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FOCUSED REMEDIAL INVESTIGATION REPORT FOR RICHARDSON FLAT TAILINGS SITE

SITE ID: UT980952840

May 7, 2004

Prepared for:

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EXECUTIVE SUMMARY

This Focused Remedial Investigation ("RI") Study Report details the results of the site characterization activities conducted at the Richardson Flat Tailings Site near Park City, Utah (the "Site"). The Site is an inactive mill tailings impoundment owned by United Park City Mines Company ("United Park"). United Park conducted the RI pursuant to an Administrative Order on Consent for a Focused Remedial Investigation /Feasibility Study, dated September 28, 2000, U. S. EPA Docket No. CERCLA-8-2000-19 (the "AOC"). The work was performed in accordance with the RI Workplan and Sampling and Analysis Plan ("SAP") that was prepared by United Park, in coordination with and approved by the U. S. Environmental Protection Agency (the "EPA") and the Utah Division of Environmental Response and Remediation (the "UDERR").

The Site is not listed on the National Priorities List, but had previously been proposed for listing by the EPA in 1988 and 1992. In 1999, the EPA and United Park initiated discussions regarding the additional site characterization work that would be needed to assess contamination conditions at, and remedial alternatives (if any) that may be required for the Site. Those discussions resulted in the issuance of the AOC and the performance of the RI work.

The initial RI sampling activities were conducted during the period of April 2001 to July 2002. Soil, surface water, groundwater, sediment, and tailings samples were collected and analyzed. During the summer of 2003 two phases of ecological sampling were conducted to assess ecological conditions in the pond and wetland area located at the base of the embankment. Sediment, surface water, sediment porewater, vegetation, fish and macroinvertebrate samples were collected and analyzed. The RI study Report presents the findings from these data gathering efforts, as well as certain data gathered from previous investigations conducted earlier by United Park and the EPA. The key findings from the RI activities, which are described in greater detail in the RI Study Report, include the following:

than

- On-site soils data indicate that the tailings cover is greater than one foot deep on the southern half of the impoundment, and more that six inches deep on the northern half of the impoundment. Except for a few localized areas, average lead concentrations in surface cover soils are less than 400 ppm. Data collected from soils in areas outside of the tailings impoundment area indicate the extent of wind-blown tailings is generally limited to areas immediately adjacent to the tailings impoundment area.

- Surface and shallow groundwater samples were collected from an adjacent and upstream area owned by United Park, referred to as the "Floodplain Tailings" area, to evaluate shallow groundwater and surface water conditions in and near Silver Creek. The data collected in this evaluation of Silver Creek was also used to evaluate Silver Creek as required in the AOC. The data demonstrate that

offsite sources of metals contamination appear to be impacting surface and groundwater quality in and near Silver Creek upstream and westerly of the Richardson Flat tailings impoundment. Water elevation and water quality data indicate that the Floodplain Tailings appear to be contributing some, but not all, of certain metals contamination to Silver Creek surface and groundwater systems in the area adjacent to and within Silver Creek west of the main Richardson Flat impoundment. Other sources of metals contamination located upstream of the Site are also impacting water quality in Silver Creek, as well. The Floodplain Tailings are part of the Upper Silver Creek Watershed Investigation. Water elevation and water quality data indicate that Silver Creek is impacting a portion of the wetland area.

- Groundwater at the Site has been detected in tailings both inside and outside of the impoundment area, in shallow alluvial aquifers beneath the Site and in the Silver Creek alluvial aquifer. Based on hydrogeologic studies, there appears to be no hydraulic connection between the groundwater found in the impounded Richardson Flat tailings and in the underlying shallow aquifers or within the Silver Creek alluvial aquifer. Groundwater quality data indicate that the alluvial aquifer underlying Silver Creek is not chemically similar to groundwater encountered in the tailings, or to surface water collected from the South Diversion Ditch.

- Sample data show that the diversion ditch and wetland sediments contain metals at all locations sampled, and that a transfer of metals from the sediments to surface water does not appear to be occurring within the diversion ditch and wetland area.

- Tailings data indicate that there are more alkaline-generating compounds in the tailings than acid-generating compounds. The average pH of the tailings is 7.5 S.U.. Thus, under current operating conditions, it is unlikely that the tailings will become acidic. Data obtained from unsaturated tailings indicate that metals, such as lead and zinc, have a potential to leach from tailings under unsaturated conditions. However, groundwater data collected from wells completed in tailings at the site suggest that any metals that may have previously leached from unsaturated tailings would have since become immobilized upon encountering underlying saturated tailings.

EPA has conducted a Baseline Human Health Risk Assessment ("BHHRA") utilizing the data obtained from the RI and prior investigations. The results of the BHHRA indicate that the Site does not present a risk to recreational visitors under current land use designations. EPA has conducted a Baseline Ecological Risk Assessment (BERA). The results of the BERA indicate that metals in surface water and sediments at the Site may have adverse effects on aquatic and semi-aquatic wildlife. Based on the data presented in this RI, the EPA will determine final Preliminary Remediation Goals for both human health and ecological receptors for the Site.

1.0 INTRODUCTION

This Focused Remedial Investigation (RI) Study Report details the results of site characterization activities conducted as part of a Focused Remedial Investigation and Feasibility Study (Focused RI/FS) at the Richardson Flat Tailings Site (the "Site") near Park City, Utah (Site ID UT980952840). The Site is an inactive mill tailings impoundment owned by United Park City Mines Company (United Park). United Park is conducting the Focused RI/FS pursuant to the Administrative Order on Consent (AOC) for a Focused Remedial Investigation/Feasibility Study, dated September 28, 2000, U.S. EPA Docket No. [**CERCLA-8-2000-19**]. The Focused RI/FS Work Plan (RMC, 2000), as referenced in this report was approved by the United States Environmental Protection Agency Region VIII (EPA) on September 28, 2000. The sampling and associated analytical analyses performed during this study were conducted in accordance with the Sampling and Analysis Plan (SAP) dated February 20, 2001 (RMC, 2001). The SAP was approved by the United States Environmental Protection Agency Region VIII (EPA) on March 10, 2001.

This report includes the relevant portions of a Remedial Investigation. As requested by EPA, the format of this report follows the suggested RI Report format outlined *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. EPA 540/G-89/004, 1988). Section titles follow the suggested outline where applicable.

1.1 Purpose of Report

The purpose of this report is to document results of a focused remedial investigation and incorporate findings from previous site investigations conducted by others at the Site. The purpose of the Remedial Investigation is to assess the risk to the environment and human health associated with past mining related activities at the Site. There have been multiple previous investigations regarding potential impacts to human health and the environment from site materials, this document focuses on data gaps from previous investigations.

1.2 Site Background

This section details the general characteristics of the Site. The Site history is presented as well as a synopsis of previous site investigations.

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1.2.1 Site Description

Site is on

The property owned by United Park and consists of approximately 650 acres in a small valley in Summit County, Utah, located one and one-half miles northeast of Park City, Utah (Figure 1-1). The tailings impoundment covers approximately 160 acres in the northwest corner of the Property and lies within the northwest quarter of Section 1 and northeast quarter of Section 2, Township 2 South, Range 4 East, Summit County, Utah (Figure 1-2). Figure 1-3 shows the Site configuration, topography and boundary.

show and label key features

1.2.2 Site 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. From time to time, tailings were transported to the Site through three distinct low areas on the southeast portion of the Site. 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. One aspect of the lease was to use the Site for disposal of additional mill tailings resulting from renewed mining in the area. PCV contracted with Dames & Moore to provide construction specifications for reconstructing 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 1-3). 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. Portions of the ditch located on the south and east side of the impoundment (South Diversion Ditch, Figure 1-3) appear to have been constructed in or through tailings materials. 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.

During the 1970's 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 design specifications for the earthen embankment as well as 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 to deposit tailings around the perimeter of the tailings impoundment and moving towards the center of the impoundment (Dames & Moore, 1974 at p. 21). This is a 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. PCV also failed to construct the main embankment in accordance with specifications provided by Dames and Moore.

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. After cessation of operations by Noranda in 1982, prevailing winds cut into the cone-shaped feature of tailings materials resulting in some tailings materials becoming wind-borne. Had the PCV 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. No new tailings have been placed at the Site since Noranda ceased its operations. A soil cover has been placed on the impoundment. The embankment has remained stable since the cessation of activities at the Site. Currently the embankment does not exhibit any signs of instability.

1.2.3 Previous 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 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 removing it from the proposed NPL. By 1992, the HRS scoring system had been revised and at that time, EPA conducted additional studies and 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." The ATSDR 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 were 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 and with an unknown degree of QA/QC, the results from such investigations are incorporated into this Focused RI as screening level data.

1.2.3.1 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 offsite 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 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 meteorological 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 p. 3). According to E&E's 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 new 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.

1.2.3.2 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 of the E&E report (E&E, 1993). According to the E&E report (1993), 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 E&E, 1993, 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 1993 study shows that the soil cover varied in thickness from less than six inches 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 hydrogeologic investigation by Weston (1999, as discussed in Section 1.2.3.4 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 essentially impermeable, with permeability's ranging from 3 to 7 x 10^{-8} cm/sec. These values roughly correspond to permeability's 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, the most prevalent clay mineral, 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 p. 4).

1.2.3.3 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 reconstructing 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, current operator of the Richardson Flat tailings impoundment at the time. 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 p. 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 noting 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. The remedial feasibility study conducted upon the completion of this remedial investigation will address the long-term stability of the embankment.

1.2.3.4 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, and MW-6). These wells are referred to as Wells 1 through 6 on Figure 1-4. It appears that PCV buried monitoring well MW-2 in 1976 during work on the embankment. Thus, five groundwater monitoring wells are remaining near the toe of the embankment. The boring and well completion logs for these five wells are summarized below:

MW-1 was drilled to a total depth of 35 feet below the ground surface (bgs). Volcanic 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 total 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 work on the embankment 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 total depths of 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, when possible, quarterly data from these embankment wells. Table 1-1 presents groundwater data collected by United Park from 1982 to 1987 and 1991 to 1998 from these monitoring wells.[1] Data presented in Table 1-1 shows that generally water quality has steadily improved in the monitoring wells generally over time. However, there are some readily apparent anomalies. 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, but the pH values were 7.7 and 4.1, respectively. This may indicate that the pH meter was not functioning correctly during the June 1998 sampling event. 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 would have a highly variable water chemistry depending on the hydrogeologic characteristics of the subsurface soils. A definitive trend in the water chemistry, however, is not apparent.

In 1985, 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

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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 it will be reported it will be reported in a future draft of this report.

[2] According to the E&E sampling report, United Park wells MW-1 and MW-2 were sampled during this event. This appears to be in error. MW-1 was most likely sampled by E&E, along with MW-5 or MW-6. 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 appears to have mislabeled its results.

downgradient wells were existing wells installed by PCV around 1974 and 1975.In 1992, EPA directed E&E to conduct an additional groundwater investigation. The 1992 groundwater data 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 1-2 compares the data collected by EPA in 1985 and 1992 with data collected from the same wells by United Park in 1998. Review of the data collected from upgradient well RT-1 in 1985 and 1992 reveals that water quality appears to have deteriorated at this location over time. Some dissolved metal concentrations have increased from 1985 to 1992. The 1992 data contains some anomalies that suggest either the sample was contaminated or there were analytical errors where dissolved metal concentrations are greater than the total concentrations 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 will abandon the well 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 groundwater study represented the most extensive groundwater investigation conducted to date to better understand groundwater systems on at the Site. Weston evaluated historical Site and regional data to derive a hydrogeological conceptual Site model (See Appendix 1). In the course of its investigation, Weston installed eleven piezometers throughout the Property (*See* Plate 1, Appendix 1). Boring logs from the piezometer installation verified the existence of two aquifers at the Site. Water level data collected from the piezometers indicate 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 p. 4). The local geology has greatly influenced the types of soils that have developed at the Site. 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 at the Site. 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 generally 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 the saturated tailings.

1.2.3.5 Investigations of Surface Water Quality

PCV, Noranda and United Park have collected surface water quality data at the Site since 1975. Data from 1982 to 1988 are presented in Table 1-3. 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 1-4 shows the sample locations.

A review of the historical and recent data from these three sampling points demonstrates that since the time of United Park's regrading and covering of the banks of the South Diversion Ditch (1992-1993), water quality has steadily improved both in the South Diversion Ditch and at the point where it leaves the Site and in Silver Creek below the Site (*See* Figure 1-4). The recent data also demonstrate that although some metals are present in upstream areas in the South Diversion Ditch, by the time water the leaves the Site and 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 1-4 presents the data collected in 1999 while Figure 1-4 shows the 1999 sample locations. 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 1-4). Samples were collected and analyzed for full suite parameters as shown in Table 5.2 of the Workplan (RMC, 1999) at RF-1 and RF-3 (Figure 1-4) 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 (RMC, 1999) 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 was not sampled in later sampling events. A flume was installed at sample location RF-3-2 to 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 1-4 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 the 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 any other applicable water quality standard. Examination of the first category of data presented in Table 1-4 reveals that for all of the metals measured, only zinc exceeds the aquatic wildlife criteria. Zinc exceeded 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) were well below the aquatic wildlife criteria.

Mercury concentrations measured in 1999 were all below the laboratory detection limit of 0.0005 ppm at all of the sample locations. The acute aquatic wildlife criteria is 0.0024 ppm and the chronic criteria is 0.000012 ppm. Therefore, measured mercury concentrations were below the acute criteria. The laboratory detection limits were not sufficiently low enough to ascertain if the mercury concentrations are above the chronic criteria. EPA recently promulgated laboratory method 1631 that establishes a standardized procedure to measure mercury at the 2 to 3 part per trillion range.

1.3 Report Organization

The organization of this report follows the suggested RI report format outlined in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. EPA 540/G-89/004, 1988). Section titles follow the suggested outline where applicable. Sections are subdivided using conventions presented in the Sampling and Analysis Plan (RMC, 2001) for each media of concern.

2.0 STUDY AREA INVESTIGATION

This section details the Study Area investigation. Each media of concern was investigated as a separate entity. The media sampled during 2001 and 2002 is consistent with the initial Sampling and Analysis Plan (SAP, RMC, 2001) for the Site. A second Sampling and Analysis Plan (ECO SAP, RMC, 2003) was prepared in 2003 to specifically detail ecological sampling in the pond and wetland areas (Figure 1-3). The sampling methodology for each media of concern is presented in this section. The ecological sampling conducted in 2003 is detailed in Section 2.10.

All samples collected in 2001 and 2002 were collected according to the RMC Standard Operating Procedures (SOP) presented in Appendix C of the SAP (RMC, 2001). Field and laboratory analytical parameters are shown on Table 2 of the SAP (RMC, 2001). Sample collection procedures were conducted according to procedures in Section 3.2 of the SAP (RMC, 2001). Analytical and laboratory procedures followed those described in Section 3.4 of the SAP (RMC, 2001).

Sample locations and groundwater elevation datum points were surveyed using Global Positioning Survey (GPS) and conventional survey techniques performed by a surveyor licensed by the State of Utah.

2.1 Surface Water

Surface water samples were collected at ten (10) to three (3) locations (RF-1, RF-2, RF-3-2, RF-4, RF-5, RF6-2, RF7-2 RF-8, RF-11 and RF-12) depending on the flow regime on and near the Site as depicted on Figure 2-1. The sample locations were selected based on data collected in 1999 and 2000. The rationale for the sample locations was to provide a data set that will be complete enough to characterize seasonal water quality and quantity in the South Diversion Ditch, as well as the unnamed drainages flowing into the South Diversion Ditch and Silver Creek. Data from the unnamed drainages will provide limited

background water chemistry data, the unnamed drainages only flow in response to snowmelt or significant storm events. Furthermore, the data were used to determine the effects of the Site on Silver Creek water chemistry and provide information to evaluate the source of elevated zinc concentrations found in the middle reach of the diversion ditch.

When possible, samples were collected monthly at each location through at least one complete seasonal time period. The sampling cycle was initiated in April 2001. A full round of twelve samples were not collected at five (5) locations due to a lack of flow: RF-1, RF-2, RF-3-2, RF-4 and RF-5. Sample locations RF-11 and RF-12 were added in the South Diversion Ditch during spring 2002, these sample locations were not presented in the SAP. Table 2-1 summarizes the months that samples were collected at each surface water sampling site.

An additional set of five (5) surface water sampling sites (FPT-SW1, FPT-SW2, FPT-SW3, FPT-SW4 and PH-SW1) were established in an area west of Silver Creek in the vicinity of the exposed tailings area referred to as the Flood Plain Tailings. These locations were not detailed in the SAP (RMC, 2001) however, sampling was conducted according to the protocols outlined for groundwater sampling in the SAP (RMC, 2001). The additional locations are presented on Figure 2-2. The sample locations were based on the need to assess surface water on the west side of Silver Creek.

In addition to the surface water sampling described above six (6) staff gauges (SG 1 through SG-6) were installed in spring 2002 throughout the Site. Surface water elevation data collected at the staff gauge locations was used to calculate surface water elevation data and groundwater flow directions. The staff gauge locations are presented in Figure 2-1.

2.2 Groundwater

Five (5) shallow monitoring wells were installed during this investigation (RT-11, RT-12, RT-13, RT-14 and RT-15). The wells were installed to assess and monitor shallow groundwater conditions in and around the Site. Monitoring well locations are presented in Figure 2-1. Monitoring wells were installed according to procedures detailed in RMC SOP 3a and Section 3.1.2 of the SAP (RMC, 2001). The rationale for the selected monitoring well locations included sites that allowed United Park to monitor groundwater upgradient and downgradient of the Site on Silver Creek and groundwater conditions near the diversion ditch. Monitoring well logs are presented in Appendix 2.

The wells installed by this study have been monitored on a monthly frequency from July 2001 through August 2002. The wells were monitored for a total of twelve months. Monitoring consisted of measuring depth to groundwater and field parameters (temperature, pH and conductivity) and collecting water samples from each well. Monitoring well sampling procedures are presented in Section 3.1.2 of the SAP (RMC, 2001).

Although the first round of groundwater sampling was conducted during the month of June 2001, the data from this month is not being used due to turbidity problems in the wells from incomplete well development (*See* RMC, 2002, Data Quality Assessment). The wells were redeveloped and sampled in July. The final round of groundwater sampling was conducted in the month of June 2002.

2.2.1 Offsite Monitoring Wells

Two (2) monitoring wells were installed offsite (Figure 2-1). Monitoring Well RT-11 was installed adjacent to Silver Creek to the west of and upgradient of the impoundment area. RT-11 is being used to assess water quality in the shallow Silver Creek alluvial aquifer upgradient from the Site. Monitoring Well RT-12 was placed adjacent to Silver Creek west of and downgradient from the impoundment area. RT-12 was installed to assess and monitor water quality downgradient from the Site. These wells will enable United Park to determine the impacts of the Site on the Silver Creek alluvial aquifer.

Monitoring Well locations RT-11 and RT-12 were determined by ground conditions in the vicinity of Silver Creek, State Road 248 and the Rail Trail as well as utility (fiber optic) locations adjacent to the Rail Trail. Well locations were selected based on combination of data needs and ground conditions that would provide ample room for drilling.

Prior to the drilling and installing Monitoring Wells RT-11 and RT-12, a series of eight (8) soil borings were drilled using a geoprobe in the vicinity of proposed well locations (Figure 2-3). Boring logs are presented in Appendix 2. All soil borings were backfilled with bentonite chips upon completion. The borings were installed to gain a better understanding of the shallow Silver Creek alluvial aquifer and enabled site personnel to correlate conditions between the two offsite monitoring well locations. The correlation was completed to insure that both monitoring wells were installed in the same hydrogeologic horizons.

2.2.2 Onsite Monitoring Wells (South of Diversion Ditch)

Three (3) monitoring wells were installed onsite in the area south of the diversion ditch (Figure 2-1). The wells were placed to gain an understanding of groundwater conditions in the tailings located south of the diversion ditch. Monitoring wells RT-13 and RT-14 were installed in the eastern portion of the site. Monitoring well RT-15 was installed in the western portion of the site in a dry horizon to monitor future water level changes.

The onsite monitoring wells were installed near test pits excavated to evaluate the tailings south of the diversion ditch (Section 2.7). This methodology allowed for a full examination of adjacent hydrogeologic conditions prior to monitoring well installation.

2.2.3 Floodplain Tailings

A series of sixteen (16) shallow monitoring wells were installed in an area of exposed tailings off site in the area west of Silver Creek referred to as the Floodplain Tailings. These wells were installed to help with the evaluation of the shallow Silver Creek groundwater aquifer in the area. These tailings are located on property owned by United Park, however, these tailings are not part of the Site and will be addressed by the watershed group. Of these wells a series of six (6) shallow monitoring wells (FPT-2B, FPT-4A, FPT-7A, FPT-8A, FPT-S4 and FPT-S-5) were determined to contain ample groundwater to serve as monitoring wells for the area (Figure 2-2). The wells were installed during the fall of 2001 and sampled in May 2002. The Floodplain Tailings monitoring wells were installed to gain an understanding of the water quality in the area west of Silver Creek and how this water is effecting the water quality of the adjacent reach of Silver Creek and the shallow groundwater aquifer. In addition, the groundwater elevation data collected from these wells was used to calculate the potentiometric surface for the reach of Silver Creek adjacent to this area.

The Floodplain Tailings monitoring wells were installed using a hand auger. Each well consists of a slotted 1" PCV interval with a sand-pack, a PCV riser and a clay surface seal. Each well was installed to the base of the tailings interval at the contact with an underlying black clay. The installation and sampling conducted in the Floodplain tailings area was not detailed in the SAP (RMC, 2001); however, sampling was conducted according to the protocols outlined for groundwater sampling in the SAP (RMC, 2001).

2.3 Onsite Soils Cover Sampling

At forty-one (41) locations, soil samples were collected on the tailings impoundment to determine: 1) the extent and thickness of the soil cover and 2) chemical characteristics of the surface soils. Sample locations are shown on Figure 2-4. Samples were collected at the surface (0-2") at each location to characterize the cover materials for potential human and ecological risks from exposure to the cover soils. All samples were analyzed for lead and arsenic and 20 percent of all surface samples collected were analyzed for RCRA metals (10 samples) plus copper and zinc. All samples were archived in the event that additional analyses are required.

The thickness of the soil cover was determined by excavating either by hand or backhoe down to the soil/tailings interface. The interface was visually verified at each location; the tailings are a characteristic gray color, sandy texture, while the soil cover is red-brown color and has a clayey texture. Eleven (11) samples were collected just above the cover/tailings interface and submitted for laboratory analyses to verify the visual method. The results of analytical sampling confirmed the verified visual inspection methods. The analytical results are presented in Section 4.3.

On-site soil sample locations are shown on Figure 2-4. Sample collection was conducted according to procedures in Section 3.2 of the SAP (RMC, 2001).

2.4 Offsite Soils Cover Sampling

At twenty-eight (28) locations, soil samples were collected along three transects, oriented perpendicular to the prevailing wind direction, to assess the extent and potential human health and/or environmental impacts from wind blown tailings. The prevailing wind direction is from the northwest as determined by EPA's contractor in the 1986 air sampling at Richardson Flat (E&E, 1987).

A wind rose from the EPA Air Sampling Report is presented as Figure 2-5. Samples were collected at 0-2" and 1-6" depth intervals along the transects indicated on Figure 2-6. Data from this sampling effort will be used in the risk assessment process to evaluate if there is a threat to human health or the environment from exposure to off-site soils.

Off-site soil sample locations are shown on Figure 2-6. Sample collection was conducted according to procedures described in Section 3.2 of the SAP (RMC, 2001).

2.5 Sediment Sampling

Sediment samples were collected at six (6) locations in the South Diversion Ditch. The sediment samples were used to evaluate the source of elevated zinc concentrations in water samples collected in 1999 and evaluate ecological risks. At each location a sample was collected at a depth of 0 to 6 inches. The samples were analyzed for RCRA metals plus zinc and copper. These samples were archived by the laboratory until it can be determined whether additional analysis is required.

All sediment sample locations are shown on Figure 2-7. Sample collection was conducted according to procedures in Section 3.2 of the SAP (RMC, 2001).

2.6 Tailings

Samples of tailings were collected at three (3) locations within the impoundment from test-pits excavated with a backhoe. At each location, five (5) discrete samples were collected at one (1) foot vertical increments, starting from the bottom of the cover over the tailings down to a depth of five (5) feet below the ground surface. In addition, a composite sample prepared from a split of each increment was prepared and analyzed for acid/base potential to assess long-term geochemical characteristics of the tailings materials.

All test-pit locations are shown on Figure 2-7. Sample collection was conducted according to procedures outlined in Section 3.2 of the SAP (RMC, 2001).

To maximize visual observations of tailings, soils and the tailings/soils interface, as well as to maximize sample quantities a backhoe was used to dig test pits. The test pit enabled site personnel to view the soils/tailings interface in a three-dimensional view. This provided an understanding of the physical characteristics of the interface and provided information about the spatial configuration of the interface. Test pits were excavated with minimal disturbance and were not excavated below the current water table. Excavated soils were sorted and stockpiled adjacent to the test pit. Upon completion of sampling

activities the test pits were backfilled. To prevent soil mixing, each soil horizon was backfilled with soils removed from that horizon. Soils were compacted with the bucket of the backhoe during backfilling.

2.7 Tailings South of the Diversion Ditch

The tailings outside of the impoundment have been covered with at least one and up to five feet of clean soil (*See* Section 4.2, Focused RI/FS Workplan, RMC, 2000). The actual limit and extent of the tailings south of the diversion ditch were identified using a combination of aerial photography review and investigative field methods. The approximate, pre-investigation limits of these tailings were marked with a dashed green line as the "tailings outside of the impoundment" on Figure 5.0 of the SAP (RMC, 2001). The results of this investigation provide a definitive model of the extent of the tailings located south of the diversion ditch and define study boundaries in that area. Subsurface samples were collected to determine: 1) the extent of tailings south of the South Diversion Ditch, 2) the thickness of soil cover on these tailings, 3) whether these tailings are contributing to elevated zinc levels in the diversion ditch and 4) to assess whether metals have migrated below the tailings and the underlying clay interface.

Subsurface samples were collected using a combination of shallow hand tool excavation, and backhoe test pits. A total of sixty three (63) backhoe test pits were excavated (Figure 2-8). In addition, a series of shallow hand excavations were dug in the southwestern portion of the Site. These hand dug excavations were completed to assess the cover thickness in the seasonally wet area of the Site. These two methods involved visual inspection of subsurface soils. To confirm the results of visual inspection, analytical samples were collected at 10 percent of the backhoe excavation locations (7 locations). The analytical soil samples were collected above and below any color or texture changes. The results of the sample analysis are presented in Section 4.7.

A review of historical aerial photographs was conducted to assess the outermost limits of the tailings south of the diversion ditch. The approximate location of tailings was determined from reviewing a series of historical aerial photographs. Where possible, the location of the tailings were determined by examining the photographs for discontinuities that may be indicative of the boundaries of the tailings and native ground. These discontinuities included changes in plant cover, drainage patterns and general geomorphology. The locations of the tailings/native ground boundary were compared to the locations of known points such as fencing and roads. The boundary was then staked on the ground using the known points as reference locations. The staked boundary locations acted as a starting point for the field delineation of the tailings/native ground boundary.

Three (3) monitoring wells , designated RT-13, RT-14 and RT-15, were installed in the tailings outside of the impoundment. The installation of these three monitoring wells was discussed in Section 2.2.2. The monitoring wells were installed in specific areas to further define the hydraulic gradient and groundwater chemistry within the tailings outside the diversion ditch.

Sample location and collection were conducted according to procedures in Section 3.2 of the SAP (RMC, 2001). Test pit and samples locations are presented in Figure 2-8.

2.8 Background Soil Sampling

At eleven (11) locations, background soil samples were collected in areas that have not been affected by tailings deposition. The samples were used to determine baseline concentrations of metals in areas not affected by tailings deposition

Discrete samples were collected at the surface (0-2") at each location and analyzed for lead and arsenic to characterize the background concentrations of metals in the area surrounding the tailings impoundment. In addition, two (2) samples were analyzed for RCRA metals plus copper and zinc.

Background soil sample locations are shown on Figure 2-9. Sample collection was conducted according to procedures in Section 3.2 of the SAP (RMC, 2001).

2.9 Study Area Boundary Sampling

At nine (9) locations, samples were collected as an aid to determine the study area boundary.

Discrete samples were collected at the surface (0-2") at each location and analyzed for lead and arsenic to characterize the soils in the vicinity of the study area.

Study area boundary soil sample locations are shown on Figure 2-10. Sample collection was conducted according to procedures in Section 3.2 of the SAP (RMC, 2001).

2.10 Ecological Sampling

This section details ecological sampling conducted in the pond and wetland areas located in the northwest portion of the study area (Figure 1-2). This sampling was conducted to assess ecological conditions in this area. In addition sampling was conducted in an offsite pond and wetland reference area (Figure 1-2).

All ecological samples collected in 2003 were collected according to the RMC Standard Operating Procedures (SOP) presented in Appendix A of the ECO SAP (RMC, 2003). Field and laboratory analytical parameters are shown on Table 4.1 of the ECO SAP (RMC, 2003). Sample collection procedures were conducted according to procedures in Section 4.0 of the ECO SAP (RMC, 2003). Analytical and laboratory procedures followed those described in Section 5.7 of the ECO SAP (RMC, 2001).

Ecological sampling was conducted in two phases. Phase I consisted of surface water and sediment sample collection. The results from Phase I were used to determine sampling locations for Phase II sampling which included the collection of surface water, sediment, sediment porewater, sediment toxicity, vegetation, fish and macroinvertebrate samples.

2.10.1 Ecological Surface Water Sampling

Phase I surface water samples were collected at four (4) locations in the wetland (SD-4, SD-7, SD-13 and SD-17) and two (2) locations in the pond (SD-18 and SD-20, Figure 2-11). Sample locations were selected to provide sufficient data to fully assess surface water quality in both the wetland and pond areas as well as to provide sufficient data to select Phase II sampling locations. Phase II surface water samples were collected at two (2) locations in the wetland (SD-13 and SD-17) and two (2) locations in the pond (SD-18 and SD-20, Figure 2-12). Due to late summer low water levels surface water samples were not collected at locations SD-4 and SD-7 during Phase II.

Surface water samples were collected in the reference pond and wetland area (1 sample per location, Figure 2-13).

In addition to the surface water sampling described above, ten (10) staff gauges (WSG-1 through WSG-10) were installed in July 2003 throughout the wetland. Surface water elevation data collected at the staff

gauge locations was used to calculate surface water elevation data and flow directions. The staff gauge locations are presented in Figure 2-14.

2.10.2 Ecological Sediment Porewater Sampling

Sediment porewater samples were collected during Phase II ecological sampling. Sediment porewater samples were collected using a micro piezometer according to procedures detailed in SOP #SRC-Ogden-01 and Section 4.5.3 of the ECO SAP. A 60cc syringe was used to extract the water from the micro piezometer. The samples were analyzed for analytes specified in table 4.1 of the ECO SAP (RMC, 2003).

Sediment porewater samples were collected at eight (8) locations in the wetland (SD2, SD4, SD6, SD10, SD11, SD14, SD15 and SD17, Figure 2-12) and two (2) locations in the pond (SD-18 and SD-20, Figure 2-12). Two sediment porewater samples were collected at the reference site (1 sample per location, Figure 2-13).

One deviation from the ECO SAP was required during sample collection. The SAP required the collection of porewater samples only in areas of positive flux (e.g. flow through the sediments). Positive flux was not observed at any sample location. Samples were collected at each location regardless of flux direction.

2.10.3 Ecological Sediment Sampling

Phase I sediment samples were collected at seventeen (17) locations in the wetland and three (3) locations in the pond (Figure 2-11). The samples were analyzed for analytes specified in table 4.1 of the ECO SAP (RMC, 2003).

Phase II sediment samples were collected at eight (8) locations in the wetland, two (2) locations in the pond and three (3) locations at the reference site (Figure 2-12). The samples were collected at a depth of zero to four (4) inches. The samples were analyzed for analytes specified in table 4.1 of the ECO SAP (RMC, 2003).

Phase II toxicity samples were collected simultaneously with sediment chemistry samples. Twelve (12) samples were tested using a twenty-eight (28) day Hyalella survival test.

Sediment sample collection was conducted in accordance with SOP-SD-10 located in Appendix A of the ECO SAP (RMC, 2003) with one exception: Difficult ground conditions precluded the use of the drive rod check valve corer or Eckman grab sampler in many locations. For consistency a posthole digger was used to collect sediment samples at all locations.

2.10.4 Vegetation Sampling

Vegetation sampling was conducted during Phase II sampling. Vegetation samples were collected at eleven (11) locations in the wetland area, three (3) locations in the pond and five (5) locations at the reference site. Vegetation sampling was conducted in accordance with SOP 2037 and SOP BI-13 located in Appendix A of the ECO SAP (RMC, 2003). The samples were analyzed for analytes specified in table 4.1 of the ECO SAP (RMC, 2003). The samples were collected at each of the Phase II sample locations detailed in figures 2-12 and 2-13.

In addition to plant tissue analysis a vegetation map (Figure 2-15) of the pond and wetland area was also prepared using standard biologic mapping techniques.

2.10.5 Fish and Macroinvertebrate Sampling

Fish and macroinvertebrate sampling was conducted during Phase II sampling.

Two (2) fish samples were collected in the Richardson Flat Pond located at the terminus of the South Diversion Ditch. Due to seasonal low water levels the wetland area did not contain sufficient water to support fish. The reference pond and wetland did not contain fish. Fish sampling was conducted in accordance with SOP BI-05 located in Appendix A of the ECO SAP (RMC, 2003) with exception that the seine net was replaced with minnow traps. The samples were analyzed for analytes specified in table 4.1 of the ECO SAP (RMC, 2003).

Three (3) macroinvertebrate and two (2) snail samples were collected and analyzed from the Site. Two (2) macroinvertebrate and one (1) snail sample were collected and analyzed from the reference site. Macroinvertebrate and snail sampling was conducted in accordance with SOPs BI-11 and BI-12 located in Appendix A of the ECO SAP (RMC, 2003) with exception that nets were used to collect the macroinvertebrates. The samples were analyzed for analytes specified in table 4.1 of the ECO SAP (RMC, 2003). The macroinvertebrate sample locations are detailed in Figures 2-12 and 2-13.

Fourteen (14) samples were collected for benthic macroinvertebrate community analysis. Twelve samples were collected at the Site and two (2) at the reference site. Each sample consisted of a series of ten (10) replicates. Sampling was conducted in accordance with SOPs SD-10 and BI-12 located in Appendix A of the ECO SAP (RMC, 2003). The samples were shipped to the laboratory for preservation in alcohol pending future analysis. Samples were collected at the Phase II sample locations presented in Figure 2-12.

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes the physical characteristics and the geologic setting of the Site and surrounding area.

3.1 Physical Characteristics

The physical characteristics of the Site presented in this report were determined by a combination of the field activities detailed in Section 2 of this report and a compilation of data from previous reports.

As discussed in Section 1.2.1, the entire Richardson Flat property, owned by United Park, covers approximately 700 acres in a small valley located in Summit County, Utah. The tailings impoundment covers approximately 160 acres in the northwest corner of the property and consists of a large geometrically closed basin formed by an embankment and a series of perimeter containment dikes. The Site boundary as determined by this study contains the tailings impoundment as well as adjacent areas impacted by historical use of the Site is presented in Figure 1-3. The Study Area Boundary determined by this study contains an area of approximately 263 acres.

3.1.1 Surface Features

The site is located at an elevation of approximately 6,600 feet above sea level and consists of a geometrically closed tailings impoundment surrounded by an earthen dam on the west side and two containment ditches on the north, south and east sides. The containment ditches flow into Silver Creek. The area surrounding the impoundment consists of valley bottom topography surrounded by rolling hills.

An old railroad grade passes through the site south of the South Diversion Ditch. The impoundment area is approximately bounded by Utah Highway 248 to the north, a rail trail (reclaimed railroad grade) to the west and the South Diversion Ditch to the south. These roads and grades are not containment features and have no bearing on the Site boundary as defined by the extents of contamination.

3.1.2 Meteorology

Long-term meteorological observations have not been kept at the Site. The two nearest meteorological data stations are located in Park City, Utah which is located 500 feet higher in elevation three miles to the southeast in the Wasatch Mountains, and Kamas, Utah located at a similar elevation to the Site and nine miles to the east. The annual precipitation rate for the Site likely falls in-between the values for the two sites. Annual precipitation at Park City is 21.44 inches of water with an annual average high temperature of 56.3 degrees and an annual average low temperature of 30.8 degrees. Annual precipitation at Kamas is 17.27 inches of water per year with an average annual low temperature of 29.0 degrees and an average annual high temperature of 58.7 degrees (www.wrc.dri.edu, 2001).

Long-term wind data have not been kept in the vicinity of the Site. The prevailing wind direction is from the northwest to southeast east as determined by the EPA contractor Ecology and Environment during an air monitoring assessment conducted in 1986 (Figure F8, E&E, 1987, Reproduced as Figure 2-5 in this document.).

3.1.3 Surface Water Hydrology

The surface water hydrology of the Site consists of two distinct but interconnected entities: the tailings impoundment and the Silver Creek watershed.

The tailings impoundment consists of a man-made geometrically enclosed basin. The impoundment is bounded to the north, south and east by containment ditches and to the west by an embankment. The embankment isolates the tailings from Silver Creek. Beneath the impoundment, a layer of clay soil provides a boundary to infiltration of impoundment water into the underlying aquifers (*See* Weston, 1999; MWH, 2002). Surface water may occur on the impoundment during winter, spring and a portion of the summer depending on the amount of precipitation occurring during the year. A substantial portion of the precipitation falling on the impoundment remains within the bounds of the impoundment until it evaporates (Weston, 1999).

Between the main embankment and Silver Creek is a wetland area where the diversion ditch meanders through the wetland and eventually joins Silver Creek near State Highway 248. The wetland area may possibly receive minor seepage from the main embankment. Beaver dams have blocked and slowed the flow of Silver Creek in this area.

Surface water hydrology outside of the impoundment consists of Silver Creek and two ephemeral drainages located to the south and east of the impoundment. Surface water from the southern drainage enters a seasonal pond south of the county road and depending on the amount of precipitation that falls within the drainage, water may be present from spring to late summer. Surface water from the eastern drainage enters the Site in the vicinity of sample location RF-1. Surface water in the eastern drainage is typically limited to periods of spring runoff.

Surface water flows have been measured as part of monthly water sampling activities at the following locations: RF-2, RF-3-2, RF-4, RF-6-2 and RF7-2. Surface water chemistry data was collected at these and other locations during the investigation. Flow data for each location is presented in Table 3-1. Surface water data were collected for a sixteen (16) month period beginning April 2001. Seasonal variations are apparent in all of the locations sampled. The seasonal variations are consistent with the variations observed in the monitoring wells located in the Silver Creek alluvial aquifer and in the tailings south of the diversion ditch. In general, peak flows were observed during the month of May with a seasonal decline through the summer and early fall months. Flow in Silver Creek as measured at location RF-7-2 began to increase in October 2001. This increase is likely related to an increase in precipitation during the fall months. Flow increases were not observed in the South Diversion Ditch and the ephemeral drainages located upgradient from the impoundment during the fall period that increases were observed in Silver Creek. Flow did not increase in the South Diversion Ditch until the onset of the spring runoff cycle. The South Diversion Ditch remained frozen during the winter months, making flow measurements and sampling infeasible.

