

Appendix J

ESL Subpile Soils Report

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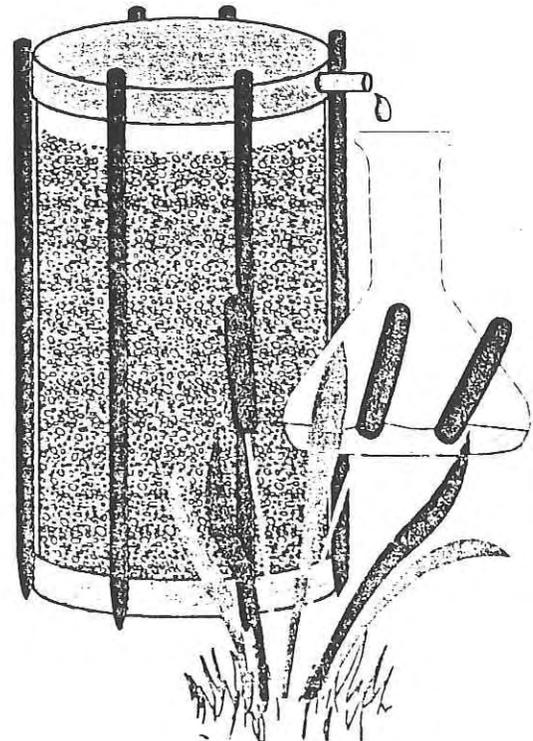
Environmental Sciences Laboratory

Contaminants in Subpile Soils

UMTRA Ground Water Project
Durango, Colorado, Site

July 2001

Prepared for
U.S. Department of Energy
Grand Junction Office
Grand Junction, Colorado



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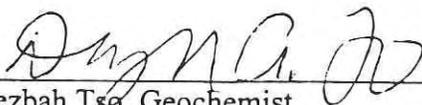
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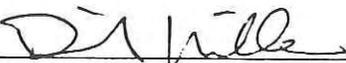
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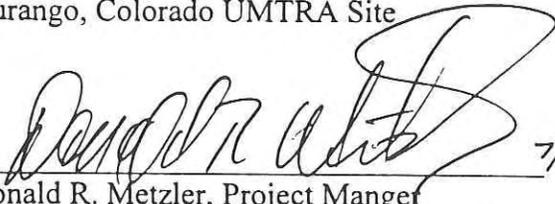
UMTRA Ground Water Project Durango, Colorado, Site

July 2001

Prepared By: 
Dezbah Tse, Geochemist
Environmental Sciences Laboratory

Reviewed By: 
Stan Morrison, Manager
Environmental Sciences Laboratory

Reviewed By: 
David Miller, Lead
Durango, Colorado UMTRA Site

Approved By:  7/26/01
Donald R. Metzler, Project Manager
U.S. Department of Energy Grand Junction Office

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Appendices

- Appendix A. Environmental Sciences Laboratory Work Submittal
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Acronyms

| | |
|------------------|---|
| DOE | U.S. Department of Energy |
| ESL | Environmental Sciences Laboratory |
| ft | feet |
| GJO | Grand Junction Office |
| HNO ₃ | nitric acid |
| mg/kg | milligrams per kilogram |
| mL | milliliter(s) |
| mm | millimeters(s) |
| rpm | revolutions per minute |
| UMTRA | Uranium Mill Tailings Remedial Action (Project) |

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Executive Summary

This study was undertaken to determine if cadmium, lead, molybdenum, selenium, and/or uranium are present in soils in sufficient concentrations to cause continuing contamination to the ground water at the Uranium Mill Tailings Remedial Action Ground Water Project Durango, Colorado, site. Remedial action criteria for soil excavation and removal was based on a radiometric standard for Radium-226 and details about the original distribution (lateral and horizontal) and the amount of these contaminants in the subpile soils is not known.

The site consists of two proximate, hydrogeologically separate areas: the mill tailings area and raffinate ponds area. A total of nineteen samples, including 3 background samples, were collected from the mill tailings area from 11 locations. A total of twenty samples, including 4 background samples, were collected from the raffinate ponds area from 9 locations. Samples were digested in 5 percent nitric acid (HNO₃) and submitted for cadmium, lead, molybdenum, selenium, and uranium analysis.

In the mill tailings area, sample 0918 at 5 ft, which contains lead smelter slag, has the highest lead, molybdenum, and uranium concentrations. Excluding this sample, the highest constituent concentrations are 7.20 milligrams per kilogram (mg/kg) cadmium, 141 mg/kg lead, 2.18 mg/kg molybdenum, 1.31 mg/kg selenium, and 21.8 mg/kg uranium. The highest background constituent concentrations are 1.27 mg/kg cadmium, 141 mg/kg lead, 0.66 mg/kg molybdenum, 0.88 mg/kg selenium, and 1.22 mg/kg uranium.

In the raffinate ponds area, the highest constituent concentrations are 13.4 mg/kg cadmium, 13.6 mg/kg lead, 0.39 mg/kg molybdenum, 2.77 mg/kg selenium, and 19.5 mg/kg uranium. The highest background concentrations are 2.17 mg/kg cadmium, 10.0 mg/kg lead, 0.13 mg/kg molybdenum, 0.35 mg/kg selenium, and 0.29 mg/kg uranium.

Uranium and cadmium concentrations of subpile samples are higher than the concentrations in background samples. This may indicate that mill processing altered the chemical composition of the soil. Concentrations of lead, molybdenum, and selenium in background samples suggest that these constituents naturally occur within the area at concentrations above their crustal mean concentrations. Overall, constituent concentrations do not appear to be sufficient to be a source of continuing ground water contamination.

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1.0 Introduction

The Durango, Colorado, Uranium Mill Tailings Remedial Action (UMTRA) Project site is located on the west bank of the Animas River outside the city limits about 0.25 miles from the central business district of Durango (Figure 1). This site contains two hydrogeologically separate areas: the mill tailings area and the raffinate ponds area.

In 1991, surface remedial action was completed. Tailings piles, mill debris, and contaminated soils from both areas were relocated to the nearby Bodo Canyon disposal site. After relocation, the mill tailings area and the raffinate ponds area were contoured and planted with grasses. In this study, "soil" is defined as the unconsolidated material above the bedrock regardless of genesis.

The purpose of this report is to show soil sample locations, describe the methods used, and provide the results of laboratory analyses. Samples were collected September 25, 2000 and November 18–20, 2000. In January 2001, the samples were acid leached in the Environmental Sciences Laboratory (ESL). Thirty-nine soil samples were analyzed. Nineteen samples at 11 locations were obtained from the mill tailings area, including 3 background samples (Figure 2). Twenty samples at 9 locations were collected from the raffinate ponds area, including four background samples (Figure 3). Appendix A contains the ESL work submittal for this project, Appendix B contains copies of the ESL notes and field notes, and Appendix C contains an abbreviated set of the data submitted for inclusion in the SEEPro database.

The ESL was established in 1991 to provide support to programs at the DOE Grand Junction Office. The geochemical laboratories are equipped with bench space and equipment to conduct research, treatability studies, and pilot-scale tests to supplement numerical modeling efforts and to evaluate promising remediation technologies. The ESL also maintains an ecology laboratory equipped to conduct testing to design and evaluate landfill covers and phytoremediation technologies, and operates a mobile laboratory that is routinely used for expedited site characterization at field sites.

End of current text

2.0 Sample Locations

The goal of this study was to determine if residual contaminants were left on site and if they provide a continuing source of contamination to ground water. Soil samples were selected from site locations most likely to have contaminated subpile soils and were collected from beneath the former tailings piles and raffinate ponds.

In the mill tailings area, a total of 19 soil samples were collected from 11 locations (Figure 2). Three background samples were collected north along the Animas River (sample 0930) and upgradient to the northeast along Lightner Creek (samples 0931 and 0932). In the raffinate ponds area, a total of 20 samples were collected from 9 locations (Figure 3). Four background samples were collected from location 0903 at depths ranging from 4 to 28 feet (ft) below the surface.

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3.0 Background

3.1 Site Conditions

DOE began relocating the tailings piles, mill debris, and contaminated soil from the mill tailings area and raffinate ponds area to the Bodo Canyon disposal site in November 1986; remedial action was completed in May 1991. After tailings piles and contaminated soil were removed the remaining surficial material was mixed and spread over both areas. This "fill" is a mixture of clayey sands, gravels, and cobbles. Both areas were contoured and planted with grasses.

Supplemental standards in the mill tailings area were applied to contamination left in place in two regions along the banks of the Animas River, and to unreachable areas of windblown contamination on the slope of Smelter Mountain (Figure 2). In the raffinate ponds area, supplemental standards were applied to thorium-230 soil (Figure 3).

3.2 Site Geology and Hydrology

The Durango UMTRA site is located on the west bank of the Animas River outside the city limits and contains two hydrogeologically separate areas: the mill tailings area and the raffinate ponds area (Figure 1). Each area will be described separately. Both areas have common stratigraphic units. The characteristics of each unit will be provided before discussing the particular geology of each area.

3.2.1 General Geology

Three surficial units are present at the Durango site and the most recent is the fill material used for contouring and planting grasses after surface remediation was completed. Before site remediation, unconsolidated surficial deposits in the raffinate ponds area consisted of colluvium from the slope of Smelter Mountain, glacial outwash, and recent river alluvium. The surficial deposits were 20 to 30 ft thick in the area of the ponds. As much as 20 ft of surficial deposits were removed during site remediation. Most of the remaining surficial material was mixed during remediation activities and now is a mixture of clayey sands, gravels, and cobbles. Some gravel beds overlying the bedrock remain. In addition to mixed colluvium and alluvium, surface material collected during excavation of the Bodo Canyon disposal site was added to the mixture.

Colluvium collects along the base of Smelter Mountain. Near the Animas River and below the colluvium is alluvial material. Generally, these geologically recent surficial units are a mixture of silt, sand, gravel, and cobbles. The colluvium is poorly sorted, silty soil from Smelter Mountain that contains angular gravel and cobble sized rock fragments. It can be difficult to distinguish fill material from colluvium. Alluvial river deposits, which may also be glacial outwash, consist of well-sorted sands and sub-rounded to rounded gravel and cobbles.

Beneath the unconsolidated surficial deposits are two members of the Mesaverde Group of Cretaceous age. The younger unit is the Menefee Formation and the older is the Point Lookout Sandstone. Below the Point Lookout Sandstone is the Mancos Shale.

The Menefee Formation consists of massive sandstone and shale with beds of carbonaceous shale and coal. The Point Lookout Sandstone is the basal formation of the Mesaverde Group divided into two members: a lower transitional member containing interbedded lenticular sandstone and shales, and an upper massive sandstone member. The Point Lookout Sandstone consists of siltstone with interbedded sandstone and minor amounts of shale and crops out on the slopes and upper cliffs of Smelter Mountain. The thickness of the Point Lookout Sandstone in the project area is approximately 400 ft.

Below the Point Lookout Sandstone is the Mancos Shale of Cretaceous age. Mancos Shale is typically a marine black shale interbedded with gray siltstone and minor thin dark-gray limestone beds and lenses.

3.2.2 Mill Tailings Area

The mill tailings area covers approximately 40 acres and is located on a bedrock-supported river terrace between Smelter Mountain to the west, the Animas River to the east and south, and Lightner Creek to the north (Figure 2).

Along the base of Smelter Mountain, surface material consists of a layer of colluvium up to 25 ft thick. Below the layer of colluvium is a layer up to 15 ft thick of alluvial river deposits and/or glacial outwash. The unconsolidated layers are underlain by dark gray to black Mancos Shale of Cretaceous Age, which is more than 1,700 ft thick. The Mancos Shale is truncated by the Smelter Mountain fault to the south. The Smelter Mountain fault is located between the mill tailings and the raffinate ponds areas.

A lead smelter located at near the south end of the mill tailings area operated from 1880 to 1930. A layer of vitreous lead smelter slag as much as 25 ft thick remains from the smelter operation near the southeast corner of the mill tailings area along the edge of the Animas River. In addition, a small lens of uranium ore was left in place below the layers of lead slag along portions of the riverbank.

Ground water in the colluvium near the base of Smelter Mountain is recharged primarily by runoff from the mountain and by infiltrating precipitation. The drainage basin upslope of the mill tailings area is small because of a steep cliff along the east side of Smelter Mountain. Therefore, the amount of recharge from this area is relatively small.

Alluvium deposits receive recharge from Lightner Creek and the Animas River. During spring runoff when the river stage is high, water flows into the aquifer. When the river stage is lower the ground water flows from the aquifer back into the Animas River. Some of the ground water may flow down through the colluvium into the underlying Mancos Shale. Ultimately, water from the site that moves through the Mancos Shale discharges into the Animas River. Because the permeability of the Mancos Shale is very low, only a small quantity of water passes by this route to the river as compared to the route through the more permeable alluvium/colluvium.

3.2.3 Raffinate Ponds Area

The raffinate ponds area occupies approximately 20 acres on another river terrace about 1,500 ft south of the mill tailings area. A narrow terrace above the Animas River connects the two areas.

A small intermittent creek called South Creek forms the southern boundary of the raffinate ponds area.

The Bodo Fault, which is a normal fault, dissects the raffinate ponds area and is northeast southwest trending and dips to the southeast at approximately 55 degrees. As a result of faulting, the Point Lookout Sandstone underlies the northwestern part and the Menefee Formation underlies the southeastern part of the raffinate ponds area. Associated with the fault in the raffinate ponds area is an andesite porphyry dike of probably Laramide age which appears to have intruded the fault along its entire length in the raffinate ponds area. This dike may be related to igneous activity that formed the La Plata Mountains approximately 10 miles northwest of the project area in late Cretaceous or Tertiary time.

Ground water below the raffinate ponds area is recharged by infiltration of precipitation and by ground water moving through the bedrock from the west. The elevations of both the alluvium/bedrock interface and the ground water are higher than the water level in the Animas River. Therefore, unlike the mill tailings area, the river does not recharge the aquifer in this area.

Based on the existing network of monitoring wells at the raffinate ponds area the ground water is within the bedrock and the alluvium is unsaturated. Ground water in the bedrock flows toward and discharges into the Animas River. Ground water flow in the Point Lookout Sandstone and Menefee Formation is mostly through open bedding planes and joints. Aquifer tests completed before surface remediation indicate ground water also flows through the fault cutting the bedrock.

Surface water flowing down South Creek during wet times may infiltrate the surficial deposits and recharge the ground water. Infiltration from South Creek also recharges the fault.

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4.0 Soil Chemistry and Leaching

Concentration of constituents in soil are determined through sample digestion, separation of the liquid phase by centrifuging or filtering, analysis of liquid phase constituent concentrations, and calculation of the concentrations in the solid phase. The most suitable digestion methods are those that remove only the loosely bound constituents because those have the highest potential for contaminating ground water and being accessible to plants and animals.

The choice of extraction method and leaching fluid determines the specific contaminants that can be extracted. The kinds of liquid media used to digest samples range from deionized water to strong acids combined with hot fluxing agents. Some digestion agents are designed to selectively remove specific mineral phases. For example, a mixture of sodium citrate, sodium dithionite, and sodium bicarbonate can selectively remove ferric oxyhydroxide minerals. A low pH solution would be used to desorb cations, and a high pH solution would be used to desorb anions. However, no solution can be completely selective. Some constituents, such as those adsorbed to mineral grains, are also released during the digestion. Numerous digestions with different solutions would be needed to provide a complete picture of contaminant distribution in a soil.

This project was intended to provide data for a screening-level assessment of soil that would be accessible to plants and animals. A 5 percent solution of nitric acid (HNO_3) was used for digestion. This acidic solution should release the adsorbed cations and dissolve the carbonate minerals. Although anions adsorb more strongly at low pH, they should also be released because the acid will dissolve most of the amorphous oxyhydroxide adsorbent phases. Five-percent HNO_3 will not dissolve most silicate minerals, which is desirable because the constituents in silicate minerals are not readily available to ground water.

To help interpret the soil data, samples were collected from background areas. These areas have similar lithology and could not have been affected by milling operation. Comparison to background samples, which were prepared according to the same method as on-site samples, helped to determine if the on-site samples contained releasable mill-related contaminants.

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5.0 Methods

Soil samples were collected from locations most likely to be contaminated by using a backhoe. Two samples were collected from each location; both were collected above the water table. Samples were taken from the backhoe bucket at depths ranging from 2 to 6 ft. Two samples, 0913 from 3.5 ft deep and 0914 from 3 ft deep, were obtained from the Menefee Formation and Point Lookout Sandstone Formation rock units, respectively. In these locations a soil sample could not be collected at these depths. The samples were collected as individual grab samples.

