199953 - R8 SDMS

From Jim C
1/25/01

Summary of Relevant Richardson Flats Work and Findings

PAST WORK

557108

- Prior to 1993, various site assessment activities were performed with the intention of determining if the site could be listed on the NPL. The site was first proposed for the NPL in 1985; in response to comments it dropped below the necessary score and was removed from proposal. Because the HRS scoring guidelines changed, the site was reproposed in 1992. The primary pathway was "observed release to surface water." This release was documented with a photograph and only loosely supported by data. EPA again received critical comments and has since opted not to place the site on the final NPL. I have not included any of these reports, though they are available.

- In 1993, under the removal programs "Make Sites Safe Initiative," an investigation was performed by EPA (Ecology and Environment) to determine if the site warranted removal action. In my opinion, this is the first real comprehensive data we have on the site. The conclusions were generally that the site presented little or no risk, and any risk presented should be addressed through the remedial process. This report is included.

- In 1994, ATSDR completed the last in a short series of preliminary public health assessments. The report concluded that the site presented no important health risks. The report is included. Several recommendations for future work have been incorporated into the current RI.

- In 1999, United Park City Mines began working with EPA to start work on this site again. One of the biggest remaining information gaps was ground water. UPCM hired a well respected local consultant to compile existing hydrogeologic data and acquire limited new data to develop a conceptual hydrogeologic understanding of the site. EPA worked informally with UPCM on this. The resulting report, "Preliminary Hydrogeologic Review of Richardson Flats Tailings Site" is included. Monitoring work in this report has been carried on through today and will eventually be a large part of a comprehensive ground water report as part of the RI.

- Since the 1980s, a UPDES permit for an unrelated site required UPCM to monitor Silver Creek up and downstream of Richardson Flats and also monitor several wells below the tailings impoundment. This and other historic data is presented and summarized in the RI/FS work plan prepared by UPCM. This report is included. This data provides a sound historical background of both ground water and surface water quality. The data shows very little impact to Silver Creek from Richardson Flats.

IMMEDIATE FUTURE WORK

- UPCM recently prepared an RI sampling plan. This includes additional data and site condition summary and the first good discussion on risk with conceptual site models. Should be finalized within a month or so.

- UPCM and EPA conducted watershed wide surface water sampling in 2000. A report on this work will be available in the spring. Again, this data shows that Richardson Flats contributes only a tiny fraction of metals to Silver Creek relative to other sites.

- RI work is ongoing.

Richardsons Flat
HISTORIC DATA
11/29/01

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FINAL REPORT
RICHARDSON FLATS TAILINGS SITE
TDD #T08-9204-015 and #T08-9210-050
PAN EUT0039SBA and EUT0039SDA

1.0 INTRODUCTION AND PURPOSE

This report is written to satisfy the requirements of Technical Direction Documents (TDDs) #T08-9204-015 and T08-9210-050 issued to to the Ecology and Environment, Inc. Technical Assistance Team (E & E-TAT) by the Region VIII U.S. Environmental Protection Agency (USEPA) Emergency Response Branch (ERB). This work was begun in April 1992. Other reports submitted by the TAT under this TDD include: "Trip Report, Richardson Flats Tailings Site, August 17, 1992"; and "Inspection of the Tailings Dam at Richardson Flats, Memorandum to EPA-OSC", August 6, 1992. Within this same time frame the TAT has also performed work relevant to the site under three separate TDDs (T08-9204-041, T08-9207-019 and T08-9210-041). Reports/documents generated by the TAT as a result of these three TDDs are: the "Report of Drilling Activities, Richardson Flats Tailings Site, July 13, 1992"; "Response to PRPs September 10, 1992 Memorandum Regarding Well Installation Activities, Memorandum to EPA/OSC, September 11, 1992"; and "Report of Sampling Activities, January 4, 1993".

Also relevant to this work is the report entitled "Air Sampling and Analysis, Final Report", August 1992, prepared by the Environmental Response Team (ERT) of the USEPA.

The Richardson Flats Tailings site is located three and one-half miles northeast of Park City, Summit County, Utah. On approximately 160 acres from 1975 through 1981 mine tailings were placed by slurry pipeline from mines owned by United Park City Mines (UPCM). A small portion of the site was also used for a municipal/sanitary landfill during the mid-1970s.

The Richardson Flats Tailings site appeared in the Federal Register on February 7, 1992 as a proposed National Priorities List (NPL) site. Because of this proposed listing the USEPA/ERB became responsible for assuring immediate site safety for the interim period following proposed listing through the initiation of remedial activities. The purpose of this work has thus been to examine the site in terms of immediate threats to human health or the environment. This report is a summary of findings to that end.

2.0 SUMMARY AND RECOMMENDATIONS

Four areas of concern at the Richardson Flats Tailings site have been examined to determine immediate threats to human health or the environment. These four areas are: 1. the airborne release of contaminants; 2. the release of contaminants from the tailings area; 3. the release of contaminants from the municipal/sanitary landfill area; and 4. site access. In general, the site presents little or no immediate threat to human health or the environment. Following is a summary of specific findings and specific recommendations to assure site safety in the interim period preceding remedial activities.

Findings

- Airborne releases of metal contaminants from the tailings area have been minimized and do not pose an immediate threat.

- Existing soil and salt grass cover over the tailings area are providing adequate dust suppressing capability to prevent an immediate threat of airborne contaminant releases. For the long term however, soil cover is sparse and salt grass may disappear as the site becomes drier. In the long term, dusty conditions may recur.

  Cover is still strong.

- Soil being used by UPCM for tailings cover does not contain contaminants at concentrations that pose an immediate threat to human health or the environment.

- There is no immediate threat of gross failure of the tailings containment structure. There is seepage, however, through and/or around the dam end of the structure. In the summer of 1992, a hillside diversion ditch on the north perimeter of the tailings area had also been cut off from the main drainage ditch. This could permit runoff into the tailings area.

  Seepage is expected and part of design

- During the period of this assessment, surface water flow and runoff from the tailings area was very low. Almost no contaminants attributed to the site could be documented entering local surface water. The exception was the documentation of a release of lead (151 µg/l) to Silver Creek from the site. Although this release is a very important finding, it is not considered an immediate threat to human health and the environment. This release would be better addressed by a comprehensive remedial plan rather than by emergency response actions.

  This is a suspect result. Lab Flags and splits didn't match

- The placement of tailings has contributed to a significant rise in total dissolved solids (TDS) of shallow groundwater. Concentrations of individual metal contaminants do not increase to significant levels within shallow groundwater near the tailings area.

  ?

- Sediment in the "wetlands" area of the site between Silver Creek and the base of the tailings dam is severely contaminated with

tailings material and the associated high levels of metals (arsenic, cadmium, lead, ...). Because this area is six to eight feet above Silver Creek and surface water flow through it is from the diversion ditch and from seepage through the tailings containment structure, this sediment contamination appears directly attributable to the site. Although this is a very significant finding, contaminated sediment is relatively immobile and the result of a long term process. It is not considered an immediate threat and would be better addressed by a comprehensive remedial plan rather than by emergency response actions.

Still a concern

- In the area of the municipal/sanitary landfill, no organic or inorganic contaminants that could be attributed to the site were detected in surface water.

Not part of site

- Shallow groundwater in the area of the municipal/sanitary landfill showed no organic contaminants attributed to the site; however, TDS and arsenic concentrations do show increases which are attributed to the site.

Not part of site

- Site access has been satisfactorily limited by a security fence surrounding the site.

No Fence any-oo

Recommendations

- Although serious environmental concerns have been documented at the Richardson Flats Tailings site, this report does not recommend that any of these concerns be addressed with emergency response actions as immediate threats to human health or the environment. The concerns of surface water, groundwater, and sediment contamination and potential airborne releases of metals documented by this and other studies are problems which have existed for many years. The severity of these problems will not increase dramatically but will persist at a steady level. This report recommends that all concerns at the Richardson Flats Tailings site be addressed through the comprehensive remedial planning process which NPL sites are subject to. The body of this report should clarify some of the site concerns and should assist in developing the remedial plans.

3.0 SITE ACTIVITIES

Following an initial site visit in April 1992, the TAT prepared a work plan to assess contaminant releases to groundwater, surface water, and to the local environment via the air pathway. Contaminants of concern include metals from the tailings area and the landfill area, and several types of potential organic contaminants from the landfill area.

Additional monitoring wells were installed at the site during the week of June 22, 1992. Air monitoring was conducted by the ERT on June 10 and 11, 1992. During the week of August 3, 1992 the TAT was on-site for several activities including groundwater and surface water sampling, determination of depth of cover on the tailings area, sampling of cover

soil material, and inspection of the tailings containment structure and diversion ditch system. Additional groundwater sampling occurred during the week of November 9, 1992.

4.0 RESULTS AND FINDINGS

4.1 AIR MONITORING

In July 1986 air monitoring documented the airborne release of arsenic, cadmium, lead, and zinc in particulate form from the Richardson Flats Tailings site. Since that time UPCM has placed cover soil over approximately 85% (UPCM's estimate) of the tailings area. On June 10 and 11, 1992 air samples were again collected to assess the airborne release of these four metals. At 5 sampling locations on the site's perimeter boundary 17 air samples were collected. The sampling procedure and analytical results are contained in their entirety in the Air Sampling and Analysis, Final Report, Richardson Flats, August 1992, prepared by the USEPA/ERT. In summary, these air monitoring activities showed no detectable levels of cadmium, lead, or arsenic in any samples. Trace levels of zinc (at the level of quantitation) were detected in four samples only. No samples on any day under any wind condition exhibited elevated levels of contaminants. Restriction from site access precluded the implementation of the optimum sampling strategy; however a conclusion can still be made that airborne releases of contaminants from the Richardson Flats Tailings site are not posing an immediate threat to human health or the environment.

4.2 TAILINGS ASSESSMENT

4.2.1 DEPTH OF COVER

Depth of cover was determined at 29 locations over the tailings area. These locations are depicted on Figure 2. Locations were determined by first establishing a reference line in an approximate direction of northwest to southeast through the tailings area (Figure 1). This reference line includes and is a continuation of a straight portion of the tailings containment structure as shown in Figure 1. Points were marked along this reference line at 200 or 400 foot intervals. At 2800 feet from the base point a second reference line was established in a perpendicular direction to the first reference line. This second reference line extended in an approximate direction from southwest to northeast. For the purpose of sampling or soil cover measurements, all locations within the tailings area were identified relative to these two reference lines. For example, a sample location identified as 1900, 800L would be 1900 feet from the base point (using the first reference line) and 800 feet to the left (northeast) using the second reference line.

Sample locations were on an approximate grid pattern of 400 feet x 400 feet. The grid covered most of the tailings area. Table 1 presents the results of cover depth measurements. At all but one location a distinct line could be seen between soil cover and gray colored tailings beneath the cover. X-ray fluorescence (XRF) measurements for lead were taken to confirm the visual determination of cover depth or to determine

cover depth where a distinct line was not visible. As seen in Table 1, much of the tailings area is covered with a salt grass. This is a native grass which appeared to form an excellent cover on the tailings. Where the salt grass is present no soil cover had been placed over the tailings; however roots of the grass extended five to six inches below ground surface, and the roots and the grass itself formed an effective dust suppressing mat on top of tailings material.

The grid pattern shown in Figure 2 represent much of the entire tailings area. Of the 29 points on this grid only 1 point had no cover soil and no salt grass present. Nine of the 29 points (approximately 30 percent) had no cover soil present. At the 20 points where cover soil was present, the cover soil was 6 inches thick or less at 6 points and greater than 6 inches in thickness at 14 points.

It is important to note that the salt grass which became established on the tailings area is likely dependent upon a moist environment for survival. This grass became established when tailings were slurried to the site creating periods of standing water. The grass may slowly disappear, and its extensive root system may make conditions difficult for other plants to become established.

UPCM has expressed intentions of adding soil cover to that small portion of the site which currently has no soil cover or where salt grass is not established. When this is completed, the tailings area will have adequate cover to prevent an immediate threat of excessive dust. Much of the existing soil cover, however, is sparse (less than six inches in thickness); and much of the area is covered with a salt grass that may disappear as the site becomes drier. Dusty conditions could recur in the future if proper soil cover over the entire tailings area is not applied.

4.2.2 COVER SOIL ANALYSES

Figure 2 shows the location of six soil samples collected on August 6, 1992. Each of these samples, except sample RF-SO-3, was taken from soil that was added by UPCM as cover to the site. Table 2 contains analytical results for these samples and the normal ranges for these elements in soils of the western United States. Sample RF-SO-3 was collected within an area covered by salt grass. As discussed, where salt grass is currently established soil cover has not been added by UPCM. This soil sample is more likely to be representative of tailings material.

As Table 2 shows, constituents of soil cover do not consistently fall into the normal ranges for all elements. In soil cover samples, however, no contaminant is grossly out of line from the normal ranges presented in Table 2. Results for sample RF-SO-03 show very high concentrations of antimony, arsenic, cadmium, copper, lead, mercury, selenium, and zinc; however this sample is tailings, not cover material. It appears that soil being used for cover material by UPCM does not contain contaminants at concentrations that would pose an immediate threat to human health or the environment.

4.2.3 TAILINGS CONTAINMENT

On August 4, 1992 the TAT inspected the tailings containment structure. This inspection did not include trenching or boring into the embankment and thus was not a full assessment of the structure. Results of this inspection were summarized in a memorandum to the OSC dated August 8, 1992. This memo is included with this report as Appendix A. Important findings of this inspection follow.

1. Main Embankment.
   The main embankment is oversteep lying at 1.0:1.0 to 1.5:1.0 (run:rise). Approximately six inches of fine dry sand, possibly windblown tailings, were noted under a three inch topsoil cover layer on the downstream face of the embankment. The sand has no strength and will erode quickly if exposed. A 35% to 50% grass cover was on most of the embankment which will help in erosion control. No cracking was evident on the embankment, although the sand layer would tend to hide any small cracking. Also, no bending (bulging) was noted on the embankment.

2. Toe of the Main Embankment.
   Rank vegetation, in the form of willows and trees, is growing at the toe of the dam. Approximately eight inches of loamy damp soil is evident on the toe of the dam. The amount of vegetation and the type of soils on the toe of the dam indicate that the area receives a lot of water. As wet soils were noted approximately six to eight feet above the stream level this water is probably due to seepage under the dam. Other evidence of seepage from the toe of the dam was evident in the forms of; soft marshy areas, rank vegetation including willows, loamy soils, damp soils, and areas where water had been standing (although no standing water was observed on August 4, 1992).

3. The North Abutment.
   A swampy, loamy area on the north abutment, adjacent to where the embankment meets the abutment, was noted. The area was well above the toe of the dam at the location of the north monitoring well. This well recharged quickly when bailed. These conditions indicate that water seeps around or through the contact between the abutment and the embankment. Under full head conditions (saturated tailings) this would be an area where failure of the embankment could occur.

4. Crest of the Main Embankment.
   The crest is sloped back toward the tailings area allowing any water to drain back to the tailings pond. However, small erosional gullies are forming on the crest and downstream face of the dam and could eventually lead to larger gullying on the dam.

5. Water Flow.
   Water elevations behind the embankment are unknown, however the elevation of water in the ditch and the pond south of the tailings area are probably indicative of the elevation of

groundwater behind the embankment. From the information available in the Dames & Moore, Inc. reports, it is unlikely that a cutoff wall was installed around the perimeter of the pond to control seepage under either the embankment or the dike. The piezometer located on the toe of the dam indicated the water level to be five feet below ground surface. The swampy ground and recharge rate of the monitoring well on the north abutment indicates that water flow from some source is occurring. Inspection of the road cut north of the abutment revealed no seeps. Without further investigation it is conservative to use a worst case scenario and assume that the source of the seep is the water in the tailings behind the dam and that the abutment/embankment contact is a drainage path for the water.

6. Perimeter Dike.
   The perimeter dike was probably constructed by stripping materials off of the downstream side and piling the undifferentiated material up as a dike. The slopes are approximately 2.0:1.0. The dike is used as the access road for the pond and its elevation varies from two to five feet above the level of the tailings in the pond. The dike appears to be in good condition.

7. Diversion Ditch.
   A diversion ditch has been constructed along the perimeter of the tailings pond as designed by Dames & Moore, Inc. The ditch depth and width varies, generally getting deeper and wider as it progresses downstream. Standing water was evident in most of the ditch on the southern perimeter of the property. Rushes, sedges, and cattails wee growing in the bottom of the ditch along the entire length. Recent work has been performed by the owners in flattening the ditch banks and adding topsoil to the banks. This work is approximately one-half completed. According to the owners, the rest of the ditch is to be similarly regraded and topsoiled. At the time TAT inspected the site, the hillside diversion ditch, on the north perimeter of the tailings pond, had been cut off from the main ditch as a result of topsoil stripping. This important feature should be reconnected to the main ditch as soon as possible to prevent additional water flowing into the tailings pond.

In conclusion, based on the observed conditions of the tailings containment or embankment structure and the relatively dry condition of the tailings, there is no immediate threat of gross failure of this structure. Of more immediate concern are: seepage from the toe of the dam evidenced by wet/saturated soil well above stream level; seepage around or through the contact between the abutment and the embankment near the location of the northernmost groundwater monitoring well; and the hillside diversion ditch located on the north perimeter of the tailings area which has been cut off from the main drainage ditch by topsoil stripping activities allowing runoff into the tailings area.

Recommendations include keeping the tailings area dry through the maintenance of the diversion ditches. The connection between the

hillside diversion ditch and the perimeter diversion ditch should be restored.

4.2.4 SURFACE WATER

Surface water samples collected for assessment of the tailings area are shown on Figure 1. These eight sample numbers are RF-SW-01 through RF-SW-08. Inorganic analytical results for surface water samples are presented in Table 3. Within Silver Creek samples RF-SW-01 through RF-SW-04 are considered upgradient of the tailings area and samples RF-SW-05 and RF-SW-06 are downgradient. In comparing upgradient sample results with downgradient sample results very few significant differences are noted. Lead increases by a factor of 5.7 in sample RF-SW-05 when compared to the average lead concentration of the four upgradient samples. In sample RF-SW-06 arsenic increases by a factor of 2.1 and silver increases by a factor of 4.2 when compared to the average concentration of the four upgradient samples.

It is important to realize that within surface water most metals will be quickly oxidized, precipitate, and tend to settle out of the bulk water and became incorporated into stream sediment. Thus, metals in surface water generally are transported in particulate/suspended form. In a very low flow period of the year (August), when surface water is not turbulent, metals are not transported to the extent that they are transported during higher flow conditions.

The Utah Code, 26-11-2 through 20, has classified the Weber River from the Stoddard diversion to the headwaters (including Silver Creek) in the following manner: IC-protected for domestic purposes with prior treatment by treatment processes as required by the Utah Department of Health; 3A-protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain; and 4-protected for agricultural uses including irrigation of crops and stock watering. The Utah Code establishes specific numeric criteria for contaminants based upon use classification.

Applicable inorganic standards from the State Code are summarized in Table 4. The Utah Code prohibits discharges or placement of wastes in such a manner that will cause violations of these numerical standards. The State has designated Silver Creek to be in three use classes (1C, 3A, and 4). For the domestic source class (1C) upgradient samples from Silver Creek meet all standards. The two downgradient Silver Creek samples meet all standards except for lead in sample RF-GW-05. The data indicates that during this sampling event a violation of the lead standard for the State Domestic Source (1C) surface water class was caused by discharges from the Richardson Flat tailings site. For the Agricultural Class (4) the data also indicates a violation of the lead standard in sample RF-SW-05.

State standards for Class 3A Surface Waters, protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain, are divided into four day average (chronic) standards and one hour average (acute) standards. Grab samples collected during the week of August 4, 1992

could only be compared to the acute standards. This comparison shows that upgradient and downgradient samples from Silver Creek meet all Class 3A standards, except those standards for lead and zinc which are exceeded in both upgradient and downgradient samples.

The State Code also contains numeric standards for surface waters for the protection of human health. Those applicable inorganic standards are also presented in Table 4. All upgradient and downgradient samples from Silver Creek meet the human health standards for antimony, cadmium, chromium, copper, silver, selenium, and zinc. Both upgradient and downgradient samples fail to meet human health standards for arsenic and beryllium. One upgradient sample, RF-SW-02, does not meet the human health criteria for nickel. One downgradient sample, RF-SW-05, does not meet the human health standard for lead.

What is important to this report when examining inorganic analytical data for Silver Creek and when considering the several state standards for the protection of surface waters? The detection of lead in one downgradient sample at 151 µg/l is likely the most significant observation. This lead level and the relatively low lead concentration in the four upgradient samples constitutes a violation of the State Code for protection of Class 1C and Class 4 surface waters. Sample RF-SW-05 also demonstrates a violation of the state standard for protection of human health. This sample may help to confirm the findings of earlier studies or highlight an area of concern for later remedial activities. In the context of this project, however, this observation of an elevated lead level in one of two downgradient surface water samples cannot be seen as posing an immediate threat to human health or the environment. A "release" has been documented, however the documentation of an ongoing event is sparse.

4.2.5 GROUNDWATER

One upgradient and two downgradient monitoring wells (Figure 1) were sampled during the week of August 4, 1992. Results of inorganic analyses are presented in Table 6. Sample RF-GW-04 is from the upgradient well; samples RF-GW-05 and RF-GW-09 are from two wells at the base of the tailings dam.

Calculation of total dissolved solids (TDS) level of the upgradient well shows upgradient groundwater to contain less than 500 parts per million (ppm) TDS. This finding is consistent with upgradient TDS concentrations found during previous sampling activities in August 1985.

State of Utah Wastewater Disposal Regulations, Part II, Standards of Quality for Waters of the State establishes classes of groundwater. If only filtered samples are considered, upgradient groundwater would be classified 1A, Pristine Groundwater. If unfiltered samples are evaluated, upgradient groundwater would be classified III, Limited Use Groundwater. State regulations also establish protection criteria which prohibit discharges to groundwater that would cause violations of the numeric groundwater quality standards.

Comparison of upgradient versus downgradient water quality from Table 6 shows that no individual contaminants increase to concentrations that would cause violations of either Class 1A or Class III groundwater protection standards. TDS levels, however, show increases (downgradient versus upgradient) well in excess of the protection standards for either Class 1A or Class III groundwaters. This increase in TDS of groundwater is attributed to the influence of tailings material on water chemistry and constitutes a violation of state regulations pertaining to the protection of groundwater quality.

4.2.6 SEDIMENT

Figure 1 shows a "wetlands" area between the base of the tailings dam and Silver Creek. Within this area four sediment samples were collected. Results of inorganic analyses of these samples is presented in Table 7 along with the normal ranges of elemental concentrations in soils of the western United States.

Analytical results show the following. Antimony is present at levels 39 to 98 times higher than the normal maximum concentration in soils of the western United States. Arsenic is present at levels 11 to 28 times higher than the normal maximum concentration in soils of the western United States. Cadmium is present at levels 75 to 210 times higher than the normal maximum concentration in soils of the western United States. Lead is present at levels 75 to 210 times higher than the normal maximum concentration in soils of the western United States. Mercury is present at levels 11 to 74 times higher than the normal maximum concentration in soils of the western United States. Selenium is present at levels 17 to 76 times higher than the normal maximum concentration in soils of the western United States. Zinc is present at levels 55 to 410 times higher than the normal maximum concentration in soils of the western United States.

Water flow through the wetlands area is now primarily from the diversion ditch. Some seepage from the tailings area through or around the containment structure may also influence flow and/or chemistry of this wetlands (See Report Section on Tailings Containment). Flow is toward Silver Creek, and this badly contaminated sediment appears to be tailings material that is being transported from the site.

In Table 2, Inorganic Analytical Results for Soil, sample RF-SO-03 was a sample of tailings material. This tailings sample showed the following ratio of six elements: arsenic (4.3); cadmium (1); calcium (713); iron (811); lead (70); and zinc (120). In Table 7, Inorganic Analytical Results for Sediment, the four sediment samples plus one duplicate, when averaged, show the following ratio of the same six elements: arsenic (3.1); cadmium (1); calcium (904); iron (805); lead (72); and zinc (162). These ratios of elements are very similar and likely indicate that sediment in the wetlands area is tailings material from the site.

4.3 LANDFILL ASSESSMENT

4.3.1 GROUNDWATER

Three monitoring wells were installed in the area of the landfill during the week of June 22, 1992. These wells were sampled during the week of November 9, 1992. Sample locations are shown on Figure 1. Results of inorganic analyses are presented in Table 8. This table also contains results from a rinsate blank taken during sample collection and, for reference, results from RF-MW-04, a distant background monitoring well.

As shown in Figure 1, the three monitoring wells (1, 2 and 3) in the area of the municipal/sanitary landfill roughly surround the landfill. Analytical results confirm that sample location RF-MW-01 is hydraulically upgradient to sample locations RF-MW-02 and RF-MW-03. Estimates of total dissolved solids (TDS) for this upgradient monitoring well show that upgradient groundwater TDS is well below 500 ppm. Based on the inorganic analytical results of Table 8 and a TDS value of less than 500 ppm, groundwater immediately upgradient of the landfill is classified as Class 1A, Pristine Groundwater, by the State of Utah Groundwater Quality Standards.

State protection levels for Class 1A groundwaters are very rigid. Utah standards include the following requirements for Class 1A groundwaters.

1. TDS may not increase above 1.1 times the background value.
2. In no case will the TDS increase above 500 ppm.
3. When a contaminant is present in a detectable amount as a background concentration, the concentration of the pollutant may not exceed 1.1 times the background concentration or exceed 0.1 times the groundwater quality standard whichever is greater.
4. When a contaminant is not present in a detectable amount as a background concentration, the concentration of the pollutant may not exceed 0.1 times the groundwater quality standard value, or exceed the limit of detection whichever is greater.
5. In no case will the concentration of a pollutant be allowed to exceed the groundwater quality standard.

Comparison of the background sample, RF-MW-01, with the two downgradient sample locations, RF-MW-02 and RF-MW-03, shows the following.

1. TDS levels in groundwater increase in downgradient locations to concentrations above 500 ppm.
2. Of specific inorganic contaminants, arsenic shows the most significant increase in concentration from upgradient to downgradient samples. Arsenic was below 5.0 ppb or undetected in the upgradient sample (RF-GW-01). Dissolved arsenic was 24 ppb in RF-MW-02 and 59 and 70 ppb in two samples from RF-GW-03. The state groundwater quality standard for arsenic is 50 ppb. This is a clear violation of state groundwater

protection requirements which can be attributed to the landfill.

The groundwater samples taken from the area of the landfill were also analyzed for organic contaminants (volatiles, base-neutral acid extractable compounds, and pesticides/PCBs). Analytical results or organic analyses are not tabulated in this report but can be summarized as follows.

1. Five volatile compounds (toluene, methylene chloride, benzene, acetone, 1,2-dichloroethene) were found in one or more samples at very low concentrations. These concentrations were below the contract required detection limit of 10 ppb and cannot be considered significant.
2. Three base-neutral acid extractable compounds were found in one or more samples at very low concentrations. The three compounds were phthalate compounds present at 1 to 2 ppb. These analytical findings were not significant because the compounds were also detected in laboratory blanks or the concentrations found were below the contract required detection limits. Phthalates are common laboratory contaminants.

3. No pesticide or PCB was detected in any of the groundwater samples (RF-MW-01, RF-MW-02, RF-MW-03).

4.3.2 SURFACE WATER

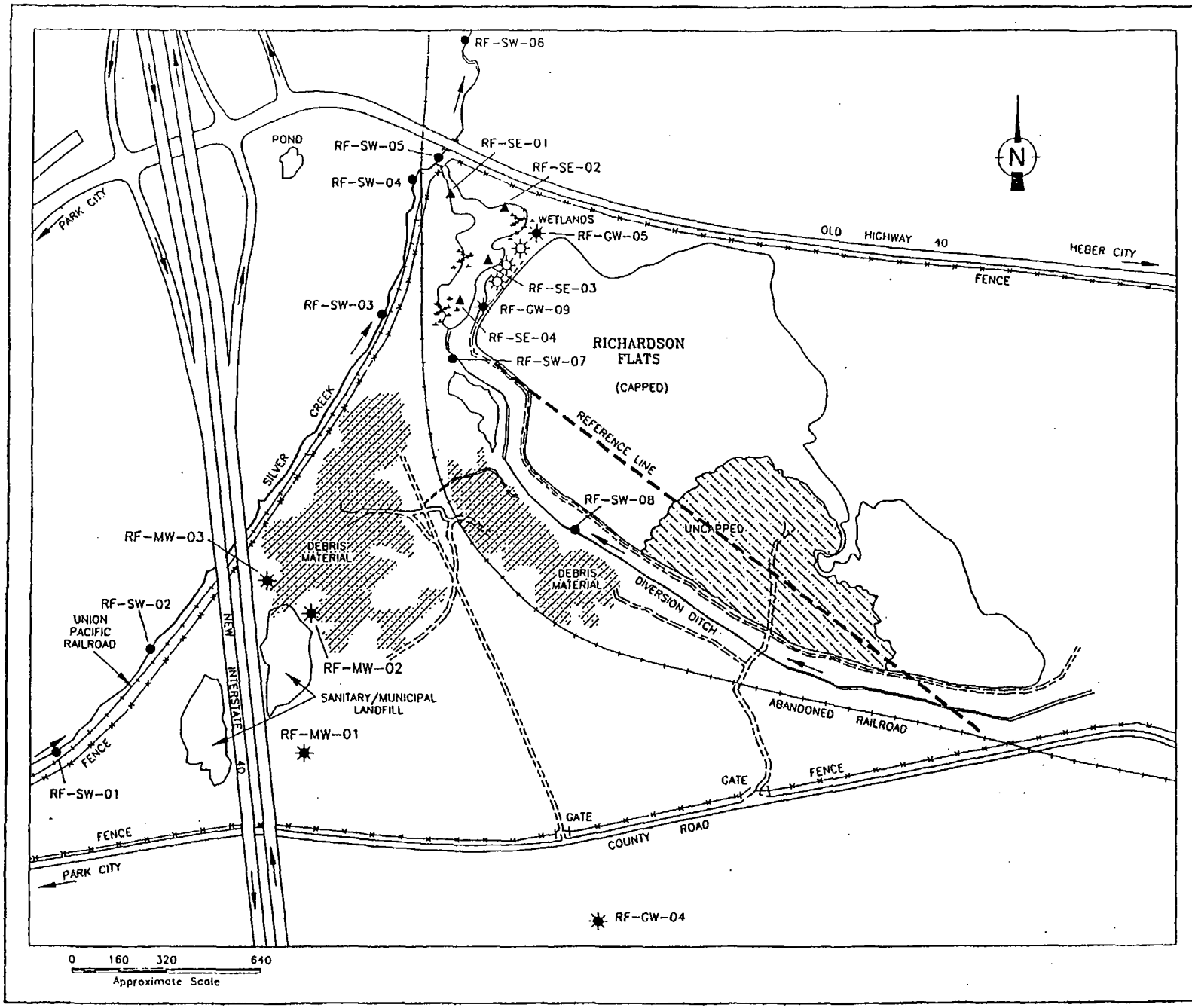
Of the six surface water sample locations shown in Figure 1, two locations (RF-SW-01 and RF-SW-02) were upgradient of the landfill; the other locations were downgradient. Comparison between upgradient and the two closest downgradient samples (RF-SW-03 and RF-SW-04) of inorganic data (Table 3) show no significant increases in contaminant concentrations as Silver Creek flows past the landfill.

These six surface water samples were also analyzed for organics (VOAs, BNAs, Pesticides/PCBs). In all samples no pesticide/PCBs were detected at or above the instrument detection level. One BNA compound, bis(2-ethylhexyl)phthalate, Cas Number 117-81-7, was detected at concentrations between 0.6 and 1 ppb at sample locations RF-SW-01, RF-SW-02, RF-SW-03, and RF-SW-04. This compound is a very common laboratory contaminant. At the very low levels detected its presence cannot be considered significant. Toluene was detected at 3 ppb at three sample locations, RF-SW-01, RF-SW-02, and RF-SW-03. At these very low concentrations the presence of toluene is not a certainty; however because two of the three sample locations were upgradient of the landfill, the presence of this contaminant would not be attributed to the landfill.

In summary, no significant findings came from the organic analyses of surface water samples.

4.4 SITE ACCESS

A security fence has been put in place surrounding the site. Based upon the TAT's inspections and observations during site activities and based upon observations made by UPCM this security fence has been very effective at preventing access to the site. Before the security fence was constructed, the site was most notably used by "off road" motorcycle enthusiasts.



LEGEND

- Approximate location of monitoring wells
- Groundwater sample location
- Surface water sample location
- Sediment sample location

TECHNICAL ASSISTANCE TEAM FOR EMERGE
RESPONSE, REMOVAL AND PREVENTIO
EPA CONTRACT 68-WO-0037

TITLE:
RICHARDSON FLATS
Park City, Utah
SAMPLE LOCATION MAP

T.O.D. T08-9204-015

ecology & environment, inc.
DENVER, COLORADO

FI

Date: 08/92 Drawn by: RSM Scale:

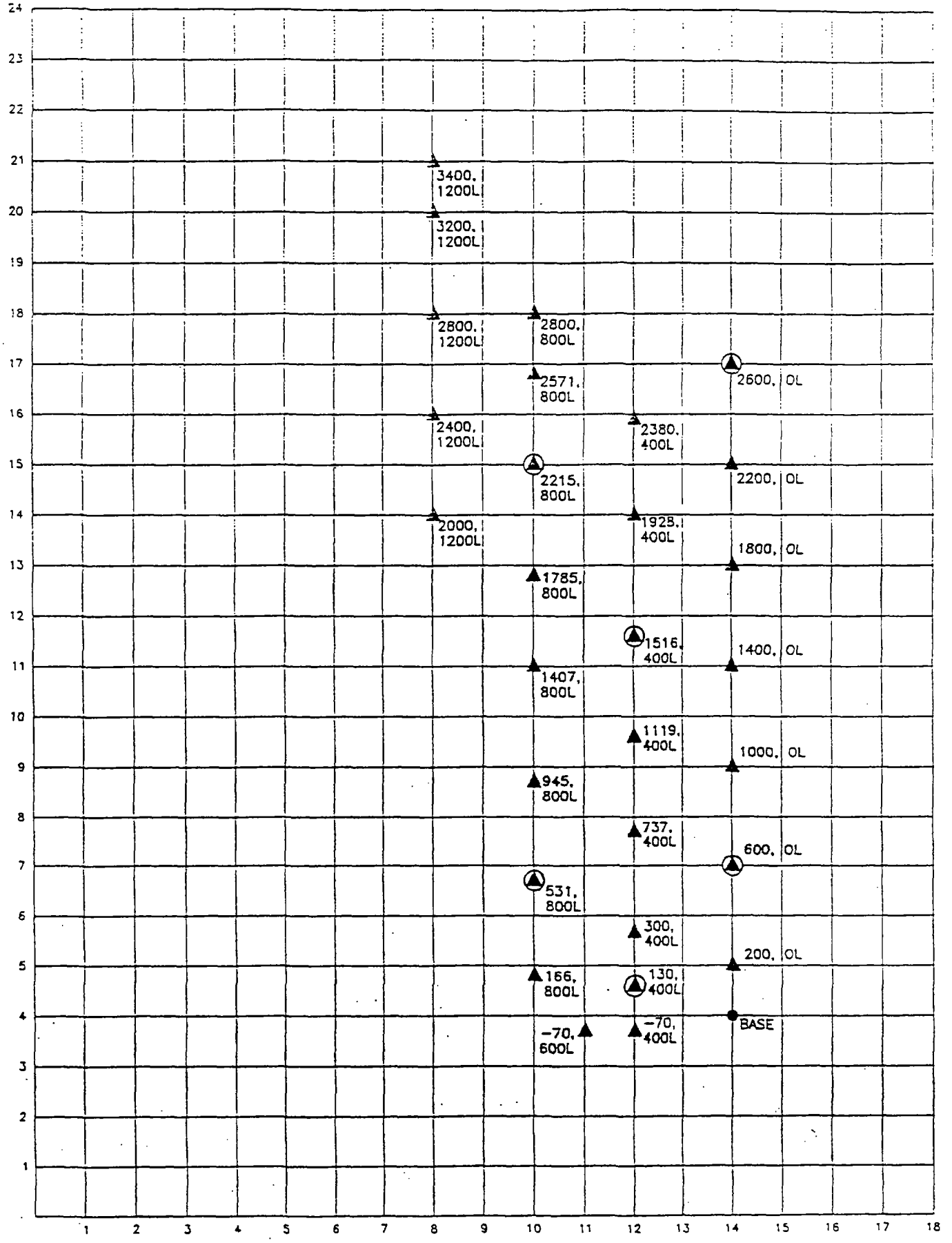

3400. 1200L
3200. 1200L
2800. 1200L
2800. 800L
2571. 800L
2600. OL
2400. 1200L
2380. 400L
2215. 800L
2200. OL
2000. 1200L
1928. 400L
1800. OL
1785. 800L
1516. 400L
1400. OL
1407. 800L
1119. 400L
1000. OL
945. 800L
737. 400L
600. OL
531. 800L
300. 400L
200. OL
166. 800L
130. 400L
BASE
-70. 600L
-70. 400L
LEGEND
Cover depth determined
Cover sample collected

TABLE 1
COVER DEPTH MEASUREMENT
RICHARDSON FLAT TAILINGS SITE
TDD #T08-9204-015

LOCATION	DEPTH OF COVER	VISUAL CONFIRMATION	XRF CONFIRMATION	XRF SAMPLE NUMBERS
200, 0L	10"	Yes	Yes	RF020, 021
600, 0L	3-6"	Yes	Yes	RF022,023,024,025
1000, 0L	>18"			
1400, 0L	>18"			
1800, 0L	>18"			RF026
2200, 0L	0-6"	No	Yes	RF027,028,029,030
2600, 0L	6-10"	Yes	Yes	RF032,033,034,035
2380, 400L	8-9"	Yes	Yes	RF036,037,038,039
1928, 400L	5-6"	Yes	Yes	RF040,041,042
1516, 400L	>6"			
1119, 400L	4"	Yes	Yes	RF044,045
737, 400L	7-8"	Yes	Yes	RF048,049,050
330, 400L	8"	Yes	Yes	RF055,056
2800, 800L	No Cover (Salt Grass)	Yes	Yes	RF057,058,059,060
2571, 800L	No Cover (Salt Grass)	Yes	Yes	RF061,062
2215, 800L	No Cover (Salt Grass)	Yes	Yes	RF063,064
1785, 800L	No Cover (Salt Grass)	Yes	Yes	RF065,066
1407, 800L	3"	Yes	Yes	RF067,068,069
945, 800L	6-7"	Yes	Yes	RF071,072,073
531, 800L	7-8"	Yes	Yes	RF074,075
166, 800L	No Cover	Yes	Yes	RF076,077
130, 400L	2"	Yes	Yes	RF080,081,082
-70, 400L	6.5"	Yes	Yes	RF083,084,085
-70, 600L	11"	Yes	Yes	RF086,087,088,089
2000, 1200L	No Cover (Salt Grass)	Yes	Yes	Rf091,092
2400, 1200L	No Cover (Salt Grass)	Yes	Yes	RF093,094
2800, 1200L	No Cover (Salt Grass)	Yes	Yes	RF095,096
3200, 1200L	No Cover (Salt Grass)	Yes	Yes	RF097,098
3400, 1200L	>10"	Yes	Yes	RF099,100

TABLE 2
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SOIL
CONCENTRATION IN mg/kg
TDD #T08-9204-015

ANALYTE	NORMAL RANGE (mg/kg) *	RF-SO-01	RF-SO-02	RF-SO-03	RF-SO-04	RF-SO-05	RF-SO-06
Aluminum	29000-116000	21200	25300	2960	25800	22000	25200
Antimony	0.22-1.01	5.0U	5.0U	142J	5.0U	5.7NJ	5.6NJ
Arsenic	2.8-10.9	20.9J	3.5J	357J	5.9J	16.6J	8.9J
Barium	337-998	253	282	117	267	317	197
Beryllium	0.30-1.56	1.1	1.1	1.2	1.2	1.1	1.2
Cadmium	0.01-2.0***	3.0J	1.8J	83.0J	1.9J	5.0J	2.4J
Calcium		5850	5900	59200	5900	9480	4920
Chromium	19-90	24.4J	27.9J	12.9J	22.2J	24.3J	28.2J
Cobalt	3.6-14.0	13.9	12.7	12.6	15.0	14.5	10.0B
Copper	10-43	31.4	24.8	454	27.2	50.4	29.4
Iron	10600-41000	21800	25600	67300	23500	27500	23100
Lead	9-31	111	34.9	5770	125J	223	102
Magnesium		4910	5200	10100	5150	4780	5570
Manganese	192-752	1190	637	2020	899	1030	697
Mercury	0.02-0.11	0.11U	0.11U	3.6J	0.10U	0.11U	0.16J
Nickel	7-32	20.7	21.6	18.5	18.4	21.3	19.9
Potassium		4730	4580	917	4330	4540	5650
Selenium	0.09-0.56	0.61U	0.61J	25.4J	0.61U	0.61U	0.61U
Silver	0.01-8***	4.1J	2.0J	20.3J	2.0J	2.0J	2.0J
Sodium		136NJ	319NJ	209NJ	244NJ	248NJ	159NJ
Thallium	0.1-0.8***	0.35NJ	0.43NJ	41.7	0.59NJ	1.9NJ	0.32U
Vanadium	36-136	41.4	56.3	13.0	51.4	57.4	42.2
Zinc	31-98	214	96.3	10000	127	432	184

* Data From: Shacklette, H.T., and Boerngen J.G., 1984; Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 105pp.

*** - Bowen, H.J.M., 1979, Environmental Chemistry of the Elements, Academic Press, NY.

TABLE 3
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SURFACE WATER
CONCENTRATION IN μg/l
TDD #T08-9204-015

ANALYTE	RF-SW-01	RF-SW-02	RF-SW-03	RF-SW-04	RF-SW-05	RF-SW-06	RF-SW-07	RF-SW-08
Aluminum	20.3NJ	70.1NJ	19.3NJ	65.5NJ	17.1U	185NJ	36.7NJ	319
Antimony	36.7NJ	24.8NJ	24.3U	38.7NJ	24.3U	30.1NJ	24.3U	24.3U
Arsenic	4.2NJ	5.2NJ	7.3NJ	7.6NJ	7.2NJ	12.5J	5.7NJ	11.4J
Barium	49.2NJ	54.6NJ	50.5NJ	54.4NJ	65.6NJ	66.0NJ	32.7NJ	54.3NJ
Beryllium	3.4NJ	2.8NJ	2.1NJ	2.1NJ	2.4NJ	0.93NJ	3.2NJ	1.0NJ
Cadmium	3.9NJ	3.3U	3.3U	3.5NJ	3.3U	3.3U	3.3U	3.3U
Calcium	233000	157000	128000	149000	163000	146000	341000	190000
Chromium	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U
Cobalt	6.0U	6.0U	6.0U	10.4NJ	6.0U	6.0U	6.0U	6.0U
Copper	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U	20.0NJ
Iron	193	158	307	356	279	446	703	1320
Lead	35.3J	18.8J	15.0J	36.4J	151J	33.2J	33.3J	146J
Magnesium	38700	37000	30600	33600	36700	37700	61000	38100
Manganese	249J	495J	458J	438J	269J	399J	9230J	1590J
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U	0.24	0.20U
Nickel	11.1U	25.4NJ	11.1U	11.1U	11.1U	11.1U	12.8NJ	20.9NJ
Potassium	3510NJ	2110NJ	1640NJ	1950NJ	1270NJ	1400NJ	3180NJ	1150NJ
Selenium	15.0U	15.0U	15.0U	15.0U	15.0U	15.0U	15.0U	15.0U
Silver	2.4U	2.4U	2.4U	2.4U	2.4U	10.0N	10.0U	10.0U
Sodium	63600	24500	20900	25500	25900	27600	51200	29500
Thallium	1.6U	1.6U	1.6U	1.6U	1.6U	1.6U	1.6U	1.6U
Vanadium	35.7U	35.7U	35.7U	35.7U	35.7U	35.7U	35.7U	35.7U
Zinc	1110J	2080J	769J	776J	466J	321J	64.2J	745J

TABLE 4
NUMERIC STANDARDS OF QUALITY
SILVER CREEK
STATE OF UTAH
WASTEWATER DISPOSAL REGULATIONS

	DOMESTIC SOURCE (1C) (Max. µg/l)	AQUATIC WILDLIFE (3A) 4 Day Avg./1 Hr. Avg. (µg/l)	AGRICULTURAL (4) (Max. µg/l)	HUMAN HEALTH (B) (µg/l)
Antimony				146
Arsenic	50	190/360 (tri As)	100	.002
Barium	1000			
Beryllium				.0037
Cadmium	10	2.5/12.5[A]	10	10
Chromium	50	11/16 (hex Cr) 480/4035 (tri Cr)[A]	100	50
Copper		28.5/47[A]	200	1000
Iron		1000 (Max.)		
Lead	50	2.5/5.7[A]	100	50
Mercury	2	.012/2.4		.144
Nickel		377/3390[A]		13.4
Selenium	10	5/20	50	10
Silver	50	/24[A]		50
Zinc		254/280[A]		5000

[A] - Based on hardness level of 280 mg/l as $CaCO_3$.

B - Human health criteria applied to all Class 1C water bodies to protect for the consumption of water and aquatic organisms.

TABLE 5
FEDERAL QUALITY CRITERIA FOR WATER
RICHARDSON FLATS TAILINGS
TDD #T08-9204-015
(Concentration in µg/l Unless Otherwise Stated)

	CRITERIA FOR PROTECTION OF FRESH WATER WILDLIFE		CRITERIA FOR PROTECTION OF HUMAN HEALTH	
	ACUTE CRITERIA	CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY
Antimony	9000*	1600*	1.46	
Arsenic	850 (pent)* 360 (tri)	48 (pent)* 190 (tri)	2.2 ng/l**	17.5 ng/l**
Barium			1 mg/l	
Beryllium	130*	5.3*	6.8 ng/l**	117 ng/l**
Cadmium	12.5A	2.5A	10	
Chromium (hex)	16	11	50	
Chromium (tri)			170 mg/l	3433 mg/l
Copper	46.8A	28.5A		
Iron		1000	0.3 mg/l	
Lead	303A	11.8A	50	
Manganese			50	100
Mercury	2.4	0.012	144 ng/l	146 ng/l
Nickel	3390A	377A	13.4	100
Selenium	260	35	10	
Silver	24A	.12	50	
Thallium	1400*	40*	13	48
Zinc	280A	254A		

From: Quality Criteria for Water, 1986, EPA 440/5-86-001.

A - Calculated based on hardness at 280 mg/l $CaCO_3$.

* - Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level (LOEL).

** - Human health criteria for carcinogens reported for three risk levels. Values presented is the 10^{-6} risk level.

TABLE 6
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR GROUNDWATER
CONCENTRATION IN µg/l
TDD #T08-9204-015

ANALYTE	RF-GW-04 TOTAL	RF-GW-04 DISSOLVED (FILTERED)	RF-GW-05 TOTAL	RF-GW-05 DISSOLVED (FILTERED)	RF-GW-09 TOTAL	RF-GW-09 DISSOLVED (FILTERED)
Aluminum	15700	191NJ	2690	49.6NJ	1630	68.5NJ
Antimony	24.3U	33.2NJ	24.3U	40.5NJ	28.4NJ	35.9NJ
Arsenic	3.7NJ	3.6U	5.2NJ	3.6U	11.3J	8.8NJ
Barium	196NJ	93.9NJ	99.6NJ	64.NJ	58.3NJ	46.2NJ
Beryllium	1.3NJ	0.90U	3.4NJ	1.8NJ	4.9NJ	3.7NJ
Cadmium	3.3U	3.3U	3.3U	3.3U	3.3U	3.3U
Calcium	42200	43500	191000	196000	318000	365000
Chromium	10.5	7.8U	7.8U	7.8U	7.8U	7.8U
Cobalt	11.0NJ	6.0U	7.5NJ	6.0U	9.0NJ	6.0U
Copper	30.0	171J	30.0	20.0NJ	20.0NJ	20.0U
Iron	14100	151	3180	62.6NJ	3190NJ	2170
Lead	627J	40.9J	15.6J	2.2U	31.0J	2.2U
Magnesium	12200	8380	44200	41800	52500	55000
Manganese	162J	19.5J	890J	684J	6670J	7420J
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U
Nickel	13.0NJ	11.1U	11.1U	24.9B	25.6NJ	28.9NJ
Potassium	3970NJ	1360NJ	6060	5530	3290NJ	3010NJ
Selenium	3.0U	3.0U	15.0U	15.0U	15.0U	15.0U
Silver	2.4U	10.0U	2.4U	10.0U	3.3NJ	10.0U
Sodium	16100	16800	38100	35700	48600	49700
Thallium	1.6U	1.6U	1.6U	1.6UW	1.6U	1.6U
Vanadium	35.7U	35.7U	35.7U	35.7U	35.7U	35.7U
Zinc	136J	20.1J	99.5J	14.4NJ	92.5J	13.1NJ

TABLE 7
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SEDIMENT
CONCENTRATION IN mg/kg
TDD #T08-9204-015

ANALYTE	NORMAL RANGE (mg/kg) *	RF-SE-01	RF-SE-01D	RF-SE-02	RF-SE-03	RF-SE-04
Aluminum	29000-116000	28800	28300	1930	4530	11800
Antimony	0.22-1.01	98.5J	97.2J	85.4J	99.0J	40.1J
Arsenic	2.8-10.9	202J	128J	189J	310J	189J
Barium	337-998	260	307	92.1	157	562
Beryllium	0.30-1.56	2.3	2.2	1.2NJ	1.1NJ	2.3NJ
Cadmium	0.01-2.0***	75.6J	93.1J	52.8J	64.9J	40.3J
Calcium		39800	50800	56300	51000	96000
Chromium	19-90	57.7J	62.4J	15.8J	14.9J	25.0J
Cobalt	3.6-14.0	13.4	20.0	5.8NJ	19.3	10.4NJ
Copper	10-43	571	725	183	313	190
Iron	10600-41000	31400	42800	31100	91900	64400
Lead	9-31	6520	6210	3010	5220	2350
Magnesium		14100	14100	13800	11900	10900
Manganese	192-752	3100	5060	2200	2330	42000
Mercury	0.02-0.11	5.9J	8.2J	2.7J	2.4J	1.3J
Nickel	7-32	41.6	51.2	13.2	21.3	97.2
Potassium		4760	4760	886NJ	1120	2710
Selenium	0.09-0.56	9.9J	14.5J	11.4J	43.1J	12.0J
Silver	0.01-8***	28.2J	41.3J	10.7J	16.3J	8.0J
Sodium		472NJ	555NJ	206NJ	634NJ	1150
Thallium	0.1-0.8***	7.1	7.8	13.6	7.8	6.6
Vanadium	36-136	65.4	70.6	9.5NJ	17.8	28.4
Zinc	31-98	12700	15200	8160	11200	5400

* Data From: Shacklette, H.T., and Boerngen J.G., 1984; Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 105pp.

