at a height of 10 meters and temperature was collected at a height of two meters. The atmospheric stability data presented in this report is derived from a parameter known as "Sigma Theta" (the standard deviation of the horizontal wind direction fluctuations).

The meteorological data is summarized below. Actual hourly data is provided in Appendix Z. The meteorological instruments were calibrated and audited twice during the sampling period and met or exceed the applicable calibration and audit requirements.

The meteorological data was collected in accordance with ERM's Air Quality Monitoring Plan for the Battle Mountain North Project.

Data Recovery

The data recovery rate for each of the meteorological parameters for the sampling period is presented below.

- Wind Speed – 99.7%
- Wind Direction – 99.7%
- Temperature – 99.7%
- Sigma Theta – 99.7%

Wind Speed

The maximum hourly average wind speed for the sampling period was 15.2 miles per hour ("mph") and was recorded on October 4th. The highest recorded wind gust was 47.8 mph and was recorded on November 14th. A summary of the wind speed data in miles per hour is presented in Table 23.

Table 23 Wind Speed

Month	*Maximum Hourly Average (mph)*	*Maximum Gust (mph)*
August	13.0	31.4
September	12.9	40.4
October	15.2	40.4
November	12.8	47.8

Wind Direction

The predominant wind directions for the sampling period were from the north-northwest through north. The winds blew from these directions approximately 25 percent of the time with north-northwesterly winds being the most prevalent at 15 percent. Figure 67 presents the percent occurrence of wind direction for the sampling period.

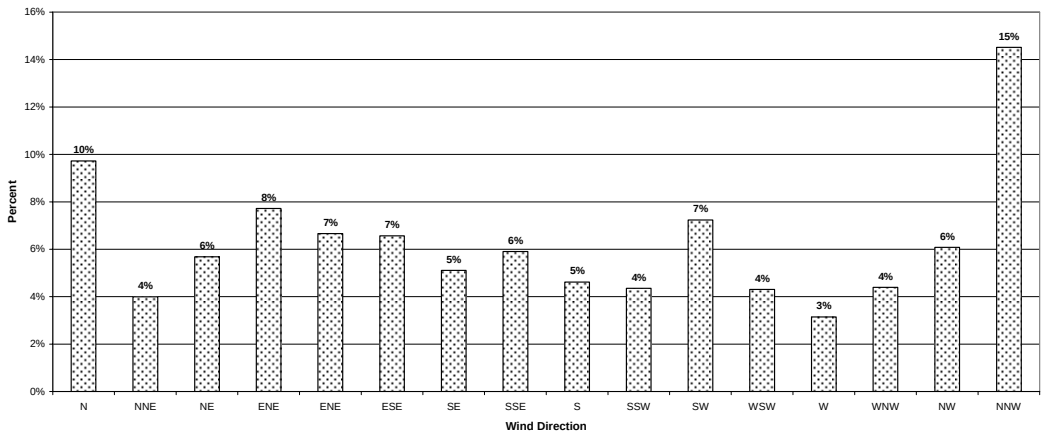


Figure 67 – Prevailing Wind Directions at the North Property – August 19 through November 21, 2005

Atmospheric Stability

Atmospheric stability is a measure of the degree to which the atmosphere is capable of dispersing pollutants. Stability classes vary from Stability Class 1, very unstable atmosphere, to Stability Class 6, very stable atmosphere. Generally speaking, an unstable atmosphere disperses and dilutes pollutants better than a stable atmosphere. Unfortunately, atmospheric stability does not lend itself readily to meaningful summaries. Therefore, none are provided. Hourly stability values are provided in Appendix Z along with the hourly values of the other meteorological data.

Temperature

The maximum hourly average temperature for the sampling period was 27.9 °C (82.2 °F) and occurred on August 30th. The minimum hourly average temperature was -15.2 °C (4.6 °F) and occurred on November 18th. A summary of the maximum and minimum hourly average temperatures is provided in Table 24.

Table 24 Temperature

Month	*Maximum Hourly Average*	*Minimum Hourly Average*
August	27.9 °C (82.2 °F)	-1.7 °C (28.9 °F)
September	27.3 °C (81.1 °F)	-4.1 °C (24.6 °F)
October	23.6 °C (74.5 °F)	-5.9 °C (21.4 °F)
November	16.5 °C (61.7 °F)	-15.2 °C (4.6 °F)

3.6 GEOPHYSICAL EVALUATION

Figure 68 Foundation block in Test Pit 1

Five areas of significant magnetic anomalies were identified by the EM-61 survey. These areas were investigated by excavating. The results of the test pit excavations did not encounter buried metal objects that present a new, significant environmental concern at the North Property, such as buried tanks or drums. Buried scrap metal and debris, consisting of wire cable, wire strapping, metal scrap and concrete blocks were encountered in most of the test pits. The first test pit which was excavated at metallic anomaly A-1 encountered buried foundation blocks similar to those used to support the Mine Water Transport Pipeline (Figure 68). Pieces of what appeared to be a car axle also were encountered at this location.

Metal scrap was also detected on the surface near several test pits in which buried metal objects were not encountered. The metal scrap that was encountered on the surface consisted of rolls of barbed wire, scrap rail, two crushed drums and a culvert (Figure 69).

Figure 69 Barbed wire by Test Pit 7

These objects likely were the source of metallic anomaly detected by the geophysical investigation. Following excavation activities, the test pit areas were restored and reseeded (Figure 70).

Figure 70 Test Pit after restoration and reseeding

In conclusion, there are pieces of scrap metal at the Rex Flats area both on the surface and buried in the upper one to three feet of soil. This debris is likely the cause of the metallic anomalies detected by the geophysical survey. In area A-1, near the center of Rex

Flats, buried concrete foundations and metal scrap were identified that should be removed prior to North Property redevelopment activities. The geophysical investigation of the Rex Flats area did not provide sufficient, new, and relevant data to warrant the use of geophysics at other historic tailings placement areas, such as the OTP or Roaster Pile #5.

4.0 NATURE AND EXTENT OF CONTAMINATION

The information from the Remedial Investigation including analytical results, background values, Site-specific standards, State and EPA standards, and Site history were used to establish the nature and extent of environmental impact at the North Property due to past tailings disposal activities. The following sections discuss the nature and extent of impact to the surface water, soil, and ground water.

4.1 SURFACE WATER

The CDPHE has established water quality standards for the Eagle River and its tributaries in Water Quality Control Commission Regulation No. 33 (CDPHE, 2006A). A review of the tables associated with this regulation indicates that the following seasonal Site-specific water quality standards for zinc (dissolved) have been established along portions of the Eagle River and Cross Creek that transverse the North Property:

- Segment 5a: Mainstem of the Eagle River from a point immediately above the compressor house bridge at Belden to a point immediately above the Highway 24 Bridge near Tigiwon Road. The chronic dissolved zinc standard from May 1 through February 29 is 166 µg/L and from March 1 through April 30 is 410 µg/L. Segment 5a includes North Property sampling stations E-11A, E-11B, E-11C, and E-12A.

- Segment 5b: Mainstem of the Eagle River from a point immediately above the Highway 24 Bridge near Tigiwon Road to a point immediately above the confluence with Martin Creek. The chronic dissolved zinc standard from May 1 through February 29 is 123 µg/L and from March 1 through April 30 is 310 µg/L. Segment 5b includes North Property sampling stations E-13, E-13C, and E-13B.

- Segment 7b: Mainstem of Cross Creek from a point immediately below the Minturn Middle School to the confluence with the Eagle River. The chronic dissolved zinc concentration standard from May 1 through February 29 is 116 µg/L and from March 1 through April 30 is 193 µg/L. Segment 7b includes North Property sampling station T-18.

The detected concentrations for dissolved zinc along the Eagle River are plotted in Figures 71 and 72 along with the seasonal segment-

specific CDPHE standard for zinc. Figure 71 presents the data for the summer and fall months (off-peak flow) and Figure 72 presents the data for the March and April sampling events (snowmelt / spring conditions). A review of Figure 71 indicates that the reported concentrations of zinc along the Eagle River were below CDPHE surface water standards during the summer and fall months. A review of Figure 72 indicates that during spring, detected concentrations of zinc in the Eagle River were above CDPHE surface water standards, except during the April 19 and 26, 2006 sampling events.

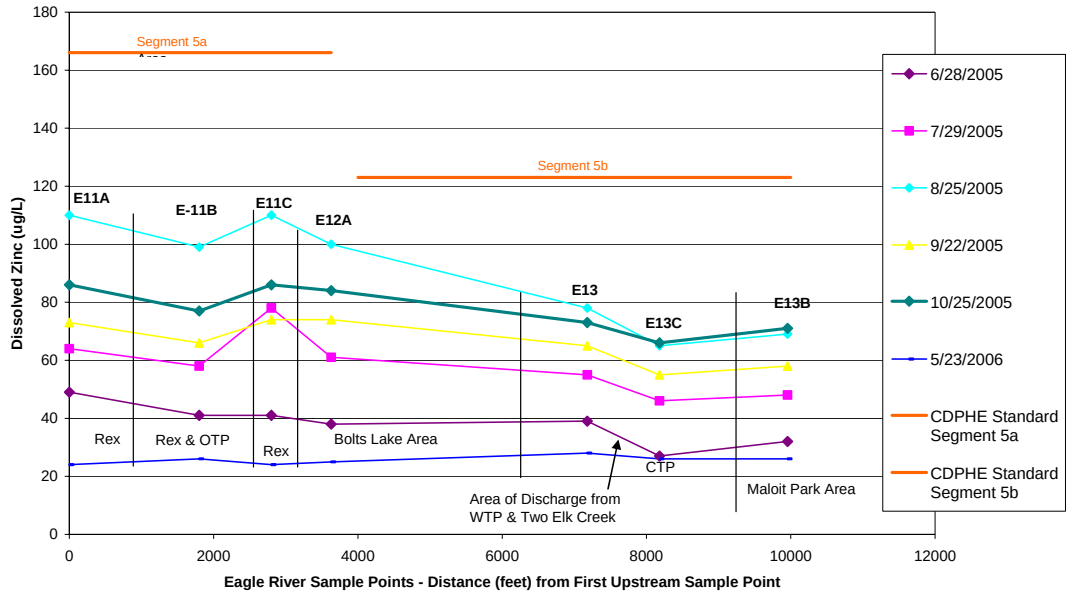


Figure 71 - Summary of Dissolved Zinc Concentrations in Surface Water of the Eagle River - Low Flow 2005 and 2006

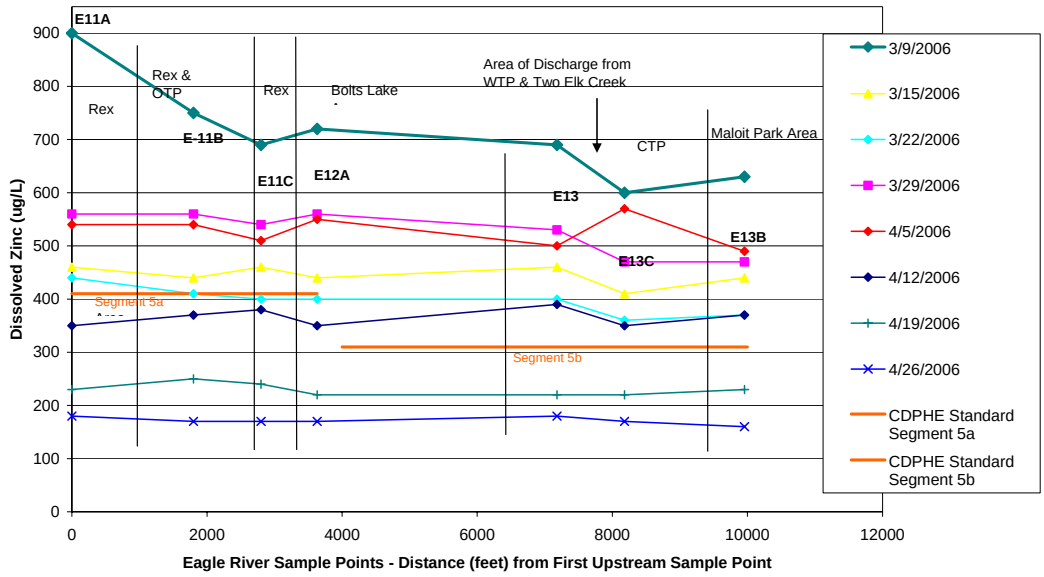


Figure 72 - Summary of Dissolved Zinc Concentrations in Surface Water of the Eagle River - High Flow 2006

The CDPHE regulation also provides calculations for establishing Site-specific standards for the other primary indicator metals at the Site. The calculations for several of the primary indicator metals require the input of a Site-specific hardness (as $CaCO_3$) concentration. To be consistent with the CDPHE guidance, mean hardness concentrations for off-peak and peak flow were calculated for each segment of the Eagle River (5a and 5b) and Cross Creek (7b). The segment-specific hardness was calculated, per the guidance, to be the 95% lower confidence limit (LCL) on the mean for hardness concentrations collected at periodic low flow criteria. Hardness concentrations were collected at each North Property sampling location during the nine sampling events that occurred in March through May 2006. The 95% LCL hardness and calculated standard for each metal are presented in Table 25 below.

Table 25 Mean Hardness and Calculated Standards

	Segment-Specific Calculated Standards for March and April 2006			*Detected Site-Specific Concentration Ranges during March and April 2006*		
	Segment 5a	*Segment 5b*	*Segment 7b*	*Segment 5a*	*Segment 5b*	*Segment 7b*
Hardness	*83*	*101*	*44*	**---**	**---**	**---**
Arsenic	50	50	50	ND	ND	ND
Cadmium	1.95	2.25	1.22	ND– **2.7**	ND – **2.2**	ND
Chromium	11	11	11	ND	ND	ND
Copper	7.64	9.03	4.44	3.1 - **15**	3.4 - **15**	ND - 2.9
Lead	2.05	2.54	1.02	ND – 1.7	ND	ND
Manganese	1550	1655	1255	120-480	150-420	120-400
	Segment-Specific Calculated Standards for May 2005 through February 2006			*Detected Site-Specific Concentration Ranges during June through October 2005 and May 2006*		
	Segment 5a	*Segment 5b*	*Segment 7b*	*Segment 5a*	*Segment 5b*	*Segment 7b*
Hardness	*42*	*43*	*48*	**---**	**---**	**---**
Arsenic	50	50	50	ND	ND	ND
Cadmium	1.18	1.20	1.30	ND	ND	ND
Chromium	11	11	11	ND	ND	ND
Copper	4.27	4.35	4.78	ND – 3.7	ND – 3.9	ND – 3.7
Lead	0.97	0.99	1.12	ND – **3.2**	ND – **1.8**	ND – **1.7**
Manganese	1236	1245	1292	25 - 180	31 - 200	21 - 82

Concentrations are reported in micrograms per liter (µg/L), dissolved
ND = Not detected
Bold concentrations exceed the CDPHE standard
The May through February calculated standards were based on hardness values collected during the May 2006 sampling event.
The arsenic and chromium standards are not segment- or season-specific.

A review of data for the primary indicator metals other than zinc at the North Property indicates that: a) copper exceeded the standards at the Eagle River stations E-11A through E-13C during the spring, b) lead exceeded the standards during the June sampling event at stations E-11A through E-13C and Station T-18, and c) cadmium exceeded the standards during the spring at stations E-11A through E-12A (Figure 73). The remaining primary indicator metals of arsenic, chromium, and manganese have not been detected above CDPHE standards in 2005 or 2006.

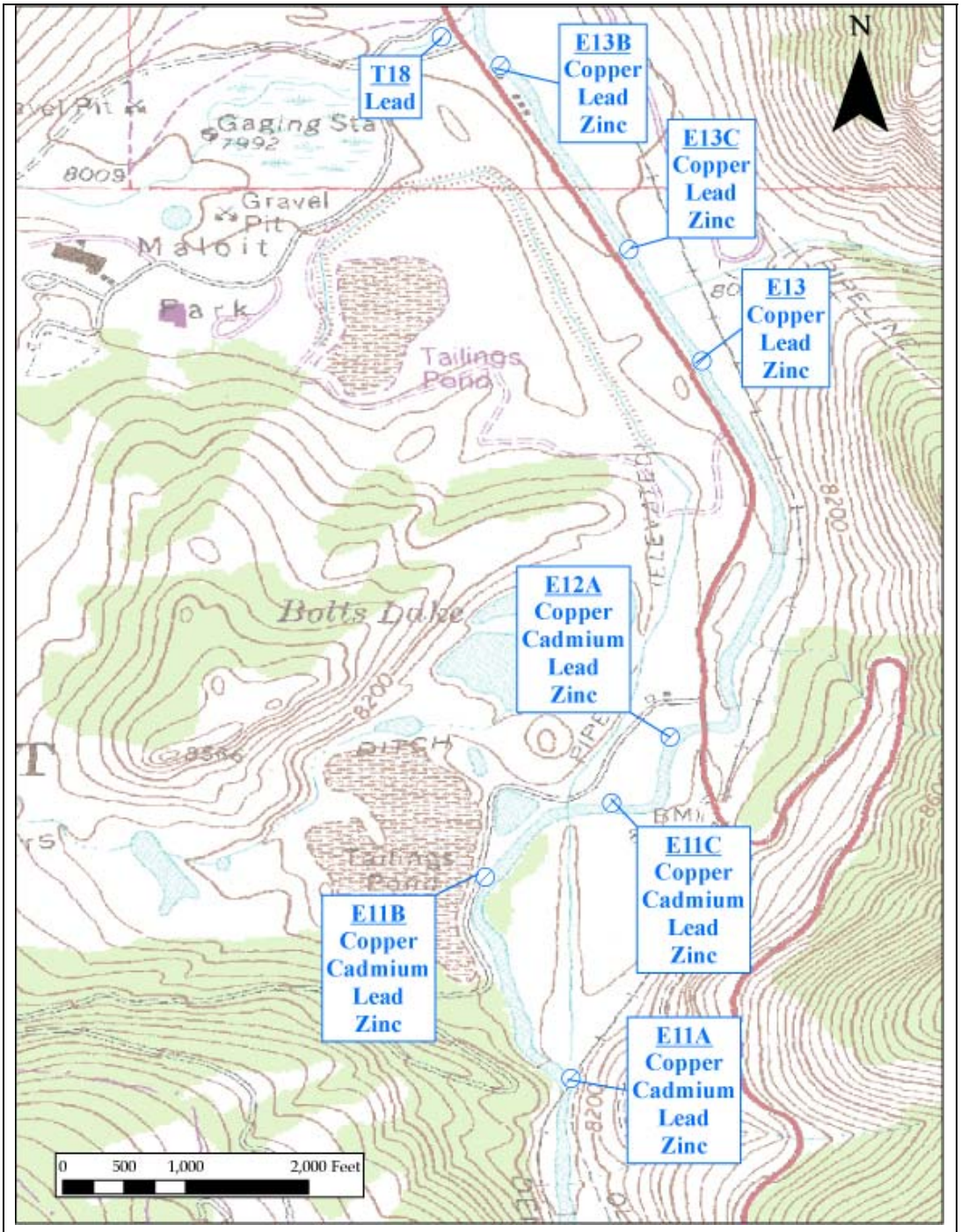


Figure 73
Summary of Eagle River Water Quality Stations with Associated Surface Water Metals Exceedance

A review of the surface water data collected in 2005 and March 2006 as part of the Remedial Investigation indicates that zinc is an indicator of mine-related impact to the Eagle River. Exceedances of CDPHE segment-specific standards for zinc correlate to exceedances of other primary indicator metals for the North Property, such as copper and cadmium. It is noted that the surface water standards will change (be lowered) effective December 31, 2007.

4.2 *SOIL*

To evaluate nature and extent of impacted soil, Site soil concentrations were evaluated with respect to Site-specific standards. The rationale for those standards and the resulting areas of surface and subsurface impact (extent) are presented below. The nature of these impacts is the historical deposition of mine waste at the Site.

4.2.1 *Background and Screening Values*

To initially assess the potential mine-impacted soil at the North Property, a statistical background concentration was established for each of the primary indicator metals. This was accomplished by using the Site-specific background data collected during this investigation.

The statistical background concentrations were calculated per the guidance document "*Soil Remediation Objectives: A Policy for Outlining the Process for Developing Site-Specific Soil Remediation Objections*" published by the Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division, and dated December 1997 (CDPHE, 1997). This method was used as requested by EPA/CDPHE, and represents a very conservative approach to calculating background in that it results in analytical data from the background samples exceeding the calculated, statistical background concentrations.

Using this approach, 19 of the 20 Site specific background samples were used to calculate background. Sample CTP-SS-3 was excluded due to its close proximity to a shooting range. The statistical background concentrations were calculated as the 95% upper confidence limit (UCL) on the mean for the combined data set for each metal. The results are presented in Table 26.