Background samples were collected from areas off-site. Two samples of colluvium (0931-COL and 0932-COL) were collected upgradient from the site, from along the base of Smelter Mountain. One sample of alluvium was collected about 1500 ft upstream from the site along the Animas River (0930-AL).

Soil samples were placed in plastic resealable bags and transported to ESL. The soil samples were placed in stainless steel trays and air-dried. To aid the drying process, the soils were stirred and clumps were disaggregated by hand. Large sticks, rootlets, and pebbles were removed by hand. After drying was complete, samples were passed through a 2-millimeter (mm) (10 mesh) sieve. The fraction less than 2 mm was used for leaching.

Two grams of each sample were weighed and divided equally into two 50 milliliters (mL) centrifuge tubes. Each centrifuge tube received 50 mL of 5 percent (volume to volume) HNO_3 . The tubes were agitated end over end for 4 hours then centrifuged for 30 minutes at approximately 3,000 revolutions per minute (rpm). The supernatant from both tubes was decanted into a 200 mL volumetric flask. The remaining soil in the tubes was washed with 50 mL of 5 percent HNO_3 to remove the remaining constituents. After the addition of 5 percent HNO_3 , the tubes were agitated end over end for 30 minutes then centrifuged for 30 minutes at approximately 3,000 rpm. The supernatant was added to the 200 mL volumetric flask. Five percent HNO_3 was added to fill the 200 mL volumetric flask to volume. Samples were filtered through a 0.45 micrometer filter and submitted to the GJO Analytical Chemistry Laboratory for analysis of cadmium, lead, molybdenum, selenium, and uranium. Analytical methods are listed in Table 1. Additional preservation was not necessary because the samples were HNO_3 solutions. Samples were kept at less than 4°C prior to analysis.

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6.0 Results and Discussion

6.1 Mill Tailings Area

A total of 19 samples were collected from 11 locations. Two samples from different depths were collected from each location, except samples from locations 0930, 0931, and 0932. Each is a single surface sample. For the paired samples, sample names include their location and collection depth. For example, sample 0918-5 ft is from location 0918 and a collection depth of 5 ft below the surface.

All sample pairs have similar lithology. Samples differ in the amount and type (well-rounded, angular, sandstone, etc.) of rock greater than 2 mm in diameter. However, the less than 2 mm fractions are mostly silt. One sample, 0918-5 ft, contains slag, which is solid waste material left from the operation of the lead smelter.

6.1.1 Cadmium

Cadmium concentrations are provided in Table 2 and shown in Figure 4. Concentrations range from 0.096 mg/kg (0918-3 ft) to 7.20 mg/kg (0917-2 ft). The mean crustal concentration of cadmium is 0.2 mg/kg. Most samples have cadmium concentrations that are greater than the mean crustal concentration. Only six samples (0915-3 ft, 0915-5 ft, 0918-3 ft, 0919-4 ft, 0920-5 ft, and 0921-4 ft) have cadmium concentrations that are less than the mean crustal value.

The concentrations of all background samples are greater than the crustal mean and range from 0.57 mg/kg (0932-COL) to 1.27 mg/kg (0930-AL). This suggests that cadmium is a natural constituent in soils. Significantly elevated cadmium concentrations are related to milling activities.

Cadmium concentrations increase substantially with depth at location 0918. Sample 0918-3 ft has a concentration of 0.096 mg/kg cadmium and 0918-5 ft has a concentration of 5.15 mg/kg. The cadmium concentration in sample 0918-5 ft is over 50 times greater than sample 0918-3 ft. Slag is present in sample 0918-5 ft and may account for the high cadmium concentration measured. Samples from location 0922 show a slight increase of cadmium concentration with depth. Sample 0922-2 ft has a cadmium concentration of 0.20 mg/kg and 0922-3 ft has a concentration of 0.28 mg/kg, which is 1.4 times greater than that of sample 0922-2 ft. All remaining sample pairs show a decrease of cadmium concentration with depth.

Under oxidizing conditions and low pH, less than 7, cadmium is soluble and mobile. As the pH rises, the cadmium concentration decreases. At first, the concentration decrease is due to adsorption and then it is due to the limited solubility of carbonates and oxides/hydroxides. Cadmium response is similar under reducing conditions, except in the presence of sulfur. If sulfur is present, cadmium will precipitate as a sulfide. Cadmium, itself, does not readily respond to changes in redox conditions. However, cadmium does respond to redox changes occurring in sulfur species and in iron and manganese oxyhydroxides, which are important substrates for adsorption. Potential exists for cadmium to be adsorbed onto calcite. Cadmium may precipitate with manganese oxide.

6.1.2 Lead

Lead concentrations are listed in Table 2 and shown in Figure 5. Concentrations range from 5.67 mg/kg (0918-3 ft) to 6,660 mg/kg (0918-5 ft). The mean crustal composition of lead is 13 mg/kg. Seven samples have concentrations that are greater than the mean crustal composition. The lead concentration of sample 0918-5 ft (6,660 mg/kg) is significantly elevated above all other samples.

The concentrations of background samples 0931-COL and 0930-AL are greater than the crustal mean. Sample 0930-AL is a background sample collected upstream from the site. It has the second-highest lead concentration, which is 141 mg/kg. The presence of lead in concentrations greater than the crustal mean in background samples indicates that lead is available in the environment and that the soils are able to adsorb it. Moreover, the source of lead contamination cannot be solely attributed to uranium milling activity.

Lead concentrations decrease with depth at all locations, except location 0918. At location 0918, lead concentration increases from 5.67 mg/kg (0918-3 ft) to 6,660 mg/kg (0918-5 ft). Slag, which is present in sample 0918-5 ft, may be the reason for the extremely high lead concentration.

Mobility of lead is naturally low because of its low solubility under both oxidizing and reducing conditions. If sulfur is present under reducing conditions lead will precipitate as a sulfide. Under oxidizing conditions, lead may coprecipitate with manganese oxide and can adsorb onto organic matter and inorganic surfaces, such as manganese and iron oxides. Under oxidizing conditions, the lead species PbSO_4^0 is important at SO_4^{2-} concentrations greater than about 96 mg/L. If iron or manganese solids are not present in sufficient amounts to scavenge all the lead from solution, lead as PbSO_4^0 may precipitate from solution. In the atmosphere, lead can be circulated by dry fallout and rainout; precipitation can then remove the dry, lead-rich particulates from the air and deposit them into the ground and to rivers and streams.

6.1.3 Molybdenum

Molybdenum concentrations are listed in Table 2 and are shown in Figure 6. Concentrations range from less than the detection limit of 0.08 mg/kg (in 10 samples) to 10.80 mg/kg (0918-5 ft). Samples 0917-4 ft and 0918-5 ft have molybdenum concentrations that are greater than the mean crustal concentration of 1.5 mg/kg.

The molybdenum concentrations of the background samples are less than the crustal mean and range in concentration from 0.13 mg/kg (0932-COL) to 0.66 mg/kg (0931-COL). Molybdenum does not appear to be a natural constituent of these soils. Elevated molybdenum concentrations may be attributed to milling activity.

Samples from locations 0917 and 0918 have molybdenum concentrations that increase with depth. The molybdenum concentration of sample 0917-4 ft (2.18 mg/kg) is about 2.5 times greater than that of 0917-2 ft (0.88 mg/kg). Lithology of this location is similar to that of the other paired samples, except those from location 0918. The high molybdenum concentration in sample 0917-4 ft may be limited to this location and this depth. The molybdenum concentration of sample 0918-5 ft (10.8 mg/kg) is about 113 times greater than that of 0918-3 ft (0.096 mg/kg):

It is possible that slag contributes to the high molybdenum concentration found in sample 0918-5 ft. At all other locations, the molybdenum concentrations decrease with depth.

Molybdenum has a relatively high geochemical mobility. Its low solubility allows it to enter into solution in water under oxidizing conditions. Molybdenum will precipitate from reduced waters. Solubility controls include precipitation with common metals as metal molybdates. The effectiveness of this control depends on the solubility of the metal. Molybdenum can be adsorbed by amorphous ferric oxyhydroxides. The solubility product for calcium molybdate suggests that water with substantial Ca^{2+} concentrations should not have large dissolved molybdenum concentrations. Molybdenum is an accessory element in many metal ores. Soluble molybdates may be produced in oxidized areas of the deposits. As a result, molybdenum may appear in detectible concentrations in stream water, sediments, ground water, and vegetation at considerable distances from their source.

6.1.4 Selenium

Selenium concentrations are listed in Table 2 and shown in Figure 7. Concentrations range from less than the detection limit of 0.35 mg/kg (in 4 samples) to 2.00 mg/kg (0918-5 ft). The mean crustal concentration of selenium is 0.05 mg/kg. All samples exceed this mean.

Selenium concentrations in background samples exceed the mean crustal concentration and range from 0.60 mg/kg (0930-AL), to 0.88 mg/kg (0931-COL). This suggests that selenium is a natural constituent in soils. Significantly elevated selenium concentrations are related to milling activities.

Selenium concentrations increase with depth at locations 0915, 0918, 0920, and 0921. The selenium concentration in sample 0915-5 ft (0.49 mg/kg) is 1.2 times greater than in sample 0915-3 ft (0.41 mg/kg), 0918-5 ft (2.00 mg/kg) is 2.9 times greater than 0918-3 ft (0.68 mg/kg), 0920-5 ft (0.92 mg/kg) is 2.6 times greater than 0920-2 ft (0.35 mg/kg), and 0921-4 ft (0.86 mg/kg) is 1.3 times greater than 0921-2 ft (0.64 mg/kg). The deeper sample from location 0918 has a different lithology than all other samples. Sample 0918-3 ft is similar to other shallow samples; they are generally silt material. Sample 0918-5 ft contains slag in addition to the fill material and silt that is common to other samples collected at a greater depth. All remaining samples have selenium concentrations that decrease with depth.

In some respects selenium chemistry is similar to that of sulfur. Under oxidizing conditions selenium occurs as selenate (SeO_4^{2-}). Selenate is readily reduced to elemental and relatively insoluble Se^0 . In the presence of iron, selenium may coprecipitate with iron sulfides under reducing conditions. Selenium in oxidized form is weakly adsorbed to ferric oxyhydroxides.

6.1.5 Uranium

Uranium concentrations are listed in Table 2 and shown in Figure 8. Concentrations range from 0.30 mg/kg (0920-5 ft) to 42.4 mg/kg (0918-5 ft). Five samples (0919-2 ft, 0919-4 ft, 0917-2 ft, 0917-4 ft, and 0918-5 ft) have uranium concentrations that are greater than the earth's mean crustal concentration of 1.80 mg/kg.

All samples show decreasing concentrations with depth, except samples from location 0918. The uranium concentration increases about 120 times from sample 0918-3 ft (0.35 mg/kg) to 0918-5 ft (42.4 mg/kg). The presence of slag in sample 0918-5 ft is the only difference between this and all other samples. The most important potential sorbent for uranium are iron oxyhydroxides followed by organic matter.

Under oxidizing conditions, uranium is soluble in ground water and mobile due to the presence of aqueous carbonate, a strong complexing agent. Uranium is often sequestered by adsorption to iron oxyhydroxides in soil. Under strongly reducing conditions, uranium can precipitate as uraninite (UO_2).

6.1.6 Discussion

The three background samples, 0930-AL, 0931-COL, and 0932-COL, generally have higher constituent concentrations than most of the samples collected. Elevated cadmium, lead, and selenium concentrations in background samples suggest the constituents are natural components of the rocks and soil. Concentrations of molybdenum and uranium in background samples are less than the mean crustal concentrations, which indicates that these constituents are not natural rock and soil components. Significantly elevated concentrations of cadmium, lead, and selenium and elevated concentrations (greater than the crustal mean) of molybdenum and uranium indicate an anthropogenic source.

Elevated constituent concentrations at some locations (such as 0917) indicate that mill processes may have influenced soil chemistry. While concentrations of cadmium, lead, and selenium appear to be naturally greater than the crustal mean, significantly elevated constituent concentrations, such as sample 0918-5 ft, appear to be limited to small, separate areas. Likewise, elevated concentrations of molybdenum and uranium appear to be limited in area. Samples with elevated concentrations are few and separate enough to suggest that the concentrations may not be a significant, continuing source of contamination.

Increases in concentration from sample 0918-3 ft to 0918-5 ft occur in all measured constituents (cadmium, lead, molybdenum, selenium, and uranium). The concentration increases range from 2.9 to 1175 times larger in the deeper sample (0918-5 ft). Slag was collected with soil in sample 0918-5 ft while no slag was collected in sample 0918-3 ft. The slag is associated with the operation of the lead smelter and could be expected to contain high concentrations of lead. Due to the presence of the slag, it is difficult to assess the nature of the elevated concentrations of cadmium, molybdenum, selenium, and uranium. The chemical composition of the slag is unknown. Cadmium, molybdenum, selenium, and uranium may have been present in the material used for operation of the lead smelter. The high constituent concentrations in sample 0918-5 ft is likely attributed to the presence of slag.

6.2 Raffinate Ponds Area

A total of 20 samples were collected from 9 locations. Two samples were collected from each location, except the samples from location 0903. At location 0903, four background samples were collected at depths of 4 ft, 14 ft, 23 ft, and 28 ft. Two samples, 0913-4 ft and 0914-3 ft were rock core samples and were crushed to obtain the required less than 2 mm fraction.

Like samples from the mill tailings area, the lithology of the samples is similar, except samples 0913-4 ft and 0914-3 ft. Variations in lithology are largely due to amount of silt and the amount, rounding, and type of rock material present and the less than 2 mm fractions are generally silty. Samples 0913-4 ft and 0914-3 ft are exceptions. Sample 0913-4 ft was collected as a consolidated core sample of unweathered medium light gray sandstone from the Menefee Formation. Sample 0914-3 ft was collected as a consolidated sample of shale from the Point Lookout Sandstone Formation. Background samples collected from location 0903 are unconsolidated deposits that fit the general description of the majority of samples. Sample 0903-4 ft is remediation-imported soil, 0903-14 ft is colluvium with minor amounts of black carbonaceous shale material, 0903-23 ft is colluvium with minor amounts of black carbonaceous shale material, and 0903-28 ft is colluvium.

6.2.1 Cadmium

Cadmium concentrations are listed in Table 3 and shown in Figure 9. Concentrations range from 0.041 mg/kg (0903-4 ft) to 13.4 mg/kg (0914-2 ft). The mean crustal concentration of cadmium is 0.2 mg/kg. Most samples have concentrations that are greater than the crustal mean. Only 5 samples (0903-4 ft, 0903-14 ft, 0903-28 ft, 0911-2 ft, and 0913-4 ft) have concentrations that are less than the crustal mean.

Concentrations of background samples are generally less than the mean crustal concentration. The concentration of sample 0903-23 ft (2.17 mg/kg) is greater than the crustal mean. The remaining background samples range in concentration from 0.041 mg/kg (0903-4 ft) to 0.110 mg/kg (0903-28 ft). Cadmium does not appear to be a natural constituent of these soils. Elevated cadmium concentrations may be attributed to milling activity.

The cadmium concentrations increase with depth in sample pairs from locations 0911, 0924, 0925, and 0927. The deeper samples have concentrations that are 2, 2.4, 1.4, and 1.5 times greater than the shallow sample, respectively. In samples from the background location 0903, concentration in 0903-14 ft is 1.4 times greater than in 0903-4 ft, and the concentration of 0903-23 ft is 38 times greater than in 0903-14 ft. Both 0903-14 ft and 0903-23 ft contain black carbonaceous material. Contact with the reducing conditions of 0903-14 ft may have initiated a series of redox reactions that resulted in the deposition of cadmium at a depth of 23 ft. Natural organic matter can adsorb cadmium where the concentration of organic matter and cadmium are relatively high. Iron and manganese oxyhydroxides are important substrates for adsorption.

6.2.2 Lead

Lead concentrations are listed in Table 3 and are shown in Figure 10. Concentrations range from 4.40 mg/kg (0903-4 ft) to 13.6 mg/kg (0914-3 ft). The mean crustal composition of lead is 13 mg/kg, only sample 0914-3 ft has a concentration that is greater.

Concentrations in background samples are less than the mean crustal concentration. Lead does not appear to be a natural constituent of these soils. Elevated lead concentrations may be attributed to milling activity.