*** - Bowen, H.J.M., 1979, Environmental Chemistry of the Elements, Academic Press, NY.

TABLE 8
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR GROUNDWATER - LANDFILL AREA
CONCENTRATION IN µg/L
TDD #T08-9210-041

ANALYTE	RF-MW-01 TOTAL	RF-MW-01 DISSOLVED (FILTERED)	RF-MW-02 TOTAL	RF-MW-02 DISSOLVED (FILTERED)	RF-MW-03 TOTAL	RF-MW-03 DISSOLVED (FILTERED)
Aluminum	4600 J	18.1 UJ	94900 J	1710 J	58000 J	16.3 UJ
Antimony	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U
Arsenic	3.8 J	3.2 U	66.8	24.2	81.1	58.5
Barium	178 J	123 J	1180	125 J	622	84.2 J
Beryllium	0.35 U	0.30 U	4.6 J	0.30 U	3.2 J	0.30 U
Cadmium	1.5 U	1.5 U	38.1	1.5 U	1.5 U	1.5 U
Calcium	102000	100000	320000	298000	230000	209000
Chromium	3.7 J	2.6 UJ	110 J	2.6 UJ	66.7 J	2.6 UJ
Cobalt	1.8 U	1.3 U	44.9 J	15.4 U	36.1 J	3.5 U
Copper	7.4 U	1.9 U	142	1.9 U	51.8 U	1.9 U
Iron	3410	5.8 U	77700	859	58000	5210
Lead	1.6 J	2.9 J	187	1.7 J	29.5	3.9
Magnesium	21900	21000	74800	47800	75800	54300
Manganese	150	74.9	22300	19900	11500	8350
Mercury	0.33	0.17	0.49	0.10 U	0.10 U	0.17
Nickel	2.7 U	2.6 U	93.1	16.4 U	71.2	8.6 U
Potassium	1780 J	1460 J	22100 J	3800 J	12800 J	1070 J
Selenium	3.9 U	3.9 U	19.5 UJ	3.9 U	19.5 UJ	3.9 U
Silver	3.6 U	3.6 U	3.6 U	3.6 U	3.6 U	3.6 U
Sodium	26200	26000	83600	82400	85900	84000
Thallium	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U
Vanadium	6.8 J	3.2 J	149	3.4 J	88.9	2.5 U
Zinc	24.7 U	7.0 U	448	20.6 U	177	5.7 U

TABLE 8 CONT.
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR GROUNDWATER - LANDFILL AREA
CONCENTRATION IN µg/L
TDD #T08-9210-041

ANALYTE	RF-MW-03 (DUP.) TOTAL	RF-MW-03 (DUP.) DISSOLVED (FILTERED)	RF-GW-04 TOTAL	RF-GW-04 DISSOLVED (FILTERED)	RF-GW-30 (RINSATE BLANK)
Aluminum	44700 J	14.7 UJ	15700	191 B	14.7 UJ
Antimony	14.8 U	14.8 U	24.3 U	33.2 B	17.9 J
Arsenic	81.7	70.0	3.7 B	3.6 U	3.2 U
Barium	514	85.1 J	196 B	93.9 B	1.4 U
Beryllium	2.4 U	0.30 U	1.3 B	0.90 U	0.30 U
Cadmium	1.5 U	1.5 U	3.3 U	3.3 U	1.5 U
Calcium	230000	211000	42200	43500	201 J
Chromium	48.8 J	2.6 UJ	10.5	7.8 U	2.6 UJ
Cobalt	28.2 J	3.5 U	11.0 B	6.0 U	1.3 U
Copper	37.6 U	1.9 U	30.0	171 EN*	1.9 U
Iron	44900	5240	14100	151	18.1 U
Lead	29.9	2.7 J	627 N*	40.9 N*	2.7 J
Magnesium	72000	54900	12200	8380	49.6 U
Manganese	11200	8440	162 E	19.5 E	7.0 U
Mercury	0.10 U	0.10 U	0.20 U	0.20 U	0.10 U
Nickel	55.1	7.2 U	13.0 B	11.1 U	3.4 U
Potassium	10500 J	1060 J	3970 B	1360 B	108 J
Selenium	19.5 UJ	3.9 U	3.0 UNW	3.0 UN	3.9 U
Silver	3.6 U	3.6 U	2.4 UN	10.0 UN	3.6 U
Sodium	87800	84700	16100	16800	259 J
Thallium	3.8 U	3.8 U	1.6 U	1.6 U	3.8 U
Vanadium	69.5	2.6 J	35.7 UN	35.7 UN	2.5 U
Zinc	136	5.7 U	136 EN	20.1 EN	5.7 U

TABLE 9
RICHARDSON FLATS TAILINGS
LIST OF INORGANIC DATA QUALIFIERS
TDD #T08-9204-015

B - Entered if the reported value is less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).

E - The reported value is estimated because of the presence of interference. An explanatory note must be included under comments on the Cover Page (if the problem applies to all samples) or on the specific FORM I-IN (if it is an isolated problem).

J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required detection limits or quality control criteria were not met.

N - Matrix spiked sample recovery not within control limits.

S - The reported value was determined by the Method of Standard Additions (MSA).

U - Entered if the analyte was analyzed for but not detected, i.e., less than the IDL.

W - Post digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.

* - Duplicate analysis is not within control limits.

+ - Correlation coefficient for the MSA is less than 0.995.

APPENDIX A

MEMO TO EPA/OSC DATED AUGUST 6, 1992,
INSPECTION OF THE TAILINGS DAM AT RICHARDSON FLATS

ecology and environment, inc.
1776 SOUTH JACKSON STREET, DENVER, COLORADO 80210, TEL. 303-757-4984
International Specialists in the Environment

Memorandum

To: Mike Zimmerman
EPA-OSC
From: Mike Sullivan
TAT Region 8
Date: 8/6/92
Subject: Inspection of the Tailings Dam at Richardson Flats T08-9204-015.

Under TDD# T08-9204-015 the U. S. Environmental Protection Agency (EPA) tasked the Ecology & Environment, Inc. Technical Assistance Team (TAT) to inspect the Tailings Dam at the Richardson Flats Tailings Pond near Park City, Utah and to provide a report on the findings of the inspection. The inspection did not encompass any trenching or boring in the embankment which would be required for a full assessment of the structure. This report relies heavily on the two reports generated by Dames and Moore, Inc., and on a visual inspection of the structure. The Dames & Moore reports are "Report of Embankment and Die Design Requirements Proposed Tailings Pond Development Near Park City, Utah for Park City Ventures Corporation" (1974) and "Report on Tailing Pond Investigation near Park City, Utah for Noranda Mining, Inc" (1980).

BACKGROUND

The Richardson Flats Tailings Pond, located near Park City, Utah, was a tailings pond which received slurried mill and mine wastes from mining operations in the Park City area. Tailings were transported to the pond via a slurry pipeline. According to the historical records, Richardson Flats was originally a flat area with intermittent drainages and Silver Creek running across it. The area was somewhat marshy and boggy. The original tailings dam was constructed of organic soils excavated from the site and piled up to form a small berm. Later raises for the embankment were constructed, as needed, out of sands, gravels, organic silts, as well as rubbish and garbage (Dames & Moore, Inc 1974).

In 1974 Dames & Moore, Inc. was contracted by Park City Ventures Corporation, the owners of the mine, to investigate enlarging the tailings pond. Dames & Moore Inc., was to provide design requirements for the proposed embankments with special attention given to minimizing seepage of contaminated pond effluent from the tailings pond. The investigation program consisted of exploratory

boring, test pits, laboratory analysis for strength characteristics of the soils, and analysis of the data to provide design requirements. The report called for construction of a main embankment, a dike along the southern and northern ends of the pond, and construction of a diversion ditch to route runoff away from the pond.

In 1974 the embankments and diversion ditch were constructed, generally in accordance with the requirements as outlined in the Dames & Moore report.

In 1980 Dames & Moore, Inc. again investigated the structure for Noranda Mining, Inc., the new owners of the mine. As stated in the reports introduction the objective of this investigation was to "... assess the overall condition and usefulness of the existing facilities and to determine what measures will be required for long-term tailings disposal from the Park City mine." In this report Dames & Moore noted that enlargement of the embankment had not been ..."built according to recommendations ..." and that the fill was not "...properly engineered during construction.". Specific problems noted by Dames & Moore in the construction of the main embankment included: oversteepened slopes of approximately 1.5:1.0 in many places, no evidence of internal zoning of the embankment (clay core), the recommended drainage zone at the downstream toe was not installed, and that overall compaction of the material in the embankment was poor. Also noted at this time was "... considerable seepage in the form of small seeps and marshy areas on the northwest abutment and at the downstream toe of the main embankment...". The report recommended adding a drainage blanket to the toe of the embankment, flattening the oversteepened slope of the main embankment, and gave construction sequences for adding to the dikes.

FIELD INSPECTION

On August 4, 1992 TATm Sullivan inspected the main abutment of the Tailings Pond. From visual inspection and referencing the cross sections provided in the Dames & Moore report it appears that the dike was raised from the 1980 levels although not to the ultimate design levels. It is probable that the main embankment was also raised at the same time. No data is available on the construction or construction inspection of this last round of construction. The visual inspection also indicated that the oversteepened slope of the main embankment had not been flattened and that the drainage zone at the toe of the main embankment had not been installed.

The Main Embankment-

The main embankment is about 30 feet high with a slope length of approximately 50 feet. The main embankment is oversteep lying at 1.0:1.0 to 1.5:1.0 (run:rise). Approximately 6" of fine dry sand, possibly windblown tailings, was noted under a 3" topsoil cover layer on the downstream face of the embankment. The sand has no

strength and will erode quickly if exposed. A 35% to 50% grass cover was on most of the embankment which will help in erosion control. No cracking was evident on the embankment,although the sand layer would tend to hide any small cracking. Also, no bending (bulging) was noted on the embankment.

Toe of the Main Embankment-

Rank vegetation, in the form of willows and trees, is growing at the toe of the dam. Approximately 8" of loamy damp soils are evident on the toe of the dam. The amount of vegetation and the type of soils on the toe of the dam indicate that the area receives a lot of water. As the wet soils were noted approximately 6 to 8 feet above the stream level this water is probably due to seepage under the dam. Other evidence of seepage from the toe of the dam was evident in the form of; soft marshy areas, rank vegetation including willows, loamy soils, damp soils, and areas where water had been standing (although no standing water was observed on August 4th).

The North Abutment-

A swampy, loamy area on the north abutment, adjacent to where the embankment meets the abutment, was noted. The area was well above the toe of the dam at the location of the north monitoring well. The north abutment well recharged well when bailed. These conditions indicate that water seeps around or through the contact between the abutment and the embankment. Under full head conditions (saturated tailings) this could be an area where failure of the embankment could occur.

Crest of the Main Embankment-

The crest is sloped back toward the tailings pond allowing any water to drain back to the tailings pond. However, small erosional gullies are forming on the crest and downstream face of the dam and could eventually lead to larger gullying on the dam.

Water Flow-

Water elevations behind the embankment are unknown, however the elevation of water in the ditch and the pond south of the tailings pond are probably indicative of the elevation of groundwater behind the embankment. From the information available in the Dames & Moore, Inc. reports, it is unlikely that a cutoff wall was installed around the perimeter of the pond to control seepage under either the embankment or the dike. The piezometer located on the toe of the dam indicated the water level to be 5 feet below ground. The swampy ground and recharge rate of the monitoring well on the north abutment indicates that water flow from some source is occurring. Inspection of the road cut north of the abutment revealed no seeps. Without further investigation it is conservative to use a worst case scenario and assume that the source of the seep is the water in the tailings behind the dam and

that the abutment\embankment contact is a drainage path for the water.

Perimeter Dike-

The perimeter dike was probably constructed by stripping materials off of the downstream side and piling the undifferentiated material up as a dike. The slopes are approximately 2.0:1.0. The dike is used as the access road for the pond and its elevation varies from 2 to 5 feet above the level of the tailings in the pond. The dike appears to be in good condition.

Diversion Ditch-

The diversion ditch has been constructed along the perimeter of the tailings pond as designed by Dames & Moore. The ditch depth and width varies, generally getting deeper and wider as it progresses downstream. Standing water was evident in most of the ditch on the southern perimeter of the property. Rushes, sedges, and cattails were growing in the bottom of the ditch along the entire length. Recent work has been performed by the owners in flattening the ditch banks and adding topsoil to the banks. This work is approximately one-half completed. According to the owners, the rest of the ditch is to be similarly regraded and topsoiled. At the time TAT inspected the site, the hillside diversion ditch, on the north perimeter of the tailings pond, had been cut off from the main ditch as a result of topsoil stripping. This important feature should be reconnected to the main ditch as soon as feasible to prevent additional water flowing into the tailings pond.

CONCLUSIONS

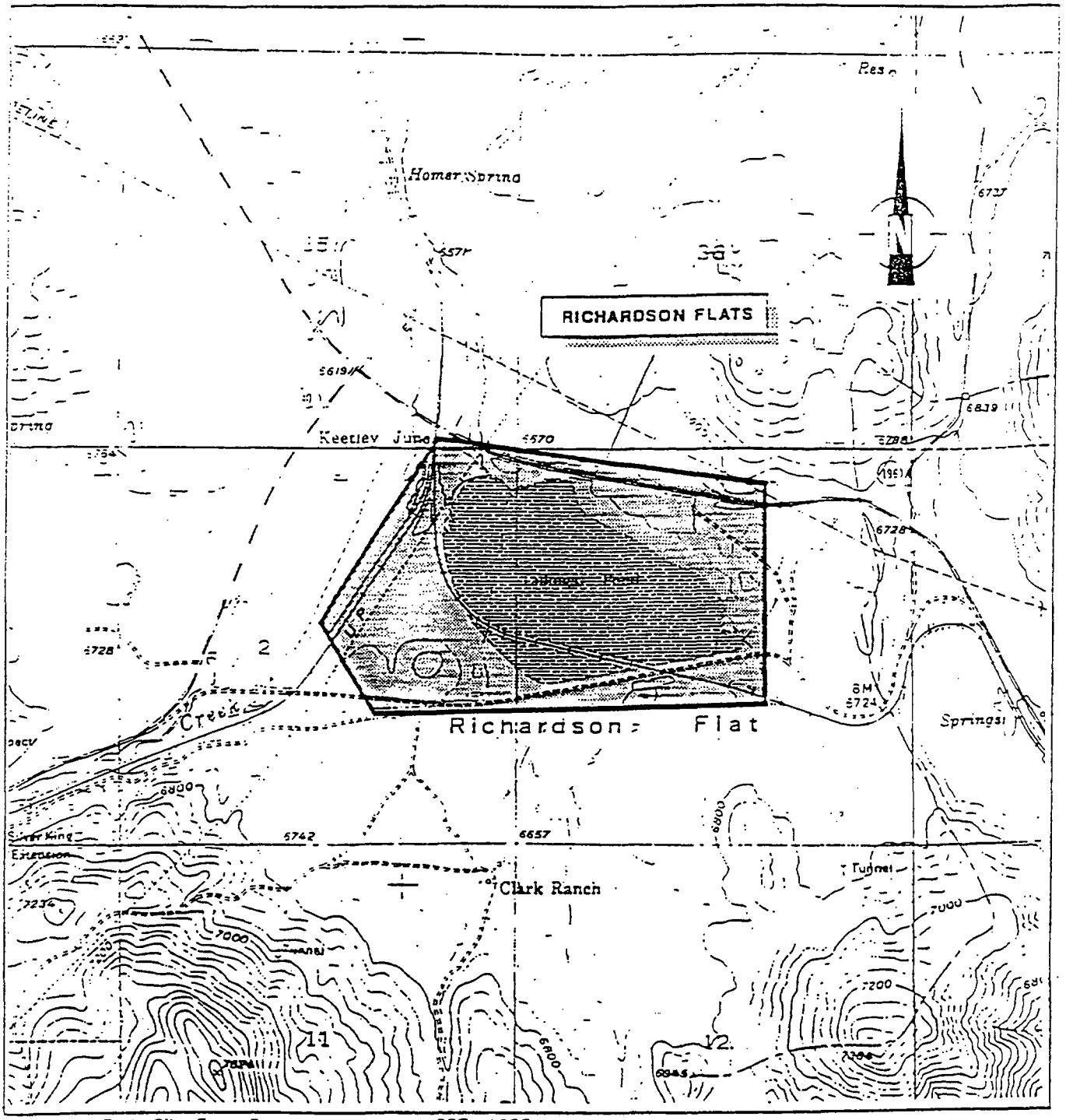
kBased on TATs inspection, the previous investigation conducted by Dames & Moore, and that the tailings pond seems to be essentially dry, there would appears to be no imminent threat of failure of the main embankment. Failure could occur due to the oversteepened nature of the embankment, especially if the embankment becomes saturated due either to saturation of the tailings or to saturation of the embankment itself. A threat exists of undermining of the dam through the uncontrolled seepage areas located along the toe of the main embankment and on the north abutment. Again the threat would be increased if the tailings become saturated thus increasing the head pressure and possibly the velocity of water flow through the seeps.
The property owners are keeping open the option of reactivating the tailings pond. If the tailings pond is reactivated additional recommended actions are noted in paragraph B. below.

RECOMMENDATIONS

A. Keeping the tailings pond dry through the maintenance of the diversion ditches will do the most to prevent failure of the embankment and a possible release of the tailings into the environment. The connection between the hillside diversion

ditch and the perimeter diversion ditch should be restored. In the future, the slopes on the main embankment should be flattened to 2.0:1.0 or greater, and the toe drainage blanket should be installed to allow liquids to drain away from the embankment. A monitoring well should be installed on the top of the tailings pond next to the embankment to monitor the elevation of groundwater within the pond and at the embankment. With water level elevation data available for both upstream of the embankment and at the toe of the embankment better, evaluations of the stability of the structure can be made. If any seeps appear on the embankment they should be monitored for both quantity and quality. Seeps carrying a sediment load generally indicate that active undermining of the embankment may be occurring. Undesirable vegetation in the form of willows and trees should be removed from the embankment.

B. If the pond is to be used for tailings deposition, saturation of the existing tailings is a distinct possibility. With saturation, the possibility of failure of the embankment is raised due to the oversteepened slopes, the existing seeps in the downstream toe of the dam, and the seeps along the north abutment. Saturation of the tailings would increase the head pressure on the seeps, possibly increasing the velocity and amount of water seeping through the embankment. Also, saturation of the tailings will tend to raise the water surface within the embankment itself. Wetting of the material within the embankment can significantly reduce the ability of the material to resist failure. Because the embankment is apparently constructed of undifferentiated materials it would be prudent to add in the drainage blanket at the toe of the embankment and to flatten the embankment as recommended in the 1980 Dames & Moore report. The possibility of a cut-off wall being installed in the embankment should also be investigated. Also, continual monitoring of the seepage from the toe, installation of a network of piezometers and inclinometers is recommended to continually assess the integrity and stability of the embankment.

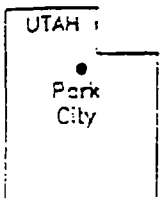


Source: Park City East Quadrangle, Utah, USGS, 1955

0 1/2 1 MILE

1000 0 1000 2000 3000 4000 5000

LOCATION MAP



LEGEND

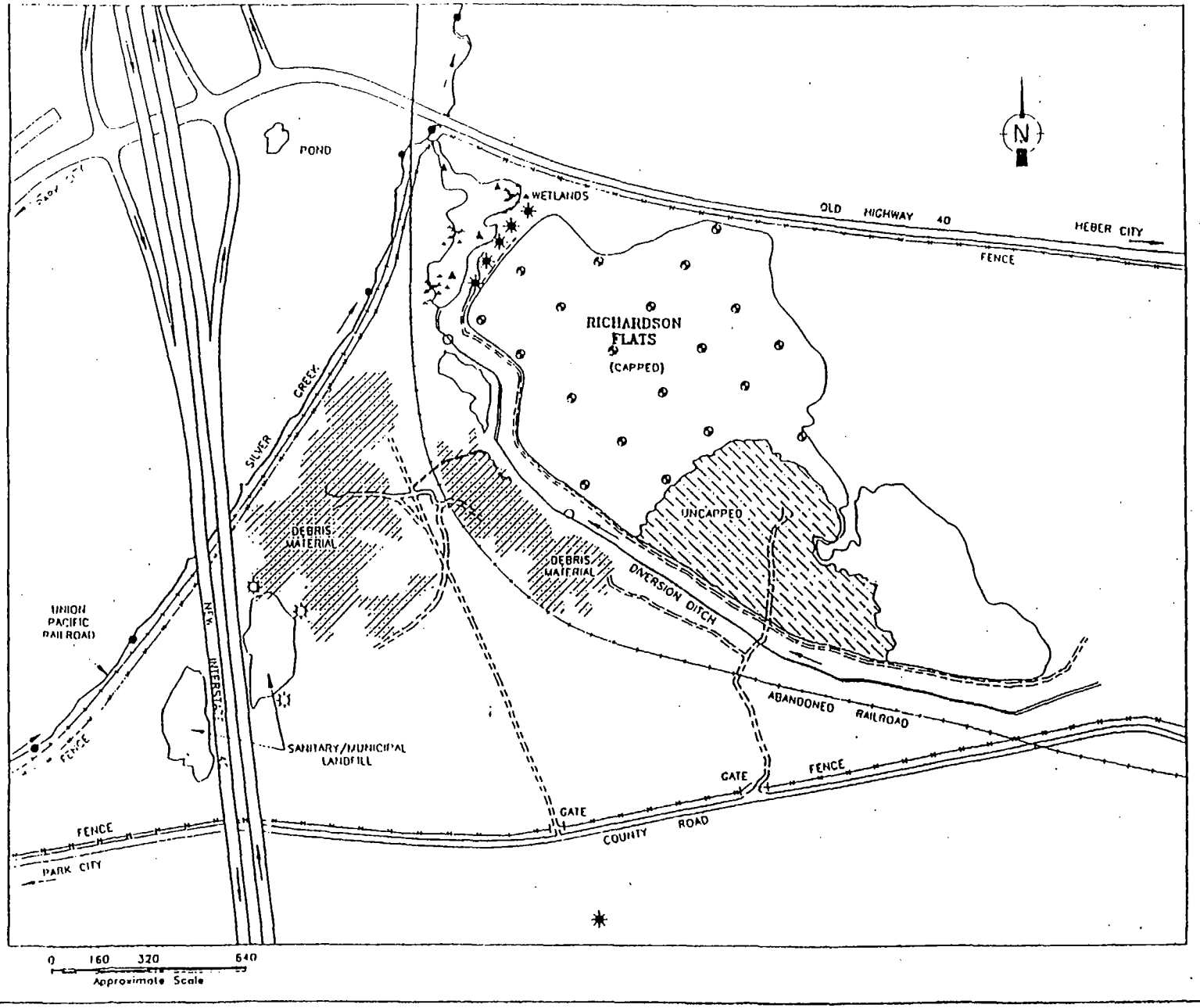
Site location

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE, REMOVAL AND PREVENTION
EPA CONTRACT 68-WO-0037

TITLE:

RICHARDSON FLATS
Park City, Utah
SITE LOCATION MAP

T.D.D. T08-9204-015



LEGEND

- Approximate location of existing monitoring wells to be sampled
- Proposed monitoring wells to be installed and sampled
- Location of surface water samples from Silver Creek
- Surface water samples from diversion ditch (Two upgradient locations will be determined at the time of sampling in the Northeast portion of the site)
- Location of sediment samples
- Location of soil boring

Note: All air samples will be collected off site

TECHNICAL ASSISTANCE TEAM FOR EME
RESPONSE, REMOVAL AND PREVEN
EPA CONTRACT 68-WO-0037

TITLE:
RICHARDSON FLATS
Park City, Utah
SAMPLE LOCATION MAP

T.D.D. T08-9204-015

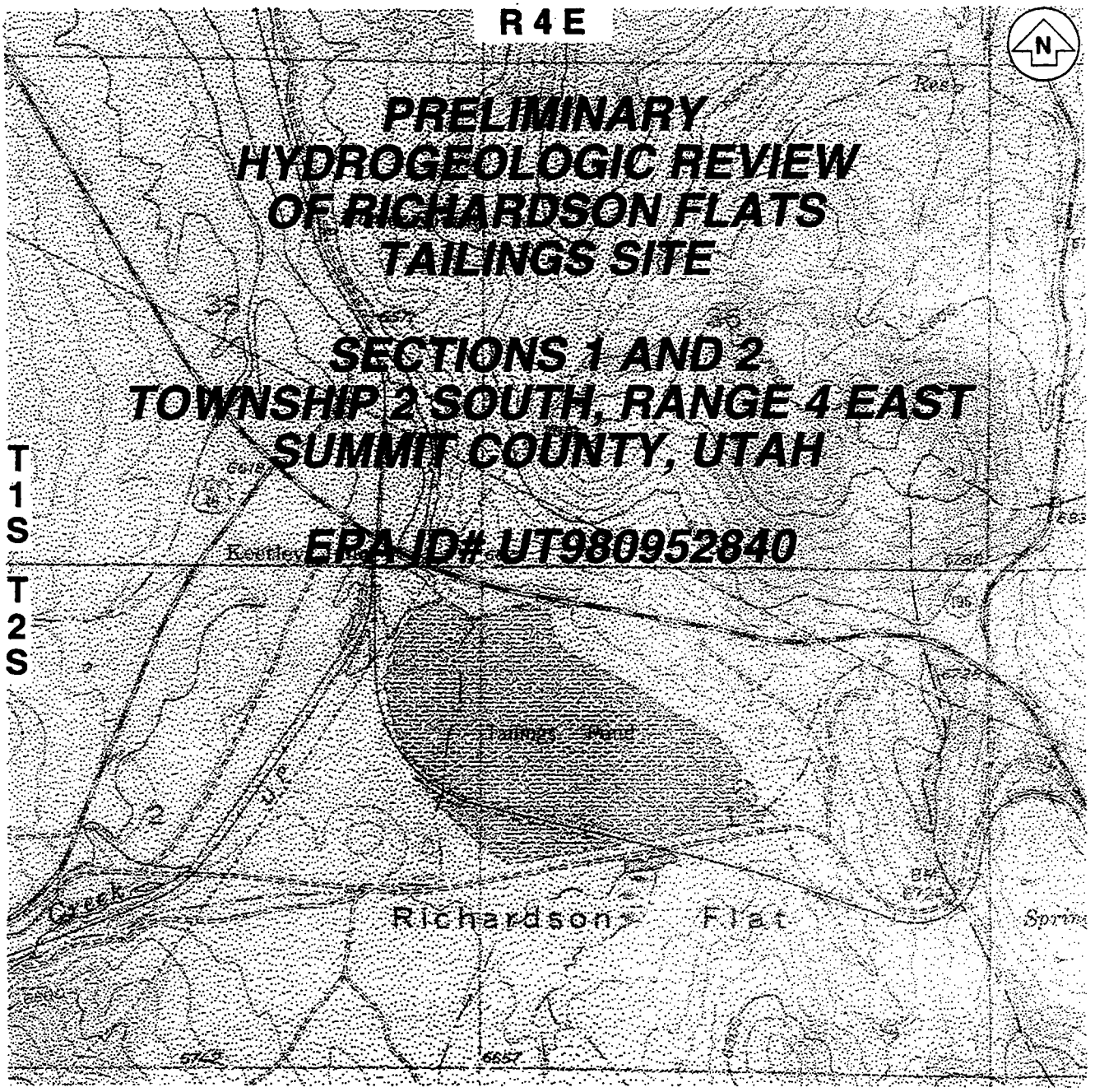
ecology & environment, inc.
DENVER, COLORADO

Date: 05/92 Drawn by: RSM Scale:

PRELIMINARY HYDROGEOLOGIC REVIEW OF RICHARDSON FLATS TAILINGS SITE

SECTIONS 1 AND 2 TOWNSHIP 2 SOUTH, RANGE 4 EAST SUMMIT COUNTY, UTAH

ERA ID# UT980952840



Base map adapted from U.S. Geological Survey Park City East, Utah 7.5 Minute Topographic Map, 1955

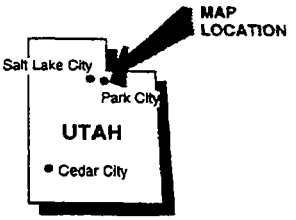
0 — 1 MILE

SCALE

MARCH, 1999

PREPARED BY

WESTON ENGINEERING, INC.



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PRELIMINARY
HYDROGEOLOGIC REVIEW
OF RICHARDSON FLATS TAILINGS SITE

SECTIONS 1 AND 2
TOWNSHIP 2 SOUTH, RANGE 4 EAST
SUMMIT COUNTY, UTAH

EPA ID# UT980952840

March 23, 1999

Prepared For

LeBOEUF, LAMB, GREENE & MacRAE, L.L.P.
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Prepared By

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Park City, Utah
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Todd Jarvis, P.G. & Bill Loughlin, P.G.

PRELIMINARY HYDROGEOLOGIC REVIEW OF RICHARDSON FLATS TAILINGS SITE

STATEMENT OF THE PROBLEM

Richardson Flats covers an area encompassing approximately 700 acres in a small valley located about 1.5 miles northeast of Park City, Utah. The Environmental Protection Agency (EPA) placed the site on the CERCLIS listing as EPA ID# UT980952840 and nominated the site to the National Priorities List (NPL) in 1992 due to the presence of potentially hazardous substances associated with disposal of mill tailings on approximately 160 acres; however, the site has not been listed on the NPL. An abundance of investigative work was completed by design consultants working on behalf of various mining companies to design the tailings impoundment during the 1970s and early 1980s. EPA contractors commenced reconnaissance-level environmental investigations in support of the Hazard Ranking Scoring (HRS) in the 1980s. However, prior to 1999, little work was conducted on developing a hydrogeologic conceptual model using the readily-available information.

PURPOSE AND SCOPE OF REPORT

The purpose of this report is to present a conceptual hydrogeologic model of the Richardson Flats site focusing on the occurrence and movement of groundwater. The mutually-agreed upon scope of work between LeBOEUF, LAMB, GREENE & MacRAE, L.L.P. and Weston Engineering, Inc. (WESTON) involved the following tasks:

- Perform initial field measurements and observations;
- Compile available historic and current data;
- Develop initial conceptual model of groundwater occurrence, interaction with surface water, and direction and magnitude of hydraulic gradients and groundwater flow;
- Identify data gaps and locations where additional information is needed;
- Establish new data collection points, if needed;
- Integrate new information with existing information;
- Refine conceptual hydrogeologic model; and
- Prepare this summary report.

This summary report is based on geologic and hydrologic data contained in published and unpublished reports, as well as field observations made during a confirmation drilling and hydrogeologic data collection program completed in January and February, 1999. Water quality issues are not a part of this investigation.

HYDROGEOLOGIC SETTING OF RICHARDSON FLATS

Location

Richardson Flats is located in Sections 1 and 2, Township 2 South, Range 4 East in Summit County, Utah. The tailings impoundment is located within a few hundred feet of Silver Creek, a perennial stream draining the Park City area where other historic tailings ponds were located (see Mason, 1989).

Structural Geology

While the Richardson Flat tailings pond is located within a complex fold and thrust belt later intruded and overlain by volcanic rocks, mapping by Bromfield and Crittenden (1971) place no faults near the site (see Geologic Map Inset - Plate I). Examination of low-altitude aerial photography indicates that the volcanic

rocks near the site are fractured; linear ridges in the surface topography indicate potential faults near Homer Spring and along a northeast-southwest trending ridge located east of Keetley Junction.

Stratigraphic Setting Based on Historic Data

EPA records indicate that the Richardson Flat tailings pond was apparently constructed during 1953 on alluvium and colluvium derived from Silver Creek and the attendant subsidiary drainages. The alluvium and colluvium is approximately 30 to 50 feet thick on the basis of logs of geotechnical borings and studies completed as part of the improvements to the reconstruction of the tailings pond in the 1970s, in addition to the logs of monitoring wells installed to assess groundwater impacts in the 1980s (see Dames & Moore, 1973; 1974; 1980; and Ecology and Environment, 1985). While the data distribution is less than ideal, the available information indicated the following materials comprise the stratigraphy of the alluvial and colluvial debris:

- Two-to-five feet of soft, organic and clay-rich topsoil;
- One-to-30 feet of various mixtures of fine-grained silt and clay;
- Four feet of sand and gravel; and
- Variable thickness of highly-weathered volcanic breccia composed of relatively soft, tight, sandy and silty clay grading to moderately hard, slightly to moderately fractured volcanic rocks.

Recent exploratory drilling by the Park City Municipal Corporation at a site located approximately one mile northwest of the tailings pond determined that the underlying Keetley volcanic rocks may be more than 1,000 feet thick (see Geologic Map Inset - Plate I). Mapping by Bromfield and Crittenden (1971) indicate that well-indurated Mesozoic and Paleozoic limestones, sandstones, and shales may underlie portions of the Richardson Flats area. Holmes and others (1986) report that some of these rock units serve as aquifers where saturated and permeable.

The tailings overlie the topsoil composing the original surface grade. The dark-colored, clay-rich organic topsoil was consistently logged by the various geotechnical and environmental investigations, and serves as the best horizon to correlate between the widely-spaced borings. The pre-tailings topography of the area was integrated with the test pits located within the tailings pond to estimate the thickness of the tailings. These data indicate that the thickness of the tailings is approximately 10 to 18 feet and perhaps thicker along the northern boundary.

Hydrogeologic Overview Based on Historic Data

Examination of the historic boring and well logs in the area indicated that at least four shallow groundwater systems may be found in the Richardson Flat area:

- Shallow alluvium with possibly a perched water table;
- Deeper alluvium composed of confined sand and gravel aquifer(s);
- The underlying and adjacent fractured Keetley volcanic rocks; and
- The impounded tailings.

Alluvium. The boring log for the upgradient monitoring well installed by Ecology and Environment (1985; see RT-1 in Attachment No. 1) [redacted] first encountered at a depth of 17 feet within primarily red-brown clay and gravelly [redacted] drilling [redacted] countered yellow-gray clay from 15 to 23 feet, red-brown sandy clay from 23 to 34 feet, and gravel yielding 10 to 15 gallons per minute (gpm) from 34 to 38 feet. Following completion of the boring as a monitoring well with screens set across both intervals where water was reported, the static water level was found at 9 feet below ground surface. Because the post-completion static water level was higher than the "first" water, one reasonable interpretation of the limited post-completion data is that (1) the boring initially encountered a water table aquifer; (2) deeper

drilling encountered a sand and gravel zone under confined conditions; and (3) the completed well connected these two previously separate aquifers.

Keetley Volcanics. The underlying weathered and unweathered Keetley volcanic rocks have low intrinsic permeabilities and yield low quantities of groundwater to wells and springs. Dames & Moore (1974) report that the low hills located north of the impounded tailings are covered by dark brown, stiff, clay of varying thickness; three to four feet of this material was encountered in Test Pit Nos. 20 and 21 (see Plate I). Dames & Moore (1974) further report the clayey material grades with some sand and dense clayey sand indicative of highly weathered volcanic breccia.

Park City Municipal Corporation recently installed a test well in the southeast corner of Section 34, Township 1 South, Range 4 East, approximately one mile northwest of the tailings pond. The well was spudded on the weathered Keetley Volcanics with the underlying Thaynes Limestone as the targeted aquifer. However, the Thaynes Limestone was not encountered at the final drilled depth of 1,000 feet. While the exploratory boring developed water from the fractures in the unweathered Keetley volcanic rocks, the quantity of water that could be reasonably developed from the Keetley Volcanics at this location was between 100 to 200 gpm with long-term drawdown estimated at 250 to 300 feet (specific capacity = 0.33 to 0.4 gpm per foot of drawdown (gpm/ft) or a transmissivity of 30 to 50 ft^2/day). This yield was considerably less than the quantity desired by Park City for a municipal water supply, and the well remains unused (see Hansen, Allen & Luce, 1996).

No water quality samples were collected from this well for analysis of potability; however, Hansen, Allen & Luce (1996) imply that the water quality may be suitable for short-term irrigation. Nearby springs also discharge water at approximately four to eight gpm with low total dissolved solids (TDS) from these volcanic rocks (Holmes and others, 1986; Downhour and Brooks, 1996).

Impounded Tailings. Based on the test boring installed by Ecology and Environment (1985; see RT-2 in Attachment No. 1), the tailings were partially saturated. Water level measurements made during the 1973 and 1974 design phases of the tailings pond development, coupled with the 1985 water level measurements, indicated that the lower 15 feet of the tailings were saturated. Cursory examination of the historic water level data indicated that the groundwater within the tailings flowed from southeast to northwest under a gentle hydraulic gradient (0.0031).

PRELIMINARY CONCLUSIONS BASED ON AVAILABLE HYDROGEOLOGIC DATA

On the basis of the historic records, uncertainty existed regarding (1) the degree of saturation within the tailings; (2) the hydraulic connection between water stored in the tailings and the shallow alluvial aquifer(s); (3) the hydrologic characteristics of the shallow aquifer(s) with respect to water table or confined conditions; (4) the hydraulic connection between the shallow aquifer(s) and Silver Creek; and (5) the hydraulic gradient in the shallow aquifer(s) between the historic landfill investigated by Ecology and Environment (1993) and the tailings embankment (see Plate I for location of historic landfill monitoring wells).

Supplemental work was conducted during early 1999 to build upon rather than duplicate the previous work efforts. This work included:

- Installation of piezometers within the tailings pond to determine whether the tailings remain partially saturated;
- Installation of piezometers outside the tailings pond to compare and contrast the hydraulic head across the embankment to evaluate the degree of hydraulic connection, if any, between the impounded tailings and shallow aquifer(s), and between Silver Creek and the shallow aquifer(s);
- Confirmation of the apparent upward hydraulic gradient indicated by the upgradient monitoring well (RT-1) installed by Ecology and Environment (1985); and
- Better characterization of the hydrogeology between the historic landfill and the downgradient tailings embankment.

SUPPLEMENTAL SOIL SAMPLING AND WATER LEVEL MEASUREMENT PROGRAM

Drilling and Piezometer Installation

Geotechnical borings and small-diameter piezometers were installed using direct-push and hollow stem auger methods during the week of January 25, 1999. Plate I depicts the locations of the supplemental drilling locations, in addition to the numerous historic test pits, borings, and existing monitoring wells in and near the tailings pond. Note the piezometer numbering system for the recent drilling program follows that employed by Ecology and Environment (1985). Ecology and Environment (1985) designated their hydraulically upgradient well as RT-1 and the boring within the tailings as RT-2. Other borings installed during this investigation were labeled in sequence of installation beginning with RT-3. Shallow borings designed to test the presence of shallow aquifer(s) were designated with the letter "A" following the boring number and the deeper borings designed to test for deeper aquifer(s) were designated with a letter "B". The lithologic logs and a description of the as-built configuration for the individual piezometers can be found in Attachment No. 1.

The supplemental lithologic information indicated the following materials, from top to bottom, comprise the stratigraphy of the tailings pond and the underlying and adjacent alluvial and colluvial debris:

- Clay-rich artificial fill derived from the burrow area depicted on Plate I and capping the impounded tailings approaches one foot in thickness;
- Fine-grained sand tailings approximately 16 to 18 feet thick in the central portion of the tailings pond, and perhaps thicker along the northern boundary;
- Two-to-five feet of clay-rich organic pre-tailings topsoil found in every test pit and boring in the tailings;
- Approximately 15 feet of reddish-brown mixtures of silt and clay;
- Two-to-six feet of reddish-brown gravelly clay;
- Two-to-ten feet of reddish-brown to yellow-brown mixtures of silt and clay; and
- Two-to-ten feet of clayey sand and gravel.

Plate I provides conceptual hydrogeologic cross sections summarizing the local distribution of the various lithologies by integrating the historic test pits, borings, and supplemental borings.

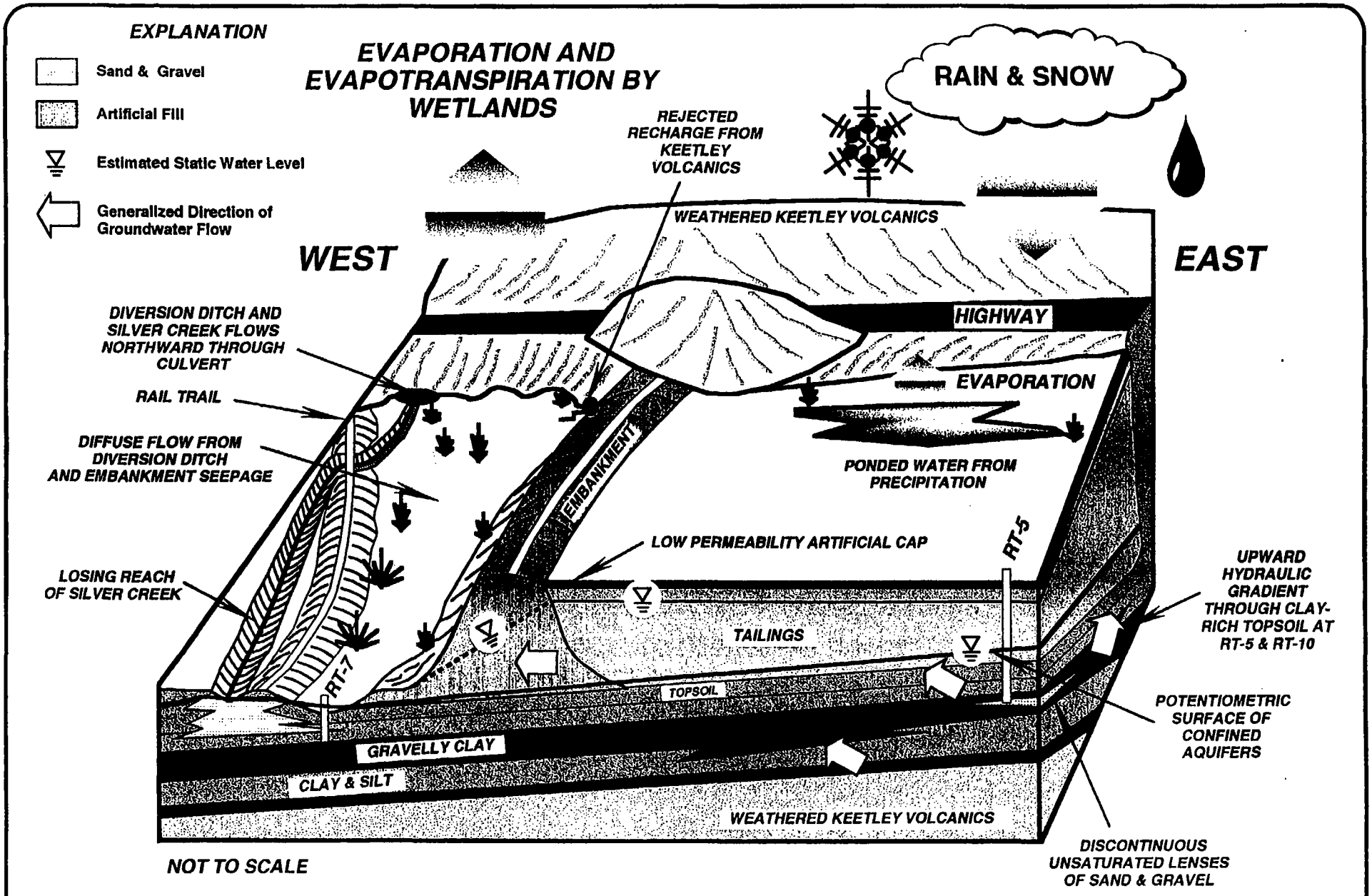
Clay Mineralogy Analysis

Knowledge of the clay mineralogy in fine-grained soils provides information on the engineering behavior of soils and potential attenuation capacity for certain contaminants. Selected soil samples from boring RT-5 were analyzed using X-ray diffraction (XRD) techniques to better characterize the mineralogy of the fine-grained sediments overlying and underlying the tailings. Samples from boring RT-5 were selected because the materials encountered included the best representation of (1) the artificial cap overlying the tailings, (2) the clay-rich organic topsoil found beneath the tailings, and (3) the clay-rich soils found beneath the top soils which created confined conditions in the deeper saturated soils. A discussion on sample preparation methods and copies of the various figures referenced below can be found in Attachment No. 2. The rectangular boxes beneath the individual XRD traces are XRD peaks for standard patterns prepared by the Joint Committee on Powder Diffraction Standards (JCPDS) which can be accessed by the computer serving the XRD device.

Artificial Cap. Material for the artificial cap was derived from the weathered volcanic rocks on the low hills north of the tailings impoundment. XRD results for the sample of the artificial fill capping the tailings found from 0 to 0.7 feet closely match the XRD peaks for illite and kaolinite. Kaolinite is the most prevalent clay mineral and is stable with little tendency for volume change when exposed to water. Illite is generally more plastic than kaolinite and does not expand when exposed to water.

Color Map(s)

The following map(s) contains color photographic imagery that the scanned image cannot capture to the full quality of the source document.



WESTON

HYDROGEOLOGIC REVIEW
RICHARDSON FLATS TAILINGS SITE
PRELIMINARY CONCEPTUAL MODEL OF SHALLOW AQUIFER GROUNDWATER FLOW SYSTEM

Native Soil Beneath Tailings. The sample of the clay-rich organic topsoil found below the tailings at approximately 11 feet in depth, in addition to the underlying sandy clay found between 13 and 14 feet, closely match the XRD peaks for the clay mineral sepiolite. The characteristic peak at a d-spacing of 12Å does not match any other "simple" clay minerals. However, it is possible that the clay identified as "sepiolite" is in fact a rather ill-defined mixed-layer clay mineral (mixed mica and illite or smectite, for example) which can be found in relatively immature soils on granitic bedrock. The distinction cannot be made without further analysis. Smectite readily absorbs water between clay layers yielding large volume changes because of this property. Likewise, because of the weak bond between layers, various contaminants can be absorbed by the mixed-layered clays.

Groundwater Occurrence and Circulation Model

Because of the fine-grained texture of the shallow aquifers, the water levels in the recently-installed piezometers were allowed to stabilize for at least four days following installation prior to measurement. A summary of the water level measurements can be found both on the individual boring logs, and in the table provided on Plate I. The point of reference for all measurements is the ground surface next to the individual piezometer or well. Elevations of selected water surface locations along Silver Creek and the diversion ditch located south of the tailings pond were also surveyed for points of reference, as indicated on Plate I.

The recent water level measurements in the local wells and piezometers indicate that the three principal shallow groundwater systems underlying the Richardson Flats area are as follows:

- Shallow alluvium along Silver Creek under unconfined conditions;
- Deeper alluvium and colluvium composed of confined sand and gravel aquifer(s) mixed with abundant fine-grained materials; and
- The impounded tailings under unconfined conditions.

Confined Aquifers. Groundwater stored in the saturated and permeable strata comprising the shallow aquifers adjacent to the tailings pond is found under confined conditions in at least three discrete intervals. Examination of the hydrogeologic cross section A-A' depicted on Plate I reveals the first water bearing interval is found at approximately 15 to 20 feet in depth. The deeper water bearing intervals are found between 25 to 35 feet in depth. Because the water levels in piezometers RT-1A/B and RT-8A/B rise above the top of the identified aquifers, the low permeability fine-grained silt and clay found overlying and layered between the shallow and deeper aquifers serve as effective confining strata.

The hydraulic communication between the shallow and deeper water bearing intervals appears to be poor. Examination of the water level elevations measured in February, 1999 and summarized on the table on Plate I indicates nearly 0.4 feet of head difference between the shallow and deeper aquifers in the vicinity of RT-1A/B. The hydraulic gradient between these aquifers is downward at this location. Likewise, the water levels in the piezometer series RT-8A/B indicates a similar hydrologic relationship with the exception that the hydraulic gradient between the deeper and shallow aquifer is upward (see hydrogeologic cross section A-A'). Mason (1989) reported a downward component of groundwater flow similar to that observed at Richardson Flats in the unconfined to semi-confined unconsolidated valley fill aquifer(s) underlying the Silver Creek tailings site near Prospector Square.

Groundwater in Impounded Tailings. The depth to water below the artificial fill cap on the impounded tailings is approximately three to five feet (see cross sections A-A' and B-B' on Plate I). Examination of section B-B' reveals some uncertainty regarding the free water surface in the tailings pond because the tailings and underlying materials open to piezometer RT-4 are unsaturated. Likewise, the tailings encountered in boring RT-5 are also unsaturated. For example, the boring encountered unsaturated tailings to a depth of 10.8 feet and was completed in silty sand and sandy clay materials to a depth of two feet below the tailings-topsoil interface (see Boring Logs in Attachment No. 1). However, the water level in piezometer RT-5 is found at an elevation of approximately two feet higher than the elevation of the water levels in the tailings piezometers RT-3 and RT-6.

While the source of the water stored in the tailings remains unknown, reasons for the unsaturated tailings include (1) evaporation prior to capping with artificial fill, (2) the artificial fill cap is composed of low permeability clay-rich material which effectively precludes downward flow of ponded surface water, (3) low-rate leakage across the tailings embankment, and (4) combinations of all of the above. Water level measurements collected during March, 1999 indicate that water levels rose in all piezometers on the order of one to two feet (see table on Plate I). Mason (1989) observed the water levels varying seasonally in monitoring wells completed in the unconsolidated fill near the Silver Creek tailings site, with the season high occurring during March and April. The effects of snow melt and storm water collecting in the tailings pond requires additional study.

Hydrologic Role of Clay-rich Organic Topsoil. The anomalously high water level elevation in piezometer RT-5 is attributed to the hydrologic confining properties of the clay-rich organic topsoil. Examination of the boring log for RT-5 indicates the original topsoil is found at 10.8 feet in depth and the overlying tailings are damp. Deeper drilling found the topsoil damp, becoming increasingly saturated with depth. The underlying silty sand is saturated. The sandy clay beneath the silty sand is moist, yet the deeper gravelly sand found at 14 feet is only damp to moist. The depth to water at RT-5 is 7.3 feet below the ground surface, approximately 3.5 feet above the interface between the unsaturated tailings and the original topsoil.

A hydrologic relationship similar to that defined at piezometer RT-5 is found at piezometer RT-10 located approximately 2,900 feet south of the impounded tailings (see Plate I). The initial 3.5 feet of fine-grained, organic-rich clay and silt soils are partially saturated. The silty sand encountered below 3.5 feet is saturated, and the depth to water in the completed piezometer is 1.1 feet below ground surface. All of these data indicate the topsoil is a low permeability confining layer overlying the shallow aquifers and underlying the tailings at the Richardson Flats site.

Volcanic Rocks. While the underlying and adjacent weathered and unweathered Keetley volcanic rocks may constitute a deeper aquifer, no piezometers were installed in these rocks for the supplemental investigation because the supplemental soil sampling and water level information indicated the shallower aquifers were separated by low permeability confining strata. For example, the artificial fill capping the impounded tailings was derived from the burrow area depicted on Plate I. Percolation tests completed on selected samples of the artificial fill indicated low permeabilities (see Plate I). Likewise, Dames & Moore (1973) indicated that while the permeability of the unweathered and fractured volcanic rocks would be greater at depth, the weathered surface of the volcanic rocks would nearly eliminate seepage to greater depths. An aquifer interference test designed to determine the possible effects of pumping a large capacity well serving Park City Municipal Corporation which was completed in fractured carbonate rocks underlying the unconsolidated sediments along Silver Creek confirmed this apparent lack of hydraulic communication between the shallow and deep alluvial aquifer systems near the Silver Creek tailings site (see Mason, 1989, p. 33)

Generalized Groundwater Flow Model. Examination of the potentiometric surface elevations depicted on Plate I indicates that groundwater flows from areas of higher hydraulic head located south of the tailings pond northward to areas of lower hydraulic head. On the basis of the water level measurements of Silver Creek located west of the impounded tailings and the water level measured in piezometer RT-7, the water surface in Silver Creek is found at a higher elevation than in the adjacent low area. Likewise, groundwater stored in the alluvium at piezometer RT-9 is also found at a higher elevation than the water surface of the pond located along the diversion ditch (see Plate I). Groundwater stored in the shallower aquifers overlain by the clay-rich organic topsoil apparently flows towards the diversion ditch as indicated by the elevations of the potentiometric surface measured in piezometers RT-8 A/B and RT-5.

On the basis of the historic and supplemental geologic and hydrologic data, a hydrogeologic conceptual model of the Richardson Flats area is depicted on Figure 1. Precipitation and snow melt serve as: (1) the principal sources of recharge to the groundwater system; (2) perennial flows to Silver Creek; and (3) surface water ponding on the impounded tailings. The shallow aquifers are primarily confined by low permeability clay and silt layers. The clay-rich organic topsoil also serves as a confining layer. On the basis of stream flow measurements by Holmes and others (1986) and surveyed water level measurements made during this study, unconfined aquifers occur locally within the alluvium along Silver Creek where the creek serves as both a gaining and a losing stream. Groundwater flow in the shallow aquifers is primarily

upward in the vicinity of the tailings impoundment and directed towards the diversion ditch and Silver Creek, both serving as local hydraulic sinks. Discharge to low areas occurs along the toe of the embankment as water stored in the impounded area seeps through the embankment as originally designed as an engineered structure. Seepage also apparently occurs along the northern extent of the embankment which may reflect rejected recharge from the weathered volcanic rocks or water seepage from the impounded tailings. As indicated in the following section, the bulk of the seepage across the tailings embankment as well as the diffuse flow from the diversion ditch completes the hydrologic cycle by evaporation or evapotranspiration through consumptive use by the wetlands located in the low area between the tailings embankment and Silver Creek.

ESTIMATES OF GROUNDWATER DISCHARGE ACROSS TAILINGS EMBANKMENT

On the basis of the February, 1999 water level data collected in the piezometers completed within the impounded tailings and comparing these data to the water levels in the embankment wells, the difference in hydraulic head across the embankment approaches 17 feet. Integrating the observed difference in hydraulic head with the assumption that the footprint of the embankment approaches 400 feet, yields a hydraulic gradient of 0.0425 (see Plate I, section B-B'). Assuming that the water level data collected in February, 1999 within the impounded tailings reasonably reflects current conditions, first-order approximations of seepage rates across the tailings embankment can be made with permeability data derived from percolation tests completed by Dames & Moore (1973; 1974; 1980) and Applied Geotechnical Engineering Consultants, Inc. (1999). A summary of the permeability data for various earth materials located in and near the tailings embankment is provided in Table I.