Table 26 Site-Specific Background Concentrations

Metal (mg/kg)	*2005 Background Data*	*2006 Background Data*	*95% UCL on the Mean*	*Distribution*	*ProUCL recommended statistical method*
Arsenic	0.67-43	2.9-48	18.4	Gamma	Approximate Gamma
Cadmium	<0.1-5.5	0.31-3.9	2.12	Gamma	Approximate Gamma
Chromium	13-22	10-18	17.4	Normal	Student's-t UCL
Copper	3.2-25	6.8-23	17.2	Normal	Student's-t UCL
Lead	4.3-170	18-100	61.1	Gamma	Approximate Gamma
Manganese	83-1300	160-900	605	Normal	Student's-t UCL
Zinc	24-810	87-920	359	Gamma	Approximate Gamma
		Sample Size	19		

As can be seen by comparing the statistical background concentrations with the background soil analytical results (Table 27), the statistical background concentrations are occasionally significantly less than the background soil analytical results. Since five background samples were analyzed for the expanded analyte list, these values are noted as-is, and statistics were not calculated for that small data set.

In addition to the background values, non Site-specific PRGs, which incorporate generic risk factors, were reviewed to evaluate soil concentrations at the Site. In this case, the EPA Region 9 PRGs were reviewed.

The Site data were also compared to Site-specific risk-based values, as presented in the document *Human Health Risk Assessment, Bolts Lake Area and Areas within OU-1 of Eagle Mine Site,* dated September 15, 2006 and prepared by ERM and Terra Technologies. That human health risk assessment ("HHRA") assessed the current baseline human health risks at the Site using the information that was collected during the 2005 and 2006 RI activities. The HHRA contained qualitative estimates of exposure compared to estimates of cancer and noncancer health effects to develop risk estimates. The following table summarizes the data for the seven primary metals. The Site-specific risk-based values discussed below represent the Reasonable Maximum Exposure ("RME") method, with dermal component, and with 50 percent (%) bioavailability.

Table 27 Data Summary for the 7 Primary Metals - Surface Soil Samples

Metal - 7 primary (mg/kg)	*Calculated Background (95% UCL)*	*Background Range (19 samples)*	*Site-Specific Risk-Based Values*	*EPA Region 9 PRGs (residential)*	*Range of Metal Concentrations for Former Mine Waste Areas*[1]	*Bolts Lake Concentrations Range*
arsenic	18.4	0.67 - 48	0.78 – 77.7 [2]	0.39	0.85 - 2,700	2.7 - 57
cadmium	2.12	<0.1 - 5.5	136	37	<0.1 - 26	0.12 - 6.3
chromium	17.4	10 - 22	410,625	210[3]	<2.3 - 62	8.7 - 21
copper	17.2	3.2 - 25	10,950	3,100	6.9 - 1,300	4.3 - 73
lead	61.1	4.3 - 170	658 [4]	400	2.4 - 14,000	7.4 - 150
manganese	605	83 - 1,300	22,974	1,800	22 - 9,800	75 - 980
zinc	359	24 - 920	82,125	23,000	29 - 7,700	44 - 890

[1] Maloit Park, Roaster Pile #5, OTP/Sump Area #3, Rex Flats

[2] Arsenic cancer risk range of 0.78, 7.8 and 77.7 mg/kg

[3] chromium PRG is for 'total chromium'

[4] IEUBK model (Integrated Exposure Uptake Bio Kinetic)

< = less than

As observed in Table 27, the Region 9 PRGs and the Site-specific risk-based values are greater than the statistical background concentrations, greater than the actual Site background analytical results, and greater than the Bolts Lake analytical results, for these metals (except for arsenic). Applying these values as Site-specific remediation goals ("RGs,") except for arsenic, will result in the identification of mine-impacted soil which imposes a concern versus naturally-occurring high metals concentrations.

For arsenic, the Region 9 PRG is less than: 1) the statistical background, 2) the actual analytical background concentrations, and 3) the Bolts Lake analytical results (excluding the one isolated area discussed in Section 3.3.2). Similarly, the two most conservative Site-specific risk-based values are also less than background and Bolts Lake results. The least conservative value of 77.7 mg/kg accounts for naturally-occurring arsenic concentrations. The highest actual analytical background concentration for the Site was arsenic at 48 mg/kg. On the basis of the naturally-occurring arsenic concentration, and the range of Site-specific risk-based values, the Site-specific RG for arsenic was selected to be 40 mg/kg. This value will result in the identification of mine-impacted soil of concern versus naturally occurring high metals concentrations. It should be noted that a concentration of 70 mg/kg has been used as the arsenic PRG by the EPA to remediate several other mine waste sites in Region VIII. In summary, the Site-specific RGs used in this RI for the Eagle Mine are as follows:

arsenic	40 mg/kg
cadmium	37 mg/kg
chromium	210 mg/kg
copper	3,100 mg/kg
lead	400 mg/kg
manganese	1,800 mg/kg
zinc	23,000 mg/kg.

Similar to the 7 primary metals, the expanded list of analytes was also compared to background concentrations and Region 9 PRGs, where established, as shown in Table 28.

Implementing these RGs, which consider naturally occurring higher concentrations, will facilitate implementation of clean fill as cover over impacted areas.

Table 28 Data Summary for the Expanded List of Analytes - Surface Soil Samples

Metal - Extended Analytes (reported in mg/kg)	*Background Range (4 Site samples)*	*Site-Specific Risk Based Values*	*EPA Region 9 PRGs (residential)*	*Range of Metal Concentrations for Former Mine Waste Areas*[3]	*Bolts Lake Concentrations Range*
aluminum	8,800 - 24,000	no Site risk	76,000	1,800 - 30,000	6,200 - 10,000
antimony	<1.1 - 41	110	31	<1 - 12	<1.3 - 51
barium	140 - 440	49,891	5,400	45 - 410	120 - 540
beryllium	<0.59 - 6.5	535	150	<0.52 - 1.4	<0.63 - 7.9
calcium	4,900 - 79,000	no Site risk	not established	320 - 83,000	1,200 - 59,000
cobalt	8.1 - 55	no Site risk	900	1.8 - 20	2.4 - 68
cyanide	<0 55 - <0.62	5,466	1,200[1]	<0.52 - 36	<0.63 - <0.72
iron	16,000 - 160,000	82,125	23,000	11,000 - 260,000	31,000 - 170,000
magnesium	3,800 - 14,000	no Site risk	not established	330 - 17,000	1,500 - 9,000
mercury	<0.036 - 0.046	82	23	<0.034 - 2.7	<0.041 - 0.048
nickel	11 - 57	5,475	1,600[2]	<4.6 - 31	5.5 - 71
potassium	2,800 - 11,000	no Site risk	not established	1,400 - 7,300	2,100 - 13,000
selenium	<1.4 - 210	1,369	390	<1.4 – 2.2/<8	<1.6 - 100
silver	<1.1 - 21	1,369	390	<1 - 52	<1.3 - 21
sodium	<590 - 7,000	no Site risk	not established	<520 - 680/<2,700	<630 - 8,600
sulfate	<55 - 78	no Site risk	not established	<52 - 42,000	<64 - 430
thallium	<1.3 - 210	22	5.20	<1.2 - 18	<1.5 - 260
vanadium	17 - 89	2,464	78	5.3 - 59	31 - 110

[1] cyanide PRG is for 'free' cyanide

[2] nickel PRG is for 'soluble salts'

[3] Maloit Park, Roaster Pile #5, OTP/Sump Area #3, Rex Flats

< = less than

As discussed in Section 3.3.2, these analytes are not necessarily mine - related wastes; naturally-occurring higher concentrations of these analytes were detected in Bolts Lake, which has no history of mine use. Review of the data for the expanded list of analytes shows that:

- Concentrations of the expanded analytes from the former areas of tailings deposition are below the Region 9 PRGs except for iron and thallium, and are below the Site-specific risk-based values except for iron;

- The concentration of thallium at Bolts Lake is greater than that detected in the former mine tailings deposition areas;

- Iron was detected at higher concentrations (greater than background or Bolts Lake values) in the area of former mine waste than in background or Bolts Lake samples (three isolated locations: Maloit Park MP-SS-3A, Rex Flats RX-HA-4, OTP OTP-SS-63);

- Samples from the Site-specific background locations and Bolts Lake meet the Region 9 PRGs except for antimony, iron, thallium, and vanadium, and meet the Site-specific values except for iron and thallium; and

- Antimony, iron, thallium, and vanadium occur at naturally high concentrations at the Site and are not indicative of mine waste.

Therefore, the expanded list of analytes is not appropriate to identify mine-impacted soil versus naturally occurring high analytes concentrations. The primary indicator metals selected by EPA during the initial remedial activities in 1970 are still appropriate to evaluate mine-related impacts at the Eagle Mine Site. It is noted that the three isolated areas of elevated iron (higher than background or Bolts Lake concentrations) are within areas of elevated arsenic concentrations. Therefore, Site remedial activities that address arsenic will also address areas with elevated iron.

4.2.2 *Extent*

The metals of arsenic, lead, and manganese are the only primary indicator metals that exceed the Site-specific RGs. Figures 74 through 88 present contoured maps that outline the areas of exceedances, by area, and represent the extent of impact to surface soil (Appendix AA). As seen on these maps, impacted arsenic is most prevalent. Impacted lead is less common and usually is within the area of impacted arsenic. Impacted

manganese occurs within isolated areas, but does not necessarily occur with impacted arsenic or impacted lead.

OTP

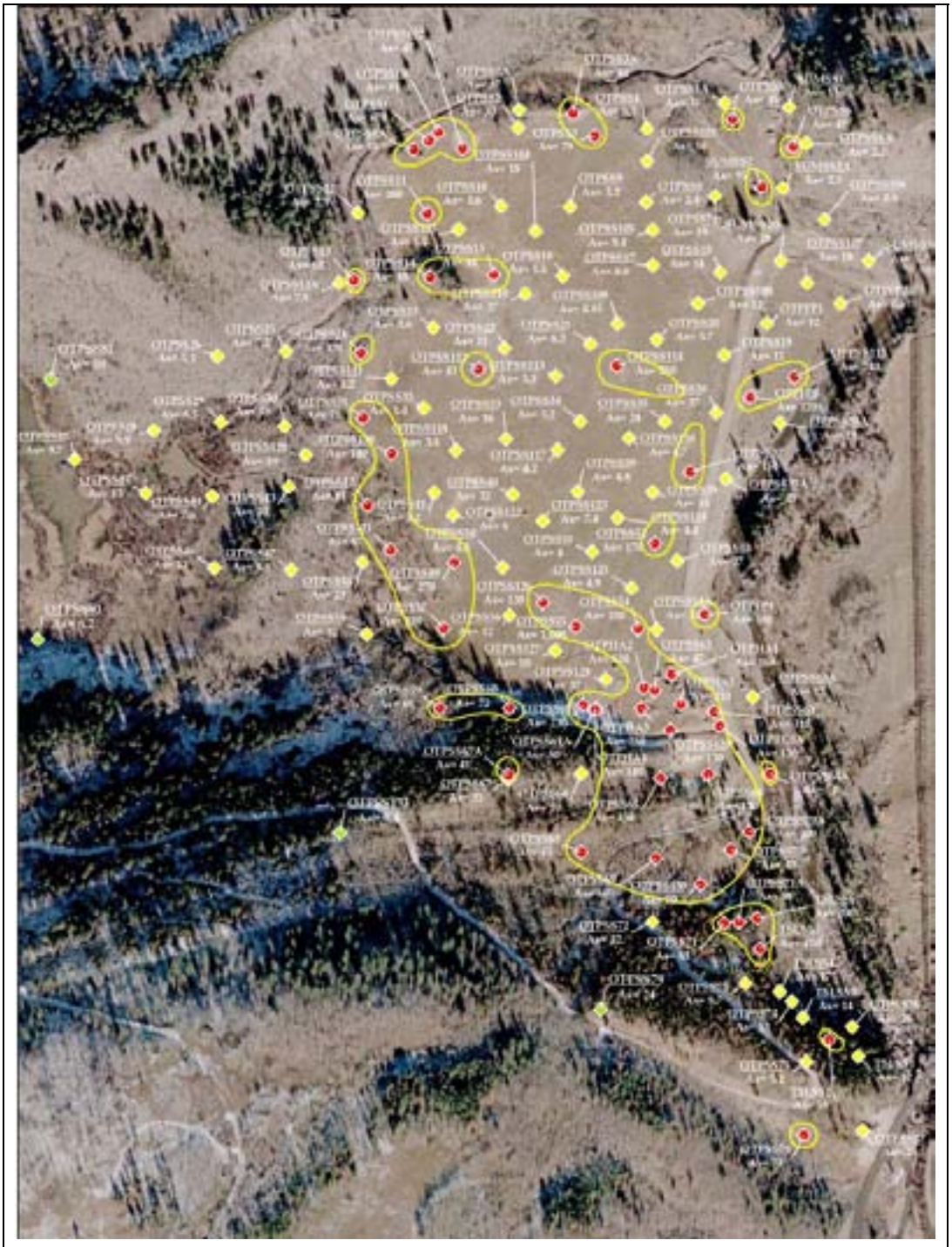


Figure 74
OTP –Impacted Area of Arsenic (greater than 40 mg/kg)

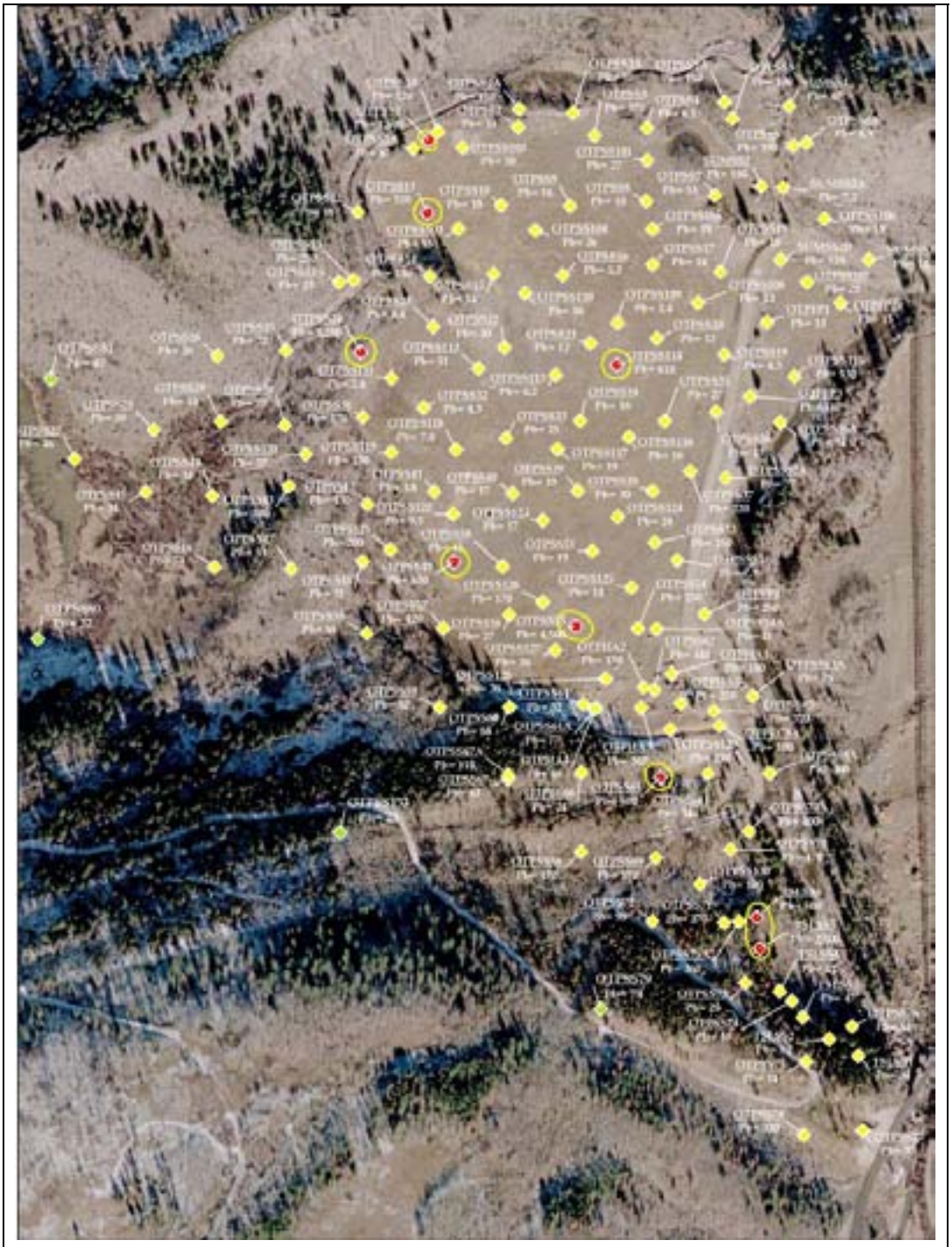


Figure 75
OTP – Impacted Area of Lead (greater than 400 mg/kg)

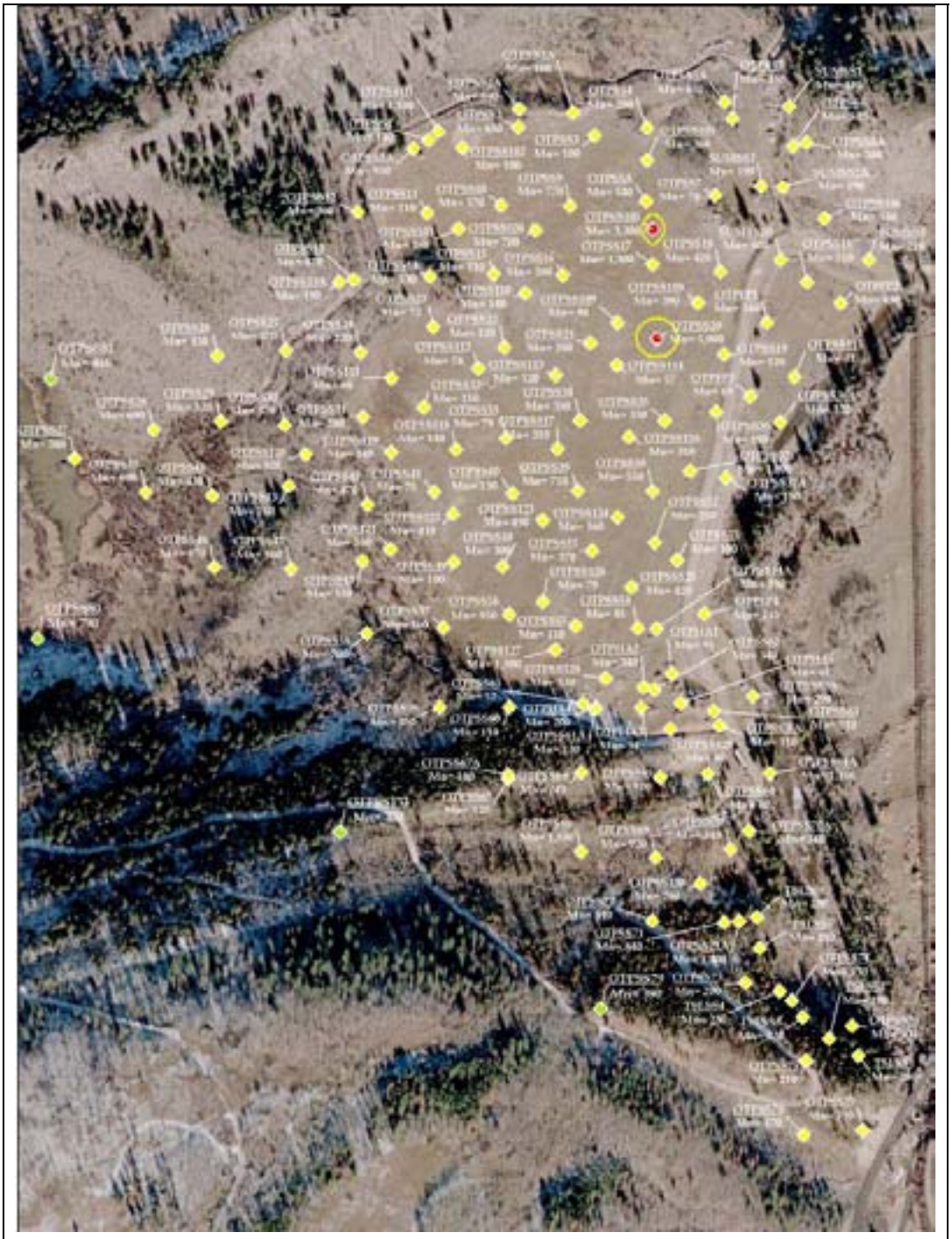


Figure 76
OTP – Impacted Area of Manganese (greater than 1,800 mg/kg)