3.1.3.1 Wetland Area Surface Water Flow Characteristics

A surface water elevation survey was conducted during July 2003 to calculate surface water elevations and flow direction data in the wetland area. A series of ten (10) staff gauges (WSG-1 through WSG-10, Figure 2-14) were installed in July 2003 throughout the wetland. The results of the survey indicate that

the northern portion of the wetland is receiving water from and influenced by Silver Creek. As presented in Figure 2-14 sample locations SD-1 through SD-8 are influenced by Silver Creek waters. Silver Creek flow enters the northwest section of the wetland and is split by a topographic high that diverts water to the north and south (Figure 2-14). The flow regime of the southern portion of the wetland is influenced by water emanating from the South Diversion Ditch.

3.1.4 Groundwater Hydrogeology

Geotechnical borings, small-diameter piezometers, monitoring wells, and groundwater exploration borings were used to characterize the stratigraphic units in and around the Site. Beginning at the surface the stratigraphic units are:

- Clay rich topsoil (hydraulic conductivity $>10^{-7}$ cm/sec)
- Alluvium/colluvium derived from Silver Creek and attendant subsidiary drainages
- Tertiary sedimentary and Keetley Volcanic rocks
- Mesozoic and Paleozoic rocks

The shallow aquifers near the tailings pond are composed of mixtures of silt, sand and gravel located along the Silver Creek drainage, and deeper gravelly clay and sand and gravels mixed with abundant fine-grained materials varying from approximately 50 feet in thickness in areas south of the tailings impoundment to approximately 20 feet thick beneath the impoundment. Approximately 500 to 1,000 feet of moderately hard and fractured volcaniclastic rocks composing the Tertiary sedimentary rocks and Keetley Volcanic rocks underlie the tailings impoundment. The volcanic rocks overly several thousand feet of shale, claystone, limestone, sandstone and quartzite comprising the Mesozoic and Paleozoic rocks which serve as the source of drinking water supplies for the Park City Municipal Corporation.

At least five groundwater systems are found in the Richardson Flats area. Groundwater stored in the impounded tailings is under unconfined conditions and is not in hydraulic connection with the deeper water bearing strata due to the lower permeability clay-rich topsoil underlying the tailings. The saturation of the shallow alluvium in the vicinity of the tailings impoundment varies with the seasons; when saturated it serves as a locally perched water table.

The deeper alluvium is composed of thin layers of saturated and confined sand and gravel mixed with abundant fine-grained materials which yield small quantities of water to the piezometers and monitoring wells. The hydraulic communication between the shallow and deeper water bearing intervals is poor. South of Richardson Flats, the hydraulic gradient between the shallow and deeper water is downward. The hydraulic gradient between the deeper and shallow aquifer reverses and is upward as groundwater flows northward towards the tailings impoundment, ultimately discharging into the diversion ditch and Silver Creek which serve as the local hydrologic sinks for the shallow aquifer system. Driller's logs and anecdotal reports by local drilling contractors indicates no wells develop water from the alluvium due to the low productivity of these unconsolidated aquifers. The only wells tapping the alluvium and colluvium overlying the Keetley Volcanics include the various piezometers and monitoring wells in the vicinity of the Site.

The underlying and adjacent fractured Keetley volcanic rocks yield low to moderate quantities of water and serve as the water supplies for industrial and public water supply wells and small springs. Twenty six wells and two springs were identified within the watershed near Richardson Flats, with the closest well located approximately one quarter mile downstream from the tailings impoundment. With the exception of the piezometers and monitoring wells, all wells are deeper than 150 feet and develop water stored in the Keetley and deeper aquifers. While the deeper fractured Mesozoic and Paleozoic rocks are developed by public water supply wells operated by the Park City Municipal Corporation, these wells are upgradient and located approximately two to three miles from Richardson Flats. Deep groundwater exploration wells drilled near Richardson Flats determined that volcanic clays within the Keetley Volcanic rocks serve as confining units between water bearing strata within the volcanic rocks and between the volcanic rocks and underlying Mesozoic and Paleozoic water bearing strata.

Flow in the shallow groundwater system mimics the local topography. Groundwater flow is generally from southwest to northeast towards the wetlands located south of the tailings impoundment. Groundwater beneath the clay rich topsoil moves from northeast to southwest and is eventually captured by the South Diversion Ditch. Water quality data from RT-7, a piezometer located in the wetlands, indicates that metal concentrations in the groundwater are well below screening criteria (see Section 4.0).

Groundwater stored in the tailings impoundment moves northwesterly towards the embankment under a relatively flat hydraulic gradient. The steep hydraulic gradient across the embankment indicates that the hydraulic conductivity of the embankment materials is less than the hydraulic conductivity of the tailings

stored in the impoundment. Seepage rates across the embankment range from 0.6 to 63 gallons per day. Water budget calculations indicate that most if not all of the calculated seepage through the embankment is either lost by evaporation or consumed by the vegetation located at the toe of the embankment

A detailed report on the Hydrogeology of the Site was prepared under separate cover by Montgomery Watson Harza (Appendix 3).

3.1.5 Onsite Soils Cover

The onsite soil cover within the impoundment area consists of imported low permeability clean soils. Construction sites throughout the Park City area and a borrow site between the northeast edge of the impoundment and Highway 248 were the sources of the onsite cover soils.

This investigation measured the thickness of cover soils on a 500 foot by 500 foot grid within, directly adjacent to and on the area immediately north of the impoundment. Onsite soils cover depths are presented in Figure 2-4 and listed in Table 3-2. The onsite soil cover thickness ranges from 6 inches to over 11 feet. The areas containing soil cover of less than one foot are generally located in the northern half of the impoundment area. The area containing the maximum soil cover is located in the south-central portion of the impoundment area. The distribution of soil cover is consistent with patterns of historical clean cover soil distribution on the Site and ground conditions during the initial placement of fill. Cover soils have been typically brought onto the Site using the entrance road located in the south-central portion of the Site. The area of the impoundment closest to the diversion ditch dried out first after tailings placement ceased allowing this area to be covered with clean fill first. Clean fill cover was progressively moved out towards the northern edge of the impoundment over time as the tailings dried and ground conditions allowed the use of heavy equipment.

Soil cover thickness south of the diversion ditch range from 7 inches to 1.5 feet. A clean soil stockpile is located south of the diversion ditch, containing approximately 100,000 cubic yards of clean soil imported from excavation sites in and around Park City. The soil cover thickness was not measured in this area. The present height of the stockpile is nearly 45 feet above the surrounding ground surface.

3.1.6 Offsite Soils Cover

The soils observed during the offsite soils cover investigation consisted of a clay-rich, loamy topsoil. Tailings were encountered in three of the sample locations south of the impoundment (T2C, T2D, T3B, T3E). Sample locations are presented on Figure 2-6. In general the soils observed where typical of those found in the surrounding area as well as those observed while conducting background soil sampling (Section 3.1.10).

3.1.7 Sediment Sampling

This section details the results for sediment characterization at the Site.

3.1.7.1 South Diversion Ditch Sediment

The six sediment samples collected from the South Diversion Ditch consisted of predominantly silty-clay/clayey-silts with some very fine to fine gravels and very fine to fine sands. The upper four to five inches of the sediment samples contained dense root material. This root material made the collection of a surface sample unfeasible. Sediment sample locations are presented in Figure 2-7.

3.1.7.2 Wetland and Pond Sediment

Wetland and Pond sediments were collected during Phase I and Phase II ecological sampling. Twenty (20) sediment samples were collected in the pond and wetland area during Phase I. Ten (10) sediment samples were collected in the pond and wetland areas during Phase II. In addition three sediment samples were collected at the reference site during Phase II.

Sediment samples collected from the wetland vary depending on whether the sample was collected in a channel or standing water environment. Samples collected in the higher energy channels in the wetland (e.g. SD-1, SD-13, SD-15 and SD-17) generally contain silty sand with occasional gravel. The remaining samples collected in the wetland are generally composed of a silt and clay mixture with high organic content. The dark gray to black color of these samples are indicative of anaerobic conditions. All samples contained significant amounts of root mass material. The sediment samples collected from the reference site wetland appear to be physically similar to the samples collected at the wetland.

The sediment samples collected from the pond consist of black silty clays with high organic contents. The samples appear to be indicative of generally anaerobic conditions. The pond samples emitted a moderate organic odor when collected.

3.1.8 Tailings

The tailings observed consisted of two types of material: sandy tailings and clay slimes. The sandy tailings consisted of a gray, fine-grained sandy material with occasional very fine to fine grained metallic material, which is likely sulfide minerals. The tailings are generally non-cohesive and moderately well sorted. The clay slimes consist of a gray, cohesive, plastic clay. The clay slimes are interbedded with the sandy tailings. The clay slime horizons could not be correlated among the three test pits. The interface with the overlying soils cover is generally sharp and distinct. Tailings sample locations are presented in Figure 2-7.

3.1.9 Tailings South of the Diversion Ditch

The physical characteristics of the tailings south of the diversion ditch are identical to the tailings observed within the impoundment area (Section 3.1.8). The observed thickness of the tailings ranged from 6 inches to 11.5 feet. The thickest area of tailings (GL-41 and GL-43) were observed in an area located adjacent to the old rail grade in the southeastern portion of the study area. Test pit Logs are presented in Appendix 4.

Tailings were observed in thirty-six (36) of the sixty-three (63) test pits excavated. The extent and thickness of the tailings are presented in Figure 2-8. Two of the test pits that contained tailings (GL-21 and GL-23) contained a mixture of tailings and soil. This area appears to have been disturbed. In twelve (12) of the locations that contained tailings, the tailings were not covered (Figure 3-1). The remaining twenty-four (24) locations contained a soil cover over the tailings (Figure 3-1). The soil cover varied from a brown, silty loamy topsoil to fill material. The interface between the tailings and the overlaying soils is generally sharp and distinct.

The tailings south of the diversion ditch are underlain by a dark brown to black, cohesive, moderately plastic clay. The interface between the tailings and the underlying clay is sharp and distinct. The

thickness of the clay was not evaluated. Evaluation of the thickness of the clay likely would have compromised the integrity of its confining properties.

Twenty-seven (27) locations did not contain tailings. These locations are primarily composed of a red-brown, clayey soil. These locations most likely represent upland areas that did not undergo tailings deposition.

The shape of the southern limits ("Green Line", Figure 2-8) of the tailings appears to have been affected by predepositional topography and the location of tailings input onto the site. Two tongues of tailings on the western portion of the area are likely present when tailings were emplaced. The eastern portion of the area contains two fan-like areas containing a shallow veneer (approximately one foot thick) of tailings. The two fans are laterally connected by a deeper (approximately 2.5 feet thick) lobe of tailings. These features may be related to pre-existing (e.g. pre-tailings deposition) topography.

3.1.10 Background Soil Sampling

Soils at the eleven (11) background soil sample locations were generally composed of a red-brown to brown, silty, clayey, loamy, topsoil. At location BG-11, tailings were obviously encountered as shown by the metals concentrations from this location (Table 4-15). Background sample locations are presented in Figure 2-9.

3.1.11 Study Area Boundary Soil Sampling

Soils at the eight (8) study area boundary soil sample locations contained soils generally composed of a red-brown to brown, silty, clayey, loamy topsoil. At location SAB-6, tailings were obviously encountered as indicated by the metals concentrations at this location. Study area boundary sample locations and concentrations are presented on Figure 2-10.

3.1.12 Wetland and Pond Vegetation Characteristics

A vegetation map of the pond and wetland area is presented in Figure 2-15.

The 2.0 acre pond contains approximately 1.0 acres of riparian habitat type. The perimeter of the pond has a "bathtub ring" of Sandbar willow (*Salix exigua*) with the nearby upland vegetation of Mountain big sage (*Artemisia tridentata vaseyana*). Unlike most other willows, Sandbar willow can send up individual stems from a complex, underground root system which enables this species to pioneer newly developed sand bars or disturbed areas (Padgett, et al, 1989). Much of the understory in this willow type is barren or disturbed (non-native weedy species), which classifies this type as a Sandbar willow/barren community type. According to Padgett et al, the undergrowth of this type is open with predominately bare ground, rock, or leaf litter and only scattered herbaceous species (Padgett, et al, 1989). Graminoids are generally absent.

On the south end of the pond is Baltic rush (*Juncus balticus*), Narrow-leaf cottonwood (*Populus angustifolia*), and Water birch (*Betula occidentalis*) minor community types. Because of the inlet they are found on alluvium type soils (delta). Narrow-leaf cottonwood and Water birch types (along with the generalist Baltic rush type) are typically found on stream (alluvial) terraces and flood plains. Because cottonwood and birch seedlings require moist, bare surfaces for germination, this would indicate that this southwest corner of the pond has flooded in the past. In August 2003, there were deep fine sediments at water's edge on the south end of the pond. It appears there's some soil texture sorting (total loading) occurring with cottonwoods and birches occupying the coarser textured soils on the terrace and Baltic rush (which is typically found in fine-textured soils) occupying closer to the shoreline. On the north end (outlet), is found a Canary reed-grass (*Phalaris arundinacea*) minor type immediately downstream of a beaver dam. There is an active beaver lodge located in the northeast corner of the pond close to the dam. Below that, the outlet transitions to a Sandbar willow/mesic graminoid type and passes through a geologic "choke" before it ends in the "wetland" below.

The wetland at the Site is the confluence of Silver Creek with the outlet of the pond, (located immediately to the south), before they flow through a culvert under Highway 248. This approximately 7.0 acre parcel is characterized by a tall willow/mesic graminoid community type on the south end before it transitions into a herbaceous type at 6,608.0 ft in elevation. Winward (1989) has found this generally occurs where the stream gradient falls below 0.5%. Because these low gradient streams have little potential for flooding and cutting of the stream channel, flood-dependent willows are absent (Winward, 1989). Here the landscape becomes a swampy meadow with permanently wet soils. According to Padgett et al, mesic or

moist conditions appear optimal for the growth of the Booth's willow/mesic graminoid community type[3] (Padgett, et al, 1989).

The low gradient, swampy meadow is dominated by cattail (*Typha latifolia*) where it forms a mostly monotypic stand. There is however, a trace of Willow herb (*Epilobium spp*) growing in the understory. The stream channel found through this cattail community was still or slowly moving. In mid-August 2003, this stand of cattails attained a height of 8.0 feet. According to Cooper, cattails grow tallest in standing water and fresh, non-saline sites (Cooper, 1989). Besides the cattail community, there are minor communities of Beaked sedge (*Carex rostrata*) and Reed canary-grass (*Phalaris arundinacea*) found in these saturated soils (Cooper, 1989). Both are strongly rhizomatous and typically form mono-typic stands.

The perimeter of this swampy meadow is dominated by Baltic rush (*Juncus balticus*). Unlike cattail and Beaked sedge, which are classified as obligates and form monotypic types, Baltic rush occupies a wide variety of habitats and commonly occurs as small inclusions within other larger community types. It can grow from saline to non-saline, mesic to hydric, and often grows with Kentucky bluegrass (*Poa pratensis*) or variably with other forbs. The forb component can be nearly absent to well over 50 percent (Padgett et al, 1989). In the Richardson Flat wetland there's a high component of Maritime arrowgrass (*Triglochin maritima)*, Big-leaved avens (*Geum macrophyllum*) and Blue Jacobsladder (*Polemonium caeruleum*).

4.0 NATURE AND EXTENT OF CONTAMINATION

This section describes the extent of contamination associated with the Site. The results of analytical testing detailed in this section are presented by medium: surface water, groundwater, onsite soils cover, offsite soils cover, sediment, tailings, tailings south of diversion ditch, background soils and study area boundary sampling. In addition ecologically related media such as wetland and pond sediment chemistry and toxicity, vegetation and aquatic wildlife are described in Section 4.10. United Park, EPA, and UDERR are presently addressing ecological media through a Screening Ecological Risk Assessment (SERA) and Biological Technical Assistance Group (BTAG) meetings.

3 Padgett, Wayne, Andrew Youngblood, Alma Winward. Riparian Community Type Classification of Utah and Southeastern Idaho, 1989. USDA Forest Service R4-Ecol-89-01.

The concentrations of analytes are summarized in Tables 4-1 through 4-23. Laboratory analytical and data validation reports are presented in Appendix 5. Analytical results are presented for data collected from April 2001 through August 2002 and ecological related data collected June through August 2003. Monthly data collection activities have ceased as of August 2002. The monthly surface water data set consists of sixteen (16) rounds of monthly sampling. The monthly groundwater data set consists of fourteen (14) rounds of monthly sampling. The duration of both the surface and groundwater sampling periods exceed the twelve (12) month specified in the SAP (RMC, 2000). The 2003 data was collected in the pond and wetland area (Figure 1-3) and was collected in two phases to assess ecological related impacts in the pond and wetland area. The ecological data is presented and discussed separately in Section 4.10.

Rather than present summary data for all metals evaluated during this study, the discussion in this section focuses on selected indicator metals. However, all data collected are presented in the attached tables. The discussion in this section focuses on arsenic and lead as marker contaminants for human health exposures. Generally, where lead and arsenic are elevated, one might assume that other heavy metals may be elevated as well. Metals such as cadmium, chromium (depending on valence state), mercury and selenium may present toxicity problems to ecological receptors. Zinc is used as an indicator contaminant in sediment, surface water and groundwater as it may pose a risk to aquatic organisms if it is dissolved in surface water, and the presence of zinc may indicate the presence of other metals. Zinc and cadmium are the contaminants of concern in the Silver Creek watershed. Based on data collected by United Park and others it appears that the zinc found in the Park City Mining District ores is soluble when exposed to water and oxygen. In most cases, these indicator metals represent the highest metals concentrations and likely greatest risk. From a risk management perspective, managing indicator metal concentrations through remedial design will likely address other contaminants as well.

4.1 Surface Water

The objectives of surface water sampling were to characterize seasonal water quality and quantity in the South Diversion Ditch and in unnamed drainages flowing into the diversion ditch and Silver Creek. A second objective was to provide additional surface water data for comparison with human health and ecological screening levels. Data from the unnamed drainages, which flow only in response to snowmelt or significant storm events, provide limited background water chemistry data. Table 4.1 presents the summary of surface water analytical data, Table 4.2 presents the low detection mercury data collected at

select locations. The analytical data are used in Section 5.0 to evaluate fate and transport of Site contaminants.

All dissolved metal measurements were screened against Utah Water Quality Standards (*See,* Table 4-3). Silver Creek is classified by the State as Class 1C (protected for domestic purposes with prior treatment), 2B (protected for secondary contact recreation), and 3A (protected for cold water species of game fish and other aquatic life). The most stringent of these standards are generally the Class 3A aquatic wildlife chronic standards. For many metals such as cadmium and zinc, these wildlife standards are hardness dependent when determining the acute or chronic toxicity concentration of a metal. All appropriate parameters were adjusted for an average hardness measured at each sample location. The Laboratory Reporting Limit (LRL) for silver is 0.005 ppm and the aquatic wildlife standard for silver is 0.0041 ppm. Most silver data for the diversion ditch are below the LRL. Assuming that one half of the LRL is an appropriate estimated concentration for non-detected values silver, it is likely that most silver concentrations measured in the diversion ditch are below the standard. Table 4-4 presents the limited data available for background water chemistry.

Surface water field parameters (pH, conductivity, temperature and flow) are presented in Table 3-1.

4.1.1 Background Water Quality

Two locations were sampled in April and May 2001 and 2002 to collect background data. Sample locations RF-1 and RF-2 (Figure 2-1) are in the ephemeral drainage upstream from the impoundment. Complete analytical results are presented in Table 4-1. Flow in this drainage occurs only in response to snowmelt or large rainfall events. No flows occurred at these locations during sampling events later in the season. Data from these locations represent background surface water quality in the vicinity of the Site. Summary statistics for metals at these two locations are presented in Table 4-4.

As shown in Table 4-4, background concentrations for silver, cadmium, chromium and selenium are below laboratory reporting limits. Background total and dissolved arsenic concentrations range from <0.005 to 0.008 ppm. Background total mercury concentrations range from 0.00000198 to 0.00000693 ppm, while dissolved mercury concentrations range from 0.00000442 to 0.0002 ppm. Mercury was analyzed using two EPA Methods, 6010 and Method 1631 which measures to a parts per trillion resolution. Background total lead concentrations range from <0.005 to 0.005 ppm, while dissolved lead

concentrations range from <0.005 to 0.007 ppm. Total antimony concentrations range from <0.005 to 0.006 ppm, while dissolved antimony concentrations range from <0.005 to 0.01 ppm. Background total zinc concentrations range from 0.022 to 0.094 ppm (average 0.048 ppm), while dissolved zinc concentrations range from 0.023 to 0.095 ppm (average 0.054 ppm). In a few instances dissolved exceeded total concentrations, this is likely due to sample collection or analytical errors. Sample collection at the background locations was difficult due to very low flows experienced during the June sampling period. The background sample locations are ephemeral drainages that flow only in response to snowmelt or high precipitation rainfall events. Other parameter statistics are presented in Table 4-4. Background pH ranges from 6.7 to 8.54 S.U. (Table 3-1).

4.1.2 South Diversion Ditch

Surface water samples were collected from five (5) locations in the South Diversion Ditch (RF-4, RF-5, RF-6-2, RF-11 and RF-12) and one (1) location in a tributary to the diversion ditch (RF-3-2). The sampling locations are shown in Figure 2-1. Due to seasonal variations in flow, samples could not be collected from all four locations during each monthly sampling event. Sampling frequency for each station is presented in Table 2-1. Complete analytical results are presented in Table 4-1, low detect mercury data are presented in Table 4-2, and comparison of the data to Aquatic Wildlife Chronic Criteria (AWCC) is presented in Table 4-3. The South Diversion Ditch, part of the operating system for the tailings impoundment, collects snowmelt and stormwater run-on and intercepts groundwater flowing towards the impoundment from the south and west. Groundwater interception is inferred based on surface and groundwater elevation data collected from monitoring well RT-14 and staff gauge SG-1. In addition, the lower section of the ditch functions as a wetland bioremediation system reducing metal concentrations in the water.

Table 4-3 presents a comparison of analytical results to the AWCC, the most stringent standards that may apply to the Site. Review of Table 4-3 indicates that zinc exceeds the criteria on the greatest frequency at location RF-4, with one sample exceeding the AWCC for zinc at RF-5. Zinc did not exceed the AWCC at RF6-2 located at the terminus of the diversion ditch. Low detection mercury analyses conducted at RF6-2 (terminus of the diversion ditch) indicated that mercury does not exceed the AWCC. Water quality at RF3-2 exceeded the AWCC for mercury one out of four rounds of sampling. Low detect mercury analyses were not conducted at this location, therefore, it is unknown if the water quality consistently exceeds the AWCC. At location RF-3-2, zinc measurements satisfied the AWCC except for one sample.

In that sample, dissolved zinc was reported to be greater than total zinc, indicating either field or laboratory error. Samples collected at locations RF-11 and RF-12 in the upper reaches of the diversion ditch indicate an increase in zinc concentrations may be occurring in the reach located between the two sample locations. The samples collected at RF-11 are below the criteria while the samples collected at RF-12 exceeded the criteria. This may indicate an inflow of zinc-impacted water in the reach between RF-11 and RF-12. Two possible sources of zinc in this area include a source in the ditch itself (such as sediments or tailings) or water that is emanating from the ponded area south of the county road (the area in the vicinity of SG-3 as shown on Figure 1-4). The ponded area commonly contains surface and sub-surface water during spring and early summer. The ponded area contains tailings that are at the surface or covered with a thin veneer of cover soils. Surface and shallow groundwater may interact with the tailings in this area and then flow at the surface or through the paleochannel (e.g. the pre-tailings channel) to be intercepted by the ditch.

The highest zinc concentrations are found at RF3-2, a tributary to the diversion ditch, while the lowest concentrations are found at RF6-2, where the diversion ditch enters the wetland. Time-series plots of dissolved zinc concentrations for each sample location except for RF-11 and RF-12 are provided on Figure 4-1. RF-11 and RF-12 are not included as they were added to the sampling program in 2002 and were only sampled two times. The time-series plots show that the peak zinc concentrations at RF3-2 were measured in June 2001, while peak concentrations at RF-4 and RF5 were measured in May 2001. Data collected at RF-4 and RF-5 during two spring runoff cycles indicate that zinc concentrations in the upper and middle reaches of the diversion ditch are proportional to flow rates. Although there is some variability in dissolved zinc concentrations at RF6-2 (0.023 to 0.15 ppm), no obvious seasonal effect is apparent. The dissolved zinc concentrations at RF6-2 were consistently less than about half of the AWCC.

4.1.3 Silver Creek

Silver Creek surface waters were sampled at two (2) locations (Figure 2-1). Sample location RF7-2 is located upgradient from the impoundment. Sample location RF-8 is located downgradient from the impoundment. Complete analytical results are presented in Table 4-1.

Comparison of analytical results, presented in Table 4-1, to the AWCC indicate that only zinc (dissolved) exceeds the AWCC at the two Silver Creek surface water sample locations (*See,* Table 4-3). Time-series

plots of dissolved zinc concentrations for each sample location are provided on Figure 4-1. The time-series plots show variability in dissolved zinc concentrations, with peak concentrations in May 2001 associated with spring runoff. Two additional peaks occur in late fall 2001 and early spring 2002.

4.1.4 Floodplain Tailings Area

Surface water samples were sampled at five (5) locations to the west of Sliver Creek in the vicinity of the Floodplain Tailings. Samples were collected in May 2002. Sample location PH-SW1 is located in the Pace Homer ditch near State Highway 224. Surface water sample FPT-SW1 was collected in Silver Creek upgradient from the Floodplain Tailings area, FPT-SW2 and FPT-SW-4 are located in the tailings area and FPT-SW3 is located downgradient from the tailings area. Complete analytical results are presented in Table 4-5.

Comparison of analytical results, presented in Table 4-6, to aquatic wildlife criteria indicate that dissolved zinc concentrations exceed the AWCC for zinc at two (2) locations FPT-SW1 and FPT-SW3.

4.1.5 Surface Water Summary

The data presented in Sections 4.1.1 through 4.1.4 indicate that metals concentrations are substantially lower in water discharged from the South Diversion Ditch (RF6-2) than in Silver Creek (RF7-2 and RF8). In fact, zinc concentrations are two orders of magnitude lower at RF6-2 than in Silver Creek. Average dissolved zinc concentrations at RF6-2 were approximately 0.055 ppm during the investigation as compared to average dissolved zinc background concentrations measured at RF-1 and RF-2 of 0.033 ppm. Zinc concentrations in Silver Creek exceed zinc concentrations collected in surface water west of the Floodplain Tailings.

Surface waters in both upstream and downstream locations in Silver Creek contain zinc concentrations that exceed the chronic and acute aquatic wildlife standard for zinc. This is in contrast to the metals concentrations measured in the downstream end of the diversion ditch (RF6-2) that are below both the chronic and acute aquatic wildlife standard for zinc. The surface water data and mixing calculations data presented in Section 5.4.4 indicate that water emanating from the Site is not impacting Silver Creek. These results strongly suggest that the Richardson Flat tailings impoundment does not significantly impact water quality in Silver Creek.

4.2 Ground Water

The objectives of groundwater sampling were to determine metal concentrations in the Silver Creek shallow alluvial aquifer both up and downgradient of the impoundment as well as to assess groundwater conditions in the shallow aquifer associated with tailings south of the diversion ditch. Due to turbidity problems, the first round of samples collected in June were discarded (see Data Quality Assessment, RMC, 2002). Sample locations are presented in Figure 2-1. Complete analytical results are presented in Table 4-7. Groundwater field parameters (pH, temperature and flow) are presented in Table 3-1.

4.2.1 Silver Creek Alluvial Aquifer

Discuss whether increase or decrease

The shallow Silver Creek Alluvial Aquifer was sampled at two locations: Monitoring Well RT-11 located upgradient of the Site, and Monitoring Well RT-12 located downgradient of the Site. Comparison of water chemistry data from these wells to Primary and Secondary Drinking Water Standards (PDWS and SDWS) and Treatment Technology Requirement (TTR) for drinking water is presented in Table 4-8. Comparison to these standards is conservative the shallow Silver Creek Alluvial Aquifer is not used as a drinking water source near or on the Site (*See*, Section 3.1.4 at p.23). This comparison indicates that antimony and cadmium exceed the PDWS both upstream and downstream of the Site; however six (6) of the last seven (7) downstream samples collected were below the PDWS for antimony. Iron exceeds the SDWS downstream of the Site, manganese and zinc exceed the SDWS both up and down stream of the site. Lead exceeds the TTR up and downstream of the site, however five (5) of the last six (6) downstream samples collected were below the standard. Three (3) out of fourteen (14) mercury samples exceeded the PDWS downstream of the site.

Time-series plots of total lead and zinc concentrations for each sample location are provided on Figure 4-2. Although there is some variability in lead and zinc concentrations, time-series patterns for these metals are somewhat consistent in RT-11, while time-series patterns are less consistent in RT-12.

4.2.2 Groundwater in Tailings South of the Diversion Ditch

Groundwater contained in the tailings south of the diversion ditch was sampled in three monitoring wells: RT-13, RT-14 and RT-15. Monitoring Well RT-15 did not contain water during most of the study except two (2) samples were collected from RT-15 in April and May of 2002. Table 4-8 presents a comparison of analytical results to groundwater standards. Review of Table 4-8 indicates that groundwater in MW-15

exceeded the PDWS for cadmium, antimony and zinc. The Secondary National Water Standard (SNWS) for manganese was exceeded in all three wells. MW–14 exceeded the SNWS for iron, and MW-15 exceeded the Secondary National Water Standard for aluminum and iron. All other metals are below the PDWS and SNWS. The results indicate that the groundwater sampled from wells RT-13 and RT-14 generally contains low concentrations of metals. Arsenic and lead concentrations are below or near the lower laboratory reporting limits. Only one dissolved zinc measurement exceeded potentially applicable standards out of twenty-six samples from these two wells. As mentioned above some metal concentrations exceed standards in well RT-15, however, given the limited volume of water present at this location impacts to surrounding resources are unlikely.

Time-series plots of total lead and zinc concentrations for each sample location are provided on Figure 4-2. Although there is some variability in lead and zinc concentrations, no clear seasonal relationship are apparent.

4.2.3 Floodplain Tailings

Shallow groundwater contained in the Floodplain Tailings was sampled from six (6) monitoring wells. Analytical results are presented in Table 4-5. Comparison of water chemistry data from these wells to Primary and Secondary Drinking Water Standards (PDWS and SDWS) and Treatment Technology Requirement (TTR) for drinking water is presented in Table 4-6. Review of Table 4-6 Indicates that arsenic (two of six wells), cadmium (five of six wells), mercury (one of six wells) and antimony (all six wells) exceeds the PDWS in the Floodplain tailings area. Aluminum (four of six wells), iron (five of six wells), manganese (five of six wells) and zinc (four of six wells) exceed the SDWS in the Floodplain Tailings area. Lead exceeds the TTR in all six of the wells sampled.

A potentiometric surface map for the reach of Silver Creek adjacent to the Floodplain Tailings is presented in Figure 4-3. A series of hydrogeologic sections for this area are presented in Figure 4-4. Based on the potentiometric data presented in Figure 4-3 it appears likely that in the reach adjacent to the Floodplain Tailings Silver Creek is a gaining stream and is receiving water through the area of the Floodplain Tailings although no perceptual difference in flow appears to exist. Water yield from the shallow Floodplain monitoring wells was extremely low with most of the wells barely yielding enough water to collect a sample. The low groundwater yield could explain why there does not appear to be a increase in the Silver Creek flow in this area. Figure 4-4 presents the hydrogeology in the vicinity of Silver creek and the Floodplain Tailings schematically.

Need better discussion

4.2.4 Groundwater Results Summary

Groundwater sampling results indicate that the groundwater contained within the tailings south of the diversion ditch has much lower concentrations of metals than the groundwater in the Silver Creek alluvial aquifer. Average dissolved zinc concentrations in groundwater associated with the tailings are about 500 times lower than concentrations measured in the upgradient Silver Creek alluvial aquifer. Based on these data, it does not appear that the Richardson Flat tailings are contributing zinc or other metals to the Silver Creek alluvial aquifer. Tailings south of the diversion ditch are contained by the native and imported clay soils, data collected by RMC and Weston show that the clay beneath the tailings is providing a barrier to the transport of metals in the tailings. In addition data from wells RT-12 and RT-13 indicate that very little leaching is occurring in those locations. This is due to the depth of clay fill (exceeding 1.0 feet) over the tailings in those areas. The data do show that leaching of metals is occurring near RT-15, however, the quantity of groundwater present in this area is low and is related to spring snowmelt. The depth of cover over tailings in the RT-15 area may be less than the area near RT-12 and RT-13. Data collected as part of the focused RI does not indicate that tailings in and around the impoundment are impacting Silver Creek alluvial wells. It does appear from water analyses and water elevation data that the Floodplain Tailings are impacting Silver Creek water chemistry. In the area near RT-12 it appears that the groundwater is approximately four (4) feet lower than surface water in Silver Creek. Based on this elevation difference Silver Creek may be a losing stream near RT-12.

4.3 Onsite Soil Cover

The objectives of the onsite soil cover investigation were to determine: (1) the extent and thickness of the soil cover and (2) the chemical characteristics of the surface soils that have been previously placed to cover the Site. A 500 by 500-foot grid was used to locate forty-one (41) sample locations (Figure 4-5). All samples were analyzed for lead and arsenic. In addition twenty-four (24) samples were analyzed for the eight RCRA metals including zinc and copper. The thickness of the soil cover was measured at each sample location. Complete sample results are presented in Table 4-9.

Forty-one (41) samples were collected at the surface (0-2") to evaluate metals concentrations in the uppermost portion of the soil cover. In addition, eleven (11) samples were collected directly above the cover/tailings interface. These samples were collected to confirm the visual verification of the interface. The depth of the interface samples ranged from 6 to 18 inches.

Analytical results for the 58 samples (includes duplicate sample results) of onsite soil cover samples indicate a range of values from 13 to 3,239 ppm lead and <5 to 121 ppm for arsenic. The average lead concentration of the forty-one (41) samples collected from the 0 to 2-inch zone was 395 ppm. The average arsenic concentration of the forty-one (41) samples from the 0 to 2-inch zone was 22 ppm.

In the eleven (11) deeper samples, lead concentrations ranged from 13 to 634 ppm with an average of 110 ppm. Arsenic concentrations ranged from <5 to 46 ppm with an average of 12 ppm.

In addition to the lead and arsenic analysis, twenty-two (22) samples were analyzed for the eight RCRA metals as well as zinc and copper. Analytical results for these metals are presented in Table 4-9. There are no regulatory criteria for metals in soils as there are for metals in water. The sampling results will be compared to appropriate risk-based concentrations, or background soil concentrations as part of the ecological and human health risk assessments.

The distribution of lead concentrations in the onsite cover soils was analyzed by plotting the concentrations on a Site Map (Figure 4-5). The distribution of lead concentrations in the 0 to 2-inch interval of onsite cover soils appears to be fairly random most of the highest concentrations are along the western and southern sides of the tailings impoundment. This appears to be related to the thickness of soil cover in those areas, in a few of the areas sampled the cover thickness was less than six inches and some mixing appears to have occurred.

4.4 Offsite Soils Cover

The objectives of the offsite cover sampling was to assess the extent and potential human health and and/or environmental impact from windblown tailings as well as to aid in the delineation of the study area boundary. Samples were collected from three (3) transects, orientated perpendicular to the prevailing wind directions. The prevailing wind direction, as determined by EPA's contractor (E&E, 1987), is from the southeast (*See,* Figure 2-5). Samples were collected from 28 locations (Figure 2-4). One transect was located to the north of the Site (T1). Two transects were located to the south of the Site (T2 and T3).

Analytical results are presented in Table 4-10. The analytical results of the samples analyzed indicate a range of 17 to 5,875 ppm lead and 7.1 to 243 ppm arsenic for the 28 samples collected from 0 to 2 inches.

The samples collected from the 1 to 6-inch interval contained a range of 18 to 6,265 ppm lead and 6 to 316 ppm arsenic. The arsenic/lead ratio is similar in samples with both high and low metals concentrations (i.e., an increase in lead values correlates to an increase in arsenic values).

The average results for each transect are presented below:

Transect	0-2" Pb	0-2"As	1-6" Pb	1-6" As
Transect 1	123 ppm	12 ppm	108 ppm	11 ppm
Transect 2	1,636 ppm	74 ppm	1,446 ppm	75 ppm
Transect 3	142 ppm	12 ppm	86 ppm	10 ppm

The results of individual transects indicate that the lead and arsenic concentrations contained in Transect 2 are significantly greater than in samples from Transects 1 and 3. Transect 2 is located to the south of the impoundment area with portions of the transect located within the area containing tailings south of the diversion ditch. It is possible that at certain locations on Transect 2 the tailings may not be completely covered. The area containing the highest lead and arsenic concentrations (T2 C, D and E) has areas of exposed tailings.

The average lead concentration data indicate that Transects T1 and T3 are not impacted by wind blown tailings. Comparison of individual data points with a background lead concentration of 114 ppm (Letter to EPA RMC, 2/11/02) indicates that a few locations (T1A and T3B, Table 4-10) may have been impacted by wind blown tailings.

In addition to the lead and arsenic analysis, five (5) samples were analyzed for the eight RCRA metals and zinc and copper. The results from the five samples do not indicate the presence of elevated concentrations of these metals in the offsite cover soils as compared to the results of background soil sampling (Section 4.8).

4.5 Sediment Sampling

Sediment samples were collected from six (6) locations in the South Diversion Ditch (see Figure 2-7). Samples were collected from the 0 to 6-inch interval. The upper four to five inches of the sediment

samples contained dense root material. This root material made the collection of a surface sample (0 to 2 inches) impossible. Complete analytical results are presented in Table 4-11.

Elevated concentrations of lead, arsenic and zinc were measured in all of the sediment samples. The analytical results for the six samples analyzed indicate a range of lead concentrations from 1,880 to 3,490 ppm, the average lead concentration is 2,578 ppm. The range for arsenic concentrations for the six samples is 101 to 205 ppm, the average arsenic concentration is 138 ppm. The range of zinc values for the six samples is 2,940 to 12,000 ppm, the average zinc value is 7,878 ppm.

The highest lead concentration was observed at the SD-1 location, this sample also contained the highest silver, cadmium, copper, iron, mercury and zinc concentrations. Location SD-1 is located in the lower most portion of the diversion ditch (*See* Figure 2.7). Arsenic, lead and zinc concentrations are lowest in the sample collected at the most upstream location (SD-6) of the ditch. The concentrations of these three metals is roughly proportional in the six samples collected. The distribution of metals in sediments along the diversion ditch is further discussed in Section 5.0.

X-ray Diffraction (XRD) analysis was performed on the six sediment samples from the South Diversion ditch. The results of the analysis indicate that the samples are predominantly composed of 30 to 45 percent quartz, 5 to 20 percent calcite, 10 to 15 percent dolomite, with smaller concentrations of the sulfide minerals pyrite (<5%) and sphalerite (<5%). Other minerals that may be present include: albite, anorthite, paragonite, montronite, clinochlore, ferro-gedrite and montmorillonite. These minerals contain a low level of crystallinity and are difficult to quantify using XRD analysis.

4.6 Tailings

Tailings samples were collected from three backhoe excavated test pits located within the impoundment area (Figure 2-7). Six (6) samples were collected from each test pit. Samples were collected at one-foot intervals beginning at one foot below the soil cover/tailings interface. The soil cover was one-foot thick at each test pit location. Complete analytical results are presented in Table 4-12.

As might be expected, higher concentrations of lead, arsenic and zinc were measured in the tailings samples as compared to sediment or surface soil metals concentrations. The range of lead values from the samples analyzed was 1,470 to 14,700 ppm with an average concentration of 4,530 ppm. The range of

arsenic values in the samples analyzed was 148 to 417 ppm with an average of 254 ppm. The range of zinc values from the samples analyzed was 2,110 to 15,300 ppm with an average of 5,992 ppm.