TABLE I
HYDRAULIC CONDUCTIVITY MEASUREMENTS OF RICHARDSON FLATS MATERIALS
SUMMIT COUNTY, UTAH

Media	Sample Location	Hydraulic Conductivity (ft/year)
Artificial Fill Cap	See Plate I	0.031 to 0.072*
Natural Soil	TP-8**; UPCMC Well No. 3***	0.001 to 5**
Rock	UPCMC Well Nos. 1,2, 3	0.6 to 1**
Tailings and Slimes	TP-1,2,3,4	3 to 4,000**
Recompacted Soil	TP-20	1**
Recompacted Tailings	TP-17	20 to 45**
Recompacted Gravel Pit Material	Near TP-6	75 to 82**

* Reported values represent unit conversions of data reported by AGEC (1999) listed in Attachment 3.
** Test Pit Locations and data from Dames & Moore (1973; 1974) - See Plate I.
*** UPCMC = United Park City Mines Co. Well Numbering System - See Insert on Plate No. 1.

A range of values were incorporated into the analysis because Dames & Moore (1980) reported the following conditions: (1) the embankment was not constructed using engineered fill; (2) the internal zoning of the embankment was not constructed as recommended by the design engineer; (3) the main embankment and adjoining dike were constructed largely of silty sand and gravel; and (4) the southeastern portion of the embankment was constructed of clay and gravelly clay derived from areas near Highway 40 located north of the impounded tailings. Using the best available estimates of hydraulic gradients, the seepage across the tailings embankment can be estimated using the Darcy equation:

$$q=kia$$

where **q** is the Darcy flux or volumetric flow rate per unit area per unit time; **k** is the saturated hydraulic conductivity; **a** = area; and **i** is the hydraulic head gradient. Substitution of the variables into the Darcy equation yields estimates of seepage across the tailings embankment as summarized in Table II.

Based on these simple calculations, reasonable estimates of the seepage rates across the embankment face range from approximately 0.6 to 63 gallons per day. Use of the higher end of the range for the hydraulic conductivity of the tailings and slimes to estimate seepage rates is not justified because the available water level elevation data indicates that the tailings embankment impedes groundwater flow (see Embankment area on Plate I, section B-B').

TABLE II
CALCULATED SEEPAGE RATES ACROSS RICHARDSON FLATS TAILINGS EMBANKMENT SUMMIT COUNTY, UTAH

Hydraulic Conductivity (ft/year)	Representative Medium	Calculated Seepage Across Main Embankment Area = 900 ft x 6 ft* (gallons per minute)	Calculated Seepage Across Main Embankment (gallons per day)
1	Recompacted Soil	0.0004	0.63
5	Natural Soil	0.0022	3.14
20	Recompacted Tailings	0.0087	12.57
100	Recompacted Gravel Pit Material	0.044	62.87
4,000	Tailings and Slimes	1.75	2,515

* Embankment area assumed to be main embankment area located at western margin of tailings pond on Plate I.

Evaporation Losses

Dames & Moore (1973) used a simple hydrologic budget analysis to determine evaporative losses in the impounded tailings as part of the impoundment design. Their analysis determined that 0.6 to 0.8 gpm per acre is lost to evaporation. Considering that the triangular-shaped land area located west of the embankment and Silver Creek approaches 5.5 acres in size and integrating the estimates of evaporation by Dames & Moore (1973) indicates that between 2,400 and 3,200 gallons per day is evaporated in the area where seepage losses would be expected to occur below the embankment (this analysis assumed that evaporation occurred on a diurnal basis on a cycle of 12 hours per day).

Wetland Consumptive Use

Studies summarized by Brooks and others (1998) and Holmes and others (1986) indicate that consumptive use by phreatophytes and riparian habitats ranges from 2.4 to 2.6 acre-feet per acre per year (ac-ft/ac/yr). Assuming that all of the triangular area located between the embankment and Silver Creek is covered by wetlands, and incorporating the available consumptive use data yields first-order approximations of evapotranspiration approaching 12,000 gallons per day. Examination of the available color aerial photography of the Richardson Flats area indicates that not all of this area is covered with the same type of vegetation. Considering that perhaps 20 percent of the area is covered with wetlands indicates that a reasonable range of wetlands consumptive use ranges from 2,400 to 12,000 gallons per day.

Contribution to Silver Creek

According to Pioneer Technical Services (1993) and Downhour and Brooks (1996), estimated flows in Silver Creek near Richardson Flats average 3.3 to 3.65 cubic feet per second (1,480 to 1,635 gpm). Likewise, estimated flows in the diversion ditch located along the southern margin of the tailings pond average 0.06 cubic feet per second (27 gpm; Pioneer Technical Services, 1993). Based on WESTON's

initial site visit on November 24, 1998, WESTON staff estimated flows in the diversion ditch to approach 100 to 200 gpm near United Park City Mines Company Monitoring Well No. 3 (see Well Location Map Inset on Plate I). Recalling the potentiometric surface data collected in the area west of the tailings embankment indicate the water surface in Silver Creek is found at a higher elevation than the potentiometric surface measured in piezometer RT-7 located between Silver Creek and the tailings embankment, the apparent hydraulic contribution, if any, of tailings embankment seepage to surface water features is negligible.

CONCLUSIONS

The following conclusions were reached on the basis of the historic and supplemental hydrogeologic data collected in the Richardson Flats area:

- The tailings are partially saturated;
- The tailings are deposited on the naturally occurring pre-tailings topsoil;
- The organic-rich clayey pre-tailings topsoil serves as an effective confining layer;
- The shallow aquifer(s) are under confined conditions;
- Monitoring well RT-1 is apparently open to at least two shallow aquifers in an area where groundwater in the shallower aquifer flows downward [redacted] aquifer with lower hydraulic head; — Higher head or lower?
- Groundwater flows from areas of higher hydraulic head located south of the tailings pond northward to areas of lower hydraulic head;
- Beyond seepage across the tailings embankment, there is no apparent hydraulic connection between groundwater stored in the tailings and underlying and adjacent to shallow alluvial aquifer(s);
- First-order approximations of seepage rates across the tailings embankment range from approximately 0.6 to 63 gallons per day;
- First-order approximations of consumptive use of seepage from the tailings embankment by the one to five acres of wetlands located west of the embankment range from approximately 2,400 to 12,000 gallons per day;
- Silver Creek is found at a higher elevation than groundwater stored in the shallow aquifer(s) located between the tailings embankment and Silver Creek;
- The apparent hydraulic contribution, if any, of tailings embankment seepage to surface water features is negligible;
- The artificial fill capping the tailings is low-permeability material derived from local sources and is composed of illite and kaolinite; and
- The effects of snow melt and storm water ponding in the tailings pond requires additional study.

REFERENCES

Applied Geotechnical Engineering Consultants, Inc., 1999, Permeability Testing, United Park City Mines/Richardson Flats Property, Summit County, Utah: Consultant's report prepared for LeBOEUF, LAMB, GREENE & MacRAE, L.L.P., January, 1999.

Bromfield, C.S., and M.D. Crittenden, Jr., 1971, Geologic Map of the Park City East Quadrangle, Utah: U.S. Geological Survey Map GQ-852. Scale 1:24,000.

Brooks, L. E., J. L. Mason, and D. D. Susong, 1998, Hydrology and Snowmelt Simulation of Snyderville Basin, Park City, and Adjacent Areas, Summit County, Utah: State of Utah Department of Natural Resources, Technical Publication No. 115, 84 pp.

Dames & Moore, 1973, Report of Ground Water Monitoring and Seepage Study, Tailings Pond Development, Near Park City, Utah: Consultant's report prepared for Park City Ventures Corporation, December, 1973.

Dames & Moore, 1974, Report of Embankment and Dike Design Requirements, Proposed Tailings Pond Development, Near Park City, Utah: Consultant's report prepared for Park City Ventures Corporation, March, 1974.

Dames & Moore, 1980, Report of Tailings Pond Investigation, Near Park City, Utah: Consultant's report prepared for Noranda Mining, Inc., November, 1980.

Downhour, P. A. and L. E. Brooks, 1996, Selected Hydrologic Data for Snyderville Basin, Park City, and Adjacent Areas, Summit County, Utah, 1967-95: U.S. Geological Survey, Open-File Report 96-494, 52 pp.

Ecology and Environment, Inc., 1985, Analytical Results Report, Richardson Flats Tailings, Summit County, Utah: Consultant's report prepared for U. S. Environmental Protection Agency, Region VIII, Waste Management Division, TDD #R8-8508-07.

Ecology and Environment, Inc., 1989, Supplemental Site Inspection Report, Richardson Flats Tailings, Summit County, Utah: Consultant's report prepared for U. S. Environmental Protection Agency, Region VIII, Waste Management Division, TDD #F08-8903-06, PAN FUT0039HDA.

Ecology and Environment, Inc., 1993, Final Report, Richardson Flats Tailings, Summit County, Utah: Consultant's report prepared for U. S. Environmental Protection Agency, Region VIII, Waste Management Division, TDD #T08-9204-015 and #T08-9210-050, PAN EUT0039SBA and EUT0039SDA.

Hansen, Allen & Luce, 1996, Keetley Well Pump Test Results: Consultant's letter report prepared for Park City Municipal Corporation, July, 1996.

Holmes, W.F., K.R. Thompson, and M. Enright, 1986, Water Resources of the Park City area, Utah, with emphasis on Ground Water: State of Utah Department of Natural Resources Technical Publication No. 85, 81 pp.

Mason, J. L., 1989, Hydrology of the Prospector Square Area, Summit County, Utah: U.S. Geological Survey, Water-Resources Investigation Report 88-4156, 75 Pp.

Pioneer Technical Services, Inc., 1993, Comments Regarding: Final Report, Richardson Flats Tailings, Summit County, Utah, Dated February 19, 1993 and Prepared by Ecology and Environment, Inc.: Consultant's report prepared for United Park City Mines Company, December, 1993.

ATTACHMENT NO. 1
BORING LOGS

PRELIMINARY Public Health Assessment for

335107

ADMINISTRATIVE RECORD

3.07

RICHARDSON FLAT TAILINGS
PARK CITY, SUMMIT COUNTY, UTAH
CERCLIS NO. UTD980952840
JULY 24, 1990
****ADDENDUM****
MARCH 3, 1994

J.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

PRELIMINARY PUBLIC HEALTH ASSESSMENT ADDENDUM

RICHARDSON FLAT TAILINGS

PARK CITY, SUMMIT COUNTY, UTAH

CERCLIS NO. UTD980952840

Prepared by

Remedial Programs Branch
Division of Health Assessment and Consultation
Agency for Toxic Substance and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations 42 C.F.R. Part 90). In preparing this document ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

Additional copies of this report are available from:
National Technical Information Service, Springfield, Virginia
(703) 487-4650

ATSDR and its Public Health Assessment

ATSDR is the Agency for Toxic Substances and Disease Registry, a federal public health agency. ATSDR is part of the Public Health Service in the U.S. Department of Health and Human Services. ATSDR is not a regulatory agency. Created by Superfund legislation in 1980, ATSDR's mission is to prevent or mitigate adverse human health effects and diminished quality of life resulting from exposure to hazardous substances in the environment.

The Superfund legislation directs ATSDR to undertake actions related to public health. One of these actions is to prepare public health assessments for all sites on or proposed for the Environmental Protection Agency's National Priorities List, including sites owned or operated by the federal government.

During ATSDR assessment process the author reviews available information on

- the levels (or concentrations) of the contaminants,
- how people are or might be exposed to the contaminants, and
- how exposure to the contaminants might affect people's health

to decide whether working or living nearby might affect peoples' health, and whether there are physical dangers to people, such as abandoned mine shafts, unsafe buildings, or other hazards.

Four <u>types</u> of information are used in an ATSDR assessment.

1) environmental data; information on the contaminants and how people could come in contact with them

2) demographic data; information on the ethnicity, socioeconomic status, age, and gender of people living around the site,

3) community health concerns; reports from the public about how the site affects their health or quality of life

4) health data; information on community-wide rates of illness, disease, and death compared with national and state rates

The <u>sources</u> of this information include the Environmental Protection Agency (EPA) and other federal agencies, state, and local environmental and health agencies, other institutions, organizations, or individuals, and people living around and working at the site and their representatives.

ATSDR health assessors visit the site to see what it is like, how it is used, whether people can walk onto the site, and who lives around the site. Throughout the assessment process, ATSDR health assessors meet with people working at and living around the site to discuss with them their health concerns or symptoms.

A team of ATSDR staff recommend actions based on the information available that will protect the health of the people living around the site. When actions are recommended, ATSDR works with other federal and state agencies to carry out those actions.

A public health action plan is part of the assessment. This plan describes the actions ATSDR and others will take at and around the site to prevent or stop exposure to site contaminants that could harm peoples' health. ATSDR may recommend public health actions that include these:

- restricting access to the site,
- monitoring,
- surveillance, registries, or health studies,
- environmental health education, and
- applied substance-specific research.

ATSDR shares its initial release of the assessment with EPA, other federal departments and agencies, and the state health department to ensure that it is clear, complete, and accurate. After addressing the comments on that release, ATSDR releases the assessment to the general public. ATSDR notifies the public through the media that the assessment is available at nearby libraries, the city hall, or another convenient place. Based on comments from the public, ATSDR may revise the assessment. ATSDR then releases the final assessment. That release includes in an appendix ATSDR's written response to the public's comments.

If conditions change at the site, or if new information or data become available after the assessment is completed, ATSDR will review the new information and determine what, if any, other public health action is needed.

For more information about ATSDR's assessment process and related programs please write to:

Director
Division of Health Assessment and Consultation
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SUMMARY

This document is an addendum to the preliminary public health assessment prepared for the Richardson Flat Tailings site by the Agency for Toxic Substances and Disease Registry (ATSDR) in July 1990.

The Richardson Flat Tailings Site lies in a broad valley northeast of Park City, Utah--approximately 1½ miles from Prospector Square, which is the nearest developed part of the city. The proposed NPL site includes a tailings pond area at Richardson Flat and an adjacent section of Silver Creek where tailings have accumulated. For purposes of this assessment, those areas are considered *on site*; and all other areas *off site*. The site is remote; four businesses and two presently vacant residences are within 1 mile of the site. Occasional tailings workers and cyclers are among the few who are expected to have visited the site.

Tailings are a waste product generated by mining activities. Sampling results have identified a few metals of potential concern. However, people are not being exposed at levels of public health concern in any known completed exposure pathway at the site. Furthermore, it does not appear likely that exposures associated with any past or present potential exposure pathway would exceed levels of public health concern. Finally, blowing dust, the single community health concern expressed, poses no apparent public health hazard. For these reasons, the Agency for Toxic Substances and Disease Registry (ATSDR) has concluded that this site poses no apparent public health hazard due to past or present exposures. However, should the site, or areas near the site where significant levels of contaminants may be found, be developed in the future for residential purposes, the people who live on top of soil contaminated at significant levels will have greater exposure duration to soil than those who live near the site or worked on the site. In this case, levels of contaminants on or very close to the site would be at levels of health concern. Because we are not certain of the future of this site, ATSDR considers the RFT site to pose an indeterminate public health hazard for future exposure.

ATSDR's Health Activities Recommendation Panel (HARP) has evaluated the data and information developed in the Richardson Flat Tailings Public Health Assessment. The panel determined that, because of the apparent lack of past and present public health hazards and community health concerns, no follow-up health activities are indicated at this time.

BACKGROUND

The Agency for Toxic Substances and Disease Registry (ATSDR), in Atlanta, Georgia, is a federal agency within the U.S. Department of Health and Human Services and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to conduct public health assessments at hazardous waste sites. ATSDR has, under this mandate, evaluated the public health significance of this site.

This document is an addendum to a preliminary public health assessment prepared in July 1990 for the Richardson Flat Tailings site (RFT site) by ATSDR after the U.S. Environmental Protection Agency (EPA) first proposed the site for the National Priorities List (NPL) on June 14, 1988 (USEPA 1992b). A copy of the previous health assessment is provided in Appendix D. In February 1991, in response to public comments on its proposed listing, EPA reevaluated site scoring and withdrew the site from consideration for the NPL. EPA again proposed the site for the NPL in February 1992 after modifying its Hazard Ranking System and obtaining new site information. Therefore, in response to our legislative mandate, ATSDR has prepared this preliminary public health assessment addendum that reevaluates available site-related information and relevant public health issues.

A. Site Description and History

The RFT site lies in a broad valley northeast of Park City--approximately 1½ miles from Prospector Square, which is the nearest developed part of the city. Figures 1 and 2 (Appendix A) show features of the vicinity and site. ATSDR's discussions with EPA indicate that the proposed NPL site includes a tailings pond area at Richardson Flat (Area A on Figure 2) and an adjacent section of Silver Creek where tailings have accumulated (Area B on Figure 2). Thus, for purposes of this assessment, Areas A and B are considered *on site*; and all other areas *off site*. Area A is enclosed within the security fence shown in Figure 2; Area B parallels the fence and is immediately outside it.

NPL Site Components

Tailings Pond

The tailings disposal pond covers approximately 160 acres; tailings are as much as 10-feet thick (USEPA 1992a). The pond has not been used since mining activity stopped in 1982. During a site visit in 1992, ATSDR observed that the disposal area is essentially flat and may nearly have reached its practical storage capacity. No water was ponded at that time. Most of the

tailings are covered with soil or a dense growth of a salt grass that has a thick root mat (E&E 1992).

The owner, United Park City Mines (UPCM), reported to ATSDR that tailings were present when they purchased the property in 1953. UPCM reports that their property boundary extends beyond the fence shown on Figure 2; however, the boundary was not defined for ATSDR. Under UPCM's ownership, most of the tailings were disposed between 1969 and 1982 from mines that were owned by UPCM and leased by Park City Ventures and Noranda Mining, Inc. (USEPA 1992a, USEPA Undated). Tailings were transported from the mine sites by slurry pipeline; UPCM reports that one to two people were present at the site to monitor the delivery. EPA reported rumors that, in earlier years, tailings were transported to the site via Silver Creek, and UPCM reported that transport mode was never used. ATSDR does not consider that possible transport mode to be a substantive issue and does not address it further in this assessment. UPCM reports that water from tailings transport, surface water runon, and snowmelt were contained within the pond and eliminated through evaporation rather than discharged to Silver Creek. UPCM reports it intends to maintain its mines, the tailings pipeline, and the tailings disposal area and will reuse those facilities when mining again becomes economically viable. UPCM reports they will not develop the property for residential use, industrial use--other than mining, or for parks or recreational uses.

A Utah Department of Environmental Quality (UDEQ) representative reported rumors that some tailings had been removed and used off site for sewer and road construction. An EPA contractor also reported use of tailings materials for sewer and road base backfill but did not provide supporting information (E&E 1987a). UPCM said there has been no activity of that nature since 1981; although, there may have been earlier. Because of uncertainty about tailings being taken off site and associated locations and any human exposure potential, ATSDR cannot address this issue.

In 1974, plans were approved for Park City Ventures to construct an embankment and perimeter dikes to contain the tailings and associated transport water (E&E 1989). A diversion ditch was excavated on site to route runoff water around the tailings impoundment. The ditch begins east of the tailings, passes the southern edge of the currently configured tailings pond, and ends in a marshy area of about 10 acres near the embankment. EPA reports that ditch was excavated through zones of tailings (USEPA 1991b). No chemical analyses are known to confirm whether tailings are present within the ditch alignment. However, in 1992, ATSDR reviewed a 1953 areal photograph that appears to show tailings extended well to the south at that time, to County Road. That photograph, together with ATSDR's on-site observation of

tailings-like zones within the ditch slope, suggest that one or more segments of the ditch were excavated through tailings materials. During that visit, ATSDR noted that ditch slopes were being regraded and covered with soil to reduce erosion and off-site transport of tailings.

In June, 1985, an EPA contractor obtained photographs of clouds of fugitive dust moving off site as a result of strong winds (E&E 1987a). UPCM said they began placing soil over the tailings and planting vegetation in 1983. In 1992, UPCM estimated that they had covered about 85% of the tailings area and that the tailings should be completely covered with soil in 1993 (E&E 1992). An EPA contractor reports that UPCM intends to place soil on the small part of the tailings area that currently has no soil cover or salt grass. The contractor expressed concern about future dust because some of the cover soils are thin (less than 6 inches thick) and salt grass may disappear if the site becomes drier. UPCM reports most cover soils are being excavated from higher ground northeast of the tailings deposit. ATSDR was informed that the workforce consists of two to four persons who are provided with respirators to use during dry, dusty weather. Haul roads are watered during such weather.

The fence that encloses the tailings deposit was constructed recently. ATSDR observed that gates were locked. Before erecting the fence, motorcyclists and cattle were reported on the property (ATSDR 1990, E&E 1987a). Sheep have been observed on adjacent property.

Silver Creek Flood Plain Tailings

Large floodplain tailings deposits are reported to exist upstream of the site as well as downstream to as far as the confluence of the Weber River (USEPA 1993). An EPA representative reports that the agency has not yet determined the linear extent of the Silver Creek flood plain that will be part of the proposed NPL site. For this assessment, ATSDR defined Area B in Figure 2, which includes two tailings deposits EPA has already investigated (E&E 1989). The specific source(s) of those tailings is not known, but ATSDR's review of area topography suggests that their origin is upstream in the watershed, not UPCM's tailings pond.

NonNPL Elements

Park City Sanitary Landfill

UPCM property also contains a closed Park City sanitary landfill; EPA reports that the landfill is not part of the proposed NPL site.

A Park City representative reports the landfill was opened in 1973 and closed in 1985. Wastes were deposited below ground in trenches and also were mounded above ground. An EPA contractor told ATSDR that the landfill materials are mostly sanitary wastes, but are believed to include some tailings from Prospector Square, and sketchy information suggests some chemical wastes like PCBs and paints might be present. City officials have said that the materials placed in the landfill materials are sanitary wastes, and the absence of substantive industry makes it unlikely that chemicals are present other than those that are used in households. During part of the operation, Park City had a policy prohibiting disposal of electrical transformers, hazardous waste, or toxic substances. In 1990, a relocation of U.S. Route 40 resulted in that highway being constructed through the middle of the landfill. ATSDR was told that wastes encountered in the path of the highway were excavated, placed on the adjoining landfill remnants, and covered with soil. Figure 2 shows the approximate limits of the landfill remnants.

Laboratory data were reviewed for samples taken from borings drilled at the landfill during highway development planning (UDT 1989). These data showed that a few inorganic elements detected were not at high concentrations, and no polychlorinated biphenyls, pesticides, or semivolatile organic compounds were detected. One volatile organic compound was detected in two samples at extremely low concentrations (maximum of 0.03 parts per million [ppm]). In addition, although landfill workmen are likely to have been exposed to waste-related contaminants in the past, no exposure is plausible now, and none is expected in the future unless the landfill is disturbed. The city does not intend to reopen the landfill; Summit County provides a landfill for the Park City area at another location. Also, UPCM reports that their property, including the part where the landfill is located, will not be developed.

Based on the information about the landfill and its operation, ATSDR is excluding the landfill and its workers from further evaluation in this public health assessment.

Prospector Square, Silver Maple Claims

Prospector Square, a large residential and commercial development in the northeast part of Park City, was partially constructed on a large deposit of mine tailings. Prospector Square is along Silver Creek about 1½ miles upstream from the RFT site (Figure 1). In 1988, ATSDR conducted a human exposure study to determine the effect of mine tailings contaminated with lead, arsenic, and cadmium on biological levels of those metals among persons living in the immediate vicinity (ATSDR 1988).

Silver Maple Claims, another location along Silver Creek at which tailings are reported, lies upstream from the RFT site, between the site and Prospector Square. The specific location and boundary of Silver Maple Claims has not been defined.

Although some contaminants released at Prospector Square and Silver Maple Claims might migrate to the RFT site, ATSDR review of available information indicates that the RFT site is not likely to have a definable impact on either of those locations. Therefore, ATSDR will not further evaluate contamination or health issues potentially associated with those locations.

B. Site Visit

ATSDR representatives--Ms. Stephanie Prausnitz and Messrs. Don Gibeaut and Glenn Tucker--visited the site area on August 18 and 19, 1992. A public availability session was held on the morning of the 19th. With the exception of representatives of UPCM and the press, no community members attended the meeting. Pertinent information obtained during that visit is described in appropriate sections of this document.

C. Demographics, Land Use, and Natural Resource Use

Demographics

The site is in a rural area. In 1992, ATSDR found one home and three house trailers within a mile of the site. The residences are ½ to ¾ mile southwest (upstream) of the RFT site and are within 100 to 400 feet of Silver Creek. Three of the residences were occupied at that time. Information received in late 1993 indicates there are now two trailers plus one former home that has been converted to vehicle repair activities--neither of the two trailers are now occupied. Three larger businesses--two concrete and aggregate suppliers and an electric power company service center--are near Silver Creek about ½ mile northwest (downstream) of the site. ATSDR learned those businesses employ a total of 51 persons at those locations. The nearest residence to Silver Creek downstream from the RFT site was observed to be about 4 miles away.

Nearby Park City is a center for skiing and recreation; its full-time population is about 4,500 (USBC 1991). The census also identifies 3,800 vacant housing units in the city; thus, when the units are filled with visitors, the total population increases substantially. EPA reports that about 4,300 residents are within a radius of 3 miles of the site (USEPA 1991b). The nearest residents within the city are at Prospector Square. The nearest schools in the city are on Route 248, next to Prospector Square.

A health clinic that provides some emergency care is also in Prospector Square, but no nursing homes are in the site vicinity.

Land Use

Essentially all of the area within a 1-mile radius of the site is open, undeveloped rangeland that supports generally low-density populations of sheep, cattle, and horses. Beyond 1 mile of the site, land use is principally open, undeveloped rangeland except for development associated with Park City, skiing, and residential and commercial development along a narrow zone by I-80, which is about 4 miles north of the RFT site (Figure 1). Park City officials report they expect future development will extend northwest of town along State Route 224 (Figure 1), rather than along Route 248 toward the RFT site.

The county extension agent reported that there has been limited agriculture, consisting of about 200 acres of pasture, in Silver Creek watershed between the site and I-80. A commenter reports that the amount of irrigated pasture has been substantially reduced for several years and for the foreseeable future because the Park City Municipal Corporation uses some of the creek water for municipal purposes. This apparently affects principally the users who withdraw from the Pace Homer Ditch for which the diversion point is well upstream of RTF. Affected parties are compensated via crop-loss payments and purchase livestock feed from out of the watershed area. Pasture is primarily grasses and some alfalfa. Stock in this watershed segment includes a dairy herd, beef cattle, and sheep. The dairy cattle are near I-80. Some grain is being raised farther north in the watershed near the community of Wanship, which is about 6 miles beyond I-80.

Natural Resource Use

Mining

The Park City area was once a major lead- and silver-mining district, but mines have not been active recently (UDNR 1986).

Surface Water

Average annual rainfall in the Park City area ranges from 16 inches at low altitudes to more than 40 inches in the Wasatch Mountains, a few miles west of the site. The Silver Creek watershed drains an area of about 26 square miles. The creek originates south of Park City and flows generally northward through the city, passes the RFT site, and discharges into the Weber River about 10 miles downstream from the site. Silver Creek is a perennial stream with an average annual discharge of 3.3 cubic feet per second (cfs) (USEPA 1991b). Flow, however, is

quite variable; substantially greater flow occurs during snow melt, and ATSDR observed essentially no flow velocity at the RFT site in August. Weber River, which has an average annual discharge of 214 cfs, is a major stream in the region and discharges into Great Salt Lake about 50 miles downstream of the site (USEPA 1991b).

The on-site diversion ditch receives surface runoff from land areas that are upgradient of the tailings deposit and transports that water around the southern edge of the current tailings impoundment to a wetland area of about 10 acres by the embankment (USEPA 1991b). From there, the runoff enters Silver Creek at a point ATSDR observed a few hundred feet northwest of the embankment.

Silver Creek is not used for human water supply (E&E 1985). Stock obtain water directly from the creek and from diversion ditches. Creek water is also withdrawn for stock watering and irrigation. Utah Division of Water Rights reports there are three diversions of Silver Creek water downstream from the RFT site (UDNR 1992). The nearest diversion is at the G.M. Pace Ditch that begins about 600 feet north of U.S. Route 189 (US-189) (UDNR 1992). Based on discussion with a Park City official and other information, it appears that G.M. Pace ditch also receives water directly from the Pace Homer ditch, which originates at a spring in Park City (E&E 1987b). Water from G.M. Pace ditch has been reported to be used for irrigating 316 acres of pasture (USEPA 1991b). The next closest diversion is north of I-80, about 7 miles downstream from the site; water is reported to be used for livestock (UDNR 1992). The third diversion, reported to be for irrigation, is farther north of I-80, about 9 miles downstream from the site and about 2 miles upstream from Wanship where Silver Creek discharges into the Weber River, a major water course in the region (UDNR 1992). As previously noted, availability of creek water for withdrawal has been substantially reduced for several years and for the foreseeable future because the Park City Municipal Corporation uses some of the creek water for municipal purposes. The curtailment apparently has been most severe for those who are served by the Pace Homer Ditch for which the diversion point is well upstream of RTF.

Weber River has only one diversion for public water supplies, at a point about 45 miles downstream from the site: UDEQ reports there are many diversions for irrigation and livestock watering (UDEQ 1992a).

Fishery

Available information provides an uncertain picture of Silver Creek as a fishery. A survey in 1954 found a small number of

trout. Electroshocking data obtained from Silver Creek in 1970 did not show the presence of game fish. Biologists, more recently, report cutthroat trout in the creek; although, there is no information to quantify the population or the location where the trout are present (E&E 1991a). The last known investigation, in 1986, produced no fish. EPA reported seeing pan-sized trout at the site in the spring of 1992 (USEPA 1993). From this information, ATSDR concludes that the creek, at best, is not an important fishery. The Weber River is an important trout fishery.

Groundwater

Groundwater exists in both consolidated rocks and unconsolidated valley fill (soils) (UDNR 1986). Consolidated rocks crop out over most of the Park City area, except along stream channels where unconsolidated valley fill is exposed at the surface. Valley fill is primarily alluvial or glacial in origin and consists of clay, silt, sand, gravel, cobbles, and boulders. The alluvium is primarily in low areas, along stream channels. The average thickness of valley fill in the Silver Creek drainage system is about 100 feet.

Silver Creek is flanked by lines of hills that rise a few hundred to 1000 feet above the valley floor. The valley floor slopes downward in a generally northerly direction, the direction of flow in Silver Creek. The RFT site lies along Silver Creek in an area that is blanketed by unconsolidated fill. The thickness of that soil zone at the RFT site is not known. EPA reports that groundwater has been encountered at relatively shallow depths at the RFT site, but a specific depth has not yet been defined. ATSDR believes that water levels beneath the site might be relatively high during wet periods of the year and may drop during drier months.

Water in consolidated rocks moves along faults and fractures from high altitudes toward discharge areas at lower elevation. Studies show that groundwater in valley fill flows in the same general direction as the streams (UDNR 1986). According to studies, the creek gains water inflow over time from the valley fill aquifer system. A study, which does not describe weather, stream segments, flows, or loss quantities, did not show any areas of significant losses (UDNR 1986). ATSDR interprets that finding to mean that some limited stream losses to valley fill aquifers did occur in that study.

UPCM reports there has never been a groundwater supply well on the property. The formerly occupied residences and the vehicle repair business that are within a mile southwest of the site obtain potable water supplies from private wells that appear to

be hydraulically upgradient from the RFT site. It is unknown whether the wells draw water from a valley fill aquifer or from bedrock. The three businesses to the northwest use bottled water for drinking and obtain industrial water from wells that are hydraulically downgradient from the RFT site (E&E 1991d). These wells are reported to be more than 300 feet deep and are probably drawing from a bedrock aquifer rather than from a valley fill aquifer.

ATSDR learned that Atkinson Special Improvement District, High Valley Water Company, and Summit County Service Area #3--serving 240, 250, and 75 persons, respectively--obtain their water from wells in the Silver Creek watershed. The wells are about 2, 3½, and 4 miles, in a generally northwesterly direction from the RFT site and are set back about ¾ to 1 mile from the creek. Park City's public water system gets its supply for its 4,500 residents and many visitors from wells and tunnels that are 1½ miles, or more, upgradient from the RFT site (UDEQ 1992a).

D. Health Outcome Data

Utah maintains birth and death certificate databases and a tumor (cancer) registry. No health outcome data were requested, as discussed in the Health Outcome Data Evaluation section below. In 1988, ATSDR conducted a human exposure study to evaluate whether mine tailings contaminated with lead, arsenic, and cadmium had an effect on biological levels of those elements among persons living in the immediate vicinity (ATSDR 1988). The study results are described in the Health Outcome Data Evaluation Site section below. No additional relevant databases or health studies were identified.

COMMUNITY HEALTH CONCERNS

ATSDR staff noted community members' concern about dust blowing off site. Staff are unaware of any other site-related community health concerns. No health concerns were expressed to ATSDR representatives at the Public Availability session. Furthermore, ATSDR staff contacted residents of nearby houses and representatives of the EPA, UT Department of Environmental Quality, UT Department of Health, Summit County Health Department, and the town of Park City. Concern had been expressed about blowing dust. No one was aware of any other site-related community health concerns.

The Addendum to the preliminary public health assessment for the Richardson Flat Tailings Site was available for public review and comment in a local library for a 30-day period ending September

9, 1993. The public comment period was announced in local newspapers. In addition, the public health assessment was sent to several individuals or organizations. Comments were received.

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

ATSDR's preliminary public health assessment of 1990 used sampling data obtained in 1985 and 1986 and addressed several inorganic contaminants: arsenic, cadmium, chromium, copper, lead, manganese, selenium, and zinc. This addendum considers that sampling data in addition to more recent data and site-related information.

Sampling data and supporting site-related information suggest that contaminants have been released into the air, groundwater, surface water, and sediment on and off site. This section identifies contaminants of potential concern that have been selected for further evaluation in subsequent sections of this public health assessment to determine whether exposure to them has public health significance. Identifying contaminants in this section does not imply that exposure will result in adverse health effects.

Contaminant selection considers the following factors:

1. concentrations of contaminants on and off site,
2. sampling plan design, field data quality, and laboratory data quality,
3. relationship of on- and off-site concentrations to public health assessment comparison values for noncarcinogenic health endpoints and for carcinogenic end points, and
4. community health concerns.

ATSDR also conducted a search of the EPA Toxic Chemical Release Inventory (TRI) to determine whether that database identifies any chemical releases for the RFT site or other facilities in the vicinity. TRI contained no data for any facilities in Summit County.

The contaminants of potential concern selected to be addressed further in the public health assessment are listed in each of the data tables (Appendix B), and many are discussed within this

section. The data tables contain several abbreviations that identify sources of public health assessment comparison values:

* EMEG Environmental Medial Evaluation Guide
* RMEG Reference Dose Media Evaluation Guide
* CREG Cancer Risk Evaluation Guide
* LTHA Lifetime Health Advisory Guide
* AL Action Level

EMEGs are estimated comparison concentrations that are based on information determined by ATSDR from its Toxicological Profiles for specific chemicals. RMEG comparison values are based on EPA's estimates of the daily exposure to a contaminant that is unlikely to cause adverse health effects. CREGs are estimated comparison concentrations for specific chemicals based on an excess cancer rate of one in a million persons and are calculated using EPA's cancer slope factors. EPA's LTHA identifies the contaminant level in drinking water at which adverse health effects would not be anticipated over a lifetime. All of the foregoing comparison values are guides and do not have a regulatory basis. An AL comparison value is an EPA regulatory concentration that, if exceeded, requires public water systems to initiate specific actions.

Groundwater, tailings, soil, surface water, sediment, and ambient air have been sampled. No data are available for food chain elements.

A. On-site Contamination

Groundwater: Area A

Several samples of groundwater obtained from monitoring wells installed next to the tailings pond and next to the landfill have been analyzed. Data for unfiltered samples show that several of the contaminants of potential concern were found at levels that exceed ATSDR's comparison values for drinking water use--antimony, arsenic, barium, beryllium, cadmium, copper, lead, manganese, silver, vanadium, and zinc. Maximum concentrations are shown in Table 1 (Appendix B). Several of those maximum concentrations were detected at a monitoring well near the landfill.

Tailings Deposits: Areas A and B

Several tailing samples were analyzed from Area A and two from Area B. Maximum concentrations of substances are presented in Table 2 (Appendix B). Arsenic, beryllium, and cadmium were present at levels that exceed ATSDR's comparison values for

incidental ingestion. In addition, lead, zinc, and calcium were at especially elevated levels.

Soil Cover Layer On Tailings: Area A

Five samples of the soil cover layer in Area A were analyzed. No sampling has been conducted on site for natural soils at or beyond the perimeter of the tailings deposit. Maximum concentrations of substances are presented in Table 3 (Appendix B). Arsenic and beryllium slightly exceed ATSDR's comparison values for incidental ingestion, but the concentrations detected are typical of soils in the western part of the country.

Surface Water: Area A and Area B

Seventeen surface water samples from the diversion ditch and marsh at Area A and 10 samples from Silver Creek at Area B were analyzed. Because water quality varies with changing flow rates, the sample data may not be indicative of conditions over time. Maximum concentrations of substances are presented in Table 3 (Appendix B).

Many of the substances were detected at levels that exceed ATSDR's comparison values for drinking water. For Area A, the substances include antimony, arsenic, barium, beryllium, cadmium, copper, lead, manganese, mercury, silver, thallium, vanadium, and zinc. At Area B, antimony, arsenic, beryllium, cadmium, mercury, silver, thallium, and vanadium exceeded comparison values; the concentration of lead was identical to its comparison value.

Sediment: Area A and B

Maximum concentrations of substances found in sediment samples from Areas A and B are presented in Table 5 (Appendix B).

Twelve samples taken in Area A from the diversion ditch, marsh, and areas where water ponds on the tailings were analyzed. Arsenic, beryllium, cadmium, and manganese were present at levels that exceed ATSDR's comparison values for incidental ingestion. Lead was found at an elevated level; antimony, iron, and zinc are also elevated when compared to their concentrations in the soil cover data presented in Table 3.

At Area B, two samples of sediment from Silver Creek were analyzed. Arsenic and beryllium were found at levels that exceed ATSDR's comparison values for incidental ingestion. Lead was present at an elevated concentration; antimony, iron, and zinc are also elevated.

Ambient Air: Area A

Ambient air sampling was conducted in 1986 at four locations within Area A. Because of the short sampling duration, the data may not be representative of air quality over time. The samples were analyzed for arsenic, cadmium, lead, and zinc; maximum concentrations reported are presented in Table 6 (Appendix B). The concentrations for arsenic and cadmium exceed ATSDR's comparison values for ambient air. Lead and zinc also occurred at levels greater than would be expected in a rural setting.

Ambient air sampling was also conducted in 1992 at locations along the security fence. These results are described in the next section.

B. Off-site Contamination

Groundwater

Background Monitoring Well and Nearby Industrial Wells

Analytical results for unfiltered groundwater samples obtained from the monitoring well south of County Road, topographically upgradient of the property, and from three nearby downgradient industrial wells are presented in Table 7 (Appendix B).

Data for two samples from the monitoring well show that arsenic, beryllium, and lead exceed ATSDR's comparison values for drinking water. Other substances are not at extraordinary concentrations.

Samples from the nearby industrial wells, which are not used for potable water supplies, were analyzed only for arsenic, cadmium, chromium, and lead. Results for seven unfiltered samples suggest that arsenic and lead are present at levels that exceed ATSDR's comparison values for drinking water (E&E 1992).

Public Water Supply Wells

Analytical data were reviewed for a few unfiltered groundwater samples from three public water supply wells (Atkinson Special Improvement District, High Valley Water Company, Summit County Service Area #3) located to the northwest of RTF on the flanks of the Silver Creek watershed. Maximum concentrations are shown in Table 8 (Appendix B). Several contaminants of potential concern were not reported in analyses of the samples, including; aluminum, antimony, beryllium, cobalt, thallium, and vanadium. ATSDR's comparison values for drinking water were exceeded only for arsenic, which was present at low levels in the samples from the High Valley and Summit County Service systems. Other substances were not at extraordinary levels.

Soils

Five samples of surface soils and two of subsurface soils were obtained near the site. Four of the surface samples were from 2 to 50 feet from roads; the fifth sample location was about 400 feet south of the county road. Maximum concentrations are shown in Table 9 (Appendix B). For surface soils, arsenic and beryllium were present at levels greater than ATSDR's comparison values for incidental ingestion. Lead and zinc were elevated in the sample obtained south of County Road, and vanadium was elevated in one of the other surface samples. The subsurface samples did not contain any substances at extraordinary levels; although, arsenic was present above ATSDR's comparison level for incidental ingestion.

Surface Water: Upstream and Downstream

Seven samples of water taken from Silver Creek upstream of Area B were analyzed; some also were reported from the creek immediately downstream of the site, near US 189, and many more analyses were for creek samples taken at Atkinson, approximately 4 miles downstream. Because water quality varies under different flow rates, the sampling data may not represent conditions over time. Maximum concentrations are shown in Table 10 (Appendix B). For most of the substances, ATSDR's review of the data suggests that maximum concentrations are not substantially greater downstream than upstream.

Upstream, substances that exceeded ATSDR's comparison values for drinking water are antimony, arsenic, beryllium, cadmium, lead, and zinc. Downstream, comparison values were exceeded by antimony, arsenic, beryllium, cadmium, lead, manganese, and zinc.

Sediments: Upstream and Downstream

Upstream of Area B, one sediment sample was taken in Pace Homer Ditch and two from Silver Creek. Downstream, a sample of sediment was taken from the creek several hundred feet from the site. Maximum concentrations of substances are shown in Table 11 (Appendix B).

The arsenic and beryllium in the upstream and downstream sediments exceed ATSDR's comparison values for incidental ingestion; antimony, lead, and zinc levels are also elevated for upstream sediments.

Ambient Air

In 1985, an EPA contractor obtained information that showed wind-driven fugitive dust moving off site. In 1986, ambient air was

monitored at one station about 3,000 feet south-southeast of Area A. Because of the short sampling interval, the monitoring data may not be representative of conditions over time. Prevailing wind during the monitoring period was from the west-northwest and south east. Thus, the monitoring location was not in the prevailing downwind direction from the site at any time during the sampling program. Maximum concentrations of substances are shown in Table 12 (Appendix B). Several samples were analyzed for arsenic, cadmium, lead, and zinc. Constituent levels were much less than had been recorded at on-site locations during that study (Table 6). Arsenic was not detected. The concentration of cadmium, although quite low, exceeds ATSDR's comparison value for ambient air. Cadmium levels and the low concentrations of lead and zinc detected appear consistent with values for rural settings. However, had the monitoring station been in the direction of prevailing wind, ATSDR believes that the concentrations 3,000 feet from the site might have been greater. Review of the on-site air monitoring data shows that one of the stations that recorded substantial concentrations was only a few hundred feet inside Area A, thus the concentrations shown in Table 6 may be indicative of the levels in immediate off-site areas at that time.

In 1992, when an estimated 80% of the tailings deposit at Area A was covered with soil or salt grass, ambient air quality monitoring was conducted for two days at five locations along the fence, shown in Figure 2. Because of the short sampling interval, the monitoring data may not be representative of conditions over time. The monitor locations were about 150 to 800 feet from Area A. Those analyses detected only zinc at low concentrations (0.1 $\mu g/m^3$) at three of the monitors. This is less than a tenth of the maximum zinc that had been found in on-site monitors in 1986. However, none of the monitors were situated downwind for any extended length of time (USEPA 1992c).

C. Quality Assurance and Quality Control

Only some of the reference documents contain quality assurance information for investigations, sampling, and laboratory analyses. In preparing this assessment, ATSDR presumed that protocols and results from other agencies are valid. The completeness and reliability of the information could affect the validity of ATSDR's conclusions.

D. Physical and Other Hazards

ATSDR did not observe any physical or other hazards at the site.

PATHWAYS ANALYSES

ATSDR identifies human exposure pathways by examining environmental and human components that might lead to contact with contaminants. A pathway analysis considers five elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population. Completed exposure pathways are those for which the five elements are evident and indicate that exposure to a contaminant has occurred in the past, is currently occurring, or will occur in the future. Potential exposure pathways are those for which one or more of the elements is not clearly defined, but could be present. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future.

ATSDR's preliminary health assessment of 1990 addressed several exposure pathways associated with soil and tailings, groundwater, food-chain, ambient air, and surface water. This addendum evaluates exposure pathways using all available sampling and site-related information.

Pathway analyses conducted for the site area indicate that there are several completed exposure pathways associated with tailings, soil, surface water, and air. Affected populations include tailings workers, and site trespassers. A completed pathway also is noted for users of the public water systems because of metals (at low concentrations), but it is unlikely that the site is the source. The completed pathway elements are summarized in Table 13 (Appendix B)

Several potential exposure pathways--associated with tailings, soil, surface water, air, groundwater, sediment, and possibly foods--could also exist. Potentially exposed populations include site and area workers and residents, trespassers, road workers, ranchers, consumers, and possibly fishermen. The potential pathway elements are summarized in Table 14 (Appendix B).

Tables 15 and 16 (Appendix B) further characterize exposed and potentially exposed populations and associated media and contaminants.

A. Completed Exposure Pathways

<u>Tailings and Surface Soil Pathways On Site: Area A</u>

Metals are present in tailings, and, at low concentrations, in the tailing cover soils. Tailings also are likely to have been mixed with surface soil on the perimeter of Area A. During the

years tailings were deposited, the workforce is considered to have been exposed to contaminants in tailings and some soils principally through incidental ingestion and inhalation. Trespassers are considered to have been exposed in a similar manner.

Surface Water Pathways On Site: Area A

Water used to transport tailings and surface water runon that ponded in Area A are likely to have contained elevated levels of metals. When tailings were being deposited, workers were likely to have been exposed to contaminants in those waters through incidental ingestion. Trespassers are likely to have been exposed less extensively to water-born contaminants through incidental ingestion.

Ambient Air Pathways On Site: Area A

Air sample data from 1986 confirm that metals have been entrained in ambient air in the past in Area A as a result of wind eroding and suspending particles from the tailings surface. At the time of that sampling activity, most of the tailings area was not covered or vegetated. ATSDR considers the on-site workforce to have been exposed to airborne contaminants through inhalation during the years the tailings were being deposited. Trespassers who entered the site before the property was fenced were likely to have been exposed through inhalation.

Public Water Systems Off Site: Downstream Silver Creek Watershed

Three public water systems obtain at least a part of their supply from wells that are within the Silver Creek watershed. Sampling data show some metals are present at low concentrations in those water supplies--arsenic, however, is potentially of concern at even low levels. Information reviewed indicates there is little likelihood that site-related contaminants do, or will, migrate to those wells. The wells are a considerable distance from the site, are located up on basin slopes--not by the stream, and withdraw from bedrock--not the valley alluvium. Also, well logs reviewed showed two of the three wells were under "artesian" pressure at the time of construction. That pressure, where it exists, results in a net upward flow of groundwater from the rock zone into the alluvium, thereby preventing downward flow of water from the valley alluvium. Furthermore, dilution and/or contaminant adsorption within the alluvium should substantially reduce metals concentrations in groundwater away from the site.

Water system customers are exposed to low levels of some contaminants--past, present, and future--principally through

ingestion and, to a small degree, through aerosol inhalation (showering).

B. Potential Exposure Pathways

Tailings and Surface Soils Pathways On Site: Area A, Area B

Remediation and maintenance workers on site in Area A after tailings disposal stopped are potentially exposed--past, present, and in the future--through ingestion and inhalation to contaminants contained in tailings and possibly to those in the layer of cover soils or in adjacent natural surface soils. Should the area ever be developed for homes or businesses, residents and workers potentially would be exposed, principally through ingestion and inhalation, to contaminants in tailings and soils.

Trespassers might enter the flood plain in Area B infrequently. They potentially are exposed--past, present, and future--through ingestion and inhalation to contaminants in tailings and possibly to contaminants in adjacent surface soils.

Surface Water Pathways On Site: Area A

Surface water that ponds in Area A or flows through the diversion ditch to the marsh and into Silver Creek contains contaminants to which remediation and maintenance workers potentially are exposed--past, present, and future--principally through incidental ingestion.

Ambient Air Pathways On Site: Area A

On-site remediation and maintenance workers are potentially exposed through inhalation--past, present, and future--to contaminants entrained by wind or by vehicle and heavy equipment activity.

Groundwater Pathways Off Site

Residential-Type Wells

The formerly occupied residences and the vehicle repair business operating at another former residence are within a mile southwest of the site and close to Silver Creek. ATSDR assumes the now-vacant residences could be reoccupied in the future. The private wells that service those locations appear to be hydraulically upgradient from the RFT site and are not likely to be affected by site releases to groundwater. Groundwater at those wells is more likely to be affected by contaminants released from tailings deposits at Prospector Square or Silver Maple Claims. Data are

not available to confirm water quality at those private wells. Therefore, ATSDR conservatively presumes that those well users potentially are exposed--past, present, and future--principally through ingestion and possibly through aerosol inhalation (showering) to contaminants that might originate from tailings near Park City.

Business/Industrial Wells

Three businesses northwest of the site get their industrial water supply from wells that are hydraulically downgradient from the site. The wells are not used for potable purposes. Arsenic and lead were present in one or more of the wells at low levels. Concentrations might increase if contaminated groundwater enters the water supply aquifer in substantive quantity in the future. However, dilution and adsorption in the groundwater regime are likely to prevent substantive contaminant increases in those wells. Workers using the industrial water potentially are exposed to contaminants in groundwater--past, present, and future--through incidental ingestion and aerosol inhalation.

Surface Soils Pathways Off Site

Wind has likely deposited tailings contaminants on surface soils in the vicinity of the site. Some surface soils on the creek flood plain also might contain elevated levels of contaminants as a result of tailings deposition. Workers who constructed US-40 possibly were exposed through incidental ingestion and inhalation to contaminants in surface soils in the vicinity. Also, nearby residents, employees, and road maintenance persons potentially are exposed--past, present, and future--through similar routes.

Creek Surface Water Pathways Off Site

Dissolved and particulate contaminants are present in creek water. The specific source(s) and amount(s) of contribution are not clear. County flood control maintenance workers and ranchers who draw water from the creek potentially are exposed--past, present, and future--through incidental ingestion to contaminants in creek water.

Creek Sediments Pathways Off Site

Creek sediments in the site vicinity contain contaminated sediment particles, including tailings particles, that have been transported from the site or from locations upstream of the site. County flood control maintenance workers and possibly ranchers who draw water from the creek potentially are exposed--past, present, and future--through incidental ingestion to contaminated creek sediments.

Ambient Air Pathways Off Site

In the past, wind was observed to suspend and transport dust (e.g., tailings and possibly contaminated surface soils) from on-site areas. Strong winds also are likely to suspend and transport flood plain tailings during dry weather. Winds also are likely to resuspend contaminated particles from areas off site where they had been deposited previously by wind. Results of air sampling at the fence in 1992 suggest that levels of site-related wind-borne contamination may be inconsequential when cover soils are in place, providing the cover and salt grass are maintained. However, data may not be representative of conditions over time.

The lateral extent of contaminant transport by wind or contaminant deposition is not known. The general prevailing wind direction is reported to be northwest; a several-day air quality study recorded winds toward the northwest and southeast (E&E 1985). For these dominant wind directions, the populations that would most likely be exposed through inhalation--past, present, and future--are the employees of three companies located a short distance northwest of the site. Other potential exposed populations include any residents of the homes and the business southwest of the site. Motorists, bikers, and maintenance workers on the roads adjacent to the site are potentially exposed for short periods. Workers who recently constructed the new segment of US-40 adjacent to the site may have been exposed as well.

Food Chain Pathways Off Site

Food Products--Cattle, Sheep, Milk, Grain

ATSDR is not aware of any sampling data for edible products grown in the site vicinity. Results of research and sampling elsewhere suggest that bioaccumulation of some metals may occur in agricultural products. This may include meat or milk from stock that drink contaminated water, from stock that graze on vegetation on which wind-blown contaminants have deposited or on vegetation grown in contaminated soil or irrigated with contaminated water from Silver Creek, or from stock that drink contaminated surface water. Some contaminants might also concentrate in grain. Therefore, persons who consume food products associated with cattle, sheep, or grain raised in the site vicinity potentially are exposed--past, present, and future--to contaminants taken up from environmental media. Appreciable exposure from this potential source is unlikely for people who obtain that food through mass distribution channels, but is plausible for repeat users of that food, such as the local ranchers and their families.