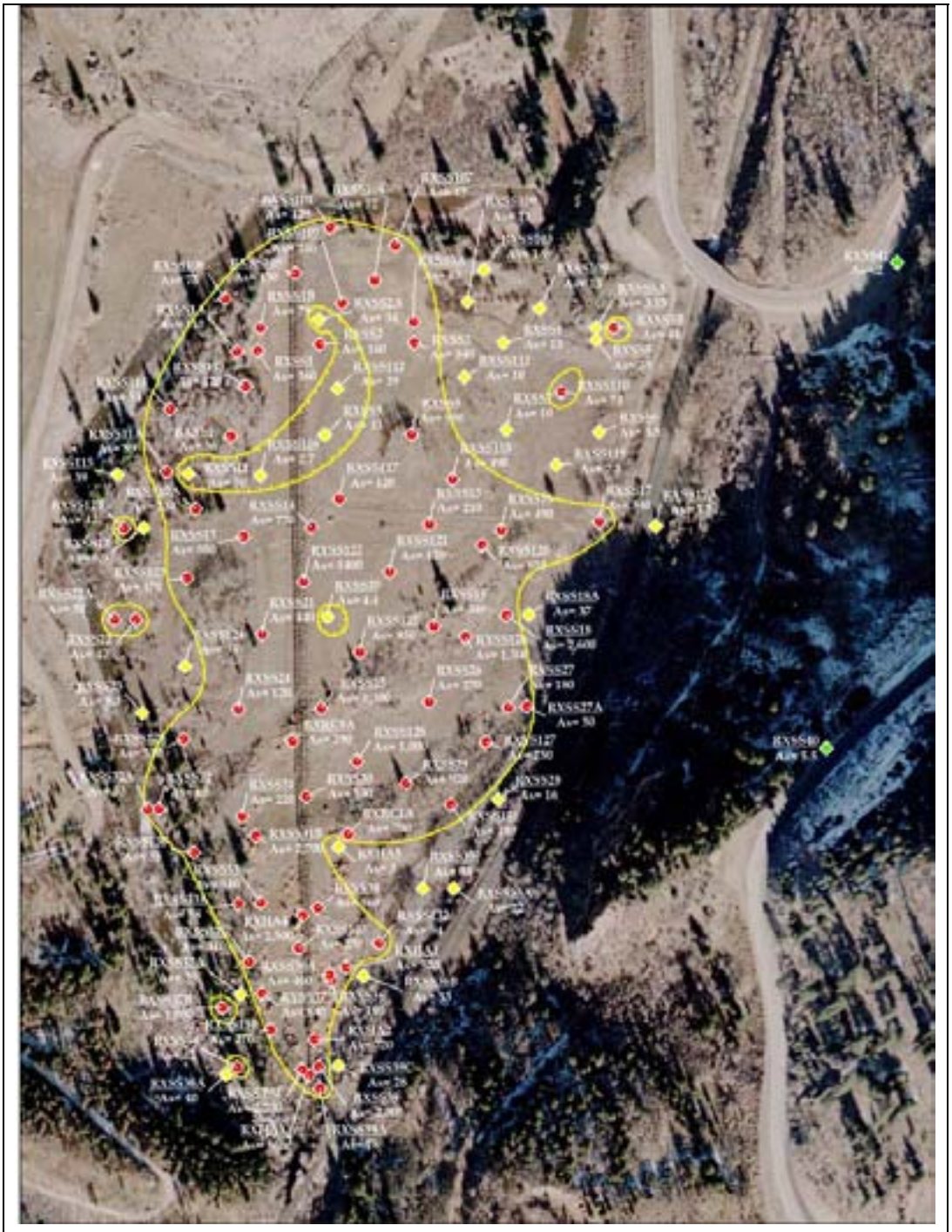


Figure 77
Rex Flats – Impacted Area of Arsenic (greater than 40 mg/kg)

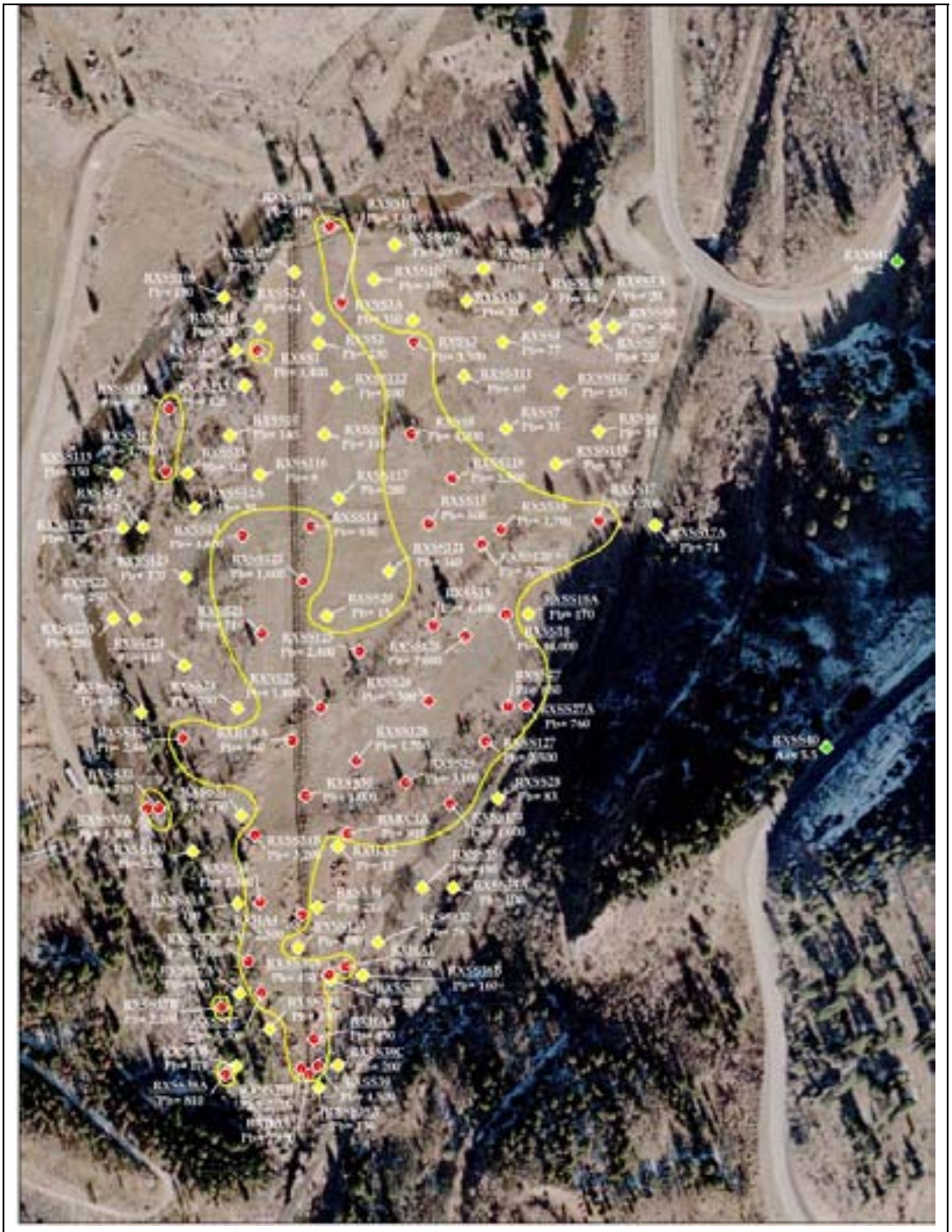


Figure 78
Rex Flats – Impacted Area of Lead (greater than 400 mg/kg)

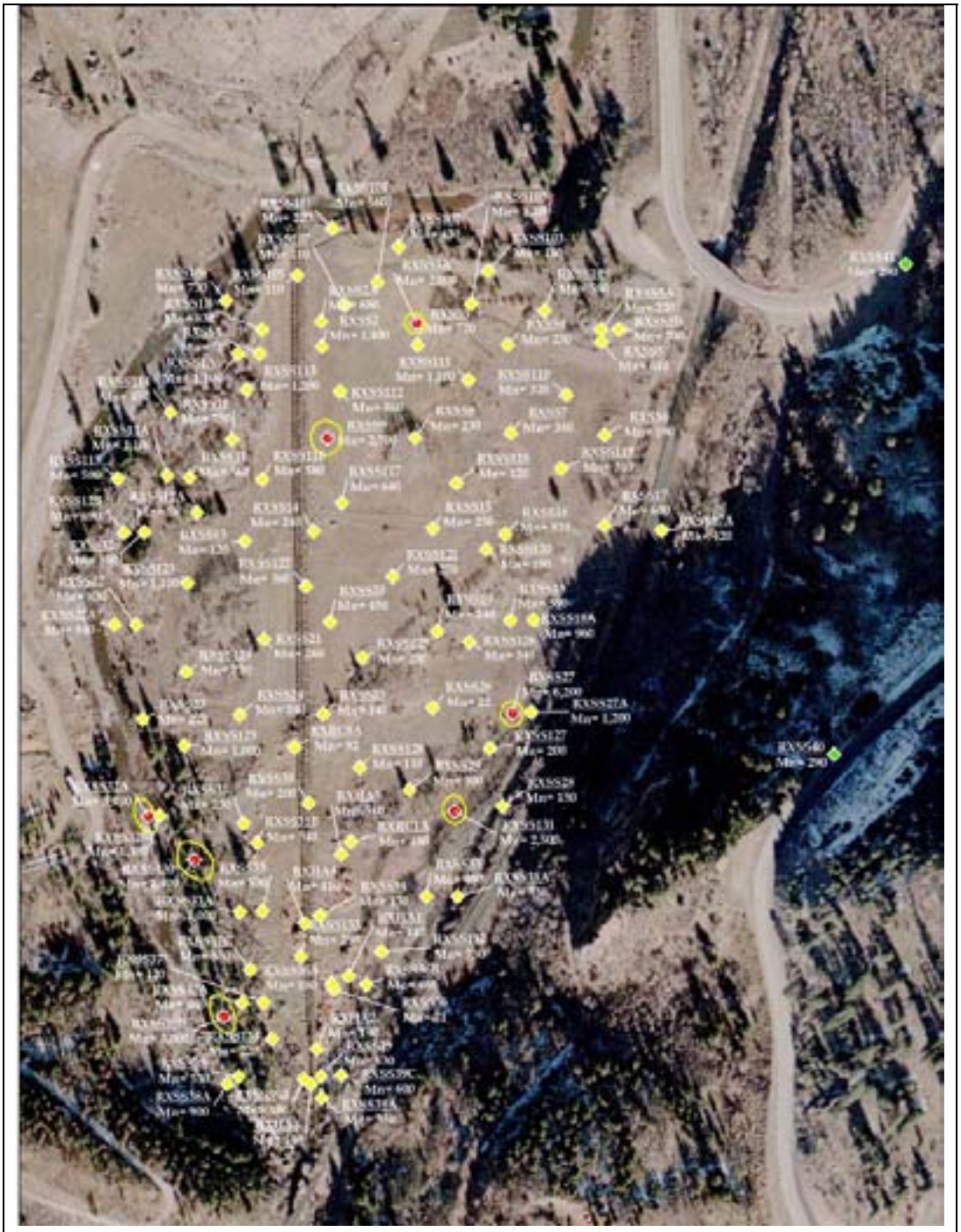


Figure 79
Rex Flats – Impacted Area of Manganese (greater than 1,800 mg/kg)

Maloit Park

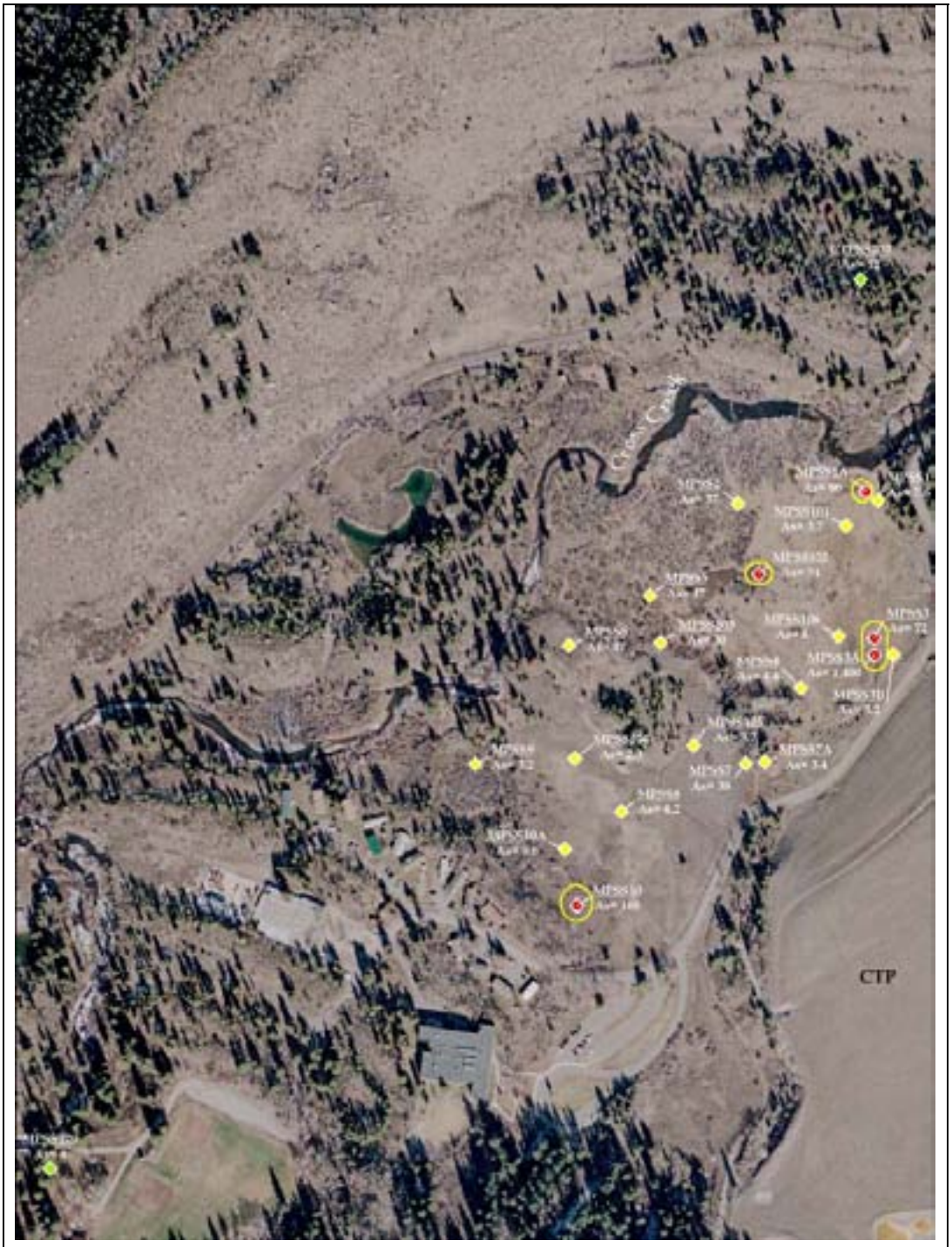


Figure 80
Maloit Park – Impacted Area of Arsenic (greater than 40 mg/kg)

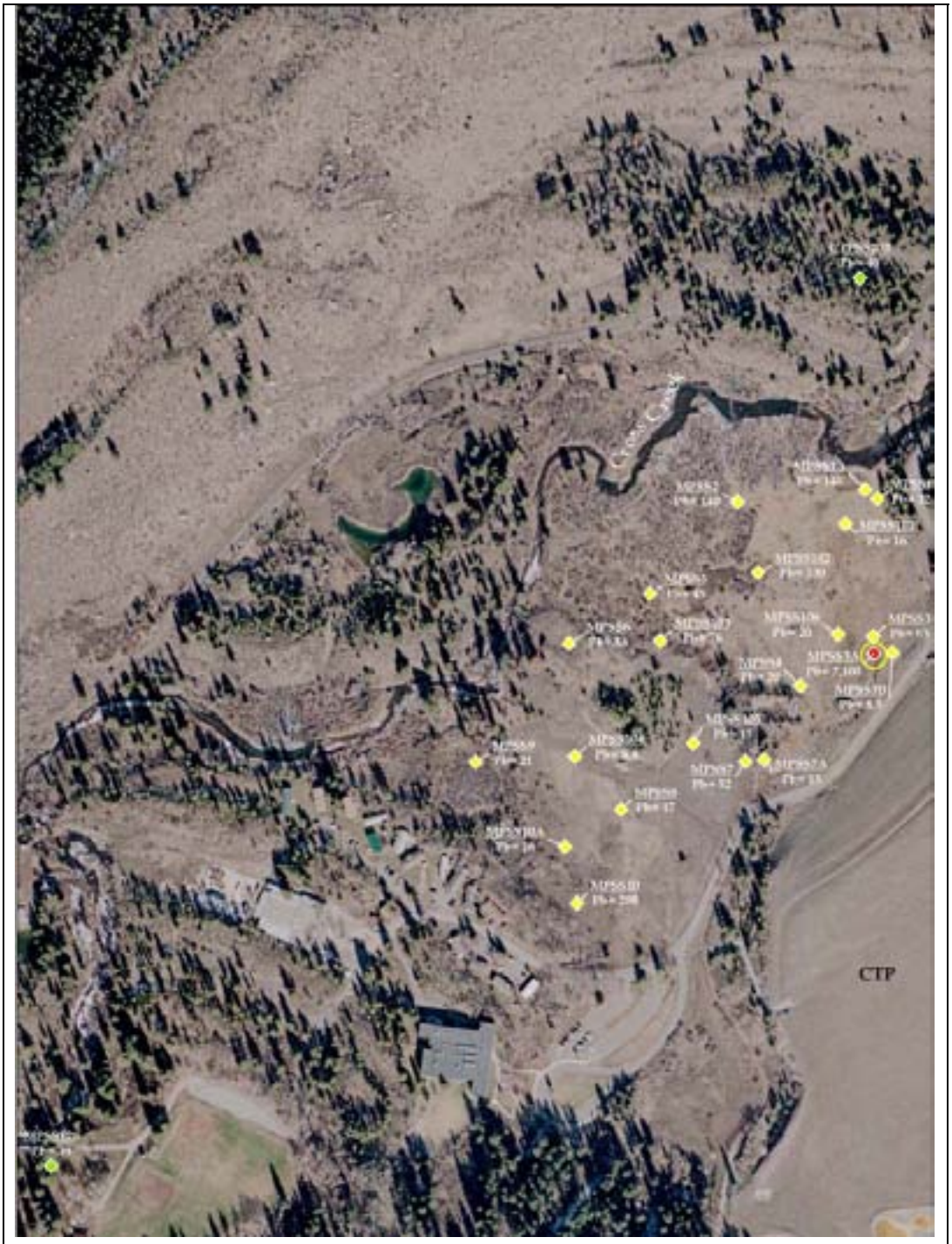


Figure 81
Maloit Park – Impacted Area of Lead (greater than 400 mg/kg)

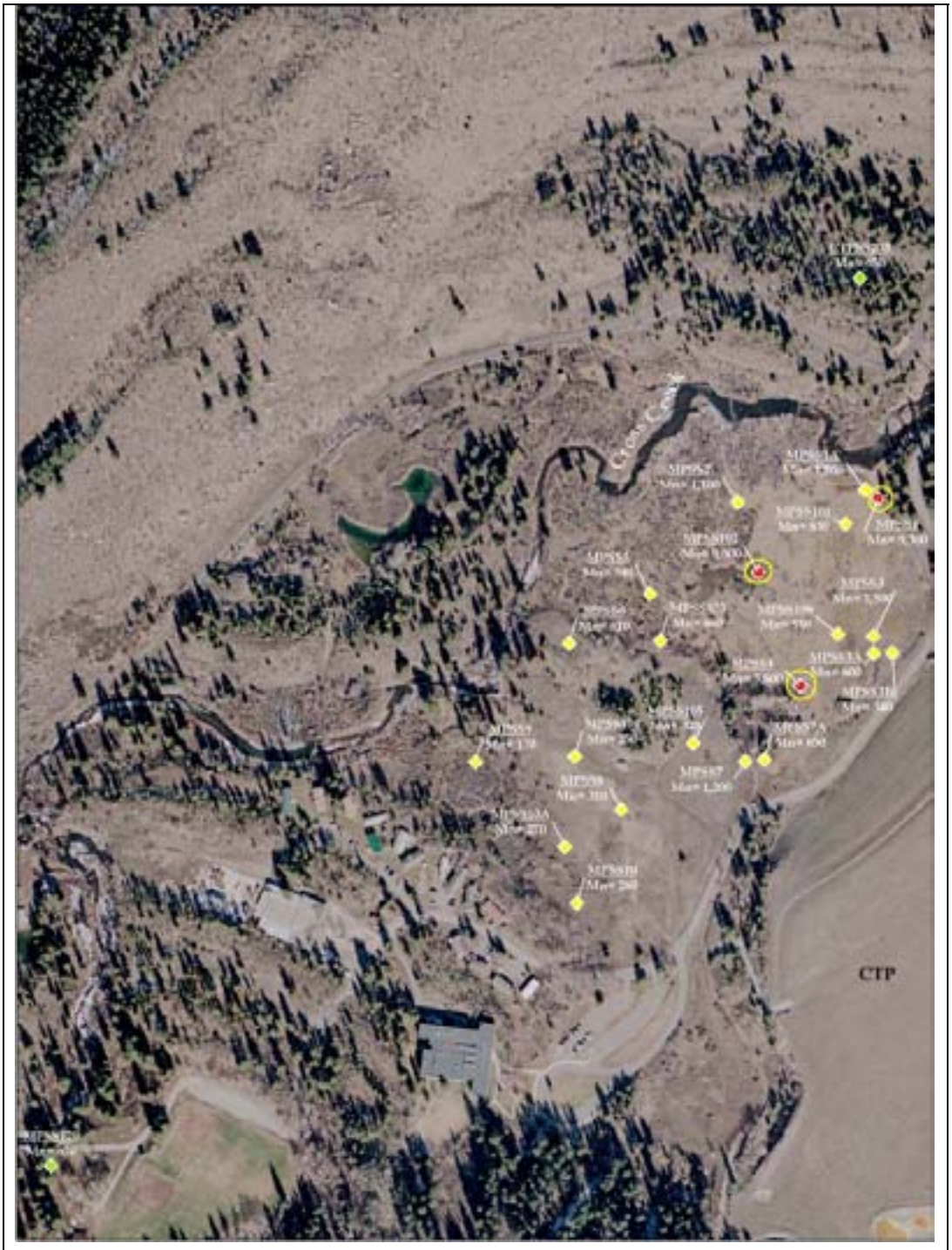


Figure 82
Maloit Park – Impacted Area of Manganese (greater than 1,800 mg/kg)