The concentration in sample pairs from locations 0914 and 0926 increases with depth 1.8 and 1.3 times, respectively. Samples from location 0926 have similar lithology as the other paired

samples. The concentration increase in this sample pair may be the result of a local variation in the fill material used. In contrast, the concentration increase in the samples from location 0914 may be due to changes in lithology. Sample 0914-3 ft is shale and siltstone from the Point Lookout Sandstone Formation. Lead may have adsorbed to soil surfaces. Of the background samples, the concentration of sample 0903-28 (terrace alluvium) ft is 2.2 times greater than sample 0903-23 ft (colluvium). Alluvial material with a high lead concentration may have been deposited from an upstream location and may account for the increase in concentration.

6.2.3 Molybdenum

Molybdenum concentrations are listed in Table 3 and are shown in Figure 11. Concentrations range from 0.080 mg/kg (0911-2 ft) to 0.390 mg/kg (0914-3 ft). The mean crustal concentration of molybdenum of 1.5 mg/kg and no sample exceeds this value.

No sample concentration is greater than the mean crustal concentration; consequently molybdenum does not appear to be a natural constituent of these soils. Background concentrations range from 0.110 mg/kg (0903-14 ft) to 0.130 mg/kg (0903-23 ft). Elevated molybdenum concentrations may be attributed to milling activity.

Concentration increases with depth at three locations, 0913, 0914, 0924, and 0926; concentrations are 3.5, 4.9, 1.3, and 1.4 times greater, respectively, in the deeper samples. In samples from locations 0913 and 0914, the shallow samples are silt and the deeper samples are bedrock samples of sandstone and shale, respectively. Molybdenum is mobile in ground water; it enters into solution easily. It can be adsorbed by amorphous ferric oxyhydroxides. It may be a natural component of the Menefee Formation and the Point Lookout Sandstone Formation. The increase seen in the pair of samples from locations 0924 and 0926 may be due to local variations in the soil.

6.2.4 Selenium

Selenium concentrations are listed in Table 4 and are shown in Figure 12. Concentrations range from less than the detection limit of 0.350 mg/kg (5 samples) to 2.77 mg/kg (0914-2 ft). The mean crustal concentration of selenium is 0.05 mg/kg. Concentrations in all samples are greater than the mean crustal value.

Concentrations of selenium in the four background samples collected at location 0903 are less than the detection limit of 0.350 mg/kg, the detection limit is greater than the crustal mean. This may indicate that background concentrations of selenium could be less than the crustal mean.

Samples from locations 0911 and 0924 have concentrations that increase with depth. The concentration in sample 0911-6 ft is 1.1 times greater than in sample 0911-2 ft and sample 0924-5 ft is 1.8 times greater than sample 0924-2 ft. The increase seen in these samples may be due to local variations in the soil.

6.2.5 Uranium

Uranium concentrations are listed in Table 3 and are shown in Figure 13. Concentrations range from 0.180 mg/kg (0903-4 ft and 0903-14 ft) to 19.5 mg/kg (0926-2 ft). Half of the samples have uranium concentrations that are greater than the mean crustal concentration of 1.80 mg/kg.

Background sample concentrations are less than the crustal mean and range from 0.180 mg/kg (0903-4 ft and 0903-14 ft) to 0.290 mg/kg (0903-23 ft). Uranium does not appear to be a natural constituent of these soils. Elevated uranium concentrations may be attributed to milling activity.

Concentrations increase with depth at locations 0911 and 0924, 2.2 and 3.2 times, respectively. These samples do not have unusual lithology. Sample 0903-23 ft has a concentration that is 1.6 times greater than that of sample 0903-14 ft. Both samples contain minor amounts of black carbonaceous shale material. Iron oxyhydroxides are the most important potential sorbents for uranium followed by organic matter. Organic matter may also reduce uranium, significantly decreasing its solubility and resulting in precipitation. Interaction with the first carbonaceous layer may have altered the redox state of uranium to induce deposition of uranium in the second, deeper carbonaceous layer resulting in a higher uranium concentration.

6.2.6 Discussion

The selenium concentrations of all samples are greater than the crustal mean concentration. Background concentrations of cadmium, lead, molybdenum, and uranium are less than the mean crustal concentrations. The higher concentrations of cadmium and lead that were seen in the mill tailings area are not seen in the raffinate ponds area.

Both samples from locations 0912, 0924, 0926, and 0927 have cadmium and uranium concentrations that are greater than the crustal mean concentrations. Both samples from locations 0914 and 0925 have cadmium concentrations that are greater than the crustal mean. The uranium concentration of sample 0914-2 ft and 0913-2 ft, and the lead concentration of 0914-3 ft are greater than the crustal mean concentrations. Cadmium concentration of samples 0903-23 ft, 0911-6 ft, and 0913-2 ft are greater than the crustal mean.

These local areas of elevated constituent concentrations suggest that mill processes influenced soil chemistry. While some samples have constituent concentrations greater than crustal mean concentrations, overall, the concentrations may not be a significant, continuing source of contamination.

6.3 Conclusions

6.3.1 Mill Tailings Area

Most samples and all background samples have cadmium concentrations that are greater than the mean crustal concentration of 0.2 mg/kg. All samples, including background samples, exceed the crustal mean selenium concentration of 0.05 mg/kg. This suggests that cadmium and selenium may be natural constituents in soils. Some of the elevated cadmium and selenium concentrations founding the subpile soils are likely related to milling activities.

Lead concentrations of seven samples are greater than the mean crustal composition of 13 mg/kg. The concentrations of background samples 0931-COL and 0930-AL are greater than the crustal mean. The presence of lead in concentrations greater than the crustal mean in background samples indicates that lead is available in the environment and that the soils are able to adsorb it. Moreover, the source of lead contamination cannot be solely attributed to uranium milling activity.

Only two samples have molybdenum concentrations that are greater than the mean crustal concentration of 1.5 mg/kg. The molybdenum concentrations of the background samples are less than the crustal mean. Five samples uranium concentrations that are greater than the mean crustal concentration of 1.80 mg/kg. Background sample concentrations are less than the mean crustal concentration. Molybdenum and uranium do not appear to be a natural constituent of these soils. Elevated molybdenum and uranium concentrations may be attributed to milling activity.

Elevated constituent concentrations in locations, such as 0917, indicate that mill processes may continue to influence soil chemistry. While concentrations of cadmium, lead, and selenium appear to be naturally greater than the crustal mean, significantly elevated constituent concentrations, such as sample 0918-5 ft, appear to be limited to small, separate areas. Likewise, elevated concentrations of molybdenum and uranium appear to be limited in area. Samples with elevated concentrations are few and separate enough to suggest that the concentrations may not be significant enough to be a continuing source of contamination.

6.3.2 Raffinate Ponds Area

The mean crustal concentration of selenium is 0.05 mg/kg. Concentrations in all samples are greater than the mean crustal value. Background samples have concentrations that are greater than the crustal mean. This may indicate that selenium is a natural component of the rocks and soil of the area.

Most samples have cadmium concentrations that are greater than the crustal mean of 0.2 mg/kg. One sample has a lead concentration that is greater than the crustal mean of 13 mg/kg. The mean crustal concentration of molybdenum is 1.5 mg/kg and no sample concentration is greater than the mean crustal concentration. Half of the samples have uranium concentrations that are greater than the mean crustal concentration of 1.80 mg/kg. Constituent concentrations in background samples are less than the mean crustal constituent concentrations. Cadmium, lead, molybdenum, and uranium do not appear to be natural constituents of these soils. The higher concentrations of cadmium and lead that were seen in the mill tailings area are not seen in the raffinate ponds area. Elevated constituent concentrations may be attributed to milling activity.

Elevated concentrations of cadmium, lead, molybdenum, and uranium suggest that mill processes influenced soil chemistry. As in the mill tailings area, high constituent concentrations are limited to small, separate areas. Overall, the concentrations may not be significant enough to be a continuing source of contamination.

7.0 References

U.S. Department of Energy (DOE), 1999, Environmental Sciences Laboratory Procedures Manual, GJO-99-124-TAR, prepared for U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado.

———, 2000. *Summary of Site Conditions and Work Plan, Durango, Colorado*, GJO-2000-155-TAR, prepared for U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, August.

Mason, B. and Moore, C.B., 1982. *Principles of Geochemistry*, Fourth Edition. New York: John Wiley & Sons.

End of current text

Table 1. Analytical Methods

| Constituent | Lab | Procedure | Description |
|-------------|-----|-----------|-------------|
| Cadmium | ACL | AS-6 R06 | ICP-MS |
| Lead | ACL | AS-6 R06 | ICP-MS |
| Molybdenum | ACL | AS-6 R06 | ICP-MS |
| Selenium | ACL | AS-5 R06 | ICP-AES |
| Uranium | ACL | AS-6 R06 | ICP-MS |

ACL = Analyses performed at the GJO ACL

ICP-AES = Inductively Coupled Plasma- Atomic Emission Spectrometry

ICP-MS = Inductively Coupled Plasma- Mass Spectrometry

Table 2. Constituent Concentrations in Durango Mill Tailings Area Soil Samples

| Sample | | Cadmium | | Lead | Molybdenum | | Selenium | | Uranium |
|------------------------------|------------|-------------|-----------------|-------------|-------------|----|-------------|----|-------------|
| Location | Depth (ft) | (mg/kg) | DQ ^c | (mg/kg) | (mg/kg) | DQ | (mg/kg) | DQ | (mg/kg) |
| 0915 | 3 | 0.14 | | 8.58 | 0.08 | U | 0.41 | B | 0.36 |
| 0915 | 5 | 0.10 | | 6.98 | 0.08 | U | 0.49 | B | 0.34 |
| 0916 | 3 | 0.25 | | 13.8 | 0.08 | U | 0.35 | U | 0.48 |
| 0916 | 5 | 0.21 | | 12.7 | 0.08 | U | 0.35 | U | 0.49 |
| 0917 | 2 | 7.20 | | 79.6 | 0.88 | B | 1.31 | | 21.8 |
| 0917 | 4 | 4.17 | | 42.5 | 2.18 | | 1.29 | | 10.7 |
| 0918 | 3 | 0.096 | B | 5.67 | 0.096 | B | 0.68 | | 0.35 |
| 0918 | 5 | 5.15 | | 6660 | 10.8 | | 2.00 | | 42.4 |
| 0919 | 2 | 0.76 | | 9.23 | 0.087 | B | 0.56 | | 6.90 |
| 0919 | 4 | 0.18 | | 7.37 | 0.08 | U | 0.47 | B | 3.24 |
| 0920 | 2 | 0.25 | | 14.7 | 0.08 | U | 0.35 | U | 0.50 |
| 0920 | 5 | 0.17 | | 6.47 | 0.08 | U | 0.92 | | 0.30 |
| 0921 | 2 | 0.22 | | 9.35 | 0.091 | B | 0.64 | | 1.72 |
| 0921 | 4 | 0.17 | | 9.10 | 0.08 | U | 0.86 | | 0.72 |
| 0922 | 2 | 0.20 | | 11.4 | 0.08 | U | 0.37 | B | 0.76 |
| 0922 | 3 | 0.28 | | 11.7 | 0.08 | U | 0.35 | U | 0.75 |
| 0930 | Al | 1.27 | | 141 | 0.50 | B | 0.60 | | 0.77 |
| 0931 | COL | 0.85 | | 13.6 | 0.66 | B | 0.88 | | 1.22 |
| 0932 | COL | 0.57 | | 6.95 | 0.13 | B | 0.72 | | 0.54 |
| Crustal Average ^a | | 0.2 | | 13 | 1.5 | | 0.05 | | 1.8 |

AL = Alluvium, surface sample; COL = Colluvium, surface sample; DQ = Data Qualifiers; B = Reported value is less than the required detection limit but greater than or equal to the actual instrument detection limit; U = Value less than the detection limit. **Bold** = Concentrations greater than the average crustal value.

^aFrom Mason and Moore 1982.

Table 3. Constituent Concentrations in Durango Raffinate Ponds Area Soil Samples

| Sample | | Cadmium | | Lead | Molybdenum | | Selenium | | Uranium |
|------------------------------|------------|-------------|-----------------|-------------|------------|----|-------------|----|-------------|
| Location | Depth (ft) | (mg/kg) | DQ ^c | (mg/kg) | (mg/kg) | DQ | (mg/kg) | DQ | (mg/kg) |
| 903 | 4 | 0.041 | B | 4.40 | 0.12 | B | 0.35 | U | 0.18 |
| 903 | 14 | 0.057 | B | 4.81 | 0.11 | B | 0.35 | U | 0.18 |
| 903 | 23 | 2.17 | | 4.50 | 0.13 | B | 0.35 | U | 0.29 |
| 903 | 28 | 0.11 | | 10.0 | 0.12 | B | 0.35 | U | 0.21 |
| 911 | 2 | 0.19 | | 8.45 | 0.08 | U | 0.35 | U | 0.41 |
| 911 | 6 | 0.38 | | 6.62 | 0.08 | U | 0.39 | B | 0.90 |
| 912 | 2 | 3.39 | | 5.21 | 0.23 | B | 1.51 | | 2.30 |
| 912 | 5 | 1.79 | | 5.96 | 0.31 | B | 1.50 | | 2.09 |
| 913 | 2 | 1.31 | | 12.6 | 0.093 | B | 1.00 | | 2.03 |
| 913 | 4 | 0.081 | B | 6.14 | 0.33 | B | 0.53 | | 0.29 |
| 914 | 2 | 13.4 | | 7.63 | 0.08 | U | 2.77 | | 15.1 |
| 914 | 3 | 0.21 | | 13.6 | 0.39 | B | 0.89 | | 0.61 |
| 924 | 2 | 0.84 | | 10.7 | 0.096 | B | 0.66 | | 2.05 |
| 924 | 5 | 2.03 | | 9.34 | 0.12 | B | 1.19 | | 6.50 |
| 925 | 2 | 0.42 | | 10.6 | 0.18 | B | 1.10 | | 1.27 |
| 925 | 5 | 0.60 | | 9.95 | 0.15 | B | 0.47 | B | 1.17 |
| 926 | 2 | 7.85 | | 5.96 | 0.11 | B | 1.22 | | 19.5 |
| 926 | 4 | 6.98 | | 7.71 | 0.16 | B | 1.16 | | 4.60 |
| 927 | 3 | 0.51 | | 6.46 | 0.08 | U | 0.59 | | 6.07 |
| 927 | 5 | 0.74 | | 7.16 | 0.08 | U | 0.52 | | 4.79 |
| Crustal Average ^a | | 0.2 | | 13 | 1.5 | | 0.05 | | 1.8 |

DQ = Data Qualifiers; B = Reported value is less than the required detection limit but greater than or equal to the actual instrument detection limit; U = Value less than the detection limit. **Bold** = Concentrations greater than the average crustal value.

^aFrom Mason and Moore 1982.