Fish in Silver Creek

A few fishery studies conducted by state wildlife personnel since 1954 either have shown that fish are present in small numbers in Silver Creek or they are absent. Additional information indicates that cutthroat trout have been noted in the creek, and EPA reported seeing pan-sized trout at the site in 1992. ATSDR's observations of the stream suggest that trout populations, if present, probably would not be viable year-around except possibly far downstream toward Wanship, which is about 10 miles from the site. The available information suggests that a fishery, if it exists, would not be an important exposure medium. Trout may concentrate some metals from surface water and from its foodchain. Therefore, if persons do consume trout or other game fish from Silver Creek, they potentially are exposed--past, present, and future,--to site-related contaminants. No sampling data are available to confirm whether fish contain contaminants.

PUBLIC HEALTH IMPLICATIONS

A. Toxicologic Evaluation

ATSDR staff evaluated all completed and potential exposure pathways in the following sections for toxicologic effects related to exposure.

Completed Exposure Pathways

To determine whether adverse health effects could result from exposure, ATSDR staff used contamination level data from each completed pathway to estimate exposure doses for each contaminant of concern. Doses were then compared to a Minimal Risk Level (MRL) or a Reference Dose (RfD). The MRL is developed by ATSDR; the RfD is developed by EPA. Both represent an estimate of daily exposure to a contaminant below which non-cancer adverse health effects are unlikely to occur. If an exposure dose has exceeded an MRL or RfD, the estimated exposure dose can then be compared to experimental data from human or animal studies to determine which effects may be of concern. When a contaminant is capable of causing cancer (carcinogenic), staff also considered the estimated exposure dose to calculate whether an increase in the cancer rate is expected.

<u>Tailings and Surface Soil Pathways On Site; Area A</u>

ATSDR staff assumed workers were in the most heavily contaminated areas at most 60 days per year, and incidently consumed 100 mg tailings (or soil) per day. ATSDR staff then compared the

estimated ingestion exposure doses with doses received by people in epidemiologic studies or received by animals in laboratory studies and evaluated whether adverse health effects are possible. Estimated exposure doses were below levels of health concern for all contaminants in soil and tailings; therefore, adverse health effects are unlikely to have occurred in workers. Given the relative infrequency of people wandering on the site before construction of the fence, adverse health effects are unlikely for trespassers.

Surface Water Pathways On Site; Area A

People who worked when tailings were being deposited may have been exposed to contaminants principally via incidental ingestion of surface water. ATSDR staff estimated exposure doses to contaminants in surface water on the site; those doses are all significantly below levels of public health concern. ATSDR staff expect no adverse health effects in workers as a result of exposure to contaminated surface water. Given the relative infrequency of people wandering onto the site before the fence was constructed, adverse health effects are unlikely for trespassers.

Ambient Air Pathways on Site; Area A

People who worked on site without respirators before the site was substantially covered with soil and vegetation were exposed to contaminants in the air. Ambient on-site air concentrations were evaluated for adverse health effects of inhalation. Concentrations measured in air presented no public health hazard.

Public Water Systems Off Site; Downstream in Silver Creek Watershed

Long-term users of the High Valley Water Company and Summit County Service Area #3 public water supplies may have been exposed via ingestion to arsenic, but that exposure probably did not last a sufficient time to pose a public health hazard. Arsenic in the public water supply may not be site related.

Although other metals are present in the public drinking water supplies, none are at levels that may be considered harmful to the general public. Sodium is at a level that people on a sodium-restricted diet should avoid.

Potential Exposure Pathways

To determine whether adverse health effects could result from exposure, ATSDR staff used contamination level data when available from each potential pathway to estimate exposure doses

for each contaminant of concern. These doses were then compared to MRLs or RfDs, as discussed above. When data were not available, staff made assumptions to enable analysis of pathways. These assumptions, when used, are stated below.

Tailings and Surface Soils Pathways On Site; Area A, Area B

ATSDR staff estimated ingestion exposure doses for workers and evaluated whether adverse health effects are possible. Estimated exposure doses were below levels of health concern for all contaminants in tailings in area B; therefore, adverse health effects are unlikely for workers. ATSDR staff do not have data regarding levels of contaminants in soils because tailings disposal ended; we also do not have information on contaminants in cover soil or adjacent natural surface soils. However, levels are not expected to be significantly higher, and could be considerably lower, than those measured in tailings on the site. Estimated exposure doses, therefore, would be lower than those estimated above in the COMPLETED EXPOSURE PATHWAYS section. Adverse health effects to workers are not expected from exposure via these potential pathways.

Should the property be developed, at a future time, for residential purposes, people would receive an exposure dose corresponding to typical residential exposures (365 days a year). ATSDR staff estimated potential ingestion exposure doses for individuals who would live on the site at a future time. In that case, people would receive exposure doses of arsenic, beryllium, cadmium and lead at levels of health concern. Elevated levels of contaminants make the site unsuitable for residential or gardening purposes.

Surface Water Pathways On Site; Area A

It is not known whether people who have worked on the site since tailings disposal ceased have come in contact with surface water. Because the completed surface water pathway previously discussed was evaluated to be of no public health concern, adverse health effects are not expected from exposure via this potential pathway.

Ambient Air Pathways On Site; Area A

The completed ambient air pathway previously discussed was evaluated to be of no public health concern. Therefore, adverse health effects are not expected from exposure via this potential pathway.

Groundwater Pathways Off Site

Residential-Type Wells

ATSDR staff have no information about contaminant levels in residential-type wells southwest of the site. Formerly, those wells served four residences. More recently, ATSDR learned one residence has been converted to a small business. Only two other residences now exist; both are vacant, but ATSDR expects they could be occupied anytime in the future. Since those wells serving those locations are hydraulically upgradient from the site, it is unlikely that people have been exposed to site-related contaminants at levels of public health concern. This document does not consider contributions from Prospector Square.

Business/Industrial Wells

Workers are potentially exposed to contaminants through incidental ingestion and possibly aerosol inhalation. Exposures associated with those potential pathways are low enough to be considered of no public health concern.

Surface Soil Pathways Off Site

Nearby residents, employees, and road maintenance people are potentially exposed to contaminants through incidental ingestion. ATSDR staff estimated exposure doses associated with off-site surface soil. Those doses are low enough to be considered of no public health concern, primarily due to the infrequency of exposure.

Should that area be developed, at some future time, for residential purposes, those residents would receive a larger incidental ingestion exposure dose than would the occasional visitor or worker. ATSDR staff estimated potential ingestion exposure doses for individuals who would live near the site at some future time. In that case, individuals would receive exposure doses of arsenic and lead at levels of health concern.

Elevated levels of contaminants make the area near the site unsuitable for residential or gardening purposes.

Creek Surface Water Pathways Off Site

County maintenance workers and ranchers are potentially exposed to contaminants through incidental ingestion of creek water. Exposures associated with that potential pathway are low enough to be considered of no public health concern.

Creek Sediments Pathway Off Site

County maintenance workers and ranchers are potentially exposed to contaminants through incidental ingestion of creek sediments. Exposures associated with that potential pathway are significantly low enough to be considered of no public health concern.

Ambient Air Pathways Off Site

People who work or live near the site are potentially exposed to contaminants in the air. Off-site ambient air concentrations were evaluated for adverse health effects of inhalation. Concentrations measured in air do not represent a public health hazard.

Food Chain Pathways Off Site

ATSDR staff have no information about contaminant levels in cattle, sheep, milk, grains, or fish on or near the site. It is not likely that those sources of food are contaminated with site-related contaminants at a level of public health concern.

B. Health Outcome Data Evaluation

The lead at this site is bound up in tailings similar to the tailings found at Prospector Square. ATSDR studies at Prospector Square indicate that exposure to these tailings did not result in any increase in blood lead, arsenic, or cadmium at clinically meaningful levels, as compared to local controls (ATSDR 1988). No further health studies were recommended. The study showed a significant increase in blood lead levels in children aged 9 to 71 months, but considered that increase clinically insignificant. At that time, the Centers for Disease Control and Prevention (CDC) considered 25 micrograms lead per deciliter blood (ug/dl) a clinically significant blood level; the CDC has since revised that level down to 10 ug/dl (CDC 1991).

Nevertheless, because the frequency and duration of exposure to tailings in the residential Prospector Square area are expected to be significantly higher than the frequency and duration of exposure to tailings at Richardson Flat, it is likely that exposure to lead at Richardson Flat will not result in an increase in blood lead levels. This conclusion is based on the margin of safety provided by the significant differences in frequency and duration of exposure to tailings at Richardson Flat, an uninhabited area, and at Prospector Square, one where people live. Furthermore, because of potential differences in populations (e.g., behavioral patterns, nutritional status, health status), and in type of construction (e.g., basement vs. slab) and landscaping, conclusions regarding exposure to people

living at Prospector Square may not apply to a future population living at Richardson Flat.

Although it is not known exactly how many people have been exposed to contaminants at the site, ATSDR staff estimate that only a few people were exposed. Furthermore, the exposure level is not of public health concern. Finally, the exposure has ended. For those reasons, ATSDR staff consider it unlikely that anyone who was exposed will develop any adverse health effects from that exposure. In addition, ATSDR staff are unaware of any recent community health concerns of the residents. Therefore, ATSDR staff did not examine health outcome data. If new information becomes available, or if nearby residents have health concerns about contaminants associated with the site, ATSDR will reconsider evaluating health outcome data.

C. Community Health Concerns Evaluation

Because there is no information about levels of contaminants in blowing dust, ATSDR staff cannot evaluate the health hazard posed by inhalation of the dust. ATSDR staff evaluated available ambient air data (see Toxicologic Evaluation section). Levels of contaminants in blowing dust generated from topsoil should not pose a public health hazard. When the tailings are completely covered by topsoil or when vegetation has adequately anchored the soil, there should not be any contaminated dust or other contaminated particulates blowing off site in concentrations above comparison values. ATSDR staff are not aware of any other community health concerns.

CONCLUSIONS

1. ATSDR considers the RFT site to pose no apparent public health hazards due to past or present exposure. Evaluations of available information for completed exposure pathways suggest that associated doses are at levels of no apparent health concern. That is, doses are not high enough to result in adverse health effects in people near the site or in people who have worked on site. ATSDR staff do not expect contaminant levels or exposure doses associated with potential pathways to be high enough to result in adverse health effects in people near the site or people who worked on the site. However, should the site, or areas near the site where significant levels of contaminants may be found, be developed in the future for residential purposes, the people who live on top of soil contaminated at significant levels will have greater exposure duration to soil than those who live near the site or worked on the site. In this case, levels of contaminants on or very close to the site would be at levels of health concern. Because we are not certain of the future of this site, ATSDR considers the RFT site to pose an indeterminate public health hazard for future exposure.

2. The only community concern expressed was about wind-blown dust. Exposure to such dust does not appear to be a public health hazard.

3. The owners report they will not develop the property; that commitment may avoid potentially adverse exposures that would result from daily exposure to some of the on-site contaminants in the future. However, that commitment is not enforceable.

4. A number of actions are warranted to minimize future site-related exposure:
   a. finish placing soil cover over tailings
   b. provide periodic maintenance for cover soils and associated vegetation, and
   c. train on-site workers.

5. The known private water wells are at locations not likely to have been affected by site releases, but water quality data are not available for those wells. Thus, a well survey and water analyses are warranted.

6. Public water systems data should be reviewed periodically to confirm whether water has been impacted.

7. Should additional data become available that indicate people are being exposed to contaminants at levels of public health concern, the first conclusion will be revised.

RECOMMENDATIONS

Cease/Reduce Exposure Recommendations

1. Finish placing soil cover over tailings in a timely manner.

2. Conduct periodic maintenance in tailings area to cover soil and vegetation.

3. See that on-site workers are well trained and use adequate protective equipment.

4. If urban development extends substantively closer to the site, consider measures to reduce potential for public exposure.

5. If evidence arises in the future that confirms tailings were taken off site and confirms their specific location(s), evaluate related exposure, public health, and remedial issues.

6. Local governments should be encouraged to impose appropriate guidelines for any activity that would disturb the tailings or soil and sediment contaminated with tailings, at the site, and at areas upstream and downstream that might be impacted by tailings. Those guidelines should be intended to ensure that any activity which would disturb the tailings would need to be conducted in a manner preventing exposures posing an unacceptable health risk.

Site/Area Characterization Recommendations

1. Conduct a private well survey within 1 mile (upgradient and downgradient); analyze groundwater samples taken from wells. If water quality is not consistent with public health criteria, alternate water supplies should be obtained and the well survey and sampling should be appropriately expanded. In addition, ATSDR's conclusion regarding the public health hazard associated with this site would have to be reevaluated.

2. Review nearby public water systems information periodically for evidence of the groundwater supply being impacted.

3. If urban development extends substantially closer to the site, sample surface soils more extensively off site. As a part of this effort, consider whether tailings deposited on site might have flowed beyond the present containment area,

for example to low-lying areas on the south side of County Road.

Health Activities Recommendation Panel (HARP) Recommendations

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, data and information developed in the Amendment to the Public Health Assessment for the Richardson Flat Tailings site in Summit County, Utah, have been evaluated for appropriate followup with respect to health activities. Available information indicates that no human exposure to contaminants at levels of public health concern is occurring or has occurred. In addition, the community has not expressed health concerns. For these reasons, ATSDR has concluded that no follow-up actions should be pursued at this time. If more information becomes available indicating that human exposure to hazardous substances is occurring or has occurred in the past at levels of public health concern, ATSDR will reevaluate this site for any additional indicated followup.

Public Health Actions

The purpose of the Public Health Action Plan (PHAP) is to ensure that this public health addendum not only identifies public health hazards but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment.

Based on discussions with EPA Region VIII, EPA will consider the Cease/Reduce Exposure and Site/Area Characterization recommendations listed above when they develop the work plan for this site. Based on the HARP determination that no health follow-up activities are required by ATSDR, no PHAP for health follow-up activities has been developed for this release.

REFERENCES

ATSDR. 1988. Silver Creek mine tailings exposure study. Agency for Toxic Substances and Disease Registry.

ATSDR. 1990. Preliminary health assessment for Richardson Flat tailings. Agency for Toxic Substances and Disease Registry.

ATSDR. 1991a. Draft Toxicological profile for arsenic. Agency for Toxic Substances and Disease Registry.

ATSDR. 1991b. Draft Toxicological profile for lead. Agency for Toxic Substances and Disease Registry.

CDC. 1991. Preventing lead poisoning in young children. Centers for Disease Control.

E&E. 1985. Analytical results report, Richardson Flat tailings. Ecology and Environment.

E&E. 1987a. Analytical results report of air sampling at Richardson Flat. Ecology and Environment.

E&E. 1987b. Record of communication with Silver Creek Irrigation Company. Ecology & Environment.

E&E. 1989. Supplemental site inspection report. Ecology and Environment.

E&E. 1991a. Record of communication with Utah Division of Wildlife Resources. Ecology & Environment.

E&E. 1991b. Record of communication with farmer. Ecology and Environment.

E&E. 1991c. Memorandum regarding air data. Ecology and Environment.

E&E. 1991d. Trip report and analytical results of the ground water sampling of 3 wells at Richardson Flat tailings. Ecology and Environment.

E&E. 1992. Draft final report, Richardson Flat Tailings. Ecology and Environment.

E&E. 1993. Final report, Richardson Flat Tailings. Ecology and Environment.

IRIS. 1992. Integrated Risk Information System. National Library of Medicine, National Toxicology Information Program, Bethesda, MD. December 28.

PC. 1992. Letter to ATSDR dated November 9, 1992. Park City Municipal Corporation.

UDEQ. 1992a. Letter, with map, to ATSDR. Utah Department of Environmental Quality.

UDEQ. 1992b. Computer printouts of public water system data. Utah Department of Environmental Quality.

UDEQ. 1992c. Analytical results for surface water for Silver Creek. Utah Division of Water Quality, Department of Environmental Quality.

UTD. 1989. Memorandum and attached laboratory data sheets for landfill samples analyzed in 1988. Utah Department of Transportation.

UDNR. 1986. Water resources of the Park City area, Utah with emphasis on ground water. Utah Department of Natural Resources.

UDNR. 1992. Diversion records database, station data printout. Utah Division of Water Rights, Department of Natural Resources.

USBC. 1991. Census of population and housing, 1990: summary tape file 1 (Utah) [machine-readable data files]. Washington, D.C. U.S. Bureau of the Census.

USEPA. Undated. A summary description of tailings area and USEPA's listing actions. US Environmental Protection Agency.

USEPA. 1991a. Aerial photographic Analysis of the Richardson Flat tailings. US Environmental Protection Agency.

USEPA. 1991b. HRS documentation record. U.S. Environmental Protection Agency.

USEPA. 1992a. Sampling qa/qc work plan, Richardson Flat tailings. US Environmental Protection Agency.

USEPA. 1992b. National Priorities List fact sheet for Richardson Flat tailings. U.S. Environmental Protection Agency.

USEPA. 1992c. Final Air Sampling & Analysis Report, Richardson Flat. U.S. Environmental Protection Agency.

USEPA. 1993. Memorandum to ATSDR concerning EPA review of Initial Release Public Health Assessment. March 9, 1993.

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APPENDIX A

SITE MAPS

Figure 1
Location Plan

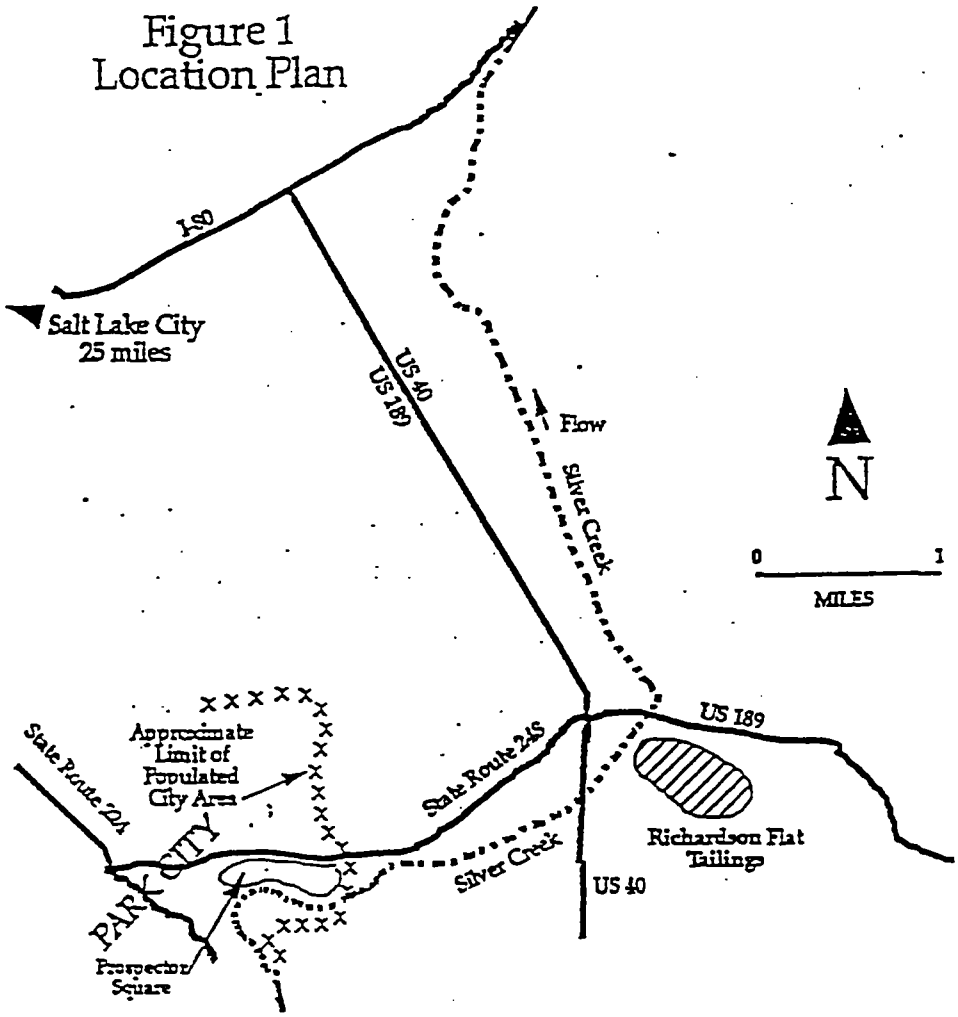
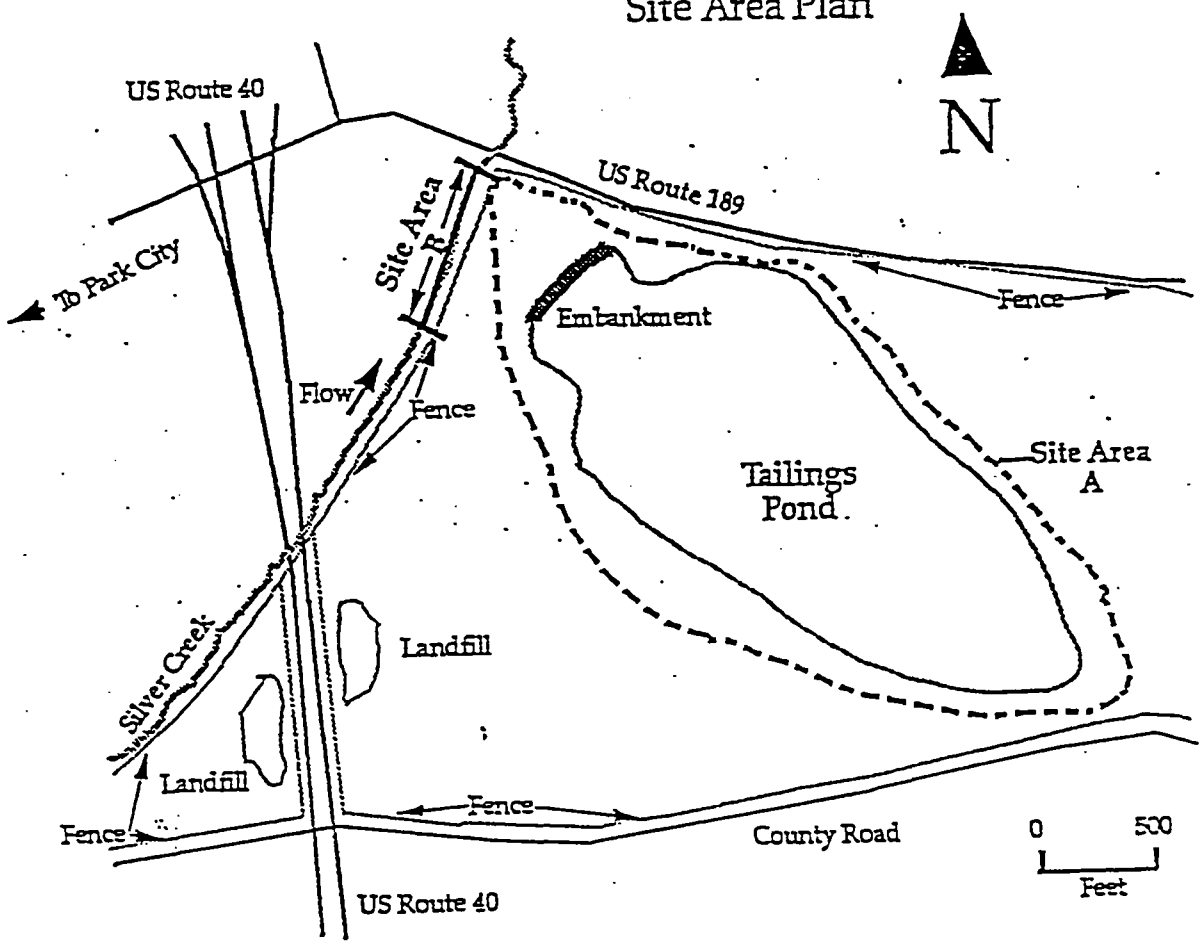


Figure 2
Site Area Plan



APPENDIX B

CONTAMINANT AND PATHWAY TABLES

TABLE 1 Contaminant Concentrations in Groundwater On Site; Area A--Monitoring Wells

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Aluminum	94,900*	E&E 1993	1992	none	
Antimony	35.9?	E&E 1992	1992	4	RMEG
Arsenic	81.1*	E&E 1993	1992	0.02	CREG
Barium	1,180*	E&E 1993	1992	700	RMEG
Beryllium	4.6J*	E&E 1993	1992	0.0081	CREG
Cadmium	48	E&E 1985	1985	2	EMEG
Calcium	365,000	E&E 1992	1992	none	
Chromium	110J*	E&E 1993	1992	10,000	RMEG
Cobalt	80	E&E 1985	1985	none	
Copper	1,583	E&E 1985	1985	1,300	AL
Iron	130,000	E&E 1985	1985	none	
Lead	1,080	E&E 1985	1985	15	AL
Magnesium	88,000	E&E 1985	1985	none	
Manganese	22,300*	E&E 1993	1992	1,000	RMEG
Mercury	0.7	E&E 1985	1985	2	LTHA
Nickel	93.1*	E&E 1993	1992	100	LTHA
Potassium	22,100*	E&E 1993	1992	none	
Silver	17	E&E 1985	1985	50	RMEG
Sodium	54,000	E&E 1985	1985	none	
Thallium	<100	E&E 1985	1985	0.4	LTHA
Vanadium	266	E&E 1985	1985	20	LTHA
	Table 1 Continues				

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Zinc	2,790	E&E 1985	1985	2,100	LTHA

*- Sample obtained by landfill
Unfiltered sample data
ppb-parts per billion
?- approximate value
<- less than
AL- action level
J- estimated value
CREG- cancer risk evaluation guide
RMEG- reference dose media evaluation guide
LTHA- lifetime health advisory
EMEG- environmental media evaluation guide

TABLE 2 Contaminant Concentrations in Tailings On Site; Areas A and B

Contaminant	Maximum Concentration (ppm)	(reference)	Date	Comparison Value (ppm)	Source
Aluminum	A-3,440 B-1,030	E&E 1985 E&E 1989	1985 1989	none	
Antimony	A-171 B-144	E&E 1985 E&E 1989	1985 1989	280	RMEG
Arsenic	A-3,600 B-259*	E&E 1985 E&E 1989	1985 1989	0.4	CREG
Barium	A-153 B-117	E&E 1989 E&E 1989	1989 1989	49,000	RMEG
Beryllium	A-1.2 B-ND	E&E 1992 E&E 1989	1992 1989	0.16	CREG
Cadmium	A-169 B-250	E&E 1985 E&E 1989	1985 1989	140	EMEG
Calcium	A-117,000 B-32,800	E&E 1985 E&E 1989	1985 1989	none	
Chromium	A-60 B-ND	E&E 1985 E&E 1989	1985 1989	700,000	RMEG
Cobalt	A-12.6 B-3.9*	E&E 1992 E&E 1989	1992 1989	none	
Copper	A-961 B-281	E&E 1985 E&E 1989	1985 1989	none	
Iron	A-154,000 B-87,000	E&E 1985 E&E 1989	1985 1989	none	
Lead	A-8,530 B-31,600	E&E 1985 E&E 1989	1985 1989	none	
Magnesium	A-23,000 B-1,140*	E&E 1989 E&E 1989	1989 1989	none	
Manganese	A-5,990 B-252	E&E 1985 E&E 1989	1985 1989	70,000	RMEG
	Table 2 continues				

Contaminant	Maximum Concentration (ppm)	(reference)	Date	Comparison Value (ppm)	Source
Mercury	A-3.6? B-8.2	E&E 1992 E&E 1989	1992 1989	none	
Nickel	A-9.4 B-6.2*	E&E 1989 E&E 1989	1989 1989	none	
Potassium	A-917 B-1,140*	E&E 1992 E&E 1989	1992 1989	none	
Silver	A-26 B-115	E&E 1985 E&E 1989	1985 1989	3,500	RMEG
Sodium	A-11,300 B-603*	E&E 1985 E&E 1989	1985 1989	none	
Thallium	A-41.7 B-9.7*	E&E 1992 E&E 1989	1992 1989	none	
Vanadium	A-13.0 B-2.6	E&E 1992 E&E 1989	1992 1989	none	
Zinc	A-23,200 B-33,800	E&E 1985 E&E 1989	1985 1989	none	

A- Area A B- Area B
ppm- parts per million CREG- cancer risk evaluation guide
?- approximate value RMEG- reference dose media evaluation guide
*- estimated value EMEG- environmental media evaluation guide

TABLE 3 Contaminant Concentrations in Soil Cover Layer Over Tailings On Site; Area A

Contaminant	Maximum Concentration (ppm)	(reference)	Date	Comparison Value (ppm)	Source
Aluminum	25,300	E&E 1992	1992	none	
Antimony	5.7?	E&E 1992	1992	280	RMEG
Arsenic	20.9?	E&E 1992	1992	0.4	CREG
Barium	317	E&E 1992	1992	49,000	RMEG
Beryllium	1.2	E&E 1992	1992	0.16	CREG
Cadmium	5.0?	E&E 1992	1992	140	EMEG
Calcium	9,480	E&E 1992	1992	none	
Chromium	28.2	E&E 1992	1992	700,000	RMEG
Cobalt	15.0	E&E 1992	1992	none	
Copper	50.4	E&E 1992	1992	none	
Iron	2,750	E&E 1992	1992	none	
Lead	223	E&E 1992	1992	none	
Magnesium	5,570	E&E 1992	1992	none	
Manganese	1,030	E&E 1992	1992	70,000	RMEG
Mercury	0.16	E&E 1992	1992	none	
Nickel	21.6	E&E 1992	1992	none	
Potassium	5,650	E&E 1992	1992	none	
Silver	4.1?	E&E 1992	1992	3,500	RMEG
Sodium	319?	E&E 1992	1992	none	
Thallium	1.9?	E&E 1992	1992	none	
Vanadium	57.4	E&E 1992	1992	none	
Zinc	432	E&E 1992	1992	none	

ppm- parts per million
?- approximate value

CREG- cancer risk evaluation guide
RMEG- reference dose media evaluation guide
EMEG- environmental media evaluation guide

TABLE 4 Contaminant Concentrations in Surface Water On Site; Area A (Diversion Ditch and Marsh) and Area B (Silver Creek)

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Aluminum	A-30,900 B-77	E&E 1989 E&E 1985	1989 1985	none	
Antimony	A-937 B-39	E&E 1989 E&E 1992	1989 1992	4	RMEG
Arsenic	A-2,326 B-619	E&E 1989 E&E 1989	1989 1989	0.02	CREG
Barium	A-2,330 B-60.8*	E&E 1989 E&E 1989	1989 1989	700	RMEG
Beryllium	A-3.2? B-2.4*	E&E 1992 E&E 1989	1992 1989	0.0081	CREG
Cadmium	A-289 B-35?	E&E 1989 E&E 1992	1989 1992	2	EMEG
Calcium	A-446,000 B-149,000	E&E 1989 E&E 1992	1989 1992	none	
Chromium	A-50.2 B-72.2	E&E 1989 E&E 1989	1989 1989	10,000	RMEG
Cobalt	A-48.7* B-5.7*	E&E 1989 E&E 1989	1989 1989	none	
Copper	A-1,540 B-9	E&E 1989 E&E 1985	1989 1985	1,300	AL
Iron	A-107,000 B-389	E&E 1989 E&E 1985	1989 1985	none	
Lead	A-22,100* B-15?	E&E 1989 E&E 1992	1989 1992	15	AL
Magnesium	A-104,000 B-33,600	E&E 1989 E&E 1992	1989 1992	none	
	Table 4 continues				

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Manganese	A-21,100 B-434	E&E 1989 E&E 1985	1989 1985	1,000	RMEG
Mercury	A-8 B-11.5	E&E 1989 E&E 1989	1989 1989	2	LTHA
Nickel	A-65.5 B-67.3*	E&E 1989 E&E 1989	1989 1989	100	LTHA
Potassium	A-15,600 B-1,950?	E&E 1989 E&E 1992	1989 1992	none	
Silver	A-201 B-117	E&E 1989 E&E 1989	1989 1989	50	RMEG
Sodium	A-58,500 B-42,700	E&E 1989 E&E 1989	1989 1989	none	
Thallium	A-83.4* B-4.2*	E&E 1989 E&E 1989	1989 1989	0.4	LTHA
Vanadium	A-58.7 B-121	E&E 1989 E&E 1989	1989 1989	20	LTHA
Zinc	A-49,100 B-1,650	E&E 1989 E&E 1985	1989 1985	2,100	LTHA

A- Area A B- Area B
ppb- parts per billion CREG- cancer risk evaluation guide
?- approximate value RMEG- reference dose media evaluation guide
*- estimated value LTHA- lifetime health advisory
AL- action level EMEG- environmental media evaluation guide

TABLE 5 Contaminant Concentrations in Sediments On Site; Area A (Diversion Ditch, Marsh, Ponded Water Locations) and Area B (Silver Creek)

Contaminant	Maximum Concentration (ppm)	(reference)	Date	Comparison Value (ppm)	Source
Aluminum	A-28,800 B-8,620	E&E 1992 E&E 1989	1992 1989	none	
Antimony	A-200* B-201*	E&E 1989 E&E 1989	1989 1989	280	RMEG
Arsenic	A-839 B-590	E&E 1989 E&E 1989	1989 1989	0.4	CREG
Barium	A-1,220 B-147	E&E 1989 E&E 1989	1989 1989	49,000	RMEG
Beryllium	A-2.3 B-0.86*	E&E 1992 E&E 1989	1992 1989	0.16	CREG
Cadmium	A-185* B-91.4*	E&E 1989 E&E 1989	1989 1989	140	EMEG
Calcium	A-249,000 B-25,600	E&E 1989 E&E 1989	1989 1989	none	
Chromium	A-62.9? B-1.0*	E&E 1992 E&E 1989	1992 1989	700,000	RMEG
Cobalt	A-64.4 B-43.5	E&E 1989 E&E 1989	1989 1989	none	
Copper	A-870 B-753	E&E 1989 E&E 1989	1989 1989	none	
Iron	A-156,000 B-148,000	E&E 1989 E&E 1989	1989 1989	none	
Lead	A-13,600 B-14,200	E&E 1989 E&E 1989	1989 1989	none	
Magnesium	A-33,800 B-9,430	E&E 1989 E&E 1989	1989 1989	none	
	Table 5 continues				

Contaminant	Maximum Concentration (ppm)	(reference)	Date	Comparison Value (ppm)	Source
Manganese	A-207,000 B-1,730	E&E 1989 E&E 1989	1989 1989	70,000	RMEG
Mercury	A-8.2? B-6.0	E&E 1992 E&E 1989	1992 1989	none	
Nickel	A-97.2 B-28.8	E&E 1992 E&E 1989	1992 1989	none	
Potassium	A-6,270 B-1,160*	E&E 1989 E&E 1989	1989 1989	none	
Silver	A-86.0 B-47.5	E&E 1989 E&E 1989	1989 1989	3,500	RMEG
Sodium	A-1,150? B-181*	E&E 1992 E&E 1989	1992 1989	none	
Thallium	A-24.1* B-4.1*	E&E 1989 E&E 1989	1989 1989	none	
Vanadium	A-70.6 B-21.2	E&E 1992 E&E 1989	1992 1989	none	
Zinc	A-26,400 B-15,500	E&E 1989 E&E 1989	1989 1989	none	

ppm- parts per million A- Area A B- Area B
?- approximate value RMEG- reference dose media evaluation guide
*- estimated value CREG- cancer risk evaluation guide
EMEG- environmental media evaluation guide

TABLE 6 Contaminant Concentrations in Ambient Air On Site; Area A

Contaminant	Maximum Concentration ($\mu g/m^3$)	(reference)	Date	Comparison Value ($\mu g/m^3$)	Source
Aluminum	NI				
Antimony	NI				
Arsenic	0.0927	E&E 1991c	1986	0.00023	CREG
Barium	NI				
Beryllium	NI				
Cadmium	0.0143*	E&E 1991c	1986	0.00056	CREG
Calcium	NI				
Chromium	NI				
Cobalt	NI				
Copper	NI				
Iron	NI				
Lead	1.6478	E&E 1991c	1986	none	
Magnesium	NI				
Manganese	NI				
Mercury	NI				
Nickel	NI				
Potassium	NI				
Silver	NI				
Sodium	NI				
Thallium	NI				
Vanadium	NI				
Zinc	1.4478*	E&E 1991c	1986	none	

$\mu g/m^3$- micrograms per cubic meter
*- estimated value
NI- no information CREG- cancer risk evaluation guide

TABLE 7 Contaminant Concentrations in Groundwater Off Site; Background Monitoring Well and Three Nearby Industrial Wells

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Aluminum	C-15,700 D-NI	E&E 1992	1992	none	
Antimony	C-<5 D-NI	E&E 1985	1985	4	RMEG
Arsenic	C-3.7? D-4.8?	E&E 1992 E&E 1991d	1992 1991	0.02	CREG
Barium	C-196? D-NI	E&E 1992	1992	700	RMEG
Beryllium	C-1.3? D-NI	E&E 1992	1992	0.0081	CREG
Cadmium	C-<5 D-ND	E&E 1985 E&E 1991d	1985 1991	2	EMEG
Calcium	C-42,000 D-NI	E&E 1992	1992	none	
Chromium	C-10.5 D-ND	E&E 1992 E&E 1991d	1992 1991	10,000	RMEG
Cobalt	C-11? D-NI	E&E 1992	1992	none	
Copper	C-30 D-NI	E&E 1992	1992	1,300	AL
Iron	C-14,000 D-NI	E&E 1992	1992	none	
Lead	C-627? D-36.9	E&E 1992 E&E 1991d	1992 1991	15	AL
Magnesium	C-12,200 D-NI	E&E 1992	1992	none	
	Table 7 continues				

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Manganese	C-162? D-NI	E&E 1992	1992	1,000	RMEG
Mercury	C-<0.1 D-NI	E&E 1985	1985	2	LTHA
Nickel	C-13 D-NI	E&E 1992	1992	100	LTHA
Potassium	C-3,970? D-NI	E&E 1992	1992	none	
Silver	C-<5 D-NI	E&E 1985	1985	50	RMEG
Sodium	C-16,100 D-NI	E&E 1992	1992	none	
Thallium	C-<100 D-NI	E&E 1985	1985	0.4	LTHA
Vanadium	C-<10 D-NI	E&E 1985	1985	20	LTHA
Zinc	C-136? D-NI	E&E 1992	1992	2,100	LTHA

Unfiltered sample data
C- background monitoring well
ppb- parts per billion
NI- no information
?- approximate value
<- less than

D- three nearby industrial wells
EMEG- environmental media evaluation guide
CREG- cancer risk evaluation guide
RMEG- reference dose media evaluation guide
LTHA- lifetime health advisory
AL- action level

TABLE 8 Contaminant Concentrations in Groundwater Off Site; Public Water Supply Wells--Atkinson Special Improvement District, High Valley Water Company, and Summit County Service Area #3

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Aluminum	E-NI F-NI G-NI			none	
Antimony	E-NI F-NI G-NI			4	RMEG
Arsenic	E-<1 F-7 G-7	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1989	0.02	CREG
Barium	E-60 F-180 G-80	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1989	700	RMEG
Beryllium	E-NI F-NI G-NI			0.0081	CREG
Cadmium	E-<1 F-<1 G-<1	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1988	2	EMEG
Calcium	E-71,000 F-78,000 G-NI	UDEQ 1992b UDEQ 1992b	1988 1987	none	
Chromium	E-<1 F-5 G-<1	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1985 1988	10,000	RMEG
Cobalt	E-NI F-NI G-NI			none	
	Table 8 continues				

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Copper	E-<10 F-120 G-30	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1989	1,300	AL
Iron	E-680 F-710 G-170	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1985 1981	none	
Lead	E-<1 F-<5 G-<1	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1988	15	AL
Magnesium	E-11,000 F-21,000 G-12,000	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1981	none	
Manganese	E-20 F-35 G-25	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1985 1981	1,000	RMEG
Mercury	E-0.2 F-<0.2 G-<0.2	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1989	2	LTHA
Nickel	E-<10 F-NI G-<30	UDEQ 1992b UDEQ 1992b	1988 1989	100	LTHA
Potassium	E-3,000 F-4,000 G-4,000	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1989	none	
Silver	E-<1 F-<2 G-<1	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1989	50	RMEG
Sodium	E-54,000 F-23,000 G-86,000	UDEQ 1992b UDEQ 1992b UDEQ 1992b	1988 1987 1989	none	
Thallium	E-NI F-NI G-NI			0.4	LTHA
	Table 8 continues				

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Vanadium	E-NI F-NI G-NI			20	LTHA
Zinc	E-100 F-150 G-130	UDEQ 1992b UDEQ 1992b	1988 1985 1989	2,100	LTHA

Reference not state whether samples were filtered
E- Atkinson Special Improvement District
F- High Valley Water Company
G- Summit County Service Area #3
ppb- parts per billion
<- less than
NI- no information
AL- action level
CREG- cancer risk evaluation guide
RMEG- reference dose media evaluation guide
LTHA- lifetime health advisory
EMEG- environmental media evaluation guide

TABLE 9 Contaminant Concentrations in Soils Off Site; Surface Soils and Subsurface Soils

Contaminant	Maximum Concentration (ppm)	(reference)	Date	Comparison Value (ppm)	Source
Aluminum	G-14,400 H-16,900	E&E 1985 E&E 1985	1985 1985	none	
Antimony	G-89* H-NAD	E&E 1987a E&E 1985	1987 1985	280	RMEG
Arsenic	G-87 H-6.5	E&E 1987a E&E 1985	1987 1985	0.4	CREG
Barium	G-668 H-147	E&E 1987a E&E 1985	1987 1985	49,000	RMEG
Beryllium	G-43* H-NAD	E&E 1987a E&E 1985	1987 1985	0.16	CREG
Cadmium	G-17 H-7.4	E&E 1985 E&E 1985	1985 1985	140	EMEG
Calcium	G-46,900 H-5,020	E&E 1987a E&E 1985	1987 1985	none	
Chromium	G-743* H-19	E&E 1987a E&E 1985	1987 1985	700,000	RMEG
Cobalt	G-159* H-9.5	E&E 1987a E&E 1985	1987 1985	none	
Copper	G-100 H-17	E&E 1987a E&E 1985	1987 1985	none	
Iron	G-94,200 H-19,700	E&E 1987a E&E 1985	1987 1985	none	
Lead	G-1,100 H-37	E&E 1985 E&E 1985	1985 1985	none	
Magnesium	G-55,000 H-7,620	E&E 1987a E&E 1985	1987 1985	none	
Manganese	G-15,400 H-625	E&E 1987a E&E 1985	1987 1985	70,000	RMEG
	Table 9 continues				

Mercury	G-1.0* H-NAD	E&E 1987a E&E 1985	1987 1985	none	
Nickel	G-52 H-22	E&E 1987a E&E 1985	1987 1985	none	
Potassium	G-1,480* H-NI	E&E 1987a	1987	none	
Silver	G-6.7 H-NAD	E&E 1985 E&E 1985	1985 1985	3,500	RMEG
Sodium	G-5,620 H-279	E&E 1987a E&E 1985	1987 1985	none	
Thallium	G-2.4 H-NAD	E&E 1987a E&E 1985	1987 1985	none	
Vanadium	G-1,390* H-31	E&E 1987a E&E 1985	1987 1985	none	
Zinc	G-1,570 H-70	E&E 1985 E&E 1985	1985 1985	none	

G- surface soils
ppm- parts per million
*- estimated value
H- subsurface soils
CREG- cancer risk evaluation guide
RMEG- reference dose media evaluation guide
EMEG- environmental media evaluation guide

TABLE 10 Contaminant Concentrations in Surface Water Off Site; Upstream (Pace Homer Ditch and Silver Creek) and Downstream (Silver Creek)

Contaminant	Maximum Concentration (ppb)	(reference)	Date	Comparison Value (ppb)	Source
Aluminum	I-172 J-370	E&E 1985 E&E 1985	1985 1985	none	
Antimony	I-36.7? J-35	E&E 1992 E&E 1985	1992 1985	4	RMEG
Arsenic	I-14 J-110	E&E 1985 UDEQ 1992c	1985 1988	0.02	CREG
Barium	I-54.6? J-140	E&E 1992 UDEQ 1992c	1992 1991	700	RMEG
Beryllium	I-3.4? J-2.4?	E&E 1992 E&E 1992	1992 1992	0.0081	CREG
Cadmium	I-3.9? J-10	E&E 1992 UDEQ 1992c	1992 1988	2	EMEG
Calcium	I-23,300 J-163,000	E&E 1992 E&E 1992	1992 1992	none	
Chromium	I-<5 J-8	E&E 1985 UDEQ 1992c	1985 1985	10,000	RMEG
Cobalt	I-<5 J-4.0*	E&E 1985 E&E 1989	1985 1989	none	
Copper	I-12 J-60	E&E 1985 E&E 1985	1985 1985	1,300	AL
Iron	I-725 J-2,290	E&E 1985 E&E 1985	1985 1985	none	
Lead	I-147 J-1,985	E&E 1985 E&E 1985	1985 1985	15	AL
Magnesium	I-38,700 J-37,700	E&E 1992 E&E 1992	1992 1992	none	
	Table 10 continues				

Manganese	I-764 J-1,900	E&E 1985 UDEQ 1992c	1985 1988	1,000	RMEG
Mercury	I-0.2 J-0.3	E&E 1985 UDEQ 1992c	1985 1992	2	LTHA
Nickel	I-25.4? J-NAD	E&E 1992 E&E 1985	1992 1985	100	LTHA
Potassium	I-3,510? J-2,090	E&E 1992 E&E 1989	1992 1989	none	
Silver	I-<5 J-10	E&E 1985 E&E 1992	1985 1992	50	RMEG
Sodium	I-63,600 J-27,600	E&E 1992 E&E 1992	1992 1992	none	
Thallium	I-<100 J-NAD	E&E 1985 E&E 1985	1985 1985	0.4	LTHA
Vanadium	I-<10 J-NAD	E&E 1985 E&E 1985	1985 1985	20	LTHA
Zinc	I-2,690 J-3,700	E&E 1985 UDEQ 1992c	1985 1988	2,100	LTHA

I- upstream of site
J- downstream of site
ppb- parts per billion
AL- action level
*- estimated value
CREG- cancer risk evaluation guide
?- approximate value
RMEG- reference dose media evaluation guide
<- less than
LTHA- lifetime health advisory
NAD- no applicable data
EMEG- environmental media evaluation guide

TABLE 11 Contaminant Concentrations in Sediments Off Site; Upstream (Silver Creek and Pace Homer Ditch) and Downstream of Site (Silver Creek)

Contaminant	Maximum Concentration (ppm)	(reference)	Date	Comparison Value (ppm)	Source
Aluminum	K-18,400* L-20,200	E&E 1989 E&E 1989	1989 1989	none	
Antimony	K-183* L-ND	E&E 1989 E&E 1989	1989 1989	280	RMEG
Arsenic	K-555 L-5.4	E&E 1989 E&E 1989	1989 1989	0.4	CREG
Barium	K-270 L-408	E&E 1989 E&E 1989	1989 1989	49,000	RMEG
Beryllium	K-1.7 L-1.6	E&E 1989 E&E 1989	1989 1989	0.16	CREG
Cadmium	K-113* L-2.2*	E&E 1989 E&E 1989	1989 1989	140	EMEG
Calcium	K-18,900 L-9,640	E&E 1989 E&E 1989	1989 1989	none	
Chromium	K-21.9 L-18.5	E&E 1989 E&E 1989	1989 1989	700,000	RMEG
Cobalt	K-76.8 L-10.9*	E&E 1989 E&E 1989	1989 1989	none	
Copper	K-496 L-40.7	E&E 1989 E&E 1989	1989 1989	none	
Iron	K-263,000 L-25,500	E&E 1989 E&E 1989	1989 1989	none	
Lead	K-12,200 L-108	E&E 1989 E&E 1989	1989 1989	none	
Magnesium	K-6,340 L-6,360	E&E 1989 E&E 1989	1989 1989	none	
	Table 11 continues				

Manganese	K-1,560 L-303	E&E 1989 E&E 1989	1989 1989	70,000	RMEG
Mercury	K-3.3 L-0.1*	E&E 1989 E&E 1989	1989 1989	none	
Nickel	K-31.4 L-17.0	E&E 1989 E&E 1989	1989 1989	none	
Potassium	K-3,160 L-6,050	E&E 1989 E&E 1989	1989 1989	none	
Silver	K-39.8 L-ND	E&E 1989 E&E 1989	1989 1989	3,500	RMEG
Sodium	K-239* L-389*	E&E 1989 E&E 1989	1989 1989	none	
Thallium	K-6.0* L-ND	E&E 1989 E&E 1989	1989 1989	none	
Vanadium	K-48.7 L-37.7	E&E 1989 E&E 1989	1989 1989	none	
Zinc	K-17,500 L-302	E&E 1989 E&E 1989	1989 1989	none	

K- upstream L- downstream
ppm- parts per million CREG- cancer risk evaluation guide
*- estimated value RMEG- reference dose media evaluation guide
EMEG- environmental media evaluation guide

TABLE 12 Contaminant Concentrations in Ambient Air Off Site

Contaminant	Maximum Concentration ($\mu g/m^3$)	(reference)	Date	Comparison Value ($\mu g/m^3$)	Source
Aluminum	NI				
Antimony	NI				
Arsenic	ND ND	E&E 1991c USEPA 1992c	1986 1992	0.00023	CREG
Barium	NI				
Beryllium	NI				
Cadmium	0.0009* ND	E&E 1991c USEPA 1992c	1986 1992	0.00056	CREG
Calcium	NI				
Chromium	NI				
Cobalt	NI				
Copper	NI				
Iron	NI				
Lead	0.0391 ND	E&E 1991c USEPA 1992c	1986 1992	none	
Magnesium	NI				
Manganese	NI				
Mercury	NI				
Nickel	NI				
Potassium	NI				
Silver	NI				
Sodium	NI				
Thallium	NI				
Vanadium	NI				
	Table 12 continues				

Zinc	0.0579* 0.1	E&E 1991c USEPA 1992c	1986 1992	none	

$\mu g/m^3$- micro grams per cubic meter
*- estimated value ND- not detected
NI- no information CREG- cancer risk evaluation guide

TABLE 13 COMPLETED EXPOSURE PATHWAYS

COMPLETED PATHWAY NAME	COMPLETED EXPOSURE PATHWAY ELEMENTS					TIME
	PLAUSIBLE SOURCE	MEDIUM	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Tailings On Site Area A	Tailings	Tailings	On Site (Area A)	Ingestion Inhalation, particulates	Tailings workers, Trespassers	Past
Surface Soil On Site Area A	Tailings	Soil	On Site (Area A)	Ingestion Inhalation, particulates	Tailings workers, Trespassers	Past
Surface water On Site Area A	Tailings transport water & runon	Surface water	On Site (Area A)	Ingestion	Tailings workers, Trespassers	Past
Ambient air On Site Area A	Tailings	Air	On Site (Area A)	Inhalation, particulates	Tailings workers, Trespassers	Past
Public water systems	Uncertain	Groundwater	Off Site	Ingestion, inhalation	Residents, Workers (water system users)	Past Present Future

TABLE 14 POTENTIAL EXPOSURE PATHWAYS

POTENTIAL PATHWAY NAME	POTENTIAL EXPOSURE PATHWAY ELEMENTS					TIME
	PLAUSIBLE SOURCE	MEDIUM	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Tailings On Site Area A & Area B	Tailings	Tailings	On Site Area A, Area B	Ingestion Inhalation, particulates	Area A: remediation/ maintenance workers; future residents & workers. Area B: trespassers	Past Present Future
Surface Soil On Site Area A & Area B	Tailings	Soil	On Site Area A, Area B	Ingestion Inhalation, particulates	Remediation/ maintenance workers	Past Present Future
Surface Water On Site Area A	Runon	Surface water	On Site Area A	Ingestion	Remediation/ maintenance workers	Past Present Future
Ambient Air On Site Area A	Tailings	Air	On Site Area A	Inhalation, particulates	Remediation/ maintenance workers	Past Present Future
Table 14 Continues						

POTENTIAL PATHWAY NAME	POTENTIAL EXPOSURE PATHWAY ELEMENTS					TIME
	PLAUSIBLE SOURCE	MEDIUM	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Private well water Off Site	Uncertain	Groundwater	Off Site, closest residences, businesses	Ingestion Inhalation, aerosols	Residents, workers	Past Present Future
Surface soil Off Site	Tailings??	Soil (tailings deposition by wind, Silver Creek)	Off Site, site vicinity	Ingestion Inhalation, particulates	US-40 constructors	Past
Surface Soil	Tailings??	Soil (tailings deposition by wind, Silver Creek)	Off Site, site vicinity	Ingestion Inhalation, particulates	Road maintenance workers, Nearest residents & employees	Past Present Future
Creek surface water Off Site	Site discharge? Upstream discharge to creek?	Water	Off Site, Silver Creek	Ingestion	Maintenance workers, ranchers	Past Present Future
Table 14 Continues						

POTENTIAL PATHWAY NAME	POTENTIAL EXPOSURE PATHWAY ELEMENTS					TIME
	PLAUSIBLE SOURCE	MEDIUM	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Creek sediment Off Site	Tailings?	Sediment & tailings	Off Site, downstream	Ingestion	Maintenance workers, ranchers	Past Present Future
Ambient air Off Site	Tailings?	Air	Off Site, site vicinity	Inhalation, particulates	Adjacent highway users & maintenance workers, Nearest residents & employees, Nearby recreational users.	Past Present Future
Ambient air Off Site	Tailings?	Air	Off Site, site vicinity	Inhalation, particulates	US-40 constructors	Past
Table 14 Continues						

POTENTIAL PATHWAY NAME	POTENTIAL EXPOSURE PATHWAY ELEMENTS					TIME
	PLAUSIBLE SOURCE	MEDIUM	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Food chain Off Site	Water & forage intake	Food products (cattle, sheep, milk, grain)	Off Site	Ingestion foodstuff	Consumers	Past Present Future
Food chain Off Site	Tailings deposit? Other upstream sources	Fish	Off Site Residences	Ingestion	Fishermen & families	Past Present Future

TABLE 15 ESTIMATED POPULATION FOR COMPLETED EXPOSURE PATHWAYS

Estimated Exposed Populations		Contaminants and Media:		
Location	**Number**	**aluminum**	**antimony**	**arsenic**
Tailings workers	unknown	surface water, tailings, soil	surface water, tailings, soil	air, soil, surface water, tailings
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil, air
Public water supply users; Atkinson well water	248			groundwater?
Public water supply users; High Valley well water	250			groundwater
Public water supply users; Summit Co. #3 well water	75			groundwater

?- indicates uncertainty whether contaminant is present in medium and pathway
Sheet 1 of 8

TABLE 15 ESTIMATED POPULATION FOR COMPLETED EXPOSURE PATHWAYS

Estimated Exposed Populations		Contaminants and Media:		
Location	**Number**	**barium**	**beryllium**	**cadmium**
Tailings workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water, tailings, soil, air
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, air, soil
Public water supply users; Atkinson well water	248	groundwater		groundwater?
Public water supply users; High Valley well water	250	groundwater		groundwater?
Public water supply users; Summit Co. #3 well water	75	groundwater		groundwater?