Bolts Lake

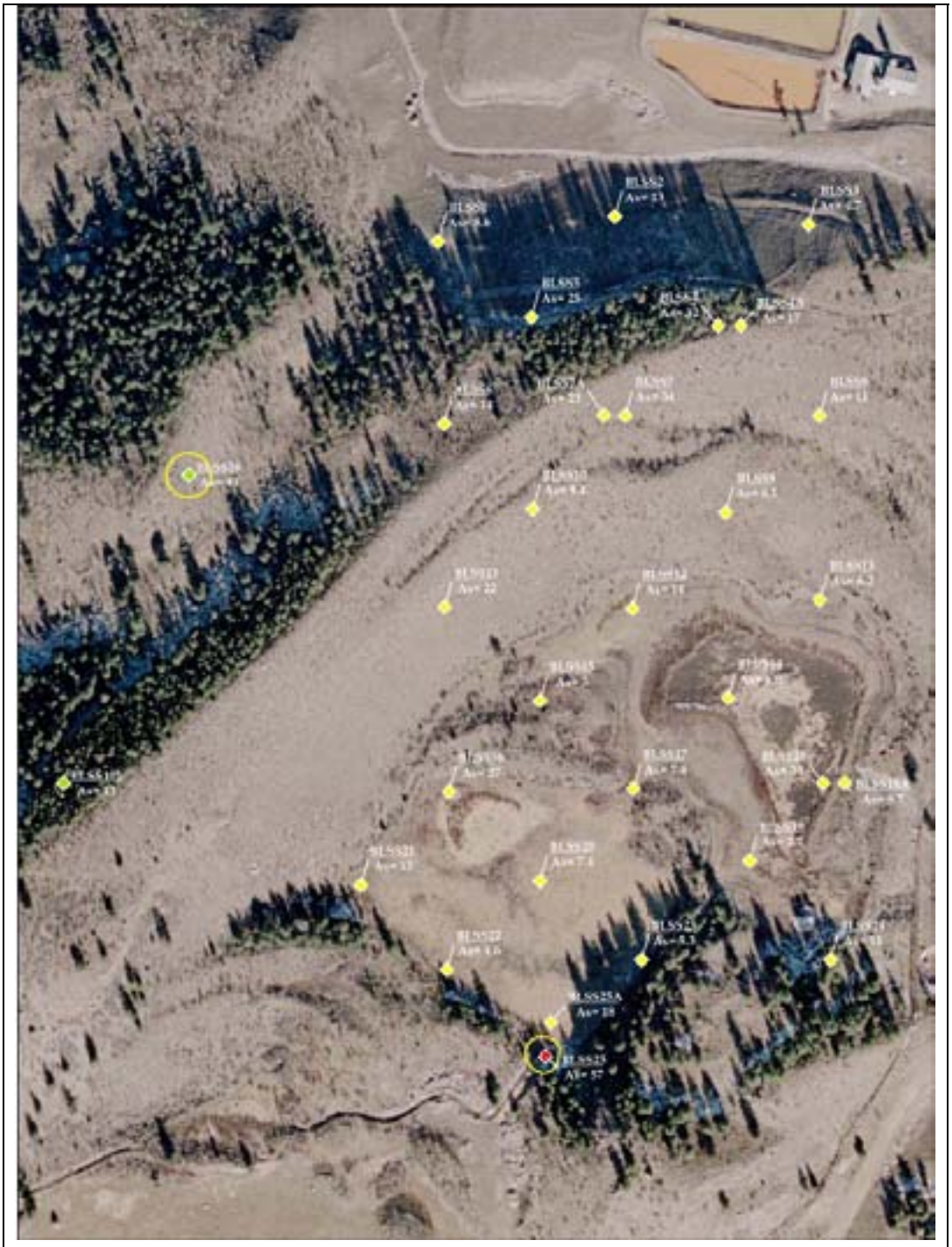


Figure 83
Bolts Lake – Impacted Area of Arsenic (greater than 40 mg/kg)

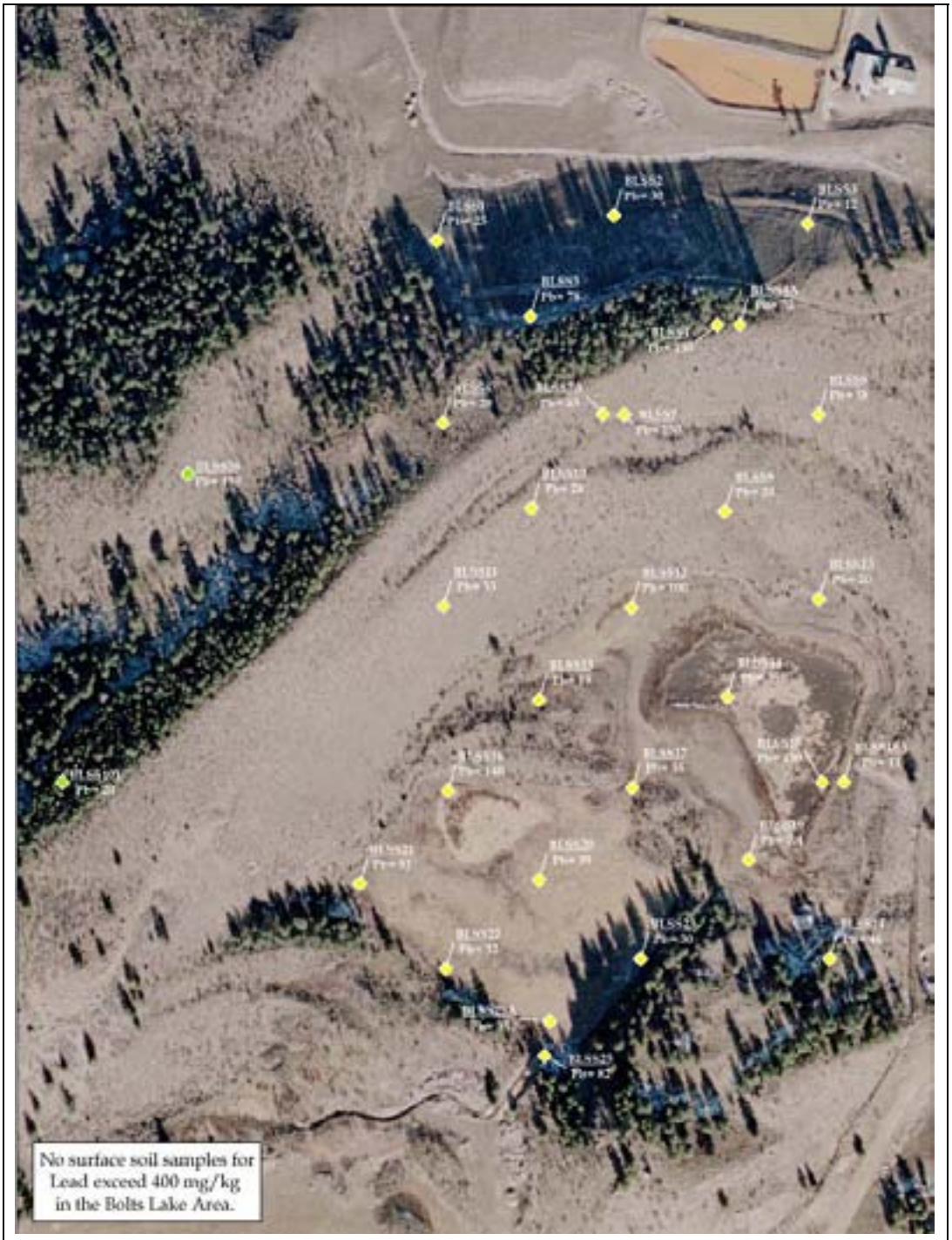


Figure 84
Bolts Lake – Impacted Area of Lead (greater than 400 mg/kg)

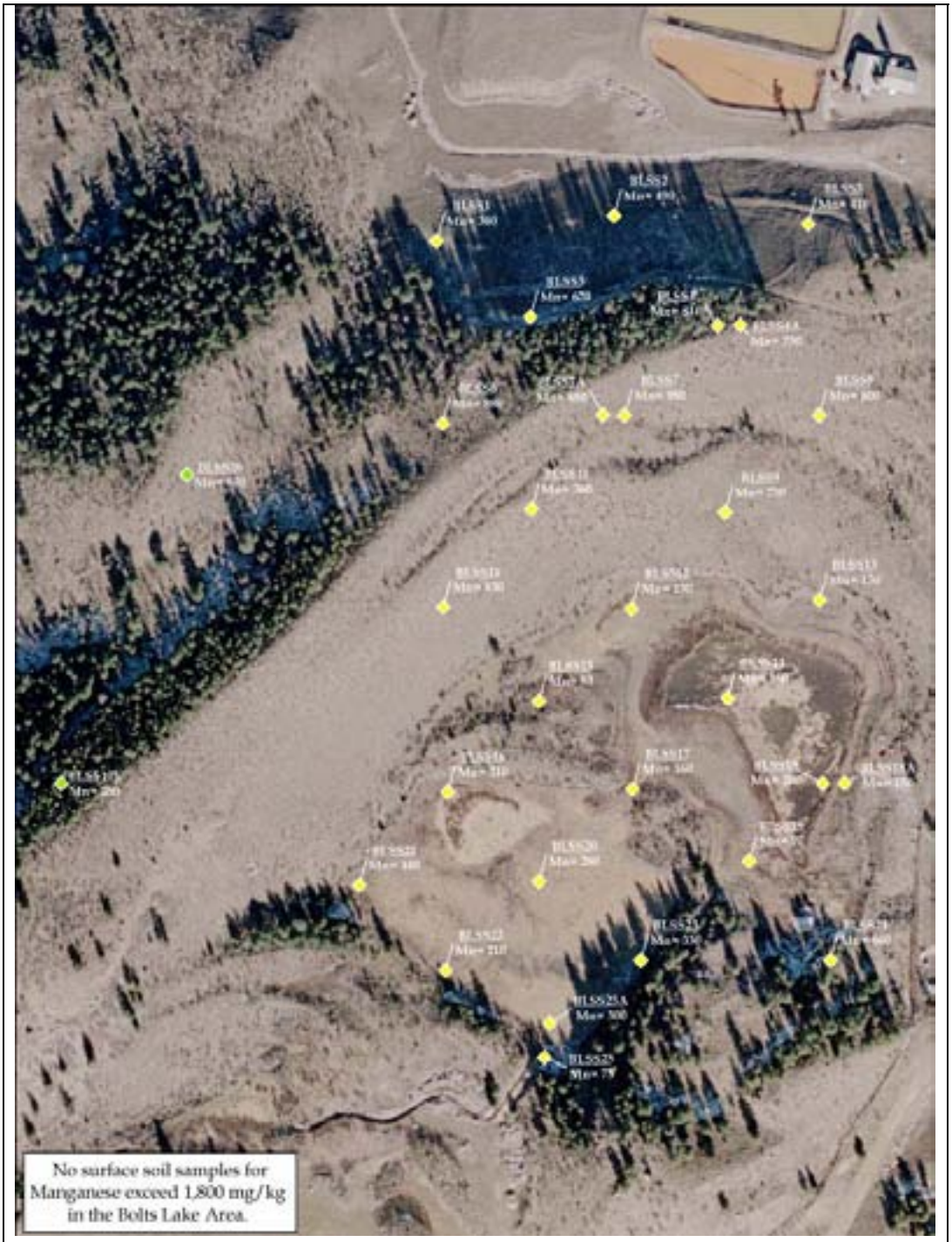


Figure 85
Bolts Lake – Impacted Area of Manganese (greater than 1,800 mg/kg)

Roaster Pile #5

Figure 86
Roaster Pile #5 – Impacted Area of Arsenic (greater than 40 mg/kg)

Figure 87
Roaster Pile #5 – Impacted Area of Lead (greater than 400 mg/kg)

Figure 88
Roaster Pile #5 – Impacted Area of Manganese (greater than 1,800 mg/kg)

4.2.3 *Tailings Slurry Pipeline Sediment Samples*

Four samples of the sediment within the Tailings Slurry Pipeline were collected and analyzed for the primary indicator metals plus mercury and cyanide. Comparison to the Site-specific standards shows that arsenic, lead, and mercury were detected at concentrations greater than those standards.

4.2.4 *Rock Chip Samples from Boulders*

The results of the 16 rock chip samples from boulders that were collected from Rex Flats and the OTP were compared to the concentrations from the one background rock sample that was collected from near Red Cliff. The concentrations were also compared to the Site-specific RG. That comparison shows the following:

Arsenic – The background rock sample did not have detectable concentrations of arsenic. Comparison to the Site-specific RG showed that 7 of the 16 rock chip samples from boulders had concentrations greater than the Site-specific standard of 40 mg/kg.

Cadmium - The background rock sample did not have detectable concentrations of cadmium. No rock chip samples from boulders had concentrations that were greater than the Site-specific RG of 37 mg/kg.

Chromium - The background rock sample contained 29 mg/kg of chromium. No rock chip samples from boulders exceeded the Site-specific RG of 210 mg/kg.

Copper - The background rock sample contained 6.4 mg/kg of copper. No rock chip samples from boulders had concentrations that were greater than the Site-specific RG of 3,100 mg/kg.

Lead - The background rock sample contained 7.6 mg/kg of lead. One rock chip sample from a boulder was greater than the Site-specific RG of 400 mg/kg (RX-RC-3).

Manganese - The background rock sample contained 360 mg/kg of manganese. Two rock chip samples from boulders had concentrations that were greater than the Site-specific RG of 1,800 mg/kg (OTP-RC-8, RX-RC-3).

Zinc - The background rock sample contained 99 mg/kg of zinc. No rock chip samples from boulders had concentrations that were greater than the Site-specific RG of 23,000 mg/kg.

The differences in the rock background concentrations and the Site-specific rock chip/boulder sample concentrations may be in part due to rock type. The background sample was collected from a rock composed of sandstone of the mostly non-mineralized Minturn Formation, whereas the boulders on site can vary from sandstone to granite, quartzite, dolomite, and limestone. The Site-specific rock chips sampled during this investigation were historically buried within the former tailings as evidenced by their discoloration, weathering, and sulfur odor.

4.2.5 *Subsurface Soil Samples*

The subsurface soil (deeper than 6 inches) analytical results for each area were compared to the Site-specific RGs (standards) for soil in Table 29.

Table 29 Comparison of Subsurface Soil Concentrations to Site Specific RGs - Seven Primary Indicator Metals

Metal (mg/kg)	*Site-specific RG (mg/kg)*		*Bolts Lake*	*OTP/ Sump 3*	*Rex Flats*	*Site Summary*
Arsenic	40	min	<1.3	0.65	<0.63	OTP and Rex Flats exceedances
		max	25	220	1000	
Cadmium	37	min	<0.21	<0.1	<0.1	No exceedances
		max	2.3	2	2.1	
Chromium	210	min	8.1	5.8	6.7	No exceedances
		max	36	92	31	
Copper	3,100	min	5.6	6.5	5.5	No exceedances
		max	23	74	250	
Lead	400	min	2.8	1.7	2.4	Rex Flats exceedances
		max	70	230	2400	
Manganese	1,800	min	57	25	73	OTP exceedances
		max	940	2200	1200	
Zinc	23,000	min	14	12	20	No exceedances
		max	460	1000	940	

< = less than the analytical detection limit

As shown in this table, there are exceedances for arsenic, lead and manganese. Figure 89 shows the locations of those exceedances.

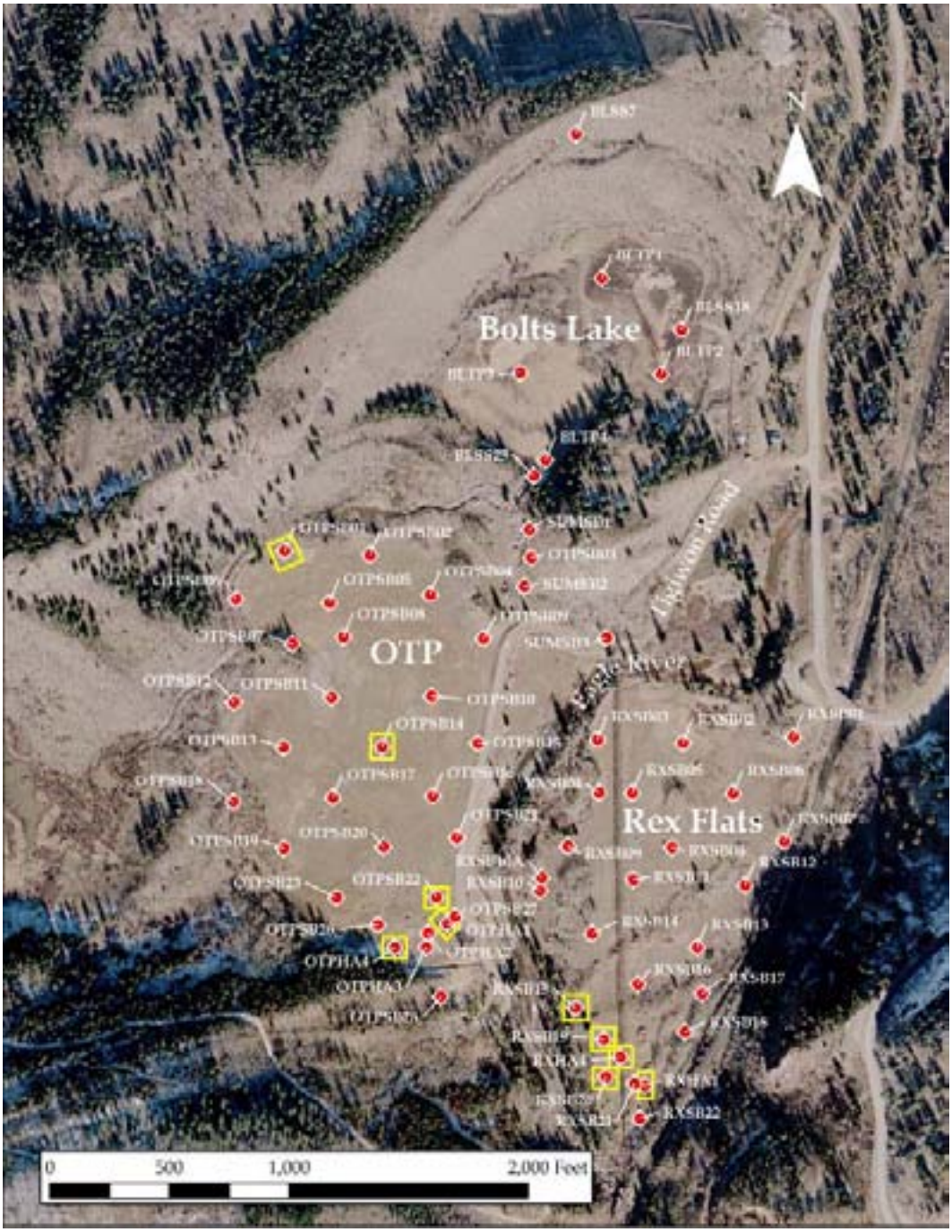


Figure 89 - Subsurface Soil Locations with Elevated Metal Concentrations

The occurrence of arsenic greater than 40 mg/kg only occasionally occurs within the subsurface. At the OTP, elevated arsenic was detected as follows:

- Hand-augered locations within the southern boulder field:
    - OTP-HA-1: 0.5 to 1 feet bgs, 220 mg/kg – no deeper samples due to the rocky nature of the immediate area.
    - OTP-HA-4: 0.5 to 1.1 feet bgs, 100 mg/kg - no deeper samples due to the rocky nature of the immediate area.
- Soil boring within the northwestern corner of the OTP:
    - OTP-SB-1: 3 to 5 feet bgs, 120 mg/kg – the next sample was collected at 13 to 15 feet bgs and contained 1.5 mg/kg arsenic.
- Soil boring within the southeastern portion of the OTP:
    - OTP-SB-22: 6 to 8 feet bgs, 180 mg/kg – the next deeper sample also contained arsenic.
    - OTP-SB-22: 10 to 12 feet bgs, 73 mg/kg – a deeper sample was not collected, but would be within ground water.