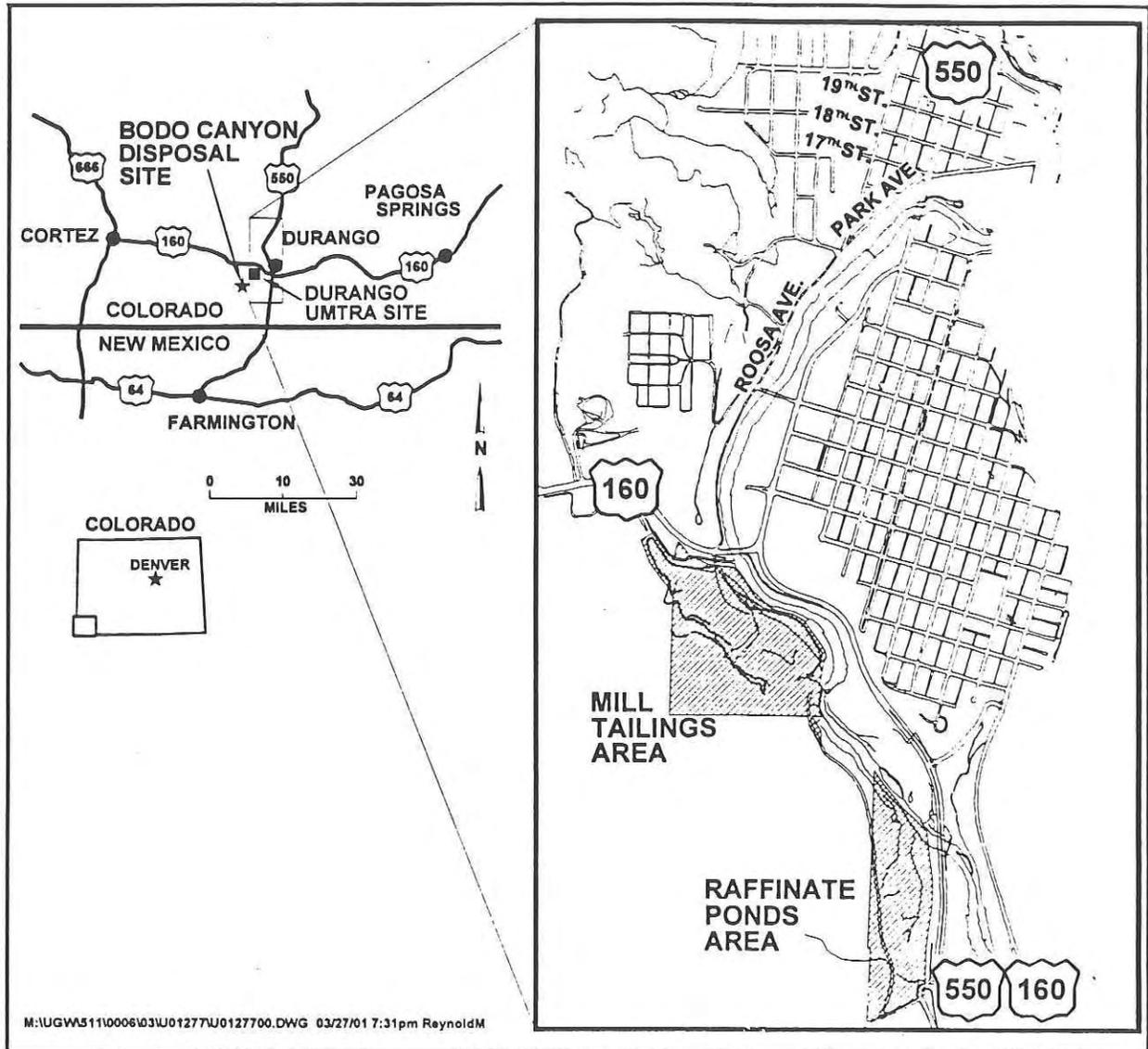
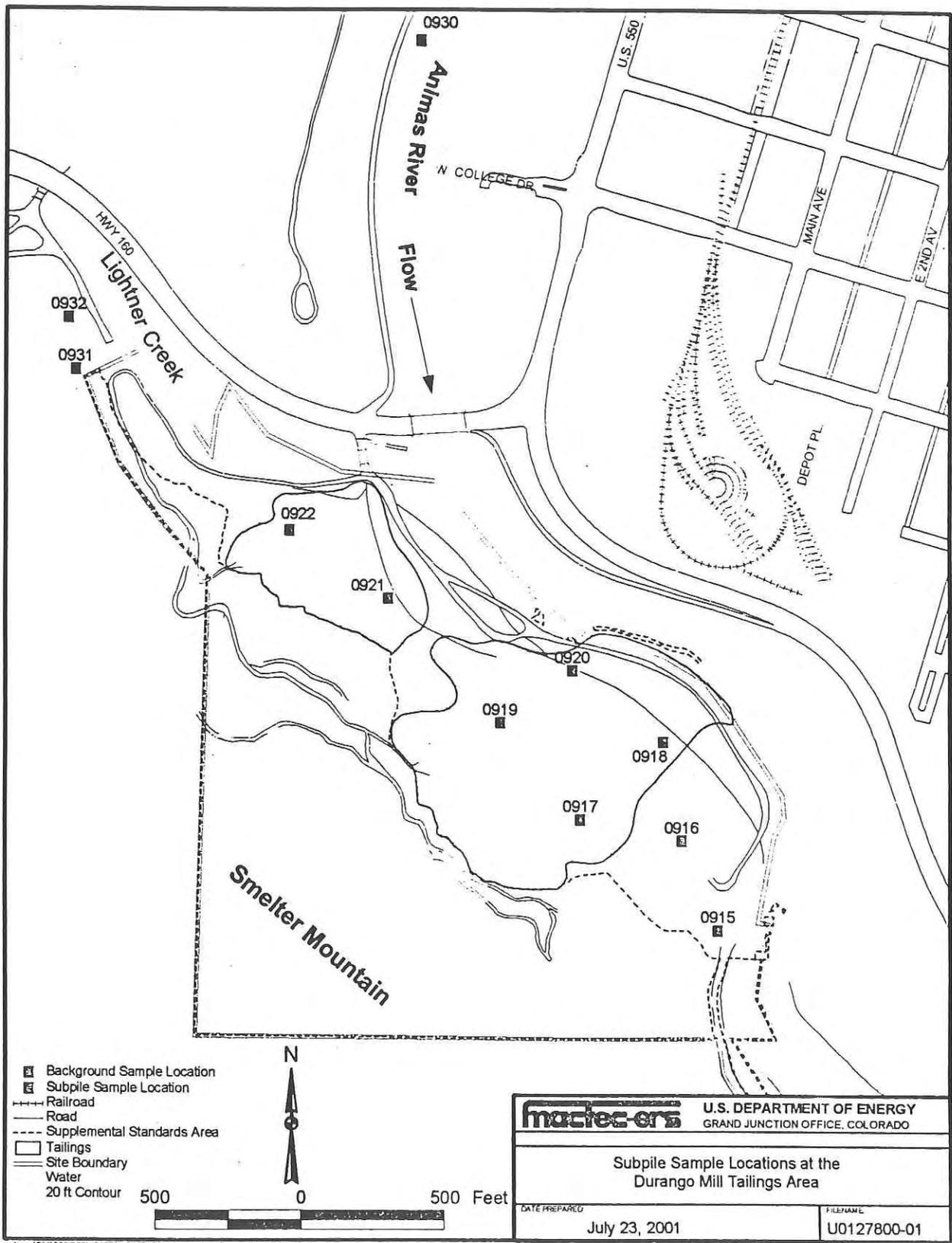
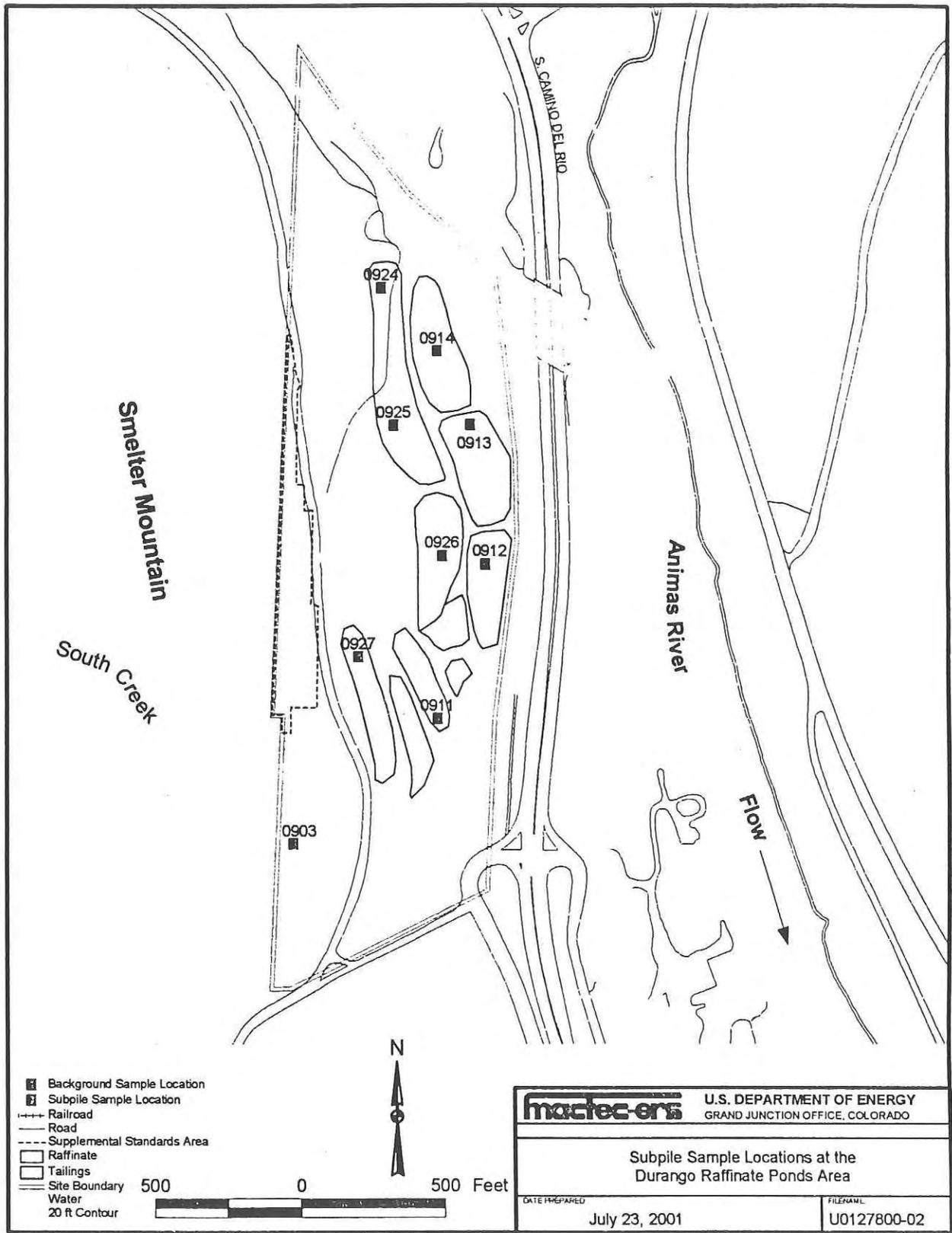


Figure 1. Regional Site Location Map



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Figure 2. Subpile Sample Locations at the Durango Mill Tailings Area



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Figure 3. Subpile Sample Locations at the Raffinate Ponds Area

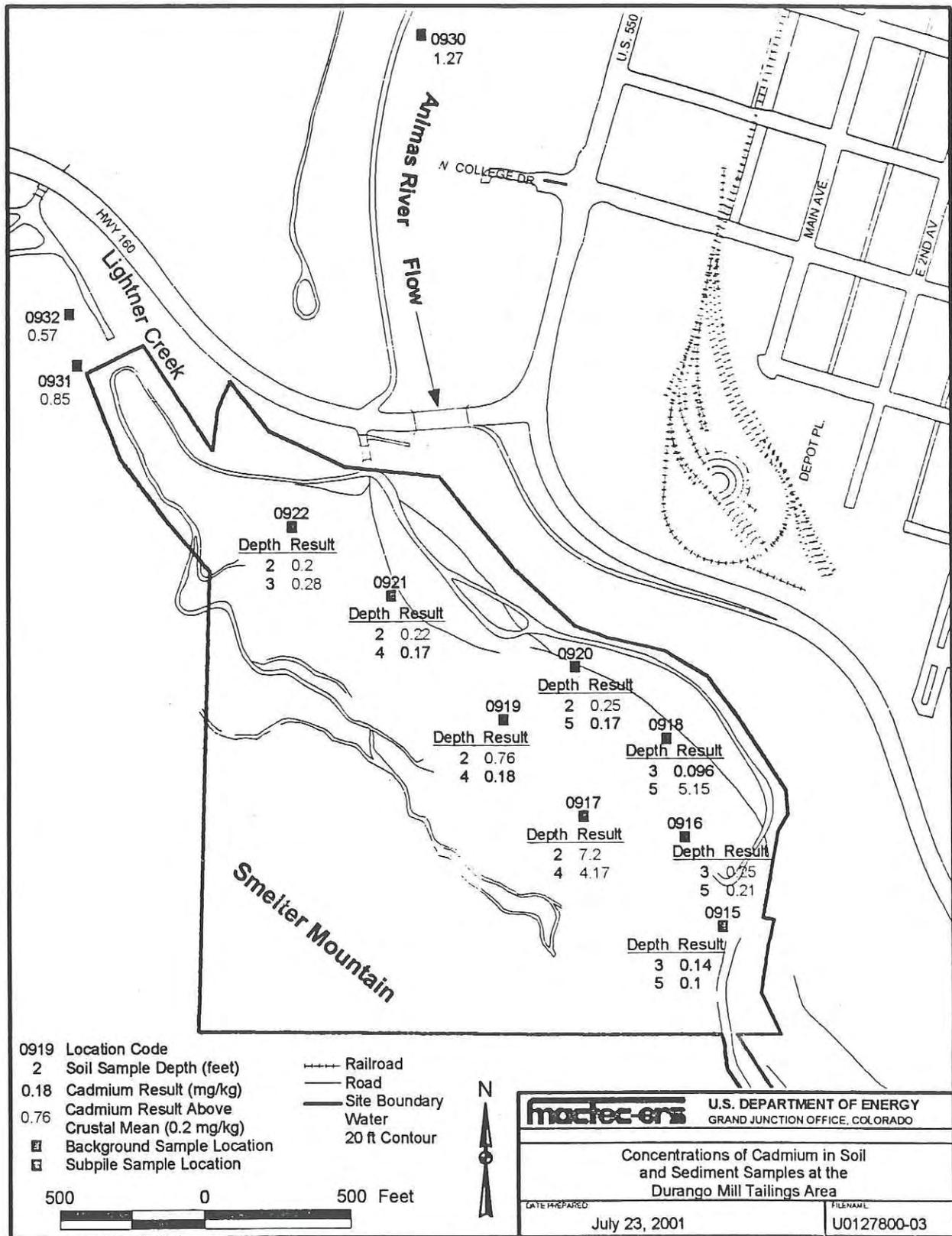
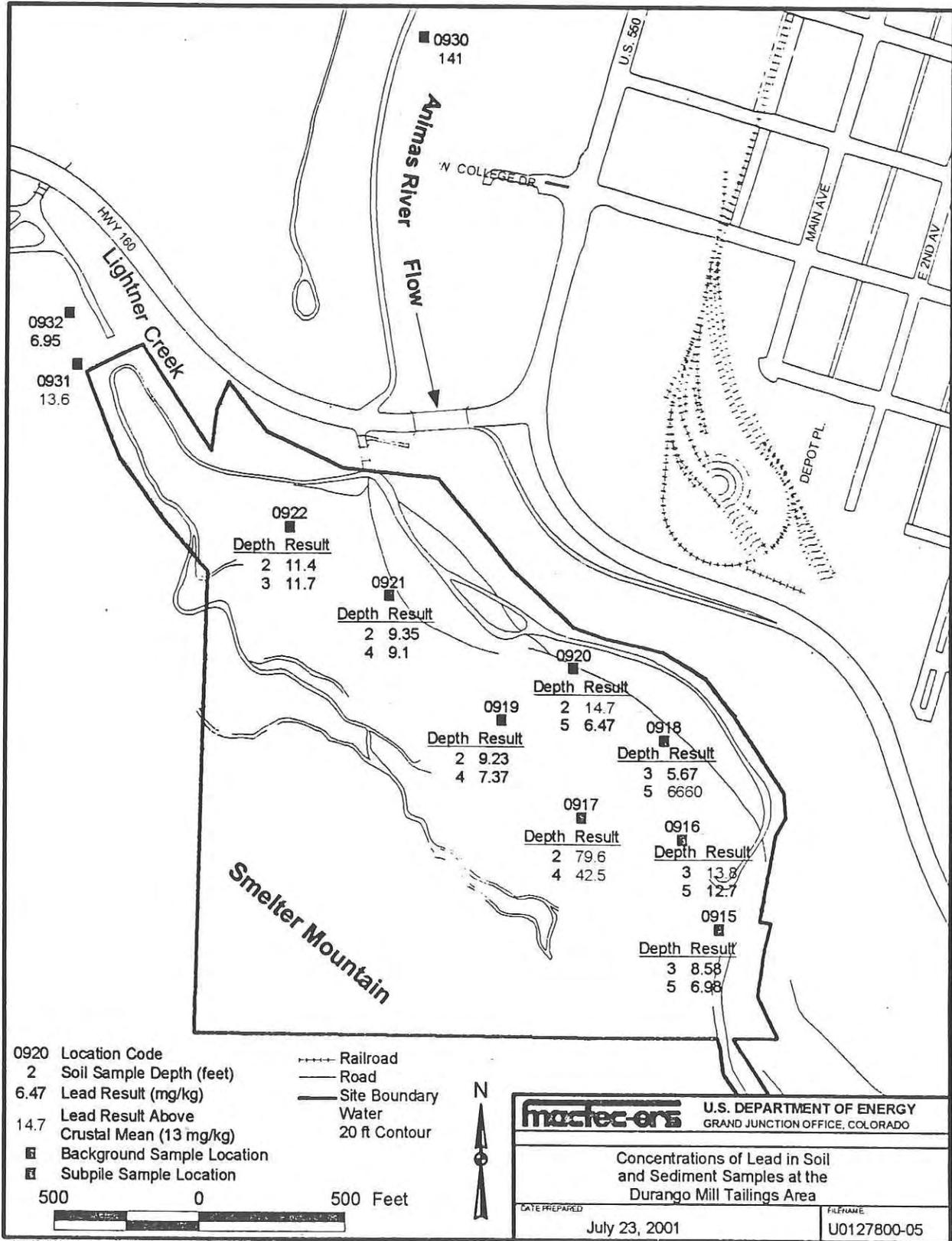
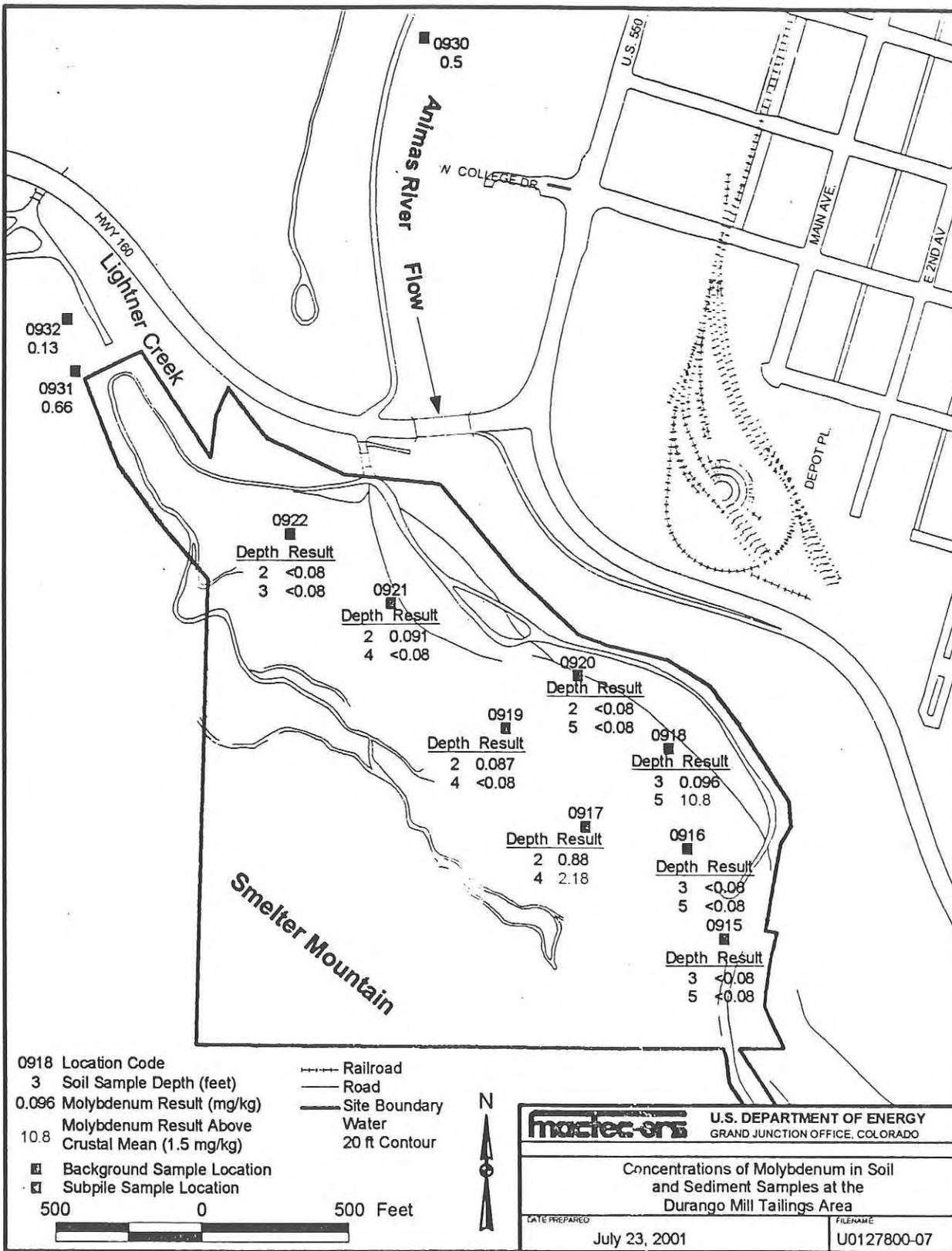