Sheet 2 of 8

TABLE 15 ESTIMATED POPULATION FOR COMPLETED EXPOSURE PATHWAYS

Estimated Exposed Populations		Contaminants and Media:		
Location	**Number**	**calcium**	**chromium**	**cobalt**
Tailings workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water, tailings, soil
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Public water supply users; Atkinson well water	248	groundwater	groundwater?	
Public water supply users; High Valley well water	250	groundwater	groundwater	
Public water supply users; Summit Co. #3 well water	75		groundwater?	

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TABLE 15 ESTIMATED POPULATION FOR COMPLETED EXPOSURE PATHWAYS

Estimated Exposed Populations		Contaminants and Media:		
Location	Number	copper	iron	lead
Tailings workers	unknown	surface water, tailings, soil	surface water, tailings, soil	air, soil, surface water, tailings,
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, air, soil
Public water supply users; Atkinson well water	248	groundwater?	groundwater	groundwater?
Public water supply users; High Valley well water	250	groundwater	groundwater	groundwater?
Public water supply users; Summit Co. #3 well water	75	groundwater	groundwater	groundwater?

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TABLE 15 ESTIMATED POPULATION FOR COMPLETED EXPOSURE PATHWAYS

Estimated Exposed Populations		Contaminants and Media:		
Location	**Number**	**magnesium**	**manganese**	**mercury**
Tailings workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water tailings, soil
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Public water supply users; Atkinson well water	248	groundwater	groundwater	groundwater
Public water supply users; High Valley well water	250	groundwater	groundwater	groundwater?
Public water supply users; Summit Co. #3 well water	75	groundwater	groundwater	groundwater?

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TABLE 15 ESTIMATED POPULATION FOR COMPLETED EXPOSURE PATHWAYS

Estimated Exposed Populations		Contaminants and Media:		
Location	Number	nickel	potassium	silver
Tailings workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water, tailings, soil
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Public water supply users; Atkinson well water	248	groundwater?	groundwater	groundwater?
Public water supply users; High Valley well water	250		groundwater	groundwater?
Public water supply users; Summit Co. #3 well water	75	groundwater?	groundwater	groundwater?

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TABLE 15 ESTIMATED POPULATION FOR COMPLETED EXPOSURE PATHWAYS

Estimated Exposed Populations		Contaminants and Media:		
Location	Number	sodium	thallium	vanadium
Tailings workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water, tailings, soil
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Public water supply users; Atkinson well water	248	groundwater		
Public water supply users; High Valley well water	250	groundwater		
Public water supply users; Summit Co. #3 well water	75	groundwater		

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TABLE 15 ESTIMATED POPULATION FOR COMPLETED EXPOSURE PATHWAYS

Estimated Exposed Populations		Contaminants and Media:		
Location	Number	zinc		
Tailings workers	unknown	surface water, air, tailings, soil		
Site trespassers	unknown	tailings, soil, air		
Public water supply users; Atkinson well water	248	groundwater		
Public water supply users; High Valley well water	250	groundwater		
Public water supply users; Summit Co. #3 well water	75	groundwater		

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TABLE 16 ESTIMATED POPULATION FOR POTENTIAL EXPOSURE PATHWAYS

Estimated Potentially Exposed Populations		Contaminants and Media:		
Location	Number	aluminum	antimony	arsenic
Site maintenance or remediation workers; or future residents & workers	unknown	surface water, tailings, soil	surface water, tailings, soil	air, soil, surface water, tailings
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Area residents	unknown	soil, sediment, surface water	soil, sediment, surface water	soil, sediment, surface water, air
Nearest residents *	10			
Nearest workers, 3 companies	50	soil	soil	soil, groundwater, air
Road maintenance workers, Rt. 40 constructors	unknown	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings	soil, sediment, surface water, sediment, air
Fishermen, families **	unknown			
Ranchers ***	unknown	surface water, sediment, tailings	surface water, sediment, tailings	surface water, sediment, air, tailings

?- indicates uncertainty whether a specific contaminant is present in medium and pathway
*- no sampling data to confirm whether residents' well water contains any contaminants
**- no sampling data to confirm whether fish contain any contaminants
***- no sampling data to confirm whether agricultural products contain any contaminants
Sheet 1 of 8

TABLE 16 ESTIMATED POPULATION FOR POTENTIAL EXPOSURE PATHWAYS

Estimated Potentially Exposed Populations		Contaminants and Media:		
Location	Number	barium	beryllium	cadmium
Site maintenance or remediation workers, or future residents & workers	unknown	surface water, tailings, soil	surface water, tailings, soil	air, soil, surface water, tailings
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Area residents	unknown	soil, sediment, surface water	soil, sediment, surface water	soil, sediment, surface water, air
Nearest residents *	10			
Nearest workers, 3 companies	50	soil	soil	soil, air
Road maintenance workers, Rt. 40 constructors	unknown	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings, air
Fishermen, families **	unknown			
Ranchers ***	unknown	surface water, sediment, tailings	surface water, sediment, tailings	surface water, sediment, air, tailings

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TABLE 16 ESTIMATED POPULATION FOR POTENTIAL EXPOSURE PATHWAYS

Estimated Potentially Exposed Populations		Contaminants and Media:		
Location	Number	calcium	chromium	cobalt
Site maintenance or remediation workers; or future residents & workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water, tailings, soil
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Area residents	unknown	soil, sediment, surface water	soil, sediment, surface water	soil, sediment, surface water
Nearest residents *	10			
Nearest workers, 3 companies	50	soil	soil	soil
Road maintenance workers, Rt. 40 constructors	unknown	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings
Fishermen, families **	unknown			
Ranchers ***	unknown	surface water, sediment, tailings	surface water, sediment, tailings	surface water, sediment, tailings

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TABLE 16 ESTIMATED POPULATION FOR POTENTIAL EXPOSURE PATHWAYS

Estimated Potentially Exposed Populations		Contaminants and Media:		
Location	Number	copper	iron	lead
Site maintenance or remediation workers; or future residents & workers	unknown	surface water, tailings, soil	surface water, tailings, soil	air, soil, surface water, tailings
Site trespass	unknown	tailings, soil	tailings, soil	tailings, soil
Area residents	unknown	soil, sediment, surface water	soil, sediment, surface water	soil, sediment, surface water, air
Nearest residents *	10			
Nearest workers, 3 companies	50	soil	soil	soil, groundwater, air
Road maintenance workers, Rt. 40 constructors	unknown	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings, air
Fishermen, families **	unknown			
Ranchers ***	unknown	surface water, sediment, tailings	surface water, sediment, tailings	surface water, sediment, air, tailings

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TABLE 16 ESTIMATED POPULATION FOR POTENTIAL EXPOSURE PATHWAYS

Estimated Potentially Exposed Populations		Contaminants and Media:		
Location	Number	magnesium	manganese	mercury
Site maintenance or remediation workers; or future residents & workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water, tailings, soil
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Area residents	unknown	soil, sediment, surface water	soil, sediment, surface water	soil, sediment, surface water
Nearest residents *	10			
Nearest workers, 3 companies	50	soil	soil	soil
Road maintenance workers, Rt. 40 constructors	unknown	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings
Fishermen, families **	unknown			
Ranchers ***	unknown	surface water, sediment, tailings	surface water, sediment, tailings	surface water, sediment, tailings

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TABLE 16 ESTIMATED POPULATION FOR POTENTIAL EXPOSURE PATHWAYS

Estimated Potentially Exposed Populations		Contaminants and Media:		
Location	Number	nickel	potassium	silver
Site maintenance or remediation workers; or future residents & workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water, tailings, soil
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Area residents	unknown	soil, sediment, surface water	soil, sediment, surface water	soil, sediment, surface water
Nearest residents *	10			
Nearest workers, 3 companies	50	soil	soil	soil
Road maintenance workers, Rt. 40 constructors	unknown	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings
Fishermen, families **	unknown			
Ranchers ***	unknown	surface water, sediment, tailings	surface water, sediment, tailings	surface water, sediment, tailings

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TABLE 16 ESTIMATED POPULATION FOR POTENTIAL EXPOSURE PATHWAYS

Estimated Potentially Exposed Populations		Contaminants and Media:		
Location	Number	sodium	thallium	vanadium
Site maintenance or remediation workers; or future residents & workers	unknown	surface water, tailings, soil	surface water, tailings, soil	surface water, tailings, soil
Site trespassers	unknown	tailings, soil	tailings, soil	tailings, soil
Area residents	unknown	soil, sediment, surface water	soil, sediment, surface water?	soil, sediment, surface water?
Nearest residents *	10			
Nearest workers, 3 companies	50	soil	soil	soil
Road maintenance workers, Rt. 40 constructors	unknown	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings	soil, sediment, surface water, tailings
Fishermen, families **	unknown			
Ranchers ***	unknown	surface water, sediment, tailings	surface water, sediment, tailings	surface water, sediment, tailings

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TABLE 16 ESTIMATED POPULATION FOR POTENTIAL EXPOSURE PATHWAYS

Estimated Potentially Exposed Populations		Contaminants and Media:		
Location	Number	zinc		
Site maintenance or remediation workers; or future residents & workers	unknown	air, surface water, tailings, soil		
Site trespassers	unknown	tailings, soil		
Area residents	unknown	soil, sediment, surface water, air		
Nearest residents *	10			
Nearest workers, 3 companies	50	soil, air		
Road maintenance workers, Rt. 40 constructors	unknown	soil, sediment, air, surface water, tailings		
Fishermen, families **	unknown			
Ranchers ***	unknown	surface water, sediment, air, tailings		

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APPENDIX C

PUBLIC COMMENTS

The Addendum to the preliminary public health assessment for the Richardson Flat Tailings Site was available for public review and comment in a local library for a 30-day period ending September 9, 1993. The public comment period was announced in local newspapers. In addition, the public health assessment was sent to several individuals or organizations. Appendix C summarizes the public comments received on the addendum and ATSDR's response to those comments. The document has been revised, where appropriate, in response to comment issues.

Comment 1: A commenter says that the Tailings Impoundment (Area A) and the Floodplain Sediments (Area B) in the ATSDR report should be separate and distinct sites, rather than areas of the same site.

Response: ATSDR conducts public health assessments on sites that EPA propose for its NPL. EPA identified its proposed NPL site as Richardson Flat Tailings and described it as including a tailings pond area and nearby tailings deposits in Silver Creek. Because of the proximity of Areas A and B and the potential for both areas to contribute to off-site stream, groundwater, and soil, etc., contamination, it would be impossible to develop totally independent assessments for the individual areas. Thus, it is appropriate that both areas be considered in one assessment. In the document, ATSDR made a concerted effort to attribute important background and contamination information and plausible pathway issues separately to Areas A and B. Thus, the document has not been changed in response to this comment.

COMMENT 2: Page 4--A commenter says that ATSDR should not cite rumors in a scientific evaluation of fact; a rumor should either be verified or excluded from consideration.

Rumor 1--In earlier years, tailings were transported to the site via Silver Creek. Commenter says tailings were never transported in that manner.

Rumor 2--Tailings were removed and used off site. Commenter says since 1982, there has been no known or approved removal of tailings from the site or approved removal of tailings from the site or use of tailings off site.

Response: ATSDR does not report rumors indiscriminately. Rumored information is included when the activity, if correct, might have substantive associated contamination and health issues; or when knowledgeable citizens might wonder whether ATSDR considered that activity in its deliberations.

Rumor 1--The document has been changed to include the commenter's statement that tailings were never transported in that manner, and that the assessment does not address the issue further.

Rumor 2--Reference E&E 1987a says that someone is leasing (at that time) the land the tailings are on and using the tailings material for sewer line and road base backfill. ATSDR has already identified the uncertainty of the off-site use of tailings and indicated that ATSDR cannot address the issue, but expanded discussions to provide more information.

COMMENT 3. Page 4--The document says that the diversion ditch was excavated through zones of tailings. A commenter reports no knowledge of analyses of materials to prove that the ditch was excavated through zones of tailings; thus the statement is purely supposition.

Response: The commenter is correct that there are no analyses of materials in the ditch as proof, but the statement is not pure supposition. ATSDR's basis for that statement was its review of a 1953 aerial photograph that appears to show that the tailings at that time extended well south of the present boundary of the tailings pond, plus Reference E&E 1989 reports taking tailings samples south of the diversion ditch, and ATSDR observed tailings-like zones in the sides of the diversion ditch while at the site. The document has been amended to provide some of this clarifying information.

COMMENT 4. Pages 5 and 21--A commenter says that EPA's contractors concern for future dust associated with salt grass disappearing if the site becomes drier is unwarranted because the salt grass does not appear to be stressed and has not disappeared during the current 5-year severe drought event.

Response: Although the grass's response to the current drought period appears to be satisfactory, the EPA contractor expressed concern for the consequences

of the site being drier. There is no way to predict how the grass may respond to a possible future, more severe event. Therefore, because of its potential dust-related consequences, ATSDR believes the concern is relevant as reported and has not changed the document.

COMMENT 5. Page 5--A commenter reports no knowledge of cattle ever having been allowed to graze on the property.

Response: Reference E&E 1987a says that cattle have been observed walking across the tailings. Thus, the statement has not been changed in the document.

COMMENT 6. Page 5--A commenter requests a reference for ATSDR's identification of the flood plain tailings deposits.

Response: Reference USEPA 1991b (the Hazard Ranking System document) says: "Name and description of the source: Flood Plain Tailings: These tailings occupy the banks of Silver Creek..." Reference USEPA 1992 describes a 6-acre "flood plains tailing pile". Reference E&E 1989 contains a figure that shows two tailings deposits. Reference information has been added.

COMMENT 7. A commenter states that there currently are three residential-type units within a mile, not four as ATSDR stated. One residential unit has been converted to a service shop for vehicle repair activities; the other two are presently vacant. Revise information on Pages 7, 10, 19, and elsewhere in document accordingly.

Response: During ATSDR's site visit four residences were found within a mile of the site; one was a conventional home and the others are remembered to be trailers. Three were occupied at that time; one was vacant. The document has been changed to reflect the commenter's more recent information.

COMMENT 8. Page 7--A commenter suggests that the nearest businesses should be reported to be more than 1/2 mile away rather than 1/3 mile.

Response: While at the site, ATSDR made rough measurements to the nearest business. It is possible that the distance might be about 1/2 mile. The document has been changed to reflect that.

COMMENT 9. Page 7--A commenter suggests that the 51 workers employed by the three businesses may not work at those specific locations.

Response: ATSDR, when calling those businesses, asked for the number of employees working at those locations. Hence, the document has not been changed except to clarify that the number reported is for those locations.

COMMENT 10. Page 7--A commenter says that there is an emergency clinic, not a hospital, at Prospector Square.

Response: The document has been revised to reflect that information.

COMMENT 11. A commenter says that the availability of water from Silver Creek for irrigation has severely diminished because of water uses by Park City. For example, little, if any, water from the creek has been available for at least 4 years to produce forage for livestock on three nearby properties in the watershed; this condition is expected to continue for the foreseeable future. Affected parties are compensated via crop-loss payments and purchase feed from out of the watershed area. Revise information on Pages 8, 9, 21, and 22 and elsewhere in the document.

Response: Pages 8 and 9 of the document have been changed. No changes are warranted for Pages 21 and 22 because the pathways are viable as stated, even though the availability of irrigation water has been reduced.

COMMENT 12. Page 8--A commenter says that a statement about the diversion ditch should say that it diverts water around the southern edge of the tailings impoundment.

Response: The document has been changed.

COMMENT 13. Page 8--A commenter reports the document should say that the Pace-Homer irrigation withdrawal is upstream of the tailings pond area.

Response: The document has been changed to reflect this information.

COMMENT 14. Page 9--A commenter says there is no scientific data to evidence the presence of cutthroat trout

in Silver Creek and no evidence of a fishery. Some exhibits submitted document discussions with a Utah Division of Wildlife representative who said that state investigations in 1970 and also one he conducted in 1986 produced no fish. The commenter desires that ATSDR either provide hard data that evidence a cutthroat trout population or delete the passage referring to the presence of those trout.

Response: ATSDR has reviewed the exhibits submitted. ATSDR also re-reviewed two memoranda that summarize EPA contractor discussions in 1991 with other personnel in the Utah Division of Wildlife. In summary, those memoranda say that 1) a survey conducted in 1954 found a small number of trout, 2) electroshocking data in 1970 did not show a presence of game fish, and 3) more recent conversations with a biologist indicate the presence of a good, but unquantified, cutthroat trout population in the creek. EPA reported seeing pan-sized trout at the site in the spring of 1992. Using the information, it is reasonable to consider that a trout fishery is not likely to be substantive, if one exists at all. ATSDR has revised trout discussions to include the varying information and has reconsidered how fishery is addressed in remaining sections of the document.

COMMENT 15. Page 10, A commenter requests a reference for the seepage studies mentioned. Commenter also requests that ATSDR's belief with respect to creek water losses to the underlying valley fill aquifers should be substantiated with scientific evidence.

Response: A reference has been added. ATSDR has some limited evidence of stream losses to the valley fill aquifers. The reference says (without describing weather, location, flow rate, loss amount, etc.,) that seepage studies on the creek did not show any areas of significant losses. To ATSDR, that means that some--apparently "small"--losses were recorded somewhere on the creek. That information suggests that stream seepage losses could be a mechanism for transporting dissolved contaminants to underlying groundwater. The document has been revised to clarify ATSDR's position.

COMMENT 16: Pages 10, 18, 19--A commenter says ATSDR implies there may be a connection between three public

water supply wells and the Silver Creek alluvial aquifer, or the site. Commenter says there is no evidence of a connection. Commenter reports the public wells are not located in the alluvial valley associated with Silver Creek, the wells draw from artesian aquifers in bedrock below the alluvial zones, and the wells are hydrogeologically upgradient of the creek.

Response: ATSDR has revised discussion to minimize the likelihood of a hydraulic connection between site contaminants and the public water systems.

COMMENT 17A: A commenter says that the document should rely on EPA's 1989 water and sediment sampling and EPA's 1992 air sampling rather than flawed 1985 water sampling and 1986 air sampling. In addition the document makes unwarranted claims about the site as a source of contaminants found in various media. More specific issues raised by the commenter are presented below.

Response: See more detailed comments below.

COMMENT 17B: Commenter says that EPA's Supplemental Site Inspection Report concludes that analytical results of surface water and sediment samples from Silver Creek and the diversion ditch do not support an observed release of contaminants to surface water. In summary, no observed release of contaminants attributable to the site has been clearly documented.

Response: On Page 11, ATSDR initiated its discussions of contaminants by saying that the sampling data and supporting site-related information <u>suggest</u> that contaminants have been released. Neither that statement, nor any subsequent discussions, are intended to say, or imply, that there is clear documentation that contaminants were released from the site. For example--EPA's Supplemental Site Inspection Report concludes that the contribution of contaminants from the flood plain tailings and historic depositing of metals into the streambed cannot be clearly segregated from contamination contributed by the Richardson Flat tailings. ATSDR agrees that those data do not prove a site release to a full certainty. It is not the intent of a public health assessment to prove releases or sources; EPA has that responsibility for sites it proposes for its National Priorities List. ATSDR addresses sources and releases because that

information can provide insight to exposure pathways. ATSDR uses available environmental sampling data, observations, along with its knowledge of contaminant migration mechanisms to identify exposure pathways. Where the sampling evidence considered for identifying pathway components, including the contaminant source, is weak or equivocal, ATSDR attempts to appropriately tailor its discussion of those issues--while at the same time asserting an appropriate level of concern for plausible exposures to the contaminants found and any associated public health issues. ATSDR has slightly modified portions of the document to reflect appropriately on source/release issues.

COMMENT 17C: A commenter says that EPA's 1986 air testing was flawed in a number of ways and site conditions have been significantly altered since the 1986 samples were obtained. The commenter says that ATSDR should rely on EPA's 1992 air data which accurately reflects current site conditions.

The commenter, in supplemental information, raises concerns that the only data used by EPA (for scoring the site) from a 5-day sampling activity was a 12-hour period when local windstorms were strong enough to entrain some of the then uncovered tailings. An additional concern is that the air sampler that detected the "release" was placed 20 feet from the tailings on the tailings embankment for the purpose of qualifying it as an "off-site" air sample, which it certainly is not. Other issues are EPA's method of comparing those data to National Air Quality Standards for lead, and that, after capping, receptors at more distant locations (e.g., Park City) can hardly be considered to have even the slightest increase in risk.

Response: ATSDR considers the flaws alleged by the commenter that might affect this public health assessment either were corrected by EPA, or were appropriately considered by ATSDR's document, or have no effect on its contents. ATSDR reviewed the 1986 air sampling report and a 1991 memorandum that included corrected concentrations for all 5 days data. ATSDR considered all the corrected 5 days of data when preparing the assessment document. ATSDR correctly identified and reported the on-site and off-site information provided on Pages 14 and 16, respectively. Both pages also

acknowledge that because of the short sampling interval, the monitoring data may not be representative of conditions over time. On Page 16, ATSDR also noted for the 1992 air data that most of the tailings were covered at that time and only zinc was detected at a low concentration. Discussion of off-site air pathways (Page 21) includes descriptions of past observed wind-borne dust and indicates that the 1992 sampling suggests that levels of site-related wind-borne contamination may be inconsequential when cover soils are (fully) in place providing cover and salt gras are maintained. Thus, ATSDR considers its uses of the 1986 and 1992 data accounted for alleged flaws that might be pertinent to the document and were appropriate. The document has not been changed with respect to these issues.

COMMENT 18: Page 12--A commenter says that it is inappropriate to make comparison between unfiltered monitoring well samples and drinking water standards.

Response: ATSDR uses the comparison value concept to "screen" an array of contaminants--it is not a determination of actual or implied toxicity, exposure, or health outcome for any of the chemicals being screened. However, each comparison value has a health-related basis--hence, for some contaminants in water, certain comparison values are based on current drinking water standards. As stated on Page 11, ATSDR uses its comparison values to identify contaminants of potential concern that can be evaluated in subsequent sections of the assessment to determine whether exposure to them has public health significance. As stated there, identifying contaminants in that section does not imply that exposure will result in adverse health effects (nor does identification in that section establish whether any exposure occurs). ATSDR considers the comparison values to have been used appropriately, and the document has not been changed.

COMMENT 19: A commenter, citing information on Page 13, says that no valid conclusions can be drawn by a comparison of unfiltered samples from the upgradient monitoring well and the downgradient monitoring wells or their comparison to drinking water wells and standards.

Response: ATSDR has eliminated the comparisons made between data from upgradient and downgradient monitoring

wells. However, ATSDR has applied its comparison value process appropriately to monitoring well data, thus no changes are made with respect to that issue.

COMMENT 20: A commenter, citing information on Page 13 takes issue with ATSDR's application of its comparison value procedure to surface water because no drinking water intakes are located downstream.

Response: The screening process, as described in an earlier comment response, uses comparison values that have a health-related basis to identify contaminants that may warrant further evaluation in the assessment. For water, ATSDR's health-based comparison can include some drinking water standards, irrespective of whether the water in question is used as a public water supply. The document has not been changed.

COMMENT 21: Page 14--A commenter says the discussion of sediment should not include a conclusion regarding the Richardson Flat site's contribution.

Response: That discussion mentions where samples were taken but does not mention contribution. The document has not been changed.

COMMENT 22: Pages 14 and 15--A commenter says it is inappropriate to compare unfiltered and filtered groundwater samples to each other or to drinking water standards or to comparison values.

Response: The unfiltered samples have not been compared to the filtered samples; only the concentration information is provided. The relevance of ATSDR's comparison value procedure has been addressed in earlier comment responses. The document has not been changed.

COMMENT 23: Page 17--A commenter says that ATSDR incorrectly assumes that the data it relied on is within the limits for adequate QA/QC. Some of the data are without QA/QC and some data were estimated values. The validity of ATSDR's conclusions is profoundly affected by the poor quality of the data used in its assessment.

Response: ATSDR stated on Page 17 that only some of the documents contained quality assurance information. ATSDR also stated that it presumed that protocols and results are valid and acknowledged that

information reliability could affect the validity of conclusions drawn. ATSDR does not concede that data should be presumed to be of poor quality when QA/QC information is not reported. Also, ATSDR has found that estimated concentrations identified through the QA/QC process frequently can be applied to at least portions of the health assessment process. ATSDR, during this comment response activity, has modified or withdrawn some statements or conclusions that its review has shown are not sufficiently supported by the data, observations, and other information. However, ATSDR has reviewed the Conclusions Section on Page 28 and find none that are affected by the issues raised in this comment.

COMMENT 24: A commenter says that potential pathways should be supported by facts. Particularly, on Page 20, the supposition that deposition of wind-blown tailings has contaminated off-site soils is made with no corroborating evidence and must be considered merely a hypothetical exposure scenario.

Response: ATSDR agrees that the potential pathway scenarios are hypothetical, but they are based on the available information plus the agency's experience in other assessments with similar pathways for which documentation is more complete. Here, and elsewhere in the document, where ATSDR's judgement has been applied, there is a possibility of judgement error. When such an error is possible, the agency chooses to err in the direction of public health.

The specific scenario identified by the commenter is described in the document under the heading of Potential Exposure Pathways. The potential pathway concept is described on Page 17. On Page 20, ATSDR said that wind has likely deposited tailings contaminants on surface soils in the vicinity of the site. This statement is founded on reported observed wind-blown dust at the site and contamination data from air sampling, plus the virtual certainty that at least some of the contaminants suspended by the wind would be deposited beyond the site boundary. However, principally because of uncertainties about deposition at identifiable receptor locations, the pathway is considered potential, rather than completed. ATSDR considers the potential pathway concept to be adequately described; therefore, additional characterization has not been provided.

COMMENT 25: Page 20--A commenter says that ATSDR's statement that runoff from on-site tailings is contaminating creek water is merely supposition. The tailings impoundment has no run-off potential because it has run-on and run-off controls.

Response: ATSDR has revised the statement.

COMMENT 26: Page 25--A commenter says that ATSDR's statement that potential future exposure to beryllium would be of health concern has no basis since beryllium was detected in the tailings at concentrations within normal ranges for western soils.

Response: ATSDR has revised the statement.

COMMENT 27: A commentor notes that ATSDR cites findings of an ATSDR study conducted at Prospector Square in discussing exposure to contaminants at Richardson Flat. On page 26, the Prospector Square study is described as indicated that exposure to tailings did not result in any increase in blood lead, arsenic or cadmium levels, as compared to local controls; ATSDR then states that, because the frequency and duration of exposure to tailings in the residential Prospector Square area are expected to be significantly higher than the frequency and duration of exposure to tailings at Richardson Flats, it is likely that exposure to lead at Richardson Flats will not result in an increase in blood lead levels. However, ATSDR concludes that, should Richardson Flat be developed for residential purposes, contaminant levels would be of public health concern. The commenter finds this conclusion to be inconsistent with the statement comparing Richardson Flat with Prospector Square, and asks for a justification regarding the conclusion about residential development at Richardson Flat, in light of the findings of no public health concern at the current residential area at Prospector Square.

Response: ATSDR has reevaluated the Prospector Square study, and has revised the Public Health Assesment to eliminate ambiguity.

APPENDIX D

ATSDR PRELIMINARY PUBLIC HEALTH ASSESSMENT OF 1990

Health Assessment

RICHARDSON FLAT TAILINGS SITE

PARK CITY, SUMMIT COUNTY, UTAH

CERCLIS No. UTD980952840

July 24, 1990

RICHARDSON FLATS TAILINGS PRELIM. PHA ADD. FINAL RELEASE

SUMMARY

The Richardson Flat Tailings, an Update 7 site proposed for the National Priorities List, is located 3.5 miles northeast of Park City, Summit County, Utah. From 1975 to 1981, the 160-acre site was used for disposing mine tailing wastes from the Keetly Ontario Mine and other mines owned by United Park City Mines. Currently no tailings are dumped at the site; however, soil from the site is being excavated and used to cover the tailings piles. Several metal contaminants, including arsenic, cadmium, chromium, lead, and zinc, have been detected in on-site and off-site areas. Contaminants may migrate from the site to off-site areas through surface water, groundwater, and airborne-associated pathways. Human exposure to site contaminants may occur through the ingestion of contaminated groundwater, food-chain entities, and soil; through dermal contact with contaminants; and through the inhalation of airborne dusts. The site is considered to be of potential public health concern because of the high levels of on-site contaminants.

BACKGROUND

A. Site Description and History

The Richardson Flat Tailings site (RFT), consisting of 160 acres located in a topographic depression approximately 3.5 miles northeast of Park City, in Summit County, Utah, is an Update 7 site proposed for the National Priorities List (NPL) (see Figures 1 and 2). From 1975 until 1981, mine tailings from the Keetly Ontario Mine and other mining operations in the area were disposed of at the site and currently range up to 10 feet in depth. Until 1987, mine tailings were removed from the site and used as backfill for sewer construction projects.

Currently, mine tailings at the site are being covered by soil excavated from on-site areas. The thickness of the soil cover varies over the surface of the site, and, as noted during the April 1989 site visit, the soil layer covering the mine tailings was less than 1-inch thick in certain areas. Site features include a pond that covers the northeastern corner of the site and is contained by a dam at the northwestern corner, and a ditch in the central portion of the site.

B. Site Visit

Staff from the Agency for Toxic Substances and Disease Registry (ATSDR) and the Utah Department of Health conducted a visit to the RFT site on April 19, 1989. During the site visit, conditions on-site and off-site were observed, including land uses in areas adjacent to the site, the proximity of residential areas to the site, the ease of site access, the presence of on-site physical hazards, and the general physical characteristics of the site. Specific observations made during the site visit will be discussed in appropriate sections of this Preliminary Health Assessment.

C. Community Health Concerns

Staff from the Utah Department of Health indicated that they were not aware of any community health concerns related to the RFT site.

DEMOGRAPHICS, LAND USE, AND NATURAL RESOURCE USE

The site lies in a rural area with very widely scattered residences. It is within 1.5 miles of Prospector Square, which is an extension of Park City, a popular recreational and ski area of Utah. The area within a 1-mile radius of the site consists of open, undeveloped rangeland and agricultural fields. Only three residences are within a 1-mile radius of the site; however, because the site is close to a popular resort, which has expanded in recent years, future development of the area may increase residential, commercial, and recreational land uses (1).

Recreational land uses in the site vicinity include fishing in Silver Creek, a popular stream for trout fishing, and downhill skiing at nearby ski slopes. Piles of mine tailings on-site are commonly used for unauthorized recreational motorcycling.

Other land uses in the site vicinity include pastureland for cattle and sheep and land parcels used for cultivating hay and grain. No industrial or commercial land uses are within 1-mile of the site.

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

A. On-Site and Off-Site Contamination

Monitoring results were analyzed for groundwater, surface water, soil, and air samples collected during initial site investigations conducted in 1985. These results are only of preliminary and are not sufficient to characterize the full nature and extent of site contamination.

1. Groundwater

Groundwater samples were collected from monitoring wells located upgradient and downgradient from the site. Groundwater samples were analyzed for total metals, cyanide, sulfate, and dissolved metals. The highest concentrations of contaminants were detected in unfiltered groundwater samples collected from monitoring wells located downgradient from the site (see Table 1).

Table 1.
Groundwater*, 1985

Contaminant	Maximum Concentration [ppb] Off-Site Upgradient	On-Site	Drinking Water Criteria+
Arsenic	<5	349	50
Cadmium	<5	48	10
Chromium	<5	104	50
Lead	<30	1,080	20#
Manganese	20	10,400	50

*Unfiltered samples.
+National Interim Primary Drinking Water Regulations. U.S. Environmental Protection Agency, Office of Drinking Water, 1976.
#Proposed Maximum Contaminant Level at the tap.

2. Surface Water

Surface water samples were collected from the east bank of Silver Creek and from an intermittent stream that flows through the tailings. Surface water samples were analyzed for total metals and sulfate. The highest contaminant levels in Silver Creek were found immediately downstream from the site and at the discharge point for the intermittent, on-site stream (see Table 2). Approximately 2 miles upstream from the RFT site, the Prospector Square tailings may also serve as an important source of surface water contaminants.

Table 2.
Surface Water, 1986

Contaminant	Maximum Concentration [ppb] Upstream Silver Creek	Downstream Silver Creek
Arsenic	14	65
Copper	12	60
Lead	147	1,985

3. Soil

Samples of surface and subsurface soil were collected from on-site and off-site areas (see Table 3 and 4). Soil samples were analyzed for total metals. Samples of subsurface, on-site soil samples (tailings) were analyzed for total metals and cyanide. Results of analyses of on-site surface soil (tailings) and off-site surface soil indicate levels of arsenic, cadmium,

lead, and zinc substantially higher than the mean concentrations for the western United States.

Results of sample analyses of subsurface mine tailings indicated elevated levels of heavy metals and arsenic (see Table 4). Off-site, subsurface samples did not have contaminant levels above mean concentrations for the western United States, indicating the likelihood that off-site soil contamination is generally limited to the upper portions of the soil profile (2).

Table 3.
Surface Soil and Tailings, 1986

Maximum Concentration [ppb]

	Background*	On-Site	Mean for Western U.S.
Arsenic	58,000	3,600,000	5,500
Cadmium	17,000	80,000	200
Lead	1,110,000	8,530,000	17,000
Selenium	6,700	<400,000	230
Zinc	1,570,000	6.360,000	55,000

*Levels reported as background may not be true background because they were collected adjacent to the site and in an area with a history of mining activity.

Table 4.
Subsurface Soil and Tailings, 1986

Maximum Concentrations [ppb]

Contaminant	Background*	On-Site	Mean for Western U.S.
Arsenic	6,500	328,000	5,500
Cadmium	7,400	169,000	200
Lead	37,000	4,920,000	17,000
Selenium	<100	9,400	230
Zinc	70,000	23,200,000	55,000

*Levels reported as background may not be true background because they were collected adjacent to the site and in an area with a history of mining activity.

4. Air

Preliminary air monitoring was conducted using five high-volume air samplers at four sampling locations over a 5-day period. Air samples were analyzed for arsenic, cadmium, lead, and zinc. During air monitoring, weather conditions were dry with winds varying up to 20 miles per hour, although winds gusted up to 40 miles per hour during the first day of sample collection. The highest levels of airborne contaminants were detected during the

first day of sampling at the air monitoring station downwind from the site (see Table 5). Air monitoring results verify that releases of airborne contaminants have occurred at the RFT site.

Table 5.
Air, 1986

Maximum Concentration [micrograms per cubic meter]

Contaminant	Upwind	Downwind
Arsenic	0.002	0.093
Cadmium	< 0.010*	0.082*
Lead	0.103	1.648
Zinc	0.091+	1.155+

*Matrix spike recovery was 65% for cadmium; actual value may be higher.
+Matrix spike recovery was 60% for zinc; values given are estimates.

B. Quality Assurance and Quality Control

Quality assurance and quality control procedures were used to ensure the accuracy of the monitoring programs conducted during site investigations at the RFT site. Sample collection and analyses were determined to have been performed according to approved procedures; therefore, monitoring results were determined to be acceptable. The conclusions contained in this report are based on the data package supplied to ATSDR. The accuracy of these conclusions depends on the reliability and comprehensiveness of the data contained in the materials reviewed.

C. Physical and Other Hazards

No on-site physical hazards were noted during the site visit.

PATHWAYS ANALYSES

A. Environmental Pathways (Fate and Transport)

1. Groundwater

Groundwater was encountered within 12 feet of the site's surface during the collection of on-site soil samples. In the site vicinity, the uppermost aquifer, with an average depth of 60 feet, lies within alluvial deposits overlying consolidated rocks of tertiary origin. It is not clear whether this alluvial aquifer is hydrologically connected to the deeper aquifer found in the consolidated rock formation. Groundwater flow beneath the site and in the site vicinity is to the north-northwest.

No private or monitoring wells are on-site. Two private domestic wells are located about 4,000 feet southwest of the site. Both of these wells are completed to a depth of about 210 feet below the ground's surface. A single municipal well used as a backup source for the Park City municipal water system is located 2.5 miles southwest of the RFT site (1). Groundwater samples were not collected from the above-mentioned private and municipal wells; however, because these wells are located upgradient from the site, they are not expected to be impacted by site contaminants.

2. Surface Water

Surface water and leachate from the site may transport site contaminants into nearby streams and creeks. The largest surface water feature in the site vicinity is Silver Creek, located about 200 feet west of the site. Approximately 1,000 feet downstream from the site, surface water from Silver Creek is diverted for the irrigation of pastureland and hay fields. Silver Creek does not serve as a source of drinking water source for humans.

Several leachate (mine tailing drainage) seeps were noted on the northwest side of the on-site earth dam; however, surface water samples were not collected in this area. These seeps flow from the site to the northwest into a swampy area that drains into Silver Creek. Leachate from the mine tailings pile may serve as an important source of surface water contamination.

3. Soil

Mine tailings consist of finely crushed rock that are easily eroded by surface water runoff and wind. Erosion of the mine tailings is likely because portions of the mine tailing piles are uncovered and lack a vegetative cover. Although a soil cover is being placed over the surface of the mine tailings, the thickness of the cover varies considerably and may be less than 1 inch. Soil used to cover the tailings may also be contaminated because it is being excavated from on-site areas in which mine tailings were dumped. The soil covering the tailings is expected to have a minimal impact on the migration of tailing contaminants into groundwater.
As precipitation percolates through the mine tailings, sulfates in the tailings dissolve, increasing the acidity of water as it seeps downward. As infiltrating water becomes more acidic, it dissolves the arsenic and heavy metal compounds in the tailings and carries these contaminants downward. Monitoring results indicate that contaminants have already migrated to lower levels of the tailing piles and impacted local groundwater and nearby surface waters. Contaminants will continue to impact groundwater and surface water if no remediation is performed.

4. Air

The small particle size of the tailings increases the likelihood that wind may be an important mechanism for dust transport to off-site areas. Site documents indicate that releases of

windblown contaminants to off-site areas have been observed, especially in the summer months when winds from the southwest blow dust from the site across Interstate 40.

5. Contaminated Food-Chain Entities

Site contaminants may bioaccumulate in food-chain entities. In the site vicinity, approximately 315 acres of agricultural land are irrigated with surface water diverted from Silver Creek. Irrigated lands are used for pastureland and the production of grains and hay. Crops irrigated with contaminated surface water may bioaccumulate contaminants.

Animals may also become contaminated if they graze in areas impacted by the site, feed on crops irrigated with contaminated water, or ingest contaminated surface water, soil, or sediments. Cattle and sheep are known to graze in shrub land adjacent to the site.

Fish from Silver Creek may also bioaccumulate contaminants from surface water and sediment. Silver Creek is known to support recreational trout fishing.

B. Human Exposure Pathways

Several potential routes exist by which humans may be exposed to contaminants from the RFT site. Ingestion of contaminated groundwater, soil, and food-chain entities and inhalation of dust are all potential routes of human contaminant exposure.

1. Soil - and Tailings-Associated Pathways

Ingestion, inhalation, and dermal exposures to soil and tailings may adversely impact human health. The highest contaminant levels were found in on-site subsurface soil and tailings; however, on-site and off-site surface soil and tailings were also contaminated. The site is located in a rural area and because access to it is not restricted, trespassers may come in contact with these contaminated media during cycling or other activities on or near the site.

2. Groundwater-Associated Pathways

Human exposure to groundwater contaminants may result from the use of contaminated groundwater for domestic, industrial, and agricultural purposes. Local residents are known to rely on groundwater as a potable water supply; however, monitoring data for off-site groundwater are limited to results from a single upgradient well and two downgradient wells. The likelihood of human exposure to groundwater contaminants is minimized by the rural nature of the site and the lack of supply wells for potable water downgradient from the site; however, without monitoring results from nearby private wells, this pathway of human exposure can not be ignored. The potential exists for completing this

pathway of human exposure in the future if groundwater wells are installed on-site or downgradient from the site.

3. Food-Chain-Associated Pathways

Another potential pathway for human exposure to contaminants is through the consumption of food-chain entities that may bioaccumulate contaminants. Cultivated grains and vegetables and other edible plants may bioaccumulate soil contaminants and result in food-chain contamination. Cattle, sheep, and wildlife that consume contaminated plant material or surface water may also bioaccumulate contaminants.

Aquatic animals, such as trout in Silver Creek, that inhabit contaminated surface water or aquatic systems with contaminated sediments may also bioaccumulate contaminants. Analytical results of surface water samples collected from Silver Creek indicate contaminants at levels significantly in excess of Federal Ambient Water Quality Criteria. These contaminants are known to bioaccumulate in fish and may reach levels that make Silver Creek trout unsuitable for human consumption.

4. Airborne-Associated Pathways

Inhalation of contaminated dusts may be a human exposure pathway. On-site activities, including cycling, soil remediation, or excavation of tailings for use as fill may result in the generation of dust and the exposure of motorcyclists, on-site workers, and area residents to site contaminants. The relative remoteness of the site may help reduce the impact of this pathway of human exposure.

5. Surface-Water-Associated Pathways

Surface water obtained from local sources is not a source of drinking water within the site vicinity; however, surface water is used to irrigate pastureland and hay and grain fields. As a result, human exposure to site-related contaminants may result from the ingestion of contaminated grains, animal products, or fish.

PUBLIC HEALTH IMPLICATIONS

Results of preliminary groundwater and soil sampling indicate that the RFT site is of potential public health concern because of contaminants in on-site air, soil, mine tailings, and groundwater and on-site and off-site surface water and sediments.

A brief discussion of the identified site contaminants of public health concern follows.

Arsenic

Human exposure to arsenic is possible through three major pathways: ingestion, inhalation, and dermal contact. Common

effects from ingestion of arsenic include irritation of the digestive tract leading to pain, nausea, vomiting, and diarrhea. Ingestion of inorganic arsenic, the form most likely found at the RFT site, also causes a pattern of skin abnormalities, such as dark and light spots on the skin and small "corns" on the palms, soles, and trunk. Some of the corns may progress to skin cancer. Other health effects of arsenic ingestion include an increased risk of liver, bladder, kidney, and lung cancer. Long-term exposure (greater than 14 days) to inorganic arsenic at levels as low as 20 micrograms per kilogram of body weight per day may result in mild health effects. The severity of symptoms tends to increase as exposure duration increases. The Environmental Protection Agency (EPA) estimates that a dose of 1 microgram per kilogram of body weight per day corresponds to a cancer risk of 1.5 in 1,000 (3). Arsenic levels are sufficiently high in surface soil to be of public health concern for ingestion, inhalation, or dermal exposures.

Inhalation of inorganic arsenic dusts may also result in mild irritation of the digestive tract. The inhalation route of human exposure is more likely to increase the risk of lung cancer than is the ingestion route. Air concentrations of about 200 micrograms per cubic meter are associated with irritation of the nose, throat, and exposed skin. The National Institute for Occupational Safety and Health (NIOSH) has set a recommended exposure limit (REL) for occupational exposure to arsenic in air at 2 micrograms per cubic meter not to be exceeded for more than 15-minutes. EPA has estimated that a lifetime inhalation exposure to 1 microgram per cubic meter causes a lifetime cancer risk of 4 in 1,000 (3). The maximum level of airborne arsenic detected at the RFT site (0.093 micrograms per cubic meter) is at a level of public health concern. Soil-disturbing activities, such as excavation of soils or motorcycling, are likely to cause an increase in airborne arsenic levels.

Dermal exposure to arsenic-containing compounds may result in mild-to-severe irritation of the skin, eyes, or throat. No reliable dose estimates are available on the exposure levels at which these effects begin to appear.

Cadmium

Human exposure to cadmium at the RFT site can occur either through the ingestion of contaminated soil, mine tailings, and food-chain entities or through the inhalation of contaminated dusts. Very small amounts of ingested cadmium are absorbed into the blood (1%-5%) while 30%-50% of that which is inhaled is taken into the blood (4). Once cadmium enters the body, it is retained very strongly. A proposed reference dose (a daily dose that is estimated to be without appreciable human health risk) of 0.5 micrograms per kilogram of body weight per day for oral exposure is currently under review (4).

Ingestion of cadmium may result in damage to the kidneys and may cause hypertension, although the importance of cadmium in

hypertension is unclear. Dermal exposure to cadmium compounds has not been observed to cause significant health effects. Long-term inhalation exposures to cadmium at levels of 100 micrograms per cubic meter may increase the risk of lung disease, such as emphysema, and may also cause kidney injury. Lifelong inhalation of air containing 0.03 micrograms per cubic meter is estimated to cause a lifetime cancer risk of 1 in 10,000 (4). Air monitoring results at the RFT site detected airborne cadmium levels (0.082 microgram per cubic meter) at levels of public health concern (1). Site remediation activities or on-site cycling activities are likely to increase airborne cadmium levels.

Under current land use, cadmium levels in surface soil are not high enough to be of public health concern. If the site is developed for residential or recreational uses, the levels may become a public health concern.

Lead

Human exposure to lead at the RFT site may occur through two major pathways: the ingestion of contaminated soil, mine tailings, and food-chain entities or the inhalation of airborne contaminated dusts. Levels of lead in surface soil and tailings, subsurface soil and tailings, and air are sufficiently high to be of public health concern.

Children are especially susceptible to the health effects of lead exposure. Low levels of lead exposure may cause decreased growth and may result in lower intelligence quotient (IQ) scores. Low levels of lead exposure may also cause hypertension in middle-aged men. Pregnant women exposed to lead transfer lead to the fetus, and this may cause preterm birth, reduced birth weight, and decreased neurological development in the infant. Results of studies have shown that lead causes cancer in laboratory animals; however, it is not known whether lead causes cancer in humans.

Human inhalation of lead-contaminated dust or lead fumes may result in the same health effects that ingestion exposure causes. Air monitoring results at the RFT site indicated lead (1.65 micrograms per cubic meter) at levels above EPA's National Primary and Secondary Ambient Air Quality Standards for lead (1.5 micrograms per cubic meter) (5). Airborne lead levels are expected to be even higher if soil is disturbed by on-site activities such as soil excavating or cycling.

The Centers for Disease Control (CDC) has cautioned that concentrations of lead greater than 500-1,000 parts per million (ppm) in residential soil could lead to elevated blood lead levels in children who inhale or ingest soil. Lead levels in excess of these values were found in on-site surface soil and mine tailings and in subsurface soil and tailings. Site trespassers, site workers, and recreational cyclists may experience short-term exposures to lead-contaminated media.

Selenium

Human exposure to selenium at the RFT site may occur through the ingestion of contaminated groundwater or soil and through the inhalation of airborne dust. Once ingested, selenium in both the organic and inorganic forms is readily absorbed. Although selenium is an essential nutrient, it may have toxic effects at levels moderately above the daily nutritional requirement. The Food and Nutrition Board of the National Academy of Sciences (NAS) suggests that 0.05 to 0.20 mg of selenium per person per day is an adequate and safe level of dietary intake in adults (6).

Inhalation of selenium may cause damage to the respiratory tract, gastrointestinal and cardiovascular effects, and irritation of the skin and eyes (7). Air samples collected from the RFT site were not analyzed for selenium; however, the levels found in surface soil and tailings and the air monitoring results for other site contaminants indicate that airborne selenium levels may be of public health concern under normal site conditions. Soil disruption by such activities as soil excavation or cycling could increase airborne selenium levels.

Selenium may also bioaccumulate in plants and animals. The health effects from long-term exposure to selenium via ingestion of contaminated food or water include loss of hair, loss and deformities of nails, problems with walking, diminished reflexes, and some paralysis. These health effects were reported from a study of populations in China that lived in areas with extremely high selenium levels in the soil and in the rice and vegetables they consumed. Selenium levels in the food were 1.6 parts per million or higher, and the period of exposure was months or even years (8).

Zinc

Human exposure to zinc at the RFT site may occur through two major pathways: the ingestion of contaminated soil, tailings, and groundwater or the inhalation of airborne contaminated dust. Which health effects result from exposure to excess levels of zinc depends on the pathway of exposure.

Ingestion of excess zinc may cause stomach or digestive problems. NAS has estimated the recommended dietary allowance (RDA) for zinc to be 15 milligrams per day (6). Long-term exposure to excessive levels of zinc (2.1 milligrams per kilogram of body weight per day) may result in copper deficiency (8); however, exposures of this magnitude are not expected to occur at the RFT site.

Inhalation of zinc dust may lead to breathing difficulties and nonspecific neurological effects such as headaches and malaise (9). Air monitoring results at the RFT site did not show zinc to be at levels of public health concern; however, during soil-disturbing activities, such as soil excavation or cycling, airborne zinc levels may become a public health concern.

CONCLUSIONS

Using the available information, ATSDR has concluded that this site is of potential public health concern because humans may be exposed to hazardous substances by ingestion of contaminated soil, groundwater, and food-chain entities; dermal contact with contaminated soil; and inhalation of contaminated dust. This Preliminary Health Assessment is based on incomplete monitoring data for groundwater and surface water. A full assessment of the public health implications of this site is not possible with the information presently available.
In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, the Richardson Flat Tailings site has been evaluated for possible follow-up with health effects studies. However, because no documentation or indication exists that human exposure to site-related contaminants is occurring or has occurred in the past, this site is not being considered for follow-up health studies at this time.

As ATSDR receives additional information, such information may indicate that further assessment is warranted by site-specific public health issues.

RECOMMENDATIONS

ATSDR recommends the following:

1. Restrict public access to the site to reduce unauthorized site entry and use of the site for recreational purposes.

2. Monitor private wells within 1 mile of the site to determine whether these wells are being impacted by site contaminants and whether water from these wells can continue to be used for potable purposes.

3. Conduct additional surface water monitoring, both upgradient and downgradient from the site, to determine the site's impact on Silver Creek and other nearby bodies of surface water.

4. Sample leachate seeps from along the north side of the on-site earthen dam, and analyze these samples for site-associated contaminants.

5. Collect additional off-site soil samples from areas adjacent to the site, especially downwind of the site, to characterize off-site contamination.

6. Collect and analyze edible portions of trout from Silver Creek to determine whether they are suitable for continued human consumption.

7. Include the following in the remediation workplan if additional site remediation occurs:

   Provide adequate personal protective equipment that meets the standards of the Occupational Safety and Health Administration (OSHA) for workers conducting remedial activities in and around the site.