At Rex Flats, elevated arsenic was detected in subsurface soils as follows:

- Hand-augered locations within the southern boulder field:
    - RX-HA-1: 0.6 to 0.8 feet bgs, 1,000 mg/kg – no deeper samples due to the rocky nature of the immediate area.
    - RX-HA-4: 0.7 to 1.2 feet bgs, 650 mg/kg - no deeper samples due to the rocky nature of the immediate area.
- Soil borings within the southwestern corner of Rex Flats:
    - RX-SB-15: 3 to 5 feet bgs, 800 mg/kg – total boring depth was 6 feet due to drilling refusal.
    - RX-SB-19: 3 to 5 feet bgs, 54 mg/kg – total boring depth was 5 feet due to drilling refusal.

- RX-SB-20: 1 to 2.5 feet bgs, 320 mg/kg – total boring depth was 2.5 feet due to drilling refusal.

Elevated lead was not detected in subsurface soils at the OTP but was detected at Rex Flats at locations RX-HA-1 and RX-HA-4 at 1,100 and 500 mg/kg, respectively. Elevated lead was also detected at RX-SB-15 at 2,400 mg/kg. These three samples also contained elevated arsenic, as discussed above.

Elevated manganese was not detected in subsurface soils at Rex Flats, but was detected at the OTP at location OTP-SB-14. At OTP-SB-14, two deep soil samples were collected, both of which were within the ground water. The depths and concentrations were; 18 to 20 feet bgs, 1,900 mg/kg; and 22 to 24 feet bgs, 2,200 mg/kg. This location was near the center of the OTP and does not correlate with the elevated arsenic locations.

Other elevated metals or areas were not detected in the subsurface soil at the Site.

As seen in Figure 89, the extent of impacted subsurface soil at the southwestern portion of Rex Flats is mainly within boulder areas. The depth of impacted soil likely coincides with the presence of tailings material that remains in this area as observed during the field investigation. Similarly, the extent of impacted subsurface soil at the southeastern portion of the OTP likely coincides with the presence of the boulder area.

The extent of elevated metals at depth at locations OTP-SB-14 and OTP-SB-22 may be associated with isolated areas of ground water impact. The general extent of elevated arsenic at OTP-SB-1 is defined by the deeper, non-impacted sample from that location, and the adjacent soil borings, which are not impacted.

4.2.6 *Extent of Impacted Soil*

The following maps show, by area, the extent of impacted surface soil, and where observed, subsurface soil (Figures 90 through 94).

Figure 90 – Bolts Lake – Summary of Extent Impacted Soil

Figure 91 –– Maloit Park - Summary of Extent Impacted Soil

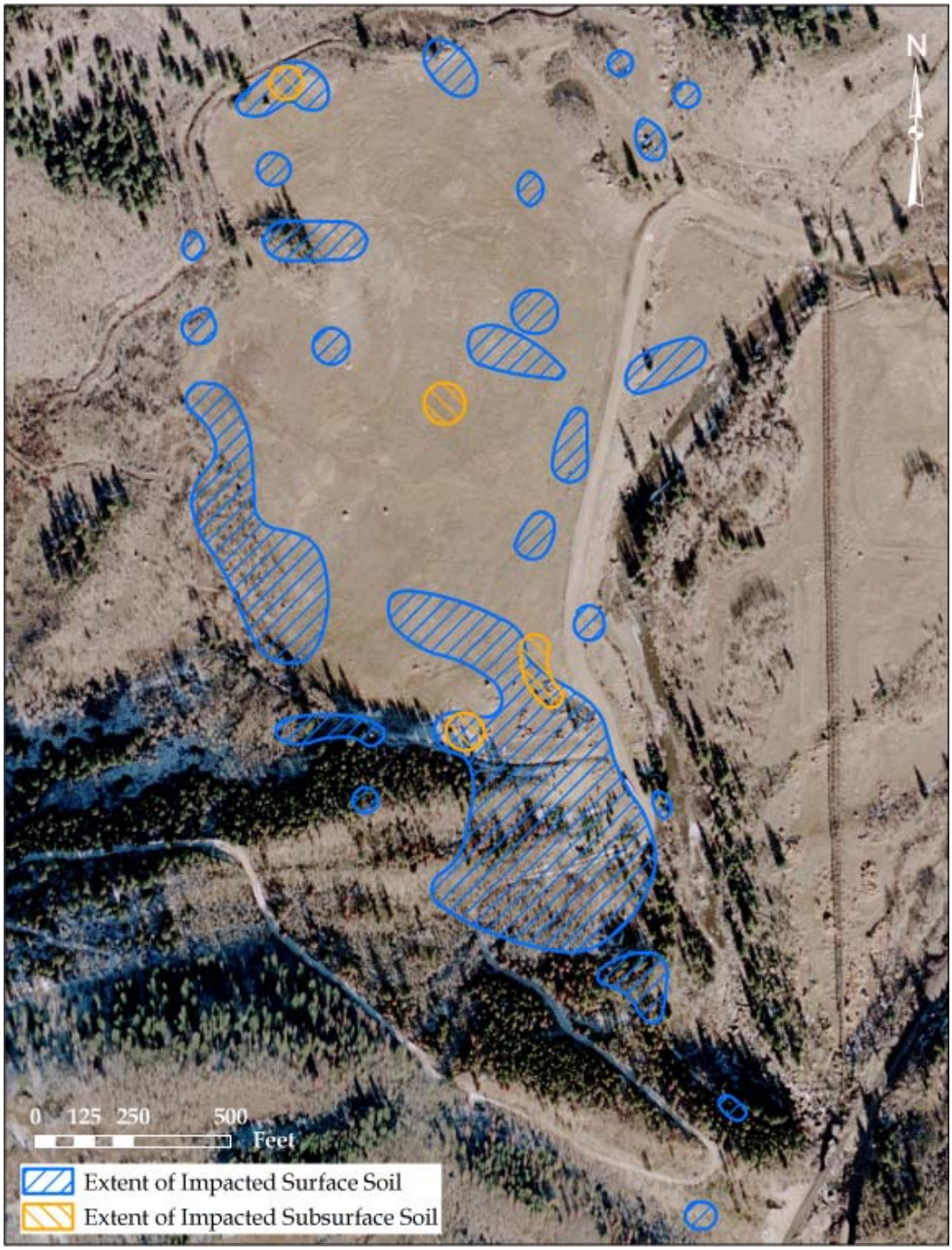


Figure 92 – OTP/Sump #3 – Summary of Extent Impacted Soil

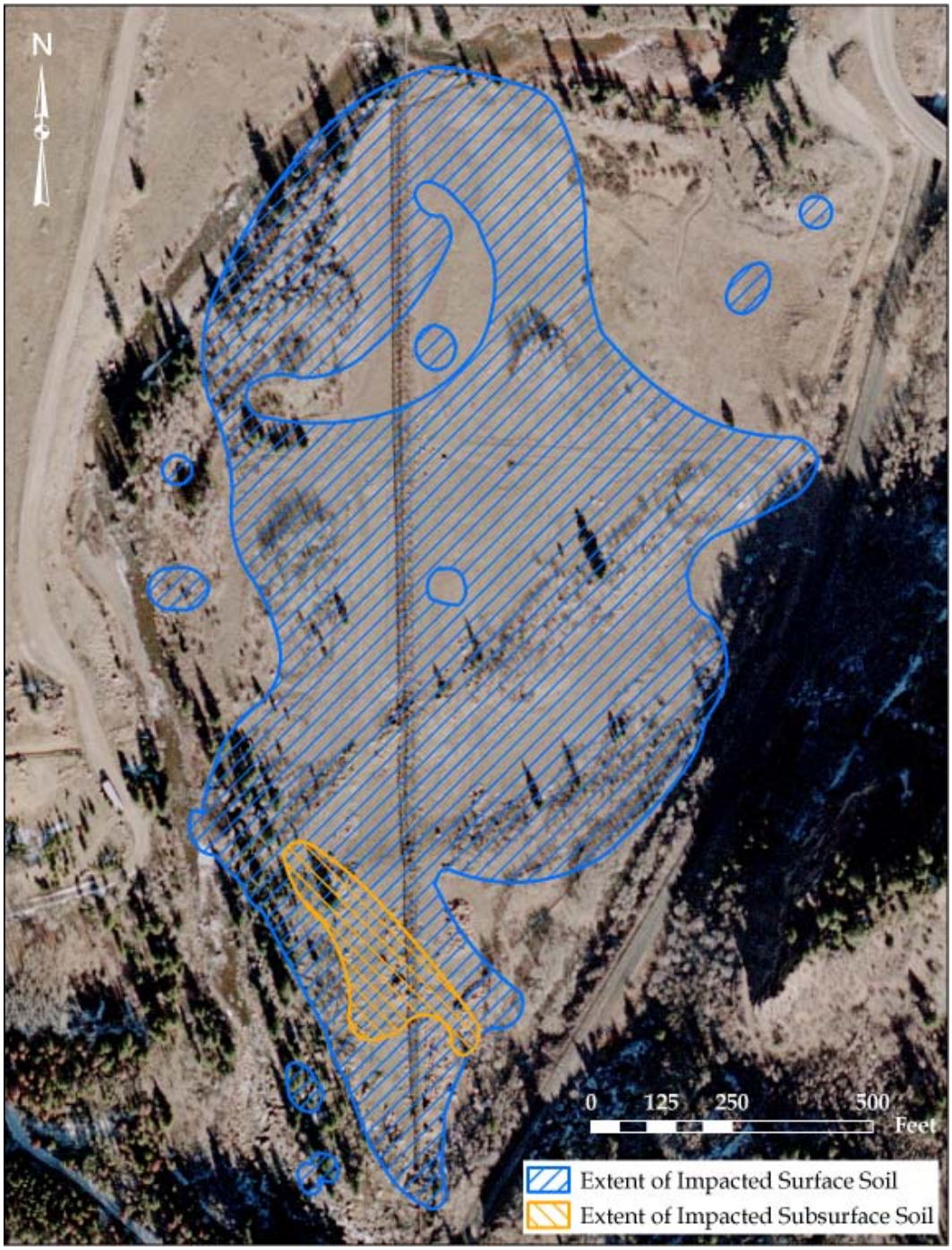


Figure 93 – Rex Flats – Summary of Extent Impacted Soil

Figure 94 – Roaster Pile #5 – Summary of Extent Impacted Soil

4.3 GROUND WATER, SEEPS, AND TRENCHES

Monitoring wells in the Rex Flats and OTP areas have the highest dissolved manganese and zinc ground water concentrations in the wells sampled during this investigation. The OTP has the highest dissolved cadmium concentrations followed by Rex Flats. These two areas are located within areas of historic tailings disposal. The ground water sampling results for the wells downgradient of the CTP (CTP-MW-2S and -2D) indicate that these wells are being impacted by manganese and zinc contamination from the CTP. The CDPHE ground water standard exceedances by region are summarized in Table 30 (CDPHE WQCD, 2005). In order to assess the potential impacts from ground water to the Eagle River, the results were also compared to the segment-specific surface water standards. The segment-specific surface water exceedances are summarized in Table 31.

Table 30 Summary of Exceedances of CDPHE Ground Water Standards at the North Property

	Analyte	OTP	Rex Flats	CTP	Bolts Lake
Ground Water Primary Indicator Metals (dissolved)	arsenic	x			
	cadmium	x	x		
	chromium				
	copper				
	lead				
	manganese	x	x	x	x
	zinc	x	x		
	pH	x	x	x	
Ground Water Extended Analyte List (dissolved)	aluminum	x			na
	beryllium	x			na
	iron	x	x	x	na
	nickel	x			na
	sulfate	x	x	x	na
	thallium	x			na
OTP and Rex Flats Seeps and Trenches Primary Indicator Metals (dissolved)	arsenic	x			
	cadmium				
	chromium				
	copper	x			
	lead				
	manganese	x	x		
	zinc	x	x		
	pH	x	x		

x = detected above CDPHE ground water standards
na = not analyzed

Table 31 Summary of Exceedances of Surface Water Standards at the North Property

	Analyte	OTP	Rex Flats	CTP	Bolts Lake
Ground Water	arsenic				
	cadmium	x	x		
	chromium				
	copper	x	x	x	x
	lead	x			
	manganese	x	x	x	x
	zinc	x	x	x	
OTP and Rex Flats Seeps and Trenches and the CTP UGDT	arsenic				
	cadmium	x		x	
	chromium	x			
	copper	x	x		
	lead		x		
	manganese	x	x	x	
	zinc	x	x	x	

x = detected above surface water standard
na = not analyzed

Rex Flats

Ground water concentrations of dissolved manganese, zinc, cadmium, iron, and sulfate above CDPHE ground water standards (CDPHE 2005A) occur in the northern portion of Rex Flats. Elevated concentrations of dissolved manganese and slightly elevated dissolved zinc occur in the seep samples collected in this area along the Eagle River. Additionally, the shallow and deep contamination is variable across Rex Flats. The relatively shallower ground water, at REX-MW-4S, is more contaminated than the deeper ground water in this area while the shallower ground water near REX-MW-1 (the shallow well) is cleaner than the deeper ground water near REX-MW-1D (deeper well).

Currently, elevated ground water and seep metal concentrations above both CDPHE ground water standards occur in the northern portion of Rex Flats. The current primary indicator metals concentrations monitored by ERM in the existing Viacom ground water wells are similar to the current Viacom ground water monitoring data collected since 1989. The extent of dissolved cadmium, manganese, and zinc above the CDPHE ground water standard is shown in Figures 95, 96 and 97, respectively.

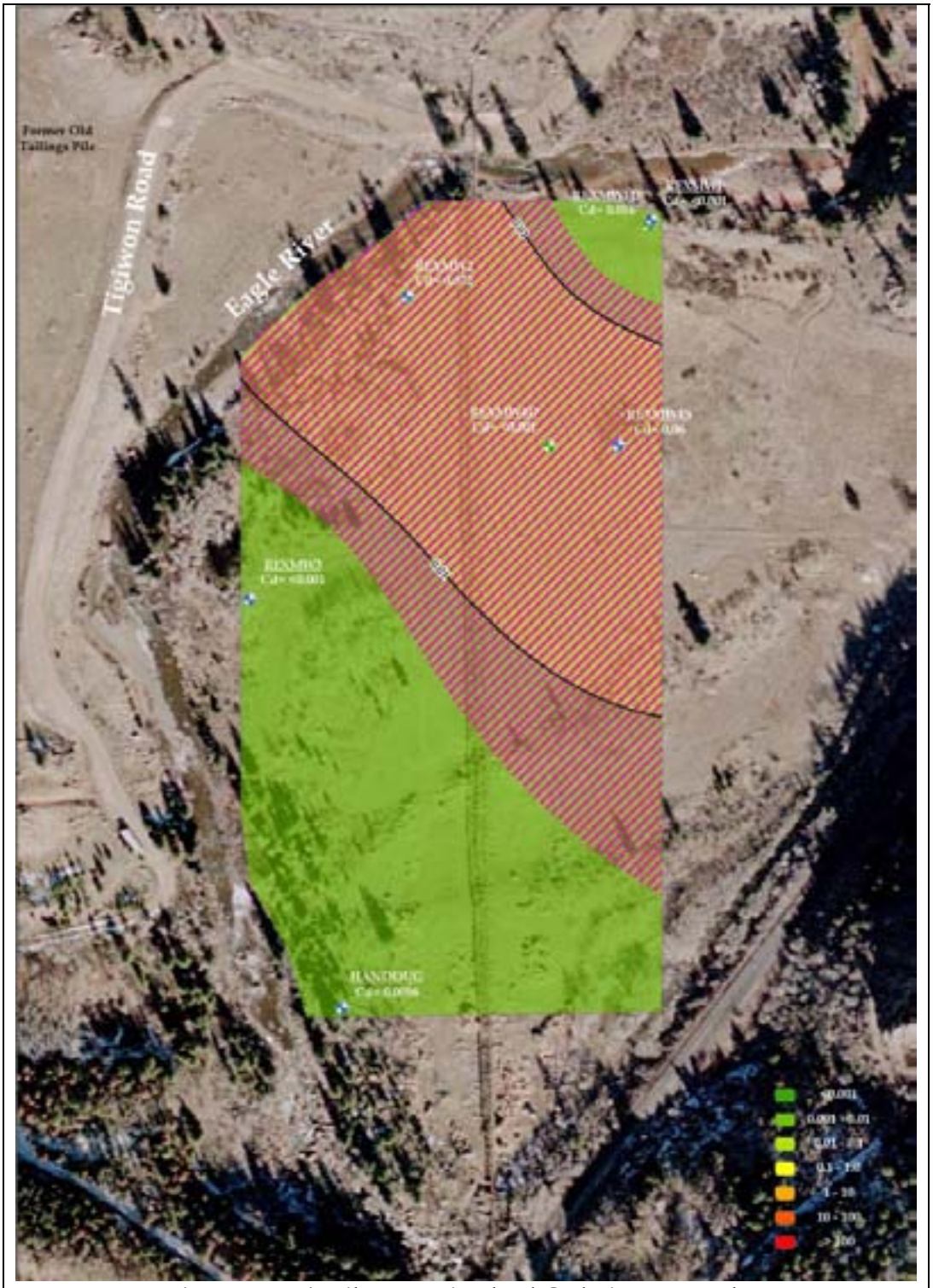


Figure 95 – April 2006 Dissolved Cadmium, Rex Flats
CDPHE Ground Water Standard Exceedance

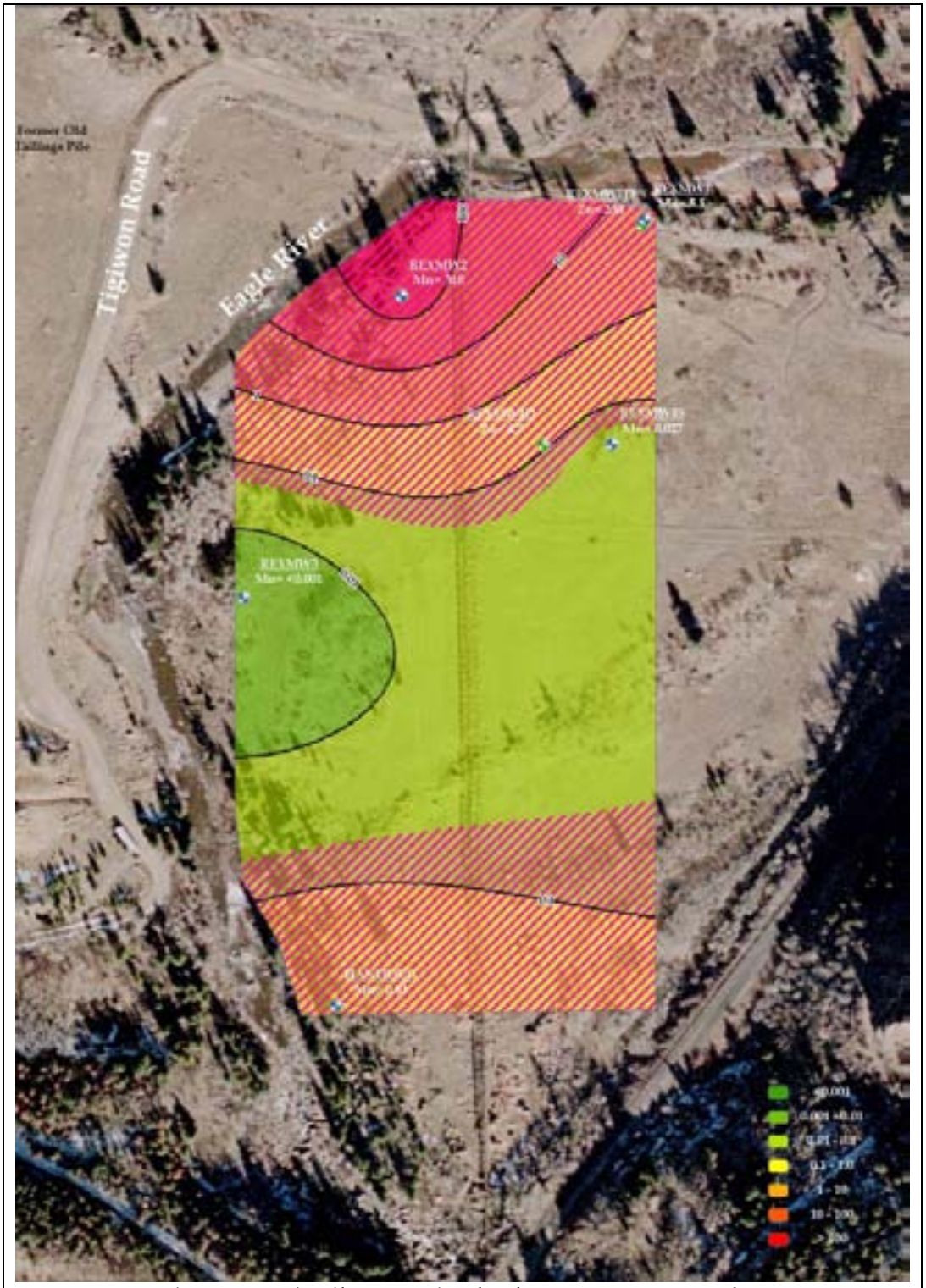


Figure 96 - April 2006 Dissolved Manganese, Rex Flats
CDPHE Ground Water Standard Exceedance