Figure 4. Concentrations of Cadmium in Soil and Sediment Samples at the Durango Mill Tailings Area



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Figure 5. Concentrations of Lead in Soil and Sediment Samples at the Durango Mill Tailings Area



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Figure 6. Concentrations of Molybdenum in Soil and Sediment Samples at the Durango Mill Tailings Area

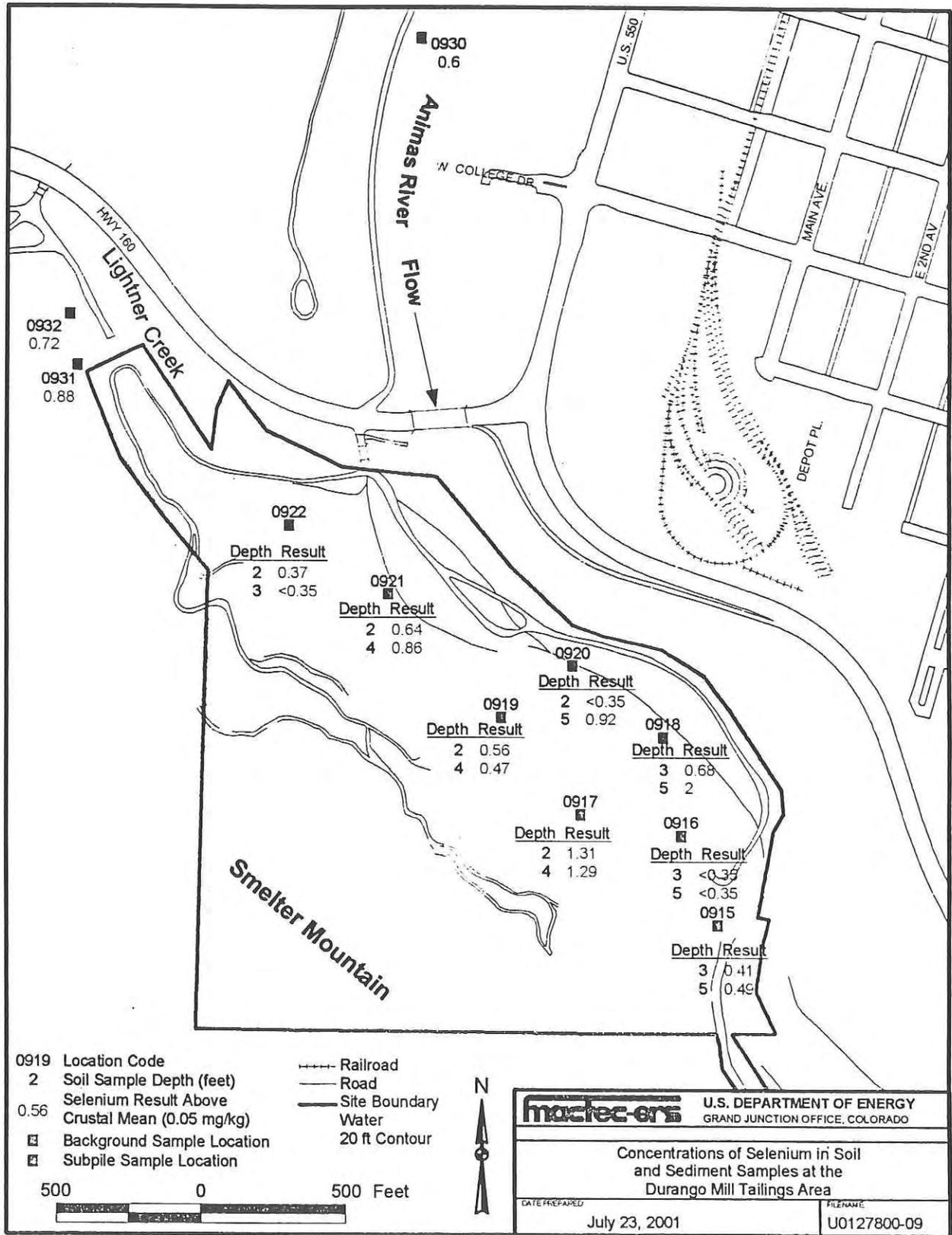


Figure 7. Concentrations of Selenium in Soil and Sediment Samples at the Durango Mill Tailings Area

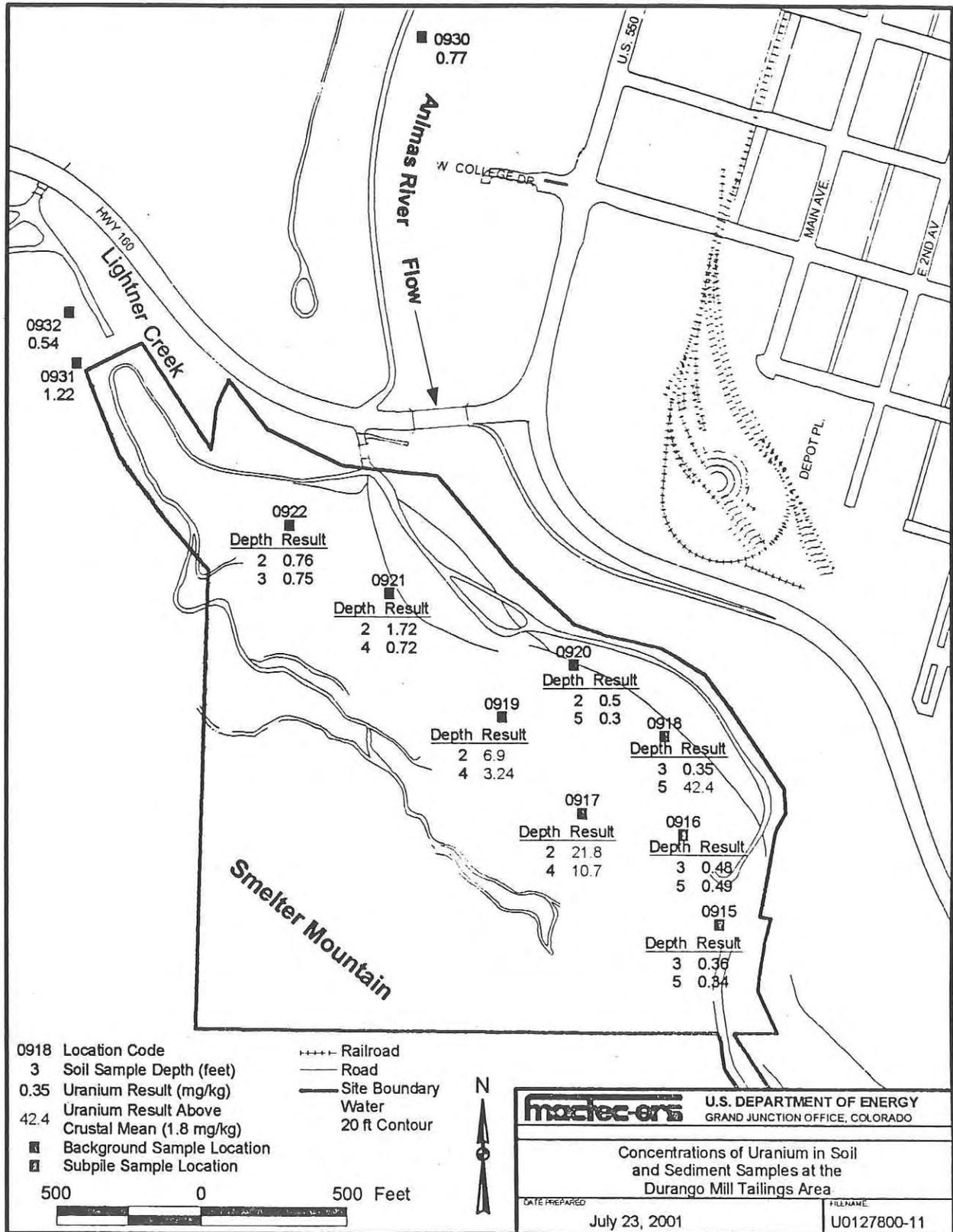
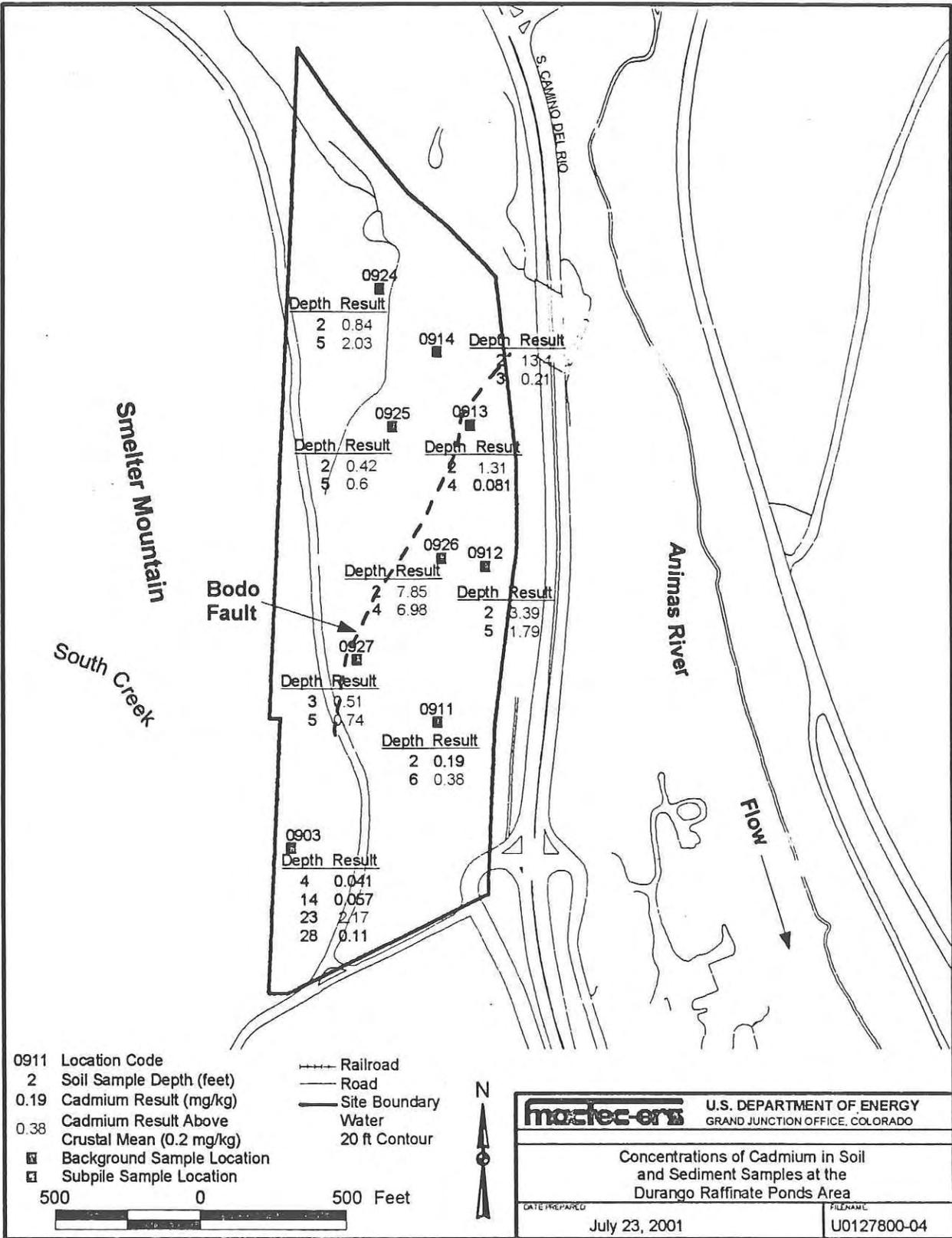
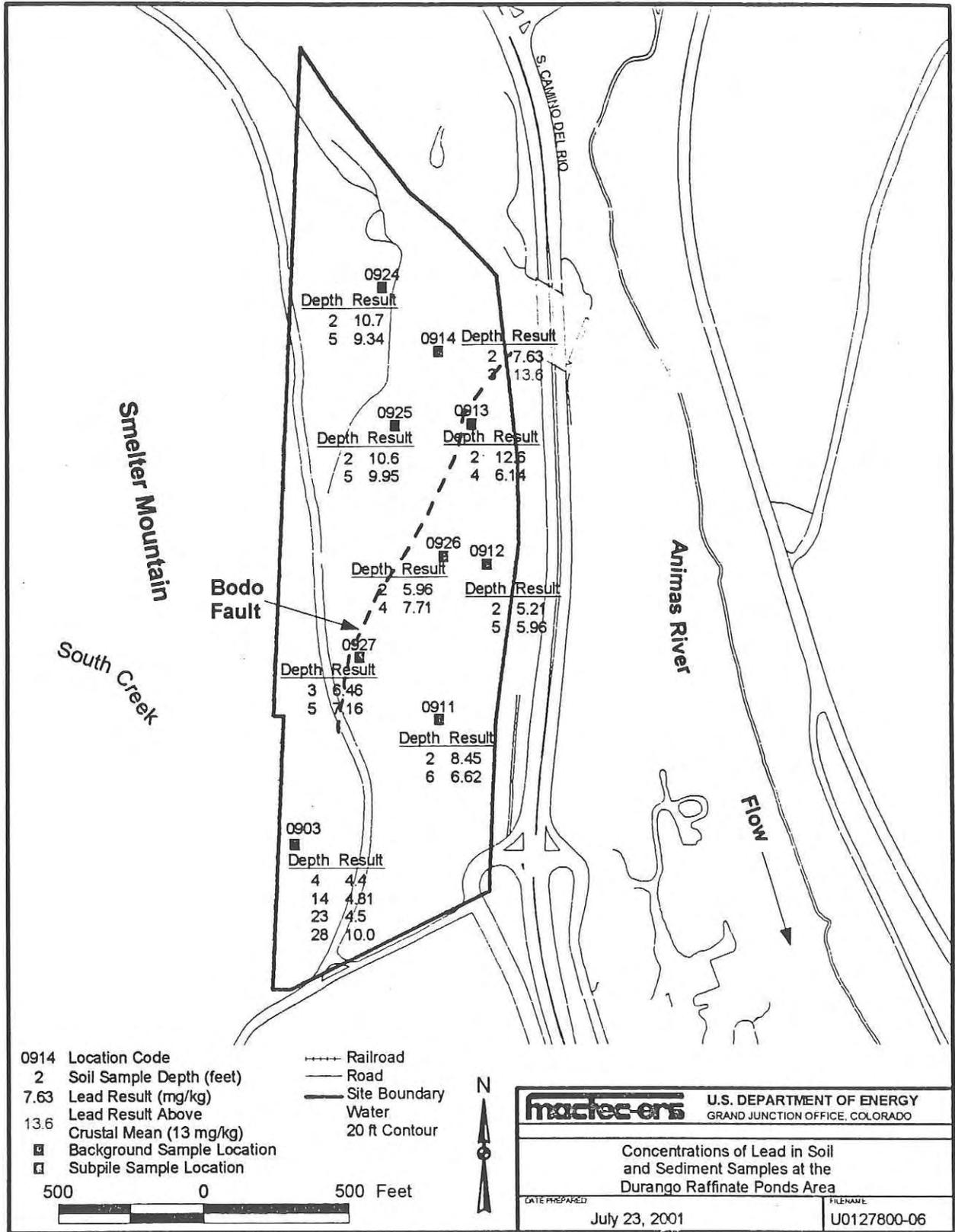