   Follow appropriate precautionary guidelines, regulations, and advisories from the National Institute for Occupational Safety and Health (NIOSH) and OSHA.

   Employ optimal dust control measures if remedial activities will involve ground-disturbing activities. In addition to on-site air monitoring, appropriate real-time air monitoring at the worksite periphery should be conducted during working hours in addition to on-site air monitoring. Levels of contaminants in the ambient air at the periphery of the site should not exceed National Ambient Air Quality Standards (NAAQS) or NIOSH recommendations.

8. When indicated by public health needs, and as resources permit, the evaluation of additional relevant health outcome data and community health concerns, if available, is recommended.

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REFERENCES

1. Hazardous Ranking Score Package, Richardson Flat Tailings Site, Park City, Utah.

2. Shacklette, J.T., and Boerngen, J.G., 1984, Elemental Concentrations in Soil and Other Surficial Materials of the Conterminous United States. U.S. Geological Survey Professional Paper 1270.

3. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Arsenic. Atlanta: ATSDR, March 1989.

4. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cadmium. Atlanta: ATSDR, March 1989.

5. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Lead. Atlanta: ATSDR, 1987.

6. Recommended dietary allowances. 1980. 9th Rev. National Resource Council. Washington, DC: Food and Nutrition Board, National Academy of Sciences., 162-164.

7. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Selenium. Atlanta: ATSDR, December 1989.

8. Yang, G., Wang, S., Zhou, R., et al. 1983: Endemic selenium intoxication of humans in China. Am J Clin Nutr 37:872-881.

9. Porter K.G., McMaster D., Elmes M.E., et al. 1977. Anemia and low serum-copper during zinc therapy. Lancet:744.

10. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Zinc. Atlanta: ATSDR, December 1989.

FOCUSED REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN

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1.0 INTRODUCTION

Respondents (as defined in the Administrative Order on Consent (U.S. E.P.A. Docket No. _____), dated _____, 2000) (the AOC") submit this Focused Remedial Investigation/Feasibility Study ("RI/FS") Work Plan pursuant to the Statement of Work, Focused Remedial Investigation/Feasibility Study, Richardson Flat Tailings Site, Summit County, Utah, UT980952840." United Park City Mines Company ("United Park") is the current owner of a large parcel of property (the "Property"), comprising approximately 700 acres, located in Summit County, Utah. Figure 1.0 shows the general geographic location of the Property. A historic mine tailings impoundment, consisting of a large, geometrically closed basin formed by an earth embankment and a series of perimeter containment dikes, covers approximately 160 acres of the Property and is sometimes referred to as "Richardson Flat" or simply the "Site." The tailings impoundment resulted from decades of mining and milling silver-laden ore in the area around Park City known as the Park City Mining District. The Site is depicted in Figure 2.0.

The Site has remained unused since mining and milling operations ceased in 1982. Over the past fifteen years, the United States Environmental Protection Agency ("EPA"), the Utah Department of Environmental Quality ("UDEQ"), and United Park have been investigating the Site in order to characterize the Site and determine potential adverse impacts to human health and the environment associated with the Site. At the same time, United Park has been implementing a series of remedial measures at the Site intended to mitigate any potential adverse impacts on human health and the environment.

As the result of previous Site operations and United Park's remedial efforts, Respondents believe that key elements are in place to support final Site closure. These existing closure elements include (i) the installation of multiple monitoring wells to monitor groundwater conditions in and around the Site; (ii) the construction of a large, earth embankment and a series of containment dikes to contain the tailings; (iii)

construction of a diversion ditch system surrounding the impoundment to collect and redirect; (iv) the placement of a vegetated clay soil cover to isolate the tailings, to prevent tailings from becoming wind-borne, and to minimize the infiltration of water to the tailings; and (v) the installation of a security fence to limit Site access.

Based on available data from the Site and from similar tailings impoundments, Respondents believe that the tailings impoundment as currently closed does not unacceptably impact upon, and does not otherwise pose unacceptable risks to, human health or to the environment. Respondents further believe that final Site closure can be achieved without the implementation of further remedial measures. On the other hand, Respondents recognize that EPA and UDEQ have expressed concerns about Site conditions that the agencies believe must be addressed through additional Site characterization and possibly through the implementation of additional remedial measures. Therefore, Respondents propose to use the data collected to date concerning the Site (after an evaluation of its suitability for use in the RI/FS process) and the data derived from the proposed, Focused Remedial Investigation and Feasibility Study, to facilitate an evaluation of the effectiveness and appropriateness of the existing in-place remedies and to determine whether any further remedial measures are needed to support final Site closure. If and to the extent further remedial measures are required at all, Respondents believe that any appropriate final remedy for the Site should incorporate to the maximum extent practicable all existing elements of Site closure.

The purpose of this Work Plan is to outline additional Site characterization work to be performed that will gather data to assist in the evaluation of the soundness and appropriateness of the existing remedies and, to the extent necessary, recommend additional remedial measures to support final Site closure. This and other data will also be presented for use by the EPA to perform a focused risk assessment. It will also be used in the Focused Remedial Investigation and Feasibility Study final reports both consistent with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("CERCLA") and the National Contingency Plan ("NCP") to support final site closure.

This Work Plan describes current knowledge about the Site and its history, summarizes investigation and characterization work completed to date, presents a conceptual model of the Site, and describes the additional investigative, risk assessment, feasibility study, and community relations work to be performed. This Work Plan also presents a description of the anticipated reports and deliverables and a project schedule.

2.0 SITE DESCRIPTION AND BACKGROUND

The Richardson Flat Property covers approximately 700 acres in a small valley in Summit County, Utah, located one and one-half miles northeast of Park City, Utah. The tailings impoundment Site covers approximately 160 acres in the northwest corner of the Property and lies within the NW quarter of Section 1 and NE quarter of Section 2, Township 2 South, Range 4 East, Summit County, Utah. Figure 2.0 shows the Site boundary.

In 1988, during the first proposal by the EPA to place the Site on the NPL, the site boundaries were limited to the impoundment area and adjacent lands. It did not include the area known as the floodplain tailings. The floodplain area, along with the Park City Municipal Landfill were evaluated as part of the work completed by the EPA in 1992 in connection with EPA's second proposal to list the Site on the NPL.

For the purposes of this Focused RI/FS, the Site will include the area shown on Figure 2. The Park City Municipal Landfill is physically separated from and has no operational connection with the Site, and thus, is not a part of the Site for purposes of this focused RI/FS.

Likewise, the Focused RI/FS does not propose including the floodplain tailings as part of the Site. As noted more fully in United Park's comments to EPA's proposals to list the site on the NPL, there is no evidence linking the floodplain tailings to the Site. The flood plain tailings are located in an area that is upgradiant from the Site and on the other side of the railroad bed, a physical barrier that isolates the floodplain tailings from the Site. But more important, analytical data from the floodplain tailings indicate

that they are of a different nature and composition than the tailings deposited at the Site. All of the evidence leads to the conclusion that the floodplain tailings are composed of upstream tailings mixed with the natural fluvial sediments in Silver Creek. The floodplain tailings originated upstream from the tailings located on the Silver Maple unpatented mining claims (BLM ownership) and the Silver Creek Tailings site (Prospector Square, Park City) and were carried downstream in Silver Creek to the floodplain. Therefore, the floodplain tailings area is also not a part of the Site for purposes of this focused RI/FS.

2.1 Site Operational History

United Park was formed in 1953, with the consolidation of Silver King Coalition Mines Company and Park Utah Consolidated Mines Company, both publicly traded mining companies at the time. Tailings were first placed at the Site prior to 1950. The mill tailings present at the Site consist mostly of sand-sized particles of carbonate rock with some minerals containing silver, lead, zinc and other metals. While few specific details are known about the exact configuration and operation of the historic tailings pond, certain elements of prior operations are apparent. It appears that from time to time, tailings were transported to the Site through three distinct low areas on the Property. Over the course of time, tailings materials also settled out into these three low areas that were ultimately left outside and south of the present impoundment area as constructed in 1973-74. An embankment constructed along the western area of the Site also appears to have been in place as part of the original design and construction of the tailings pond, but few details are known of the original embankment.

In 1970, Park City Ventures ("PCV"), a joint venture partnership between Anaconda Copper Company ("Anaconda") and American Smelting and Refining Company ("ASARCO"), entered into a lease agreement with United Park to use the Property for disposal of additional mill tailings resulting from renewed mining in the area. PCV contracted with Dames & Moore to provide construction specifications for reconstruction of the Site for continued use as a tailings impoundment (Dames & Moore, 1974). The

State of Utah approved PCV's proposed Site operations based on Dames & Moore's design, construction, and operation specifications. Before disposing of tailings at the Site, PCV installed a large, earth embankment along the western edge of the existing tailings impoundment and constructed perimeter containment dike structures along the southern and eastern borders of the impoundment to allow storage of additional tailings. *See* Figure 2.0. PCV also installed a diversion ditch system along the higher slopes north of the impoundment and outside of the containment dike along the east and south perimeter of the impoundment to prevent surface runoff from the surrounding land from entering the impoundment. PCV also installed groundwater monitoring wells near the base of the main embankment, as part of the required approval process by the State of Utah.

PCV conveyed tailings to the impoundment by a slurry pipeline from its mill facility located south of the Site. Over the course of its operations, PCV disposed of approximately 420,000 tons of tailings at the Site. In addition to developing construction specifications for the Site, Dames & Moore also provided PCV with operating requirements for the tailings pond and slurry line, that were also approved by the State of Utah as a requirement for operating the Site. Dames & Moore recommended, among other things, that PCV operate the slurry line in such a way so as to deposit tailings around the perimeter of the tailings impoundment and moving towards the center of the impoundment (Dames & Moore, 1974 at 21). This is also common operating practice in the industry. Unfortunately, PCV failed to follow the Dames & Moore requirement and operated the slurry line in such a way that a large volume of tailings were placed near the center of the impoundment in a large, high-profile, cone-shaped feature. After cessation of operations by Noranda in 1982, the presence of this cone-shaped feature of the tailings pond resulted in the prevailing winds cutting into the tailings and the tailings materials becoming wind-borne. Had the slurry line been operated according to the Dames & Moore specifications, the high-profile tailings cone would not have existed and prevailing winds would not have been a significant potential exposure pathway at the Site.

Between 1980 and 1982, Noranda Mining, Inc. ("Noranda") leased the mining and milling operations and placed an additional, estimated 70,000 tons of tailings at the Site. No new tailings have been placed at the Site since Noranda ceased its operations.

2.2 Description of Existing Closure Measures and Elements

Over the years, certain efforts have been taken at the Site that can be used to support final closure. More specifically, tailings at the Site are presently contained through a combination of man-made and natural factors, discussed below.

2.2.1 Main Embankment and Containment Dikes. As explained above, the majority of the tailings at the Site are contained in a geometrically closed basin, with a large, earth, embankment (the "main embankment") in place along the western edge of the Site. The main embankment is vegetated and is approximately 40 feet wide at the top, 800 feet long, and has a maximum height of 25 feet (Dames & Moore 1980, at Plate 2). The main embankment was designed to permit seepage of water from the impoundment to relieve hydraulic pressure on the embankment. In March of 1974, Dames & Moore recommended to PCV, and in November 1980, recommended to Noranda, that engineered seepage controls be installed at the base of the main embankment. (Dames & Moore 1974, 1980 at 9 and 16, respectively) It appears that neither company followed this recommendation. A series of man-made containment dikes contain the tailings along the southern and eastern perimeter of the impoundment. The northern edge of the impoundment is naturally higher than the perimeter dikes.

In 1980, Dames & Moore investigated the tailings impoundment structures for Noranda and noted that the main embankment was not constructed in accordance with its original design specifications and noted that it was oversteepened in some areas. Nevertheless, Dames & Moore did not have any immediate concerns about the stability of the main embankment at that time. While Dames & Moore did express reservations if additional tailings were added to the impoundment over a long period of time, Noranda ceased mining and milling operations in 1982 and no tailings or slurry water have been

disposed of at the Site since that time. Respondents agree with previous investigations that portions of the main embankment are oversteepened and were not constructed in accordance with original design recommendations. As part of the Focused RI/FS, Respondents will design an appropriate wedge buttress to address this problem. This work is further described in Section 5.6.

2.2.2 Natural Underlying Clay Soils. Past geotechnical studies by Dames and Moore and the more recent Weston report indicate that the impoundment is underlain by native high clay-content soils with sufficiently low permeability to support closure in place for the tailings. Existing data demonstrates that there is no hydraulic connection between the tailings impoundment and underlying groundwater systems, as discussed in more detail in sections 2.4, 3.4, 4.4, and 5.5 below.

2.2.3 Vegetated Soil Cover. During active operations at the Site by PCV and Noranda, tailings were slurried to the Site, using some 60 gallons of water per minute under normal operations. When Noranda ceased operations in 1982, the tailings pond was, for the most part, full of water and was too soft and unstable to get onto the impounded tailings with heavy equipment. Starting in 1983, United Park began placing soil cover on tailings outside of the impoundment, located in the three low areas south of the south diversion ditch (*See* Figure 2.0). By 1985, the tailings impoundment had dried out enough in certain areas to support heavy equipment and United Park began installing soil cover material over those portions of the tailings impoundment using soil from both the Park City area and from within the Property. The soil cover consists of clay-rich soil, with kaolinite being the predominant clay mineral (Weston, 1999 at 4).

The soil cover was installed at that time in large part to prevent prevailing winds from cutting into the cone-shaped tailings feature left at the Site by previous operators. United Park focused its initial efforts on placing soil cover around the cone-shaped tailings feature to eliminate the possibility of wind-blown tailings from leaving the impoundment. Several feet of cover were required in areas around the cone-shaped feature in order to provide for a reasonable final grade of the impoundment. By 1988,

work around and on the cone-shaped tailings feature had been completed and other areas of the tailings had begun to dry out enough to support additional work. United Park then began a more aggressive program to cover all exposed tailings. Drought conditions during the early 1990s created sufficiently stable conditions to allow United Park to complete the soil cover, even on areas that had contained, at times, ponded water. At least 12 inches of low-permeability, clay cover material is in place in the north-west area of the impoundment where ponded water occurred. Currently, there are no areas of exposed tailings material on the Site. The soil cover is also vegetated largely due to United Park's efforts to re-seed the area with appropriate plant species.

The purposes of the soil cover are to prevent direct contact with the tailings material, to prevent tailings from becoming wind-borne, and to minimize the infiltration of surface water into the tailings materials. Although United Park believes the existing soil cover is sufficient to protect human health and the environment, United Park intends to confirm the lateral and vertical extent of the existing soil cover and will evaluate the need for further remedial measures on the soil cover. This is further described in more detail in section 5.1, below.

2.2.4 Diversion Ditches. A diversion ditch system borders the north, south, and east sides of the impoundment to prevent runoff from the surrounding land from entering the impoundment (*See* Figure 2.0). Precipitation falling on the impoundment area creates the limited volume of seasonal surface water that can be seen on the Site. The north diversion ditch collects snowmelt and storm water runoff from upslope, undisturbed areas north of the impoundment and carries it in an easterly direction towards the upstream origin of the south diversion ditch. An unnamed ephemeral drainage to the southeast of the impoundment also enters the south diversion ditch at this point. Additional water enters the south diversion ditch from other areas lying south of the impoundment at a point near the southeast corner of the diversion ditch structure (*See* Figure 3.3). This water consists of spring snowmelt and storm water runoff. Water in the south diversion ditch flows from east to west and ultimately empties into Silver Creek just

upstream of Highway 189 near the north border of the Property. Although a discrete flow of water from the south diversion ditch to Silver Creek is maintained only during the higher water periods of the year.

In 1992 and 1993, United Park reconstructed the south diversion ditch by decreasing the slope of its banks from nearly vertical to a more gradual slope. United Park also placed a clay soil cover over the re-sloped banks of the south diversion ditch, down to and including areas of the banks underwater. The new banks were then seeded with appropriate varieties; presently, the existing ditch banks are vegetated. United Park did not disturb the bottom of the ditch bed. Since doing this work, surface water quality data has shown marked improvement from year to year and the downward trend in metals content measured in the surface water continues to this day (*See* Figure 3.2a). In May of 1999, United Park reconstructed the north diversion ditch along its entire length. United Park intends to continue to collect surface water quality and sediment characterization data from the south diversion ditch system, as described in more detail in section 5.4, below.

2.2.5 Fencing. In the mid 1980s, United Park installed a fence along most of the Property boundary, including the entire impoundment and much of the property south of the impoundment in order to restrict and control access to the Site. United Park maintains the fence in good repair and United Park intends to continue to do so to control access to the Site until such time as limited access is no longer necessary, consistent with Property redevelopment.

2.3 Regional Geology

The Property lies within the Park City East Geologic quadrangle map as recorded by the U.S. Geologic Survey (*See* Figure 2.1). Geologic maps at a scale of 1:24,000 compiled by Crittenden and others (1966) and by Bromfield and Crittenden (1971) cover this and nearby quadrangles. Bryant (1990) provides a regional 1:100,000-scale map of the area.

The Property is located within a complex fold and thrust belt that was later intruded and overlain by volcanic rocks. Sedimentary bedrock near the Property, dated in the Paleozoic to Mesozoic period in age, is overlain by a thick layer of extruded volcanic rock, dips approximately 25 to 60 degrees to the north, and strikes generally northeast-southwest (Crittenden and others, 1966; Bromfield and Crittenden, 1971). The Tertiary gravels and volcanic rocks unconformably overlie Mesozoic sedimentary rocks. No known faults exist near the Site.

Tailings on the Site lie on top of alluvial/colluvial sediments that are 30 to 50 feet in depth and are the product of the erosion of the adjacent and underlying volcanic extrusives. Review of borehole data indicates that these sediments are comprised of:

- Two to five feet of soft, organic and clay-rich topsoil
- One to 30 feet of various mixtures of fine-grained silt and clay
- Four feet of sand and gravel
- Variable thickness of highly-weathered, volcanic breccia composed of relatively soft, tight, sandy and silty clay, grading to moderately hard, slightly to moderately fractured volcanic rock.

2.4 Regional Hydrogeology

Hydrogeology in the area is characterized by shallow alluvial aquifers located in fine-grained, alluvial and colluvial material, and the deeper, Silver Creek Breccia bedrock aquifer located in the Keetley volcanics. Bromfield and Crittenden (1971) describe this unit of the Keetley volcanics as consisting of intermediate laharic breccias with less common flow breccias and interlayered tuffs. In the subsurface, the weakly consolidated Silver Creek Breccia is interlayered with sedimentary rocks. These sedimentary layers are more numerous toward the base of this unit and consist of quartzite, limestone, siltstone, and shale.

The shallow aquifers are generally encountered from fifteen to thirty feet below the ground surface, in confined and unconfined conditions, and located in gravelly

clay. Fine-grained, silty clays cover the top aquifer, and clay and silt separate the shallow aquifers from each other. The shallow aquifer structure appears to be consistent from south of the Site to Silver Creek on its northwest border.

Recent exploratory drilling (designed to better assess groundwater resources for private entities) about 1.5 miles northwest of the Property indicates that the paragenetic relationship between the Tertiary volcanic rocks and associated sediments are complex. Wells located approximately three miles northwest of the Property in Sections 16 and 22, Township 1 South, Range 4 East, Salt Lake Base and Meridian (SLB&M) either flowed to the surface following completion or had shallow static water. These wells indicate that confined to semi-confined aquifers comprise both shallow and deeper aquifer(s) within the Tertiary volcanic rocks and deeper associated sediments. Pump testing and monitoring of water levels in local wells that tap both the shallow and deeper aquifers indicate no apparent hydraulic communication between the shallow and deeper Tertiary volcanic rocks and associated sediments (Pers. Comm. Todd Jarvis, September 1999).

The hydraulic conductivity, effective transmissivity, saturated thickness, and effective porosity for the Tertiary volcanic rocks and associated sediments were derived from nearby wells. Controlled aquifer test data are available for wells located in Sections 16 and 22, Township 1 South, Range 4 East, SLB&M. Analysis of data collected from the well indicates that near-well transmissivities approach 110 to 310 ft^2/day with lateral variations in aquifer permeability that both increase and decrease the aquifer's transmissivity (Weston, 1999). For example, Park City Municipal Corporation (PCMC) recently installed a test well in the southeast corner of Section 34, Township 1 South, Range 4 East, approximately one mile northwest of Property. The well was spudded on the weathered Keetley Volcanics with the underlying Thaynes Limestone as the targeted aquifer. However, the Thaynes Limestone was not encountered at the final drilled depth of 1,000 feet. While the exploratory boring developed water from the fractures in the unweathered Keetley volcanic rocks, the quantity of water that reasonably could be developed from the Keetley Volcanics at this location was between 100 to 200 gpm with

long-term drawdown estimated at 250 to 300 feet (specific capacity = 0.33 to 0.4 gpm per foot of drawdown or a transmissivity of 30 to 50 ft^2 /day). This yield was considerably less than the quantity desired by PCMC for a municipal water supply, and the well remains unused (Hansen, Allen & Luce, 1996, letter report to PCMC).

Generally speaking, the hydraulic gradients in the shallow aquifers roughly parallel topography (i.e., from South to North) except near the southern boundary of the tailings embankment, where the diversion ditch causes the flow to change to the northwest (Weston, 1999 at 6). This northerly bearing orientation of the hydraulic gradient is consistent with regional trends mapped by Brooks and others (1998). Based on the artesian flow observed during the course of drilling the previously described wells located north of the Property, the unconsolidated sediments in this area have a low vertical permeability and local semi-confined to confined conditions (Pers. Comm. Todd Jarvis, September 1999).

2.5 Surface Water

Surface water is present at the Site in four areas in and around the Site. First, Silver Creek flows along the west edge of the Property, over 500 feet from the main embankment. Second, the drainage ditch system surrounding the tailings impoundment seasonally collects runoff water flowing towards the impoundment and redirects it around the impoundment and into Silver Creek. This diversion ditch system also includes a pond in the southwestern portion of the Site and a ditch traversing the hillside north of the Site. Surface water is also present in the form of ponded water in the northwestern area of the impoundment, having ponded over the clay soil cover over the impoundment. Finally, very small quantities of surface water are present in the form of a seep located near the base of and near the north end of the main embankment.

Consideration of the fate and transport of the surface waters mentioned above is necessary to understand any impact that the Site may have on surface water quality in the area, including Silver Creek. Because ponded water on the impoundment is

derived solely from precipitation falling directly on the impoundment, the volume of ponded water varies from year to year. Ponded water follows several pathways or possible fates from the impoundment. Nearly all water loss can be attributed to evaporation and plant use within the pond. A small amount of the ponded water percolates through the underlying, low permeability soil cover and into the tailings. The ponded water never leaves the impoundment as a discrete surface flow.

The north diversion ditch (which flows west to east) discharges into an area east of the impoundment where water may ultimately enter the south diversion ditch system (which flows east to west) into a pond and ultimately towards Silver Creek. In the spring, surface water in the south diversion ditch has enough flow to sustain a discrete flow to Silver Creek. In the later summer when water flows are the lowest, the water flowing from the diversion ditch is difficult to trace to Silver Creek as a discrete flow. It is likely that some of the diversion ditch water evaporates and is taken up by plants. The south diversion ditch generally stops flowing only in the late summer or fall on the easternmost end of the ditch only. The south diversion ditch, however, never completely dries out so it does not appear that diversion ditch water infiltrates into the ground. Weston reports that the diversion ditch serves as a hydraulic sink and may intercept groundwater (Weston 1999 at 7). For this reason, it appears that late-season flow in the south diversion ditch is comprised of groundwater intercepted by the ditch.

Water from the small seep at the base of the main embankment flows at a very limited rate, in the range of gallons per day. The exact flow rate has not been measured and cannot be calculated without stripping significant amounts of vegetation and organic matter from around the seep area and installing a drain to collect the dispersed flow. However, it is clear that due to the low volume of water, a discrete flow is not and cannot be maintained long enough to reach Silver Creek, over 500 feet away. The small amount of water discharging from the seep is likely utilized by the surrounding vegetation or may evaporate.

3.0 PREVIOUS SITE INVESTIGATIONS

Since the 1970s, PCV, Noranda, EPA, and United Park have conducted numerous environmental investigations relating to the Site. Beginning in the 1970s, PCV conducted groundwater, tailings pond, and embankment design studies that focused on the construction of containment structures that would accommodate additional tailings. In 1980, Noranda conducted studies to determine the current condition of the impoundment and the potential for future enlargement of the impoundment. In the 1980s and early 1990s, EPA conducted studies of groundwater, surface water, and air quality to determine whether Site contaminants posed sufficiently high threats to human health or the environment to require listing of the Site on the National Priorities List ("NPL"). United Park initially conducted studies in response to EPA's proposal to list the Site on the NPL. More recently, United Park has obtained data focusing on the characterization of Site hydrogeology and surface water quality.

EPA has proposed listing the Site on the NPL on two occasions. In 1988, EPA proposed listing the Site on the NPL based on the Site's Hazardous Ranking System ("HRS") score. After considering public comments, EPA ultimately declined to list the Site. By 1992, the HRS scoring system had been revised. At that time, EPA rescored the Site and again proposed that the Site be placed on the NPL. Based on the new proposal to list the Site, the EPA Emergency Response Branch (ERB) conducted additional investigations on the Site and determined that conditions did not warrant emergency removal action. In 1994, the Agency for Toxic Substances and Disease Registry (ATSDR) in their "Preliminary Public Health Assessment Addendum on the Richardson Flat Tailings" found that the Site posed "no apparent public health hazards due to past or present exposure." They did, however, consider Richardson Flat an "indeterminate public health hazard" in the future due to the potential for residential development on or near areas where significant levels of contamination may be found. United Park's future land use plan includes provisions that residential development will not occur in these areas.

The EPA has yet to list the Site on the NPL, but the Site's listing on CERCLIS remains in effect. While no formal regulatory action has occurred with respect to the Site since the second proposed listing, United Park has continued its efforts to investigate and close the Site by improving the soil cover, maintaining the diversion ditches, and collecting surface water and groundwater data.

This section summarizes past investigation activities and existing Site data. The reports and data from these investigations are very useful in determining the scope of additional investigative activities needed to bring final closure to the Site. From 1985 to 1988 and from 1992 to 1993, the EPA conducted and reported on investigations at the Site. Because past investigation activities by PCV, Noranda and United Park were performed without EPA oversight, the results from such investigations will be evaluated as part of, and incorporated as appropriate into, the Focused RI/FS.

3.1 Air Monitoring Investigations

Due to concerns over wind-blown tailings resulting from the cone-shaped tailings feature created by past operators, EPA conducted air monitoring investigations on two separate occasions. Due to United Park's subsequent placement of the full, vegetated clay soil cover, data from these investigations are no longer directly relevant but are reported here to support United Park's proposed study of off-Site wind blown tailings.

In 1985, when approximately 40 percent of all of the tailings on the Property had been covered with the soil cover, Ecology and Environment, Inc. ("E&E"), a contractor working for EPA, collected Site air data. Four high volume air samplers were located on or immediately adjacent to the tailings impoundment and one was located approximately one-half mile southeast of the Site. Data were collected at the Site over a five-day period and the filters from the samplers were analyzed for arsenic, cadmium, lead and zinc. A meteorologic station was installed at the Site and wind direction, air temperature, barometric pressure and relative humidity data were collected. The prevailing wind direction measured at that time was from the northwest to southeast (E&E, 1987 at 3).

According to E&Es analytical data, increases were noted for all metals measured in downwind versus upwind monitoring locations. Review of the data in Table 1 of the 1987 E&E report shows that 52% of arsenic, 92% of cadmium, 17% of lead and 14% of zinc measured on the air filters at the Site were below the laboratory's detection limits.

E&E again conducted air monitoring in 1992 at five locations. The installation of the cover within the impoundment had progressed to the point where all of the exposed tailings had been covered, with the exception of one area of tailings where salt grass and other native plant species were growing and had stabilized the tailings. These air monitoring activities showed no detectable levels of arsenic, cadmium or lead. Trace levels of zinc were detected in four of the seventeen samples collected. There are no ambient air quality standards for zinc. The significant reduction in the concentration of target analytes from these two air-monitoring programs can be explained by United Park's efforts to cover the remaining areas of the impoundment. Since 1992, all of the exposed tailings in the impoundment have been covered, including the area where salt grass was growing.

3.2 Tailings Cover Investigations

As part of the EPA ERB investigations in 1992, E&E conducted a survey of the depth of soil cover. E&E measured the depth of cover at 29 locations on a grid pattern of 400 x 400 feet. These locations are depicted on Figure 2, Appendix B. According to the E&E report (E&E, 1992at 4), a visual contrast was apparent between the soil cover and the gray colored tailings beneath the cover. X-ray fluorescence ("XRF") measurements for lead were taken at select locations to confirm the visual contrast where the distinction was not clear (see Appendix B, Table 1, for the soil cover data). E&E reported that much of the tailings either had soil or salt grass covering the exposed tailings. Generally, data from the 1992 study shows that the soil cover varied in thickness from less than six inches up to fourteen inches in depth in the areas E&E tested. E&E did not test areas of thick cover, where as much as three feet of cover were present. Of the 29 points E&E measured, only one location had no soil or salt grass present. Subsequent to E&E's work, United Park has

placed additional soil cover in this and other areas of the impoundment to improve the tailings cover and support Site closure.

As part of the recent hydrogeologic investigation by Weston (as discussed in section 3.4, below), data were collected on the soil characteristics of the tailings cover. Samples of the tailings cover soil were tested to determine classification and hydraulic characteristics. Soil cover samples were collected from three representative locations over the Site and were tested for moisture content and dry density. Based on this testing, the soil cover was classified as lean clay with sand. Two of the three samples were also submitted for laboratory analysis to determine permeability. Laboratory testing indicated that the cover soil is highly impermeable, with permeabilities ranging from 3 to 7 x 10^{-8} cm/sec. These values roughly correspond to permeabilities typically measured in clay liner systems that are required to be installed at hazardous waste landfills. X-ray diffraction ("XRD") analysis of select samples indicated that the soil cover clay mineralogy closely matched the XRD peaks for illite and kaolinite. Kaolinite was the most prevalent clay mineral and it is stable with little tendency for volume change when exposed to water. Illite is generally more plastic than kaolinite and does not expand when exposed to water (Weston 1999 at 4).

3.3 Studies of Tailings Impoundment Integrity and Stability.

In 1974, PCV hired Dames & Moore to conduct an investigation of the Site and to develop construction specifications for reconstruction of the embankment in order to accommodate the placement of additional tailings materials. While PCV raised and reconstructed the embankment and installed the containment dike system, according to subsequent work performed by Dames & Moore for Noranda, PCV did not appear to follow the design specifications developed by Dames & Moore. In 1980, Dames & Moore conducted an impoundment integrity and stability investigation for Noranda, the then-current operator of the Richardson Flat tailings impoundment. The objective of that investigation was to assess the overall condition and usefulness of the existing facilities and

to determine what measures would be required for long-term tailings disposal (Dames & Moore 1980 at 1). Dames & Moore noted several construction flaws during the 1980 investigation, specifically noting that the main embankment was oversteepened in some locations. Dames & Moore concluded that while it did not have any immediate concerns regarding the stability of the main embankment and containment dikes, it did have concerns regarding the use of the Site to dispose of additional tailings.

In 1992, E&E examined the tailings impoundment for EPA. Although E&E noted that the main embankment generally was not constructed according to the 1974 recommendations of Dames & Moore, E&E concluded that there appeared to be no immediate threat of gross failure of the tailings containment structure.

3.4 Groundwater Investigations

In the early 1970s, PCV began to collect groundwater data at the Site. Since that time, both EPA and United Park have investigated groundwater conditions at the Site. In 1973, PCV installed three monitoring wells (MW-1, MW-2 and MW-3) at the bottom of the main embankment. In 1976, PCV installed three additional wells (MW-4, MW-5, MW-6). Figure 3.3 shows the well locations. It appears that PCV buried monitoring well MW-2 in 1976 during installation of the three new wells. Thus, five groundwater monitoring wells are located near the toe of the embankment. The boring and well completion logs for these five wells can be found in Appendix D and are summarized below.

- MW-1 was drilled to a depth of 35 feet below the ground surface ("bgs"). Bedrock was encountered from 14.5 feet bgs to the total depth drilled. Well screen and gravel pack were installed from 24 to 34 feet bgs.
- MW-2 was drilled to a depth of 21 feet bgs; bedrock was encountered from 11 to 21 feet bgs. Well screen and gravel pack were installed from 3 to 9.5 feet bgs. (This well was destroyed during the installation of MWs-4 through 6 in 1976).

- MW-3 was drilled to a depth of 29 feet bgs; and bedrock was encountered from 5.8 to 31 feet bgs. Well screen and gravel pack were installed from 2.5 to 25 feet bgs.
- MW-4, MW-5, and MW-6 were drilled to 4.0 feet, 6.1 feet and 6.1 feet bgs, respectively. Boring and completion logs for these wells are not available.

Since 1973, PCV, and later, United Park, have collected data quarterly from these embankment wells. Table 3.2 presents groundwater data collected by United Park from 1982 to 1987 and 1991 to 1998 from these monitoring wells.[1] Data presented in Table 3.2 shows that the water quality has steadily improved in the monitoring wells generally over time. However, there are some anomalies that are readily apparent. For instance, in September of 1998, pH levels between 2.7 and 4.1 were noted for MW-4 and MW-5, respectively. Although these are relatively low pH values and could be indicative of a change in water chemistry in these two wells, it is interesting to note that dissolved zinc concentrations measured in MW-4 for the same time period were an order of magnitude lower than for the measurement in June of 1998 when the pH was 7.1 In MW-5, the dissolved zinc concentrations were similar between June and September of 1998 and the pH values were 7.7 and 4.1, respectively. Both of these wells are completed within the first six feet of the ground surface. Thus, it is likely that the water that is monitored here is vadose zone water that is highly oxidigenated. The oxidigenated water will have a highly variable water chemistry depending on the hydrogeologic characteristics of the subsurface soils. A definitive trend in the water chemistry is not apparent. As part of additional studies planned for the Site, United Park will review the historical data and determine the suitability of wells MW-4, MW-5 and MW-6 as groundwater monitoring wells. In 1985,

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[1] Groundwater data from the main embankment wells for the years 1988 to 1990 are not readily available to United Park and as a result are not reported herein. United Park is attempting to locate data from 1988 to 1990, if it is located, and will report it as part of the RI/FS Report, discussed below.

E&E collected groundwater samples from one upgradient well and two wells located downgradient of the main embankment.[2] E&E installed the upgradient RT-1 monitoring well. The two downgradient wells were existing wells installed by PCV around 1974 and 1975.[3]

In 1992, EPA hired E&E to conduct an additional groundwater investigation. The 1992 groundwater data collected revealed a similar trend as shown in the 1985 E&E study. E&E collected groundwater samples from the Site at three locations, referred to as RF-GW-04 (EPA well RT-1), RF-GW-05 (United Park location MW-1) and RF-GW-09 (United Park location MW-6). Table 3.3 compares the data collected by EPA in 1984 and 1992 with data collected from the same wells by United Park in 1998. Review of the data collected from RT-1 in 1984 and 1992 reveals that water quality appears to have deteriorated at this location over time. Some dissolved metal concentrations have increased from 1984 to 1992. The 1992 data contains some anomalies that suggest either the sample was contaminated or there were some analytical errors; dissolved metal

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[2] According to the E&E sampling report, United Park wells MW-1 and MW-2 were sampled. However, this was not the case: MW-1 was most likely sampled and MW-5 or MW-6 were sampled since MW-2 was believed to have been buried during the installation of MW-4, MW-5 and MW-6 (see Plate 1, Appendix A). United Park's 104(e) response to EPA in 1988 did not contain data for MW-2. The data record submitted to EPA covered the time period from 1982 to 1987. Therefore, E&E could not have sampled MW-2 at that time.

[3] While E&E compared the upgradient and downgradient metals concentrations in order to determine if the tailings materials were impacting groundwater beneath the impoundment, comparison of this data is not appropriate. Further analysis of the well completion logs for RT-1 and MW-1 compared to the total depth of wells MW-5 or MW-6 reveals that RT-1 was screened in both the upper and lower shallow aquifers. MW-1 is screened in the bedrock aquifer and wells MW-5 and MW-6 are screened in the vadose zone. Comparing data from these wells is not accurate since all the wells are completed in different aquifers. E&E reported that downgradient metals concentrations were elevated as compared to upgradient concentrations. However, in 1985, only manganese exceeded National Interim Primary (NIP) drinking water standards. (E&E 1985).

concentrations are greater than the total for antimony, copper, and silver. The change in water chemistry over the eight-year time period is difficult to explain at this time. The well is completed in two aquifers, and thus, there is likely a mixing of water between the two water bearing zones. During site visits in early 1999, it had been observed that the wellhead integrity had been compromised, apparently by vandals. It is not known if this damage had occurred in 1992. As a result, surface contamination may have impacted water quality. The well was installed by E&E in 1984, and therefore, is the property of the EPA. United Park does not sample this well. United Park believes that the well should be abandoned according to proper procedures because of the intermixing of the two aquifers and the breach in the wellhead integrity.

In 1999, United Park hired Weston Engineering, Inc. ("Weston") to conduct a supplemental hydrogeological investigation of the Site. This study represented the most extensive groundwater investigation conducted to date to better understand groundwater systems on the Property. Weston evaluated historical Site and regional data to derive a hydrogeological conceptual Site model (see Appendix A). In the course of its investigation, Weston also installed eleven additional piezometers throughout the Property (see Plate 1, Appendix A). Boring logs from the piezometer installation verified the existence of two aquifers associated with the Property. Water level data collected from the piezometers indicates that the two aquifers are confined and are separated from one another by a significant layer of stiff, clay-rich material. The upper aquifer is overlain by approximately 15 feet of reddish-brown mixtures of silt and clay. An additional two to five foot layer of clay-rich soil overlies this layer of clay-rich material (Weston, 1999, at 4). The local geology has greatly influenced the types of soils that have developed on the Property. The altering and weathering of Keetley volcanics, which form the surrounding hills, have provided the source material for soil development. The abundant clays that result from the alteration and weathering of the Keetley volcanics form the bulk of the natural alluvial material as well as the soil within the Property. Percolation tests conducted on this volcanic soil that was borrowed to cover the tailings within the impoundment indicates that

it has very low permeability, 3 to 7 x 10^{-8} cm/sec. Water level data collected after the installation of the piezometers and subsequent water level measurements indicate that the water levels in the two aquifers varies seasonally, with higher water levels occurring in the Spring.

The data reported by Weston was not available to earlier Site inspection teams and other agencies that previously evaluated the Site. Studies by Dames & Moore identified the presence of clays in the naturally-occurring material at the Site. It was not until Weston's investigation that the extent and significance of the natural clay material underlying the Property was known. The existence of two to five feet of clay-rich topsoil and the presence of the large area of silt and clay that overly the upper aquifer represent a significant barrier to the vertical migration of any water from saturated tailings.

3.5 Investigations of Surface Water Quality

United Park has collected surface water quality data at the Site since 1975. Data from 1982 to 1988 are presented in Table 3.1. Samples were collected from locations upstream and downstream of the confluence of the south diversion ditch with Silver Creek. Also, samples were collected from water that runs in the diversion ditch as it passes through the Site. Figure 3.1 shows the sample locations.

A review of the historical and recent data from these three sampling points demonstrates that since the time that United Park's re-grading and covering of the banks of the south diversion ditch (1992-1993), water quality has steadily improved both in the south diversion ditch at the point where it leaves the Site and in Silver Creek below the Site (*See* Figures 3.2 and 3.2a). The data also demonstrates that although some metals are present in upgradient areas in the south diversion ditch, by the time the water discharges to Silver Creek, metal levels have decreased significantly.

In 1999, United Park initiated a surface water sampling program designed to characterize water chemistry in the south diversion ditch and Silver Creek near the Site. Table 3.4 presents the data collected in 1999; Figure 3.3 shows the 1999 sample locations;

and Table 5.2 lists the analytical parameters that were measured in surface waters in and around the Site. Samples were collected at eleven locations in May and June of 1999 during the spring snowmelt and runoff season (designated RF-1 through RF-10 on Figure 3.3). Samples were collected and analyzed for full suite parameters as shown in Table 5.2 at RF-1 and RF-3 (*See* Figure 3.3) on the unnamed drainages that flow into the south diversion ditch. Samples were collected in May and June of 1999 at RF-2, RF-4, RF-5 and RF-6 on the south diversion ditch. Samples RF-2 and RF-6 were analyzed for full suite parameters and RF-4 and RF-5 were analyzed for total and dissolved metals. Samples RF-7, RF-7-2, RF-8 were collected from Silver Creek and analyzed for full suite parameters. Location RF-9 is the ponded water that exists on the tailings impoundment this sample was analyzed for full suite parameters. Sample location RF-10 represents background water quality from the south unnamed drainage near the county road along the eastern boundary of the site. RF-10 was sampled one time and will not be sampled in the future. Sample locations RF-3 and RF-3-2 will replace RF-10. Samples were collected monthly at three locations (RF-6, RF-7-2 and RF-8) from July to November of 1999. Full suite analyses consisted of major cations and anions, metals and field parameters. Target metals were arsenic, cadmium, chromium, copper, lead, mercury, selenium, silver and zinc. Field parameters were flow, pH, conductivity and temperature.

Table 3.4 presents the 1999 data in three categories. The first category compares the data to aquatic wildlife criteria, the second category gives the general water chemistry data, and the third category compares the data to water quality standards for a Class 1C stream (this is the classification for Silver Creek). The aquatic wildlife standard is based on hardness in the water. Therefore, the standard will have a different value depending on hardness at each location. Metal data presented in the first category are compared to hardness-dependent aquatic wildlife criteria. Protection of Aquatic Wildlife Criteria is the most stringent regulatory standard for comparison purposes. In other words, if the metal concentration is less than the aquatic wildlife criteria, then that metal concentration will be less than the applicable water quality standard. Examination of the

first category of data presented in Table 3.4 reveals that for all of the metals measured only zinc and mercury exceed the aquatic wildlife criteria. Zinc exceeds both the acute and chronic criteria in samples collected upstream in Silver Creek (RF-7 and RF-7-2) and downstream (RF-8) of the south diversion ditch confluence. Zinc concentrations measured in the diversion ditch (RF-6 and RF-6-2) are well below the aquatic wildlife criteria.

Mercury concentrations measured in 1999 were all below the laboratory detection limit of 0.0005 mg/l at all of the sample locations. The acute aquatic wildlife criteria is 0.0024 mg/l and the chronic criteria is 0.000012 mg/l. Therefore, measured mercury concentrations were below the acute criteria. EPA recently promulgated laboratory method 1631 that establishes a standardized procedure to measure mercury at the 2-3 part per trillion range.

4.0 PRELIMINARY SITE MODEL

Based on previous and current environmental studies and existing Site conditions, Respondents have developed a preliminary model of the Site. A Conceptual Site Model will be developed in coordination with EPA's toxicologist using information presented in the preliminary site model. The Conceptual Site Model will also be used to assist in the evaluation of the appropriateness of the existing remedies and, to the extent necessary, in the development of additional remedial measures to support final Site closure. The preliminary site model has been developed to portray existing site conditions and more recent data and information that have been developed by United Park. The preliminary site model is described below and graphically portrayed in Figure 4.0, and will be used to evaluate the need for additional Site characterization work to be performed as part of the Focused RI/FS. After the Conceptual Site Model is derived, it will be updated and refined as additional data are gathered during the Focused RI and, with input from EPA, will be used to support EPA's preparation of the baseline risk assessment.

4.1 The Tailings Impoundment

The tailings impoundment can be visualized as a semi-rectangular shaped, geometrically closed basin, with a man-made main embankment on the west edge and perimeter containment dike system along the south and east sides and a sloping natural surface forming the fourth side. *See* Figure 2.0. The main embankment is located along the western dimension of the impoundment. The tailings impoundment structure isolates and contains variably thick, slimy and sandy mill tailings materials. The impoundment is covered with high clay-content, vegetated soil. The tailings have been deposited on thick layers of native, clay-rich soils. Metals present in the tailings material are the primary potential sources of contaminants at the Site. Geochemical data collected during air monitoring conducted in 1984 by E&E for the EPA characterize the tailings as metal sulfide materials. Such compounds, when found in a neutral pH environment such as exists at the Site, are not easily degraded and are particularly stable. As appropriate, modeling techniques may be used during the FS to evaluate the long-term chemical stability of the materials within the impoundment to support final closure of the Site

The clay-rich soils underlying the impoundment formed the original ground surface topsoil materials that existed at the Site prior to the deposition of the tailings. Permeability data reported by Weston indicate that these underlying clay soils have a low hydraulic conductivity, ranging from 0.001 to 5 ft/year. The clay soil cover materials have permeabilities ranging from 0.031 to 0.072 ft/year (Weston, Table 1, page 7, 1999). A diversion ditch system prevents most storm water from entering the impoundment from off-Site sources, as explained more fully below in Section 4.3.

4.2 Other Tailings Materials

Some tailings materials are present outside and to the south of the current impoundment area. During historic operations of the tailings pond, tailings materials of varying thickness accumulated in three naturally low areas leading to the property that eventually became the impoundment.

In the 1970s, when PCV constructed the perimeter dike and diversion ditch along the south perimeter of the impoundment, tailings present in the three low areas were left in place, outside of the present impoundment. Starting in 1983, United Park covered most of these tailings outside of the current impoundment with the same kind of low permeability, vegetated soil cover United Park also placed over the tailings impoundment. Other types of clean fill material, imported from construction work in Park City, was also used to cover the tailings outside of the impoundment. Because these areas were naturally low, the cover in some of these areas is as thick as 10 to 15 feet. Data from the Weston Report indicates that the same underlying, natural soil conditions exist in these locations as beneath the impoundment.

As explained more fully in Section 5.2, below, United Park will estimate the areal and vertical extent of tailings outside of the impoundment. United Park will also study any adverse impacts the tailings materials may have on surface water in the south diversion ditch. With this information, United Park will evaluate the necessity and the feasibility of excavating these off-impoundment tailings and cover materials and placing the same within the impoundment.

4.3 Surface Water

As noted above, surface water is present in four areas in and around the Site. First, Silver Creek flows along the west edge of the Property, over 500 feet from the main embankment. Second, the drainage ditch systems surrounding the tailings impoundment seasonally collect runoff water flowing towards the impoundment and redirect it around the impoundment and towards Silver Creek. Surface water is also present in the form of ponded water in the northwestern area of the impoundment, having ponded on the surface of the clay soil cover. Finally, very small quantities of surface water are present in the form of seeps located near the base of and near the north abutment of the main embankment.

Ponded water on the surface of the soil cover within the impoundment is derived solely from precipitation falling directly on the impoundment. The amount of

water ponding on the surface of the impoundment varies from year to year. Ponded water follows several pathways or possible fates from the impoundment. Nearly all water loss can be attributed to evaporation and plant use within the pond. A small amount of the ponded water likely percolates through the underlying, low permeability soil cover and into the tailings. The ponded water never leaves the impoundment as a discrete surface flow. It is highly unlikely that surface water would ever fill the basin within the impoundment. Even if large amounts of water ended up on the impoundment for some unlikely reason, studies indicate that the area within the impoundment has sufficient capacity or "freeboard" to contain the 100-year/24-hour precipitation event, thus eliminating the possibility of overtopping (Dames & Moore, 1980 at 12, Alliance Engineering 1999). But even if the tailings impoundment were to ever overfill with water for some unlikely reason, excess water would flow to the lower, east end of the containment dike system, near the east end or point of origin of the south diversion ditch system. Water from an overtopping event would not flow west across or cut into the main embankment.

The north diversion ditch (which flows west to east) discharges into an area east of the impoundment where water may ultimately enter the south diversion ditch system (which flows east to west) towards Silver Creek. Water from the south diversion ditch flows west and collects in a pond located in a historic excavation where materials were removed for use in the construction of the main embankment during 1973-74. The grade of the south or main diversion ditch is low, and therefore, the velocity of water flowing through the ditch does not carry enough energy to erode the channel. Where higher water velocities do occur in the ditch, rip-rap or vegetation is present to minimize any potentially-adverse impacts to the ditch banks due to erosion. The ditch is well-vegetated by common wetland species such as cattails and willows. This vegetation helps to buffer the banks from erosion and also serves to decrease water velocity, thereby eliminating potential erosion problems.

In the spring, surface water in the south diversion ditch has enough flow to sustain a discrete flow to Silver Creek. In the later summer when water flows are the

lowest, the water flowing from the diversion ditch is difficult to trace to Silver Creek as a discrete flow. Some of the diversion ditch water evaporates and is taken up by plants. As noted above, the south diversion ditch never completely dries out and it does not appear that diversion ditch water significantly infiltrates into the ground. If the diversion ditch is acting as a hydraulic sink, it may be intercepting groundwater.

The seep at the base of the main embankment generates a very small flow of water, in the range of gallons per day. Due to the low volume of water, a discrete flow is not and cannot be maintained long enough to reach Silver Creek, over 500 feet away. The existence of the seep is consistent with the design of the tailings impoundment. As noted above, the main embankment was designed to allow seepage as necessary in order to alleviate the build-up of hydraulic pressure from within the impoundment. No data indicate or even remotely suggest that a potential soil piping failure may occur at the point of the seep. The physical characteristics of the seep have remained constant since it was first observed at the Site. Seepage water has not been observed to carry sediment and has been occurring at a very low flow rate that has not increased over time.

While seasonal runoff water from the south diversion ditch reaches Silver Creek during the spring and summer months of the year, United Park believes the data establish that water quality in the south diversion ditch has been steadily improving for the past decade. This has been clearly evident after United Park completely covered the tailings inside of the impoundment and re-graded and covered the banks of the south diversion ditch in 1992. This trend toward improved water quality not only reflects United Park's remedial efforts taken at the Site, but also the change in Site conditions from the more dynamic status as an operating tailings pond (receiving hundreds of thousands of gallons of water and thousands of tons of tailings per week) to a large parcel of land that only receives water from snow melt or rain. However, additional characterization of the water and wetlands in this ditch will be performed to address the long-term ability of the wetlands to continue to improve water quality. The scope of the additional characterization is discussed in Section 5.4.

In addition, recent water quality data provides sufficient parameters upon which United Park has evaluated the impacts of the tailing impoundment on Silver Creek water chemistry. United Park has used existing data in a simple mixing calculation to: (1) determine if discharges from the diversion ditch are impacting Silver Creek and (2) if such impacts are occurring, then determine what further detailed modeling and data requirements would be required to examine the impacts to Silver Creek. The mixing "model" is described in detail in Appendix C. This model has essentially calculated waste loads to Silver Creek from the diversion ditch and embankment seeps under four different scenarios. First, it is assumed that Silver Creek meets ambient water quality ("AWQ") standard for zinc. Modeling is then completed on the diversion ditch and the main embankment seep to determine what the metals loading in these two sources of water would have to be in order to assure that Silver Creek does not exceed standards. Second, modeling is done using actual values for both the seep and diversion ditch. The actual metal concentrations in Silver Creek are calculated in this scenario. The third scenario makes the assumption that Silver Creek contains no zinc or 0.00 mg/l. The fourth scenario assumes that most of the loading from tailing impoundment is eliminated.

Using available data, the calculations establish that any metal load contributions made by the south diversion ditch and, potentially, by the main embankment seep, do not adversely impact Silver Creek, even when Silver Creek is presumed to contain no metals. Stated differently, the load contribution to Silver Creek from the south diversion ditch (and to the extent relevant, from the main embankment seep) is not significant enough to cause an effect on the quality of water in Silver Creek. The contribution of the low metal concentrations from the Site do not cause Silver Creek to exceed surface water quality standards for the State of Utah, even if it is presumed that Silver Creek contains no metal. In summary, by utilizing waste-load calculations similar to those used on an NPDES permitted discharge, it can be shown that the south diversion ditch and main embankment seep do not have enough flow or metal loading to cause Silver Creek to exceed water quality standards. United Park recognizes that water quality in

Silver Creek does not meet the standards for a variety of uses. However, United Park believes that zinc concentrations observed in Silver Creek are not a result of waters flowing from the south diversion ditch and the main embankment seep from the Site. Through the RI/FS process, this modeling will be updated with newly acquired data and reevaluated, as appropriate, to assure that it is representative of existing conditions.

4.4 Groundwater

Recent and historic data establishes that there are at least four shallow groundwater systems associated with the Richardson Flat area :

- The impounded tailings
- Relatively shallow alluvium with possibly a perched water table
- Deeper alluvium composed of confined sand and gravel aquifer(s)
- The underlying and adjacent fractured Keetley volcanic rocks (Weston 1999, at 2).