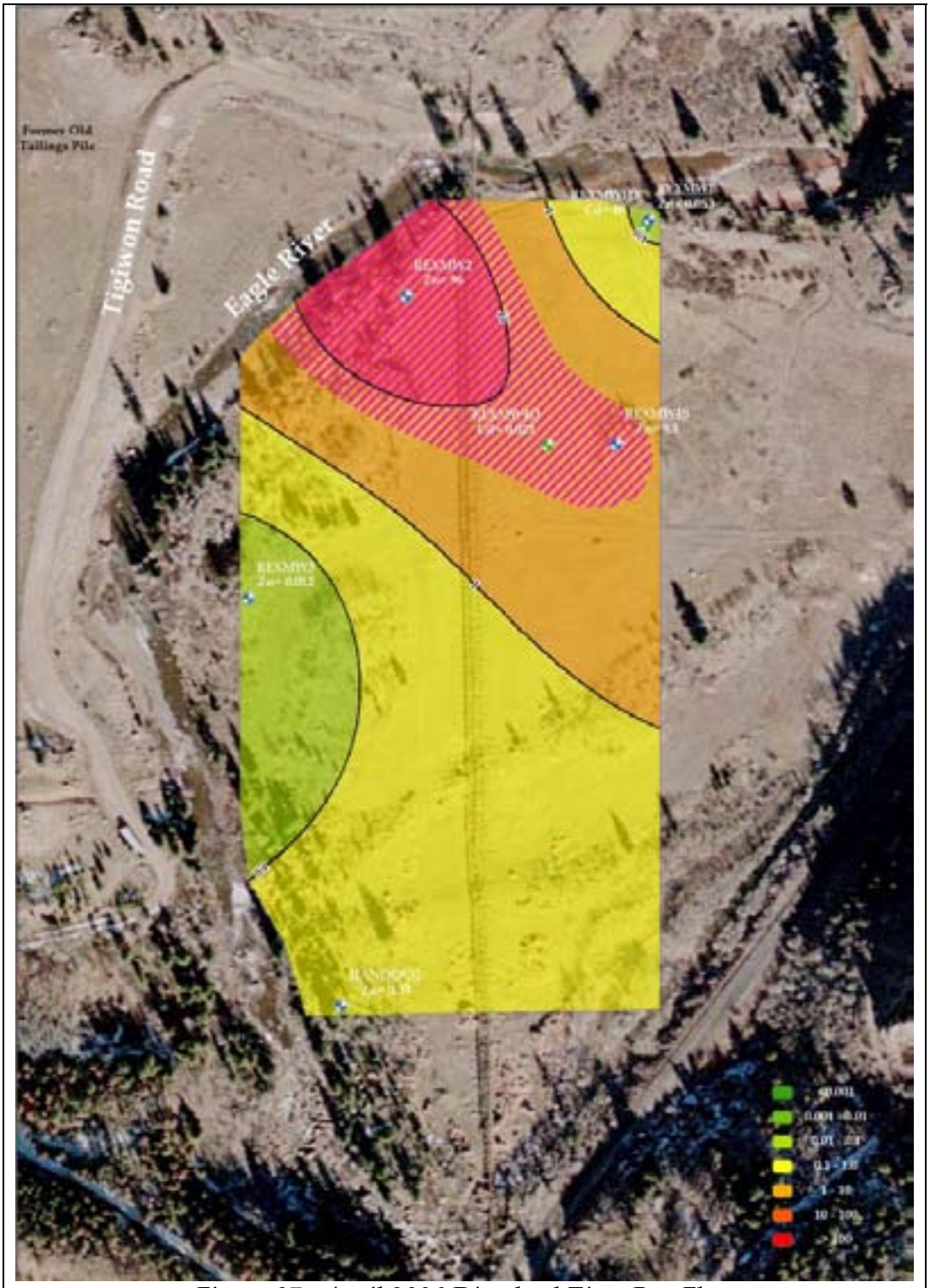


Figure 97 - April 2006 Dissolved Zinc, Rex Flats
CDPHE Ground Water Standard Exceedance

OTP

Elevated ground water concentrations of dissolved metals above either the CDPHE ground water or surface water standards occur in most of the OTP monitoring wells. Low dissolved metals detected in SUM-MW-1 and OTP-MW-7 indicate that the current Sump #3 area is not significantly impacted by dissolved metals. Additionally, elevated ground water concentrations of dissolved aluminum, beryllium, nickel, and thallium occur at OTP-MW-5, which is located in the north-central portion of the OTP. Ground water samples collected from the shallower new wells (OTP-MW-8S and OTP-MW-9) have low pH measurements (3.0 to 4.7). These wells also indicate that elevated concentrations of dissolved metals and elevated pH are apparent near the Eagle River at the OTP. The extent of dissolved cadmium, manganese, and zinc above the CDPHE ground water standard is shown in Figures 98, 99 and 100. Generally, all of the samples collected from the OTP have dissolved oxygen values below 1.0 mg/L except for OTP-MW-3. This indicates that the most of the surficial aquifer is under reducing conditions.

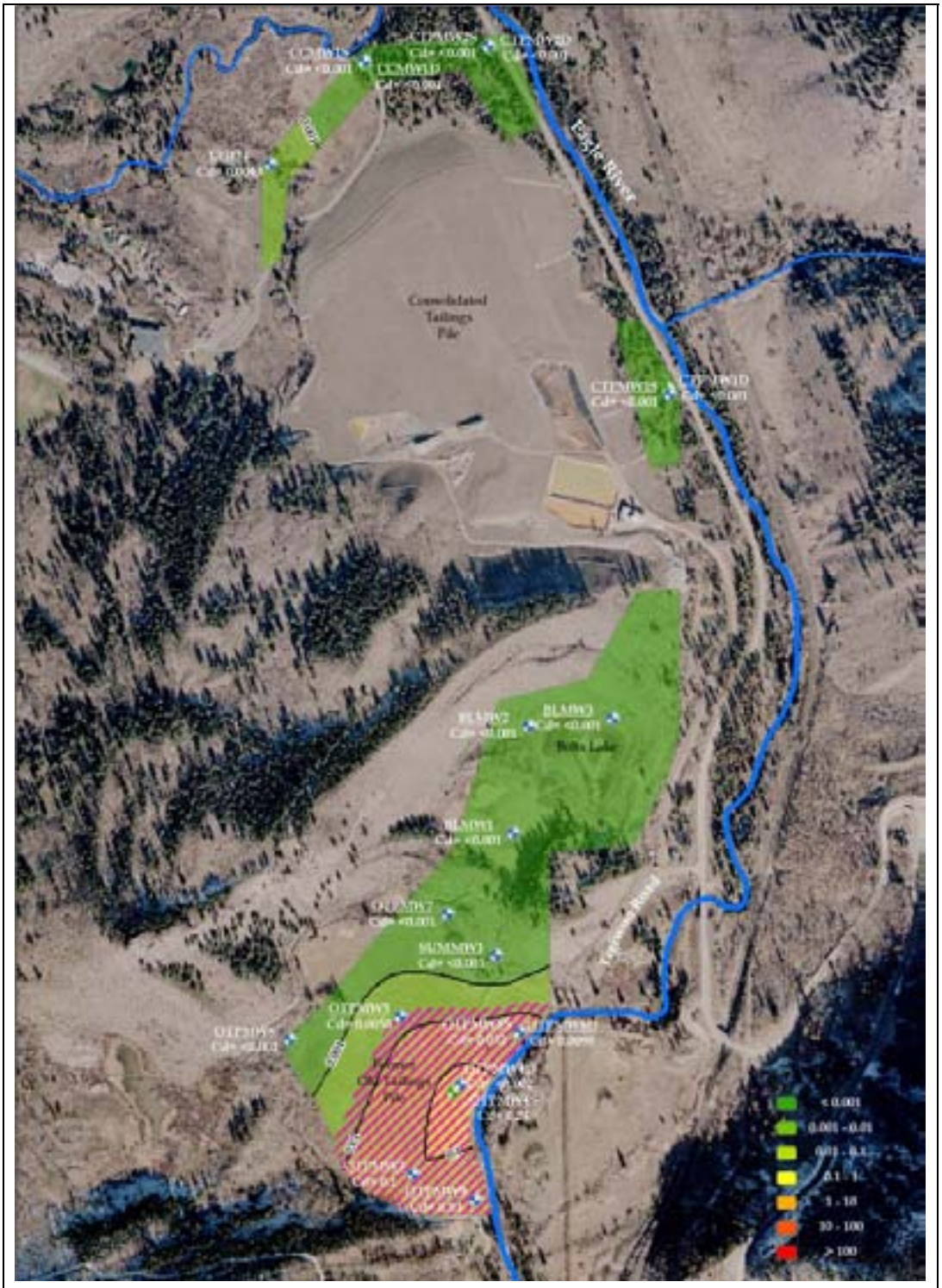


Figure 98 - April 2006 Dissolved Cadmium, OTP, Bolts Lake and CTP Areas CDPHE Ground Water Standard Exceedance

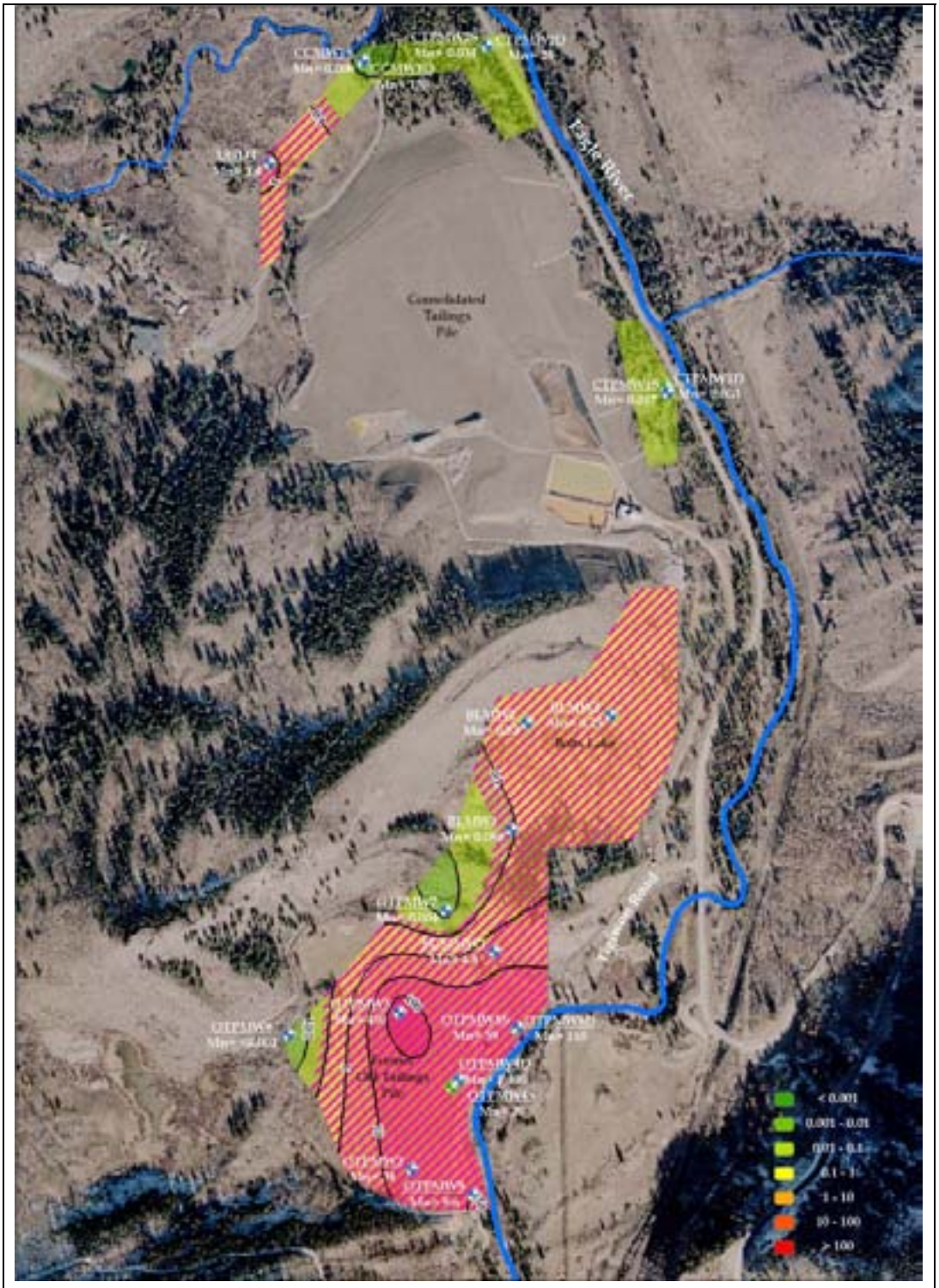


Figure 99 - April 2006 Dissolved Manganese, OTP, Bolts Lake and CTP Areas CDPHE Ground Water Standard Exceedance

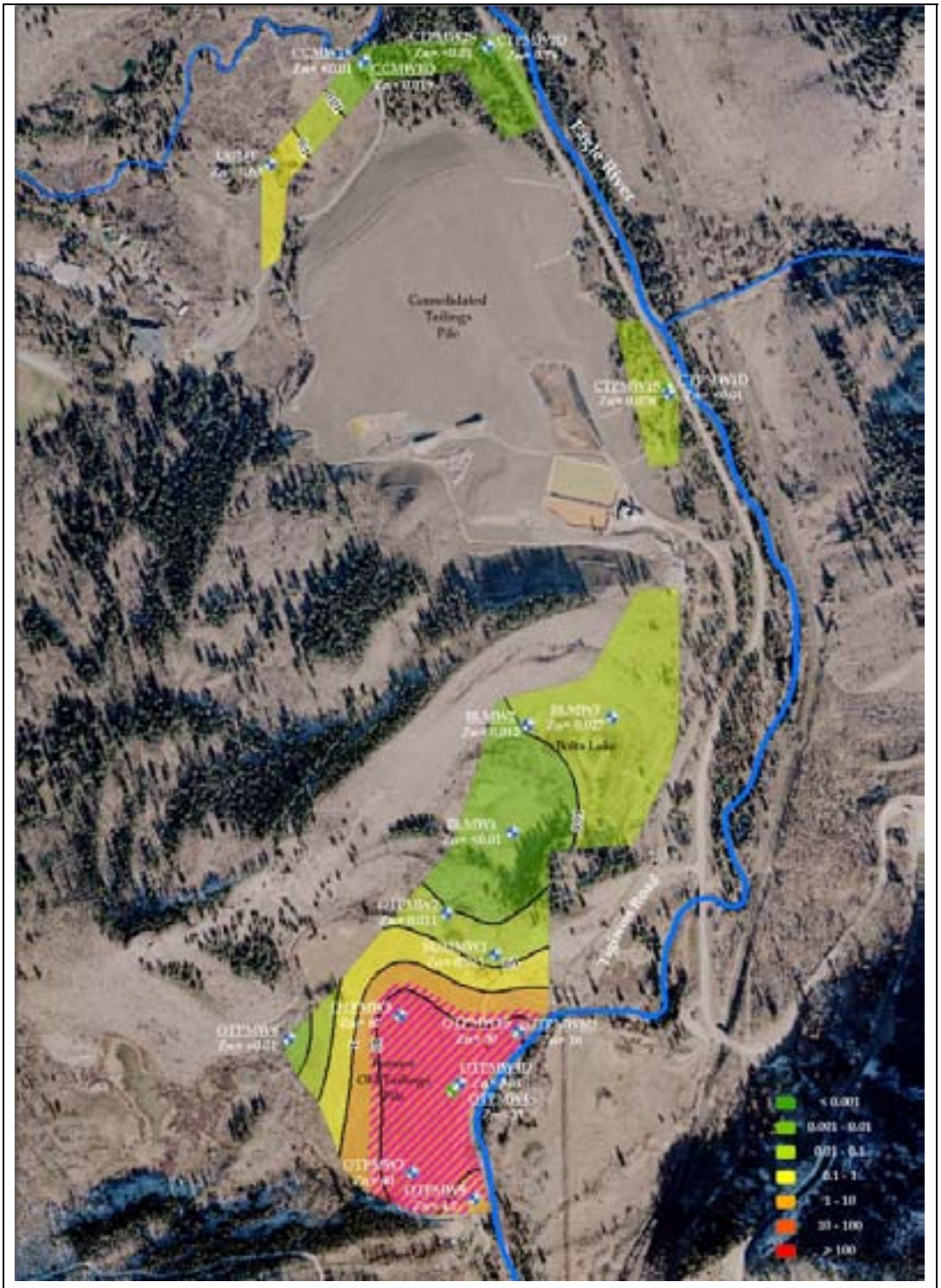


Figure 100 - April 2006 Dissolved Zinc, OTP, Bolts Lake and CTP Areas CDPHE Ground Water Standard Exceedance

The shallow and deep contamination is variable across the OTP. While both the deeper and shallow ground water are contaminated at OTP-MW-4D and -4S, the deeper ground water is more contaminated than the

shallower ground water with respect to dissolved manganese and zinc. The relatively shallower ground water at OTP-MW-8S (shallow well) is more contaminated than the deeper ground water at OTP-MW-8D (deeper well) with respect to dissolved zinc but slightly less contaminated with respect to manganese. Aerial photos of the historic Sump #3 area, between Tigiwon Road and the Eagle River, show ponding of reddish brown water in this area. The historic ponding is likely a source for the deeper contamination in this area.

Generally, the OTP:

- contains the most exceedances of CDPHE ground water standards for the primary indicator metals and extended analyte list in ground water,
- has the greatest area of ground water contaminant exceedances,
- has historical aerial photographs showing staining along the Eagle River next to the OTP,
- contains ponded water in the spring (as shown on Figure 101), and
- has lower pH ground water and seeps.

Currently, elevated ground water metal concentrations occur in most of the areas of the OTP. The surrounding wells, outside the lower portion of the OTP do not have elevated primary metal detections like the monitoring wells inside the OTP. The current primary metals concentrations monitored by ERM in the existing Viacom ground water wells are similar to current Viacom ground water monitoring data. With the exception of OTP-MW-5, the dissolved zinc, manganese, and cadmium concentrations in the Viacom monitoring wells have decreased over time, since around 1991, due to removal of mine tailings and natural attenuation but still remain elevated and above CDPHE ground water standards.

The north and south diversion trenches within the OTP were sampled once in August and September, 2005, and once in April, 2006, per the Work Plan. The laboratory analysis of these surface water samples detected dissolved manganese, zinc, and copper. The pH of the water in the diversion trenches ranged from 5.1 to 6.7. Both of these surface diversion trenches had water in them during this investigation but generally contained more water during the spring of 2006. Portions of the south diversion trench contained stagnant water in the fall of 2005.

Figure 101 - Ponding water on the OTP

ERM also observed seeps along the northern edge of the OTP near the north surface water diversion trench in 2005. These seeps were flowing from the toe of the berm around the northern portion of the OTP. Several seeps were observed along the north side of the south diversion trench in the OTP. Some of these seeps were reddish-orange colored. Another seep was observed near the south diversion ditch and Tigiwon Road. The ground water seeps at the OTP indicate areas where the downward percolation of water in and around the surface water diversion trenches intersects a lower permeability layer which causes the ground water to daylight. The pH of the seeps ranged from 2.57 to 4.39, indicative of Acid Mine Drainage ("AMD"), and contained metals concentrations above both the CDPHE ground water and surface water standards.

Bolts Lake

Analysis of ground water samples from Bolts Lake indicate that the shallow surficial aquifer in this area is not currently significantly impacted by the primary indicator metals. Although elevated dissolved manganese was detected, the concentrations of other dissolved metals were low. Figures 98, 99 and 100 show the extent of cadmium, dissolved manganese and zinc within the ground water in this area.