Soil pH was analyzed for each of the three composite tailings samples collected (Table 4-13). The range of soil pH for the composite tailings samples was 7.3 to 7.7. The average pH value for the composite tailings samples was 7.5.

X-ray Diffraction (XRD) analysis was performed on the three composite tailings samples. The results of the analysis indicate that the samples are predominantly composed of 25 to 50 percent quartz, 5 to 40 percent calcite, 5 to 25 percent dolomite with the sulfide mineral pyrite (<5%) and ankerite (one sample, <5%). Minerals that may be present include: clinochlore, tosudite, galena, brushite, carlosturanite, ferro-gedrite and iron oxide. These minerals contain a low level of crystallinity and are difficult to quantify.

4.7 Tailings South of the Diversion Ditch

Samples collected from the area south of the diversion ditch containing tailings were analyzed from a total of seven (7) sample locations (GL-50, Gl-52, Gl-53, GL-56, Gl-58, GL-59, GL-62). The sample locations are shown in Figure 2-8. Two (2) samples were analyzed from each location. One sample was collected from the tailings located directly above the tailings/clay interface. A second sample from the clay was analyzed from directly below the tailings/clay interface. All samples were analyzed to confirm the visual assessment of the interface as well as to assess concentrations of metals above and below the interface. Analytical results are presented in Table 4-14.

The average lead concentration in the tailings above the interface in the seven samples analyzed is 10,434 ppm. The average concentration of lead in the clay below the interface is 52 ppm, well below 114 ppm, the upper-bound background soil lead concentration (Letter to Jim Christiansen, RMC, 2/11/02). The average arsenic concentration in the tailings above the interface in the seven samples analyzed is 412 ppm. The average concentration of arsenic in the clay below the boundary is 9 ppm, well below 17.4 ppm, the upper-bound background soil arsenic concentration (Letter to Jim Christiansen, RMC, 2/11/02).

In general, the tailings metals concentrations are higher in the samples collected south of the diversion ditch than those of the samples collected from the three tailings test pits located within the impoundment (Section 4.6). The average lead concentration for the samples collected within the impoundment is 4,530

ppm as compared to 10,434 ppm for the samples collected south of the diversion ditch. The average arsenic concentration for the samples collected within the impoundment is 254 ppm as compared to 412 ppm for the samples collected south of the diversion ditch.

The average zinc concentration in the tailings above the interface in the seven samples analyzed is 11,355 ppm. The average concentration of zinc in the clay below the boundary is 349 ppm.

The difference in concentrations of metals in the tailings above the interface and the clay below the interface indicate distinct differences in the chemical composition of the two media. The difference also indicates that the downward migration of metals to the clay has not occurred and verifies the visual method employed to distinguish between the layers. Given the significant amount of time these tailings have been located in this area, it is unlikely that any significant downward migration of metals will occur in the future.

The average aluminum concentration in the tailings above the interface in the seven samples analyzed is 4,613 ppm. The average concentration of aluminum in the clay below the boundary is 24,594 ppm. The difference in aluminum concentrations can be attributed to the fact that the tailings and clay are composed of two separate materials. The aluminum concentrations in the clay can be attributed to the presence of clay minerals in which aluminum is the primary metal (Grim, 1968). Clay minerals are essentially hydrous aluminum silicates (Hurlbut and Klein, 1977) and naturally contain significant amounts of aluminum. X-ray diffraction analysis performed by Weston Engineering (1999) on soils underlying the tailings confirms the presence of sepiolite or mixed layer clay minerals (mixed mica and illite or smectite) in the material underlying the tailings. Mixed layer minerals typically adsorb water (Grim, 1968). Likewise, because of the weak bond between layers, metals are absorbed by the mixed-layered clays (Weston, 1999). As shown in Weston's report, (*See*, Appendix 1) Plate 1 the clay layer is continuous throughout all areas where tailings were deposited.

X-ray Diffraction (XRD) analysis was performed on three clay samples (Weston, 1999). The samples were analyzed for general minerals and also specifically for clays. The results of the general mineral analysis indicate that the samples are predominantly composed of 22 to 37 percent quartz. Other minerals that may be present include: clinochlore, albite, sanidine, muscovite, orthoclase and montmorillonite. The clay-specific analysis results indicate that the samples contained the following clays: montmorillonite,

illite and dickite. The clay minerals contained low levels of crystallinity indicative of mixed layer clays (Grim, 1968).

Soil pH was analyzed for three of the clay samples collected (Table 4-13). The range of soil pH for the clay was 7.0 to 7.6. The average pH value for the clay samples was 7.2.

In summary, based on the analysis of the tailings and the underlying clays, it appears that metals contained in the tailings have not migrated into or through the clays. Migration of metals from the tailings into the underlying clay has not occurred south of the diversion ditch as shown by the tailings and clay metals analyses. Consequently, it appears unlikely that metals have leached from tailings in the impoundment and affected offsite resources. Therefore the clay layer appears to be serving as an effective liner for the impoundment.

4.8 Background Soil Sampling

Soil samples were collected at eleven (11) locations to determine background metals concentrations in soils near the Site. The data obtained from the background samples was also used to define the Site limits. Samples were collected from locations shown on Figure 2-9. Analytical results are presented in Table 4-15. Table 4-16 presents a comparision of background sampling results with results obtained from onsite and offsite sampling for the full suite of metals (Ag, As, Ba, Cd, Cr, Cu, Hg, Pb and Zn. Soil data presented in Table 4-16 represent background metal concentrations in that the soil samples are either from native soil locations (e.g., transects) or of imported soil that came from surrounding sites in the area to provide cover for the tailings. As can be seen by the comparison metal concentrations in background (BG identifier) fall within the mean, plus or minus the standard deviation, of metal concentrations for either the cover or transect samples.

One sample collected was not indicative of background conditions. The lead concentration at BG-11 (7,731 ppm) is more indicative of metals impacted areas. Sample location BG-11 is located approximately one mile north of the Site in the floodplain of Silver Creek. Sample BG-11 was not used in background ranges or in calculating the average values.

The average lead concentration for the area surrounding the Site is 43.3 ppm. The average concentration for arsenic for the area surrounding the Site is 9 ppm. Two background samples were also analyzed for

the eight RCRA metals. Elevated concentrations of the metals analyzed were not present in either of the samples analyzed.

4.9 Study Area Boundary Sampling

The study area boundary was determined by utilizing off-site soils data and collecting an additional eight (8) samples. Samples were collected from locations where data gaps prevented the definition of a study area boundary. Study area boundary soil sample locations are presented on Figure 2-10. Study area boundary analytical results are presented in Table 4-17.

The Study Area Boundary was evaluated using data collected as part of the RI/FS investigation. The boundary was delineated using background soil lead concentrations and by circumscribing a line within those soil concentrations. This line represents the point at which background soil concentrations generally begin with lead being used as an indicator contaminant. The data indicate that if lead concentrations are elevated then other related metal concentrations are elevated as well. Table 4-17 portrays background soil lead concentrations and statistics used to estimate a mean background lead concentration for this area. A realistic estimate for the upper bound of the background soil lead concentration is the mean + the standard deviation. This results in a background soil lead concentration of 114 mg/kg. The area enclosed by the study area boundary contains approximately 263 acres.

Because sample results indicate SAB-6 was located in an impacted area, the results from SAB-6 were not included in the data set used to calculate the upper-bound background concentration.

4.10 Wetland and Pond Area Ecological Nature and Extent

This section describes the extent of contamination in the pond and wetland area and how it relates to ecological receptors. As stated in Section 4.0 the ecological data was collected in two (2) phases during June and July 2003. Surface water and sediment data collected was collected at up to twenty (20) locations during Phase I. The Phase I data was used to select a set of ten (10) sample locations for Phase II sampling. Phase II sample locations were selected to encompass the full range of concentrations obtained during the Phase I sampling with a sufficient concentration gradient between the sample locations. Ecological data is presented in Tables 4-18 through 4-23. A reference site containing a pond and wetland area was sampled as part of Phase II sampling activities (Figure 1-2).

4.10.1 Wetland and Pond Area Surface Water

The objectives of surface water sampling in the pond and wetland area were to characterize water quality and how it relates to ecological health. Surface water samples were collected at four (4) locations in the wetland and two (2) locations in the pond during Phase I sampling. Phase I surface water analytical data is presented in Table 4-18. Phase II surface water sampling included the collection of two (2) wetland samples, two (2) pond samples as well as one (1) pond and one (1) wetland sample at the reference site. Two locations were not sampled during Phase II due to seasonally low water. Surface and porewater field parameters (pH, temperature and conductivity) are presented in Table 3-3.

All dissolved metal measurements were screened against Utah Water Quality Standards (*See,* Table 4-19). Silver Creek is classified by the State as Class 1C (protected for domestic purposes with prior treatment), 2B (protected for secondary contact recreation), and 3A (protected for cold water species of game fish and other aquatic life). The most stringent of these standards are generally the Class 3A aquatic wildlife chronic standards. For many metals such as cadmium and zinc, these wildlife standards are hardness dependent when determining the acute or chronic toxicity concentration of a metal. All appropriate parameters were adjusted for an average hardness measured at each sample location.

The Laboratory Reporting Limit (LRL) for silver is 0.005 ppm; the aquatic wildlife standard for silver is 0.0041 ppm. Silver data for all sample locations are below the LRL. Assuming that one half of the LRL is an appropriate estimated concentration for non-detected values silver, it is likely that most silver concentrations measured in the diversion ditch are below the standard. Two locations contained zinc concentrations that exceed the Chronic Aquatic Criteria for zinc. Locations SD-4 and SD-7 are located in the northern portion of the wetland. As discussed in Section 3.1.3.1 this area of the wetland contains waters that are directly influenced by Silver Creek, which contains zinc concentrations that exceed the standard (Section 4.1.3).

4.10.2 Sediment Porewater

The objectives of porewater sampling in the pond and wetland area were to characterize porewater quality and how it relates to surface water quality, metals concentrations in sediments and ecological health. Porewater samples were collected at eight (8) locations in the wetland and two (2) locations in the pond as well as one (1) pond and one (1) wetland sample at the reference site. Porewater analytical data is presented in Table 4-18.

Porewater results were not compared to standards and are discussed here in general terms. The discussion of porewater quality is generally limited to dissolved constituents due to moderately high total suspended solids values (TSS). The TSS range of <1.0 to 287 ppm (average 115 ppm) was likely caused by typical porewater collection methodologies. The micropiezometer is a temporay miniture wellpoint that is not constructed with a filter pack therefore there is no mechanism to filter out fine-grained sediments. The filtering of samples for dissolved metals analysis eliminates the suspended material. In addition, metals standards for biologic receptors are based on dissolved constituents.

Metals concentrations in porewater are generally highest in the three wetland locations (SD-2, SD-4 and SD-6) that are influenced by Silver Creek and the two sample locations located in the upper reaches of the wetland (SD-15 and SD-17). These locations contain water that have had a lower exposure time in the wetland. Sulfide concentrations are generally highest in sample locations in which the porewater has had a longer exposure time to the sediments this includes areas with slow travel time (e.g. the pond). The concentration and/or presence of sulfides are generally inversely proportional to the concentration of dissolved metals. The presence of sulfides and the reduction in porewater metals concentrations in these areas are indicative of the presence of sulfide reducing bacteria. The sulfide reducing bacteria convert metals to metal sulfides reducing the bioavailability. This is evidence that the wetland is functioning as a biotreatment system that is reducing the amount of metals in porewater as well as the bioavailability of metals.

4.10.3 Wetland and Pond Sediment

Sediment samples were collected during Phase I and Phase II sampling. Sediment samples were collected from twenty (20) locations during Phase I sampling (Figure 2-11). Phase II sampling included the collection of ten (10) samples at the Site (Figure 2-12) and three (3) samples at the reference site (Figure 2-13). Sediment samples were collected from the 0 to 4-inch interval. All sediment samples contained significant amounts of root material. Phase I and II sediment analytical results are presented in Table 4-20.

Sediment samples collected during the two phases of sampling are discussed together. The ten onsite samples collected during Phase II were collected from identical locations as during Phase I.

Elevated concentrations of lead, arsenic and zinc were measured in all of the Site sediment samples. The analytical results for the thirty (30) samples analyzed indicate a range of lead concentrations from 250 to 8,079 ppm, the average lead concentration is 3,424 ppm. The range for arsenic concentrations for the thirty (30) samples is 36 to 453 ppm, the average arsenic concentration is 206 ppm. The range of zinc values for the thirty (30) samples is 1,871 to 22,600 ppm, the average zinc value is 9,831 ppm.

The three samples collected at the reference site did not contain elevated concentrations of metals. The analytical results for the three (3) samples collected at the reference site indicate a range of lead concentrations from 39 to 82 ppm, the average lead concentration is 58 ppm. The range for arsenic concentrations for the three (3) samples is 10 to 44 ppm, the average arsenic concentration is 31 ppm. The range of zinc values for the three (3) samples is 118 to 145 ppm, the average zinc value is 133 ppm.

The lowest metals concentrations were generally observed in the pond samples (SD-18, SD-19 and SD-20). The samples collected in the northern portion of the wetland which is influenced by Silver Creek generally contains above average metals concentrations.

4.10.3.1 Sediment Toxicity Testing

Sediment toxicity testing was conducted on ten (10) samples from the Site and two (2) samples from the reference site. Sediment toxicity results are summarized in Table 4-21. Three (3) samples (SD-2, SD-4 and SD-6) collected in the northern portion of the wetland, which is influenced by Silver Creek, resulted in zero percent (0%) survival. The metals content in these samples were generally above the average. The sample collected at SD-17 resulted in twenty-eight percent (28%) survival. The two samples collected from this location contained 161,000 and 70,170 ppm manganese (Mn). The reference site wetland sample resulted in a sixty percent (60%) survival this sample contained 70,240 ppm Mn.

Overall survivability is generally inversely proportional to metals content in the sediments. The samples with the lowest survivability contained the highest concentrations of metals. A report of the full toxicity study is presented in Appendix 6.

4.10.4 Vegetation

Vegetation tissue analysis was conducted on nineteen (19) samples. Twelve (12) species were analyzed. Vegetation tissue analysis results are presented in table 4-22.

Fourteen (14) samples representing twelve (12) species were collected at the Site. The analytical results for the fourteen (14) samples analyzed indicate a range of lead concentrations from 2.2 to 107 ppm, the average lead concentration is 20.5 ppm. The range for arsenic concentrations for the fourteen (14) samples is <0.50 to 23 ppm, the average arsenic concentration is 5.5 ppm. The range of zinc values for the fourteen (14) samples is 12 to 1,299 ppm, the average zinc value is 297 ppm.

Five (5) samples representing four (4) species were collected at the reference site. The analytical results for the five (5) samples collected at the reference site indicate a range of lead concentrations from 13 to 62 ppm, the average lead concentration is 37.6 ppm. The range for arsenic concentrations for the five (5) samples is <0.50 to 14 ppm, the average arsenic concentration is 5.2 ppm. The range of zinc values for the five (5) samples is 13 to 62 ppm, the average zinc value is 37.6 ppm.

Metals concentrations were variable throughout the Site. The full range of concentrations were observed in samples collected in both the pond and wetland. No standard plant tissue benchmarks exist to compare the results to.

4.10.5 Aquatic Wildlife

This section details the results of aquatic wildlife sampling at the Site and reference site.

4.10.5.1 Fish

Two fish (2) samples were collected from the pond. Fish analytical results are presented in Table 4-23. The wetland area as well as the reference pond and wetland did not contain fish. Due to the small sample set the results from one (1) duplicate QA/QC sample is included in the following discussion to increase the sample set.

The analytical results for the three (3) samples collected at the Site indicate a range of lead concentrations from 2.7 to 7.9 ppm, the average lead concentration is 5.1 ppm. The range for arsenic concentrations for the three (3) samples is 0.25 to 0.53 ppm, the average arsenic concentration is 0.34 ppm. The range of zinc values for the three (3) samples is 68 to 127 ppm, the average zinc value is 96 ppm. No standard fish tissue benchmarks exist to compare the results to.

4.10.5.2 Benthic Macroinvertebrate Tissue Analysis

Five (5) benthic macroinvertebrate samples were collected from the Site. Three (3) of the samples consisted of bugs and two (2) consisted of snails. Benthic macroinvertebrate analytical results are presented in Table 4-23. Due to the small sample set the results from one (1) duplicate QA/QC sample each for bug and snail media is included in the following discussion to increase the sample set.

The analytical results for the four (4) bug samples collected at the Site indicate a range of lead concentrations from 0.43 to 4.5 ppm, the average lead concentration is 2.6 ppm. The range for arsenic concentrations for the four (4) bug samples is <0.50 to 1.7 ppm, the average arsenic concentration was not calculated due to three samples with concentrations below laboratory detection limits. The range of zinc values for the four (4) bug samples is 23 to 496 ppm, the average zinc value is 35.5 ppm.

The analytical results for the three (3) snail samples collected at the Site indicate a range of lead concentrations from 0.43 to 4.5 ppm, the average lead concentration is 2.6 ppm. The range for arsenic concentrations for the three (3) snail samples is 0.72 to 3.1 ppm, the average arsenic concentration is 1.74 ppm. The range of zinc values for the three (3) snail samples is 20 to 201 ppm, the average zinc value is 132 ppm.

The analytical results for the two (2) bug samples collected at the reference site indicate a range of lead concentrations from 0.11 to 0.16 ppm. The two (2) bug samples collected did not contain detectable arsenic concentrations. The range of zinc values for the two (2) bug samples is 17 to 19 ppm.

The snail sample collected at the reference site contained 0.18 ppm lead, 0.68 ppm arsenic and 5.3 ppm zinc.

No standard macroinvertebrate tissue benchmarks exist to compare the results to.

5.0 CONTAMINANT FATE AND TRANSPORT

This section details contaminant fate and transport.

5.1 Introduction

This section presents a discussion of the fate and transport of contaminants at Richardson Flat. Data and observations of source characteristics (e.g., tailings), site physical characteristics (e.g., hydrogeology, soil cover conditions) and the nature and extent of the contamination have been combined to develop an interpretation of the fate and transport of chemical constituents at the Site.

Because of the Site's complexities, it may not be practical to completely evaluate the fate and transport of contaminants using quantitative methods. A combination of semi-quantitative and qualitative methods will be used to develop as definitive as possible understanding of the fate and transport of contaminants at the Site. Several considerations can be raised regarding fate and transport based on the data presented in this study. These considerations include:

- What surface and subsurface processes are occurring at the Site, and how do they affect chemical constituents fate and transport?
- How do the characteristics and properties of the tailings and the local and regional hydrogeologic/geochemical system affect the distribution and migration of chemical constituents?
- What is the potential for chemical constituents generation from the tailings and potential for migration of contaminants offsite?
- What is the long term stability of the tailings and how will this affect long term use of the Site?

A site conceptual model has been developed based on the physical site characteristics presented in Section 3 and the nature and extent of contamination presented in Section 4. This conceptual model is graphically presented in two ways, as a three-dimensional block diagram (*See* Appendix 3, MWH, 2002) and as a schematic diagram showing connections between sources and the various potentially impacted media (Figure 5-1). These diagrams will serve as the basis for much of the discussion in this section.

The remainder of this section is subdivided into four subsections: Sources and Primary Contaminants of Concern; Contaminant Characteristics and Transport Parameters; Potential Routes of Migration; and Contaminant Persistence and Source Stability. Section 5.2, presents Sources and Primary Contaminants of Concern, our understanding of the nature of the tailings and the primary contaminants of concern associated with the tailings. In Section 5.3, Contaminant Characteristics and Transport Parameters, the

chemical and physical properties of the contaminants are discussed in order to develop an understanding of the processes likely controlling the fate and transport of contaminants at the Site. In Section 5.4, Release Mechanisms and Potential Routes of Migration, the potential and apparent pathways of contaminant migration between the various media at the Site are discussed. Evidence for the absence of a pathway is also evaluated. In Section 5.5, Contaminant Persistence and Source Stability, the physical and chemical parameters that control the persistence and stability of metals in the environment and the long-term stability of the metals within the tailings impoundment are discussed.

5.2 Sources and Primary Contaminants of Concern

In addition to naturally-occurring levels of metals in the area, the source of metals at the Site is the historical placement of tailings from off-site mining operations. To better understand the potential for mobilization of metals, the source has been conceptually divided into three parts: (1) the tailings that are contained within the tailings impoundment where they are covered by a low permeability soil cover system consisting of a vegetated clay soil and contained within a containment dike system, (2) the tailings that are mostly covered by a vegetated clay cap in small, naturally low areas outside and to the south of the impoundment, and (3) the tailings that are located in the wetland area that were emplaced by historical off-site mining operations.

5.2.1 General Characteristics of Tailings

The tailings are associated with historic ore processing. The tailings are composed of fine sand-sized granular material and clay-sized (<0.005 millimeters) slimes. 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 3-D block diagram in MWH, 2002). 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 a low permeability high clay-content, vegetated soil. The tailings have been constructed on naturally occurring thick layers of native, clay-rich soils (Geological Barrier).

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 (1999) indicate that these underlying clay soils have a low hydraulic conductivity, ranging from 0.001 to 5

ft/year ($9X10^{-10}$ to $5X10^{-6}$ cm/sec). However, closer review of the Weston report and Dames and Moore (1973) indicates that the hydraulic conductivity of 5 ft/year ($5X10^{-6}$ cm/sec) was reported for test pit TP-8 and the log for this test pit indicates that 4.5 feet of tailings overlie the 2.0 feet of silty soils. Therefore, the upper range of hydraulic conductivity of 5 ft/year ($5X10^{-6}$ cm/sec) reported for natural clay soils at Richardson Flat is skewed by the presence of tailings in TP-8. The clay soil cover on the tailings impoundment, for the most part, came from the same kinds of soils as found beneath the impoundment. The clay soil cover materials have hydraulic conductivity's ranging from 0.031 to 0.072 ft/year ($3X10^{-8}$ to $7X10^{-8}$ cm/sec) (Weston, Table 1, page 7, 1999). The hydraulic conductivity of the natural clay soil surface beneath the impoundment likely ranges from 0.001 to 0.072 ft/year ($9X10^{-10}$ to $7X10^{-8}$ cm/sec). It should be noted that EPA RARC Guidance documents specify soil liners of exhibiting $1X10^{-7}$ cm/sec permeability for use in disposal facilities. The Richardson Flats Tailings impoundment is constructed over a naturally occurring clay layer meeting and exceeding this EPA guidance requirement for liner system for RCRA landfills.

A diversion ditch system prevents most storm water from entering the impoundment from offsite sources.

5.2.2 Chemical Characteristics of Tailings

The chemistry of the tailings is summarized in Table 5-1, which shows the range and average of metals data collected during this study. This table also presents data from the *Analytical Results Report – Richardson Flats Tailings* (E&E, 1985) and the *Final Report – Richardson Flats Tailings* (E&E, 1993) for comparative analysis and to provide additional analytical data for metals constituents not analyzed during this study. Data collected during this study are generally consistent with past analytical results from tailings samples.

5.2.3 Mineralogy of Tailings

XRD analysis was conducted to determine the tailings mineralogy. The XRD test results indicate that the tailings typically consist of normal rock forming minerals (quartz, calcite, dolomite), sulfide ore minerals (pyrite, galena), and small fractions of hydroxides (tosudite, brushite, carlosturanite), and mica (clinochlore). These results are summarized in Table 5-2. Although the major portion of the tailings is quartz (25 to 50 percent), carbonate minerals calcite (5 to 40 percent) and dolomite (5 to 25 percent); sulfide minerals contain most of the metals of concern. Although galena (PbS) and pyrite (FeS_2) were identified, no zinc sulfide minerals such as sphalerite (ZnS) were identified in the three composite

samples tested. The high percentage of carbonate minerals provides substantial neutralizing buffering capacity, maintaining the tailings at near neutral pH conditions which limits the solubility of most metals. As reported in Section 4.6, pH ranged from 7.3 S.U. (Standard Unit) to 7.7 S.U. in the tailings samples.

5.2.4 Leaching Characteristics of Tailings

The leaching characteristics of the tailings were evaluated using two laboratory testing methods: (1) the synthetic precipitation leaching procedure (SPLP), EPA SW-846 Method 1312, and (2) the acid-base potential test (USDA Handbook 60 Method 23C; EPA Method 670/2-74-070; EPA Method 600/2-78/084 Modified Sobek). Three composite tailings samples plus one duplicate sample were tested with these methods. The extraction fluid for the SPLP is an aqueous solution intended to simulate rain water prepared with deionized water buffered to a pH of 5.0 S.U. with sulfuric and nitric acids. The SPLP was developed to evaluate the fate and transport of metals in an engineered land disposal facility. The acid-base potential test measures the percentage of lime, the acid producing potential and the neutralization capacity of materials. The results also provide a percent breakdown of sulfur into non-sulfate sulfur, hot water extractable sulfur, hydrochloric acid extractable sulfur, nitric acid extractable sulfur and residual sulfur. The acid extractable sulfur fractions are often termed acid volatile sulfides.

As shown on Table 5-3, the SPLP results indicate that if the tailings were directly leached by the mildly acidic synthetic (rainwater) as used in the test, metals constituents such as cadmium, copper, lead, antimony and zinc would mobilize from the tailings. As the data indicate, zinc and lead would be the most leachable metals. This test indicates that the leachate would contain between 47 and 65 ppm zinc and between 10 and 13 ppm lead. The leachate could also contain up to 0.55 ppm cadmium. No silver, arsenic, chromium, iron, mercury, or selenium was mobilized during these tests. Although the SPLP results indicate that some metals can be leached from the tailings, the fact that metals levels in surface water and groundwater at the Site are not observed at concentrations of the same order-of-magnitude as the SPLP values indicates that the tailings are physically and hydraulically isolated and/or that there is sufficient buffering capacity in surficial soils, tailings carbonates and cover materials to rapidly buffer any acidity in local precipitation. Therefore, the SPLP does not provide the most appropriate data to assess the true leachability of the tailings in their present setting.

As shown in Table 5-4, the acid-base potential results for the three tailings samples and one duplicate indicate that the acid potential of the tailings is between 112 and 181 tons $CaCO_3$/1000 tons of tailings in the form of water and acid extractable sulfur between 3.68 and 8.53 percent. However, the neutralization

potential is between 198 and 271 tons $CaCO_3$/1000 tons tailings (19.8 to 27.1 percent lime) which indicates that there is a large excess base potential between 52 and 90 tons $CaCO_3$/1000 tons of tailings. Because most of the sulfur is in the form of acid volatile sulfides (leachable only under extremely acid conditions) and with abundant buffering capacity, the potential of the tailings to generate acidity which would allow metals to leach is extremely low.

5.3 Contaminant Characteristics and Transport Parameters

This section details the characteristics of contaminants and their transport parameters.

5.3.1 Metals Behavior and Relevant Fate and Transport Processes

This section details the parameters that govern the fate and transport of metals at the Site. The fate and transport of metals is generally influenced by the following processes:

- Dissolution/Precipitation
- Oxidation/Reduction
- Complexation
- Adsorption and Coprecipitation
- Ion Exchange.

More specifically, the behavior of zinc, the primary contaminant of concern at the Site, is controlled by several processes including: the dissolution and precipitation of zinc-containing minerals; the formation of complexes with available anions; and the removal of zinc from solution by adsorption and coprecipitation. Although this section discusses the behavior of metals in general, it focuses on zinc which is the most mobile and widespread metal at the Site.

Mineral Phases and Dissolution/Precipitation Reactions

The dissolution of metals-containing minerals is the mechanism for exchanging metals from the solid phase to liquid phase. Although dissolution is often perceived as a one-way non-reversible reaction, metals can be re-precipitated in the original or as other mineral phases if geochemical conditions change. As discussed in Section 5.2, the tailings contain minerals, including sulfides, that can leach to the environment. Although galena (PbS) and pyrite (FeS_2) were the only sulfide minerals identified by XRD, it is probably safe to assume that some sphalerite (ZnS) is present in the tailings. Sphalerite was the common zinc mineral encountered during mining of the ore body that produced the tailings (pers. comm. Kerry Gee, United Park, 2002).

The solubility of zinc is typically controlled by pH, Eh (redox) of the dissolving solutions and the presence and chemistry the of zinc-containing solid phases, and the availability of other ions to create dissolved complexes. At the pH range observed in samples for this Site, typically 6.4 S.U. to 7.5 S.U., Zn^{+2} is the predominant dissolved zinc species (Hem, 1972). At the near neutral pH conditions measured at the Site, a pH/Eh plot (Figure 5-2) by Hem (1972) indicates that Zn^{+2} is stable at Eh values above about -0.1 volts, mildly reducing to oxidizing conditions. Below this Eh, zinc sulfide is stable as a solid phase. Although not directly detected by XRD in the tailings samples, the presence of the mineral sphalerite (ZnS) likely plays a role in limiting the amount of zinc in solution. The presence of other zinc-containing sulfides, zinc oxides, hydroxides, and carbonates may also play a role.

Reduction/Oxidation

Reduction-oxidation (redox) reactions involve a change in the oxidation state of elements. The level of change is determined by the number of electrons on the element transferred during the reaction (Stumm and Morgan, 1981). Redox reactions can greatly affect contaminant transport (EPA, 1989). For example, in slightly acidic to alkaline environments, Fe (III) precipitates as a highly adsorptive solid phase (ferric hydroxide), where as Fe(II)is very soluble and does not retain other metals. Although Zn^{+2} or Zn (II) is the stable valence state for zinc over a wide range of pH and Eh conditions, changes in the redox state of other ions may greatly affect the solubility of zinc. For example, changing the redox state of sulfur from S(+IV) to S(-II), sulfate to sulfide in the dissolved state, can cause the precipitation of zinc as the sulfide mineral sphalerite.

Complexation

In a complexation reaction, a metal ion reacts with an ion that functions as a so-called ligand (EPA, 1989). The metal and the ligand bind together to form a new soluble species called a complex. Complexation can effectively increase the solubility of metals because the metals are mostly bound up in the soluble complexes (EPA, 1989).

The ability of zinc to form complexes with available major anions, particularly carbonate, sulfate and chloride, is an important factor affecting the solubility of zinc. Results of modeling using the USGS geochemical equilibrium program PHREEQC for waters in monitoring wells RT-11 and RT-12 indicate that about a third of the dissolved zinc exists as complexes with bicarbonate, carbonate, sulfate, chloride

and hydroxide ions. The ability of the solution to create these dissolved complexes allows more zinc to be dissolved from available mineral phases than would be expected based on solubility constants, essentially increasing zinc solubility. The PHREEQC modeling also shows that the solutions at monitoring wells RT-11 and RT-12 are under-saturated with respect to sphalerite, smithsonite ($ZnCO_3$) and $Zn(OH)_2$, suggesting that the solubility limit of zinc has not yet been reached (e.g. the water has the capacity to dissolve more zinc).

Adsorption and Coprecipitation

Adsorption and coprecipitation can be important processes affecting the concentrations of metals in both solid and liquid phases. Adsorption occurs when a dissolved ion becomes attached to the surface of a pre-existing solid substrate (Drever, 1982). Coprecipitation occurs when a dissolved species is incorporated as a minor component in a solid phase as that phase itself is precipitated (Drever, 1982). Manganese and iron oxides often play important roles in both adsorption and coprecipitation reactions.

The likelihood of zinc adsorption depends on the adsorptive capacity of aquifer and/or streambank materials and the relative selectivity of zinc compared to other available cations. The surface adsorption of dissolved metal ions is a function of pH (Kekow, 2001). According to Kekow (2001) no zinc is adsorbed below a pH of 5 and all zinc is adsorbed above a pH of 8 (See Figure 5- 3). However, because of the relatively narrow range of pH observed at the Site, pH does not appear to be an important factor controlling the transport of zinc. Figure 5-3 also shows that lead and cadmium are fully adsorbed at even lower pH values than zinc, possibly explaining in part why lead and cadmium are more greatly attenuated than zinc.

The primary factors controlling selectivity are the charge of an ion and its ionic radius (Sposito, 1989). Compared to other available ions, zinc has a lower selectivity suggesting it would have a lower likelihood for adsorption. For example, Sposito (1989) worked out the following relative selectivity sequence for mercury, cadmium and zinc:

$$Hg^{2+} > Cd^{2+} > Zn^{2+}.$$

Based on zinc's relatively low selectivity and the abundance of other more preferable cations, zinc adsorption may not be an important factor affecting the zinc concentration in site waters. Solubility processes, as controlled by redox conditions and the relative abundance of dissolvable zinc minerals, more likely affect zinc concentrations in water.

Ion Exchange

Ion-exchange reactions are similar in effect to adsorption, but unlike adsorption where ions are held in coordination bonding to specific two-dimensional surface sites, ion exchange sites are viewed as three-dimensional sites containing electrostatic forces. (EPA, 1989). Ion exchange best describes binding of metals and some anions to clays and condensed humic matter (Sposito, 1984). The capacity of a soil for cation exchange can be determined by displacing the exchangeable surface ions with ions in a standard solution that is brought in contact with the soil. Cation exchange capacity (CEC) tests were conducted on the six sediment samples from the South Diversion Ditch and three samples of "clay" underlying the tailings south of the diversion ditch. The results, provided in Table 5-5, indicate that the both the sediments and "clays" have substantial cation exchange capacities. The CEC values for the sediments range from 9.2 to 44.5 meq/100g, typical values for illite (Kekow, 2001). The CEC values for the "clays" range from 35.3 to 64.2 meq/100g, typical values for a mixture of illite and montmorillonite (Kekow, 2001).

5.4 Release Mechanisms and Potential Routes of Migration

This section explains the fate and transport of chemical constituents within and between the media at the Site. The fate and transport of contaminants, particularly zinc, are evaluated and discussed in terms of the pathways shown on the schematic model of contaminant transport pathways (Figure 5-1).

5.4.1 Leaching of Metals from Tailings Impoundment

As described in Section 5.2, the tailings within the impoundment are deposited in well-contained layers, located between native clay materials below and a constructed low permeability vegetated clay soil cover above and surrounded by clay dikes. XRD data collected during this study confirm the findings of Weston (1999) that the underlying materials are predominantly composed of clay minerals, sepiolite or mixed layer clay minerals, mixed mica and illite or smectite. XRD analysis found that the samples contained primarily illite and dickite (a kaolinite group mineral with the same chemistry as kaolinite but with a slightly different structure), with one sample also containing montmorillonite. As discussed by Weston (1999) and MWH (2002), there is no hydraulic connection between the tailings and the upper aquifer. However, as shown on Figure 5-1, there are two potential release mechanisms for metals within the tailings impoundment: (1) leakage through the dikes into the South Diversion Ditch, and (2) observed seepage along the tailings embankment to the wetlands. If metals do leach from the tailings impoundment

to the South Diversion Ditch they will likely be attenuated prior to discharge at the ditch terminus (See Section 4.1.2). This is evidenced by the low metals concentrations at RF6-2 which is located at the ditch terminus. Observed seepage from the tailings embankment does not contain sufficient volume to adversely impact the wetlands. A complete analysis of the mixing of water from the diversion ditch and seepage from the main tailings embankment with Silver Creek is provided in Appendix C of the Work Plan (RMC, 1999).

5.4.2 Leaching of Metals from Tailings Outside Impoundment

The tailings outside the impoundment sporadically contribute metals to the tailings aquifer and the South Diversion Ditch. Concentrations of zinc and other metals in monitoring wells RT-13, RT-14, and RT-15 (see Section 4.2.2) indicate that elevated zinc concentrations are measured in the tailings aquifer after tailings are inundated by spring snowmelt. For example, a dissolved zinc concentration of 4.3 mg/l was measured in May 2002, but dropped to 1.4 mg/l then 0.42 mg/l in June and July 2002. These elevated concentrations correspond directly with peak groundwater elevations at these wells. Another example of the relationship between zinc concentrations and groundwater levels is RT-15, which has been dry for several months. In April and May of 2002, 23 and 16 mg/l of dissolved zinc, respectively, were measured in RT-15. Figure 5-4 shows time-series plots of dissolved zinc concentrations in RT-13 and RT-14. Metals in the upper section of the diversion ditch are either coming from the tailings in the bottom of the ditch, are migrating seasonally from water within the tailings, or are related to the ponded area south of the Site, where tailings may be oxidized by storm water. The increase in zinc concentrations between locations RF-11 and RF-12 in the diversion ditch may be related to leaching from tailings in area that provides the source of inflows for that reach.

5.4.3 Transport of Metals from South Diversion Ditch to Wetlands

Elevated metals concentrations have been measured in water and sediments within the South Diversion Ditch. The history of dissolved zinc concentrations at the six sample stations along the South Diversion Ditch are shown on Figure 5-5. With the exception of the very high spike at RF-3-2 in June 2001 (7.9 ppm), the general pattern is similar during each sampling round. Zinc concentrations are low in the upper reaches of the diversion ditch, but increase substantially between RF-3-2 (a tributary) and RF-4. This suggests a source of zinc and/or changes in geochemistry causing dissolution of zinc from sediments, an influx of zinc-containing groundwater between these two stations, or that the ponded area is providing oxidized water and leaching zinc to the diversion ditch.

Although zinc is the only metal at concentrations of concern in water, sediments within the ditch contain high levels of several metals including lead and zinc (Figure 5-6). Also shown in Figure 5-6, somewhat elevated concentrations of arsenic and cadmium have also been measured in sediments. Metals concentrations in the sediment increase from the beginning to the terminus of the diversion ditch with zinc and cadmium increasing by about 400 percent and lead and arsenic increasing by about 50 percent. The increase in metals may be attributable to several factors which may include:

- variability in reconstruction of the channel
- increasing percentage of tailings material via runoff or wind-blown processes
- biologically mediated precipitation of sulfide minerals
- adsorption on solids and organic material
- coprecipitation with other metals (such as manganese)
- cation exchange
- mechanical concentration (e.g. settling) of heavier materials
- variability in sediment sampling.

The presence of tailings in the sediments may be evaluated in two ways: (1) mineralogy by x-ray diffraction (XRD) patterns and (2) trace metal ratios.

A comparison of the mineralogy of tailings and sediment samples (Table 5-6) indicates that the bulk of the materials are composed of similar percentages of quartz, calcite, dolomite, pyrite, and clinochlore (a mica) suggesting a common source. However, the sediment sample lacks galena (PbS) which was found in all tailings samples, but contains sphalerite (ZnS) in all samples except the uppermost station SD-6. The sediment sample also lacked the hydroxides (tosudite, brushite, carlosturanite) and iron oxide reported in some of the tailings samples, but contained a wide assortment of other minerals including feldspars (albite, anorthite, sanidine, orthoclase), micas (paragonite, muscovite), clays (nontronite, montmorillonite), and an amphibole (ferro-gedrite). The sediments thus appear to be a mixture of biologically derived sulfide precipitates, tailings and imported soils. This combination of materials is due to past uses and reconstruction activities. 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.

An evaluation of trace metal ratios indicates that although the sediments have generally lower metals concentrations than the tailings, the ratios of the important trace metals arsenic, cadmium, lead, and zinc are similar. In fact, the pie diagram for SD-6 and the average tailings are almost identical (see Figure 5-7). However, of note is that the average zinc concentration in the sediments is actually higher than the average tailings concentration suggesting that zinc is preferentially concentrated in the sediments by adsorption and precipitation processes (Table 5-6).