Tailings were initially placed on native, clay-rich topsoil that was the original ground surface prior to the deposition of tailings. (Weston, 1999; *see* Figure 3.0). Water is also present in the tailings from the tailings slurry transport system and the limited percolation of storm water and snowmelt through the existing soil cover. The underlying low permeability clayey soils effectively create a barrier to the vertical movement of groundwater from the tailings impoundment to the underlying shallow alluvial or bedrock aquifers. (Weston 1999, at 6).

Within the immediate area of the impoundment, groundwater flow in the bedrock aquifer monitoring well (MW-1) is reported as quite low. (Dames & Moore, 1973 at 4). Based on limited but useful data, the groundwater flow in the deeper volcanic bedrock aquifer does not appear to be significant, either. Weston reported (*see* Appendix A, page 3) that a test well located approximately one mile northwest of the Site was completed to a depth of 1,000 feet into the volcanic bedrock aquifer. The well produced

insignificant water for use as municipal water supply. Transmissivities ranged from 30 to 50 ft^2 /day for this well. (Weston, 1999, at 3).

4.5 Identification of Potential Contaminant Migration Pathways

Based on data collected to date, Respondents have identified three potential contaminant migration pathways. First, releases to the air as the result of wind-blown dispersion of tailings materials occurred in the past. This pathway has been eliminated because the tailings within the impoundment are covered with a soil and vegetative cover. Existing data suggests that the high clay-content soil cover is relatively impermeable, is stable, and is suitable to prevent direct contact with, and wind dispersion of, the underlying tailings materials. United Park proposes to conduct additional field work to confirm the thickness and effectiveness of the soil cover in order to determine whether additional remedial measures are needed to achieve final site closure, as described in more detail in section 5.2, below.

Second, Respondents understand that EPA has raised concern over potential releases to groundwater as the result of leaching metals from the tailings and hydraulic connectivity between saturated tailings and Site groundwater systems. Tailings materials and the substances leached therefrom would be the primary source of potential contamination to the groundwater. The potential exposure route for terrestrial or aquatic biota would be ingestion of surface water that has been affected by contaminated groundwater.

This second potential contaminant migration pathway is inconsistent with existing, natural Site conditions. Low-permeability, native clay soil is continuous beneath the impoundment, as illustrated in Figure 4.0. Mineralogical data on the underlying soils indicate that the clay layer is comprised of a mixed clay mineral (i.e., mixed mica and illite or smectite). Based on recent studies by Weston, Respondents believe that existing data establishes that it is unlikely that leached metals would migrate through the significant clay soil layer and into the underlying shallow aquifer because of the low permeability of the

soil layers underlying the tailings. The tailings are derived from mineralized bodies that are hosted in carbonate or carbonate-rich rocks. These materials have a high buffering ability to counter any acid that might form as the result of sulfide degradation. Finally, there are no drinking water wells completed in the shallow or deep alluvial aquifers on or near the Site. Additional efforts will be undertaken as part of the Focused RI to further confirm this as discussed in Section 5.5 below.

The third potential contaminant migration pathway consists of releases to surface water as the result of leaching of metals from the tailings materials. As with groundwater, tailings materials are the primary potential source of contamination of surface water. With the possible exception of the bottom of portions of the south diversion ditch and the small amount of water discharging from the seep at the base of the main embankment, surface water does not come into direct contact with the tailings materials. While a potential contamination pathway to surface water exists in portions of the south diversion ditch and in the seep at the base of the main embankment, existing data also suggests that neither pathway is having any adverse impact on the water quality or the general water chemistry, including zinc concentrations, in Silver Creek. Nevertheless, United Park will conduct additional surface water characterization work to further evaluate the condition of the southern diversion ditch and to evaluate any impacts caused or potentially caused through the surface water contaminant migration pathway, as described in more detail in section 5.4 below.

5.0 SUPPLEMENTAL REMEDIAL INVESTIGATION WORK

As summarized in Section 3.0 above, extensive investigation work has already been completed at the Site. Moreover, over the years, United Park and others have taken actions to support final closure of the Site, including the installation of a soil cover over the tailings, drainage ditches, and a security fence. In order to evaluate the need for any further remedial measures to support final Site closure and to assure that the existing remedies in place are adequate and have longevity, United Park proposes conducting the

following remedial investigation work. This Section describes and discusses the rationale and scope of the proposed work, including a description of applicable data quality objectives.

5.1 Tailings Cover Investigation

Since 1983, United Park has been placing soils over the impounded tailings in an effort to control wind-blown dust from exposed tailings. The tailings are now entirely covered with a vegetated, clay soil cover. Additional studies on the tailings cover will gather data to support evaluation of the following: (i) the minimization of surface water infiltration into the tailings embankment; and (ii) the adequacy of existing cover to support final site closure, consistent with contemplated future redevelopment of the Site and the adjacent Property. To that end, Respondent will gather sufficient supplemental data in order to meet the following objectives:

- Confirm the lateral and vertical extent of the existing tailings cover;
- Determine the technical specifications for any additional cover, if needed;
- Determine the specifications for suitable borrow material;
- Determine revegetation requirements, if needed;
- Determine surface grading requirements to improve drainage, if needed; and
- Evaluate whether or not there are any unacceptable health risks associated with potential exposure to the tailings cover materials.

Respondents will confirm the lateral and vertical extent of the soil cover by using data collected by E&E in 1992 as a baseline and collecting new soil samples on a 500 by 500 foot grid. Following procedures similar to those E&E used in 1992, Respondents will dig shallow excavations either with shovels, hand augers or backhoes, if necessary, until the tailings are exposed. Visual observations of the contact between the cover soils and

tailings will be used to document the depth of the soil cover at each grid point. The tailings materials are sufficiently different in grain size and color from the cover materials to permit use of a visual identification method to differentiate between tailings and the soil cover. The cover soils are characteristically identified as a reddish-brown clay material while the tailings are characterized as a gray silty-sand material. Verification of the visual method will be conducted by collecting samples at ten-percent of the sample points and submitting them for laboratory analysis. The samples will be collected from the cover material at the surface (0 to 1 inch) (such that EPA can assess potential health risks as a result of exposure to such cover materials) and just above the tailings interface (to assess the vertical extent of the tailings cover). The samples will be analyzed for metals noted in the Analytical List for soils shown in Table 5.2. Figure 5.0 shows the sampling grid, and Figure 2 in Appendix B shows the 1992 sample locations. Respondents will undertake additional work, as necessary, if the findings from the proposed work prove to be insufficient to meet the above-mentioned objectives. A Sample and Analysis Plan (SAP) that specifies the sample and analytical methods for this and subsequent work described in Section 5.0 will be submitted to EPA within 60 days of the effective date of the AOC.

Based on the results of the sampling and evaluation of health risks, if any, Respondents will evaluate (i) the need for additional cover material to supplement existing cover (including but not limited to evaluation of soil type, thickness, permeability, and compaction requirements); (ii) vegetation and revegetation requirements; and (iii) surface drainage requirements.

5.2 Off-Impoundment Tailings Investigation

Tailings are present in three naturally low areas south of the present south perimeter containment dike and south diversion ditch. *See* Figures 2.0 and 3.3 Respondents propose to use historical aerial photographs to determine the areal extent of off-impoundment tailings materials. Respondents will also estimate the vertical extent of tailings and cover material using existing historical information and limited borehole data.

Respondents will also study whether or not shallow groundwater is moving through these tailings and is potentially intercepted by the south diversion ditch. At a minimum, United Park will install three (3) borings in the low lying areas in locations shown on Figure 3.3. The borings will be drilled down to the tailings/soil interface. If groundwater is encountered, the borings will be converted to monitoring wells. Data from the borings will be used to determine the thickness of tailings. Additional borings may be installed to better define the lateral and vertical extent of the off-impoundment tailings, if additional information is required. Such additional information may be necessary if it were determined that these tailings are adversely impacting the ground or surface water quality so as to require removal of the tailings. A surface water elevation datum will be installed at the south diversion ditch near RF-4 in the event that the monitoring wells are installed. Groundwater elevations in the monitoring wells would be compared to the surface water elevation measured near RF-4 to better quantify and qualify the interaction between the two systems. Respondents will use this additional data to determine the approximate volume of tailings located south of the impoundment, and whether these tailings are having any potential, adverse impact on the water quality in the south diversion ditch. Respondents will further use this information to determine whether or not the tailings presently located to the south of the impoundment need to be excavated and placed within the impoundment. This will include an estimation of the costs of excavation of the off-impoundment tailings (and associated cover), placement of the same within the impoundment, and installing additional soil cover as needed. Should these studies indicate that the tailings located south of the impoundment must be relocated, Respondents will also evaluate the potential geotechnical impacts excavation may have on the containment dikes along the diversion ditch, as well as the main embankment.

5.3 Wind-Blown Tailings

As previously discussed, prior to United Park's placement of a soil cover over all of the tailings, some of the tailings material may have been blown by the wind to areas near the Site. The areal extent of any wind-blown tailings has not been fully addressed in prior studies. EPA has requested that, as part of the remedial investigation work, Respondents evaluate such wind-blown tailings.

Respodnents will gather sufficient data in order to meet the following objectives:

- Confirm the lateral and vertical extent of the wind-blown tailings; and
- Evaluate whether or not there are any unacceptable health risks associated with potential exposure to the wind-blown tailings.

Respondents will conduct soil sampling at select locations along three sampling transects. Sampling transects, 3,500 feet long, will be established in field with the following criteria:

- One sample transect will be placed perpendicular to the tailings impoundment, approximately 500 feet north of the main embankment.
- Two sample transects will be placed beginning 500 feet south of the county road and a second transect at a 500-foot interval.

The sampling transects locations were determined by utilizing information in E&E's report on air monitoring activities in 1986. Sample transects are placed perpendicular to observed site wind directions. E&E reported that the prevailing wind direction in Park City is from the southeast. Review of the Site wind direction data recorded by E&E confirms that the prevailing wind is from the southeast with lower velocity winds from the northwest occasionally. (E&E, 1986, at 3)

Respondents will collect soil samples at 500-foot intervals along the transects and at depths of 0-1 and 1-6 inches. The samples will be analyzed for the soil parameters listed in Table 5.2. Figure 6.0 shows the proposed location of the transects and sample intervals. Respondents will undertake additional work, as necessary, if the findings from the proposed work prove to be insufficient to meet the above-mentioned objectives. Data collected from wind-blown tailings will be used by EPA to assess potential health risks, if any, associated with exposure to such tailings, and, if necessary, determine whether any remedial action will be required.

5.4 Surface Water

Surface water is present at and near the Site, primarily in the south diversion ditch system and in Silver Creek. As noted above, elevated metal concentrations have been detected in the south diversion ditch, which not only decrease in concentration as the water flows towards Silver Creek but overall have also decreased in concentration during the last several years. Despite significant existing surface water quality data, previous surface water quality investigations did not analyze sufficient parameters to be useful in United Park's metal loading model. Additional surface water data will be collected specifically to determine impacts to Silver Creek from the Site surface waters. Expanded surface water characterization data will be gathered to determine whether the data varies with changing seasons. Respondents will also collect a series of sediment samples from the south diversion ditch to more accurately characterize the potential source of zinc in the south diversion ditch water quality samples. Samples will be collected and analyzed according to procedures that are discussed in detail in the SAP. The sediment samples will be analyzed for metals parameters listed in Table 5.2. Data from the sediment samples will be used to determine the long term fate and transport of metals in the Site wetland areas. Wetlands in the diversion ditch contain similar vegetation and sediments as wetlands present between the main embankment and Silver Creek.

Based on surface water data collected in 1999, presented in Table 3.4, and a review of historic aerial photographs, it appears that the diversion ditch channel bed may be constructed in tailings in the area just upstream and downstream of the RF-4 sample location (*See* Figure 3.3). In order to isolate potential source areas, six sediment samples will be collected at 500-foot intervals between sample locations RF-2 and RF-5. Water quality data presented in Table 3.4 indicates that zinc is the primary metal that is either solubilizing in the sediments or is leaching into the diversion ditch via a groundwater pathway. In addition, the long-term viability of the wetland system to continue to enhance water quality will be evaluated. This will include an evaluation of the existing biological system, identification of metal removal mechanisms, fate and transport of metals in the wetland system, and a discussion of the operation and maintenance of the diversion ditch.

In addition, more precise water flow information is needed for the "mixing model". To gather precise flow information, United Park has recently installed a twelve-inch parshall flume on the south diversion ditch downstream of the pond. The flume will be used to measure flow in the diversion ditch upstream from the location where it enters the wetland area and Silver Creek (location RF-6). Two smaller flumes, nine inches at the throat, were installed at upstream locations on the south diversion ditch (RF-2 and RF-3-2). Flow measurements in Silver Creek will be determined just upstream of sampling station RF-7-2 by using a current meter and standardized measurement methods for open channel flow determinations. Flume installation on Silver Creek proper is difficult due to a variety of issues outside of Respondents' control. Accurate flow information cannot be gathered at the downstream confluence of Silver Creek and the diversion ditch due to dispersed flow through the wetland area. Water flow at RF-8 in Silver Creek will be determined by adding the flow measured at RF-6 and RF-7-2. Figure 3.3 shows the flume locations.

Insufficient data currently exist to determine whether the metals loading modeling that Respondents have developed adequately characterizes conditions throughout a complete year. Future water sampling will be collected to complete the existing database.

Respondents will submit a report to EPA that summarizes data collected from May of 1999 to date. The report will be submitted with the RI report. The surface water monitoring program will be performed to collect water samples on a monthly basis at the following locations: RF-2, RF-3-2, RF-6, RF-7-2 and RF-8 (see Figure 3.3). As shown in Figure 3.3, RF-3 has been replaced with a new location, RF-3-2, to allow for flow measurement from the parshall flume. Surface water samples will be analyzed for the water parameters listed in Table 5.2. After sufficient data have been gathered, Respondents' "mixing model" will be refined using the new information. The modeling will be reevaluated with newly acquired data to assure that it is representative of existing conditions.

While more precise flow rate data from the main embankment seep may be useful, a significant amount of existing vegetation and organic matter, grown during the last ten years or so, would have to be removed before flow data can be obtained. Because Respondents believe that the existing natural conditions are very likely mitigating any dissolved metals present in the water from the seep, Respondents are reluctant to propose disturbing existing conditions at this time, unless the proposed wedge buttress design requires this information. The seep does not generate a significant volume of water. In fact, it is quite difficult to detect flow water; hence the identification as a seep. Water chemistry from this location is quite likely to be of little use other than to identify the potential source of the water. Nevertheless, Respondents will collect a sample from the main embankment seep area in order to better characterize water quality and concentrations of dissolved metals. The sample will be analyzed for the water parameters listed in Table 5.2. If additional data regarding the seep is necessary in connection with the design of the proposed wedge buttress, Respondents will collect data for that purpose.

5.5 Groundwater

The hydrogeologic conceptual model prepared by Weston will be used as the basis of further work on refining the understanding of groundwater conditions at the Site. As part of its study, Weston installed 11 new piezometers. Groundwater elevation data is

currently collected on a monthly basis to determine whether seasonal groundwater fluctuations exist. This sampling will occur through another runoff cycle or until the end of the last quarter of 2000. The data from these measurements will help determine the relationship between the shallow aquifers, the tailings impoundment and Silver Creek alluvial groundwater. A report will be drafted upon completion of the data collection process that addresses any changes in the groundwater levels.

As noted by EPA in its informal review of the Weston report, additional information is required to refine the Site's water balance. Monthly water levels will be collected from the piezometers installed by Weston in and around the impoundment. The groundwater level data will be collected in conjunction with the surface water monitoring. Groundwater and surface water elevation data will be collected at paired locations such as RT-5 and the south diversion ditch, at RT-7, and at Silver Creek. The data will be used to quantify the surface water-groundwater interaction. The hydrogeologic data coupled with existing and new groundwater chemistry will be used to evaluate the potential for groundwater impacts at the Site.

Shallow groundwater in the Silver Creek floodplain both above and below the tailings impoundment will be sampled and evaluated to determine the impact, if any, of the tailings from the Site on off-site shallow groundwater or surface water. A monitoring well will be installed downgradient of the Site in the Silver Creek alluvium. RT-7 will be used as the upgradient Silver Creek alluvial well. The data, along with all existing water quality data, will be used to better define and model groundwater quality in the Silver Creek alluvium.

As previously discussed in Section 5.2, Respondents will install three borings into the tailings areas located south of the diversion ditch to evaluate the potential for these tailings to impact groundwater or surface water in the south diversion ditch. The borings will be drilled down through the tailings and terminate at the tailings/soil interface. The borings will be converted to monitoring wells if groundwater is encountered. Figure 3.3 shows the locations of the proposed borings.

Respondents will also evaluate the potential impacts to current users of groundwater near the Site. Respondents will conduct a survey of private wells within a one-mile radius of the Site. Respondents will locate and map groundwater elevations of all private wells within a one-mile radius of the Site. If the groundwater elevation data demonstrate that the wells are downgradient and connected to Site aquifers, then the wells will be sampled according to procedures outlined in the SAP and tested to assess whether potential groundwater impacts are occurring as a result of Site conditions.
Finally, groundwater monitoring well RT-1 will be abandoned because it was completed both in the shallow confined and unconfined aquifers. Based on the well construction, cross flow between the two aquifers may be occurring. According to state well construction regulations, such construction is not allowed without prior approval. Respondents will prepare a closure plan for the EPA RT-1 monitoring well, proposing that the well be grouted with a bentonite seal to within five feet of the ground surface and that the casing removed to below grade.

5.6 Main Embankment Investigation

The main embankment is the permanent enclosure device for the tailings materials. The stability and integrity of the main embankment have been examined two separate times by consultants for Noranda (Dames & Moore 1980) and EPA (E&E 1992). Although both groups determined that while the main embankment appeared to be stable in its then-current condition, concerns were raised about two issues:

- The oversteepened downstream slope of the embankment.
- Seepage present at the toe of the main embankment.

Respondents agree that portions of the main embankment are oversteepened and were not constructed in accordance with the recommendations made by Dames & Moore in 1974. As a result, Respondents proposes to design an appropriate wedge buttress to be installed along oversteepened portions of the main embankment. The buttress will

enhance the long-term effectiveness of the final closure remedy for the Site. Respondents will evaluate the condition of the main embankment during the RI/FS phase, and will prepare construction design specifications for the wedge buttress as part of the final remedial design process.

Because several of the groundwater monitoring wells installed by previous operators are currently located in the area where the wedge buttress would likely be constructed, United Park anticipates that it will be necessary to close these wells. United Park will prepare a well abandonment plan for EPA approval. The wells will be grouted with a bentonite seal to within five feet of the ground surface and the casing removed to below grade. Data from the seep may also need to be gathered in order to develop an appropriate wedge buttress design.

In addition, the long-term chemical stability of the tailings will be evaluated. Samples of the tailings materials will be collected at three (3) locations on the impoundment as shown on Figure 5.0. The samples will be analyzed for metals and long term leaching potential. The SAP provides details on the sample collection and analytical procedures.

5.7 Sampling and Analysis and Health and Safety Plans

As part of the focused RI/FS, Respondents will prepare a sampling and analysis plan ("SAP"), and a site health and safety plan ("HASP"). The SAP provides a mechanism for planning field activities and consists of a field sampling plan (FSP) and a quality assurance project plan (QAPP). The FSP will define the sampling and data-gathering methods that will be used on the project. The QAPP will describe the project objectives and organization, functional activities, and quality assurance and quality control (QA/QC) protocols that will be used to achieve the desired data quality objectives. The HASP will be prepared in conformance with the United Park's health and safety program, and in compliance with OSHA regulations and protocols.

6.0 FOCUSED RISK ASSESSMENT

The EPA will perform the focused risk assessment. Given the current isolated nature of the Site, the knowledge of future land use of the Site, and the past health assessments which have been conducted for the Site, EPA agrees that a "streamlined" risk assessment using a proposed future land use and a "focused" RI/FS (using existing data to the fullest extent possible and evaluating a limited number of alternatives consistent with proposed future land use) is appropriate.

7.0 TREATABILITY STUDIES

Respondents will develop and evaluate potential additional remedial alternatives to support a final closure of the Site that will be protective of human health and the environment, and consistent with the contemplated future land use of the Site. At this time, such additional remedial measures would not involve treatment of hazardous wastes or substances. Consequently, it is unlikely that treatability studies would need to be performed as part of the evaluation and selection of final additional remedial measures to support final closure of the Site. However, if new information comes to light as a result of Respondents' focused RI/FS efforts, or if circumstances change, then Respondents will evaluate the need for and conduct, as necessary, treatability tests in accordance with the NCP and EPA's Model the Statement of Work, and as approved by EPA.

8.0 FURTHER REMEDIAL ACTION

Based on the data collected from and the remedial measures that have already been implemented at the Site to date, and in consideration of remedial measures implemented at similar tailings impoundment sites throughout Utah and other Rocky Mountain states, Respondents believe that final Site closure can be achieved without the implementation of further remedial measures. However, Respondents recognize that EPA and UDEQ have concerns about Site conditions that the agencies believe must be

addressed through additional Site characterization and possibly through the implementation of additional remedial measures. Therefore, Respondents agree to further investigate the nature and extent of contamination at the Site to supplement the investigation efforts performed at the Site to date and confirm that the measures implemented at the Site to date are adequate to support final closure of the Site. If necessary, based on the findings of these efforts, Respondents will also develop and evaluate potential additional remedial alternatives to support a final closure of the Site that is protective of human health and the environment, and consistent with contemplated future land use of the Site. Respondents propose to use the data derived from the Focused RI/FS (together with a focused risk assessment to be performed by EPA) to determine whether any further remedial measures are needed to support final Site closure.

If and to the extent further remedial measures are required at all, Respondents believe that any appropriate final remedy for the Site should incorporate, to the maximum extent practicable, all existing elements of Site closure, and where necessary and appropriate, should adopt additional measures to improve Site closure. Such additional measures, if required, may include:

- Improving and maintaining the main embankment stability and integrity
- Improving and maintaining the soil cover
- Improving and maintaining the surface drainage
- Improving and maintaining the diversion ditches
- Excavating tailings located outside of the impoundment, placing the same within the impoundment, and placement of additional cover
- Establishing appropriate institutional controls to prevent unacceptable exposure risks

If necessary, as part of the FS, Respondents will develop appropriate remedial action objectives, and develop and evaluate potential additional remedial

alternatives, to support a final closure of the Site that is protective of human health and the environment. Respondents will begin to develop and evaluate a range of appropriate further remedial alternatives to support final Site closure, concurrent with the RI Site characterization task. Based on EPA's focused risk assessment, Respondents will review, and if necessary and appropriate for the Site: 1) modify the site-specific remedial action objectives; 2) develop general response actions for each medium of interest to satisfy the remedial action objectives; 3) identify areas or volumes of media to which general response actions may apply, taking into account requirements for protectiveness as identified in the remedial action objectives; 4) identify, screen and document technologies, if any, applicable to each general response action to eliminate those that cannot be implemented at the Site; 5) assemble and document further alternative remedial measures; 6) refine the further alternative remedial measures, as necessary; and 7) conduct and document a screening evaluation of each further remedial alternative measure.

Respondents will also conduct a detailed analysis of additional remedial alternatives to support final closure of the Site. These will consist of an analysis against a set of nine evaluation criteria to ensure that the selected additional remedial measures will be protective of human health and the environment; will be in compliance with, or include a waiver of, ARARs; will be cost- effective; will utilized permanent solutions and alternative treatment technologies, or resource recovery technologies, to the maximum extent practicable; and will address the statutory preference for treatment as a principal element (if appropriate). The evaluation criteria include: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state (or support agency) acceptance; and (9) community acceptance. (Note: criteria 8 and 9 are considered after the focused RI/FS report has been released to the general public.) As part of its evaluation of the long-term effectiveness of the final closure remedy for the Site, Respodents will also utilize, as appropriate, modeling

techniques to evaluate the long-term chemical stability of the materials within the tailings impoundment.

It should be noted that long-term, non-residential land uses are being considered for the Site and the Property. While the Property outside the impoundment is already suitable for development, the Property is not currently being used for any productive purpose. The area outside of the actual impoundment may be suitable for development for non-residential, recreational uses. Certain non-residential uses, consistent with the soil cover and any appropriate institutional controls, may be appropriate for the southern area of the tailings impoundment area itself.

9.0 DELIVERABLES

Respondents will prepare an RI/FS Report that will present analytical data collected during the focused remedial investigation and an interpretation of the data in relation to human health and environmental exposures. It will address the following topics:

- Site characteristics
- Site physical characteristics
- Source characteristics
- Nature and extent of contamination
- Contaminant fate and transport
- Streamlined risk evaluation

Respondents will also prepare an appropriate FSP, QAPP and HASP prior to fully implementing the work proposed in this Work Plan.

10.0 SCHEDULE

Respondents will develop a schedule to guide the work proposed in this document using the Critical Path Method (CPM). Negotiations with the EPA over the administrative agreement will determine the initiation date for the focused RI/FS and will define roles and responsibilities for its completion. Should additional work be deemed necessary as a result of the discovery of new information gathered in the performance of the work tasks outlined herein, the deliverable schedule will be adjusted to accommodate work revisions.

11.0 COMMUNITY RELATIONS

Consistent with the requirements of the NCP, EPA and UDEQ, with support from Respondents, will prepare a Community Relations Plan.

TABLES

Table 3.1: Historic Surface Water Data

Table 3.2: Historic Groundwater Data

Table 3.3 Comparison of 1985, 1992 and 1998 Groundwater Data

Table 3.4: 1999 Surface Water Data

Table 5.2: Analytical List

Table 3.1:Richardson Flats Surface Water Results, 1982 to 1987 and 1990 to 1998

All units are in mg/l.

Station N4 - Upstream Silver Creek

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	30-Nov-90	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	5-Nov-86	10-Oct-86	3-Sep-86	10-Aug-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	0.042	0.27	0.012	<.008	0.39	0.038	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005
Mn-T	0.34	0.58	0.6	1.3	0.5	0.79	0.24	0.18	0.14	0.28	0.24	0.3	0.28	0.55	0.25	0.073	0.16	0.2	0.18	0.33	0.033	0.12	0.16	-	0.36	0.17	0.027	-	0.085	0.038	0.1
Pb-T	1.6	7.5	0.035	0.038	26	2.6	<0.01	0.012	0.033	0.02	0.033	0.033	<0.02	0.15	0.37	0.033	0.079	0.05	<0.02	0.18	0.033	0.02	0.05	0.12	0.05	0.05	0.05	-	0.033	0.02	0.07
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-
Zn-T	1.1	1.8	0.28	0.77	2.8	2.8	0.77	0.45	0.65	0.85	1.3	0.68	1.2	0.81	0.94	0.8	0.69	0.85	0.85	-	-	-	-	0.79	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.56	-	-	-	-	-	-	-
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	<0.004	-	<0.004	0.004	<0.004	-	<0.004	0.007	<0.004
TDS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	730	666	628	720	-	1053	638	642	-	615	604	260
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.8	-	-	-	-	-	-	-

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-85	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	31-Jan-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	2	<0.0005	<0.0005	0.9	<0.0005	0.0089	<0.0005	<0.0005	<0.0005	0.0046	<0.0005	0.0008	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	0.0007
Mn-T	0.18	0.27	0.33	0.17	0.1	0.055	0.33	0.083	0.3	0.063	0.1	0.4	0.7	0.37	0.13	0.1	0.67	0.33	0.1	0.28	0.38	0.38	0.33	0.32	0.17	0.38	0.12	0.17	0.17	0.43	0.28
Pb-T	0.03	0.083	0.05	0.12	0.05	0.033	0.05	0.05	0.18	0.067	0.067	0.78	0.067	0.1	0.13	0.05	1.3	0.033	0.05	0.05	0.9	0.02	0.17	0.07	0.05	0.13	0.03	0.03	0.07	0.92	0.35
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cn	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.054	<0.008	<0.004	0.014	<0.004	0.004	0.009	<0.004	<0.004	<0.004	<0.004	0.005	<0.004	<0.004	0.004	<0.004
TDS	648	760	638	583	729	558	648	498	661	552	600	456	1015	684	387	613	586	830	726	496	303	720	659	809	609	538	719	723	554	516	491
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Station N5 - Diversion Ditch

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	30-Nov-90	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	5-Nov-86	10-Oct-86	3-Sep-86	10-Aug-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.013	<0.008	0.008	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn-T	3.4	1.7	1.9	7	7.7	2.1	1.1	1.4	8.7	1.8	8.3	1.7	1.5	61	12	0.083	0.42	0.92	3	3.1	1.3	1.6	1.4	-	1.1	0.78	1.8	0.75	0.045	1.2	0.23
Pb-T	<0.01	<0.01	<0.01	<0.01	0.014	<0.01	<0.01	<0.01	0.05	0.033	0.05	0.05	<0.02	<0.1	<0.02	0.033	0.095	0.02	<0.02	0.067	0.02	0.05	0.067	<0.017	0.033	0.067	0.05	0.05	0.05	0.02	<0.017
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.017	-	-	-	-	-	-	-
Zn-T	0.056	0.49	0.036	0.12	0.076	0.3	0.7	0.62	0.097	0.17	0.41	0.23	1.1	0.65	0.58	0.048	0.28	0.58	0.13	-	-	-	-	1.2	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.76	-	-	-	-	-	-	-
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
TDS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1867	1704	1511	1300	-	1676	1538	1671	1882	1731	1693	1542
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-	-

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-85	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	31-Jan-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn-T	0.84	0.58	0.7	1.2	0.6	1.4	1.6	1.7	2	0.95	0.1	0.57	-	0.23	0.48	0.17	0.17	0.48	0.22	0.53	1.4	-	3.2	0.45	9.5	1.4	6	6.1	3	3.1	0.33
Pb-T	0.02	0.033	0.042	0.067	0.067	0.042	0.02	0.05	0.1	0.05	0.067	0.067	-	0.053	0.033	0.05	0.05	0.05	0.05	0.067	0.05	-	0.07	0.05	0.03	0.05	0.08	0.07	0.08	0.08	0.08
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cn	<0.004	<0.004	<0.004	<0.004	<0.004	0.004	<0.004	<0.004	0.014	<0.004	<0.004	<0.004	-	0.004	<0.004	0.007	0.016	<0.004	0.006	<0.004	<0.004	-	<0.004	0.004	<0.004	<0.004	0.007	0.006	0.019	0.034	<0.004
TDS	687	566	1277	1570	1610	1372	1520	1418	870	1166	581	1717	-	1533	655	1419	1809	1867	1762	1604	1010	-	1343	839	1192	881	1979	2016	1640	1517	638
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Station N6 - Downstream Silver Creek

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	30-Nov-90	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	5-Nov-86	10-Oct-86	3-Sep-86	10-Aug-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.009	<0.008	0.011	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
Mn-T	0.3	0.45	0.2	0.7	0.35	0.36	0.26	0.21	0.16	0.4	0.21	0.25	0.43	0.56	0.21	0.057	0.12	0.22	0.18	0.32	0.11	0.19	0.24	-	0.3	0.23	0.37	-	0.93	0.057	0.11
Pb-T	<0.01	0.05	<0.01	0.033	0.042	0.016	<0.01	0.01	0.033	0.033	0.033	0.05	0.025	0.22	0.043	0.033	0.097	0.08	<0.02	0.13	0.058	0.12	0.12	0.14	0.27	0.083	0.05	-	0.05	0.02	0.04
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.025	-	-	-	-	-	-	-
Zn-T	0.37	1	0.33	0.56	0.44	0.83	0.78	0.45	0.62	0.85	1.2	0.67	1.6	0.82	0.86	0.77	0.63	0.83	0.82	-	-	-	-	0.75	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.37	-	-	-	-	-	-	-
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.005	<0.004	<0.004	-	0.005	<0.004	<0.004	-	<0.004	<0.004	<0.004
TDS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	723	655	915	750	-	886	636	629		656	569	265
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37	-	-	-	-	-	-	-

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-85	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	31-Jan-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	2.1	<0.005	<0.005	<0.005	<0.005	0.0084	<0.005	<0.005	<0.005	0.0033	-	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	0.0022	<0.005
Mn-T	0.073	0.33	0.35	0.15	0.18	0.23	0.42	0.083	0.21	0.1	0.5	0.35	0.83	0.72	0.12	0.08	0.68	0.42	0.13	0.3	0.32	-	-	-	0.22	0.38	0.2	0.32	0.27	0.48	0.25
Pb-T	<0.02	0.017	0.05	0.05	0.067	0.033	0.03	0.05	0.083	0.067	0.05	0.62	0.067	0.1	0.12	0.07	0.5	0.17	0.05	0.05	0.58	-	-	-	0.05	0.1	0.03	0.05	0.08	1	0.18
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cn	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.008	0.007	0.005	<0.004	<0.004	-	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
TDS	590	772	664	603	709	648	782	470	652	589	1524	481	1122	684	403	595	580	801	689	476	295	-	-	-	598	552	1506	708	596	330	329
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Refer to Figure 3 1 for sample locations

Table 3.2: Richarson Flat Groundwater Results, 1982 to 1987 and 1991 to 1998

All units are in mg/l except pH (standard units).

Station MW-1

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.012	<0.008	0.011	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.067	0.11	0.052	0.47	0.25	0.27	0.14	0.05	0.017	0.092	0.16	0.11
Mn-D	10	8.9	9.1	9.4	8.7	0.65	0.6	0.71	0.65	0.56	0.48	1.1	0.63	33	0.18	0.062	<0.02	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.067	0.035	0.033	0.083	0.08	0.083	0.033	0.05	0.05	0.04	0.05	0.017
Pb-D, TR	<0.01	<0.01	<0.01	<0.01	<0.01	0.016**	<0.01	<0.01	0.033**	0.033**	0.033**	0.033**	<0.02	<0.1	<0.02	0.02	0.57	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	0.038	0.049	0.025	0.12	0.19	0.016	0.027	0.049	0.023	0.01	0.042	0.11	0.041	<.050	0.25	0.018	0.039	0.017	-	-	-	-	-	-	-	-	-	-	-	-
pH	7.2	7.4	6.9	6.9	6.6	7	8	7.3	7.3	7.8	7.1	7.1	6.9	7.7	7.8	7.8	7.6	7.7	-	-	-	-	-	-	-	-	-	-	-	-
TDS	730	1575	2044	1836	1919	1212	1124	1101	1093	1083	1082	1068	596	1732	901	826	750	842	841	919	843	1100	1041	1143	1433	1163	1216	1182	1169	1171
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	0.006	<0.004	<0.004	<0.004	0.008	<0.004	<0.004	0.013	<0.004

Station MW-3

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.012	<0.008	0.008	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	4.8	5.4	5	4.2	4.5	2.9	1.7	4	2.5	0.95	2.8
Mn-D	0.85	0.76	0.75	0.78	0.72	7.7	6	4.6	6.6	4.7	7.3	6.4	5	-	3.8	3.7	2.2	2.1	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	0.02	0.083	0.1	0.053	0.067	0.033	0.067	0.033	0.05	0.033	0.03
Pb-D, TR	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.025**	0.05**	0.05**	0.05**	0.033**	<0.02	-	0.02	0.02	0.062	0.03	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	0.034	0.034	0.035	0.03	0.017	0.017	0.033	0.037	0.054	0.023	0.047	0.11	0.033	-	0.17	0.047	0.065	0.08	-	-	-	-	-	-	-	-	-	-	-	-
pH	7.2	7.4	6.8	6.9	6.7	6.9	8	7.3	7.2	7.9	7.1	7.2	7.1	-	7.7	7.9	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1736	1153	1335	1344	1145	1610	1588	1071	1775	1445	1629	1600	741	-	1479	1711	14321	1681	1639	1490	1374	1500	1458	1622	2046	1755	1539	1516	1438	1338
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	0.005	0.005	0.004	<0.004	<0.004	<0.004	0.007	0.004	0.006

Station MW-4

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	0.009	<0.008	0.014	0.008	0.015	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.8	11	12	11	6.2	0.23	11	9.4	7.5	8.4	9.4	11
Mn-D	7.2	2.2	6.9	2.1	2	3	4.1	5.7	4.3	3.1	3.6	4.8	7.7	-	7.4	4.7	11	7.7	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.067	0.035	0.05	0.083	0.017	0.05	0.067	0.083	0.067	0.067	0.17	0.017
Pb-D, TR	<0.01	0.018**	0.018**	0.046**	0.033**	0.016**	<0.01	<0.01	0.05**	0.05**	0.033**	0.033**	<0.02	-	<0.02	<0.02	0.11	0.05	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	0.066	0.11	0.044	0.064	0.035	0.095	0.066	0.034	0.03	0.058	0.12	0.12	0.47	-	0.28	0.35	0.12	0.05	-	-	-	-	-	-	-	-	-	-	-	-
pH	2.7**	7.4	7.3	6.7	6.6	7	7.3	6.4**	7.2	7.2	7	6.9	6.8	-	3.1**	7.8	5.6**	5**	-	-	-	-	-	-	-	-	-	-	-	-
TDS	819	1783	2150	1848	1543	1879	2448	2591	1896	2260	2168	2175	2690	-	1911	2289	2190	2348	2583	2593	2556	2700	1902	689	2913	2531	2553	2563	1609	2559
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28	0.4	0.41	0.96	0.78	0.004	1.1	0.9	99	0.9	0.96	1

Station MW-5

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	0.009	<0.008	0.014	<0.008	0.015	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	15	16	16	14	1.6	13	12	12	14	15	15
Mn-D	15	9.1	5.8	9.6	9.7	7.3	2	1.9	1.9	0.7	3.2	3	8.5	-	8.4	6.7	15	10	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.15	0.033	0.067	0.12	0.12	0.067	0.083	0.083	0.067	0.067	0.067	0.017
Pb-D, TR	0.015	0.018**	0.031**	0.047**	0.027**	<0.01	<0.01	<0.01	0.033**	<0.02	0.033	0.05	<0.02	-	<0.02	0.05	0.14	0.03	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	1.9	1	0.27	1	1.9	0.64	0.052	<.008	0.057	0.029	0.22	0.21	1.2	-	0.21	0.75	0.084	0.067	-	-	-	-	-	-	-	-	-	-	-	-
pH	4.1**	7.7	7.2	6.7	6.6	7	6.5	6.6	6.9	6.8	6.5	6.3**	6.9	-	6.7	3.9**	5**	5.5**	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1900	2006	1926	2087	1849	1715	1810	1794	1287	1000	1751	1714	1114	-	651	2026	2225	2344	2435	2460	2318	2400	2509	1989	3102	2464	2498	2467	2465	2407
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	0.006	0.005	<0.004	<0.004	0.005	0.006	0.005	0.004	0.006

Station MW-6

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.038	0.008	<0.008	<0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9	1.3	1.7	2	2.5	0.13	1.8	1.9	1.7	2	2.5	2.8
Mn-D	9.4	1.1	1.1	1.2	0.93	0.64	2.2	1.2	1.1	0.92	1.3	1.1	0.49	7	1.3	2.2	1.1	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.033	0.02	0.033	0.05	<.017	0.12	0.067	0.083	0.067	0.083	0.067	0.033
Pb-D, TR	<0.01	<0.01	<0.01	0.027**	<0.01	<0.01	<0.01	<0.01	0.05**	<0.02	0.05**	0.033**	<0.02	<0.1	<0.02	0.033	0.056	<0.02	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	0.061	0.036	0.039	0.019	0.043	0.052	0.029	<0.008	0.013	0.018	0.035	0.07	0.017	<0.05	0.21	0.03	0.017	0.017	-	-	-	-	-	-	-	-	-	-	-	-
pH	7.1	8.2	7.1	7.1	7	7.2	7.4	6.9	7	7.4	7	7	6.6	7.8	6.7	7.4	7.1	7	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1354	1076	1225	687	1150	954	641	685	587	582	529	576	172	1131	651	1516	893	630	974	1226	1135	2460	1130	680	1588	1364	1402	[illegible]	[illegible]	[illegible]
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.022	-	0.18	<0.004	0.088	0.18	[illegible]	[illegible]	[illegible]	[illegible]

** Value exceeds Utah GW Quality Standard

Refer to Plate 1, Weston Report, Appendix A for monitor well locations

Table 3.2: Richardson Flat Groundwater Results (continued)
1982 to 1987 and 1991 to 1998

All units are in mg/l except pH (standard units).

Station MW-1

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Mn	0.073	0.18	0.05	0.13	0.17	0.96	0.45	0.57	0.17	0.083	0.3	0.25	0.35	0.32	0.1	0.35	0.37	0.42	0.9	0.53	0.88	-	-	0.4	0.27	0.53	0.52	0.68	0.57	0.57
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.03	0.025	0.042	0.067	0.05	0.042	0.02	0.067	0.067	0.05	0.033	0.067	0.067	0.05	0.067	0.05	0.05	0.083	0.083	0.05	0.067	-	-	0.05	0.07	0.07	0.03	0.07	0.08	0.07
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1193	1262	1208	1223	1243	1187	1189	1210	1201	1412	1349	1344	1431	1297	1334	1322	1471	1516	1359	1344	1281	-	-	1274	1216	1435	1429	1310	1268	1238
Cn	<0.004	<0.004	0.004	0.004	0.004	0.006	0.008	0.012	<0.004	0.28	0.008	0.01	0.007	0.007	0.006	0.067	0.025	0.016	0.036	0.017	0.024	-	-	0.035	0.03	0.032	0.032	0.021	0.027	0.027

Station MW-3

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.0005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	0.95	0.37	2.1	3.2	3.6	0.63	1.9	3.3	2.1	3.8	3.4	0.42	1.8	0.87	2.6	4.2	3.8	3.4	1.5	1.2	3.8	6.6	5.7	0.9	4.4	3.3	2.6	2.8	3	2.6
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.02	0.017	0.05	0.067	0.05	0.05	0.02	0.067	0.05	0.05	0.067	0.05	0.083	0.067	0.067	0.07	0.067	0.05	0.05	0.067	0.12	0.12	0.1	0.05	0.05	0.07	0.05	0.08	0.08	0.08
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1174	1166	1551	1484	1475	1342	1339	1173	1109	1524	1676	1576	1722	1401	1189	1879	2168	2164	1682	1540	1625	1871	2335	2148	1928	2056	1876	1630	1492	1265
Cn	<0.004	<0.004	<0.004	0.004	0.005	0.004	0.006	0.006	<0.004	0.005	0.004	<0.004	<0.004	<0.004	0.004	0.025	0.022	0.006	0.02	0.01	0.016	0.008	0.004	0.0004	<0.004	0.009	0.016	<0.004	0.013	0.01

Station MW-4

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0007	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
Mn	12	9.3	12	12	7.5	10	7.5	8.6	-	9.7	11	8	10	8.8	8	9.2	8.3	10	9.8	5.9	4.5	-	-	3.2	6.1	7.7	8.3	3.3	2	-
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.05	0.067	0.067	0.13	0.067	0.067	0.02	0.1	-	0.067	0.067	0.1	0.099	0.1	0.1	0.18	0.2	0.4	0.12	0.067	0.13	-	-	0.18	0.1	0.07	0.07	0.12	0.12	-
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	2482	2532	2651	2659	2662	2583	2518	2194	-	2569	2693	2648	2713	2660	2183	2667	2666	2525	2685	2120	1893	-	-	2908	2232	2800	2879	2230	1019	-
Cn	0.12	1.2	1.6	1.2	0.91	2.2	2.9	2.3	-	0.006	2.1	1.4	1.5	1.4	0.73	4.7	1.6	2.1	8.4	1.6	1.7	-	-	1.2	2.5	3.7	2.5	2.2	0.056	-

Station MW-5

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
Mn	14	10	11	13	9.2	15	11	14	8	12	16	13	13	12	9.3	12	8.3	10	9.2	3.2	0.27	-	2	9.3	7.8	10	8.3	2.7	0.27	-
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.05	0.05	0.067	0.067	0.067	0.083	0.02	0.1	0.067	0.13	0.1	0.1	0.23	0.1	0.1	0.1	0.12	0.43	0.17	0.033	0.05	-	0.05	0.17	0.2	0.22	0.15	0.13	0.12	-
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	2188	2220	2635	2667	2401	2436	2333	2546	2349	2697	2840	3039	2746	2781	2324	2836	2506	2261	3844	684	73	-	1450	3032	2315	1197	2101	883	96	-
Cn	<0.004	<0.004	0.006	0.005	0.008	0.011	0.015	0.007	<0.004	0.35	0.008	<0.004	<0.004	0.005	0.005	0.024	0.03	<0.004	0.2	0.01	<0.004	-	<0.004	0.006	0	0.01	0.006	<0.004	<0.004	-

Station MW-6

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0005	<0.005	<0.005	<0.005	<0.005	0.0005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	-	<0.006	<0.006
Mn	2.7	2.8	2.4	2.4	2.4	2.9	3.7	4	4.2	3.1	3.2	3.5	4	3.8	2.8	3.2	2.7	2.9	3.7	3.7	1.7	-	-	2.5	1.7	3.7	3	-	2.1	1.1
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.02	0.033	0.05	0.033	0.033	0.067	<0.020	0.1	0.05	0.05	0.067	0.13	0.13	0.067	0.067	0.07	0.05	0.13	0.083	0.05	0.05	-	-	0.03	0.08	0.15	0.12	-	[illegible]	[illegible]
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1526	1212	1298	1319	1314	1310	1304	1458	1281	1446	1417	1520	1510	1597	1060	1422	1288	1322	2201	1260	644	-	-	1433	936	2073	1141	-	[illegible]	[illegible]
Cn	0.006	0.19	0.25	0.086	0.29	0.98	0.92	0.019	0.92	0.008	0.55	0.31	0.53	0.26	0.22	0.018	0.51	0.52	4.6	0.08	0.032	-	-	0.74	0.028	0.06	[illegible]	-	[illegible]	[illegible]

** Value exceeds Utah GW Quality Standard

Refer to Plate 1, Weston Report, Appendix A for well locations

Table 3.3: Comparison of 1985, 1992, and 1998 Groundwater Data

All units are in mg/l except pH (standard units).

Location: Well RT-1				
Date	September, 1985 [1]		August, 1992 [1]	
Sample ID	RF-GW-1		RF-GW-04	
	Total	Dissolved	Total	Dissolved
Aluminum	1.04	<0.03	15.7	0.191
Antimony	<0.005	<0.005	0.02436	0.0332
Arsenic	<0.005	<0.005	0.0037	0.0036
Barium	0.083	0.076	0.196	0.0939
Beryllium	<0.01	<0.01	0.0013	0.0009
Cadmium	<0.005	<0.005	0.0033	0.0033
Calcium	0.045	0.047	42.2	43.5
Chromium	<0.005	<0.005	0.0105	0.0078
Cobalt	<0.005	<0.005	0.011	0.006
Copper	<0.005	<0.005	0.03	0.171
Iron	0.955	<0.01	14.1	0.151
Lead	<0.03	<0.03	0.627	0.0409
Magnesium	0.909	0.908	12.2	0.0088
Manganese	0.02	0.011	0.162	0.0195
Mercury	<0.0001	<0.0001	0.0002	0.0002
Nickel	<0.03	<0.03	0.013	0.0111
pH	-	-	-	-
Potassium	-	-	1.39	1.36
Selenium	<0.005	<0.005	0.003	0.003
Silver	<0.005	<0.005	0.0024	0.01
Sodium	0.016	0.016	16.1	16.8
TDS	-	-	-	-
Thalluim	<0.1	<0.1	0.0016	0.0016
Tin	-	-	-	-
Vanadium	<0.01	<0.01	0.0357	0.0357
Zinc	<0.005	0.006	0.136	0.0201
Cyanide	<0.01	-	-	-
Sulfate	0.035	-	-	-

Location: Well MW-1						
Date	September, 1985 [1]		August, 1992 [1]		September, 1998 [2]	
Sample ID	RF-GW-3		RF-GW-05		MW-1	
	Total	Dissolved	Total	Dissolved	Total	Dissolved
Aluminum	80.7	<0.03	2.69	0.0496	-	-
Antimony	<0.005	<0.005	0.0243	0.0405	-	-
Arsenic	0.076	<0.005	0.0052	0.0036	-	-
Barium	1.534	0.104	0.0996	0.064	-	-
Beryllium	-	<0.01	0.0034	0.0018	-	-
Cadmium	0.042	<0.005	0.0033	0.0033	-	-
Calcium	0.352	0.254	191	196	-	-
Chromium	0.095	<0.005	0.0078	0.0078	-	-
Cobalt	0.046	0.01	0.0075	0.006	-	-
Copper	1.583	<0.005	0.03	0.02	<0.008	-
Iron	126	0.376	3.18	0.0626	-	-
Lead	0.588	<0.03	0.0156	0.0022	-	<0.01
Magnesium	0.088	0.056	44.2	41.8	-	-
Manganese	2.23	0.924	0.89	0.684	-	10
Mercury	0.0007	<0.0001	0.0002	0.0002	<0.0002	-
Nickel	0.088	<0.03	0.0111	0.0249	-	-
pH	-	-	-	-	7.2	-
Potassium	-	-	6.06	5.53	-	-
Selenium	<0.005	<0.005	0.015	0.015	-	-
Silver	<0.005	<0.005	0.0024	0.01	-	-
Sodium	0.044	0.042	38.1	35.7	-	-
TDS	-	-	-	-		730
Thalluim	<0.1	<0.1	0.0016	0.0016	-	-
Tin	-	-	-	-	-	-
Vanadium	0.262	<0.01	0.0357	0.0357	-	-
Zinc	0.65	<0.005	0.0995	0.0144	-	0.038
Cyanide	<0.1	-	-	-	-	-
Sulfate	0.625	-	-	-	-	-

Location: Well MW-6						
Date	September, 1985 [1]		August, 1992 [1]		September, 1998 [2]	
Sample ID	RF-GW-2		RF-GW-09		MW-6	
	Total	Dissolved	Total	Dissolved	Total	Dissolved
Aluminum	4.92	<0.03	1.63	0.0685	-	-
Antimony	0.063	<0.005	0.0284	0.0359	-	-
Arsenic	0.349	0.009	0.0113	0.0088	-	-
Barium	2.665	0.099	0.0583	0.0462	-	-
Beryllium	<0.01	<0.01	0.0049	0.0037	-	-
Cadmium	0.016	<0.005	0.0033	0.0033	-	-
Calcium	0.314	0.307	318	365	-	-
Chromium	0.042	<0.005	0.0078	0.0078	-	-
Cobalt	0.08	0.067	0.009	0.006	-	-
Copper	0.19	<0.005	0.02	0.02	<0.008	-
Iron	26.3	14.8	3.19	2.17	-	-
Lead	1.08	<0.03	0.031	0.0022	-	<0.01
Magnesium	0.072	0.07	52.5	55	-	-
Manganese	10.4	9.99	6.67	7.42	-	9.4
Mercury	0.0001	<0.0001	0.0002	0.0002	-	<0.0002
Nickel	0.03	<0.03	0.0256	0.0289	-	-
pH	-	-	-	-	7.1	-
Potassium	-	-	3.29	3.01	-	-
Selenium	<0.005	<0.005	0.015	0.015	-	-
Silver	0.017	<0.005	0.0033	0.01	-	-
Sodium	0.054	0.052	0.486	49.7	-	-
TDS	-	-	-	-	-	1354
Thalluim	<0.1	<0.1	0.0016	0.0016	-	-
Tin	-	-	-	-	-	-
Vanadium	0.017	<0.01	0.0357	0.0357	-	-
Zinc	2.79	0.144	0.0925	0.0131	-	0.061
Cyanide	0.2	-	-	-	-	-
Sulfate	0.775	-	-	-	-	-

[1] Data collected by EPA contractor, E&E in 1984 and 1992

[2] Data collected by United Park

UTAH GROUND WATER QUALITY STANDARDS (units mg/l, standards for dissolved metals)

METALS	
Arsenic	0.05
Barium	2.0
Cadmium	0.005
Chromium	0.1
Copper	1.3
Lead	0.015
Mercury	0.002
Selenium	0.05
Silver	0.1
Zinc	5.0

Table 3.4: Richardson Flat Surface Water Sample Data, May 19, 1999 and June 9, 1999

Sample Results Compared to Aquatic Wildlife Criteria

Sample Location	Utah Water Quality Standards		Arsenic[1]	Cadmium	Chromium[1]	Copper	Lead	Mercury	Selenium	Silver	Zinc
RF-6	Aquatic Wildlife	Chronic	0.19	0.004	0.812	0.049	0.026	0.000012	0.005	N/A	0.436
19-May-99	Criteria[2]	Acute	0.36	0.026	0.81	0.085	0.683	0.0024	0.02	0.072	0.481
Diversion Ditch	Lab Results	Dissolved	<0.020	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.15
RF-6-2	Aquatic Wildlife	Chronic	0.19	0.004	0.812	0.049	0.026	0.000012	0.005	N/A	0.436
9-Jun-99	Criteria[2]	Acute	0.36	0.026	6.81	0.085	0.683	0.0024	0.02	0.072	0.481
75' Downstream of RF-6	Lab Results	Dissolved	<0.020	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.02
RF-7	Aquatic Wildlife	Chronic	0.19	0.004	0.686	0.042	0.02	0.000012	0.005	N/A	0.363
19-May-99	Criteria[2]	Acute	0.36	0.02	5.76	0.07	0.526	0.0024	0.02	0.05	0.405
Upstream Silver Creek	Lab Results	Dissolved	<0.020	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.51
RF-7-2	Aquatic Wildlife	Chronic	0.19	0.003	0.552	0.033	0.015	0.000012	0.005	N/A	0.292
9-Jun-99	Criteria[2]	Acute	0.36	0.015	4.63	0.055	0.375	0.0024	0.02	0.032	0.322
Upstream of RF-7	Lab Results	Dissolved	<0.020	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.89
RF-8	Aquatic Wildlife	Chronic	0.19	0.004	0.686	0.041	0.02	0.000012	0.005	N/A	0.366
19-May-99	Criteria[2]	Acute	0.36	0.02	5.76	0.07	0.526	0.0024	0.02	0.05	0.405
Downstream Silver Creek	Lab Results	Dissolved	<0.020	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.49
RF-8	Aquatic Wildlife	Chronic	0.19	0.003	0.572	0.034	0.015	0.000012	0.005	N/A	0.303
9-Jun-99	Criteria[2]	Acute	0.36	0.016	4.8	0.057	0.396	0.0024	0.02	0.032	0.335
Downstream Silver Creek	Lab Results	Dissolved	<0.020	0.003	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.85

[1] Aquatic Wildlife Criteria is based on Trivalent species of arsenic and chromium; the sample result is for all species of arsenic and chromium.