CTP

The new ground water wells at the CTP were installed to assess vertical gradients near the Eagle River and to investigate potential data gaps in the ongoing monitoring by Viacom. Figures 98, 99 and 100 show the extent of cadmium, dissolved manganese and zinc above CDPHE ground water standards on the periphery of the CTP. Analysis of ground water samples from these wells indicates that the ground water to the southeast of the CTP, near the Eagle River, is not currently significantly impacted by the primary indicator metals. However, analysis of ground water samples from wells downgradient (to the north) of the CTP, especially near CTP-MW-2S and -2D, indicate that this area is currently impacted, by dissolved metal contaminated ground water from the CTP. Additionally, the dissolved metal contamination in the shallow and deep monitoring wells varied between the deep and shallow well sets located along the eastern and northern portion of the CTP.

Past reports indicate that the north and east ground water extraction trenches capture about 50 to 75% of the ground water near the trenches, respectively (Dames and Moore, 1997). Therefore, some metals-impacted ground water from the CTP flows past the trenches and into Maloit Park/Cross Creek and the Eagle River.

4.3.1 Hydraulic Testing

Based on the data obtained from the slug tests performed during this investigation, estimates of hydraulic conductivities in areas near the Eagle River were as follows:

- the OTP/Rex Flats area ranged from about 1.54 to 23.66 feet per day,
- the Sump #3 area ranged from about 9.59 to 56.42 feet per day,
- the Bolts Lake area ranged from 14.61 to 44.93 feet/day,
- the CTP area ranged from 1.36 to 88 feet/day,
- the Cross Creek area was about 0.68 feet/day, and
- on the eastern portion of the ridge between the CTP and Bolts Lake was about 167 feet/day.

The pump test results at BL-MW-2 indicate a lower hydraulic conductivity of 4.58 feet/day than estimated from the slug tests. However, this measured hydraulic conductivity could be one order-of-magnitude lower than the actual conductivity due to head losses that typically occur at pumping wells.

The hydraulic conductivity data was collected to improve the Site hydrogeologic model. The data obtained indicates that hydraulic conductivity, controlled geographically by lithology in the glacial deposits and alluvium near the river, can vary significantly or at least by 1 to 2 orders-of-magnitude across the Site. Therefore, any future remedial action plan or remedial alternative study should account for these differences.

4.4 AIR

The air quality data that were collected between July 21, 2005 and November 18, 2005 were compared to potentially applicable state and federal air quality standards. The air quality data collected during the period indicates that air quality levels were at or below applicable standards and criteria. On the basis of these data, there is not a current impact to air, and therefore, nature and extent is not applicable during the sampling time frame.

5.0 CONTAMINANT FATE AND TRANSPORT

The following sections evaluate the fate and transport of metal constituents within the soil, ground water, and surface water at the North Property. The results of air sampling indicated that impact to air is not apparent at the North Property; therefore, contaminant fate and transport in air is not applicable.

5.1 POTENTIAL ROUTES OF MIGRATION

Potential routes of migration that could apply to the tailings-impacted media are summarized in Table 32.

Table 32 Potential Routes of Metal Transportation

Source	*Release*	*Transport*	*Media Affected*
Surface soil	Erosion	Runoff / overland flow	Surface water
Surface soil	Erosion	Runoff / overland flow	Stream sediment
Surface soil	Erosion	Wind	Air particulates
Surface soil	Leaching from surface water	Percolation	Subsurface soil
Subsurface soil	Leaching from surface water	Percolation	Ground water
Ground water	Leaching and migration	Advective and dispersive flow	Surface Water
Surface water	(via upstream concentrations, surface soil, subsurface soil, ground water)	Overland flow, stream flow	Downstream surface water

These potential transport and exposure pathways were evaluated with respect to the analytical data from the North Property to assess whether these mechanisms were active and pose an environmental concern at the North Property. The Risk Assessment for the Site evaluates the potential human health concerns from these transport and exposure pathways.

5.2 SURFACE SOIL

Surface Soil to Surface Water

Potential transport from surface soil to surface water was evaluated by comparing total and dissolved concentrations of zinc in surface water.

The totals analyses are unfiltered and may include sediments suspended within the water sample. These sediments could be from within the Eagle River or from the adjacent land, such as the OTP or Rex Flats. The total and dissolved constituents were analyzed in surface water during the March 2006 sampling event, and again during the April and May 2006 sampling events. The March 22, 2006 and April 19, 2006 surface water data are shown in Figures 102 and 103, respectively.

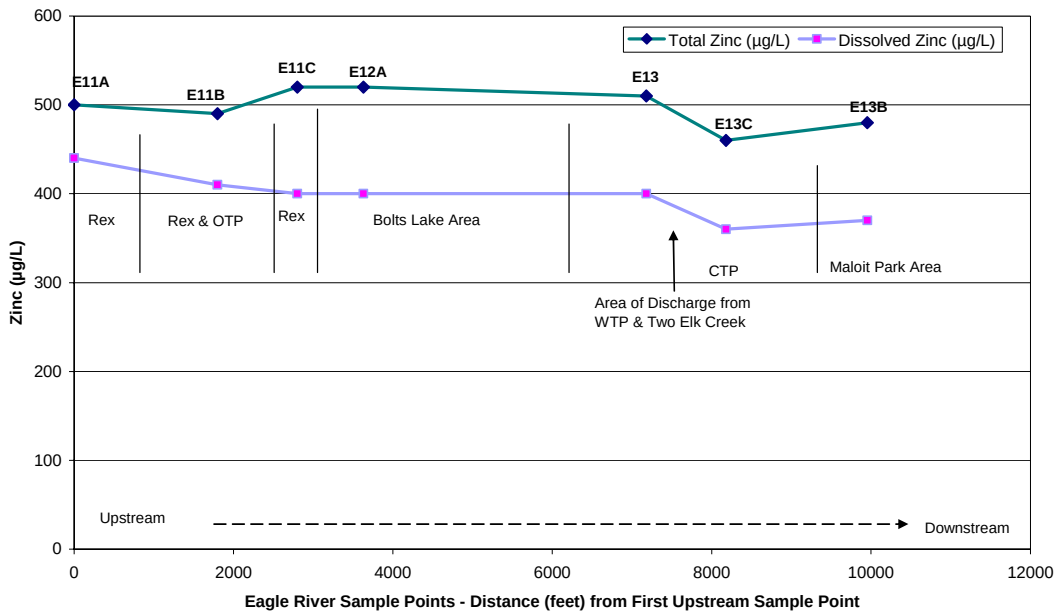


Figure 102 - Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River – March 22, 2006

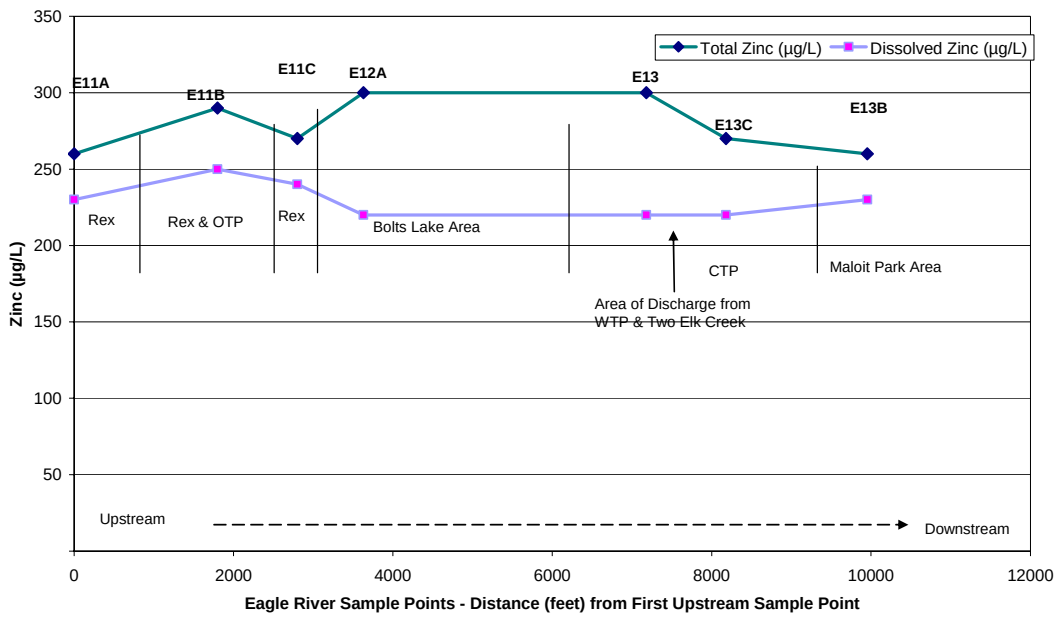


Figure 103 - Comparison of Total and Dissolved Zinc Concentrations in Surface Water of the Eagle River – April 19, 2006

In general, the total and dissolved zinc concentrations parallel each other, except in the areas between stations E-11B and E-12A, which are near the northeastern portion of the OTP and the north portion of Rex Flats. In this area, the total concentrations increase whereas the dissolved concentrations decrease. This divergence could be the result of impacted soil (via runoff/overland flow) and/or ground water with impacted suspended solids (via flow) entering the Eagle River surface water. Surface soil to surface water is likely an active transport mechanism at the North Property.

It is noted that zinc, which meets Site-specific RGs for soil, appears to be entering the Eagle River between stations E-11B and E-12A and is impacting surface water quality. However, arsenic, which is the most prevalent metal that exceeds Site-specific RG, does not appear to have an impact on surface water quality. That is, both total and dissolved concentrations of arsenic in the Eagle River surface water samples are less than the laboratory detection limit of 5 µg/L. This pathway may be metal-specific, in this case, specific to zinc.

Surface Soil to Stream Sediment

Potential transport from surface soil to stream sediment was evaluated by comparing the metals concentrations of the stream sediments to: 1) the range of surface soil analytical results observed at the OTP and Rex Flats, which border a portion of the Eagle River; and 2) the Site-specific standards (Table 33).

Table 33 Comparison of Eagle River Sediment Concentrations

Metal (mg/kg)	*Site-Specific RG*	*Eagle River Sediment Samples from the North Property*	*Background Eagle River Sediment Sample Downstream of Belden and Gilman*	*Background Eagle River Sediment Samples Between Belden and Red Cliff*	*Ginn 2005-06 Surface Soil Data Range – OTP and Rex Flats*
Arsenic	40	14 -97	43	4.3 – 16	0.85 – 2,700
Cadmium	37	3.5 – 8.1	5.9	Less than 0.78 – 1.4	Less than 0.1 - 16
Chromium	210	5.9 – 8.5	3.5	2.9 – 4.5	Less than 2.3 - 62
Copper	3,100	41 - 160	63	15 – 120	6.9 - 850
Lead	400	350 – 810	530	99 – 240	2.4 – 14,000
Manganese	1,800	880 – 2,200	1,000	330 – 550	22 – 6,200
Zinc	23,000	940 – 2,500	1,200	270 - 330	29 – 4,600

The comparison shows that the North Property sediment concentrations are: 1) similar to the samples collected downstream of Belden and Gilman; 2) within the range of the OTP/Rex Flats soil analytical results; and 3) exceed the Site-specific RGs for arsenic, lead, and manganese – same as for the surface soil samples. Because of past mine waste disposal activities in this area and mining activities upstream of the North Property, it is not possible to distinguish the source of the metals concentrations. The source could be one or a combination of: a) current runoff from surface soil at the OTP and Rex Flats, b) previous runoff from the tailings historically located at the OTP and Rex Flats, or c) upstream mine-related activities. Based on the existing data, the surface soil to Eagle River sediment is considered an active transport mechanism at the North Property.

Surface Soil to Air

Potential transport from surface soil to air was evaluated by air quality samples collected at the North Property from July through November of 2005. The air quality samples included PM10 (particles less than 10 microns in diameter), and TSP for arsenic, cadmium, and lead. One of the sample locations was along Tigiwon Road between the OTP and Rex Flats, another sample location was along Tigiwon Road and north of Rex Flats,

and a third location was north of the CTP. The PM10 levels met potentially applicable Colorado and Federal standards. The arsenic and cadmium samples were found to be below the laboratory detection limits. Of the 15 lead samples, 12 were below the laboratory detection limit, and the three detections (from the location between the OTP and Rex Flats) were below the Colorado standard. Because the air quality at the North Property does not appear to be impacted, transport (via wind) is not a current migration route.

Surface Soil to Subsurface Soil/Ground Water

Potential transport from surface soil to subsurface soil / ground water was evaluated by: 1) observation of the soil concentration with depth profiles; 2) the SPLP data; and 3) observation of ground water quality data.

As discussed in Section 4.3.1, soil concentrations of arsenic, lead, and manganese exceed the Site-specific RGs in the surface soil samples. Review of these metal concentrations in the subsurface soil samples showed only isolated occurrences of elevated arsenic, lead, and manganese in the subsurface, which is an indicator that surface soil leaching of those metals to the subsurface is not prevalent. Since zinc is a metal of concern at this Site, it was also evaluated with respect to depths and concentrations (Appendix P shows the concentrations of the soil boring and the nearest surface soil location). Overall, zinc concentrations decreased with depth, especially as observed in the samples from the OTP/Sump #3 area. There were three locations at the OTP/Sump #3 areas where zinc concentrations were similar as opposed to showing a distinct decrease in concentrations (OTP-SB-13, SUM-SB-2, and SUM-SB-3). Zinc concentrations at these three soil boring locations were all less than 100 mg/kg. At Rex Flats, four locations showed higher concentrations with depth (RX-SB-12A, RX-SB-11, RX-SB-15, and RX-SB-20). Zinc concentrations at these four soil boring locations varied from 150 to 620 mg/kg.

As discussed in Section 3.2.6, the SPLP data showed that arsenic, cadmium, chromium, and zinc did not readily leach from the soil samples (0 to 6 of the 30 samples leached), that copper and lead moderately leach (10 to 12 of the 30 samples leached), and that manganese readily leaches (24 of the 30 samples leached).

Review of the ground water quality data (Section 3.4.2) shows that manganese, zinc, and cadmium are the metals that most consistently exceed ground water standards. The presence of elevated manganese in the ground water may be explained in part by the SPLP results, which indicate that manganese readily leaches. The presence of elevated zinc in

the ground water at Rex Flats may be explained in part by apparent localized areas of saturated soil that retain relatively higher concentrations of zinc (but much lower than the Site-specific RGs). Although not directly observed at the OTP, the ground water data indicates potential similar localized areas of relatively higher zinc concentrations in the saturated soil. The presence of cadmium is not explained by either the SPLP data or the soil concentrations that are often below the detections and do not exceed 16 mg/kg, which is much below the Site-specific RG of 37 mg/kg.

In summary, surface soil to subsurface soil/ground water is a transport pathway at the Site, but may be metal-specific; in this case, specific to manganese. Other metals were leached from the soils more easily prior to the addition of buffering compounds (lime) during Site remediation when the soil and water pH was more acidic.

5.3 SUBSURFACE SOIL

Potential transport from subsurface soil to ground water was evaluated using the same SPLP data set as for the surface soil to subsurface soil / ground water evaluation. As discussed in the above section, the data indicate that subsurface soil to ground water is likely an active transport mechanism for the North Property. Manganese readily leaches from soil as shown by the SPLP results. Localized areas of relatively high (but less than Site-specific RGs) zinc concentrations within the saturated soil may contribute to the elevated zinc concentrations in ground water.

5.4 GROUND WATER

The following sections discuss migration of the metals-impacted ground water at each area of the North Property.

5.4.1 General Chemistry

The mine tailings historically deposited at the Site were gangue (waste) mineral concentrates left over from the milling and concentrating process at the Eagle Mine. These minerals and others also contain impurities including cadmium, arsenic, and chromium. The pyrite naturally oxidizes to form acidic ground water known as Acid Mine Drainage (AMD). Oxygen in the atmosphere or dissolved in either surface water or ground water, causes pyrite and other sulfides to oxidize forming acidic conditions. AMD is commonly associated with sulfide ore deposits and their mine tailings contain abundant iron sulfide, including the Eagle Mine. The source for the very high iron and sulfate ground water concentrations at the OTP, Rex Flats, and the CTP is attributable to the

oxidation of iron sulfide (pyrite). The generated acid decreases the pH which, under certain geochemical conditions, mobilizes other metals and creates metals impacted ground water. Therefore, low pH is an indicator of pyrite oxidation (Deutsch, 1997).

Water samples collected from all the areas during this investigation had pHs that ranged from 2.6 to 7.6 and include the following:

- OTP Seeps = 2.6 to 4.4,
- OTP = 2.8 to 7.1 (more acidic in the southern half and at OTP-MW-8S),
- Rex Flats = 4.3 to 7.2 (more acidic in REX-MW-2 and REX-MW-4S),
- OTP Surface Water Diversion Trenches = 5.1 to 6.7,
- CTP = 6.3 to 7,3, and
- Bolts Lake = 6.8 to 6.7.

Generally, the OTP water samples are more acidic than the other investigation areas, followed by Rex Flats. However, ground water in some of the wells at both the OTP and Rex Flats has only slightly acidic conditions (i.e., pH greater than 6) and still has elevated concentrations of zinc and manganese. This indicates that at the OTP and Rex Flats, ground water can have only slightly acidic conditions and still carry relatively high dissolved manganese, zinc, and cadmium concentrations.

OTP

Ground water sample analysis and measurements from the new and existing ground water monitoring wells indicate that ground water that exceeds either CDPHE ground water or surface water standards for manganese, zinc, cadmium, arsenic, copper and lead flows from the OTP to the Eagle River. Additionally, ground water with elevated iron, sulfate, arsenic, aluminum, beryllium, nickel, and thallium likely flows to the Eagle River from the OTP.

Currently, the likely sources of metals dissolved in ground water are: 1) metal-laden ground water which has not naturally attenuated and was generated from the initial mine tailings, and 2) impacted mine tailings and soil still located at the Site. The residual metals contained in these two potential sources at the OTP are distributed/mobilized by the evolving ground water and soil chemistry.

The initial source of the dissolved metals in ground water at the OTP was likely the wet mine tailings which were deposited in this area during a 17 year period. These mine tailings were exposed to atmospheric conditions for 44 years after their deposition when they were removed and placed at

the CTP. The historic aerial photos indicate that the western bank of the Eagle River has been affected by the OTP since at least 1974 and likely earlier. Based on the historic water levels the ground water elevation within the tailings, prior to remediation, was 10 feet higher than the current shallow aquifer. Prior to the mine tailings removal, this higher hydraulic head from the water within the mine tailings likely increased the hydraulic gradient towards the Eagle River, distributing metals-impacted ground water to the Eagle River and into deeper areas of the surficial aquifer near the OTP. During some years in the past, the historic Sump #3 area and current Sump #3 area collected some of the ground water and pumped it to the CTP. There was no documentation that the historical or current Sump #3 areas were lined. The increased hydraulic head from ponded metal impacted water at the historic Sump #3 area, next to the Eagle River, likely increased the contribution of metals to the Eagle River and potentially deeper portions of the surficial aquifer in this area.

Removal of the mine tailings and natural attenuation of metals at the OTP has reduced the dissolved zinc and manganese concentrations in most of the existing Viacom OTP monitoring wells by an order of magnitude. Since around 1998, the concentrations of zinc and manganese in most of the existing Viacom monitoring wells have decreased slightly but remain elevated.

The amount of ground water interaction with the Eagle River near the OTP is largely dependent on the elevation of the Eagle River and ground water gradient across the OTP. The ground water gradient at the OTP fluctuates throughout the year towards the Eagle River and there is at least 10 feet of ground water elevation difference between the central portion of the OTP and monitoring wells near the Eagle River. The hydraulic head difference across the OTP indicates that ground water flows into the Eagle River. The ground water gradient flattens out in the historic Sump #3 area located in the northeast portion of the OTP in between Tigiwon Road. This area is relatively low lying and the ground water elevations at the monitoring wells in this area are only 1 of 2 feet above the river elevation during the spring. Therefore, there could be some localized mixing of Eagle River water with the ground water during the fall and winter when the ground water levels are lower.

The easterly ground water flow across the OTP towards the Eagle River drives ground water contamination to the Eagle River as evidenced by:

- the ground water contamination distribution which is generally higher in the eastern portion of the OTP,

- the presence of upward vertical ground water gradients near the Eagle River,

- the relatively lower Eagle River elevations compared to ground water elevations during at least a portion of the year, and

- historic staining in the Eagle River east of the OTP on the west bank of the Eagle River shown in historic aerial photos.

Based on the surface water loading presented in this report, the reach of the Eagle River between E-11B to E-11C, which includes the area next to the OTP, includes up to 7.7 pounds of zinc per day as measured in July 2005. Using average zinc concentrations in ground water as measured in OTP-MW-8S, -8D, and -9, an estimated ground water discharge rate between 30 to 43 gallons per minute ("gpm") and zinc load of between 3.2 to 8.2 pounds per day was calculated. The calculated zinc load from ground water to the Eagle River explains the zinc load measured in the river. However, the effects of zinc precipitation and interaction/mixing at the ground water/surface water interface is highly variable.