Considering the behavior of metals in water and sediments within the diversion ditch as a coupled system, a better understanding of the processes that are occurring emerges. For example, plotting the water results from 5/7/01 and the sediment results from 5/11/01 (Figure 5-8) together shows a generally inverse relationship between zinc concentrations in the water and solid phases. A similar relationship is observed for lead (Figure 5-9). Figure 5-10 provides plots of dissolved zinc versus other chemical parameters such as sulfate, TDS, bicarbonate, calcium, and manganese showing clear relationships between zinc and other chemical species. Between RF-2 and RF-4 major changes in water and sediment chemistry are occurring that strongly indicate a major inflow of poor quality, oxygenated water. In this reach, the concentrations of the following parameters increase sharply by the listed factors: TDS 2X, sulfate 10X, zinc 65X, manganese 92X, magnesium 3X, bicarbonate 2.5X, calcium 4X. RF3-2 is a tributary to this reach of the ditch the low concentrations are a "clean" water source draining into the ditch and is not experiencing similar concentration levels as RF-12. Field measurements of temperature and pH (Figure 5-11) also indicate that substantial mixing is occurring in this reach. The inflow into the ditch in this area is likely from cooler, lower pH, water, possibly from the ponded area south of the County Road.

Based on the similarity between the plots of dissolved zinc and manganese (see Figure 5-10e), it is possible that zinc may be coprecipitating with manganese or at least both metals are being attenuated by the same process. Cation exchange does not appear to be an important processes. In fact, the concentrations of zinc and cadmium in sediments along the ditch have a strong inverse relationship with cation exchange capacity (CEC) with a linear correlation coefficient of 0.93 for zinc and 0.86 for cadmium (Figure 5-12). In other words, as the (CEC) increases, the concentrations of these metals in ditch sediment decrease substantially. This suggests that cation exchange is not an important process.

The apparent attenuation of zinc and other metals in the diversion ditch appears to be at least biologically mediated by the diversion ditch wetlands. The coincident decrease in bicarbonate and calcium

concentrations, rise in pH, and slight decrease in sulfate is consistent with the typical behavior of sulfate reducing bacteria in wetlands. Significant research by EPA, academia and industry has documented the effectiveness of wetlands to remove metals from water. Wetlands utilize naturally occurring biogeochemical processes to precipitate dissolved metals from solution and retain the resulting solid phase in the sediments of the wetland (Pantano, et.al. 1999). Although the subtle decline in sulfate concentrations which accompanies the dramatic drop in zinc concentrations does not at first glance appear to be significant, if we consider that the concentrations of zinc and other dissolved metals are more than two orders of magnitude lower (300X lower for zinc), then only a subtle decline of several parts-per-million in sulfate concentrations is required to precipitate all the zinc from solution. The presence of sulfide in sediment porewater in the pond and middle reaches of the wetland indicate the presence of sulfide reducing bacteria which is further indication that the Site wetlands (South Diversion Ditch and wetland) are performing biotreatment functions.

5.4.4 Migration of Metals from South Diversion Ditch and Wetlands to Silver Creek

Metals concentrations measured in the South Diversion Ditch have declined markedly since the 1980's when United Park reconstructed the ditch and covered exposed tailings with clean soil. As stated in the Work Plan (RMC, 1999), data collected in 1999 and during this study indicate that zinc concentrations measured at the outfall of the ditch meet applicable water quality standards and are lower than zinc concentrations measured in Silver Creek. The downstream Silver Creek zinc concentrations are less than the upstream concentrations, this along with wetland surface water quality data indicates that flow from the diversion ditch may be diluting the zinc concentrations in Silver Creek. Metals concentrations in the wetland area below the diversion ditch outlet increase in the downgradient northern portion of the wetland, which is influenced by Silver Creek (Figure 2-13). A complete analysis of the mixing of water from the diversion ditch and seepage from the tailings embankment with Silver Creek is provided in Appendix C of the Work Plan (RMC, 1999).

5.4.5 Interaction of Wetlands with Silver Creek Alluvial Aquifer

Although there is little groundwater data between the tailings impoundment and the vicinity of Silver Creek, the wetlands likely interact directly with the shallow part of the Silver Creek Alluvial Aquifer. Data from RT-7 indicates that there is little exchange of zinc and other metals between sediments in the wetlands and underlying shallow groundwater.

5.4.6 Transport of Metals Between Upper Aquifer and Silver Creek Alluvial Aquifer

Although some transport of zinc and other metals may occur between the upper aquifer and the Silver Creek alluvium, the groundwater chemistry of the Silver Creek alluvium does not appear to be noticeably influenced by the main body of Richardson Flat tailings. Although a small volume of groundwater may flow from the vicinity of the tailings impoundment toward Silver Creek, groundwater in the Silver Creek alluvium does not appear to be adversely impacted by the tailings or by surface water flowing in the South Diversion Ditch. Although groundwater in contact with tailings south of the South Diversion Ditch may seasonally contain elevated zinc concentrations, much of this groundwater is captured by the ditch. This is evidenced by the water level contour map presented in Appendix 3 (Figure 8, MWH 2002). This conclusion is supported by several lines of evidence including:

1. Groundwater originating in the vicinity of the tailings impoundment cannot be the source of elevated zinc concentrations observed in groundwater adjacent to Silver Creek because zinc concentrations are generally much lower near the tailings. Zinc concentrations, as measured in piezometer RT-7 (0.027 ppm on 2/27/01), in groundwater between the tailings impoundment and Silver Creek is substantially less than zinc concentrations measured in RT-11 and RT-12 which contains concentrations always greater than 4.8 ppm.

2. Surface water draining the tailings impoundment area cannot be the source of the elevated zinc concentrations observed in groundwater adjacent to Silver Creek. Although there have been some part-per-million concentrations measured in water from the South Diversion Ditch, these concentrations, when mixed with zinc concentrations at RT-11, do not result in the zinc concentrations measured in RT-12.

3. As shown in the Piper Plot for water samples collected during May 2002 (Figure 5-13), major ion data indicate that groundwater in the Silver Creek alluvium (RT-11, RT-12, RT-7) is similar to surface water in Silver Creek (RF-7-2 and RF-8) and the floodplain tailings indicating an intermingling of surface and ground-water along Silver Creek, while groundwater typical of the tailings impoundment area (RT-13 and RT-14) and surface water from the South Diversion Ditch (RF-6-2) generally plot as separate and distinct groups.

4. The concentration of total dissolved solids (TDS) in groundwater in the vicinity of the tailings (1,177 to 1,794 ppm in RT-13 and RT-14) and surface water in the South Diversion Ditch (644 to 2,110 ppm at RF6-2) is higher than the TDS in the Silver Creek Alluvium. In fact, TDS generally decreases from RT-11 (998 to 1,891 ppm, average 1,389 ppm) to RT-12 (754 to 2,095 ppm, average 1,112 ppm) suggesting dilution by lower TDS water, likely from Silver Creek (714 to 1,174 ppm, average 876 ppm at RF7-2). Mixing the higher TDS ground or surface water from the vicinity of the tailings with groundwater at RT-11 cannot result in groundwater with the lower TDS chemistry observed at RT-12.

5.4.7 Interaction Between Silver Creek and Silver Creek Alluvial Aquifer

Elevated concentrations of total and dissolved zinc are observed in groundwater within the Silver Creek alluvium. As shown in Figure 5-14, dissolved zinc concentrations range from 5.6 to 10 ppm in upgradient monitoring well RT-11 and from 6.4 to 22 ppm in downgradient monitoring well RT-12. As is apparent from the histogram of dissolved zinc concentrations, (Figure 5-15). The down-gradient zinc concentrations correspond to some of the highest zinc concentrations observed in surface and ground-water samples collected for the focused RI for the Site. Dissolved zinc concentrations of up to 85 mg/l were measured in Floodplain Tailings wells adjacent to Silver Creek. Other ranges of dissolved zinc concentrations in site waters include:

Groundwater (RT-13, RT-14)	<0.01 to 4.3* ppm
Groundwater (RT-15)	16 to 23 ppm (This well only contains water during spring)
Groundwater (RT-7)	0.027 ppm
Groundwater (RT-9)	0.021 ppm
Surface Water (South Diversion Ditch)	0.023 to 7.9* ppm
Surface Water (Silver Creek)	0.39 to 2.0 ppm

** Anomalous value possible laboratory or field error.*

The elevated zinc concentrations in groundwater adjacent to Silver Creek may be the result of several factors including: (1) dissolution of zinc from tailings and mine waste within the alluvium, Floodplain Tailings or within the Silver Creek embankments, (2) oxidizing conditions created by surface/ground-water exchange, and (3) ideal geochemical conditions for the dissolution of zinc-containing minerals (i.e., readily soluble minerals, available major anions for complexation, lack of available surface adsorption sites).

The increasing concentrations of zinc, in conjunction with generally decreasing TDS levels, between RT-11 and RT-12 should be noted. Although the concentrations in these two monitoring wells are not substantially different from a statistical standpoint, the increase may be caused by spatial heterogeneities in hydraulic conductivity (a function of grain size), adsorption potential, and sedimentation patterns. Hydraulic conductivity and groundwater flow rates are likely much higher near RT-11, where Silver Creek is flowing at a much higher rate than near RT-12 where it is partially dammed by the highway and beaver dams. Slower groundwater flow rates would allow for a longer residence time and increase the

potential for zinc dissolution, however this is not consistent with the decrease in TDS. Variations in adsorption coefficients may be due to mineralogy (relative percentage of sulfides, feldspars, calcite), grain size and surface area of particles, and grain coatings (Davis and others, 1993). Sedimentation patterns may vary between RT-11 and RT-12 resulting in different relative masses of tailings and zinc-containing minerals. The increase in zinc concentrations between RT-11 and RT-12 may be the result of a combination of several factors including: (1) mixing with oxygen rich water from Silver Creek which would decrease the TDS concentration and increase zinc solubility, (2) an increase in residence time due to lower groundwater flow rates which would increase the time for zinc dissolution, and (3) possibly a slight increase in available zinc-containing minerals for dissolution.

Preliminary simulations with PHREEQC indicate that if even a small fraction of water from Silver Creek (RF-7-2), presumably in equilibrium with the atmosphere, is mixed with groundwater in the Silver Creek alluvium (RT-11) that is assumed to be in equilibrium with sphalerite, zinc concentrations will increase by a factor of 2 or more. This increase in zinc concentration results primarily from the change in redox conditions from the addition of oxygen-rich water from Silver Creek. This is consistent with data reported by Weston (1999) indicating that "Silver Creek is found at a higher elevation than groundwater stored in the shallow aquifer(s) located between the tailings embankment and Silver Creek." Figure 4-3, shows that Silver Creek at Rail Trail Bridge is about 4 feet higher than groundwater in RT-12. This difference in the potentiometric surface may be caused by variable gradients in different locations due to diffuse flow in the alluvial sediments. This same phenomena was also observed approximately one mile further downstream in the Silver Creek alluvium (Todd Jarvis, pers. comm. 2002). The increase in the relative difference between zinc concentrations in RT-11 and RT-12 in November and December 2001 suggests that Silver Creek may be losing more water in the winter than in the spring and summer. However, the dissolved zinc concentration of 22 mg/l measured in April 2002 suggests other possible sources of zinc such as the upper aquifer or the Floodplain Tailings. Coincidentally, 23 mg/l of dissolved zinc was measured in monitoring well RT-15 in April 2002, however this well is typically dry and only contains water during periods of high water during the spring runoff.

5.5 Contaminant Persistence and Source Stability

This section discusses the persistence of the metals in the environment and the stability of the tailings (source) in their present state. As previously discussed, because of its solubility and mobility zinc is the primary contaminant of concern for water at the Site. Although other metals, including lead, arsenic, and

cadmium, are measured in elevated concentrations in sediment in the South Diversion Ditch, dissolved concentrations of these metals in ground and surface water are generally low indicating they are stable in the solid phase and not mobile in the aqueous phase.

Natural mechanisms that prevent acid formation and mobilization of metals from tailings are present in the tailings and the under lying soils and naturally occurring geologic materials. These mechanisms include:

- Predominant upward movement of water in the tailings due to evaporation exceeding precipitation rates
- Fine-grained nature of the tailings and cover that provides a physical barrier to percolation of water
- Geochemical properties of the tailings such as the presence of gangue minerals that limit the acid production and percolation of chemical constituents
- Geochemical and physical properties of the under lying soils that create a barrier to further migration of metals constituents form the site

For chemical constituents to mobilize from the tailings, metals from the tailings need to dissolve from the reactive minerals and move through the underlying tailings and soils to groundwater. This requires downward percolation of metals-bearing solutions. In the arid environment of the site, the dominant movement of water in tailings is upward, toward the tailings impoundment surface. Regional precipitation is much less than evapotranspiration (http//climate.usu.edu), so there is a net water loss from the upper portion of the tailings.

In an uncovered tailings impoundment upward movement of moisture through the tailings results in the formation of metal-sulfate salts that deposit on exposed surfaces of the tailings. Metals and sulfate are wicked to the tailings surface from oxidized pyrite and other form of sulfides species. These salts are readily dissolved during rainfall. Typically, ponds may form on tailings during precipitation events and slowly evaporate, leaving crusts of metal-sulfate salts. If sufficient precipitation occurs, the salts will contribute metals and sulfate to the runoff water. Such is not the case at the Site, however as the tailings surface is covered with a high clay content soil ranging in thickness from approximately seven (7) inches to ten (10) feet. There are some locations on the Site where tailings are present on the surface and it is estimated that the surface area of these locations is less than 0.5% of the total site area.

The mobilization of metal constituents through site tailings is very limited due to fine grained tailing materials presented at the site and very low hydraulic conductivity measured in cover soils, tailings and

underlying soils. Furthermore; the production of an oxidizing environment is inhibited by the lack of sufficient oxygen in the thick, low permeability tailings at Richardson Flats.

5.5.1 Controls on Tailings Chemical Stability

The chemical stability of the tailings is controlled by physical, hydraulic and geochemical factors. Physical factors include: underlying sorptive, low-permeability native materials; impoundment dykes and a vegetated clay-rich soil cover. Hydraulic controls consist of the soil cover that minimizes the infiltration of precipitation to the tailings and the diversion ditches that control runon and runoff in the area. Chemical factors include the availability of abundant minerals to provide pH buffering capacity (i.e., the tailings contain 10 to 30 percent calcite and dolomite). The acid-base potential data indicates that an abundant amount of excess buffering capacity is available to neutralize any mildly acidic infiltration reaching the tailings. This buffering capacity is confirmed by XRD data indicating that the tailings contain between 25 and 45 percent of the carbonate minerals calcite and dolomite. The acid-base potential data also indicate that most of the sulfur is in the form of acid volatile sulfides that require much lower pH waters to leach metals than the mildly acidic precipitation that falls in this area. Clearly, the combination of almost infinite buffering capacity and physical and hydraulic controls maintain the metals in the tailings in a stable state. As long as the present physical and hydraulic controls are maintained, the tailings should remain chemically stable indefinitely.

5.5.2 Acid Generation Analysis

Acid is generated in the tailings when metal sulfide minerals are oxidized. When metal sulfide minerals are present in the host rock, prior to mining, oxidation of these minerals will result in formation of sulfuric acid as a function of weathering processes. The oxidation of undisturbed ore bodies and acid generation and mobilization is very slow process.

Mining, extraction and beneficiation operations will increase the chemical reactions by exposing large volumes of sulfide rock material with an increased surface area to air and water. The potential for a mine waste to generate acid and release contaminants is a function of many factors and is site and waste specific. The acid generation and mobilization of constituents from a mine waste unit is a function of a series of factors that need to come together in a systematic manner, that can be divided into three groups:

A) Primary Factors
   a. Presence of sulfide minerals

b. Water
c. Oxygen
d. Ferric iron
e. Bacteria to catalyze the oxidation reaction, and generate heat.

B) Secondary Factors
a. Neutralization potential
b. Reaction with other minerals

C) Tertiary Factors
a. Physical placement of the waste
b. Hydrological regime above and below the waste
c. Partial size
d. Permeability
e. Physical weathering characteristics

Based on close examination and results of tests conducted on Richardson Flat tailings there are several factors that will prevent the long-term acid generation from the tailings. These factors are as follows:

A) Although sulfide minerals are present in the original ore body and the host rock, the major portion of the rock formation consists of carbonate-rich minerals as presented in Table 5-2. As can be seen from Table 5-2 sulfide minerals are present as a low percentage of total minerals in the tailings.

B) Initially; the tailings were deposited in a slurry form. Therefore at the time of placement the tailings were saturated, much of this water was likely evaporated. Overtime free draining water has percolated from the tailings and achieved an equilibrium moisture condition at or close to the tailings field capacity. A seven inch to 10 feet soil cover consisting of low permeability clay was placed over the tailings impoundment. This clay cover system effectively sheds a major portion of the precipitation as surface run-off. Only at limited areas over the tailings impoundment where surface ponding is occurring will a small fraction of precipitation percolate into tailings.

C) Oxygen penetration is very limited due to the presence of a clay cap and limited rate of surface water percolation. High moisture content and fine tailing particle size further minimizes the rate of oxygen penetration into the tailings.

D) Ferric iron is present at very low levels indicating that the acid generation potential is low. During the production of tailings the ore is subjected to milling, chemical processes and wet depositional placement. These conditions will result in rapid oxidization and transformation of ferrous and ferric ions into ferric iron precipitation as iron hydroxide [$(Fe(OH)_3$] manifested by yellow, orange or red deposits (referred to as yellowboy). There are no yellowboy deposits on the Site.

E) Sulfide oxidizing bacteria are present at much lower numeration in tailings as compared to waste rock piles due to limited oxygen penetration, high moisture content, and low permeability.

Based on the factors discussed above and past experience with similar tailings impoundments in a similar environment, the potential for acid generation is very low and limited to the shallow (0 to 5 feet) depth tailings subjected to limited oxygen penetration. As previously stated the acid-base potential is positive in that there is net base potential in the tailings; should any acids become generated they will be

immediately neutralized by the base compounds present in the tailings. However, because zinc can be soluble even under neutral pH conditions, zinc can still be in solution where water is in contact with tailings.

Assuming the primary factors are present in order to further evaluate the potential for acid production within the tailings one can evaluate the secondary factors.

5.5.3 Neutralization Potential

Static tests were conducted on representative samples of tailings to predict drainage quality by comparing the sample's maximum acid production potential (AP) with its maximum neutralization potential (NP). The results of static tests for the tailings are presented in Table 5-4.

The Net Neutralization Potential (NNP) is the difference between the NP and AP. If the NNP is positive this is an indication that the acid production is low risk and the neutralization capacity of tailings can overcome the acid potential. As it can be seen from Table 5-4 the surplus neutralization capacity for tailings is very high in excess of 50 tons of $CaCo_3$ per ton of tailings. The NP/AP ratio is also an indictor of potential acid production generation. At this site NP/AP ratios are generally 1.5 and above indicting low potential for acid generation.

In order to calculate the time required to fully overcome surplus neutralization capacity is very difficult if not impossible. The main controlling factor will be the availability of oxygen to allow for continuous oxidization of tailings. Based on our past experience with various tailings (ESE 1995) the depth of oxygen penetration into tailings is limited to upper the 3 to 4 feet. This condition can further be verified with examination of the pH profile of tailings as function of depth. Table 4-11 presents the pH value of tailings vs. depth. As it can be seen from this table the tailings pH vary from 7.3 to 7.7 at two to six feet below the ground surface. Therefore, the pH data do not indicate that the tailings are generating acid in the oxidized zone of the tailings vertical profile.

5.5.4 Chemical Stability of Sediments in South Diversion Ditch and Wetlands

The chemical environment operating in the South Diversion Ditch is dynamic, allowing for elevated dissolved zinc concentrations in the central reach but then transferring zinc to the solid phase in the lower reach. Metals removal likely occurs by some combination of the following processes:

- Biologically mediated precipitation as sulfide minerals

- adsorption on solid mineral phases or decaying organic matter
- coprecipitation with other metals such as manganese
- and to a lesser degree uptake by wetland plants

Although adsorption processes may have a limit, bio-attenuation mechanisms and coprecipitation processes are essentially unlimited as long as the present ecology in the ditch is maintained. Although not initially requested, acid-base potential tests were also run on six (6) sediment samples plus one duplicate. The acid-base potential data (Table 5-4) for the six sediment samples and one duplicate indicate that the neutralization potential is between 62 and 106 tons $CaCO_3$/1000 tons tailings (8.2 to 20.3 percent lime) indicating that there is a large excess base potential between 52 and 90 tons $CaCO_3$/1000 tons of tailings. The fraction of hot water extractable sulfur is between 0.04 and 0.53 percent compared to an acid extractable fraction of between 0.55 and 2.89 percent. Because the sediments have a lower fraction of extractable sulfur with a similar buffering capacity as the tailings, it would be very difficult to use up the neutralization potential and increase the leaching of sulfide minerals above present levels. The pH of water in the diversion ditch during this study has been between about 6.7 and 8.5. Therefore, very little, if any, of the neutralization capacity is consumed and the sediments should be stable as long as the current ditch operations are maintained.

6.0 RISK ASSESSMENT

This section details human and ecological risk assessment work conducted for the Site.

6.1 Baseline Human Health Risk Assessment

A Baseline Human Health Risk Assessment (BHHRA) for recreational visitors to the Site was conducted by the EPA (SRC, 2003) The BHHRA and its conclusions are summarized below.

Under the BHHRA, arsenic and lead were identified as chemicals of potential concern (COPCs) for the site through a four-step screening process. Two separate recreational use scenarios were evaluated: low intensity users such as picnickers, hikers, and bikers (young child to adult) and high intensity users such as horseback riders, ATV users, dirt-bikers, soccer and baseball players (teenage to adult). Calculations were conducted using both central tendency exposure (CTE) and reasonable maximum exposure (RME) values for each scenario.

Several exposure pathways were determined to be potentially significant and were evaluated quantitatively for each of the two recreational use scenarios. For the low intensity user, five pathways were evaluated quantitatively: ingestion of soil/tailings, ingestion of surface water, dermal exposure to surface water, ingestion of sediment, and inhalation of particulates in air. For the high intensity user, two pathways were evaluated quantitatively: ingestion of soil/tailings, and inhalation of particulates in air. For arsenic, risk calculations for all scenarios using both CTE and RME values showed that all noncancer hazard indices were less than one, indicating that no appreciable noncancer health effects are expected to occur. All calculated cancer risks were below 1×10^{-4}.

Lead was evaluated using the Integrated Exposure, Uptake and Biokinetic (IEUBK) model for children, and the Bower's model for adult receptors. Both models predicted blood lead levels below the EPA's health-based goal of a 5% probability of exceeding a blood lead level of 10 μg/dL for all recreational use scenarios.

Thus, the results of the BHHRA indicate that the average concentrations of lead and arsenic at the Site are not expected to pose a risk to recreational users of the Site above a level of regulatory concern.

6.2 Ecological Risk Assessment

A Baseline Ecological Risk Assessment (BERA) was conducted by the EPA and a draft version was released in January 2004 (SRC, 2004). The Draft BERA and its conclusions are summarized below.

Risk levels calculated in BERA determined that metals in sediment in the wetlands and diversion ditch are likely having effects on aquatic receptors such as fish and aquatic invertebrates with antimony, arsenic, cadmium, lead and zinc likely to be the main risk drivers (BERA, 2004). As part of the remedial action sediments in the wetland will be removed and a barrier will be placed over sediments in the diversion ditch. Elevated metal concentrations in the diversion ditch and wetland are likely the result of PCV's improper construction of the diversion ditch. Very little risk to aquatic receptors from ingestion of Site waters was present in the pond.

The BERA used a semi quantitative approach to evaluate risks to amphibians. As part of the remedial action source removal on portions of the Site contaminant levels will likely be reduced in the diversion ditch.

The BERA evaluated risks to aquatic/semi aquatic wildlife. The incidental ingestion of lead, manganese and zinc in sediments are likely to be causing adverse effects on waterfowl and other birds which feed at the Site. Birds that consume fish, aquatic invertebrates and aquatic plants at the Site may be adversely effected by lead, manganese and possibly zinc concentrations in these food items. Risks in the portion of the wetland affected by Silver Creek (approximately 40% of the wetland) are greater than the remaining portion of the wetland and the pond at the terminus of the diversion ditch. This is evidenced by the results of toxicity testing (Section 4.10.3.1) which indicates 0% survivability in the area of the wetland influenced by Silver Creek with greater survivability (up to 100%) in other locations not influenced by Silver Creek.

The risks to upland wildlife were not evaluated by the BERA because it is expected that proposed remedial activities will address these concerns.

7.0 SUMMARY AND CONCLUSIONS

The objective of the focused RI at the Site is to assess the nature and extent of contamination and the potential risks to the environment and human health associated with historical operations at the Site. The purpose of this report is to document results of this remedial investigation and incorporate findings from previous site investigations conducted by others at the Site. Following EPA and UDERR concurrence on the RI report, United Park will prepare a Feasibility Study analyzing alternatives to address potential excess risks, if any. Presented in this section are conclusions regarding the nature and extent of contamination and fate and transport of site contaminants. These conclusions, which consider EPA'a completed ecological risk assessment for the Site, will be used to determine what, if any additional remedial action may be necessary in order to reach final closure for the Site.

7.1 Summary of Nature and Extent of Contamination

Surface Water

- The data presented in Sections 4.1.1 through 4.1.3 indicate that metals concentrations are substantially lower in water discharged from the South Diversion Ditch (RF6-2) than in Silver Creek itself (RF7-2 and RF8). In fact, zinc concentrations are two orders of magnitude lower at RF6-2 than in Silver Creek. Zinc concentrations at RF6-2 are only slightly greater than background concentrations measured at RF-1 and RF-2 in the ephemeral drainage upstream from the tailings impoundment.

- Surface waters in both upstream and downstream locations in Silver Creek contain zinc concentrations that exceed the chronic and acute aquatic wildlife standard for zinc. This is in contrast to the metals concentrations measured in the downstream end of the diversion ditch (RF6-2) which are below both the chronic and acute aquatic wildlife standard for zinc.

- Zinc concentrations exceed water quality criteria in the upper section of the diversion ditch (roughly from RF-4 to RF-11) are likely due to PCV's actions described in 1.2.2.

- Water discharging from the diversion ditch and entering the wetlands meets all applicable water quality criteria, whereas water from Silver Creek entering the wetlands and converging with the diversion ditch water does not meet applicable water quality criteria for zinc. Surface water flow direction data along with surface water chemistry data confirms that the northern portion of the wetland is impacted by Silver Creek waters.

- Surface water in the pond located at the terminus of the South Diversion Ditch meets water quality criteria. Surface water in the wetland meets water quality criteria in areas upgradient from Silver Creek influence.

Groundwater

- Groundwater sampling results indicate that, although some seasonally-elevated zinc concentrations are observed, in general the groundwater contained within the tailings south of the diversion ditch has much lower concentrations of metals than the groundwater in the Silver Creek alluvial aquifer. Much of the groundwater south of the diversion ditch is captured by the ditch. Average dissolved zinc concentrations in groundwater associated with the tailings are generally about 500 times lower than concentrations measured in the upgradient Silver Creek alluvial aquifer. Based on these data, it does not appear that the Richardson Flat tailings are contributing zinc or other metals to the Silver Creek alluvial aquifer.

- Beyond seepage across the tailings embankment, there is no hydraulic connection between the groundwater stored in the tailings and underlying and adjacent to shallow alluvial aquifers (*See,* MWH Americas report Appendix 5).

- There is no apparent hydraulic connection between groundwater stored in the tailings and the underlying aquifer(s) within the Keetley Volcanic rocks developed as a groundwater supply by downstream Public Water Systems (*See,* MWH Americas report Appendix 5).

- First-order approximations of seepage rates through the tailings embankment range from approximately 0.6 to 63 gallons per day (*See,* MWH Americas report Appendix 5). This volume of water is insufficient to adversely impact the wetlands area.

- Pumping wells serving Public Water Systems along Silver Creek do not capture groundwater stored in Keetley Volcanic rocks underlying Richardson Flat (*See,* MWH Americas report Appendix 5).

- Groundwater quality at piezometer RT-7 indicates groundwater within the wetland area between the main embankment and Silver Creek is not impacted by mine wastes.

Soils

- On-site soils data indicate that the tailings cover is greater than 1.0 feet deep on the southern half of the impoundment and more than six inches deep on the northern half. Average surface soil concentrations for lead are less than 400 ppm. There are a few localized areas of the cover where surface lead concentrations exceed 400 ppm.

- Off-site soils data indicate that the extent of wind blown tailings is generally limited to areas immediately adjacent to the impoundment. Samples collected north of State Highway 248 indicate that the average lead concentration for this transect is 128 ppm. Transect 2 located immediately south of the tailings impoundment reveals that there are areas of exposed tailings along this transect. Transect 3 average lead concentrations are 142 ppm which are elevated above background however, the results of risk assessment indicates that these levels do not pose a risk to human health or the environment.

- Sample data show that the diversion ditch, pond and wetland sediments contain metals at all locations sampled. XRD data for diversion ditch sediments indicate that there are sulfide minerals present in the sediments indicating that biogeochemical processes are occurring in the ditch sediments. The sulfide minerals are likely less bioavailable than other mineral phases. The presence of sulfides in sediment porewater samples in the pond and wetland indicate that biogeochemical processes are occurring in the sediments.

- Tailings data indicate that there is net base potential in the tailings meaning that there are more alkaline or basic compounds in the tailings than acid generating compounds. Under current operating conditions it is unlikely that the tailings will become acidic. The average tailings pH is 7.5 Su. SPLP data from unsaturated tailings indicate that metals such as lead and zinc will leach, however, Site groundwater data from wells RT-13, RT-14, and RT-15 (completed in tailings) suggest that metals leached from tailings are re-saturated after being above the water table for an extended period of time.

7.2 Risk Summary

- The Draft Human Health Risk Assessment for Recreational Visitors, conducted by EPA, has determined that there are no unacceptable risks to the targeted population at this site.

- The Draft Ecological Risk assessment, conducted by EPA, has concluded that metals in sediments and surface water in the pond and wetland area are likely having an adverse effect on aquatic wildlife in these areas. Upland species were not evaluated due to the anticipated results of proposed remedial measures negating the potential for the exposure of these species to Site contaminants.

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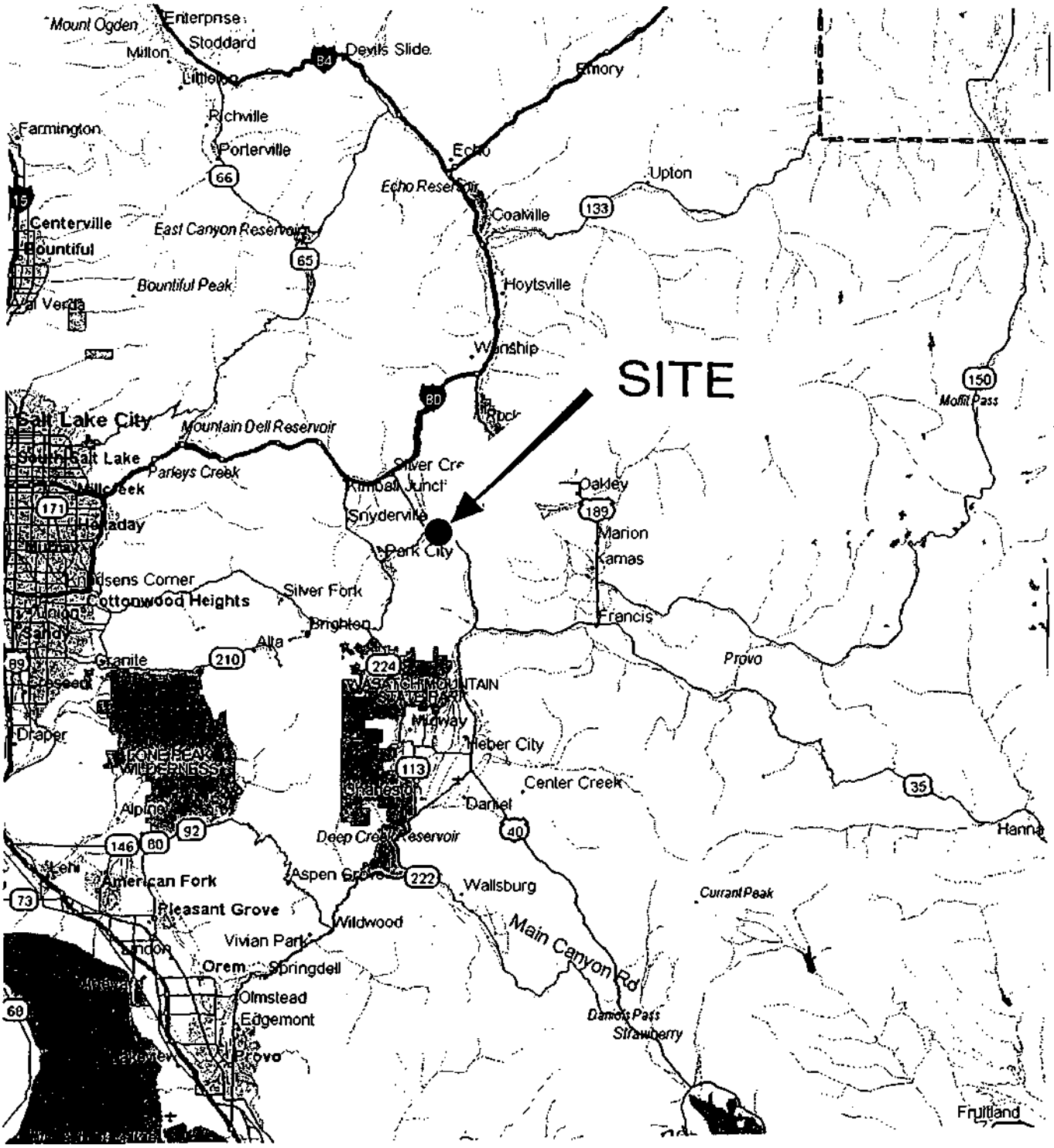
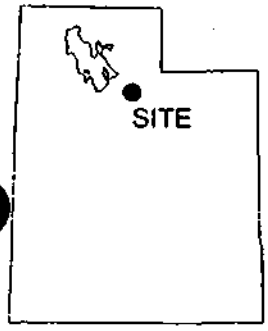




NOT TO SCALE

RICHARDSON FLAT RI

FIGURE 1-1
SITE LOCATION MAP

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

APRIL 2002

ri-site-location-map-dwg

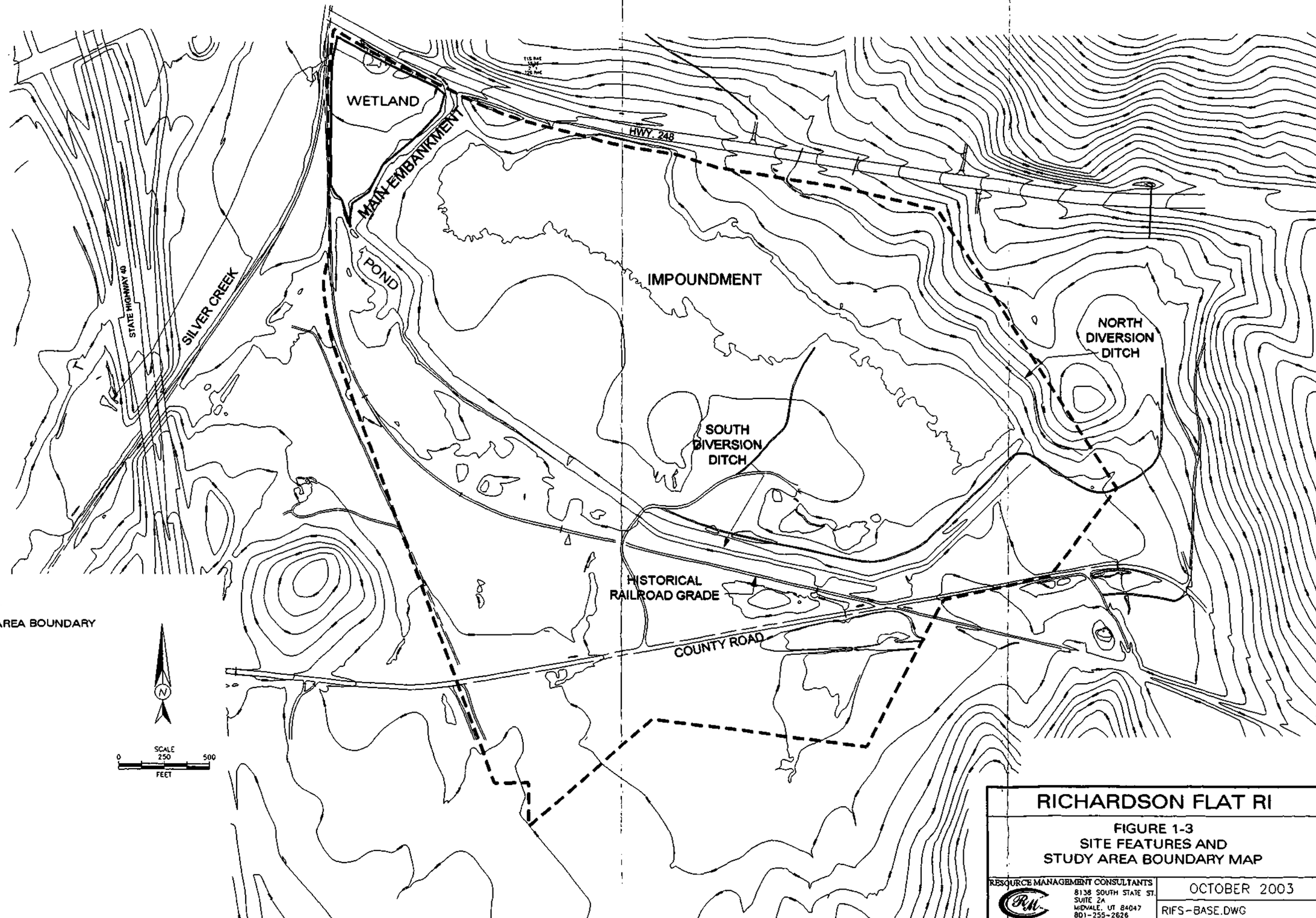
RICHARDSON FLAT RI

FIGURE 1-2
SITE VICINITY MAP

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

October 2003

parkcity-quads-rifs.dwg



RICHARDSON FLAT RI

FIGURE 1-3
SITE FEATURES AND
STUDY AREA BOUNDARY MAP

RESOURCE MANAGEMENT CONSULTANTS
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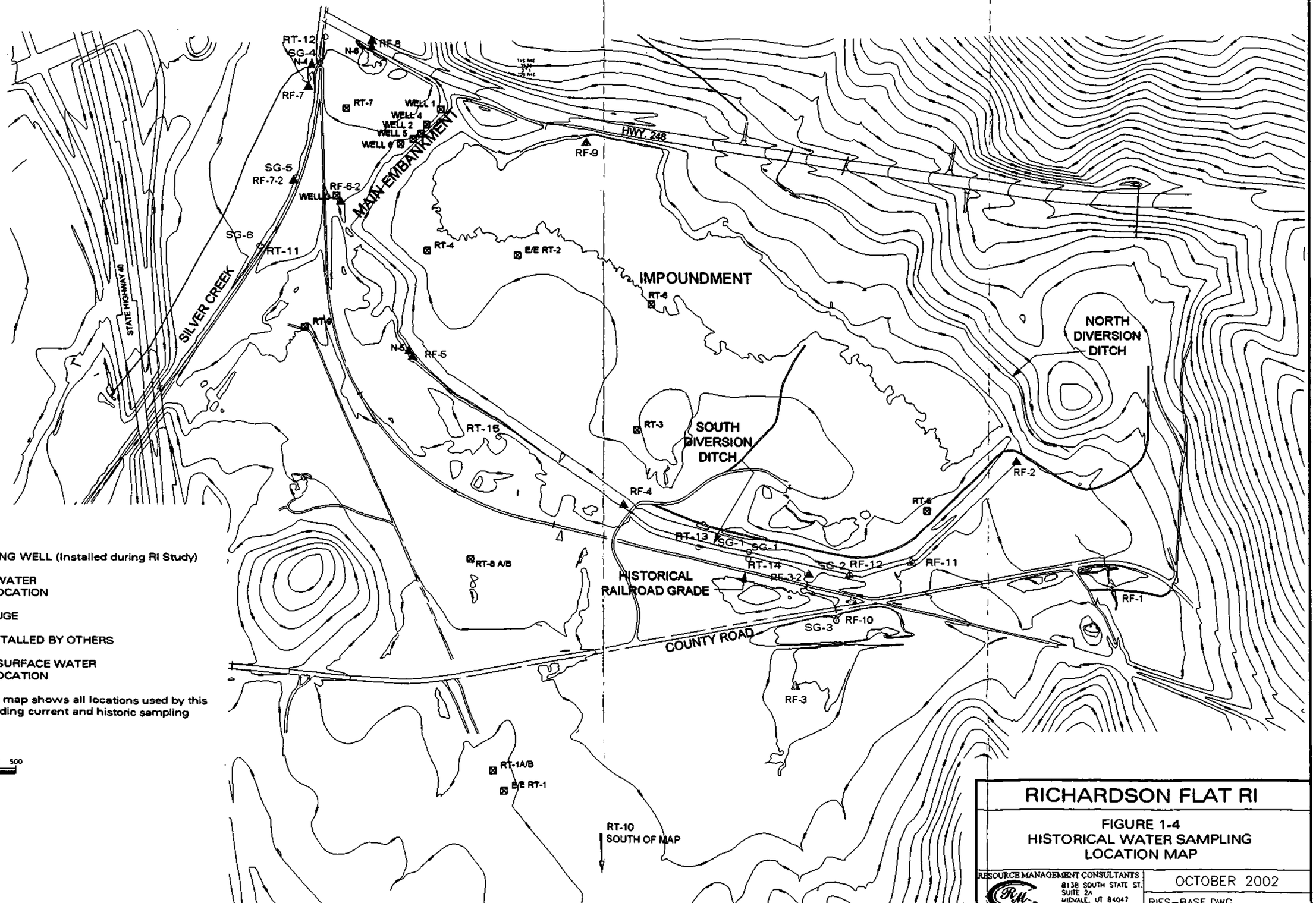