[2] Utah Water Quality Standard for Stream Classification 3A (Aquatic Wildlife Criteria) for Dissolved Metals as related to Hardness

General Water Chemistry

Sample Location	Date	Alkalinity	Calcium	Chloride	Cation/Anion Balance	Carbonate	Bicarbonate	Hardness	pH (LAB)	Potassium	Magnesium	Nitrite/Nitrate	Sodium	Sulfate
RF-1	19-May-99	122	39	15	7.5	<1	122	135.27	7.5	<4	9.2	<0.1	18	20
RF-3	19-May-99	198	56	30	6.1	<1	198	197.48	7.8	<4	14	<0.1	32	23
RF-6	19-May-99	214	153	92	5.9	<1	214	530.29	7.7	<5	36	0.6	54	259
RF-6	9-Jun-99	-	187	-	-	-	-	644.01	-	<4	43	0.16	44	-
RF-7	19-May-99	140	122	220	<1	<1	140	432.3	8.2	<4	31	0.4	110	200
RF-7-2	9-Jun-99	-	98	-	-	-	-	331.18	-	<4	21	0.24	80	-
RF-8	19-May-99	142	126	222	<1	<1	142	446.4	8	<4	32	0.6	110	192
RF-8	9-Jun-99	-	102	-	-	-	-	345.29	-	<4	22	0.27	76	-
RF-9	19-May-99	96	82	300	7	4	92	287.11	8.4	6.2	20	0.2	177	50
RF-10	9-Jun-99	-	60	-	-	-	-	219.85	-	<4	17	0.1	47	-

-	-	Flow (cfs)
RF-1	9-Jun-99	0.39
RF-2	9-Jun-99	0.39
RF-6	9-Jun-99	0.32
RF-7-2	9-Jun-99	3.17

Sample Results Compared to Domestic Use Criteria

Sample Location	Date	Type	Arsenic WQS*: 0.05	Barium WQS: 1	Cadmium WQS: 0.01	Chromium WQS: 0.05	Copper WQS: 1	Lead WQS: 0.05	Mercury WQS: 0.002	Selenium WQS: 0.01	Silver WQS: 0.05	Zinc WQS**
RF-1	19-May-99	Total	<0.020	0.16	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.027
		Dissolved	<0.020	0.15	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.047
RF-2	19-May-99	Total	<0.020	0.18	<0.001	<0.020	<0.010	0.005	<0.0005	<0.005	<0.010	0.038
		Dissolved	<0.020	0.17	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.042
RF-3	19-May-99	Total	<0.020	0.17	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.017
		Dissolved	<0.020	0.16	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.024
RF-4	19-May-99	Total	<0.020	0.09	0.002	<0.020	0.015	<0.005	<0.0005	<0.005	<0.010	1.1
		Dissolved	<0.020	0.14	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.95
RF-5	19-May-99	Total	<0.020	0.14	<0.001	<0.020	0.011	<0.005	<0.0005	<0.005	<0.010	0.9
		Dissolved	<0.020	0.14	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.85
RF-6	19-May-99	Total	<0.020	0.13	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.45
		Dissolved	<0.020	0.13	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.15
RF-6	9-Jun-99	Total	<0.020	0.17	0.003	<0.020	<0.010	0.028	<0.0005	<0.005	<0.010	0.85
		Dissolved	<0.020	0.18	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.85
RF-7	19-May-99	Total	<0.020	0.11	0.003	<0.020	0.013	0.074	<0.0005	<0.005	<0.010	0.82
		Dissolved	<0.020	0.1	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.51
RF-7-2	9-Jun-99	Total	<0.020	0.21	0.004	<0.020	<0.010	0.078	<0.0005	<0.005	<0.010	1.5
		Dissolved	<0.020	0.19	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.89
RF-8	19-May-99	Total	0.031	0.13	0.009	<0.020	0.038	0.34	<0.0005	<0.005	<0.010	1.7
		Dissolved	<0.020	0.1	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.49
RF-8	9-Jun-99	Total	<0.020	0.17	0.003	<0.020	<0.010	0.028	<0.0005	<0.005	<0.010	0.85
		Dissolved	<0.020	0.18	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.85
RF-9	19-May-99	Total	<0.020	0.14	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.011
		Dissolved	<0.020	0.13	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.029
RF-10	9-Jun-99	Total	0.021	0.26	<0.001	<0.020	<0.010	0.023	<0.0005	<0.005	<0.010	0.069
		Dissolved	<0.020	0.25	<0.001	<0.020	<0.010	0.009	<0.0005	<0.005	<0.010	0.009

*Utah Water Quality Standard for Stream Classification 1C (Domestic Use Criteria) for Dissolved Metals.

** There is no WQS for Stream Classification 1C for Zinc.

All units are in mg/L except Flow (cfs) and pH (standard units).

Table 5.2: Summary of Analytical Parameters for Water and Soil Samples

WATER SAMPLES

Analytical Parameters	Method	Reference
Metals		
Ag, As, Cd, Fe Cu, Pb, Sb, Se, Zn	SW-846 6010	EPA SW-846*
Hg	EPA 245.1 /1631	EPA Methods**
Ions		
Ca, K, Mg, Na	SW-846 6010	EPA SW-846*
Cl	EPA 325.2	EPA Methods**
Cation/Anion Balance	-	-
CO_3, HCO_3	EPA 310.1	EPA Methods**
NO_2, NO_3	EPA 353.2	EPA Methods**
SO_4	SW-846 9036	EPA SW-846*
Other Parameters		
Alkalinity	EPA 310.1	EPA Methods**
pH (lab)	EPA 150.1	EPA Methods**
pH (field)	Digital pH Meter	RMC SOP
conductivity	Digital Meter	RMC SOP
Hardness	-	-
TSS	EPA 160.2	EPA Methods**
TDS	EPA 160.1	EPA Methods**

SOIL SAMPLES

Analytical Parameters	Method	Reference
Metals (Soil)		
Ag, As, Cd, Fe, Cu, Pb, Sb, Se, Zn	SW-846 6010	EPA SW-846*
Hg	SW-846 7471	EPA SW-846*
Metals (Sedimentary)		
Ag, As, Cd, Fe Cu, Pb, Sb, Se, Zn	XRF	-
Hg	SW-846 74.71	EPA SW-846*
Other Parameters		
Cation Exchange Capacity	SW-846 9081	EPA SW-846*
pH (lab)	SW-846 9045C	EPA SW-846*

* EPA SW-846 Test Methods for Evaluating Solid Waste, December, 1996
** EPA Methods for Chemical Analysis of Water and Waste, March, 1983

FIGURES

Figure 1.0: Site Location Map

Figure 2.0: Site Map

Figure 2.1: Site Geology

Figure 3.1: Sample Locations

Figure 3.2: Water Quality Data-Zinc (Surface)

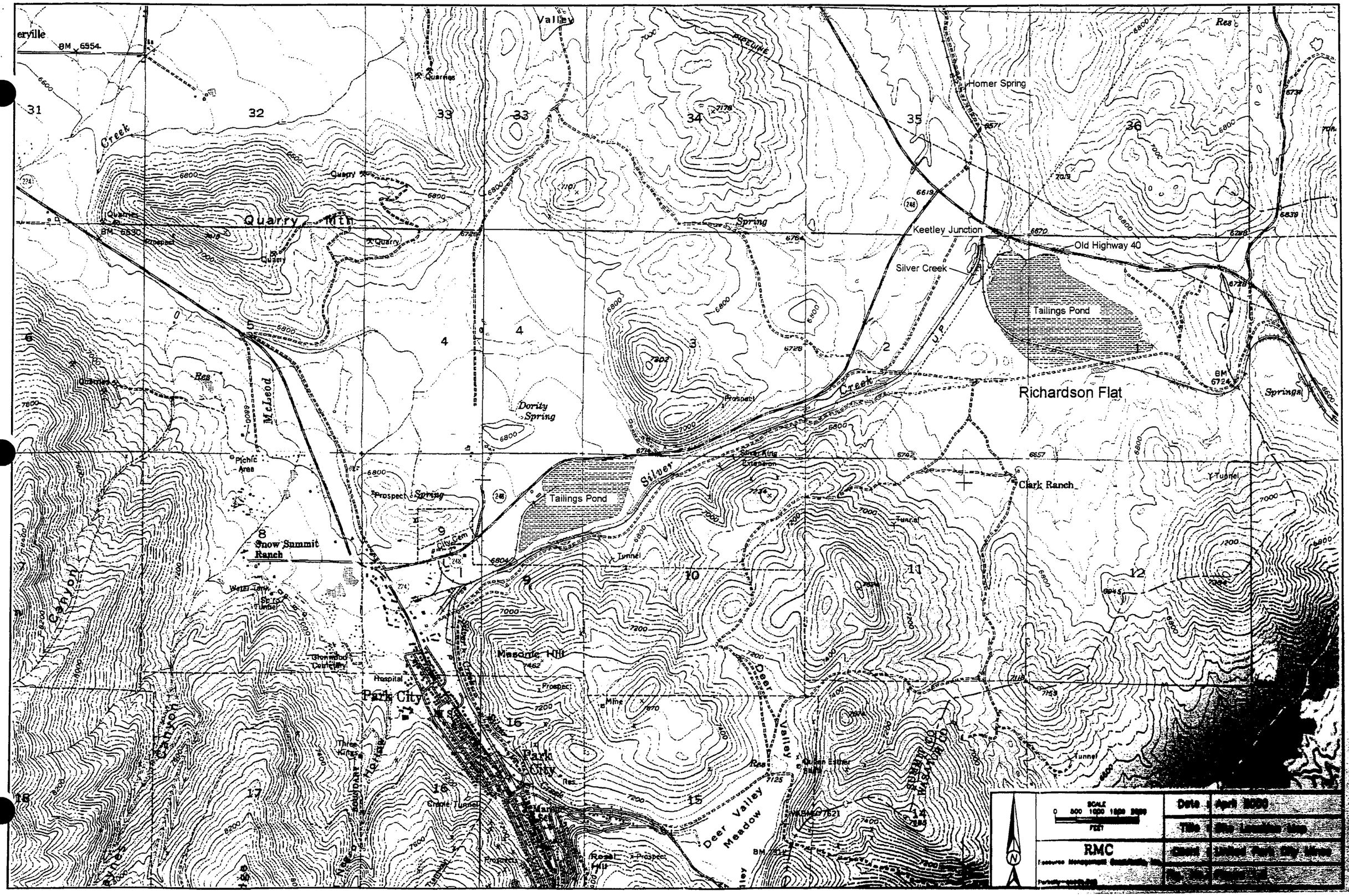
Figure 3.2a Water Quality Data-Zinc (Surface) Line Graph

Figure 3.3: Sample Locations

Figure 4.0: Preliminary Site Model

Figure 5.0: Soil Sediment and Tailings Sample Locations

Figure 6.0: Off-Site Soil Sample Locations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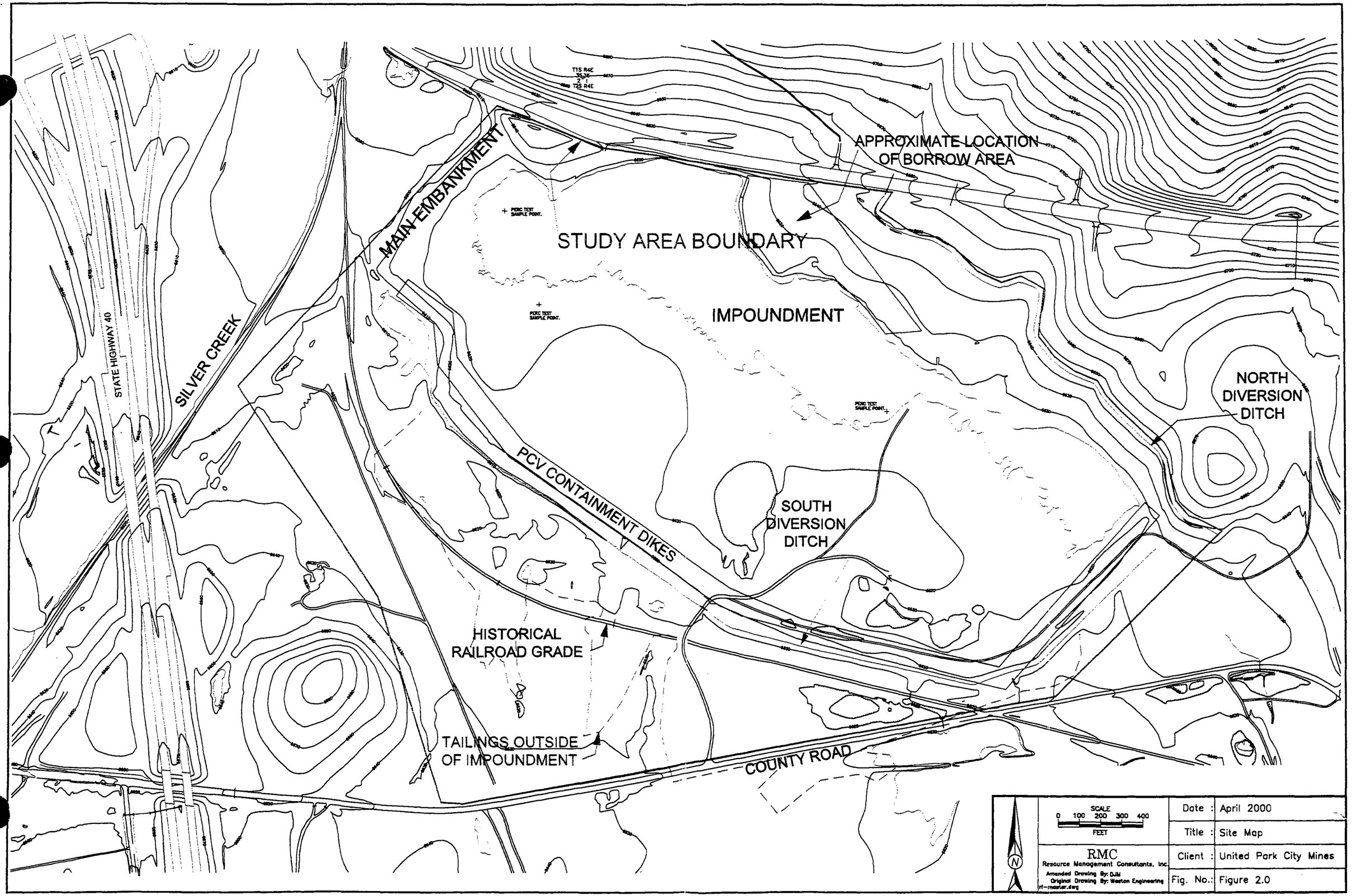
Homer Spring
Keetley Junction
Old Highway 40
Silver Creek
Tailings Pond
Richardson Flat
Dority Spring
Silver Creek
Tailings Pond
Clark Ranch
Snow Summit Ranch
Masonic Hill
Park City
Deer Valley Meadow
Picnic Area
Hospital
Cemetery
Water Tank
Tunnel
Mine
Prospect
Spring
Quarries
Quarry
Res
Springs
McLeod
Canyon
Valley
Creek
Silver
Deer
Hotel
Summit Co
Wasatch Co
Boundary
Queen Esther Shaft
Silver King Extension
Prospect Hill
Masonic Hill
Park City
Date : April 2020
Title : Site Location Map
Client : United Park City Mines
RMC
Resource Management Consultants, Inc.
SCALE
0 500 1000 1500 2000
FEET
N


T1S R4E
35,36
2
T2S R4E
APPROXIMATE LOCATION
OF BORROW AREA
MAIN EMBANKMENT
STUDY AREA BOUNDARY
PERC TEST
SAMPLE POINT.
IMPOUNDMENT
STATE HIGHWAY 40
SILVER CREEK
NORTH
DIVERSION
DITCH
PCV CONTAINMENT DIKES
SOUTH
DIVERSION
DITCH
HISTORICAL
RAILROAD GRADE
TAILINGS OUTSIDE
OF IMPOUNDMENT
COUNTY ROAD
N
SCALE
0 100 200 300 400
FEET
RMC
Resource Management Consultants, Inc.
Amended Drawing By: DJM
Original Drawing By: Weston Engineering
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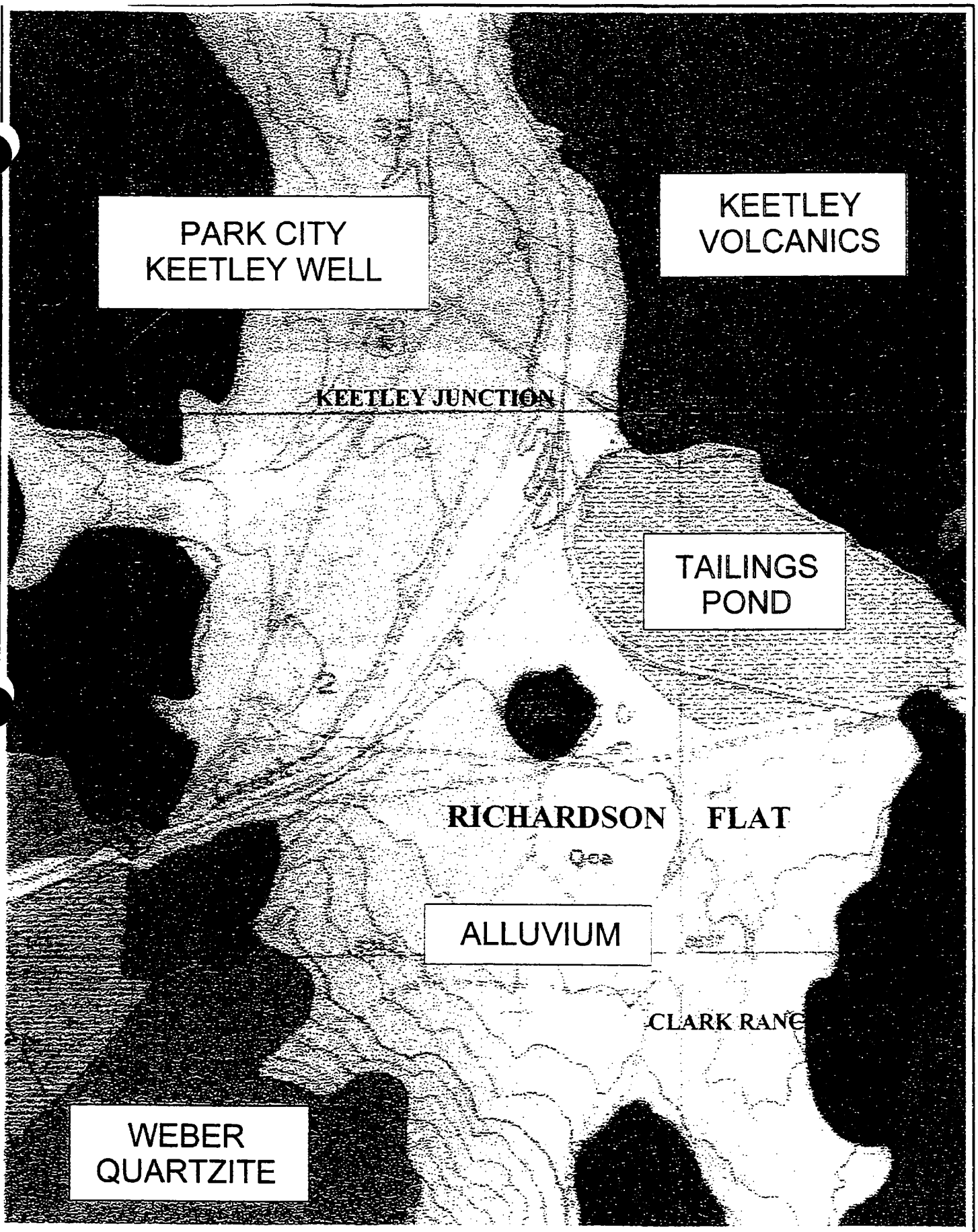
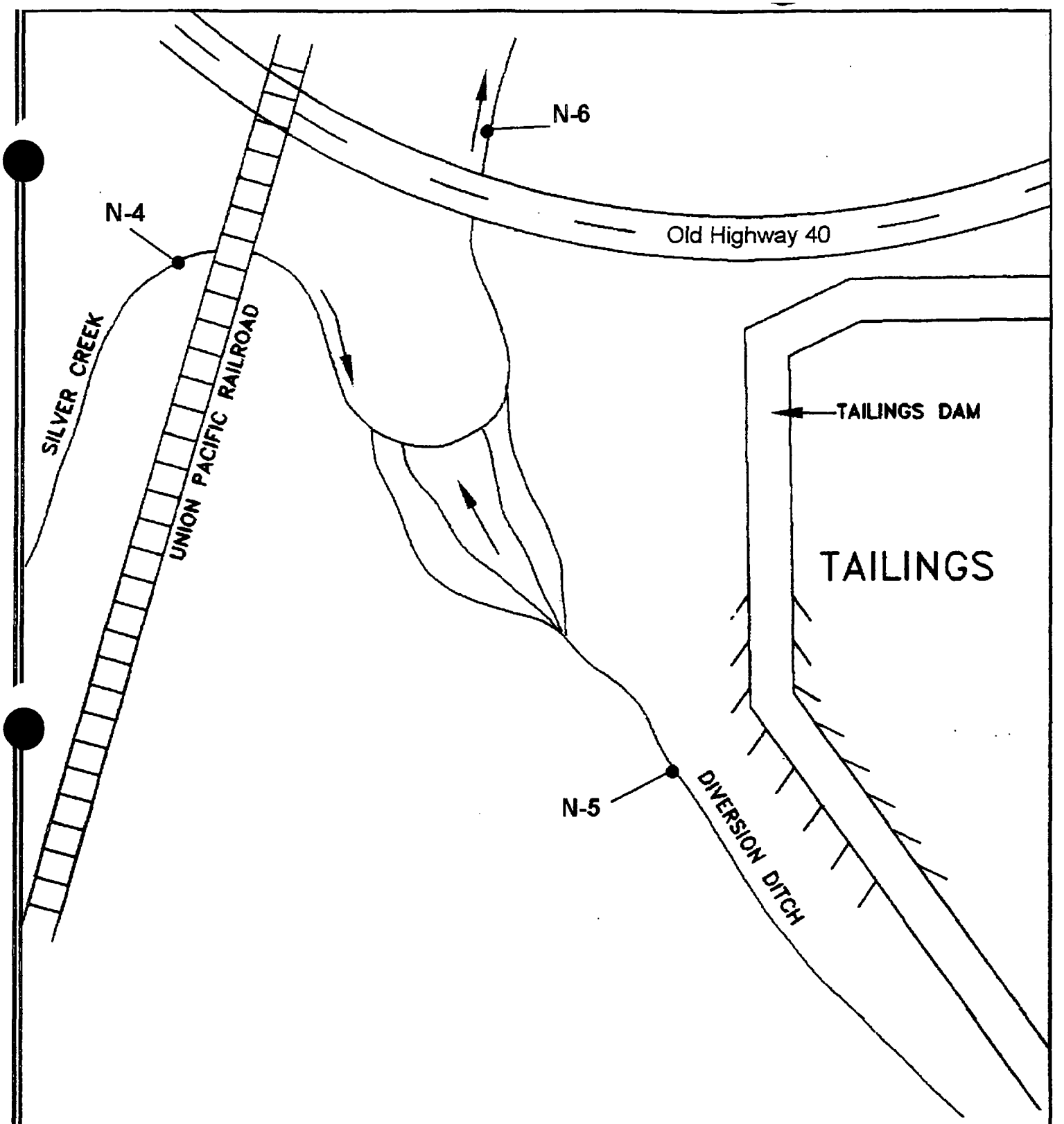
Date : April 2000
Title : Site Map
Client : United Park City Mines
Fig. No.: Figure 2.0



DRAFT

* Figure as amended from Bromfield and Crittenton, 1971

N	**RMC** Resource Management Consultants, Inc.	Date :	June 21, 1999
		Title :	RF Geology
		Client :	United Park City Mines
		Fig. No. :	FIGURE 2.1



DRAFT

Surface Water Sample Stations

N-4 - Silver Creek Upstream
N-5 - Diversion Ditch
N-6 - Silver Creek Downstream

Approximate Scale
100' 50' 0' 100'

RMC
Resource Management Consultants, Inc.
Drawn By: PTS
Original Drawing By: Weston Engineering

Date :	June 10, 1999
Title :	Historic Sample Loc.
Client :	United Park City Mines
Fig. No. :	FIGURE 3.1

FIGURE 3.2

Richardson Flat Surface Water

Zinc (T) ppm

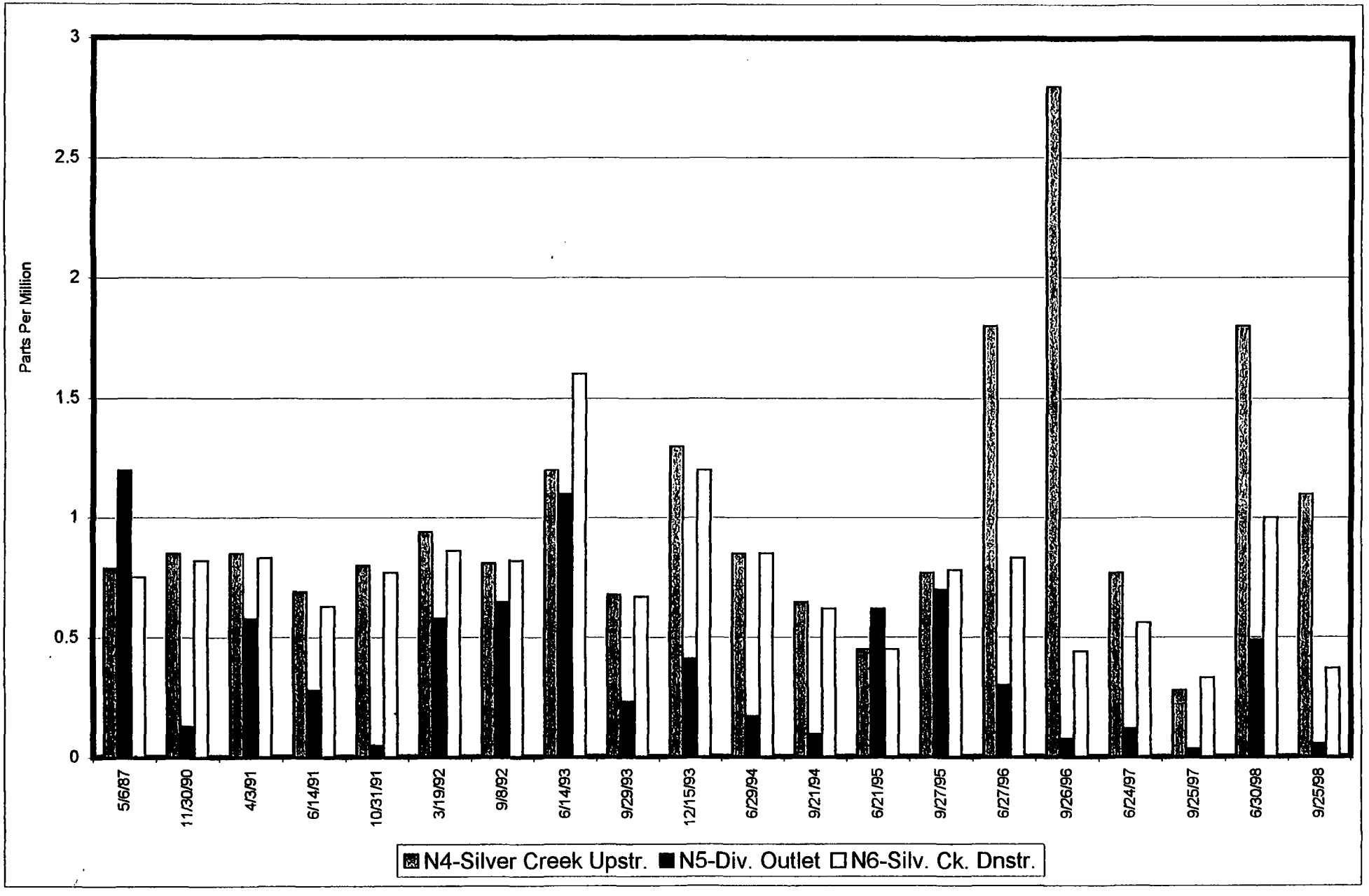
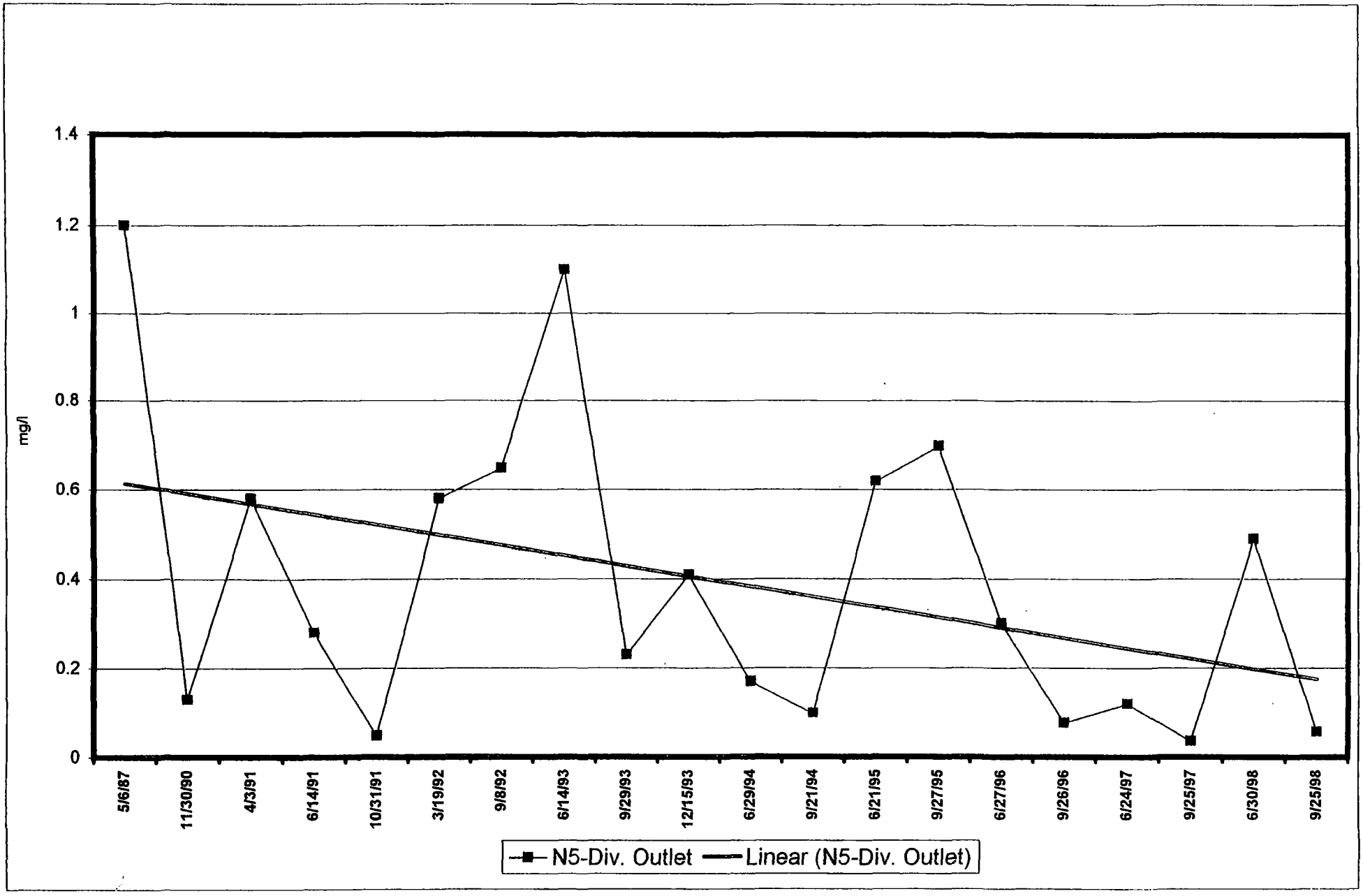
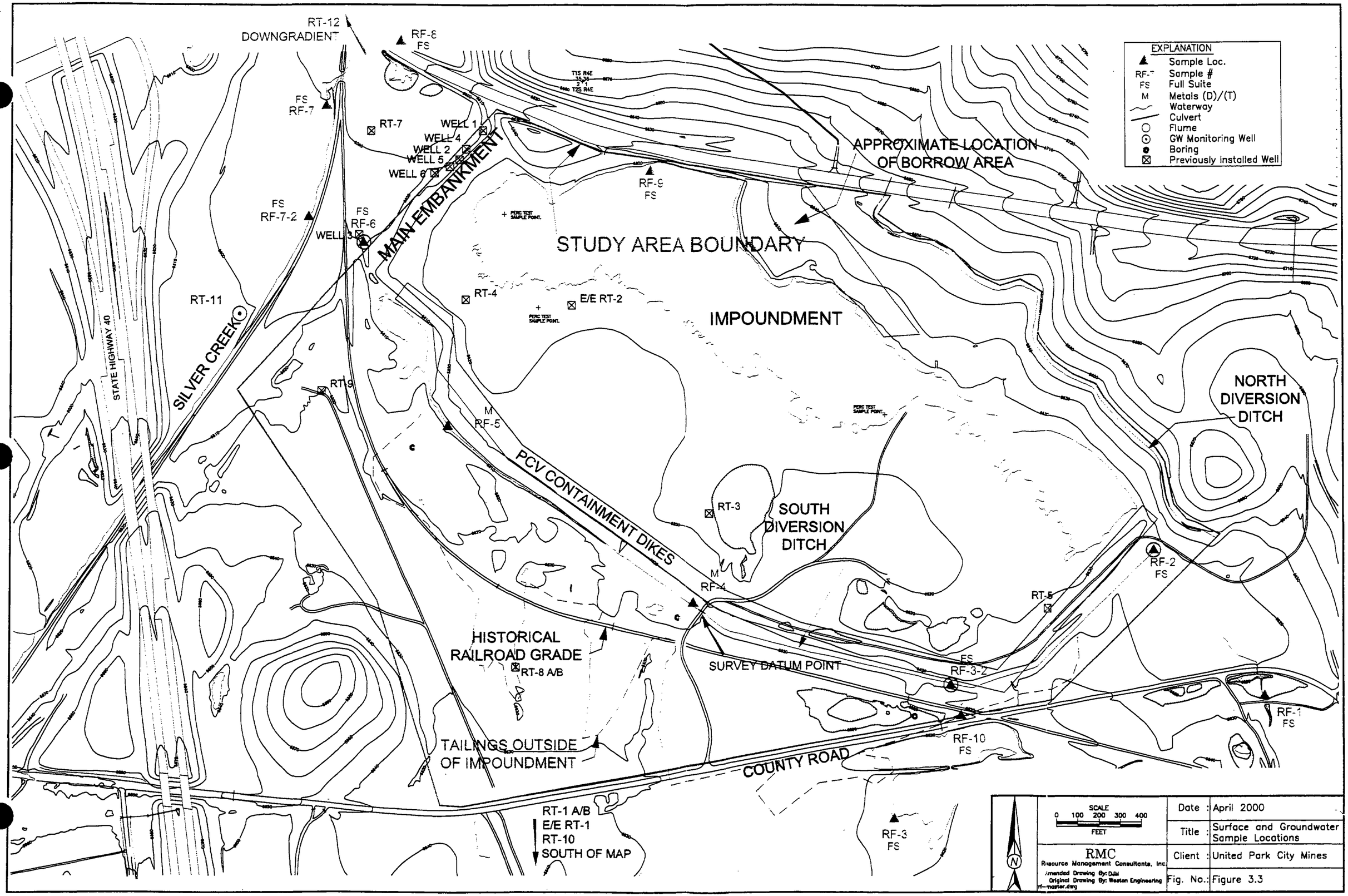


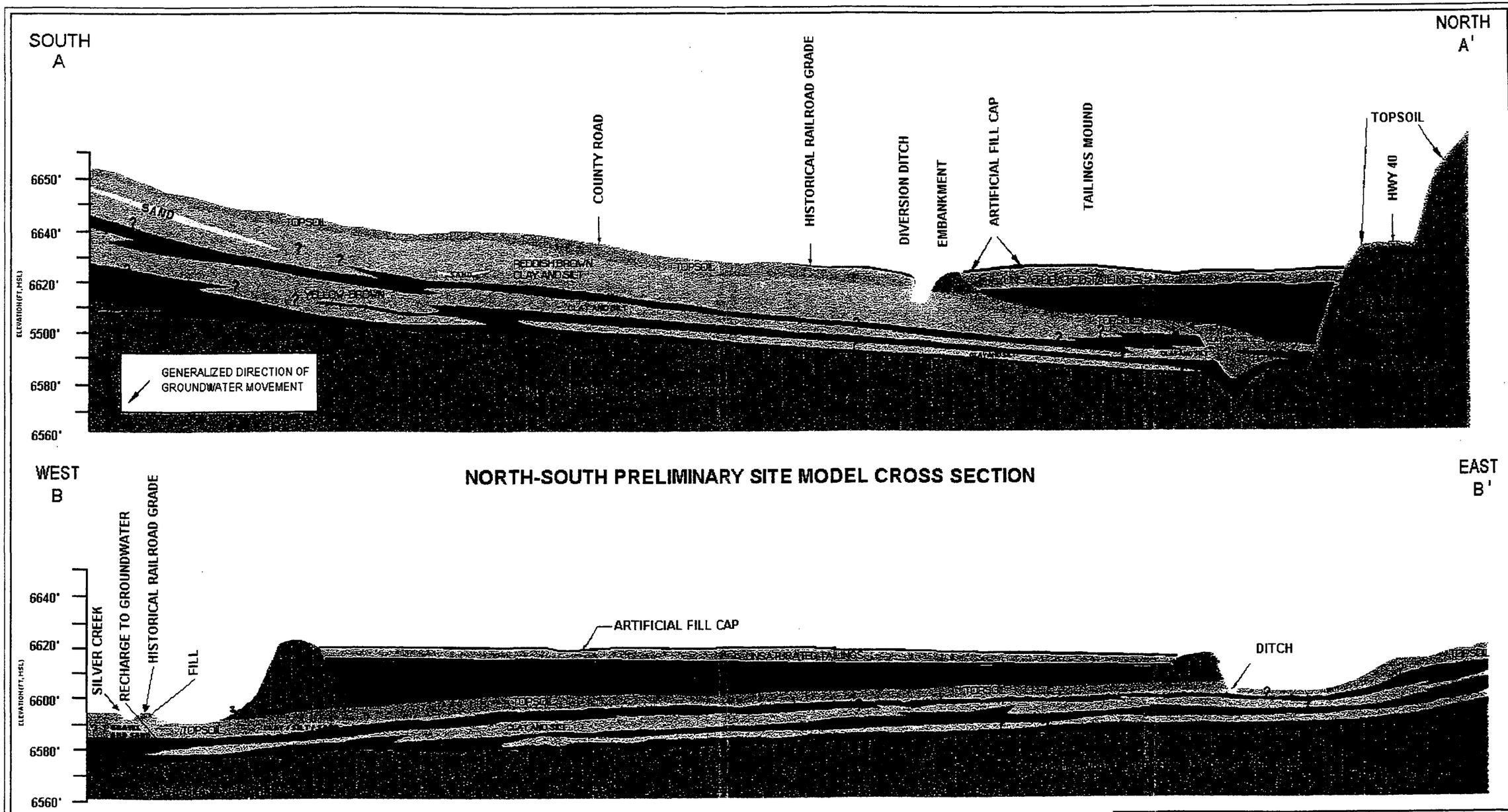
FIGURE 5.2a

Richardson Flat Surface Water - Diversion Ditch Outlet - Station N5

Zinc (T) mg/l



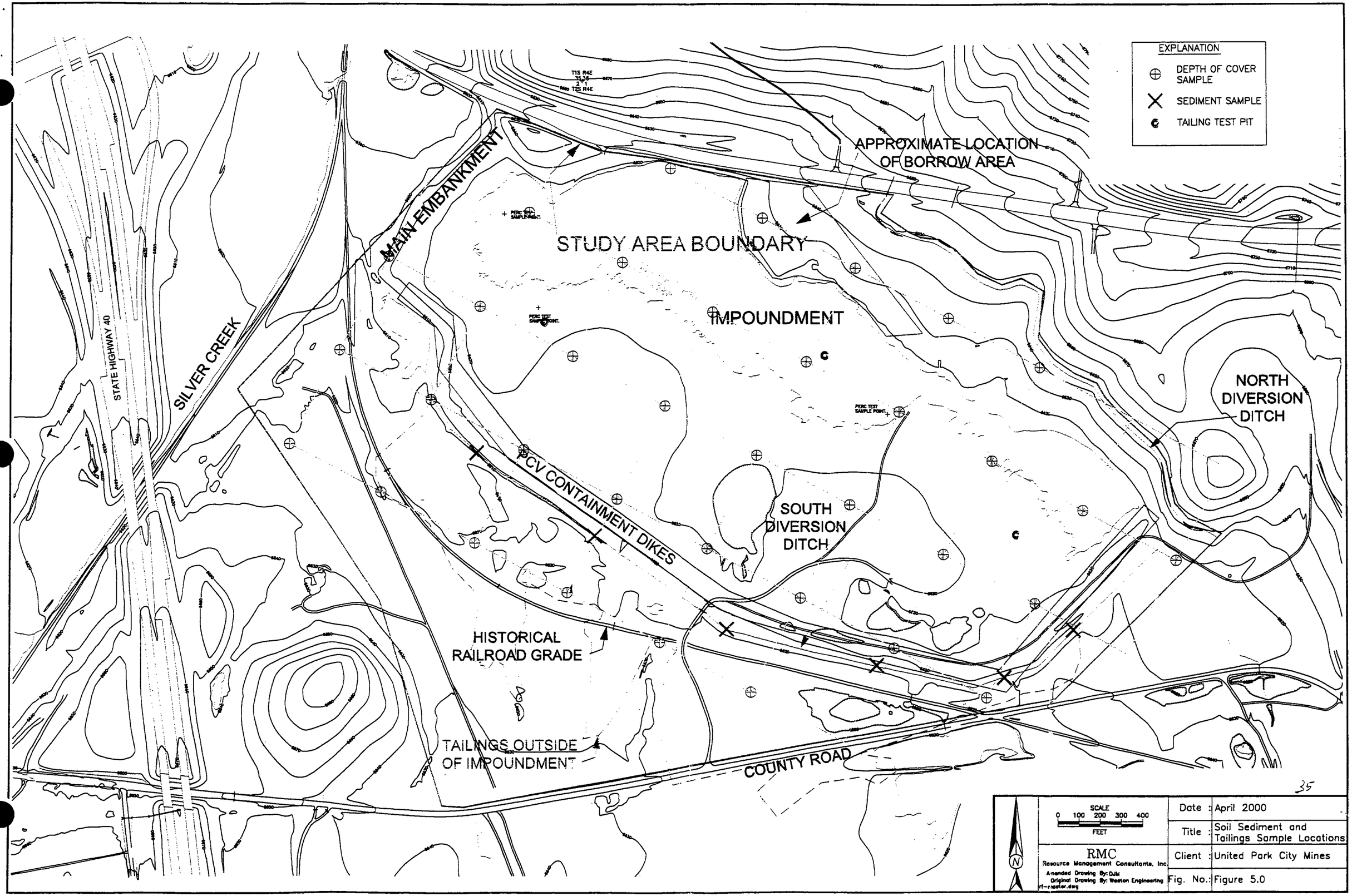

EXPLANATION
Sample Loc.
RF-# Sample #
FS Full Suite
M Metals (D)/(T)
Waterway
Culvert
Flume
GW Monitoring Well
Boring
Previously installed Well
RT-12
DOWNGRADIENT
RF-8
FS
FS
RF-7
RT-7
WELL 1
WELL 4
WELL 2
WELL 5
WELL 6
MAIN EMBANKMENT
APPROXIMATE LOCATION
OF BORROW AREA
RF-9
FS
FS
RF-7-2
FS
RF-6
WELL 3
STUDY AREA BOUNDARY
RT-11
RT-4
E/E RT-2
IMPOUNDMENT
STATE HIGHWAY 40
SILVER CREEK
RT-9
M
RF-5
NORTH
DIVERSION
DITCH
PCV CONTAINMENT DIKES
RT-3
SOUTH
DIVERSION
DITCH
M
RF-4
RF-2
FS
RT-5
HISTORICAL
RAILROAD GRADE
RT-8 A/B
SURVEY DATUM POINT
FS
RF-3-2
RF-1
FS
TAILINGS OUTSIDE
OF IMPOUNDMENT
RF-10
FS
COUNTY ROAD
RT-1 A/B
E/E RT-1
RT-10
SOUTH OF MAP
RF-3
FS
N
SCALE
0 100 200 300 400
FEET
RMC
Resource Management Consultants, Inc.
Amended Drawing By: DJM
Original Drawing By: Weston Engineering
rf-master.dwg
Date : April 2000
Title : Surface and Groundwater Sample Locations
Client : United Park City Mines
Fig. No.: Figure 3.3



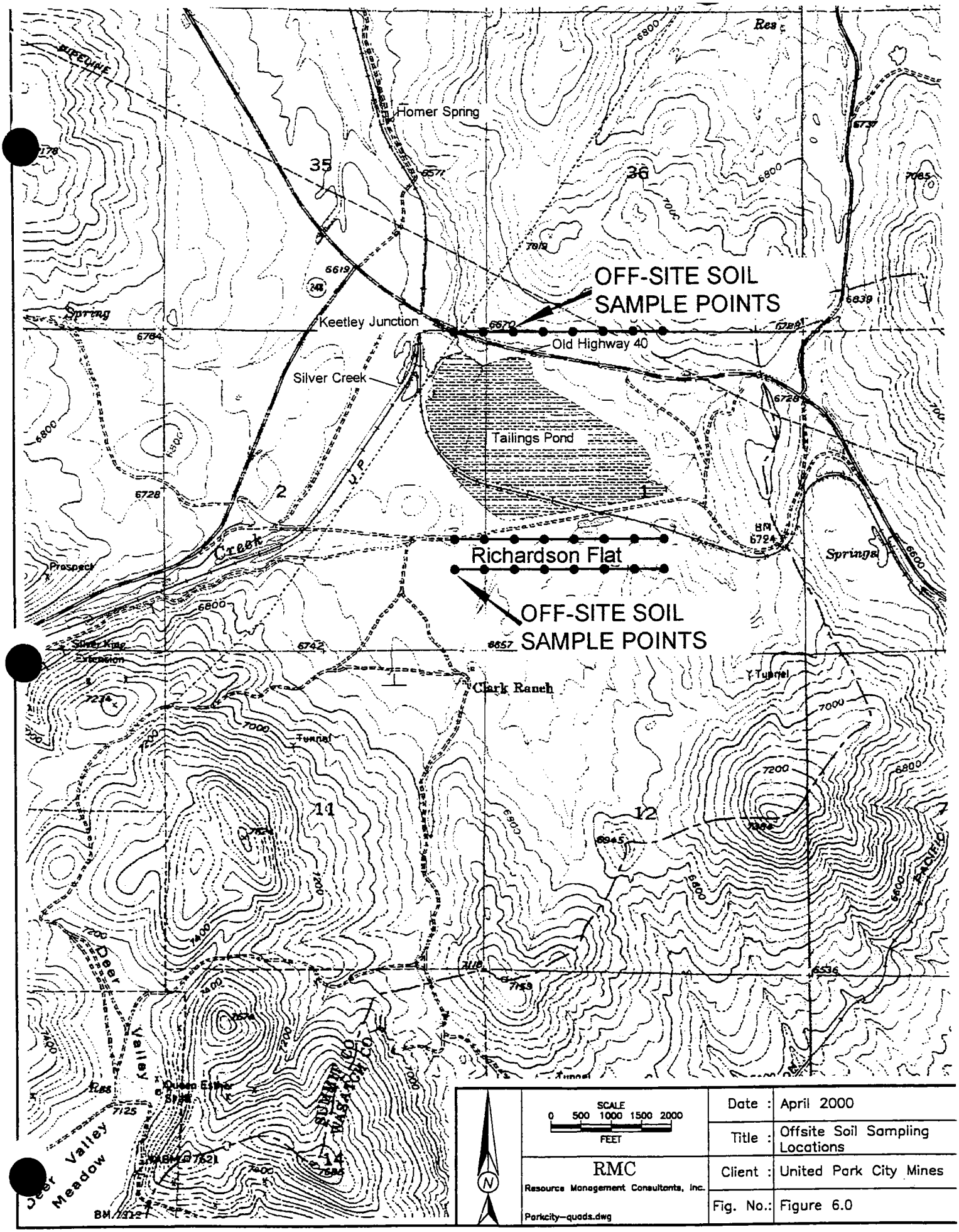
NORTH-SOUTH PRELIMINARY SITE MODEL CROSS SECTION

EAST-WEST PRELIMINARY SITE MODEL CROSS SECTION

RMC Resource Management Consultants, Inc.	Date :	April 04, 2000
	Title :	Preliminary Site Model
	Client :	United Park City Mines
Original Drawing By : Weston Engineering	Fig. No. :	FIGURE 4.0


EXPLANATION
DEPTH OF COVER SAMPLE
SEDIMENT SAMPLE
TAILING TEST PIT
APPROXIMATE LOCATION OF BORROW AREA
MAIN EMBANKMENT
STUDY AREA BOUNDARY
IMPOUNDMENT
STATE HIGHWAY 40
SILVER CREEK
NORTH DIVERSION DITCH
PCV CONTAINMENT DIKES
SOUTH DIVERSION DITCH
HISTORICAL RAILROAD GRADE
TAILINGS OUTSIDE OF IMPOUNDMENT
COUNTY ROAD
T1S R4E
T2S R4E
SCALE
0 100 200 300 400
FEET
RMC
Resource Management Consultants, Inc.
Amended Drawing By: DJM
Original Drawing By: Weston Engineering
Date : April 2000
Title : Soil Sediment and Tailings Sample Locations
Client : United Park City Mines
Fig. No.: Figure 5.0

35


Homer Spring
OFF-SITE SOIL SAMPLE POINTS
Keetley Junction
Old Highway 40
Silver Creek
Tailings Pond
Richardson Flat
OFF-SITE SOIL SAMPLE POINTS
Clark Ranch
Tunnel
Deer Valley
Deer Valley Meadow
Queen Esther Spring
SUMMIT CO
WASATCH CO
Scale
0 500 1000 1500 2000
FEET
N
RMC
Resource Management Consultants, Inc.
Parkcity-quads.dwg
Date : April 2000
Title : Offsite Soil Sampling Locations
Client : United Park City Mines
Fig. No.: Figure 6.0