Figure 8. Concentrations of Uranium in Soil and Sediment Samples at the Durango Mill Tailings Area



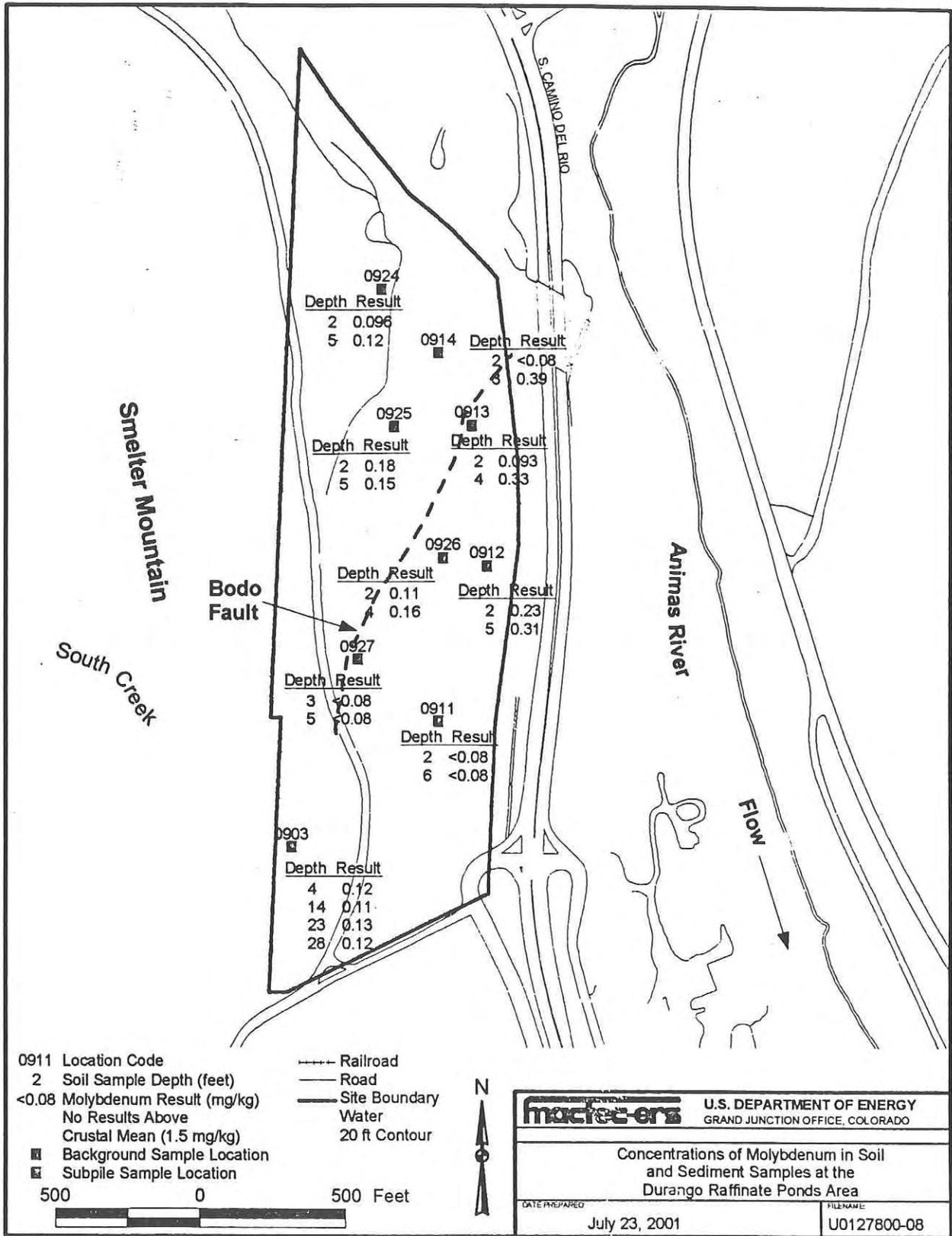
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Figure 9. Concentrations of Cadmium in Soil and Sediment Samples at the Durango Raffinate Ponds Area



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Figure 10. Concentrations of Lead in Soil and Sediment Samples at the Durango Raffinate Ponds Area



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Figure 11. Concentrations of Molybdenum in Soil and Sediment Samples at the Durango Raffinate Ponds Area

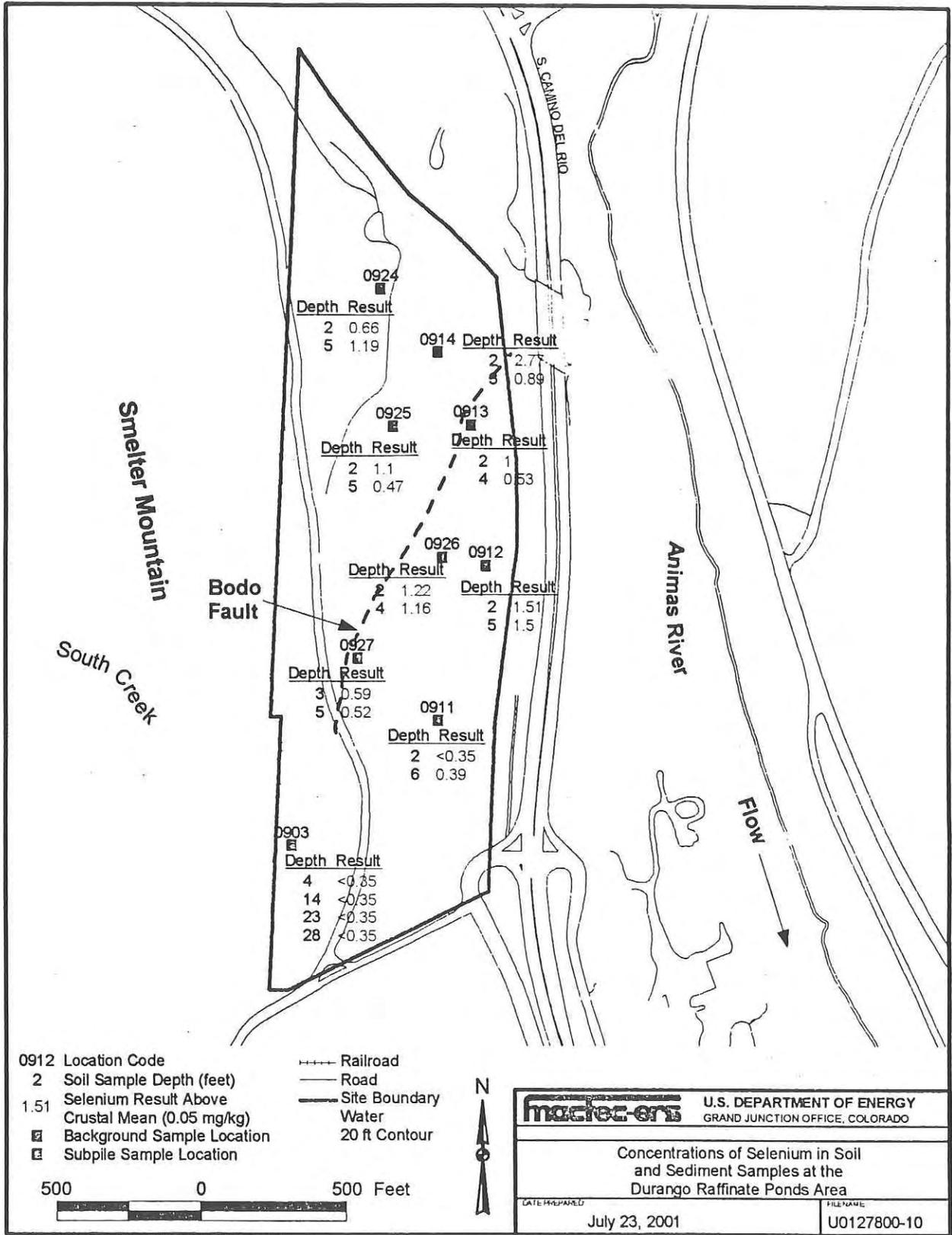
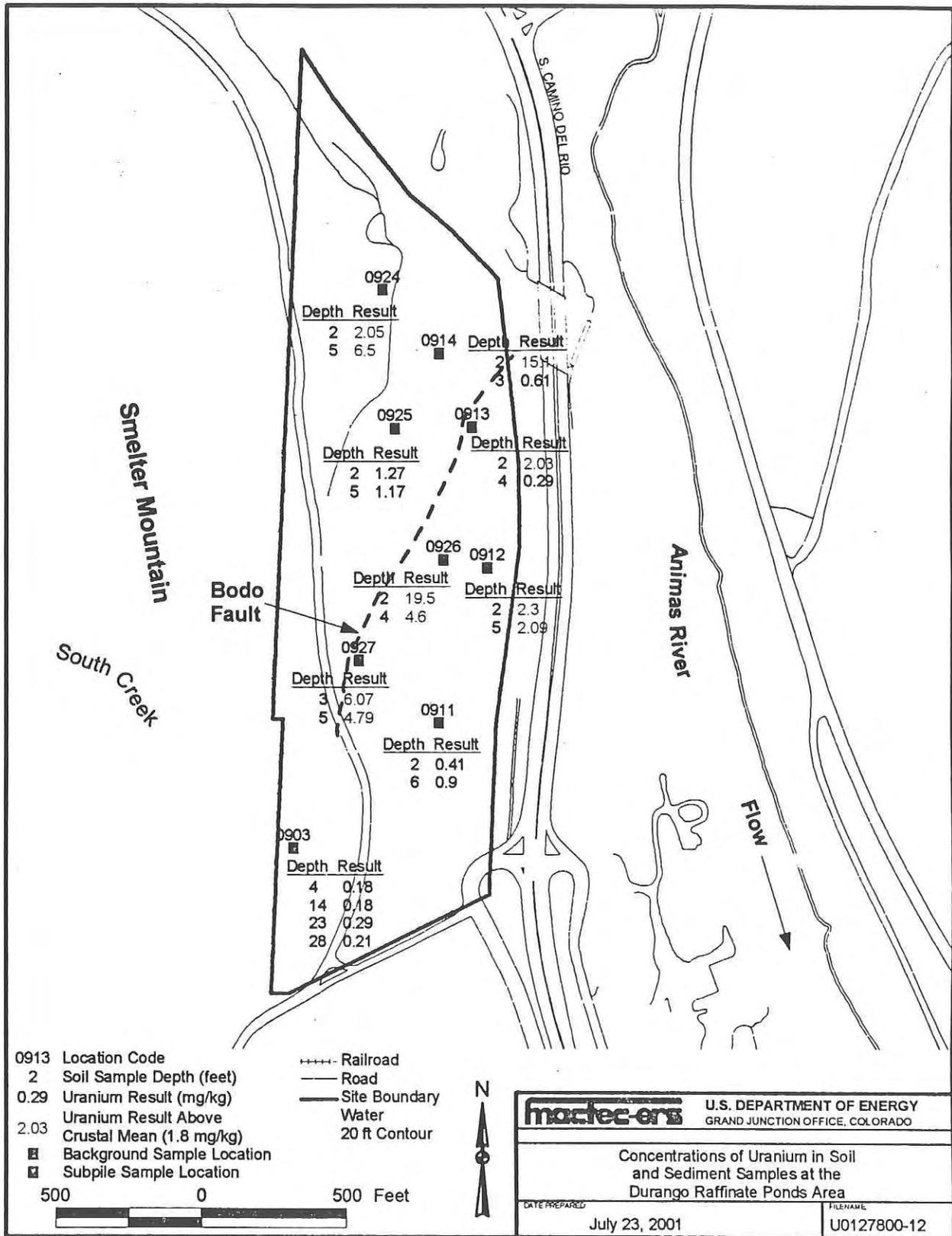


Figure 12. Concentrations of Selenium in Soil and Sediment Samples at the Durango Raffinate Ponds Area



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Figure 13. Concentrations of Uranium in Soil and Sediment Samples at the Durango Raffinate Ponds Area

Appendix A

Environmental Sciences Laboratory Work Submittal

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WORK SUBMITTAL TO ENVIRONMENTAL SCIENCES LABORATORY

Submittal Date 12/18/00

Date Required _____

Submitted By Dezhaun TSO

Signature Dezhaun TSO for Dave Miller

Formal Report Required (check one)? Yes No _____

Project: Durango - Field Invest.