RICHARDSON FLAT RI

FIGURE 1-4
HISTORICAL WATER SAMPLING LOCATION MAP

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
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MIDVALE, UT 84047
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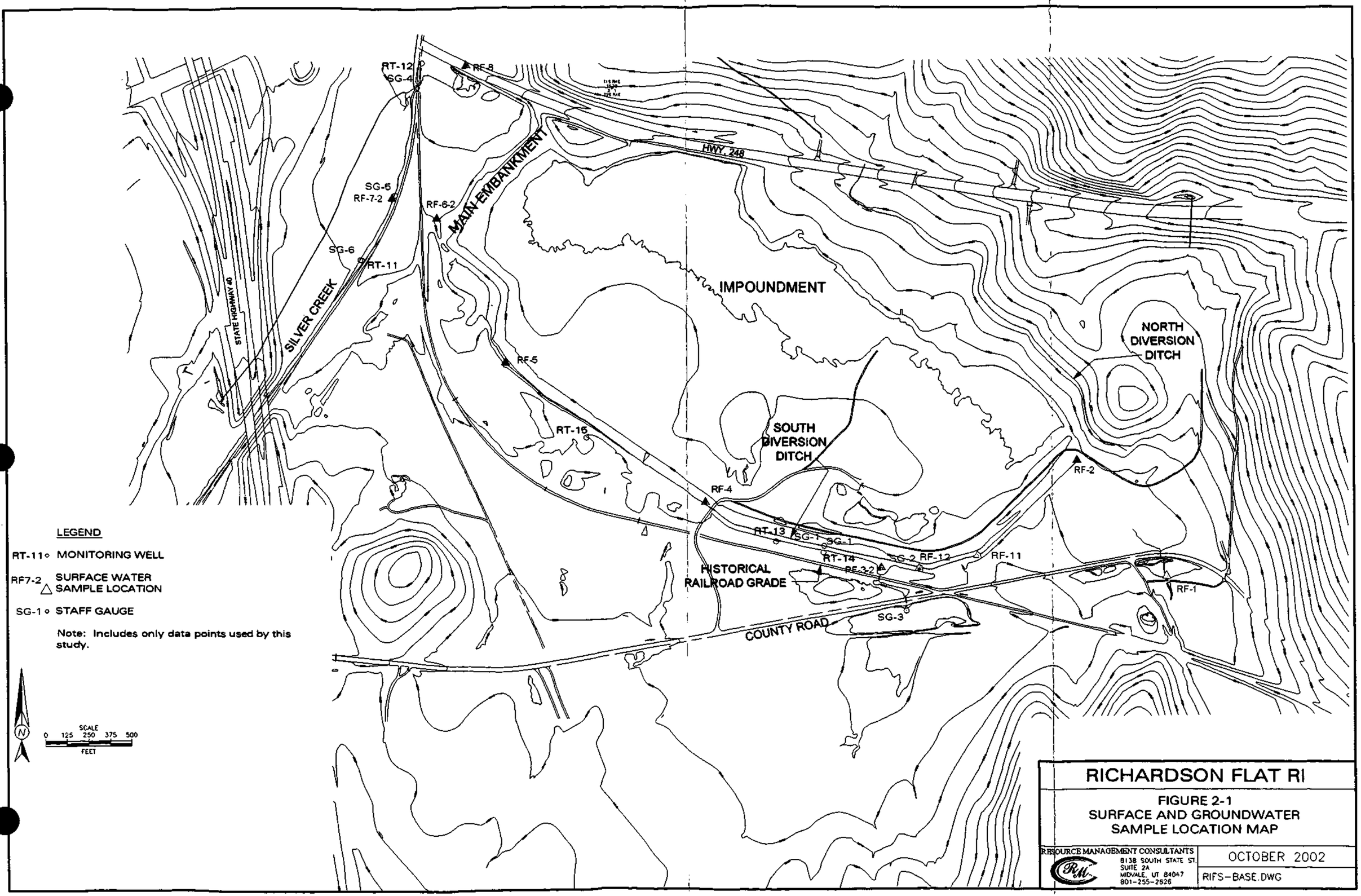
RT-12
SG-4
RF-8
HWY. 248
MAIN EMBANKMENT
SG-5
RF-7-2
RF-6-2
SG-6
RT-11
SILVER CREEK
STATE HIGHWAY 40
IMPOUNDMENT
NORTH DIVERSION DITCH
RF-5
RT-15
SOUTH DIVERSION DITCH
RF-2
RF-4
RT-13
SG-1
SG-1
RT-14
SG-2
RF-12
RF-11
RF-3-2
HISTORICAL RAILROAD GRADE
RF-1
SG-3
COUNTY ROAD
LEGEND
RT-11 MONITORING WELL
RF7-2 SURFACE WATER SAMPLE LOCATION
SG-1 STAFF GAUGE
Note: Includes only data points used by this study.
N
SCALE
0 125 250 375 500
FEET
RICHARDSON FLAT RI
FIGURE 2-1
SURFACE AND GROUNDWATER SAMPLE LOCATION MAP
RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626
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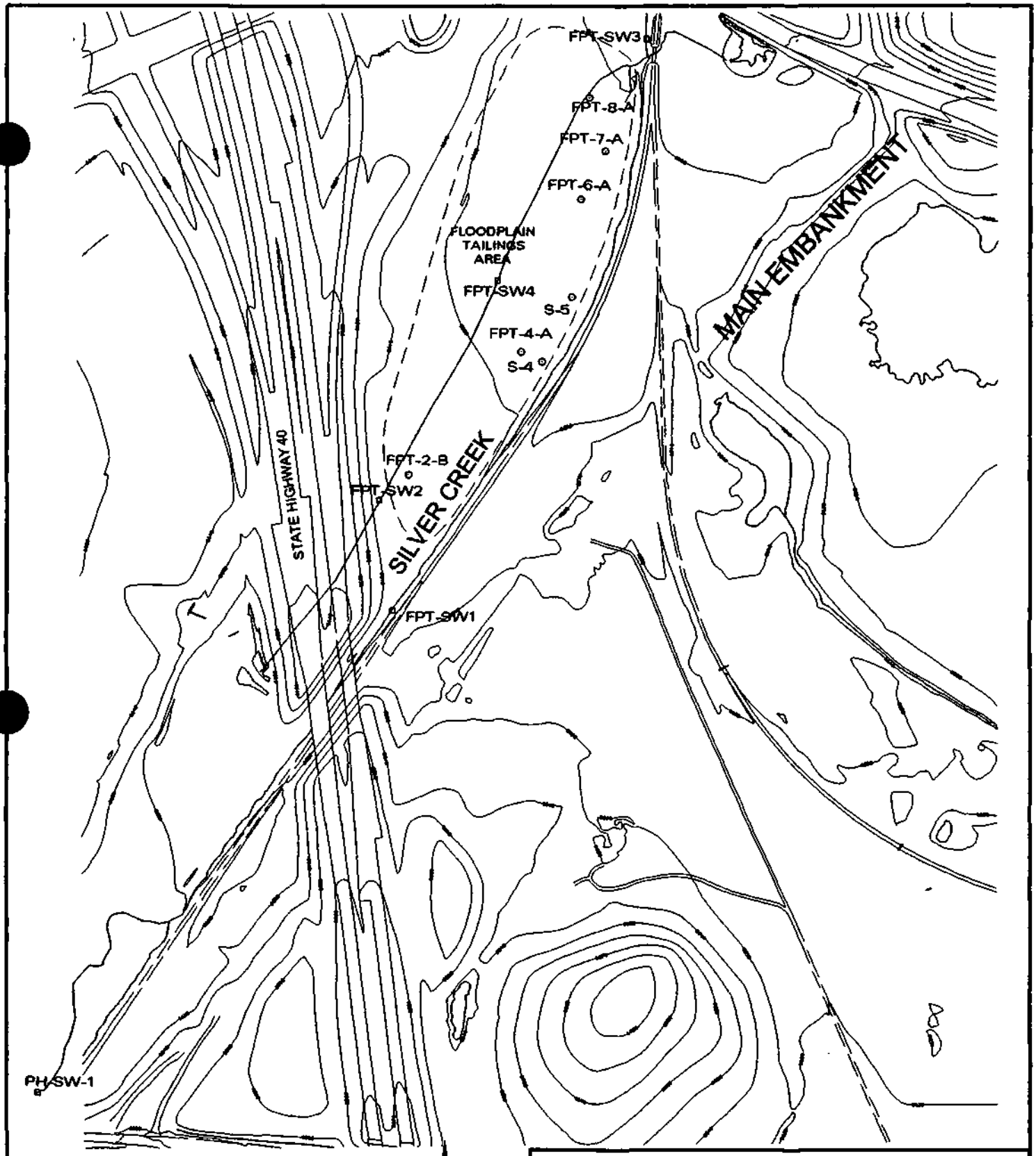
RIFS-BASE.DWG



LEGEND

○ FPT-4A MONITORING WELL

FPT-SW1 SURFACE WATER SAMPLE LOCATION

N

SCALE
0 100 200 300 400
FEET

RICHARDSON FLAT RI

FIGURE 2-2
FLOODPLAIN TAILINGS AREA SAMPLE LOCATION MAP

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

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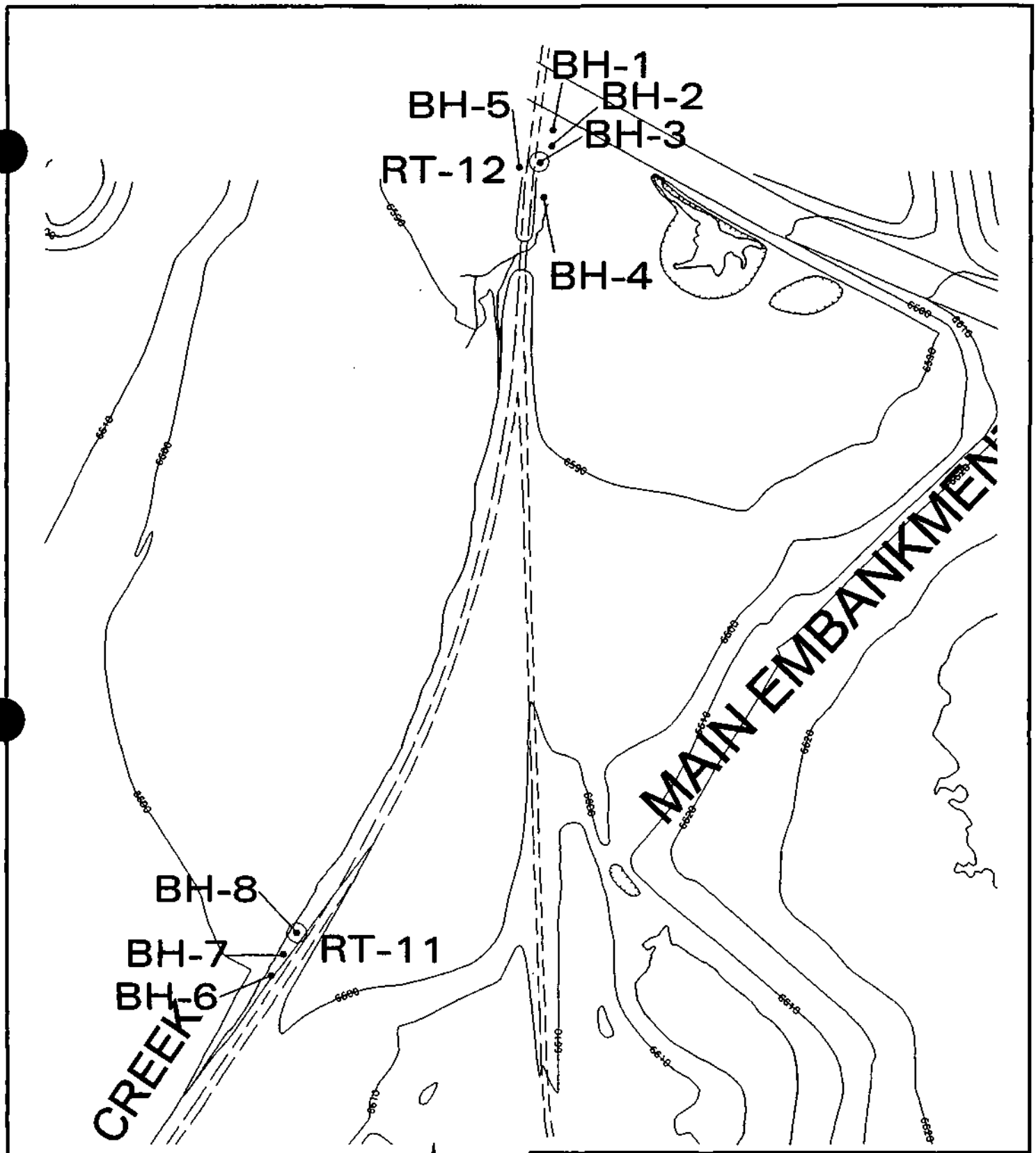
RIFS-BASE-6.DWG



RICHARDSON FLAT RI

FIGURE 2-3
SOIL BORING LOCATION MAP

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

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RIFS-BASE.DWG

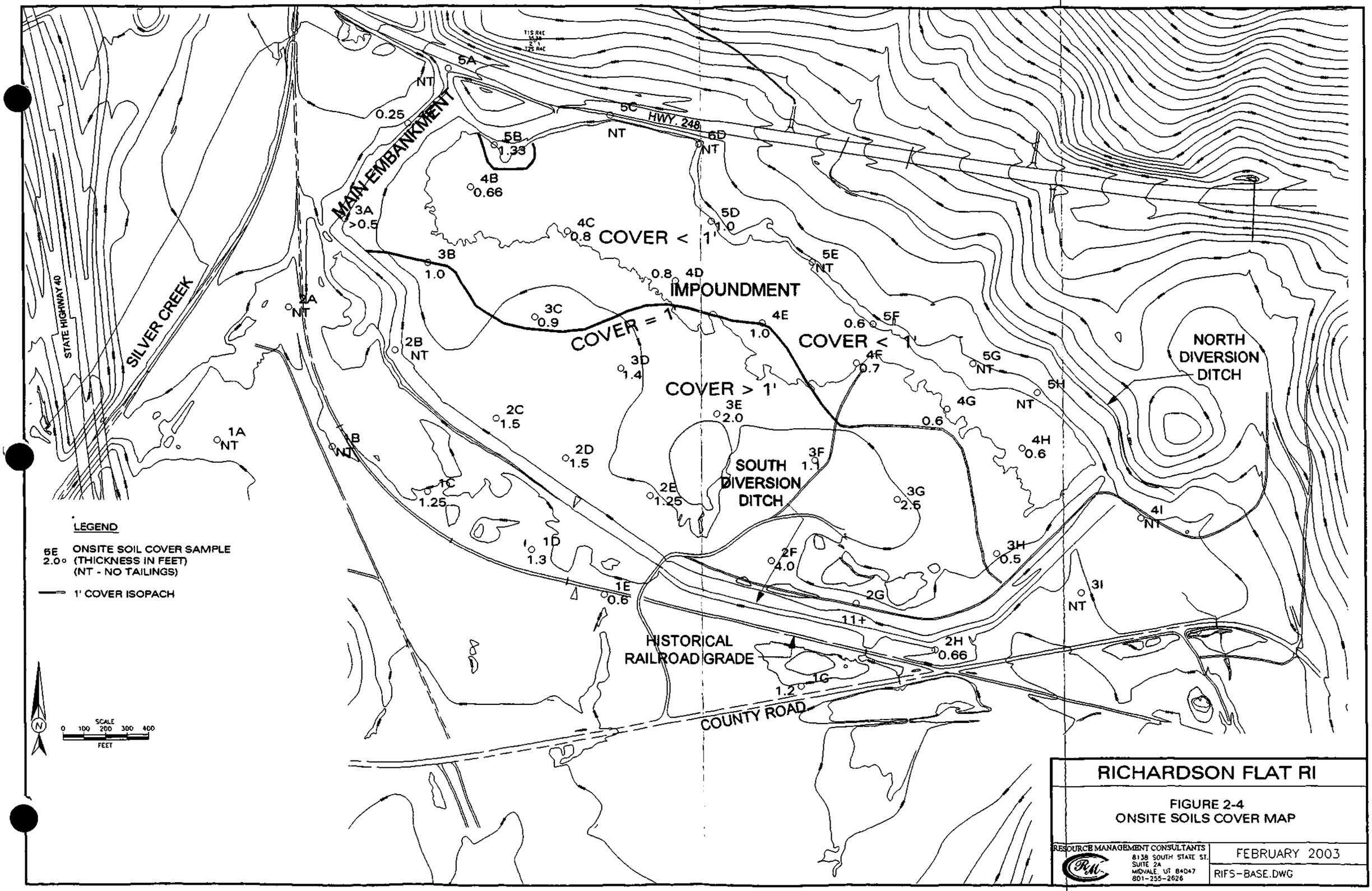
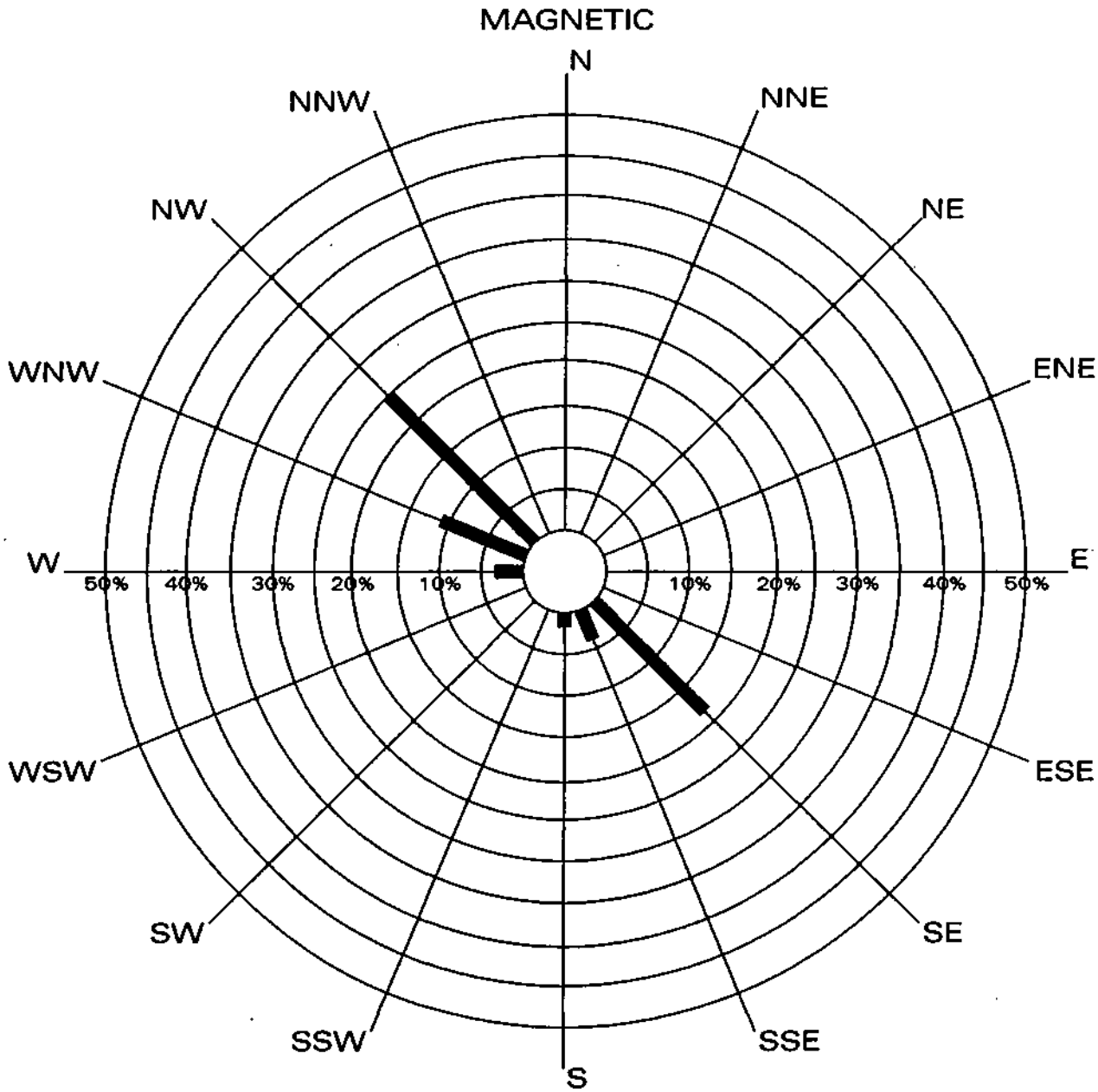
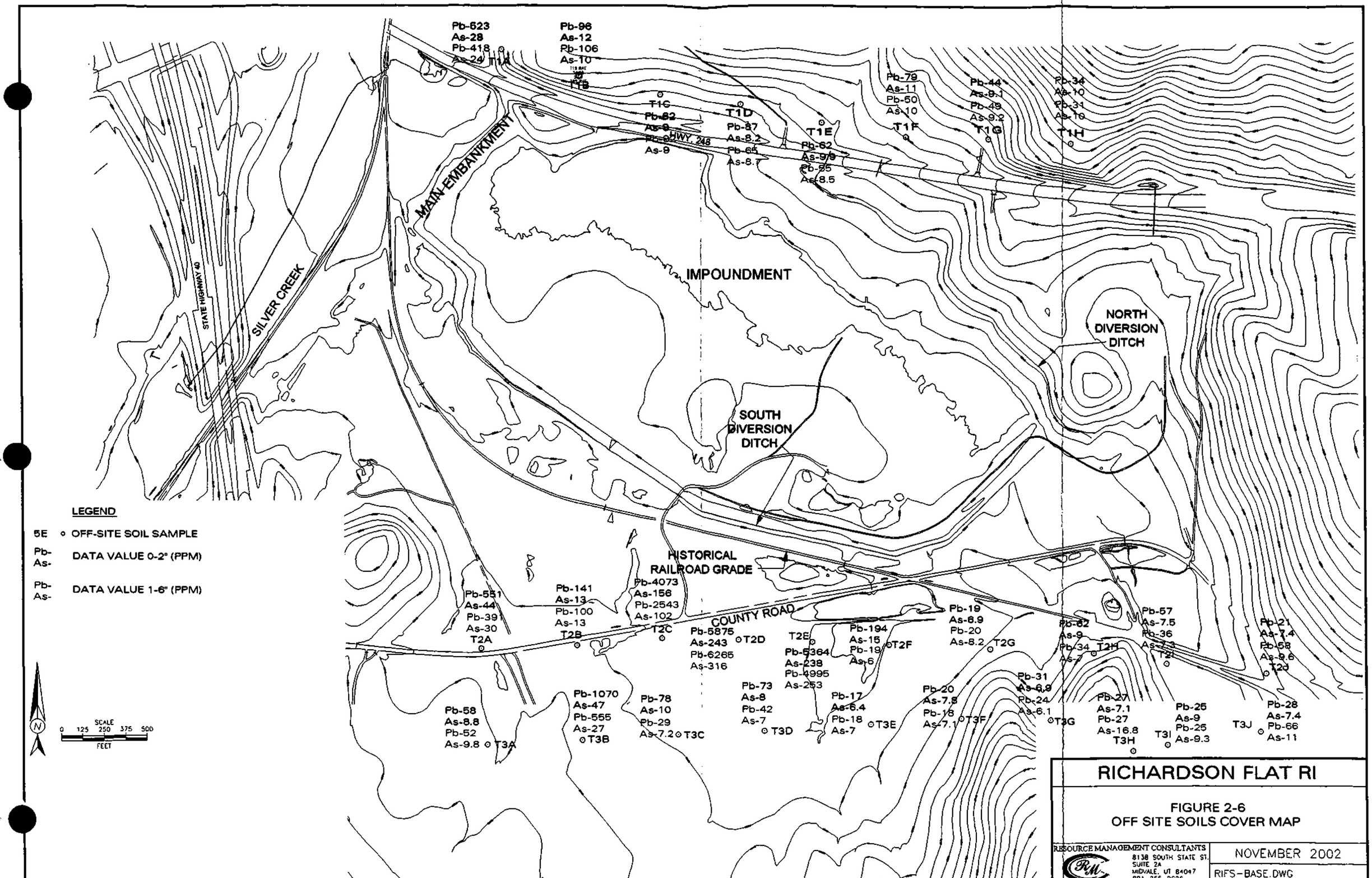

MAIN EMBANKMENT
HWY. 248
SILVER CREEK
STATE HIGHWAY 40
IMPOUNDMENT
COVER < 1'
COVER = 1'
COVER > 1'
COVER < 1'
NORTH DIVERSION DITCH
SOUTH DIVERSION DITCH
HISTORICAL RAILROAD GRADE
COUNTY ROAD
5A NT
0.25
5B 1.33
5C NT
6D NT
4B 0.66
3A >0.5
4C 0.8
5D 1.0
3B 1.0
0.8 4D
5E NT
2A NT
3C 0.9
4E 1.0
0.6 5F
2B NT
3D 1.4
4F 0.7
5G NT
5H NT
4G 0.6
2C 1.5
3E 2.0
1A NT
1B NT
2D 1.5
3F 1.9
4H 0.6
1C 1.25
2E 1.25
3G 2.5
4I NT
1D 1.3
2F 4.0
3H 0.5
1E 0.6
2G 11+
3I NT
2H 0.66
1G 1.2
LEGEND
6E 2.0 ONSITE SOIL COVER SAMPLE (THICKNESS IN FEET) (NT - NO TAILINGS)
1' COVER ISOPACH
N
SCALE
0 100 200 300 400
FEET
RICHARDSON FLAT RI
FIGURE 2-4
ONSITE SOILS COVER MAP
RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626
FEBRUARY 2003
RIFS-BASE.DWG

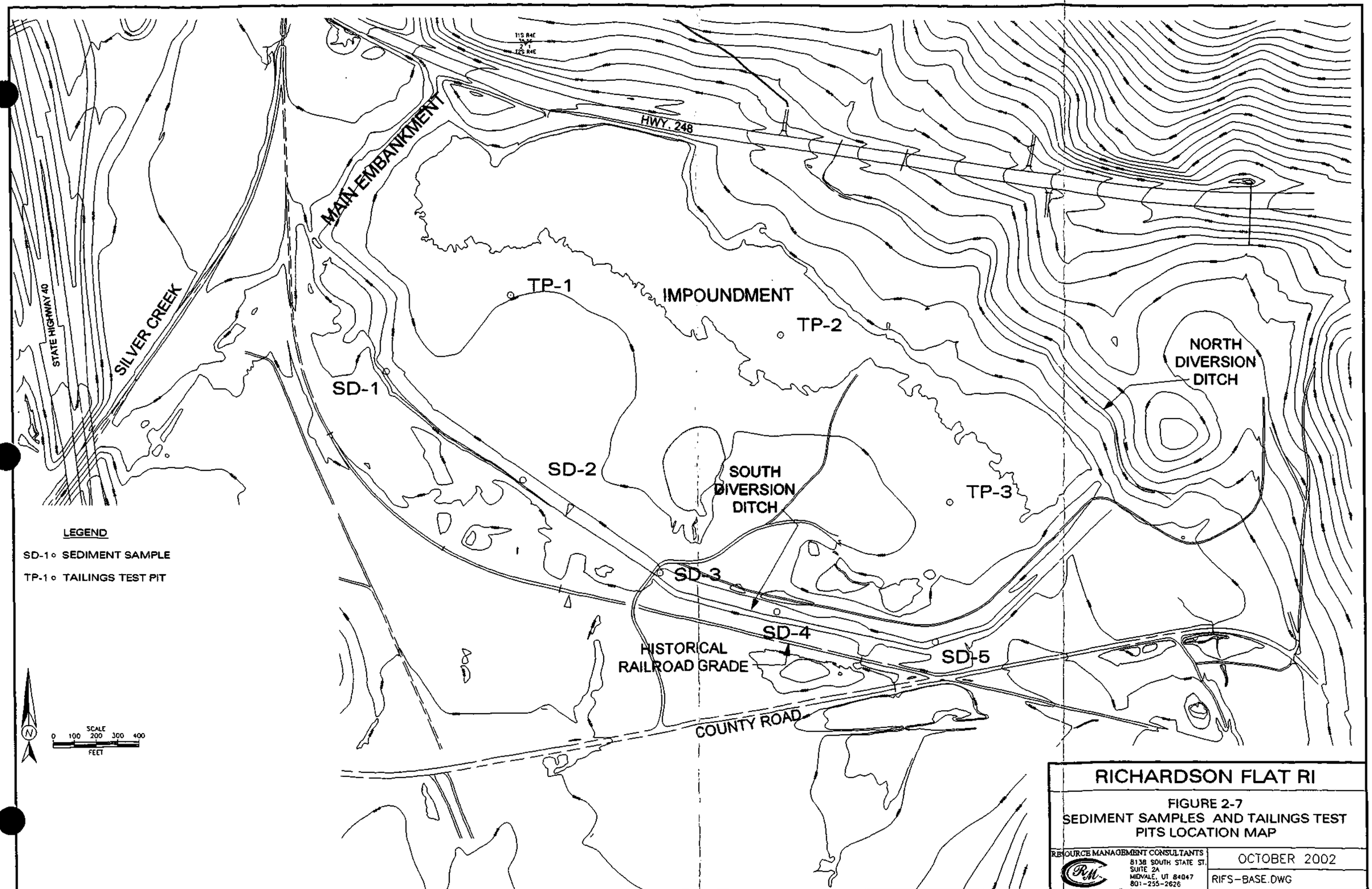
FIGURE 2-5 - Richardson Flat Wind Rose

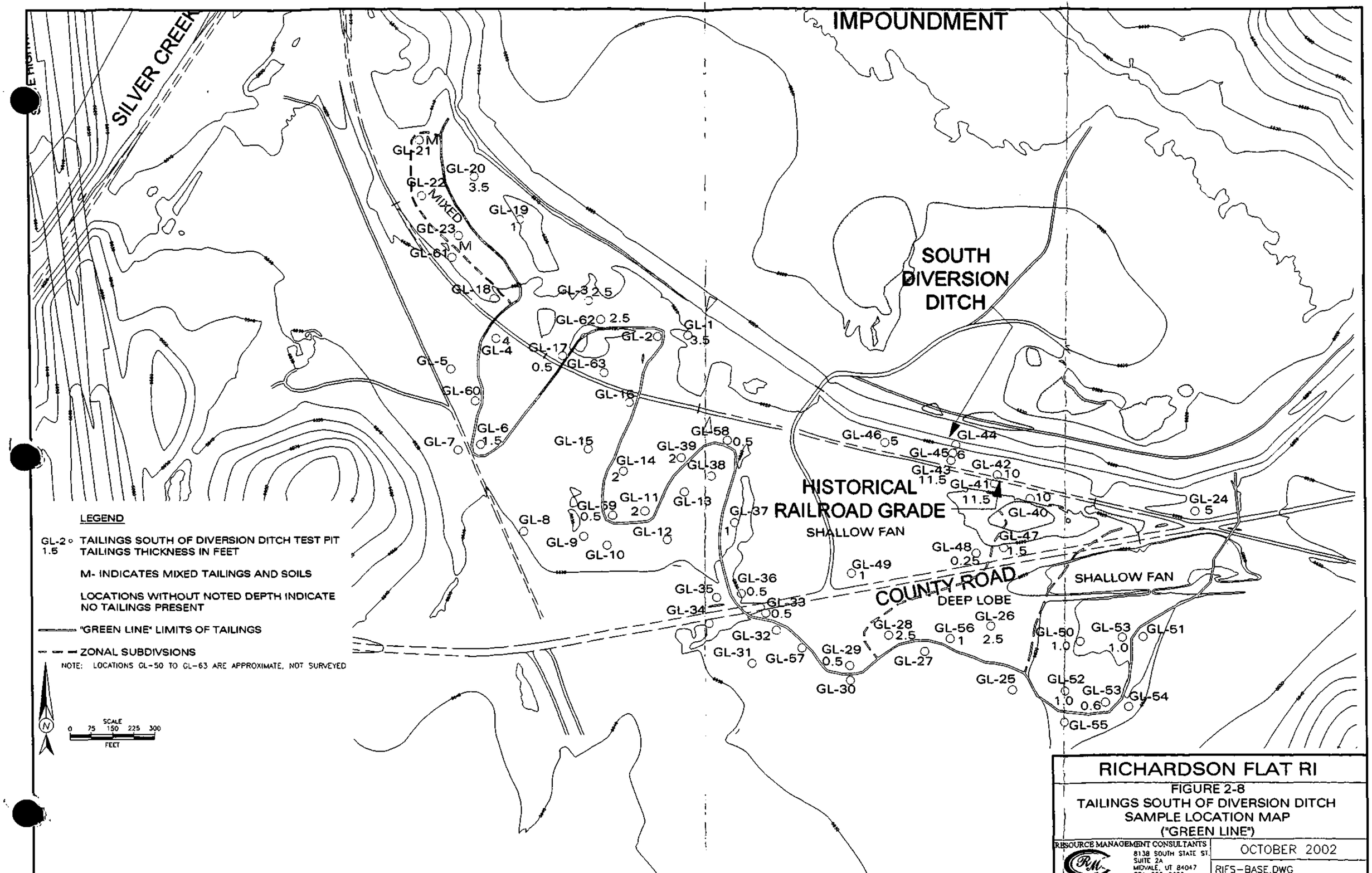


DATA COLLECTION DATE: JULY 12, 1986
21.4% CALM

DATA SOURCE: ECOLOGY AND ENVIRONMENT, INC.
ANALYTICAL RESULTS REPORT OF AIR SAMPLING AT RICHARDSON FLAT,
PARK CITY, UT
SEPTEMBER 9,1987
FIGURE 8


Pb-623
As-28
Pb-418
As-24
T1A
Pb-96
As-12
Pb-106
As-10
T1B
T1C
Pb-82
As-9
Pb-92
As-9
HWY 248
T1D
Pb-87
As-8.2
Pb-65
As-8.7
T1E
Pb-62
As-9.9
Pb-55
As-8.5
Pb-79
As-11
Pb-50
As-10
T1F
Pb-44
As-9.1
Pb-49
As-9.2
T1G
Pb-34
As-10
Pb-31
As-10
T1H
MAIN EMBANKMENT
IMPOUNDMENT
SILVER CREEK
STATE HIGHWAY 40
NORTH DIVERSION DITCH
SOUTH DIVERSION DITCH
HISTORICAL RAILROAD GRADE
COUNTY ROAD
LEGEND
5E OFF-SITE SOIL SAMPLE
Pb- As- DATA VALUE 0-2" (PPM)
Pb- As- DATA VALUE 1-6" (PPM)
SCALE
0 125 250 375 500
FEET
Pb-551
As-44
Pb-391
As-30
T2A
Pb-141
As-13
Pb-100
As-13
T2B
Pb-4073
As-156
Pb-2543
As-102
T2C
Pb-5875
As-243
T2D
Pb-6265
As-316
T2E
Pb-5364
As-238
Pb-4995
As-253
Pb-194
As-15
Pb-19
As-6
T2F
Pb-19
As-6.9
Pb-20
As-8.2
T2G
Pb-62
As-9
Pb-34
As-7
T2H
Pb-57
As-7.5
Pb-36
As-7.3
T2I
Pb-21
As-7.4
Pb-58
As-9.6
T2J
Pb-58
As-8.8
Pb-52
As-9.8
T3A
Pb-1070
As-47
Pb-555
As-27
T3B
Pb-78
As-10
Pb-29
As-7.2
T3C
Pb-73
As-8
Pb-42
As-7
T3D
Pb-17
As-6.4
Pb-18
As-7
T3E
Pb-20
As-7.8
Pb-18
As-7.1
T3F
Pb-31
As-6.9
Pb-24
As-6.1
T3G
Pb-27
As-7.1
Pb-27
As-16.8
T3H
T3I
Pb-25
As-9
Pb-25
As-9.3
T3J
Pb-28
As-7.4
Pb-66
As-11
RICHARDSON FLAT RI
FIGURE 2-6
OFF SITE SOILS COVER MAP
RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626
NOVEMBER 2002
RIFS-BASE.DWG


11S R4E
12S R4E
HWY. 248
MAIN EMBANKMENT
STATE HIGHWAY 40
SILVER CREEK
TP-1
IMPOUNDMENT
TP-2
NORTH DIVERSION DITCH
SD-1
SD-2
SOUTH DIVERSION DITCH
TP-3
SD-3
SD-4
HISTORICAL RAILROAD GRADE
SD-5
COUNTY ROAD
LEGEND
SD-1 ∘ SEDIMENT SAMPLE
TP-1 ∘ TAILINGS TEST PIT
N
SCALE
0 100 200 300 400
FEET
RICHARDSON FLAT RI
FIGURE 2-7
SEDIMENT SAMPLES AND TAILINGS TEST PITS LOCATION MAP
RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626
OCTOBER 2002
RIFS-BASE.DWG