Although the tailings were removed by 1991, smaller areas of tailings remain especially on the southern portion of the OTP. Ground water seeps at the OTP interact with the leftover mine tailings generating AMD at the surface as evidenced by the sampling results from OTP-Seep-1 and OTP-Seep-2 (Figures 104 and 105). The pH measurements in these samples were some of the lowest measured at the Site. The south surface water diversion trench is leaking and supplies water to OTP-Seep-1. Portions of the south surface water diversion trench were constructed in existing tailings material. Prior to emerging at the OTP-Seep-1, the water from the south surface water diversion trench interacts with leftover mine tailings in this area which causes the decrease in pH (more acidic) which mobilizes metals in this water. Additionally, the OTP-Seep-2 also occurs within the remaining tailings material and releases into a swale located near the south surface water diversion trench. The OTP-Seep-2 water has a very low pH and contains elevated arsenic, cadmium, copper, manganese, and zinc. This water ponds in the swale and drains to the north and to the south.

Figure 104 - Seep in the OTP draining east toward the Eagle River

Figure 105 - Seep in the OTP near Tigiwon Road

Surface water drains on to the OTP from the Highlands Area. This water flows across the OTP to the northern culvert below Tigiwon Road and to the historic Sump #3 area. This water, water from the leaking surface water diversion trenches, and water from snow melt within the OTP, all recharge the surficial aquifer at the OTP and infiltrate through areas which contain remaining mine tailings or areas where elevated metals exist in the soil. This water interacts with tailings material in the subsurface, create acidic conditions, and mobilized metals which increase metal concentrations in the OTP ground water.

Rex Flats

As discussed above, the dissolved zinc and manganese concentrations in the Viacom monitoring wells at Rex Flats have generally decreased over time, since 1989, due to removal of mine tailings and natural attenuation. Concentrations of dissolved zinc, manganese, cadmium and copper still remain elevated and above CDPHE ground water or surface water standards. Additionally, the iron, aluminum and sulfate ground water concentrations, in the monitoring wells tested, are elevated.

Currently, the likely sources of metals dissolved in ground water are: 1) metal-laden ground water which has not naturally attenuated and was generated from the initial mine tailings and, 2) mine tailings and impacted soil still located at Rex Flats. The initial source of the dissolved metals in ground water at Rex Flats was wet mine tailings which were deposited in this area in the mid-1940s to the 1950s. These mine tailings were exposed to atmospheric conditions for at least 34 years after their deposition when they were removed and placed at the CTP. The historic aerial photos indicate that the southern bank of the Eagle River has been affected by mining impacts at Rex Flats since at least 1974. As within the OTP, the elevated mine tailings pushed more metals-impacted ground water to the Eagle River and potentially into deeper areas of the surficial aquifer in this area. This would explain the elevated primary indicator metals detected in the deeper well in this area. Removal of the mine tailings and natural attenuation of metals at Rex Flats have reduced the dissolved zinc and manganese concentrations in most of the existing Viacom Rex Flats monitoring wells by an order of magnitude.

Although the tailings were removed by 1989, other areas of tailings remain especially in the southern portion of Rex Flats near the area containing boulders (Figure 106). This area is significantly higher than the northern portion of Rex Flats, 20 to 30 feet, and the ground water is deeper in this area.

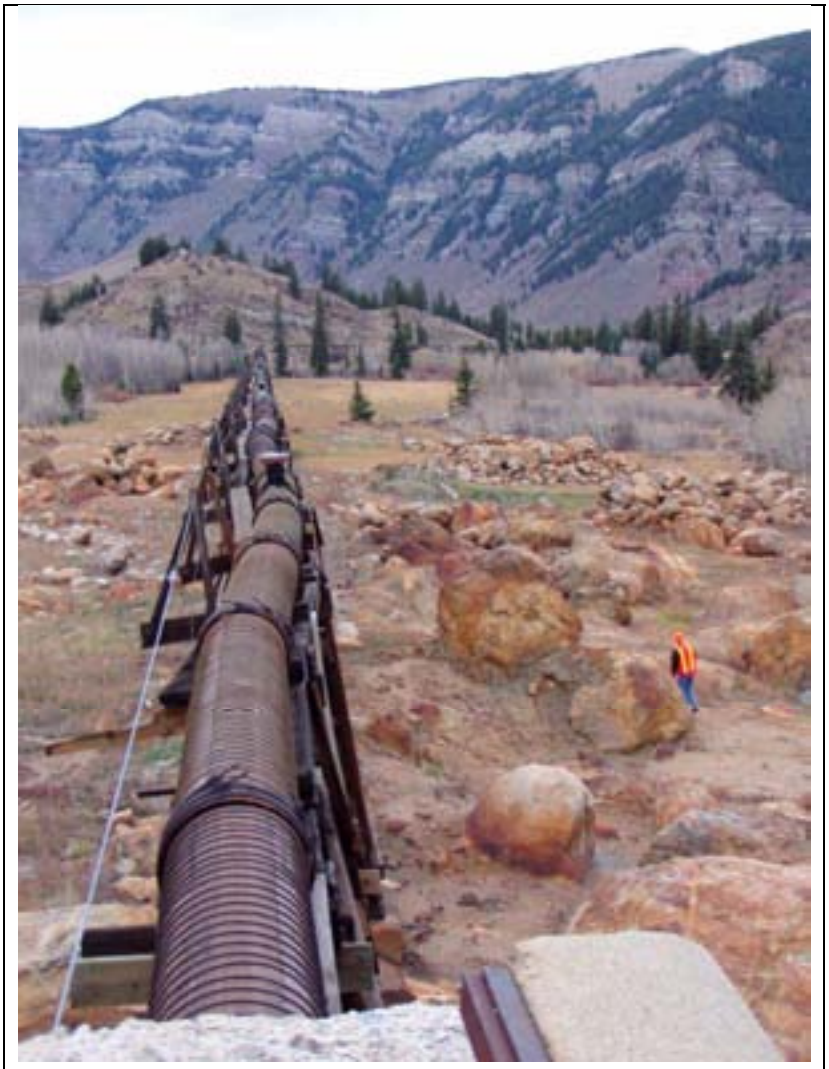


Figure 106 - Rex Flats looking north

Ground water flow directions in Rex Flats are generally to the north, toward the Eagle River. The ground water gradient fluctuates throughout the year across Rex Flats toward the Eagle River to the north. This hydraulic head pushes metal-impacted ground water to the Eagle River. The northerly ground water flow in the surficial aquifer at Rex Flats drives ground water contamination across the northern portion of Rex Flats to the Eagle River, as evidenced by:

- the distribution of contaminants at Rex Flats,
- the presence of ground water seeps north of Rex Flats,
- the presence of upward vertical ground water gradients near the Eagle River,

- the relatively lower Eagle River elevations compared to ground water elevations, and

- the staining of the Eagle River and north portion of Rex Flats as recorded in the historic aerial photographs.

Based on the surface water zinc loading presented in this report, the reach of the Eagle River between E-11B and E-13C to E-12A, which includes the area adjacent to the northern portion of Rex Flats, includes between 7.7 to 0.8 pounds of zinc per day, respectively. Using average zinc concentrations in ground water as measured in REX-MW-1 and -1D, an estimated ground water discharge rate from Rex Flats to the Eagle River is between 2 to 5 gpm and a zinc load of between 0.3 and 1.5 pounds per day. The effects of zinc precipitation and interaction/mixing at the ground water/surface water interface is also highly variable.

Surface water is collects beneath the Mine Water Transport Pipeline and drain to the Eagle River in the spring (Figure 107. Some of this water is reddish brown and drains into the swale on the west side of the Mine Water Transport Pipeline to the north, towards the Eagle River. This swale passes close to REX-MW-2 and the area around REX-MW-2 is saturated during the spring. Sampling results from this well during April, 2006, were an order of magnitude higher for zinc, manganese, and cadmium. This indicates either that there is a source of metals in this area or that impacted surface water is infiltrating into this well. Additionally, the more recent water levels in this well indicate that the concentrations are highest during higher water levels in April.

Figure 107 - Ponded water beneath the Mine Water Transport Pipeline at Rex Flats.

CTP

The purpose of the Remedial Investigation ground water sampling at areas outside the CTP was to identify areas which may be captured by the north ground water extraction trench and in the area east of the sludge cell. The monitoring data indicate that concentrations of dissolved manganese, zinc and copper detected in the CTP wells exceeded either the CDPHE ground water or surface water standards. Elevated concentrations of dissolved zinc at CTP-MW-2S and 2D are migrating from the CTP to the Eagle River in this area. The concentrations of dissolved zinc and manganese detected in the wells sampled during this investigation are generally orders-of-magnitude below the historic ground water concentrations. Concentrations of iron and sulfate in some of the CTP wells exceeded the CDPHE ground water standards.

ERM also sampled ground water near DT-5, and the UGDT. The UGDT was only sampled when it was running which is exclusively in the spring. These data indicate that ground water intersected by the UGDT exceeds either the CDPHE ground water or surface water standards for zinc and manganese.

Past reports indicate that the north and east ground water extraction trenches capture about 50 to 75% of the ground water near the trenches, respectively (Dames and Moore, 1997). Therefore, a portion of metals impacted ground water from the CTP flows past the trenches and into Maloit Park/Cross Creek and the Eagle River. During the spring of 2006, ERM personnel observed several orange stained areas in Maloit Park behind the north ground water extraction trench. These areas are likely ground water seeps from the CTP. The CDPHE was notified of a release at the North Ground Water Extraction Trench on May 1, 2006 (CDPHE, 2006). However, ERM's visual field observations did not indicate that the Maloit Park areas described above were associated with this release.

Historical reports also indicate that the ground water extraction trenches periodically become clogged with iron precipitate and that the gravel in the ground water extraction trenches needs to be replaced (Dames and Moore, 1997). This would increase the flow of impacted water into Cross Creek and/or the Eagle River if not corrected.

Based on the surface water zinc loading presented in this report, the E-13 to E-13C segment generally decreased in zinc load while the E-13C to E-13B segment, adjacent to the East Groundwater Extraction Trench at the CTP, generally increased in zinc load. Using an average zinc concentration in ground water as measured in ET-1 (Newfields, 2006). An estimated ground water discharge rate is between 64 and 88 gpm and a zinc load between 2.9 and 3.9 pounds per day. This calculated zinc load from ground water to the Eagle River could explain zinc loading measured in the river. However, the effects of the ground water extraction trenches, zinc precipitation, and interaction/mixing at the ground water/surface water interface is highly variable.

Bolts Lake

Although the surficial aquifer at Bolts Lake contains manganese above the CDPHE ground water standard (CDPHE WQCD, 2005), this area is not currently significantly impacted by the primary indicator metals.

Ground water flow directions at Bolts Lake are to the east-northeast and northeast. The ground water flows into the Eagle River or follows the Eagle River valley to the north. In order to determine if ground water from Bolts Lake can flow beneath the ridge to the north and to the CTP, water levels from additional existing Viacom monitoring wells, including NTP-MW-2, CT-6, and DAP-MW-1R, and new monitoring wells CTP-MW-3 and CTP-MW-4 were measured to better determine the ground water flow in this area. Ground water flow in this area is generally to the northeast and a component of ground water flows from western portions of Bolts Lake to the CTP.

5.5 SURFACE WATER

Potential impact from surface water at the North Property to downstream surface water was evaluated using zinc as an indicator of impacted surface water in the Eagle River. Seasonally, concentrations of zinc, lead, copper, and cadmium were detected at concentrations exceeding water quality standards both entering and exiting the North Property. Therefore, stream flow is a transport mechanism for off site impact.

6.0 HUMAN HEALTH AND ENVIRONMENT EVALUATION

Current conditions at the North Property include impacted soil, ground water, and surface water, as discussed in Section 4.0 of this RI Report. Additionally, these impacted media are contributing to further impact at the North Property, as discussed in Section 5.0. The resulting potential effects to human health and the environment are presented below, by media.

6.1 SOIL

Metal constituents naturally occur in soil, often in mineralized districts such as the Eagle Mine Site. Additionally, the mine waste that was historically deposited at the Eagle Mine Site contains elevated concentrations of metals. The following impacted areas remain at the North Property:

- Surface soil at the OTP, current Sump # 3, Rex Flats, Maloit Park, Former Roaster Pile #5,
- Localized areas of tailings at the OTP, Rex Flats, and Maloit Park,
- Contaminated discolored boulders at the OTP and Rex Flats,
- Localized areas of subsurface soil at the OTP and Rex Flats,
- Localized areas of soil beneath and near the WTP Trestle, and
- An isolated area of surface soil at Bolts Lake.

In the North Property's current condition, the surficial soil, tailings, and boulders are exposed and available: 1) to recreational Site users, including rafters, hikers, fishermen and hunters; 2) to runoff into the Eagle River during snow melt and precipitation events; and 3) to leach to the subsurface soil and ground water.

6.2 GROUND WATER

There are two potential impacts from metal-impacted ground water to human health and the environment: 1) direct ingestion of ground water and 2) impacts to the Eagle River. The ground water within the OTP, Rex Flats, and CTP currently contains elevated primary indicator metals and expanded analyte list constituents that exceed CDPHE ground water standards (CDPHE WQCD, 2005). The ground water in these areas is unsafe for human ingestion and should not be consumed. Therefore, the

use of ground water for domestic purposes in these areas is prohibited because it exceeds CDPHE ground water standards.

The ground water underlying Bolts Lake currently contains elevated dissolved manganese which exceeds the CDPHE Drinking Water Standard. Drinking Water Standards are defined by the CDPHE as contaminants which may "adversely affect the aesthetic quality of a drinking water such as taste, odor, color, and appearance and which thereby may deter public acceptance of and confidence in that ground water source as a drinking water supply." Therefore, based on the laboratory analysis of ground water samples from the three Bolts Lake monitoring wells for the primary indicator metals, and the current Site conditions, the ground water in Bolts Lake could potentially be used for human consumption. However, due to Bolts Lake proximity to metals - impacted ground water at the OTP, ground water pumping at Bolts Lake could draw metals impacted ground water that exceeds CDPHE ground water standards from the OTP into this area. Therefore, ground water pumping at Bolts Lake is not recommended without further investigation.

Currently, metal-impacted ground water from the OTP, Rex Flats, and CTP flows to and enters the Eagle River. The metals concentrations in this ground water exceed the surface water standard for the Eagle River. Additionally, water from seeps and surface water diversion trenches identified in the OTP and Rex Flats ultimately enters the Eagle River. The ground water in these areas is impacting surface water in the Eagle River.

6.3 SURFACE WATER

Reported concentrations of metals in the Eagle River in exceedance of the CDPHE segment-specific standards during the months of March and April of 2006 at the North Property have the potential to impact human health and the environment. Although the segments of the Eagle River that transverse the North Property are classified as restricted access, on site activities of camping, hunting, fishing, and kayaking have been observed. During the summer and fall, when recreational use is at its highest, zinc concentrations do not appear to exceed the water quality standards established for the North Property; therefore, impact to recreational users of the Eagle River is not anticipated during that time frame.

7.0 CONCLUSIONS

Portions of the North Property historically received mine waste associated with the Eagle Mine, and specifically, from processing activities at Belden, which is located approximately 1.5 miles upstream of the Site. Areas of the North Property that received mine tailings included the OTP, Rex Flats, Maloit Park, NTP (currently known as the CTP), and the Roaster Pile #5. These areas are included within the Eagle Mine Superfund Site.

Most of the completed remediation activities at the Eagle Mine Superfund Site began in the mid-1980s and continued through 2001. Ongoing remediation includes ground water extraction and treatment at the CTP, treatment of mine-impacted water from the Eagle Mine at the CTP, continued revegetation monitoring, CTP settlement and erosion monitoring, waste pile removal at Belden, and remediation of an existing seep at the OTP, as noted in the Second Five Year Review (CDPHE, 2005). The purpose of the OU-1 remedy was to control the transport of metals from various sources to the Eagle River and to ground water; however, portions of the North Property remain a Superfund Site primarily due to the presence of residual tailings and due to elevated metals concentrations in the soil, surface water, and ground water. Access to the Eagle Mine Superfund Site is therefore restricted since the concentration of metals in these media exceeds levels considered safe for humans.

Given the proposed reuse of the North Property as a residential and recreational community, the existing remedy is not sufficiently protective of human health and the environment. To address this potential data gap, the Remedial Investigation was conducted in 2005 and 2006. The Work Plan for this investigation incorporated public comment and was approved by the CDPHE and EPA. The key focus of the Remedial Investigation was to document current conditions, which included the quality of surface and subsurface soil, surface water, ground water, and air. The primary constituents of concern included the EPA primary indicator metals of arsenic, cadmium, chromium, copper, lead, manganese, and zinc.

The Remedial Investigation activities included soil sampling on a grid pattern with in-fill locations as determined by the field team and CDPHE, ground water monitor well installation, hydrogeologic evaluation of the shallow aquifer, monthly ground water sampling (excluding winter months), monthly and weekly surface water sampling (excluding winter months), and nearly continuous air monitoring during the summer and fall months. Additionally, existing North Property conditions were documented throughout the investigation activities.

Impacted soil, tailings and/or rock material, surface water, and ground water remain at the North Property. Impacted is defined as: 1) soil locations with metal concentrations greater than the Site-specific RGs; 2) ground water with metal concentrations greater than the CDPHE ground water standards, and locations near the Eagle River which exceed surface water standards; 3) surface water with metal concentrations greater than existing CDPHE Eagle River Segment 5a and 5b and Cross Creek Segment 7b standards; and 4) tailings with rock material present on the North Property. Impacted media include the following:

- Impacted surface soil is located throughout the OTP, current Sump # 3, Rex Flats, Maloit Park, and Roaster Pile #5 areas; and at an isolated area of Bolts Lake. Soil concentrations generally decrease with depth and only localized areas within the OTP and Rex Flats contain impacted subsurface soil.

- Distinct areas of mine waste (tailings and/or rock material or roaster material) left from the original Site remediation remain within the OTP, Rex Flats, Maloit Park, and Roaster Pile #5 and one very isolated area with Bolts Lake. The larger areas of tailings material with orange-stained boulders are present within the southern-most portions of the OTP and Rex Flats.

- Seeps with elevated metals concentrations are located in the OTP and Rex Flats. These seeps are stained orange and reddish brown and were observed on the OTP and Rex Flats areas in the fall and especially during the spring. Water from the ponds to the west of the OTP and the leaky surface water diversion trenches drain into the OTP and likely interact with remnant mine tailings in these areas.

- Surface water with elevated metals concentrations enters and leaves the Site during the peak flow season that occurs seasonally in March and April. There was also a one-time exceedance of lead (June 2005). Each segment of the Eagle River within the North Property has shown an increase in zinc concentrations at least once during the 2005-2006 investigation. These increases are attributed to seeps, ground water, and surface water runoff.

- The ground water concentrations of some primary indicator metals and other analytes in monitoring wells at the OTP, Rex Flats, and CTP currently exceed CDPHE ground water standards. Additionally, due to the proximity of Bolts Lake to impacted ground water at the OTP, pumping of ground water at Bolts Lake is not recommended without further investigation.

- Ground water with elevated primary indicator metals and other metals enters the Eagle River from the OTP, Rex Flats, and CTP. The dissolved zinc, manganese, cadmium, copper, and lead concentrations of this ground water exceeded the Eagle River surface water standards for this reach of the river.

Findings related to the current operation of the Eagle Mine Superfund Site are:

- Both the north and east ground water extraction trenches at the CTP allow metals-impacted ground water from the CTP flow into Maloit Park.

- The ground water trenches periodically become clogged with iron precipitate, and the gravel in the ground water extraction trenches needs to be replaced. This may increase the release of impacted water into Cross Creek and/or the Eagle River if not corrected. The ground water extraction trenches, as well as the UGDT and surface water diversion trenches, will need additional monitoring, reconstruction, and maintenance for an undetermined amount of time in the future.

- The WTP, upper and lower surge ponds, and sludge pit will continue to operate for treatment of ground water from the extraction trenches and from the Eagle Mine for an indefinite period of time. A cap was not placed on these areas or on the temporary cell on top of the CTP (about 6 acres).

- The temporary cell on top of the CTP is open and Viacom is placing waste rock, timber and debris from Waste Pile #14 in Belden into this area as of September 2006.

- Other mine-related features that remain on site include the Mine Water Transport Pipeline that transports mine water to the WTP; the WTP; CTP; and the Former Tailings Slurry Pipeline.

The presence of the impacted areas results in the ongoing transport of elevated metals to subsurface soil, ground water, and surface water. Specifically, impacted surface soil is transported via overland flow (such as snow melt runoff) to the Eagle River. Specific metals leach to ground water, which then flows to the Eagle River. Diverted surface water from the OTP and Rex Flats comes into contact with impacted surface soil, becomes impacted by the metals, and then flows into the Eagle River. Similarly, ground water seeps that come into contact with impacted surface or subsurface soil transports elevated metals to the Eagle River.

These impacted media (soil, ground water and surface water) pose a continued risk to human health and the environment. These risks are modeled and discussed in detail in ERM's Risk Assessment Report of September 2006.

ERM is completing an assessment of Remedial Alternatives which addresses the environmental impacts and their threat to human health. This feasibility Study will be completed and submitted to the EPA and CDPHE within 30 days of this RI Report.

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