Charge No. 351415002

Analysis Type (check one): Kd _____

Leaching

Other _____

Sample Numbers see attached

NDL 556 to NDL 600

Analytes U, Mo, Se, Cd, Pb

Solution Composition 5% HNO₃

Comments (attach procedure if needed)

4 Blanks (MilliQ H₂O)

2 Process Blanks (5% HNO₃)

} no solids

delete sequential leaching 12/00 Leach only with 5% HNO₃

Tracking (ESL use only):

Actual Labor Hours (ESL use only):

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Appendix B

Environmental Sciences Laboratory Notes and Field Notes

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DUR02-01-01

Durango Subpile samples

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|----------|----|--|---|---|---|---|---|---|---|----|----|----|----|
| 11/22/00 | 1 | Subpile soil sample received from David Miller at ESL. | | | | | | | | | | | |
| | 2 | Of the 39 subpile samples received, 2 are consolidated/coherent bedrock samp. | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | |
| | 4 | All samples set out to air dry. When dry they will be separated | | | | | | | | | | | |
| | 5 | into >2mm and <2mm size fractions by passing samples through | | | | | | | | | | | |
| | 6 | a 10mesh (2mm) sieve. The <2mm fraction will be used for | | | | | | | | | | | |
| | 7 | at or analytical processing. | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | |
| | 9 | Sample DUR01-930-AZ (alluvium) was collected for both Kd and | | | | | | | | | | | |
| | 10 | subpile analyses. | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | |
| 1/18/01 | 12 | Subpile samples at or processing completed. Processing followed the | | | | | | | | | | | |
| | 13 | ESL procedure CB(BT-1) "Standard Batch Leaching" | | | | | | | | | | | |
| | 14 | ① weighed 1g ± 5mg portion of solid into a 50ml centrifuge tube | | | | | | | | | | | |
| | 15 | weighed a second 1g ± 5mg into a second 50ml c-tube. | | | | | | | | | | | |
| | 16 | ② added 50ml 5% HNO ₃ to each tube | | | | | | | | | | | |
| | 17 | ③ agitated end-over-end for 4 hours | | | | | | | | | | | |
| | 18 | ④ removed tubes from shaker + centrifuged ~30min @ 3000rpm | | | | | | | | | | | |
| | 19 | ⑤ poured off supernatant from both tubes into 200ml volumetric flask | | | | | | | | | | | |
| | 20 | ⑥ added 50ml 5% or 50ml 5% HNO ₃ to the residue in each tube | | | | | | | | | | | |
| | 21 | ⑦ shake for ~30 min | | | | | | | | | | | |
| | 22 | ⑧ centrifuged for ~30 min @ ~3000rpm | | | | | | | | | | | |
| | 23 | ⑨ poured off supernatant into 200ml volumetric flask | | | | | | | | | | | |
| | 24 | ⑩ added 5% HNO ₃ to volumetric flask (if necessary) & fill to volume | | | | | | | | | | | |
| | 25 | ⑪ filtered solution 200ml solution through 0.45um filter or | | | | | | | | | | | |
| | 26 | ⑫ submitted to analytical laboratory for analyses of Cd, Mo, Pb, Se, U | | | | | | | | | | | |
| | 27 | | | | | | | | | | | | |
| | 28 | | | | | | | | | | | | |
| | 29 | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | |
| | 31 | | | | | | | | | | | | |

DUR02-01-01

DUR02-01-02

Durango subpile samples, cont

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---------------|----|---|-------|------------|------------------------------|---|---|---|---|----|----|----|----|
| 1/18/01, cont | 1 | During processing, the following samples reacted to the addition of 5% HNO ₃ . They bubbled indicating the presence of CaCO ₃ in the solid samples | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | |
| | 4 | (craynote point = 02) | DUR02 | 912-5 |] bubbled for over 5 minutes | | | | | | | | |
| | 5 | | DUR02 | 912-2 | | | | | | | | | |
| | 6 | | DUR02 | 913-2 | | | | | | | | | |
| | 7 | | DUR02 | 914-2 | | | | | | | | | |
| | 8 | (missile = 01) | DUR01 | 917-2 | | | | | | | | | |
| | 9 | | DUR01 | 921-2 | | | | | | | | | |
| | 10 | | DUR01 | 921-4 | | | | | | | | | |
| | 11 | | DUR02 | 924-2 |] bubbled for over 5 minutes | | | | | | | | |
| | 12 | | DUR02 | 924-5 | | | | | | | | | |
| | 13 | | DUR02 | 926-2 | | | | | | | | | |
| | 14 | | DUR02 | 926-4 | bubbled longer than 926-2 | | | | | | | | |
| | 15 | | DUR01 | 931-colluv | | | | | | | | | |
| | 16 | | DUR01 | 932-colluv | | | | | | | | | |
| | 17 | | | | | | | | | | | | |
| | 18 | | | | | | | | | | | | |
| | 19 | → Before they could be processed samples DUR02-913-3.5 & DUR02-914-3 were sent to sample prep for crushing. They were coherent/cohesive bedrock samples on 01/9/01. They were processed & submitted with the remaining subpile samples. Submittal date: 01/18/01. | | | | | | | | | | | |
| | 20 | | | | | | | | | | | | |
| | 21 | | | | | | | | | | | | |
| | 22 | | | | | | | | | | | | |
| | 23 | | | | | | | | | | | | |
| | 24 | | | | | | | | | | | | |
| | 25 | | | | | | | | | | | | |
| | 26 | | | | | | | | | | | | |
| | 27 | | | | | | | | | | | | |
| | 28 | | | | | | | | | | | | |
| | 29 | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | |
| | 31 | | | | | | | | | | | | |

Durango subpile samples

| Loc. | depth (ft) | comment | sample lithology (fr. C. Goodknight) | description |
|--|------------|------------|--------------------------------------|--|
| DUR01 = Durango Millsite | | | | |
| 915 | 3 | | silt | soil material brought in w/ hard angular PLS Fm frag |
| 915 | 5 | | rock frag & slag | colluvial material |
| 916 | 3 | | silt | soil material brought in |
| 916 | 5 | | silt & rock frag. | colluvial material |
| 917 | 2 | | silt | soil material brought in |
| 917 | 4-5 | | silt & rock frag. | colluvial material- PLS Fm rock frag |
| 918 | 3 | | silt | soil material brought in |
| 918 | 5 | | silt, rock frag & slag | colluvial material, rock frag & slag |
| 919 | 2 | | silt & rock frag. | colluvial material |
| 919 | 4 | | rock frag | colluvial material, rock frag derived from PLS Fm |
| 920 | 2 | | silt | soil material brought in for final grade |
| 920 | 5 | | silt & rock frag | colluvial material |
| 921 | 2 | | silt | soil material brought in for final grade |
| 921 | 4 | | silt & rock frag | colluvial material |
| 922 | 2 | | silt | soil material brought in for final grade |
| 922 | 3-4 | | silt & rock frag | colluvial material |
| 930 | AL | | alluvium | |
| 931 | COL | background | colluvium | mixture of siltstone & shale fro PLS Fm & Mancos Shale |
| 932 | COL | background | colluvium | mixture of siltstone & shale fro PLS Fm & Mancos Shale |
| DUR02 = Durango Raffinate Ponds | | | | |
| 903 | 14-16 | background | colluvium | silty sand, clasts of ss & black carbonaceous shale |
| 903 | 23-26 | background | colluvium | silty sand, clasts of ss & black carbonaceous shale |
| 903 | 28-29 | background | terrace alluvium | gravel & med sand |
| 903 | 4-6 | background | terrace alluvium | gravel & med sand |
| 911 | 2 | | silt fill | soil material brought in for final grade |
| 911 | 6 | | gravelly sand | fill and colluvial material |
| 912 | 2 | | silt fill | soil material brought in for final grade |
| 912 | 5 | | silty gravel | fill and colluvial material |
| 913 | 2 | | silt fill | soil material brought in for final grade |
| 913 | 3.5 | bedrock | sandstone core | Menefee Fm: sandstn unweathered med light gray |
| 914 | 2 | | silt fill | soil material brought in for final grade |
| 914 | 3 | bedrock | shale | weathered shale and siltstone from PLS Fm |
| 924 | 2 | | silt fill | soil material brought in for final grade |
| 924 | 5-6 | | weathered shale | weathered shale and siltstone from PLS Fm |
| 925 | 2 | | silt fill | soil material brought in for final grade |
| 925 | 5 | | weathered shale | weathered shale and siltstone from PLS Fm |
| 926 | 2 | | silt fill | soil material brought in for final grade |
| 926 | 4 | | silty gravel | fill and colluvial material |
| 927 | 3 | | silty sand | soil material as fill for final grade |
| 927 | 5-6 | | sandy gravel | fill |

Notes:

Sample name is combination of area, location, and depth. For example, DUR02-903-14 is the sample collected from the Raffinate Ponds area, at location 903, beginning at at depth of 14 ft. This is abbreviated to 903-14 ft when discussing only the Raffinate Ponds area.

background = background sample

bedrock = sample collected was consolidated rock, was mechanically crushed in order to perform analyses

Appendix C

**Electronic Data Deliverable for Inclusion in the
SEEP Pro Database**

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Durango Raffinate Ponds Area: November 2000 Soil Sample Results

Requisition number: 17272

| Lab Number | ID | Ticket Number | Date Received | Analyte Name | Analyte Alias | Result (mg/kg) | UNITS | Lab Qualifiers | Date Analyzed | Analysis Method | Sample start-end Depth (ft) | Sampling Method | Lithology | Sample Comments | ESL Preparation Method | Result Comments |
|------------|--------------|---------------|---------------|--------------|---------------|----------------|-------|----------------|---------------|-----------------|-----------------------------|-----------------|--------------------|-----------------|------------------------|-----------------|
| 272672 | DUR02-903-4 | NDL556 | 11/22/00 | Cadmium | 7440-43-9 | 0.041 | MG/KG | B | 1/24/01 | AS-6 R06 | 4-6 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272672 | DUR02-903-4 | NDL556 | 11/22/00 | Lead | 7439-92-1 | 4.4 | MG/KG | | 1/24/01 | AS-6 R06 | 4-6 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272672 | DUR02-903-4 | NDL556 | 11/22/00 | Molybdenum | 7439-98-7 | 0.12 | MG/KG | B | 1/24/01 | AS-6 R06 | 4-6 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272672 | DUR02-903-4 | NDL556 | 11/22/00 | Selenium | 7782-49-2 | 0.35 | MG/KG | U | 2/2/01 | AS-5 R06 | 4-6 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272672 | DUR02-903-4 | NDL556 | 11/22/00 | Uranium | 7440-61-1 | 0.18 | MG/KG | | 1/24/01 | AS-6 R06 | 4-6 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272673 | DUR02-903-14 | NDL557 | 11/22/00 | Cadmium | 7440-43-9 | 0.057 | MG/KG | B | 1/24/01 | AS-6 R06 | 14-16 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272673 | DUR02-903-14 | NDL557 | 11/22/00 | Lead | 7439-92-1 | 4.81 | MG/KG | | 1/24/01 | AS-6 R06 | 14-16 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272673 | DUR02-903-14 | NDL557 | 11/22/00 | Molybdenum | 7439-98-7 | 0.11 | MG/KG | B | 1/24/01 | AS-6 R06 | 14-16 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272673 | DUR02-903-14 | NDL557 | 11/22/00 | Selenium | 7782-49-2 | 0.35 | MG/KG | U | 2/2/01 | AS-5 R06 | 14-16 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272673 | DUR02-903-14 | NDL557 | 11/22/00 | Uranium | 7440-61-1 | 0.18 | MG/KG | | 1/24/01 | AS-6 R06 | 14-16 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272674 | DUR02-903-23 | NDL558 | 11/22/00 | Cadmium | 7440-43-9 | 2.17 | MG/KG | | 1/24/01 | AS-6 R06 | 23-26 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272674 | DUR02-903-23 | NDL558 | 11/22/00 | Lead | 7439-92-1 | 4.5 | MG/KG | | 1/24/01 | AS-6 R06 | 23-26 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272674 | DUR02-903-23 | NDL558 | 11/22/00 | Molybdenum | 7439-98-7 | 0.13 | MG/KG | B | 1/24/01 | AS-6 R06 | 23-26 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272674 | DUR02-903-23 | NDL558 | 11/22/00 | Selenium | 7782-49-2 | 0.35 | MG/KG | U | 2/2/01 | AS-5 R06 | 23-26 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272674 | DUR02-903-23 | NDL558 | 11/22/00 | Uranium | 7440-61-1 | 0.29 | MG/KG | | 1/24/01 | AS-6 R06 | 23-26 | GB | Colluvium | Background | CB (BT-1) | 5% HNO3 |
| 272675 | DUR02-903-28 | NDL559 | 11/22/00 | Cadmium | 7440-43-9 | 0.11 | MG/KG | | 1/24/01 | AS-6 R06 | 28-29 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272675 | DUR02-903-28 | NDL559 | 11/22/00 | Lead | 7439-92-1 | 10 | MG/KG | | 1/24/01 | AS-6 R06 | 28-29 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272675 | DUR02-903-28 | NDL559 | 11/22/00 | Molybdenum | 7439-98-7 | 0.12 | MG/KG | B | 1/24/01 | AS-6 R06 | 28-29 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272675 | DUR02-903-28 | NDL559 | 11/22/00 | Selenium | 7782-49-2 | 0.35 | MG/KG | U | 2/2/01 | AS-5 R06 | 28-29 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272675 | DUR02-903-28 | NDL559 | 11/22/00 | Uranium | 7440-61-1 | 0.21 | MG/KG | | 1/24/01 | AS-6 R06 | 28-29 | GB | Terrace Alluvium | Background | CB (BT-1) | 5% HNO3 |
| 272676 | DUR02-911-2 | NDL560 | 11/22/00 | Cadmium | 7440-43-9 | 0.19 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272676 | DUR02-911-2 | NDL560 | 11/22/00 | Lead | 7439-92-1 | 8.45 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272676 | DUR02-911-2 | NDL560 | 11/22/00 | Molybdenum | 7439-98-7 | 0.08 | MG/KG | U | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272676 | DUR02-911-2 | NDL560 | 11/22/00 | Selenium | 7782-49-2 | 0.35 | MG/KG | U | 2/2/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272676 | DUR02-911-2 | NDL560 | 11/22/00 | Uranium | 7440-61-1 | 0.41 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272677 | DUR02-911-6 | NDL561 | 11/22/00 | Cadmium | 7440-43-9 | 0.38 | MG/KG | | 1/24/01 | AS-6 R06 | 6-6 | GB | Gravelly sand fill | | CB (BT-1) | 5% HNO3 |
| 272677 | DUR02-911-6 | NDL561 | 11/22/00 | Lead | 7439-92-1 | 6.62 | MG/KG | | 1/24/01 | AS-6 R06 | 6-6 | GB | Gravelly sand fill | | CB (BT-1) | 5% HNO3 |
| 272677 | DUR02-911-6 | NDL561 | 11/22/00 | Molybdenum | 7439-98-7 | 0.08 | MG/KG | U | 1/24/01 | AS-6 R06 | 6-6 | GB | Gravelly sand fill | | CB (BT-1) | 5% HNO3 |
| 272677 | DUR02-911-6 | NDL561 | 11/22/00 | Selenium | 7782-49-2 | 0.39 | MG/KG | B | 2/2/01 | AS-5 R06 | 6-6 | GB | Gravelly sand fill | | CB (BT-1) | 5% HNO3 |
| 272677 | DUR02-911-6 | NDL561 | 11/22/00 | Uranium | 7440-61-1 | 0.9 | MG/KG | | 1/24/01 | AS-6 R06 | 6-6 | GB | Gravelly sand fill | | CB (BT-1) | 5% HNO3 |
| 272678 | DUR02-912-2 | NDL562 | 11/22/00 | Cadmium | 7440-43-9 | 3.39 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272678 | DUR02-912-2 | NDL562 | 11/22/00 | Lead | 7439-92-1 | 5.21 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272678 | DUR02-912-2 | NDL562 | 11/22/00 | Molybdenum | 7439-98-7 | 0.23 | MG/KG | B | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272678 | DUR02-912-2 | NDL562 | 11/22/00 | Selenium | 7782-49-2 | 1.51 | MG/KG | | 2/2/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272678 | DUR02-912-2 | NDL562 | 11/22/00 | Uranium | 7440-61-1 | 2.3 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272679 | DUR02-912-5 | NDL563 | 11/22/00 | Cadmium | 7440-43-9 | 1.79 | MG/KG | | 1/24/01 | AS-6 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272679 | DUR02-912-5 | NDL563 | 11/22/00 | Lead | 7439-92-1 | 5.96 | MG/KG | | 1/24/01 | AS-6 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272679 | DUR02-912-5 | NDL563 | 11/22/00 | Molybdenum | 7439-98-7 | 0.31 | MG/KG | B | 1/24/01 | AS-6 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272679 | DUR02-912-5 | NDL563 | 11/22/00 | Selenium | 7782-49-2 | 1.5 | MG/KG | | 2/2/01 | AS-5 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272679 | DUR02-912-5 | NDL563 | 11/22/00 | Uranium | 7440-61-1 | 2.09 | MG/KG | | 1/24/01 | AS-6 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272680 | DUR02-913-2 | NDL564 | 11/22/00 | Cadmium | 7440-43-9 | 1.31 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |