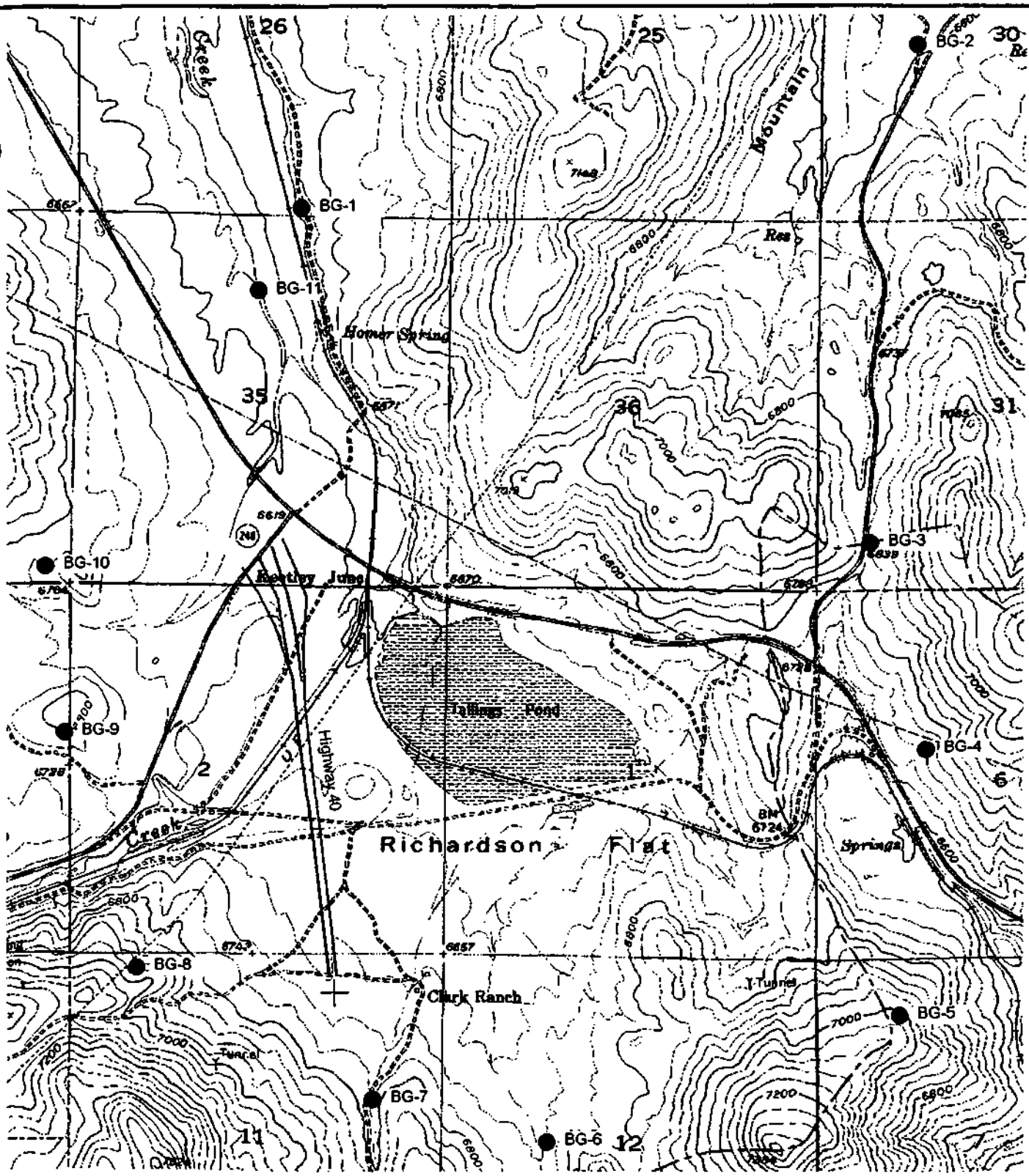
RICHARDSON FLAT RI

FIGURE 2-8
TAILINGS SOUTH OF DIVERSION DITCH SAMPLE LOCATION MAP ("GREEN LINE")

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

OCTOBER 2002

RIFS-BASE.DWG



LEGEND

● BACKGROUND SOIL SAMPLE LOCATION

SCALE
0 500 1000 1500 2000
FEET

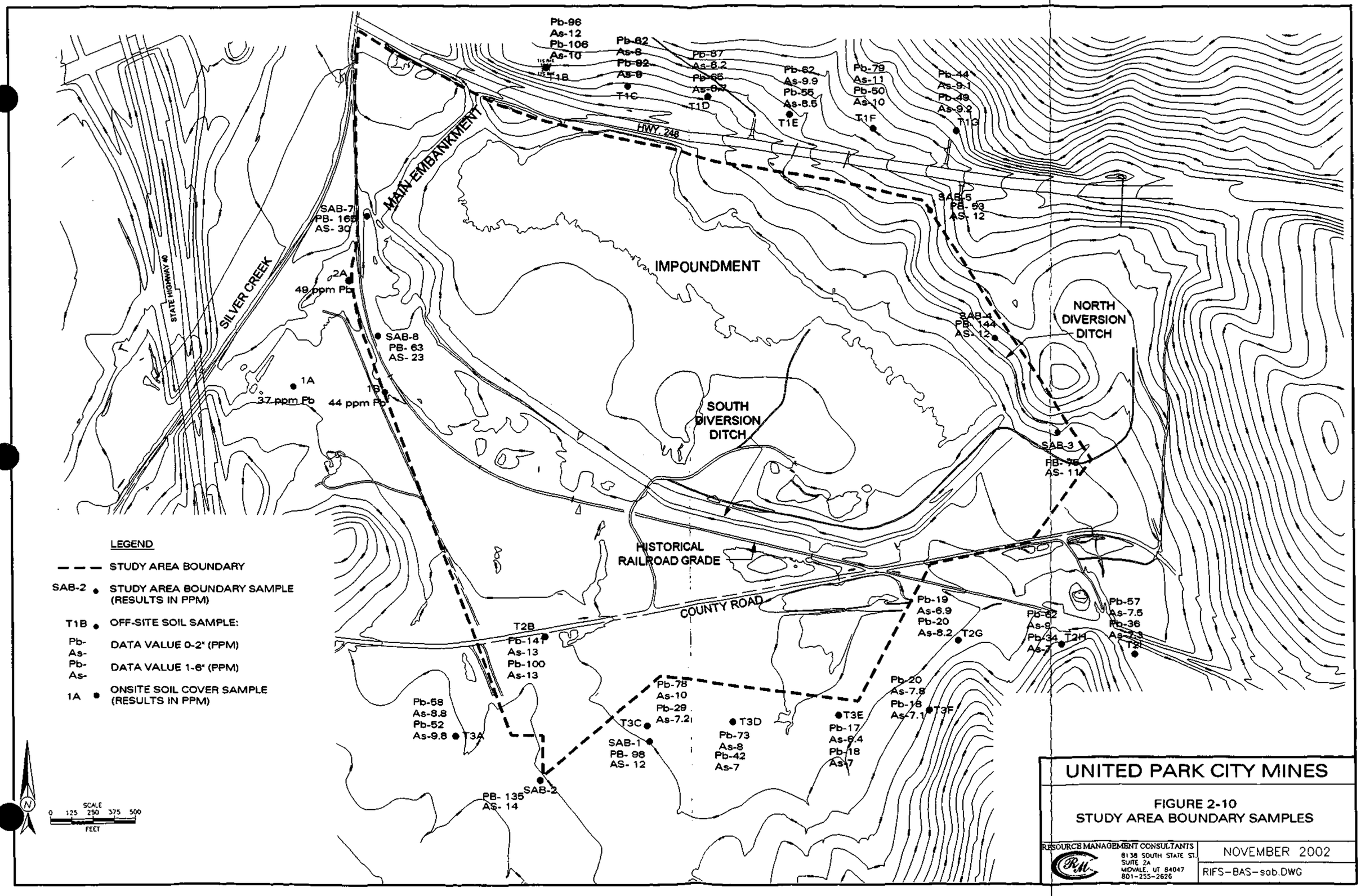
RICHARDSON FLAT RI

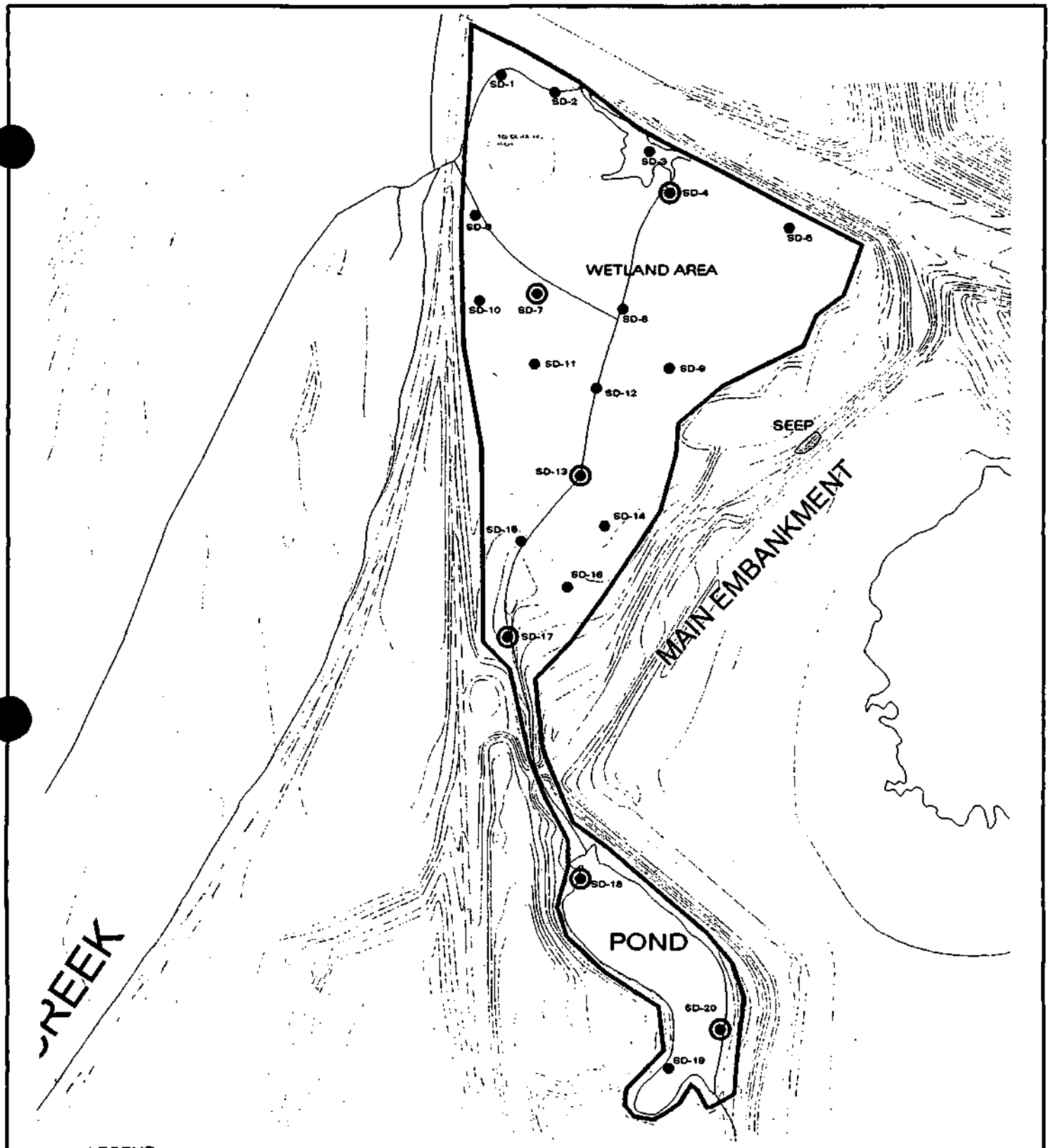
FIGURE 2-9
BACKGROUND SAMPLE LOCATION MAP

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

OCTOBER 2002

parkcity-quads-rifs.dwg


Pb-96
As-12
Pb-106
As-10
T1B
Pb-82
As-8
Pb-92
As-9
T1C
Pb-87
As-8.2
Pb-65
As-8.7
T1D
Pb-62
As-9.9
Pb-55
As-8.5
T1E
Pb-79
As-11
Pb-50
As-10
T1F
Pb-44
As-9.1
Pb-49
As-9.2
T1G
HWY. 248
MAIN EMBANKMENT
SAB-5
PB- 53
AS- 12
SAB-7
PB- 165
AS- 30
IMPOUNDMENT
2A
49 ppm Pb
SILVER CREEK
STATE HIGHWAY 40
SAB-8
PB- 63
AS- 23
SAB-4
PB- 144
AS- 12
NORTH DIVERSION DITCH
1A
37 ppm Pb
1B
44 ppm Pb
SOUTH DIVERSION DITCH
SAB-3
PB- 76
AS- 11
HISTORICAL RAILROAD GRADE
COUNTY ROAD
Pb-19
As-6.9
Pb-20
As-8.2
T2G
Pb-62
As-8
Pb-34
As-7
T2H
Pb-57
As-7.5
Pb-36
As-7.3
T2I
T2B
Pb-14
As-13
Pb-100
As-13
Pb-78
As-10
Pb-29
As-7.2
Pb-20
As-7.8
Pb-18
As-7.1
T3F
Pb-58
As-8.8
Pb-52
As-9.8
T3A
T3C
SAB-1
PB- 98
AS- 12
T3D
Pb-73
As-8
Pb-42
As-7
T3E
Pb-17
As-6.4
Pb-18
As-7
SAB-2
PB- 135
AS- 14
LEGEND
STUDY AREA BOUNDARY
SAB-2 STUDY AREA BOUNDARY SAMPLE (RESULTS IN PPM)
T1B OFF-SITE SOIL SAMPLE:
Pb- DATA VALUE 0-2' (PPM)
As-
Pb- DATA VALUE 1-6' (PPM)
As-
1A ONSITE SOIL COVER SAMPLE (RESULTS IN PPM)
N
SCALE
0 125 250 375 500
FEET
UNITED PARK CITY MINES
FIGURE 2-10
STUDY AREA BOUNDARY SAMPLES
RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626
NOVEMBER 2002
RIFS-BAS-sab.DWG



LEGEND

- SEDIMENT SAMPLE LOCATION
- SEDIMENT AND SURFACE WATER SAMPLE LOCATION
- ECOLOGICAL STUDY AREA BOUNDARY

N

SCALE
0 50 100 150 200
FEET

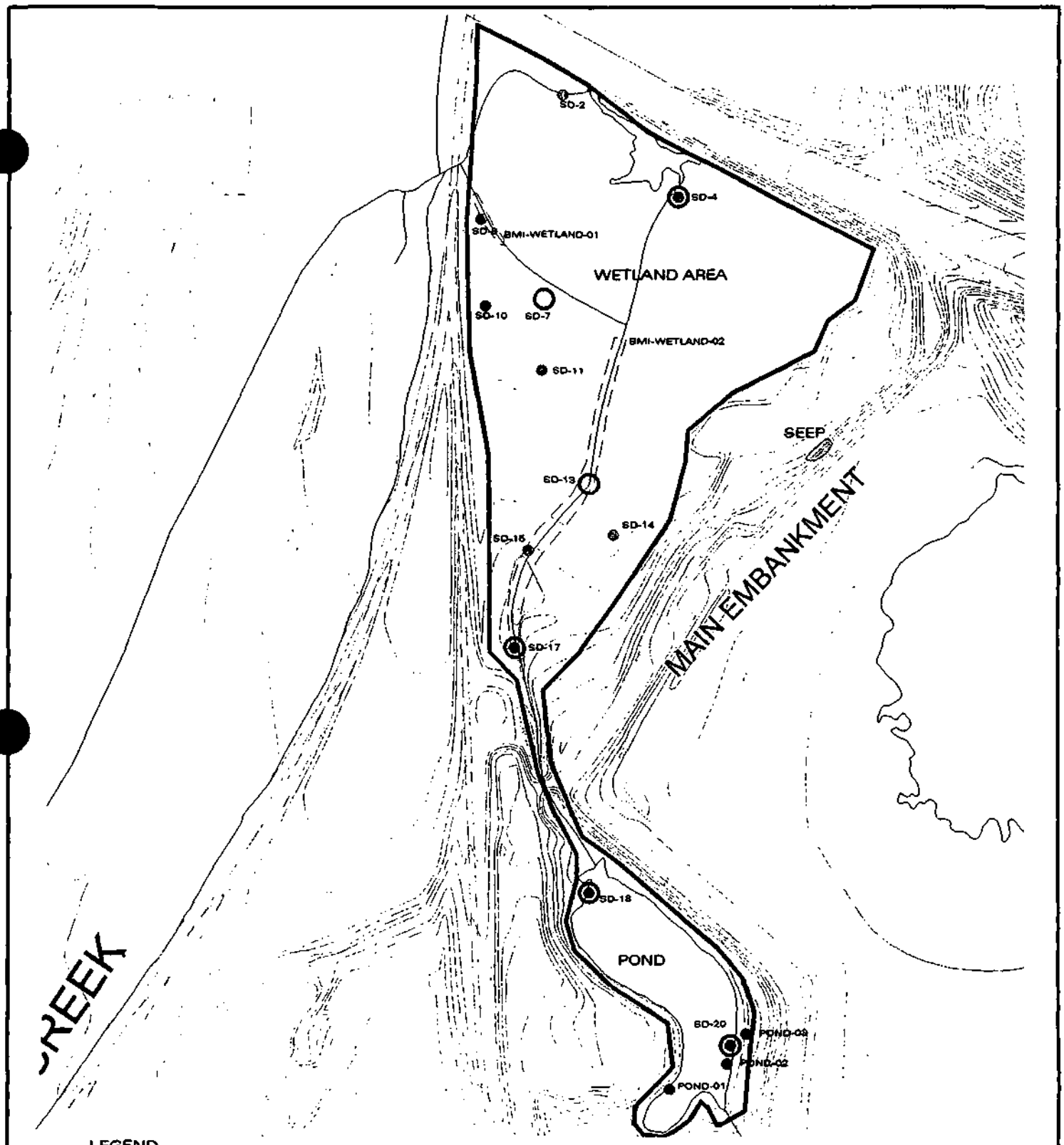
RICHARDSON FLAT RI

FIGURE 2-11
ECOLOGICAL PHASE I
WETLAND AND POND AREA
SAMPLE LOCATION MAP

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

October 2003

RIFS-BASE-4-BIOSAP.DWG



LEGEND

- SAMPLE LOCATION STATION: SEDIMENT, POREWATER AND VEGETATION
- SAMPLE LOCATION STATION AND SURFACE WATER SAMPLE LOCATION
- SURFACE WATER SAMPLE LOCATION
- COMPOSITE SAMPLE ZONE
- ECOLOGICAL STUDY AREA

SCALE 0 50 100 150 200 FEET

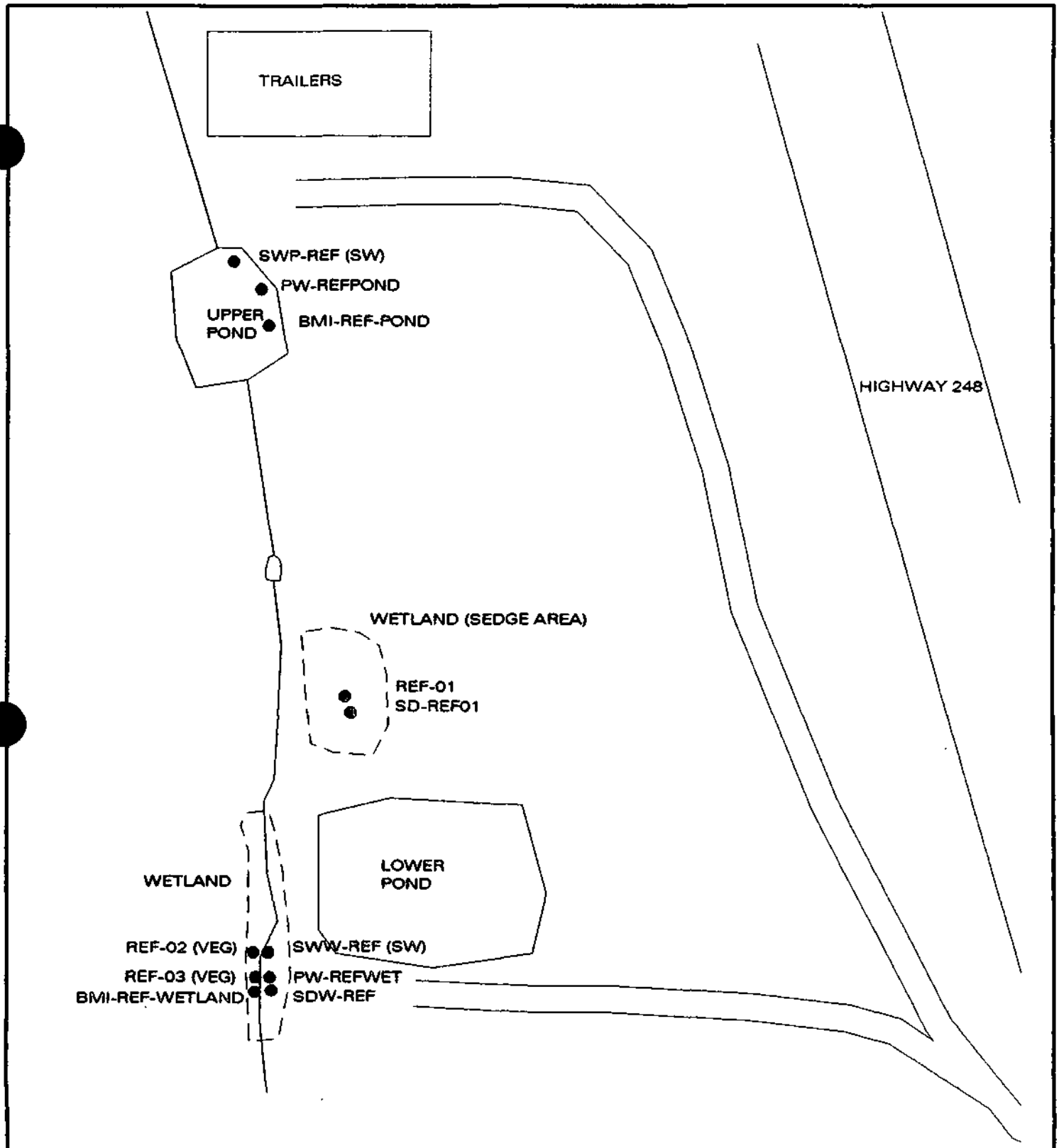
RICHARDSON FLAT RI

FIGURE 2-12
ECOLOGICAL PHASE II
WETLAND AND POND AREA
SAMPLE LOCATION MAP

RESOURCE MANAGEMENT CONSULTANTS
6138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

October 2003

RIFS-BASE-7-BIOSAP.DWG



LEGEND

● SAMPLE LOCATION STATION

NOTE:

locations not surveyed

SCALE 0 25 50 FEET

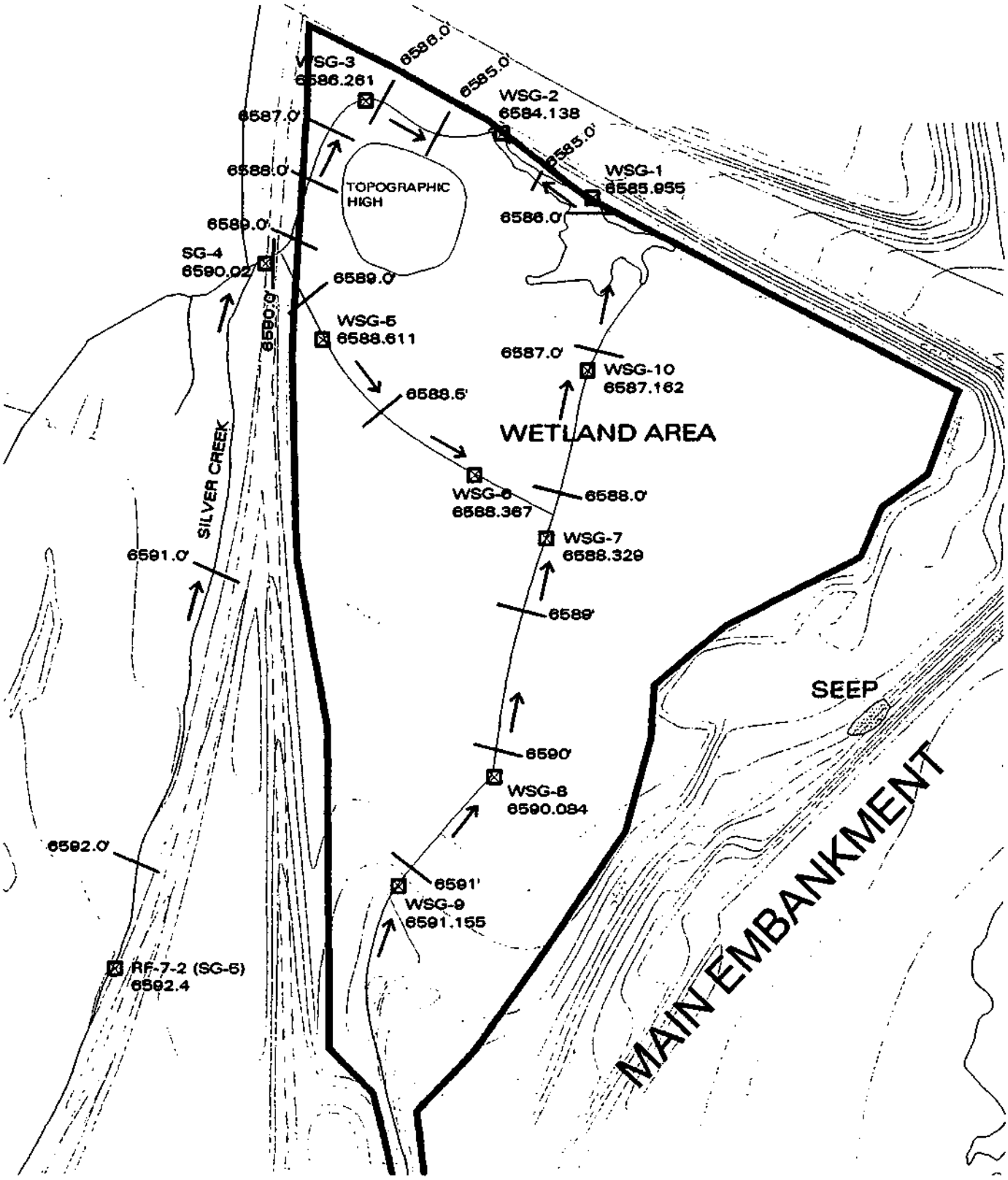
RICHARDSON FLAT RI

FIGURE 2-13
REFERENCE SITE
PHASE II
SAMPLE LOCATION MAP

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

October 2003

RIFS-BASE-7-BIOSAP.DWG



LEGEND

- SURFACE WATER SURVEY POINT (STAFF GAUGE)
- SURFACE WATER ELEVATION CONTOUR (FEET)
- SURFACE WATER FLOW DIRECTION
- ECOLOGICAL STUDY AREA BOUNDARY

N

SCALE
0 125
FEET

RICHARDSON FLAT RI

FIGURE 2-14
SURFACE WATER
FLOW DIRECTION MAP
JULY 2003

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

OCTOBER 2003

RIFS-BASE-4-BIOSAP.DWG

RICHARDSON FLAT RI

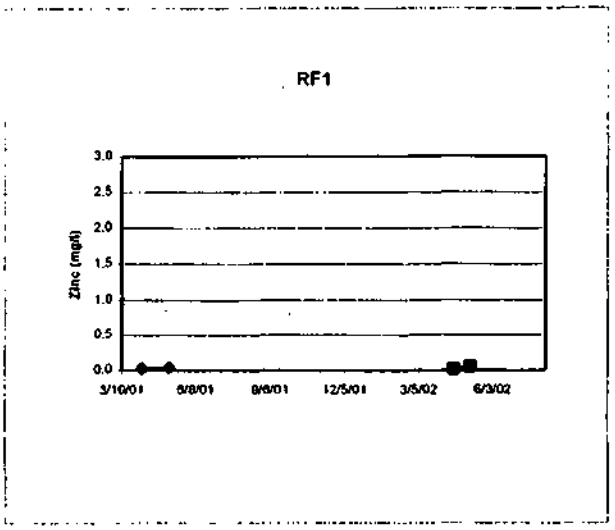
FIGURE 2-15
VEGETATION MAP

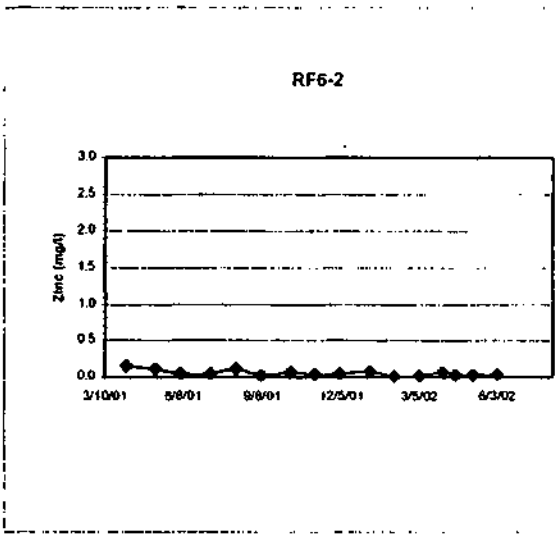
RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

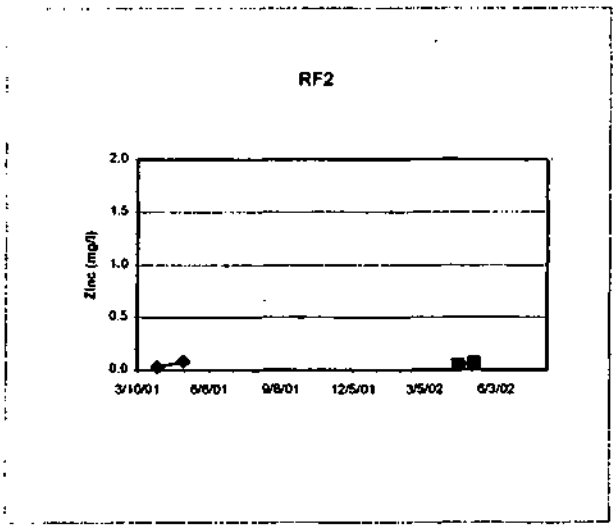
SEPTEMBER 2003

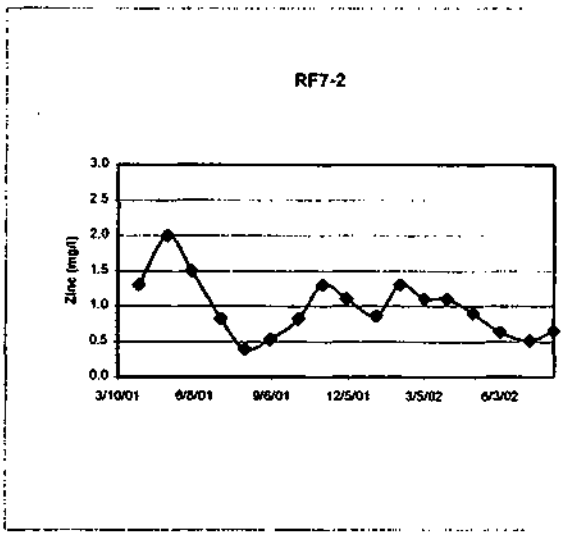
RIFS-BASE-5-BIOSAP.DWG

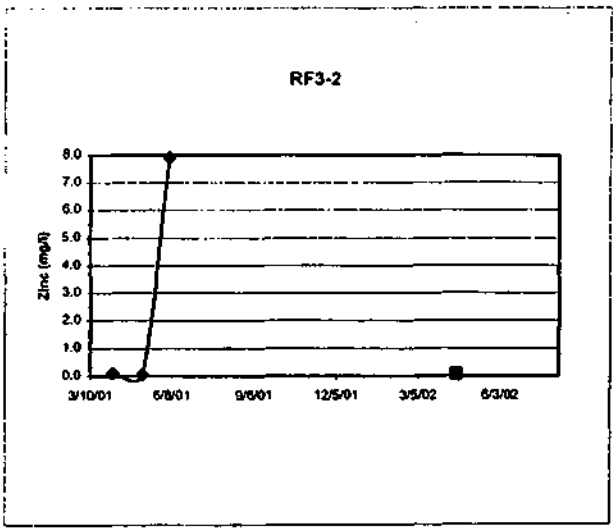
Figure 4-1
Dissolved Zinc Time Series, Surface Water











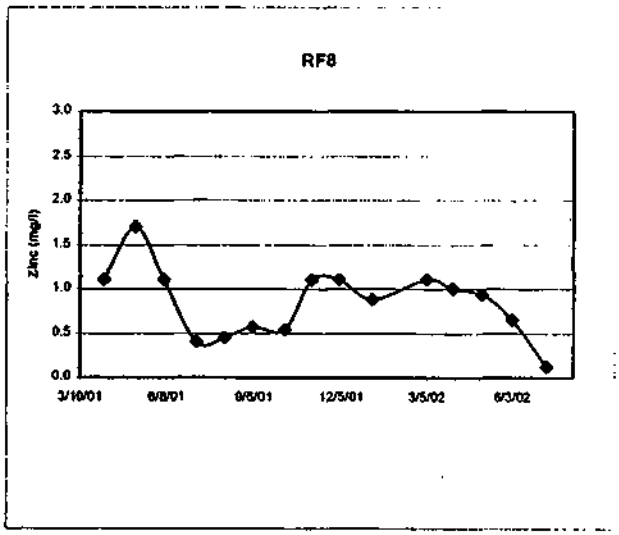
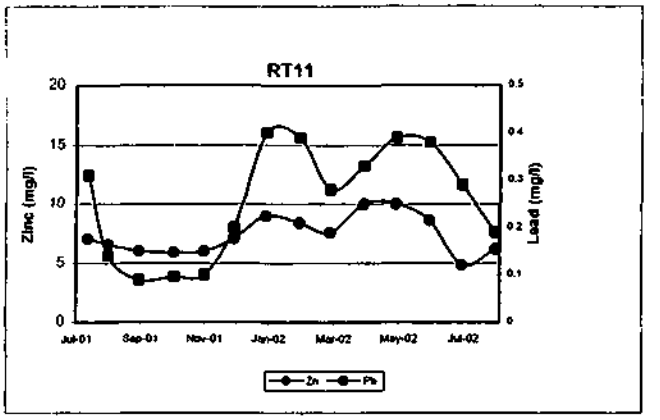
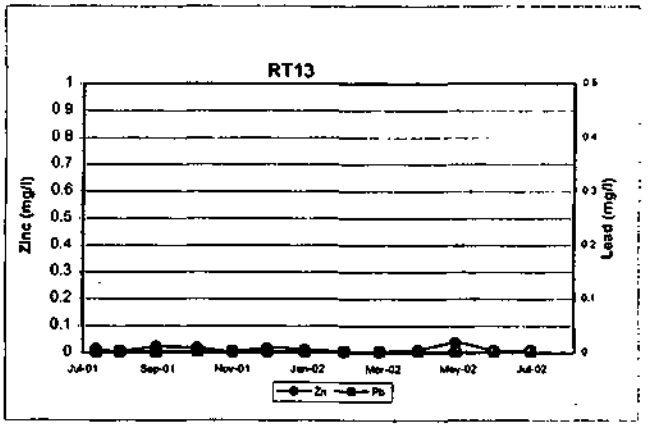
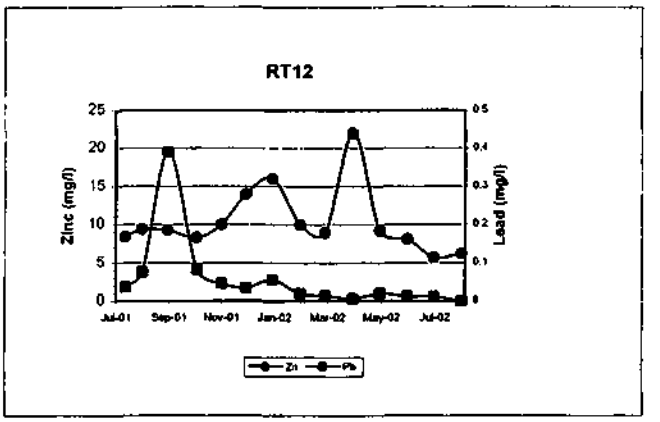
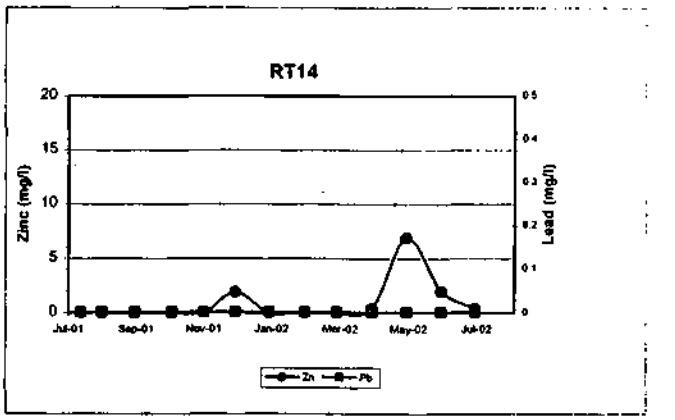


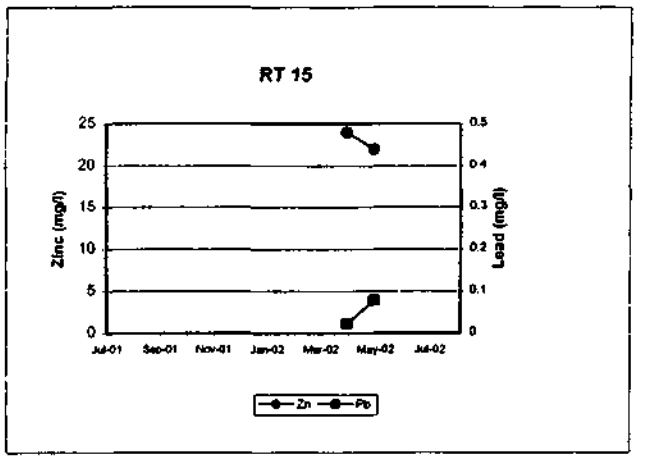
Figure 4-2
Total Zinc and Lead Time Series, Groundwater

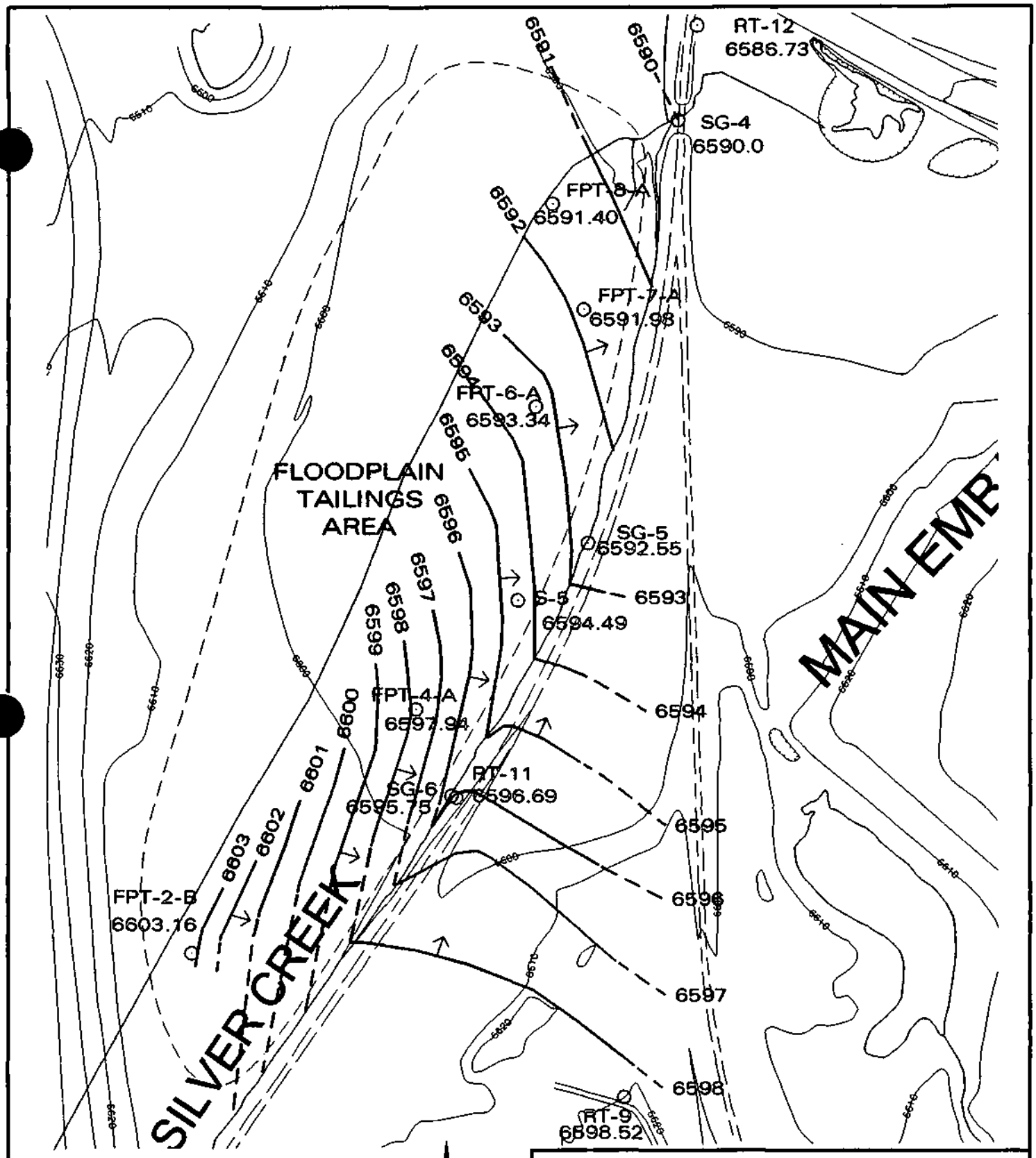












LEGEND

RT-11 6595.75 — DATA POINT (ELEVATION IN FEET)

6595 — POTENTIOMETRIC SURFACE CONTOUR (FEET) DASHED WHERE INFERRED

← FLOW DIRECTION

N

SCALE 0 50 100 150 200 FEET

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FIGURE 4-3
FLOODPLAIN TAILINGS AREA
POTENTIOMETRIC SURFACE MAP
MAY 6, 2002

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RIFS-BASE-2.DWG

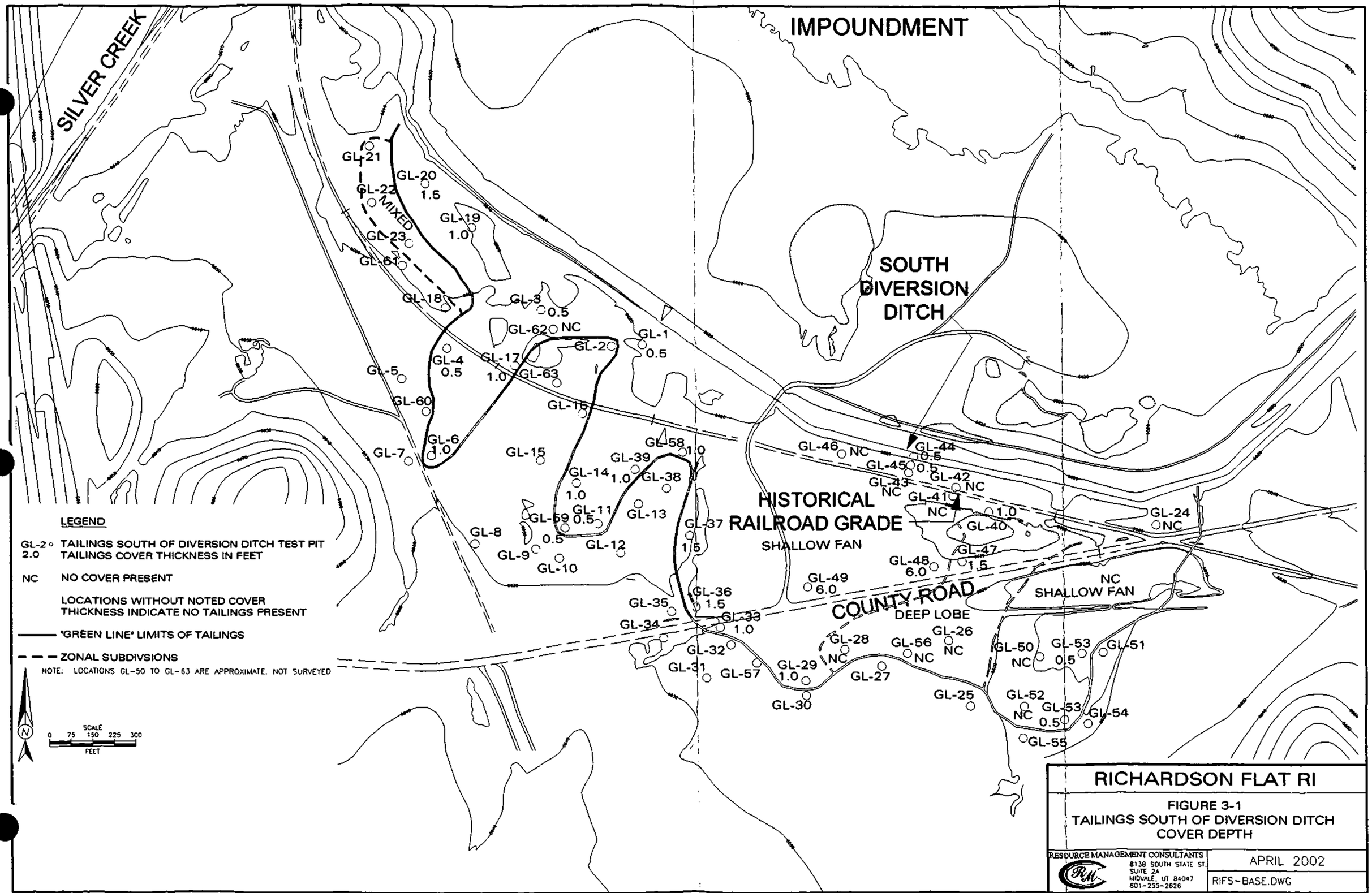

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FIGURE 3-1
TAILINGS SOUTH OF DIVERSION DITCH
COVER DEPTH

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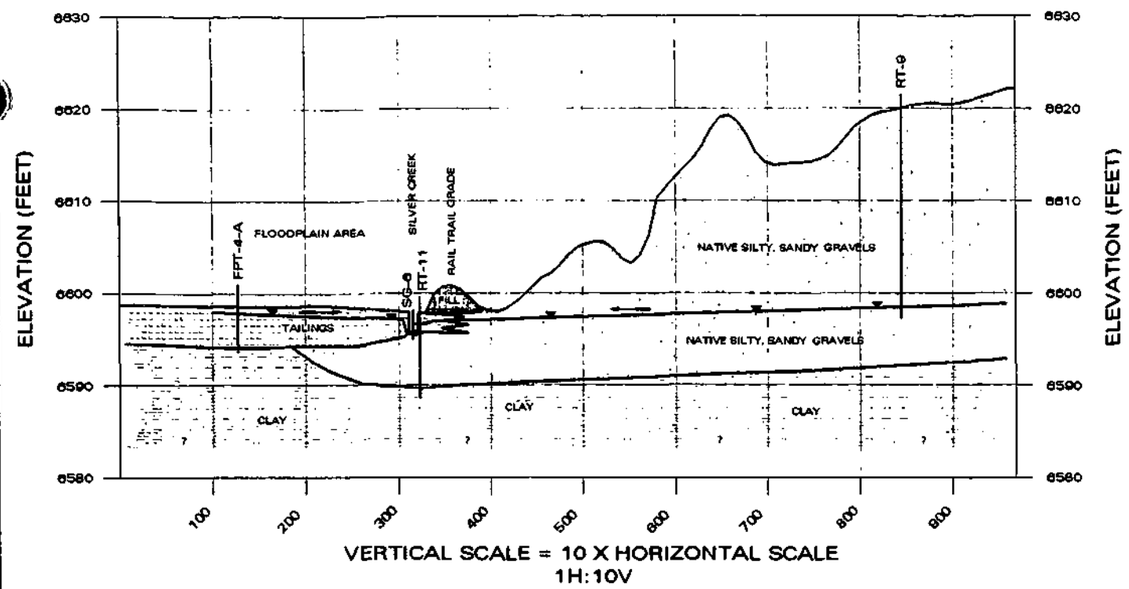
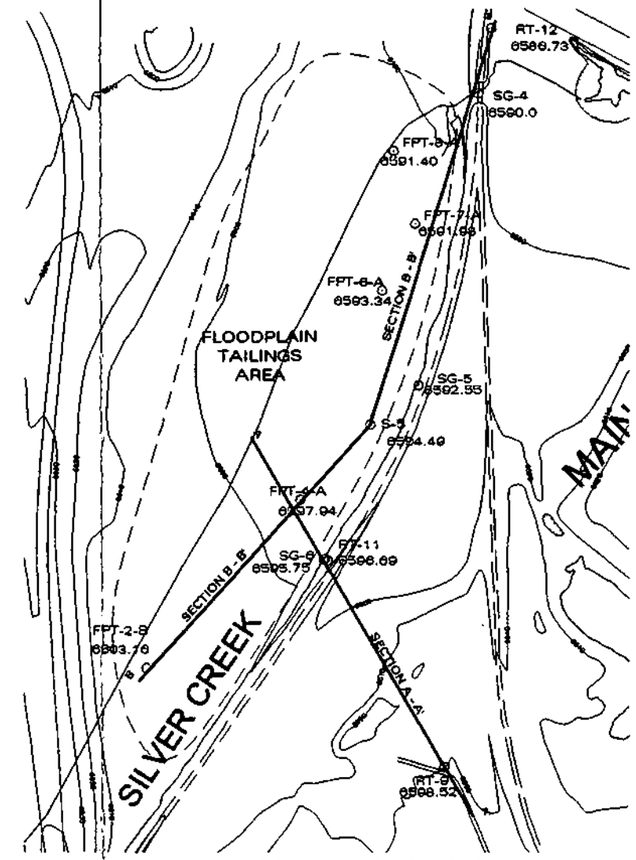
SECTION A - A', LOOKING NORTHEAST



VERTICAL SCALE = 10 X HORIZONTAL SCALE
1H:10V

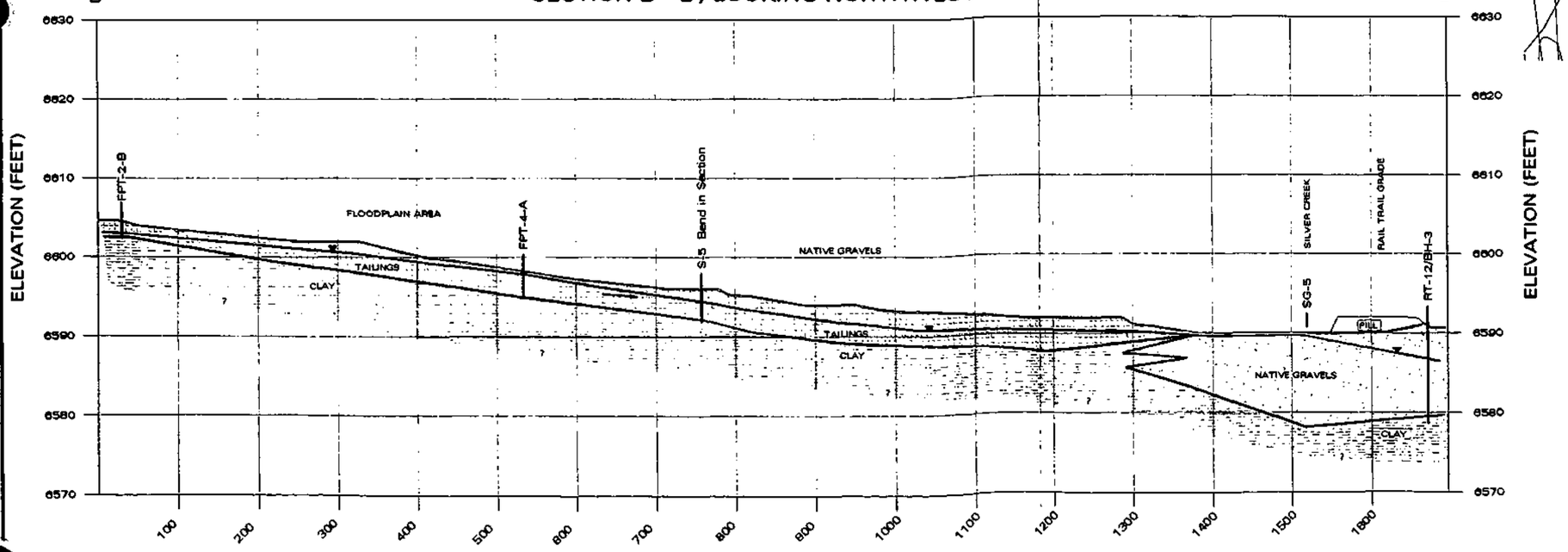
NOTE: NATIVE SILTY, SANDY GRAVEL INCLUDES BOTH ALLUVIAL AND NON-ALLUVIAL MATERIAL

GROUNDWATER FLOW DIRECTION



SECTION LOCATION MAP

SECTION B - B', LOOKING NORTHWEST



VERTICAL SCALE = 10 X HORIZONTAL SCALE
1H:10V

NOTE: NATIVE GRAVEL INCLUDES BOTH ALLUVIAL AND NON-ALLUVIAL MATERIAL

GROUNDWATER FLOW DIRECTION

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FIGURE 4-4
SILVER CREEK AREA
HYDROGEOLOGIC CROSS SECTIONS
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RIFS-BASE-7.DWG

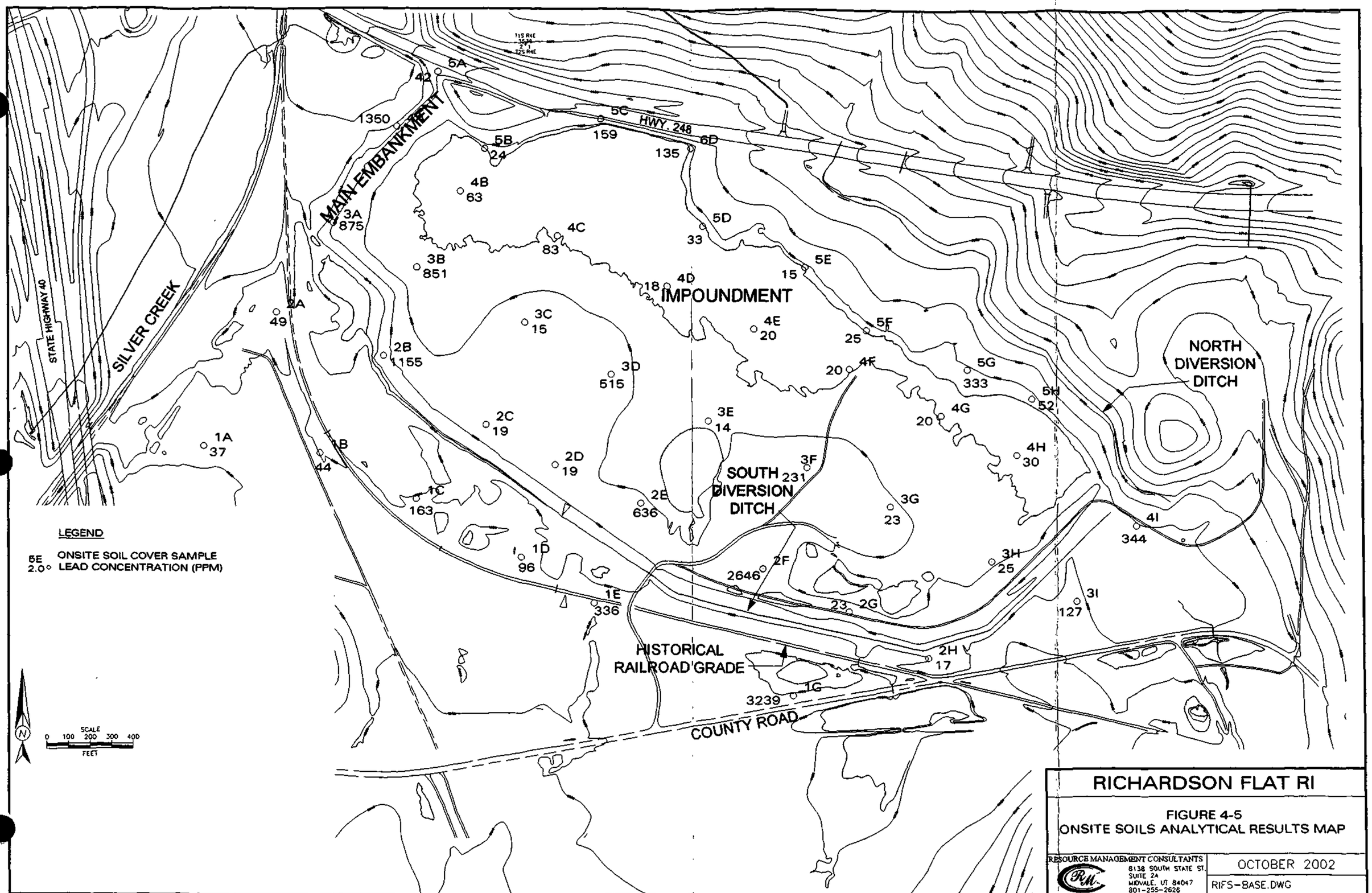

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FIGURE 4-5
ONSITE SOILS ANALYTICAL RESULTS MAP

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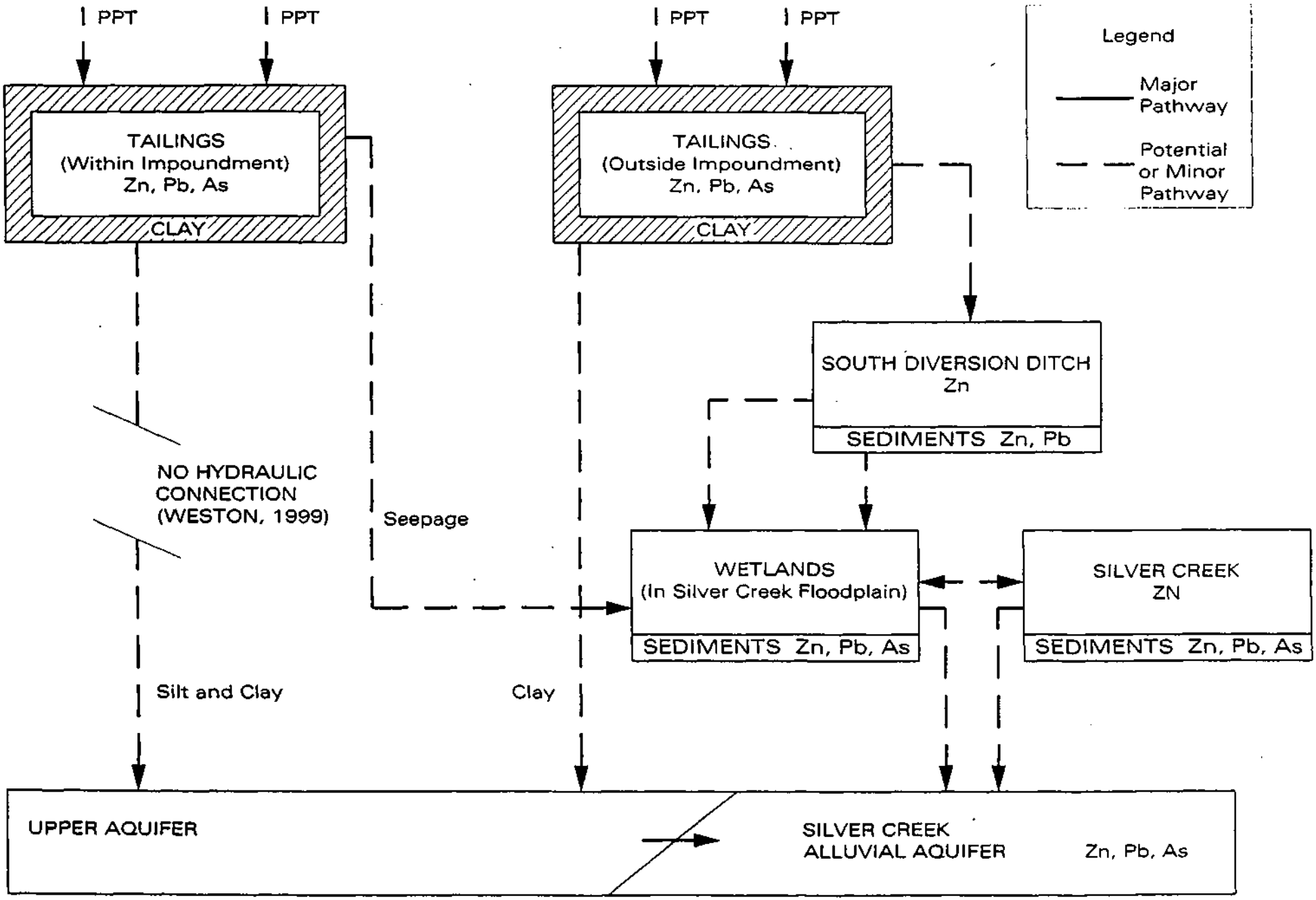
FIGURE 5-1
Schematic Model of Contaminant Transport Pathways
Richardson Flat



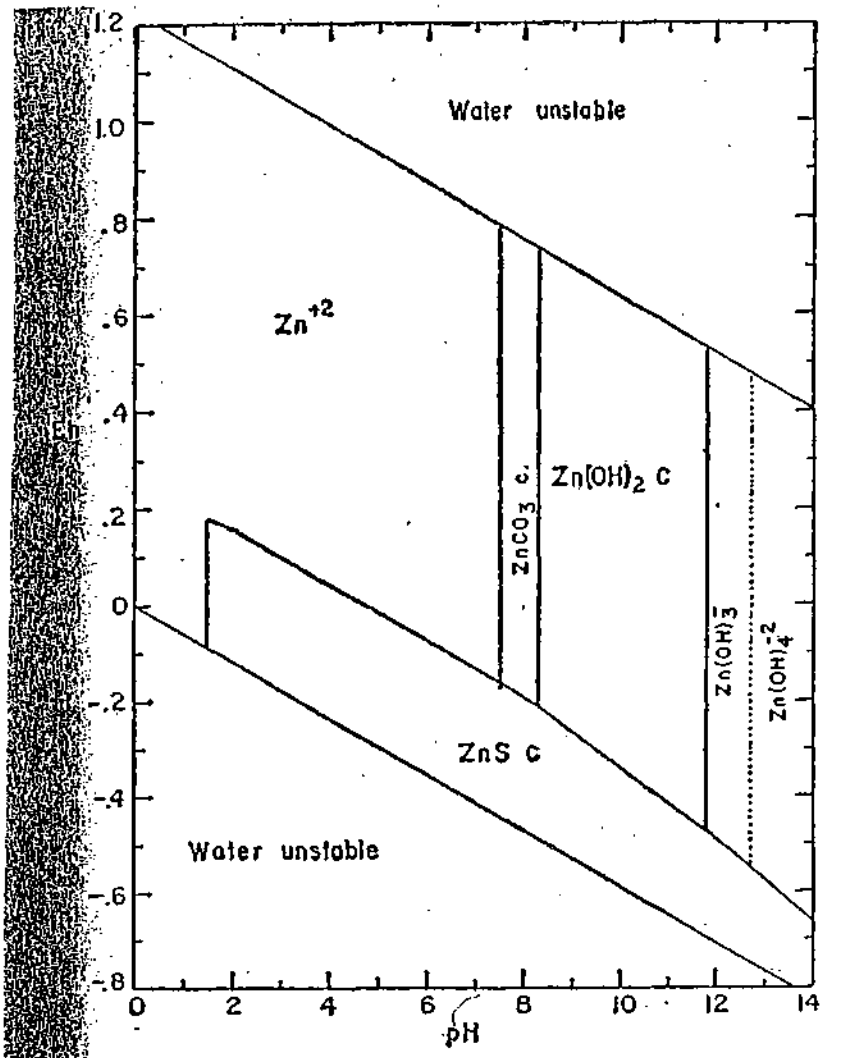


Fig. 2. Fields of stability of solids and predominant dissolved zinc species in system Zn + CO_2 + S + H_2O at 25°C and 1 atm pressure in relation to Eh and *p*H. Dissolved zinc activity, 10^{-5} moles/l; dissolved carbon dioxide and sulfur species, 10^{-3} moles/l.

FROM: HEM (1972)

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FIGURE 5-2
pH/Eh PLOT

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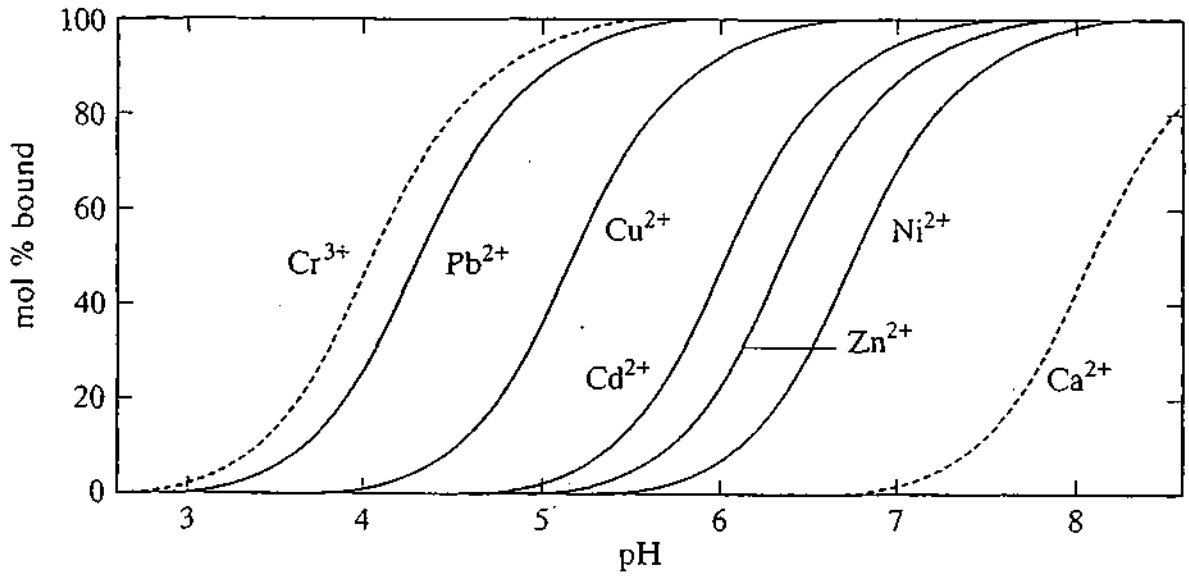

FIGURE 4–33 Surface complexation of dissolved metal ions as a function of pH (from *Aquatic Chemistry* 3/e, by Stumm and Morgan. Copyright © 1996 by Wiley Interscience. Reprinted by permission of John Wiley & Sons, Inc.).

FROM: KEKOW (2001)

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FIGURE 5-3
SURFACE COMPLEXATION OF DISSOLVED METAL IONS

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Figure 5-4: Time Series Plot of Dissolved Zinc Concentrations in Upper Aquifer South of Tailings Impoundment

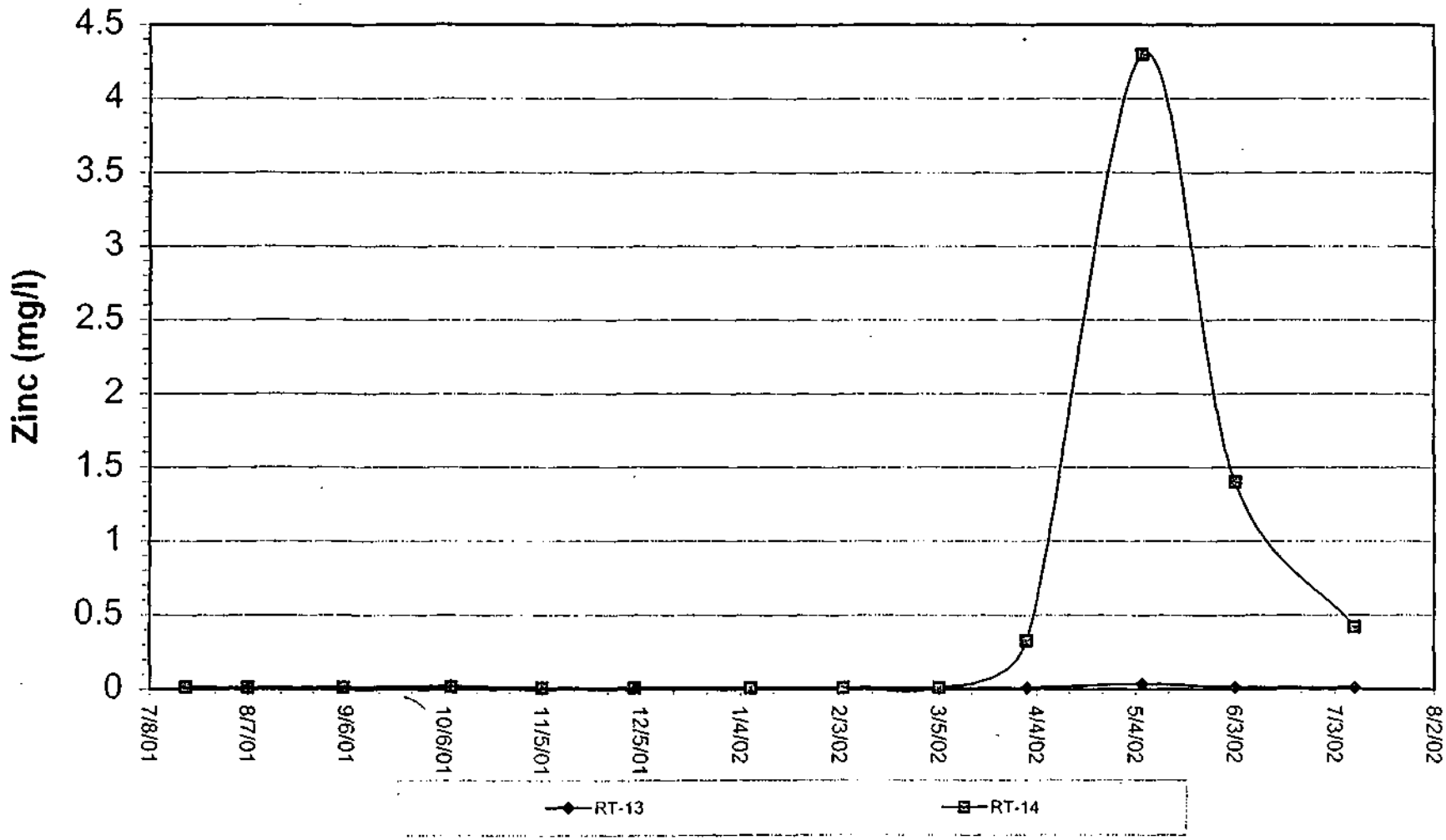
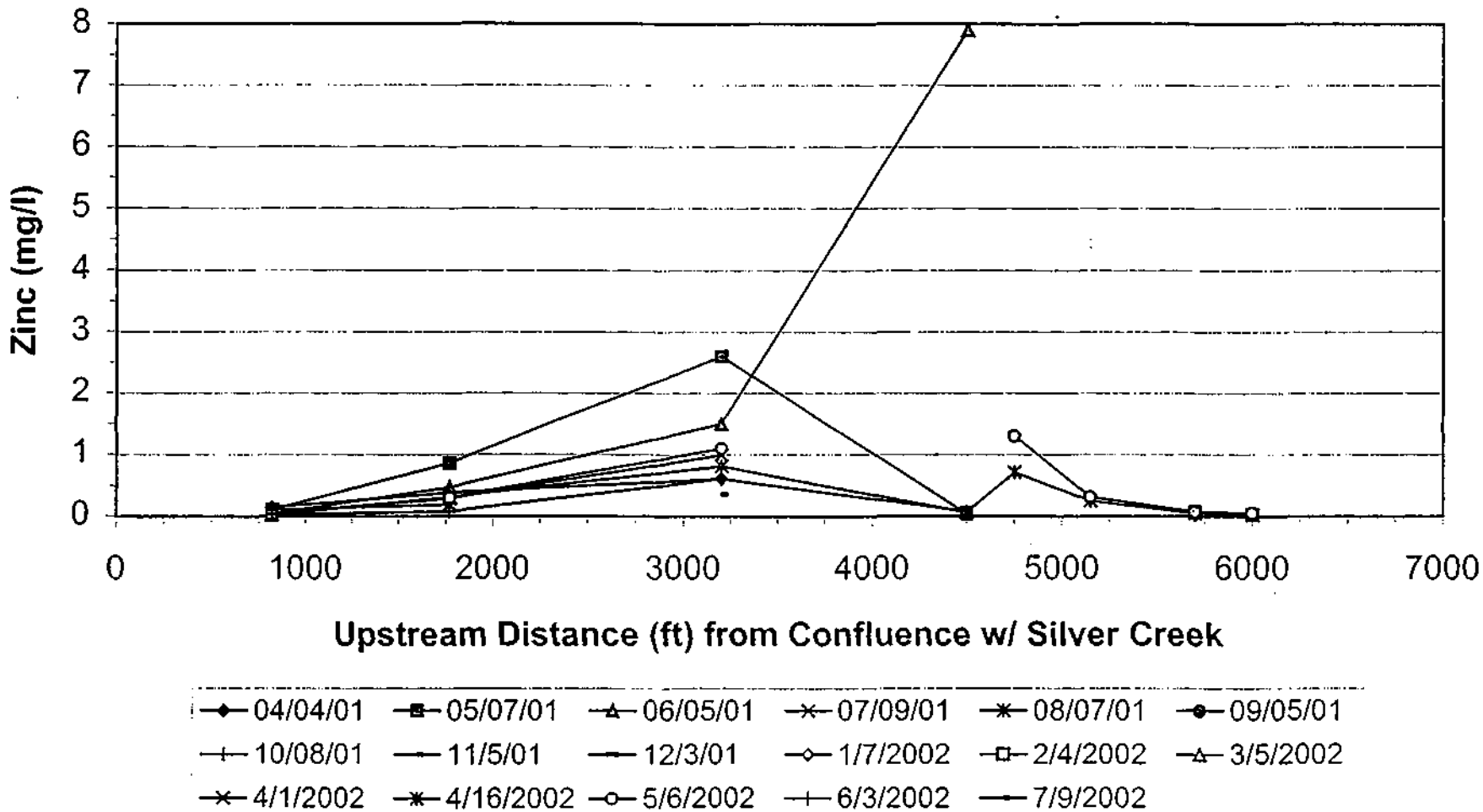
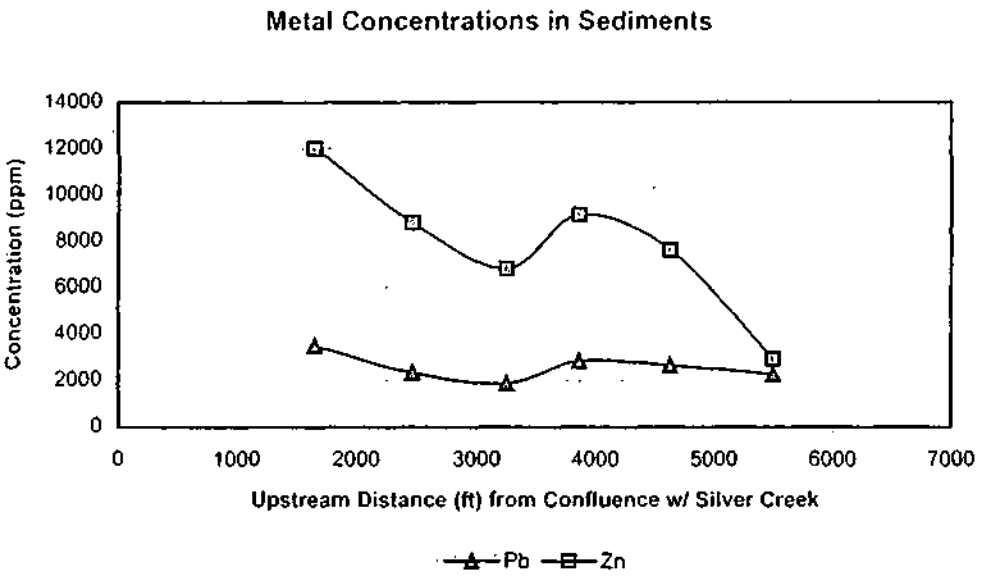


Figure 5-5: Dissolved Zinc Concentrations in South Diversion Ditch





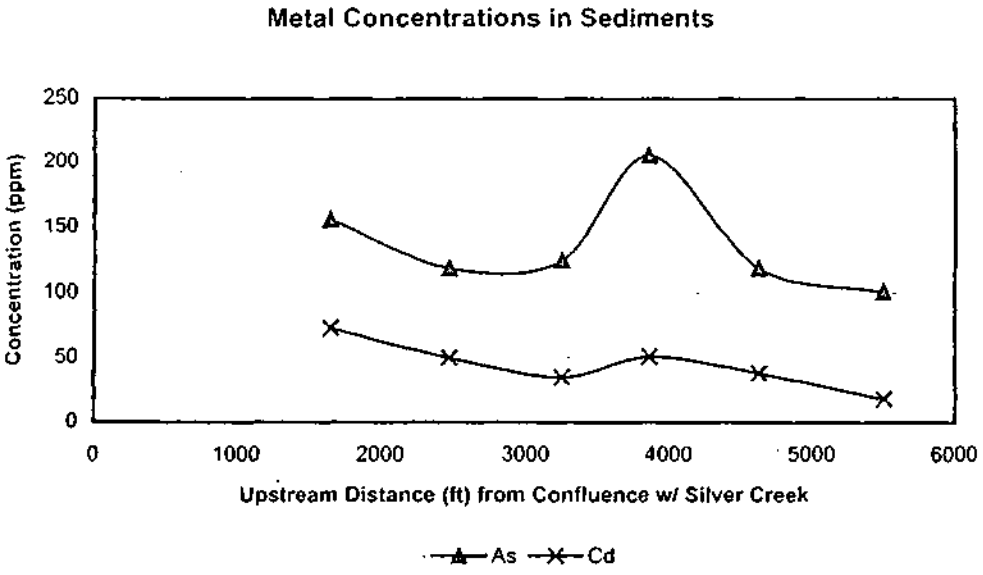


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FIGURE 5-6
METALS CONCENTRATIONS IN SOUTH DIVERSION DITCH SEDIMENTS

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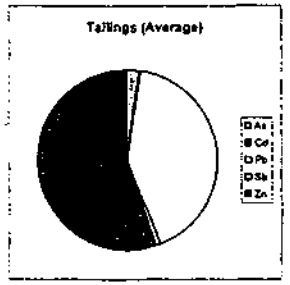
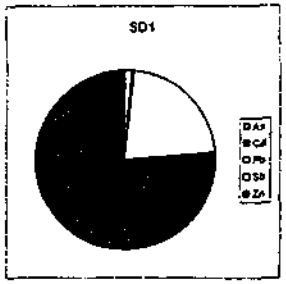
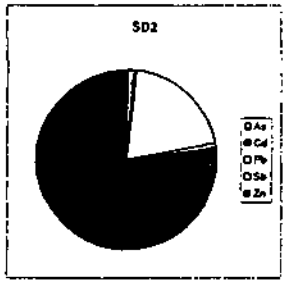
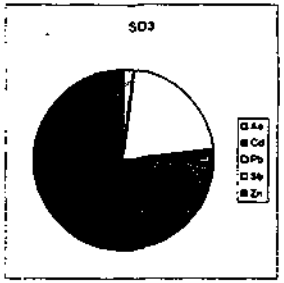
Figure 5-7, Comparison of Trace Metal ratios in tailings and South Diversion Ditch Sediments