Durango Raffinate Ponds Area: November 2000 Soil Sample Results
 Requisition number: 17272

| Lab Number | ID | Ticket Number | Date Received | Analyte Name | Analyte Alias | Result (mg/kg) | UNITS | Lab Qualifiers | Date Analyzed | Analysis Method | Sample start-end Depth (ft) | Sampling Method | Lithology | Sample Comments | ESL Preparation Method | Result Comments |
|------------|---------------|---------------|---------------|--------------|---------------|----------------|-------|----------------|---------------|-----------------|-----------------------------|-----------------|-----------------------------------|-----------------------|------------------------|-----------------|
| 272680 | DUR02-913-2 | NDL564 | 11/22/00 | Lead | 7439-92-1 | 12.6 | MG/KG | | 1/24/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272680 | DUR02-913-2 | NDL564 | 11/22/00 | Molybdenu | 7439-98-7 | 0.093 | MG/KG | B | 1/24/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272680 | DUR02-913-2 | NDL564 | 11/22/00 | Selenium | 7782-49-2 | 1.00 | MG/KG | | 2/2/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272680 | DUR02-913-2 | NDL564 | 11/22/00 | Uranium | 7440-61-1 | 2.03 | MG/KG | | 1/24/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272681 | DUR02-913-3.5 | NDL565 | 11/22/00 | Cadmium | 7440-43-9 | 0.081 | MG/KG | B | 1/24/01 | AS-6 R06 | 4-4 | GB | Menefee Formation | Unweathered sandstone | CB (BT-1) | 5% HNO3 |
| 272681 | DUR02-913-3.5 | NDL565 | 11/22/00 | Lead | 7439-92-1 | 6.14 | MG/KG | | 1/24/01 | AS-6 R06 | 4-4 | GB | Menefee Formation | Unweathered sandstone | CB (BT-1) | 5% HNO3 |
| 272681 | DUR02-913-3.5 | NDL565 | 11/22/00 | Molybdenu | 7439-98-7 | 0.33 | MG/KG | B | 1/24/01 | AS-5 R06 | 4-4 | GB | Menefee Formation | Unweathered sandstone | CB (BT-1) | 5% HNO3 |
| 272681 | DUR02-913-3.5 | NDL565 | 11/22/00 | Selenium | 7782-49-2 | 0.53 | MG/KG | | 2/2/01 | AS-5 R06 | 4-4 | GB | Menefee Formation | Unweathered sandstone | CB (BT-1) | 5% HNO3 |
| 272681 | DUR02-913-3.5 | NDL565 | 11/22/00 | Uranium | 7440-61-1 | 0.29 | MG/KG | | 1/24/01 | AS-6 R06 | 4-4 | GB | Menefee Formation | Unweathered sandstone | CB (BT-1) | 5% HNO3 |
| 272682 | DUR02-914-2 | NDL566 | 11/22/00 | Cadmium | 7440-43-9 | 13.4 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272682 | DUR02-914-2 | NDL566 | 11/22/00 | Lead | 7439-92-1 | 7.63 | MG/KG | | 1/24/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272682 | DUR02-914-2 | NDL566 | 11/22/00 | Molybdenu | 7439-98-7 | 0.08 | MG/KG | U | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272682 | DUR02-914-2 | NDL566 | 11/22/00 | Selenium | 7782-49-2 | 2.77 | MG/KG | | 2/2/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272682 | DUR02-914-2 | NDL566 | 11/22/00 | Uranium | 7440-61-1 | 15.1 | MG/KG | | 1/24/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272683 | DUR02-914-3 | NDL567 | 11/22/00 | Cadmium | 7440-43-9 | 0.21 | MG/KG | | 1/24/01 | AS-6 R06 | 3-3 | GB | Point Lookout Sandstone Formation | Weathered shale | CB (BT-1) | 5% HNO3 |
| 272683 | DUR02-914-3 | NDL567 | 11/22/00 | Lead | 7439-92-1 | 13.6 | MG/KG | | 1/24/01 | AS-6 R06 | 3-3 | GB | Point Lookout Sandstone Formation | Weathered shale | CB (BT-1) | 5% HNO3 |
| 272683 | DUR02-914-3 | NDL567 | 11/22/00 | Molybdenu | 7439-98-7 | 0.39 | MG/KG | B | 1/24/01 | AS-6 R06 | 3-3 | GB | Point Lookout Sandstone Formation | Weathered shale | CB (BT-1) | 5% HNO3 |
| 272683 | DUR02-914-3 | NDL567 | 11/22/00 | Selenium | 7782-49-2 | 0.89 | MG/KG | | 2/2/01 | AS-5 R06 | 3-3 | GB | Point Lookout Sandstone Formation | Weathered shale | CB (BT-1) | 5% HNO3 |
| 272683 | DUR02-914-3 | NDL567 | 11/22/00 | Uranium | 7440-61-1 | 0.61 | MG/KG | | 1/24/01 | AS-6 R06 | 3-3 | GB | Point Lookout Sandstone Formation | Weathered shale | CB (BT-1) | 5% HNO3 |
| 272700 | DUR02-924-2 | NDL584 | 11/22/00 | Cadmium | 7440-43-9 | 0.84 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272700 | DUR02-924-2 | NDL584 | 11/22/00 | Lead | 7439-92-1 | 10.7 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272700 | DUR02-924-2 | NDL584 | 11/22/00 | Molybdenu | 7439-98-7 | 0.096 | MG/KG | B | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272700 | DUR02-924-2 | NDL584 | 11/22/00 | Selenium | 7782-49-2 | 0.66 | MG/KG | | 2/2/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272700 | DUR02-924-2 | NDL584 | 11/22/00 | Uranium | 7440-61-1 | 2.05 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272701 | DUR02-924-5 | NDL585 | 11/22/00 | Cadmium | 7440-43-9 | 2.03 | MG/KG | | 1/24/01 | AS-6 R06 | 5-6 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272701 | DUR02-924-5 | NDL585 | 11/22/00 | Lead | 7439-92-1 | 9.34 | MG/KG | | 1/24/01 | AS-6 R06 | 5-6 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272701 | DUR02-924-5 | NDL585 | 11/22/00 | Molybdenu | 7439-98-7 | 0.12 | MG/KG | B | 1/24/01 | AS-6 R06 | 5-6 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272701 | DUR02-924-5 | NDL585 | 11/22/00 | Selenium | 7782-49-2 | 1.19 | MG/KG | | 2/2/01 | AS-5 R06 | 5-6 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272701 | DUR02-924-5 | NDL585 | 11/22/00 | Uranium | 7440-61-1 | 6.5 | MG/KG | | 1/24/01 | AS-6 R06 | 5-6 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272702 | DUR02-925-2 | NDL586 | 11/22/00 | Cadmium | 7440-43-9 | 0.42 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272702 | DUR02-925-2 | NDL586 | 11/22/00 | Lead | 7439-92-1 | 10.6 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272702 | DUR02-925-2 | NDL586 | 11/22/00 | Molybdenu | 7439-98-7 | 0.18 | MG/KG | B | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272702 | DUR02-925-2 | NDL586 | 11/22/00 | Selenium | 7782-49-2 | 1.1 | MG/KG | | 2/2/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272702 | DUR02-925-2 | NDL586 | 11/22/00 | Uranium | 7440-61-1 | 1.27 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272703 | DUR02-925-5 | NDL587 | 11/22/00 | Cadmium | 7440-43-9 | 0.60 | MG/KG | | 1/24/01 | AS-6 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272703 | DUR02-925-5 | NDL587 | 11/22/00 | Lead | 7439-92-1 | 9.95 | MG/KG | | 1/24/01 | AS-6 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272703 | DUR02-925-5 | NDL587 | 11/22/00 | Molybdenu | 7439-98-7 | 0.15 | MG/KG | B | 1/24/01 | AS-6 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272703 | DUR02-925-5 | NDL587 | 11/22/00 | Selenium | 7782-49-2 | 0.47 | MG/KG | B | 2/2/01 | AS-5 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272703 | DUR02-925-5 | NDL587 | 11/22/00 | Uranium | 7440-61-1 | 1.17 | MG/KG | | 1/24/01 | AS-6 R06 | 5-5 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272704 | DUR02-926-2 | NDL588 | 11/22/00 | Cadmium | 7440-43-9 | 7.85 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272704 | DUR02-926-2 | NDL588 | 11/22/00 | Lead | 7439-92-1 | 5.96 | MG/KG | | 1/24/01 | AS-6 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |

Durango Raffinate Ponds Area: November 2000 Soil Sample Results
 Requisition number: 17272

| Lab Number | ID | Ticket Number | Date Received | Analyte Name | Analyte Alias | Result (mg/kg) | UNITS | Lab Qualifiers | Date Analyzed | Analysis Method | Sample start-end Depth (ft) | Sampling Method | Lithology | Sample Comments | ESL Preparation Method | Result Comments |
|------------|-------------|---------------|---------------|--------------|---------------|----------------|-------|----------------|---------------|-----------------|-----------------------------|-----------------|---------------------|-----------------------------|------------------------|-----------------|
| 272704 | DUR02-926-2 | NDL588 | 11/22/00 | Molybdenu | 7439-98-7 | 0.11 | MG/KG | B | 1/24/01 | AS-3 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272704 | DUR02-926-2 | NDL588 | 11/22/00 | Selenium | 7782-49-2 | 1.22 | MG/KG | | 2/2/01 | AS-5 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272704 | DUR02-926-2 | NDL588 | 11/22/00 | Uranium | 7440-61-1 | 19.5 | MG/KG | | 1/24/01 | AS-3 R06 | 2-2 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272705 | DUR02-926-4 | NDL589 | 11/22/00 | Cadmium | 7440-43-9 | 6.98 | MG/KG | | 1/24/01 | AS-5 R06 | 4-4 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272705 | DUR02-926-4 | NDL589 | 11/22/00 | Lead | 7439-92-1 | 7.71 | MG/KG | | 1/24/01 | AS-3 R06 | 4-4 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272705 | DUR02-926-4 | NDL589 | 11/22/00 | Molybdenu | 7439-98-7 | 0.16 | MG/KG | B | 1/24/01 | AS-3 R06 | 4-4 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272705 | DUR02-926-4 | NDL589 | 11/22/00 | Selenium | 7782-49-2 | 1.16 | MG/KG | | 2/2/01 | AS-5 R06 | 4-4 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272705 | DUR02-926-4 | NDL589 | 11/22/00 | Uranium | 7440-61-1 | 4.6 | MG/KG | | 1/24/01 | AS-5 R06 | 4-4 | GB | Silty gravel fill | | CB (BT-1) | 5% HNO3 |
| 272706 | DUR02-927-3 | NDL590 | 11/22/00 | Cadmium | 7440-43-9 | 0.51 | MG/KG | | 1/24/01 | AS-3 R06 | 3-3 | GB | Silty sand & gravel | | CB (BT-1) | 5% HNO3 |
| 272706 | DUR02-927-3 | NDL590 | 11/22/00 | Lead | 7439-92-1 | 6.46 | MG/KG | | 1/24/01 | AS-3 R06 | 3-3 | GB | Silty sand & gravel | | CB (BT-1) | 5% HNO3 |
| 272706 | DUR02-927-3 | NDL590 | 11/22/00 | Molybdenu | 7439-98-7 | 0.08 | MG/KG | U | 1/24/01 | AS-3 R06 | 3-3 | GB | Silty sand & gravel | | CB (BT-1) | 5% HNO3 |
| 272706 | DUR02-927-3 | NDL590 | 11/22/00 | Selenium | 7782-49-2 | 0.59 | MG/KG | | 2/2/01 | AS-5 R06 | 3-3 | GB | Silty sand & gravel | | CB (BT-1) | 5% HNO3 |
| 272706 | DUR02-927-3 | NDL590 | 11/22/00 | Uranium | 7440-61-1 | 6.07 | MG/KG | | 1/24/01 | AS-3 R06 | 3-3 | GB | Silty sand & gravel | | CB (BT-1) | 5% HNO3 |
| 272707 | DUR02-927-5 | NDL591 | 11/22/00 | Cadmium | 7440-43-9 | 0.74 | MG/KG | | 1/24/01 | AS-3 R06 | 5-6 | GB | Sandy gravel | | CB (BT-1) | 5% HNO3 |
| 272707 | DUR02-927-5 | NDL591 | 11/22/00 | Lead | 7439-92-1 | 7.16 | MG/KG | | 1/24/01 | AS-3 R06 | 5-6 | GB | Sandy gravel | | CB (BT-1) | 5% HNO3 |
| 272707 | DUR02-927-5 | NDL591 | 11/22/00 | Molybdenu | 7439-98-7 | 0.08 | MG/KG | U | 1/24/01 | AS-3 R06 | 5-6 | GB | Sandy gravel | | CB (BT-1) | 5% HNO3 |
| 272707 | DUR02-927-5 | NDL591 | 11/22/00 | Selenium | 7782-49-2 | 0.52 | MG/KG | | 2/2/01 | AS-5 R06 | 5-6 | GB | Sandy gravel | | CB (BT-1) | 5% HNO3 |
| 272707 | DUR02-927-5 | NDL591 | 11/22/00 | Uranium | 7440-61-1 | 4.79 | MG/KG | | 1/24/01 | AS-3 R06 | 5-6 | GB | Sandy gravel | | CB (BT-1) | 5% HNO3 |
| 272712 | DUR02-P2 | NDL596 | 1/17/01 | Cadmium | 7440-43-9 | 0.03 | MG/KG | U | 1/24/01 | AS-3 R06 | | | | Process blank 5% HNO3 | CB (BT-1) | 5% HNO3 |
| 272712 | DUR02-P2 | NDL596 | 1/17/01 | Lead | 7439-92-1 | 0.01 | MG/KG | U | 1/29/00 | AS-3 R06 | | | | Process blank 5% HNO3 | CB (BT-1) | 5% HNO3 |
| 272712 | DUR02-P2 | NDL596 | 1/17/01 | Molybdenu | 7439-98-7 | 0.08 | MG/KG | U | 1/24/01 | AS-5 R06 | | | | Process blank 5% HNO3 | CB (BT-1) | 5% HNO3 |
| 272712 | DUR02-P2 | NDL596 | 1/17/01 | Selenium | 7782-49-2 | 0.35 | MG/KG | U | 2/2/01 | AS-5 R06 | | | | Process blank 5% HNO3 | CB (BT-1) | 5% HNO3 |
| 272712 | DUR02-P2 | NDL596 | 1/17/01 | Uranium | 7440-61-1 | 0.01 | MG/KG | | 1/24/01 | AS-3 R06 | | | | Process blank 5% HNO3 | CB (BT-1) | 5% HNO3 |
| 272715 | DUR02-B3 | NDL599 | 1/17/01 | Cadmium | 7440-43-9 | 0.03 | MG/KG | U | 1/24/01 | AS-5 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272715 | DUR02-B3 | NDL599 | 1/17/01 | Lead | 7439-92-1 | 0.014 | MG/KG | B | 1/29/00 | AS-6 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272715 | DUR02-B3 | NDL599 | 1/17/01 | Molybdenu | 7439-98-7 | 0.08 | MG/KG | U | 1/24/01 | AS-6 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272715 | DUR02-B3 | NDL599 | 1/17/01 | Selenium | 7782-49-2 | 0.35 | MG/KG | U | 2/2/01 | AS-5 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272715 | DUR02-B3 | NDL599 | 1/17/01 | Uranium | 7440-61-1 | 0.01 | MG/KG | | 1/24/01 | AS-6 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272716 | DUR02-B4 | NDL600 | 1/17/01 | Cadmium | 7440-43-9 | 0.03 | MG/KG | U | 1/24/01 | AS-5 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272716 | DUR02-B4 | NDL600 | 1/17/01 | Lead | 7439-92-1 | 0.02 | MG/KG | B | 1/29/00 | AS-6 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272716 | DUR02-B4 | NDL600 | 1/17/01 | Molybdenu | 7439-98-7 | 0.08 | MG/KG | U | 1/24/01 | AS-6 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272716 | DUR02-B4 | NDL600 | 1/17/01 | Selenium | 7782-49-2 | 0.35 | MG/KG | U | 2/2/01 | AS-5 R06 | | | | Blank: 18MΩ deionized water | | WATER |
| 272716 | DUR02-B4 | NDL600 | 1/17/01 | Uranium | 7440-61-1 | 0.01 | MG/KG | | 1/24/01 | AS-3 R06 | | | | Blank: 18MΩ deionized water | | WATER |