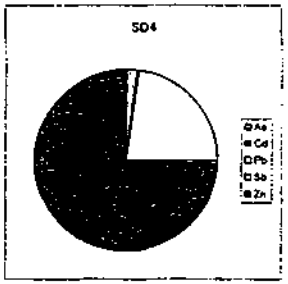
	Tailings Average	Sediment Average	SD1	SD2	SD3	SD4	SD5	SD6
As	254	138	156	119	125	205	119	101
Cd	34	44	73	50	35	51	38	18
Pb	4530	2578	3490	2330	1880	2840	2650	2280
Sb	110	64	72	53	36	65	97	63
Zn	5993	7678	12000	8780	6800	9140	7510	2940

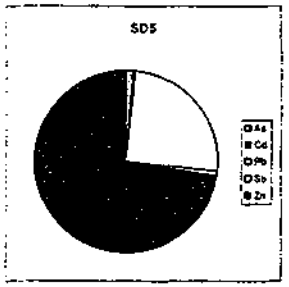












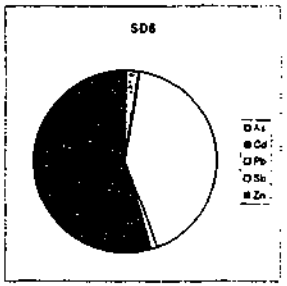


Figure 5-8
Zinc Concentrations in Sediment (5/11/01) and Water (5/7/01) along South Diversion Ditch

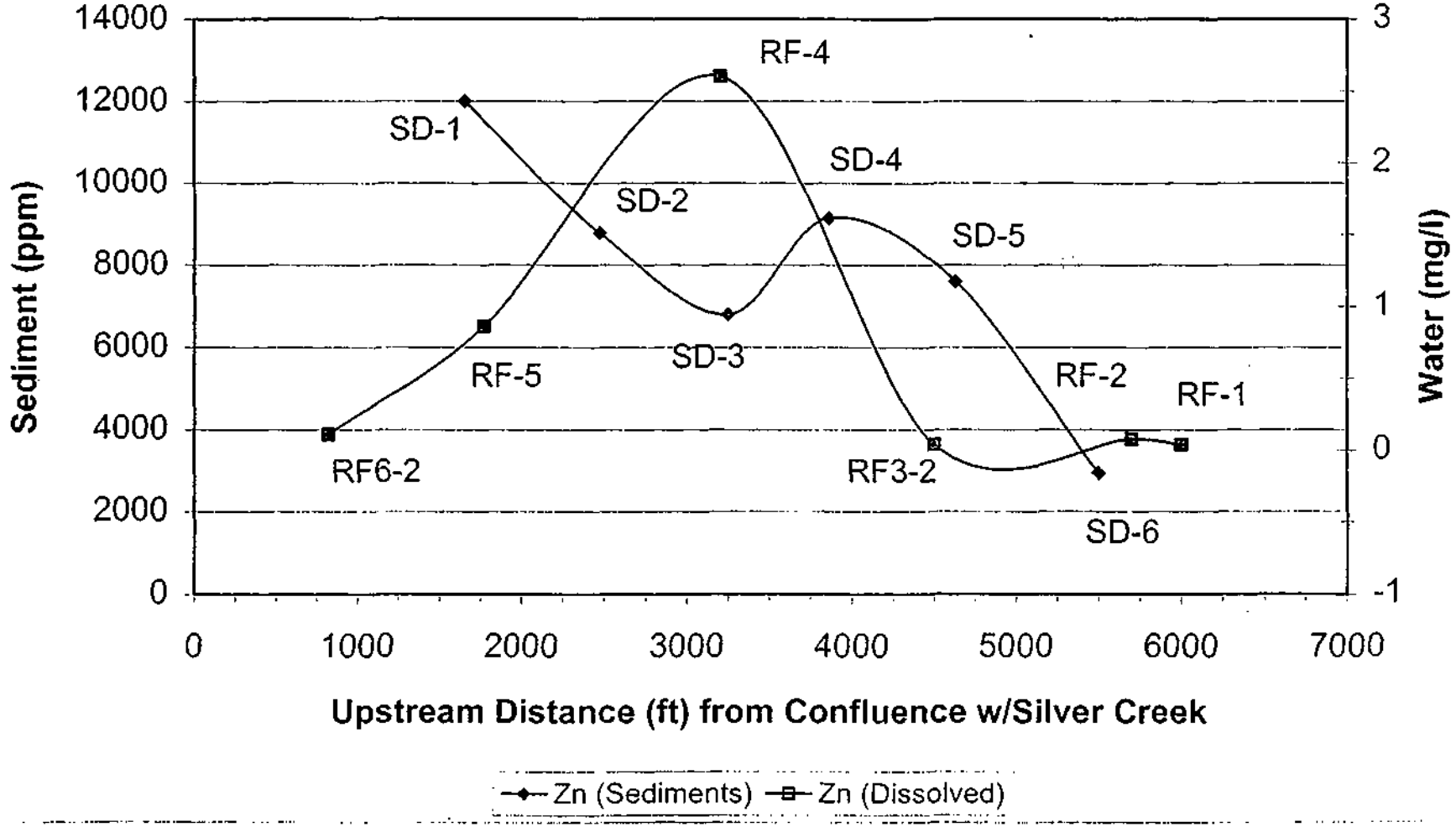


Figure 5-9
Lead Concentrations in Sediment (5/11/01) and Water (5/7/01) along South Diversion Ditch

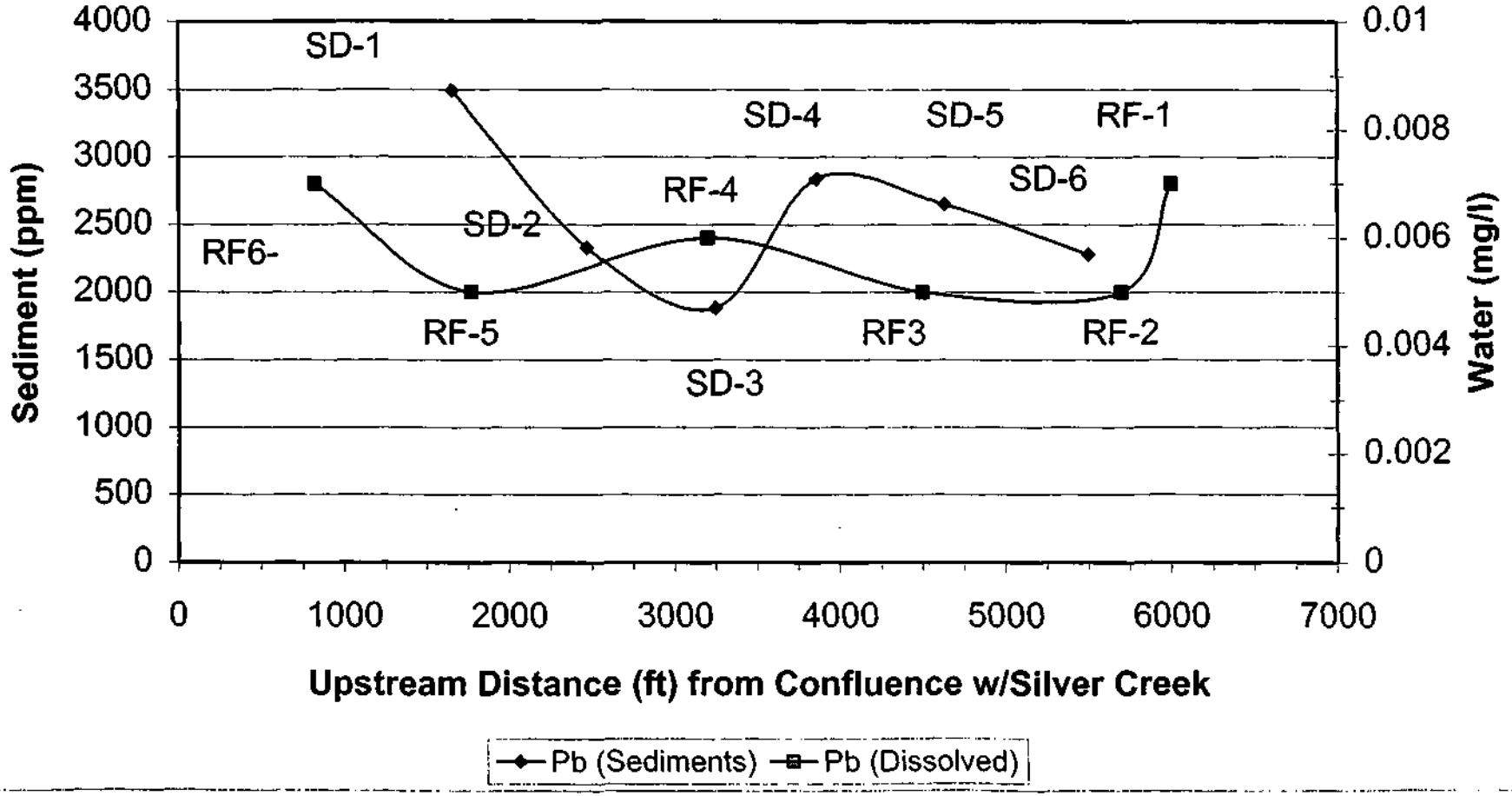
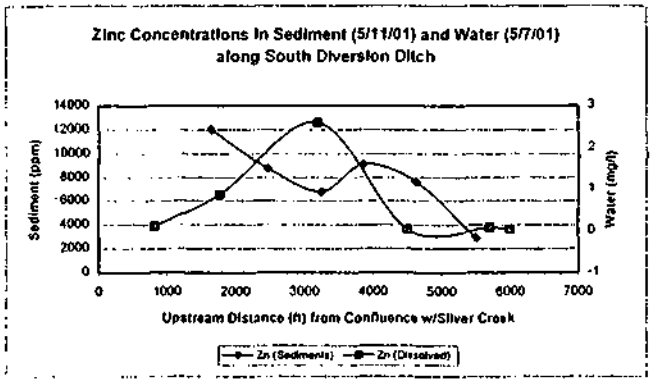
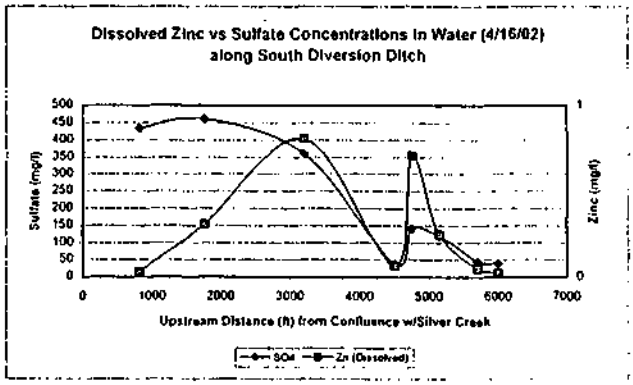
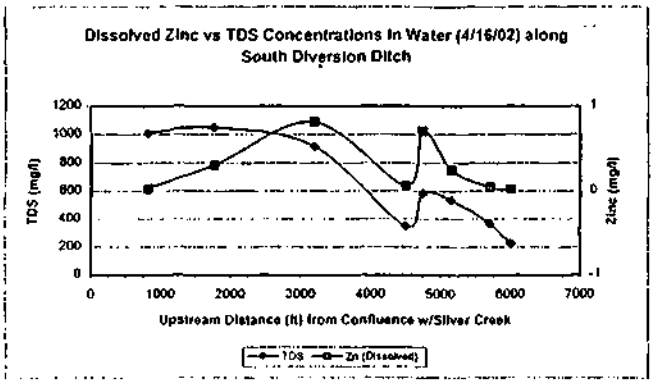
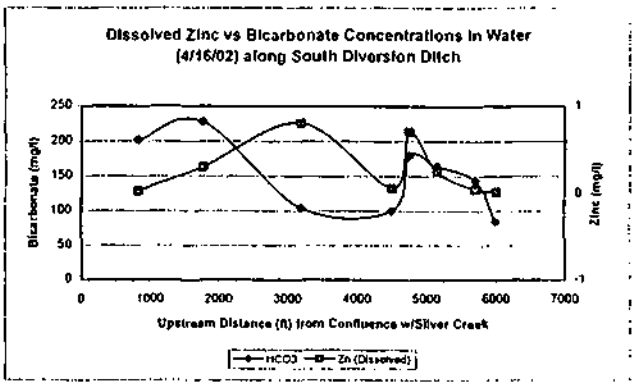


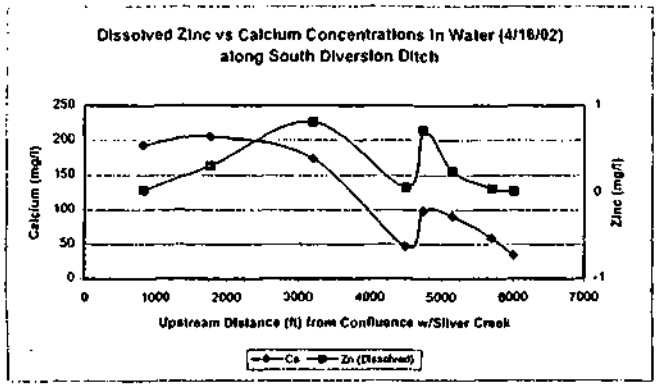
Figure 5-10. Plots of Dissolved Zinc Versus Key Chemical Parameters











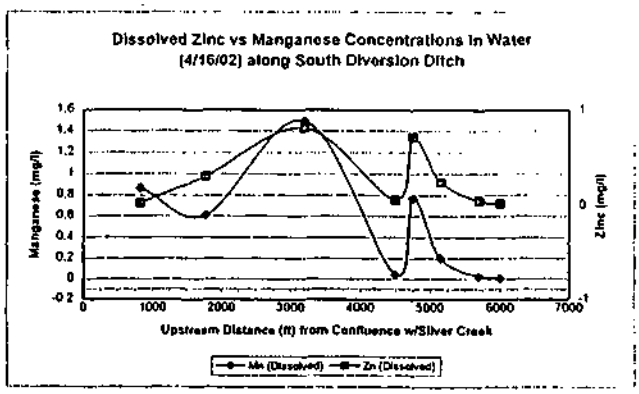
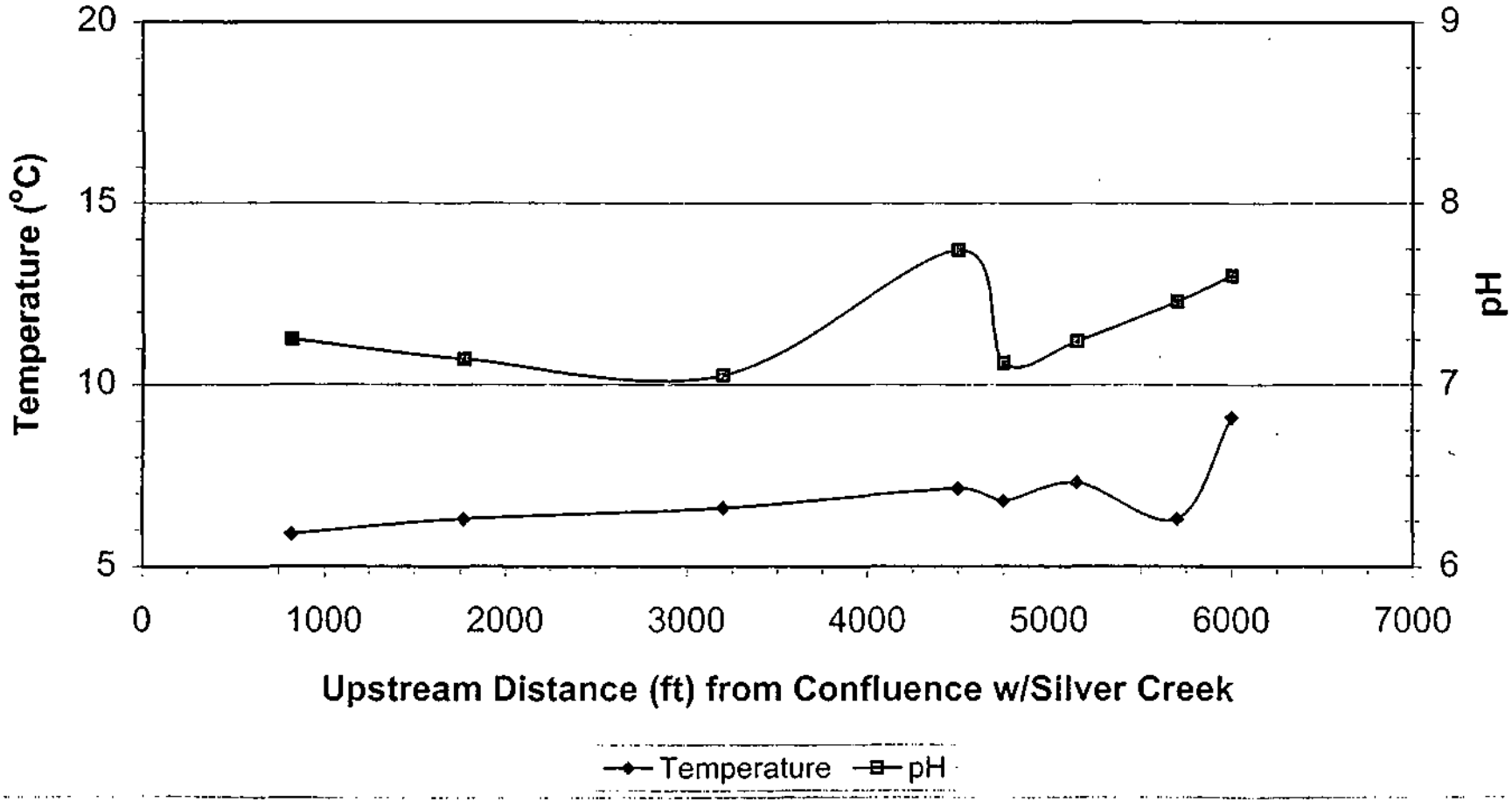
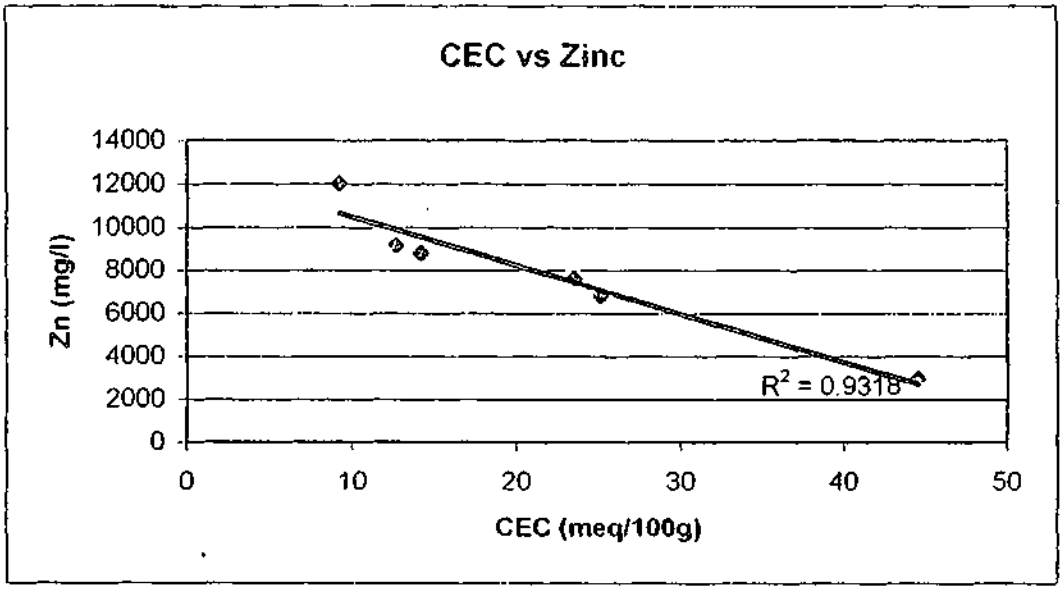


Figure 5-11
Temperature and pH in Water (4/16/02) along South Diversion Ditch





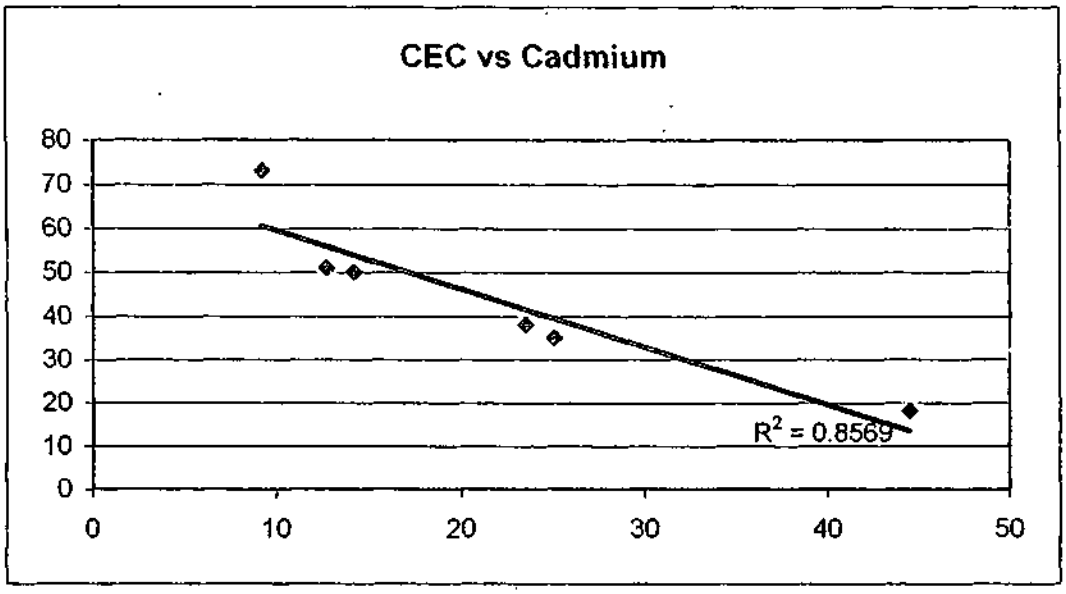


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FIGURE 5-12
CATION EXCHANGE CAPACITY VERSUS METALS CONCENTRATION IN SOUTH DIVERSION DITCH SEDIMENTS

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Legend:

- Silver Creek (GW)
- Tailings (GW)
- Diversion Ditch (SW)
- Silver Creek (SW)
- Floodplain Tailings
- Impoundment (GW)

Figure 5-13
Piper Plot of May 2002 Data

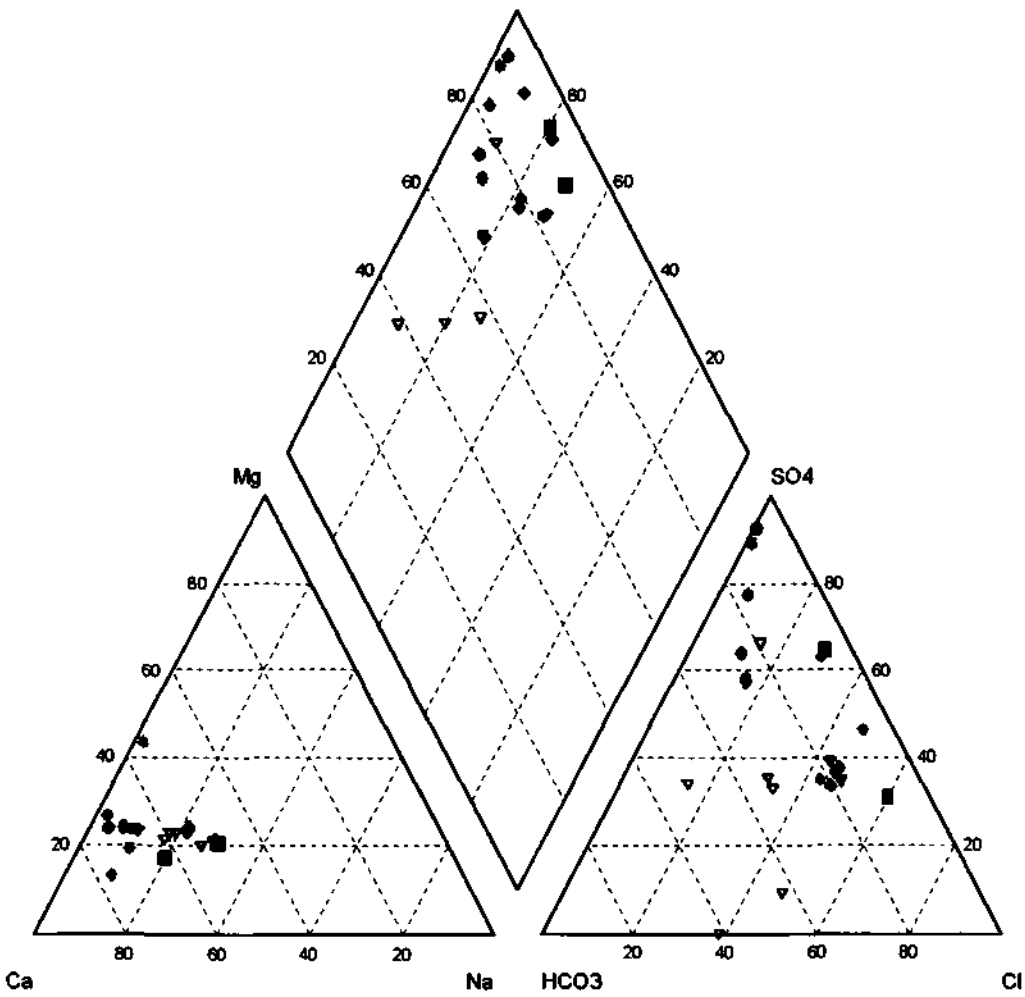

Figure 5-14: Time Series Plot of Dissolved Zinc Concentrations in Silver Creek Alluvium

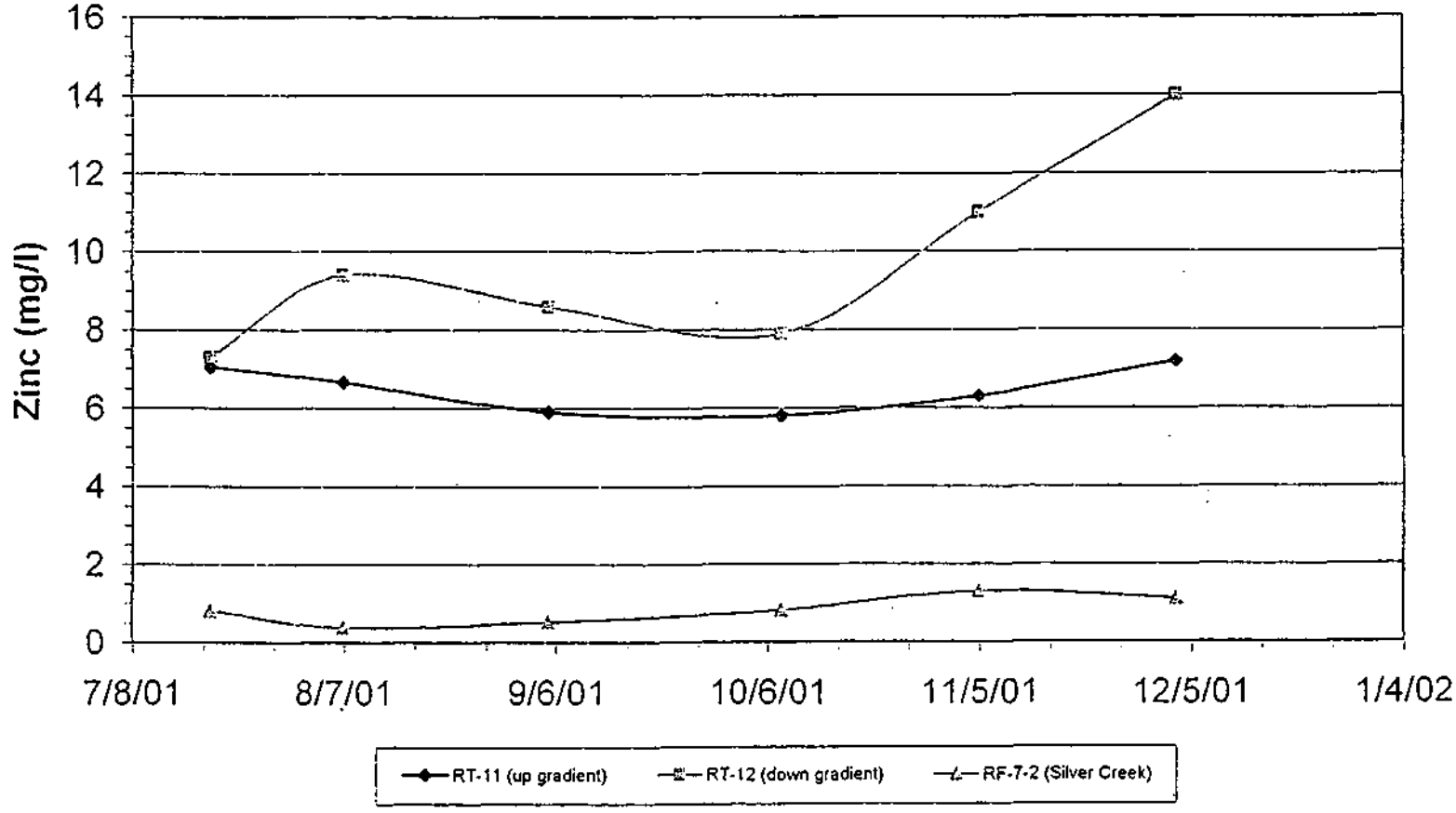

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FIGURE 5-14
TIMES SERIES PLOT OF DISSOLVED ZINC CONCENTRATIONS IN SILVER CREEK ALLUVIUM

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Table 1-1: Richardson Flat Historical 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	6	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	6	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	0.98	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	2487	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	0.005

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	2.6
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	0.023
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	1354	1402	1399	1489	1463
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.022	-	0.18	<0.004	0.068	0.18	0.088	0.33	0.2	0.19

** Value exceeds Utah GW Quality Standard

Table 1-1: Richardson Flat Historical 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	0.008	<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	0.16	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	2516	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	6.4	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	7.6	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	-	<0.005	<0.005
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	3.6	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	-	0.27	0.28
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	938	2973	1141	-	972	1725
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	0.026	0.06	0.054	-	<0.004	0.01

** Value exceeds Utah GW Quality Standard

Table 1-2 : Richardson Flat, 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 1-3: Richardson Flat Historical 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	0.043	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	0.8	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	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<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	6-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	<0.0006	0.0005	<0.0005	2	<0.0005	<0.0005	0.9	<0.0005	0.0069	<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	0.083	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cs	<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	563	729	558	648	496	861	552	600	456	1015	684	367	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	1.2	0.083	0.42	0.92	3	3.1	1.3	1.8	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	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<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	-	1876	1538	1671	1882	1731	1693	1542
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.4	-	-	-	-	-	-	-

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	6-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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cs	<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	670	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	0.18	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	0.62	0.86	0.77	0.63	0.83	0.82	-	-	-	-	0.75	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.37	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<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	-	866	636	629		658	569	285
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.7	-	-	-	-	-	-	-

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	6-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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cs	<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	562	1506	708	596	330	329
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1-4: Richardson Flat Surface Water Sample Data, May 19, 1999 and June 9, 1999

All units mg/L except flow (cfs) and pH) standard units.

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	38	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	0.16	<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	0.16	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	0.35	<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.

TABLE 2-1
RICHARDSON FLAT
WATER SAMPLING FREQUENCY

SURFACE WATER

Location	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02
RF1	*	*											*	*			
RF2	*	*											*	*			
RF3-2	*	*											*	*			
RF4	*	*	*	*									*	*	*	*	
RF5	*	*	*	*	*								*	*	*		
RF6-2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
RF7-2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
RF8	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	
RF11													*	*			
RF12													*	*			

GROUND WATER

Location	Jun-01	Jul-01	Aug-01	Sep-01	Oct-01	Nov-01	Dec-01	Jan-02	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02
RT-11	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
RT-12	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
RT-13	*	*	*	*	*	*	*	*	*	*	*	*	*	*	DRY
RT-14	*	*	*	*	*	*	*	*	*	*	*	*	*	*	DRY
RT-15	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	*	*	DRY	DRY	DRY

TABLE 3-1
RICHARDSON FLAT SURFACE AND GROUNDWATER FIELD DATA

Temp - Degree C, Flow - CFS

RF-1					
DATE	Ph	TEMP	CON	FLOW	
4-Apr-01	7.31	4.1	242	NM	
7-May-01	7.45	18.8	403	NM	
16-Apr-02	7.6	9.1	309	NM	DO#-9.35, DO%-82.7, ORP-429
6-May-02	7.89	19	420	NM	

RF-2					
DATE	Ph	TEMP	CON	FLOW	Flume 9"
4-Apr-01	7.35	3.3	458	0.3	0.22
7-May-01	6.7	15.7	619		Flow below scale on flume
16-Apr-02	7.46	6.3	508	0.16	DO#-7.72, Do%-65.8, ORP-426
6-May-02	7.68	15.8	687	0.06	

RF- 3-2					
DATE	Ph	TEMP	CON	FLOW	Flume 9"
4-Apr-01	7.69	4.8	555	1.03	0.49
7-May-01	8.54	15.1	894		Flow below scale on flume
5-Jun-01	7.26	14.3	1134		Flow below scale on flume
16-Apr-02	7.74	7.14	514		(0.05) Too low to quantify. DO#-9.0, DO%-76.2, ORP-426

RF-4					
DATE	Ph	TEMP	CON	FLOW	
4-Apr-01	7.3	4.5	677	NM	
7-May-01	7.05	11.6	1357	NM	
5-Jun-01	7.16	9.7	1432	NM	
9-Jul-01	7.2	18.9	1562	NM	
16-Apr-02	7.05	6.6	1078	NM	DO#-8.86, DO%-73.3, ORP-414
6-May-02	7.02	13.7	1145	NM	
3-Jun-02	6.87	16.3	1274	NM	

RF-5					
DATE	Ph	TEMP	CON	FLOW	
4-Apr-01	7.11	4.1	738	NM	
7-May-01	7.5	11.5	1420	NM	
5-Jun-01	7.27	10.4	1541	NM	
9-Jul-01	7.42	20.1	1624	NM	
7-Aug-01	7.06	19.8	1658	NM	
16-Apr-02	7.14	6.3	1171	NM	DO#-8.83, DO%-73.3, ORP-418
6-May-02	7.29	12.9	1267	NM	
3-Jun-02	7.19	16.6	1303	NM	

RF-6-2					
DATE	Ph	TEMP	CON	FLOW	18" FLUME
4-Apr-01	7.21	4.6	896	0.976	0.4'
7-May-01	7.7	9.7	1472	0.51	0.2'
5-Jun-01	7.31	11.3	1627		??Flow readings
9-Jul-01	7.05	18	1722		?? Flow readings
7-Aug-01	6.98	19.1	1737		Flume plugged by beaver
5-Sep-01	6.69	18	1800		Flume plugged by beaver
8-Oct-01	6.62	13	1820		Flume plugged by beaver
5-Nov-01	6.66	10	1849		Flume plugged by beaver
3-Dec-01	6.78	0.6	2260		Flume plugged by beaver
7-Jan-02	6.79	4.1	1875		Flow to low to read
4-Feb-02	6.87	0.6	1957		Flow to low to read
5-Mar-02	6.93	5.2	1677		Flow to low to read
1-Apr-02	6.64	10.7	1239		
16-Apr-02	7.25	5.9	1135	0.1	ORP = 419
6-May-02	7.2	14.6	1229	0.11	
3-Jun-02	6.97	16.3	1290		

RT-11				6600.14	
DATE	Ph	TEMP	CON	LEVEL	ELEV.
7-May-01	6.81	12.4	2460	3.66	6596.48
9-Jul-01	6.7	16.3	1906	NM	#VALUE!
19-Jul-01	7.05	20.2	1713	4.2	6595.94
7-Aug-01	6.67	19.7	1642	4.2	6595.94
5-Sep-01	6.52	22	1450	4.45	6595.69
8-Oct-01	6.94	11.7	1370	4.37	6595.77
5-Nov-01	6.41	11.5	1286	4.09	6596.05
3-Dec-01	6.42	2.7	1582	3.82	6596.32
7-Jan-02	6.46	5.2	1947	3.8	6596.34
4-Feb-02	6.26	5.4	1850	4.23	6595.91
5-Mar-02	6.29	5.1	1702	4.21	6595.93
1-Apr-02	6.52	12.8	1877	2.78	6597.36
2-May-02	6.91	9.7	3570	3.45	6596.69
3-Jun-02	6.31	10.8	2550	3.56	6596.58
9-Jul-02	6.93	15.6	2240	4.42	6595.72
6-Aug-02	7.48	21.6	1435	4.74	6595.4

RT-12				6592.49	
DATE	Ph	TEMP	CON	LEVEL	ELEV.
7-May-01	6.73	9.9	1638	6.11	6586.38
9-Jul-01	6.79	14.6	1014	NM	#VALUE!
19-Jul-01	6.97	20.3	1030	7.33	6585.16
7-Aug-01	6.67	18.1	1075	7.62	6584.87
5-Sep-01	6.37	11	990	7.42	6585.07
8-Oct-01	6.77	10.2	1002	7.05	6585.44
5-Nov-01	6.3	11	1184	6.54	6585.95
3-Dec-01	6.3	0.1	1460	6.42	6586.07
7-Jan-02	6.46	3.2	1606	6.22	6586.27
4-Feb-02	6.61	3.4	1316	6.64	6585.85
5-Mar-02	6.7	8	1230	6.58	6585.91
1-Apr-02	6.45	9.7	1867	5.42	6587.07
2-May-02	7.19	8.9	2650	5.76	6586.73
3-Jun-02	6.11	9.3	1680	6.2	6586.29
9-Jul-02	6.81	12.4	960	7.45	6585.04
6-Aug-02	7.09	21	1156	8.24	6584.25

RT-13				6623.65	
DATE	Ph	TEMP	CON	LEVEL	ELEV.
5-Jun-01	6.78	10.7	1564	9.63	6614.02
9-Jul-01	6.83	16	1519	NM	#VALUE!
19-Jul-01	7.02	16.8	1472	10.2	6613.45
7-Aug-01	6.72	16.2	1485	NM	#VALUE!
5-Sep-01	6.58	14	1150	10.69	6612.96
8-Oct-01	6.81	11.6	1413	10.78	6612.87
5-Nov-01	6.61	11.5	1470	10.78	6612.87
3-Dec-01	6.69	4.3	1657	10.72	6612.93
7-Jan-02	6.75	6.9	1503	10.75	6612.9
4-Feb-02	6.85	7.3	1410	10.68	6612.97
5-Mar-02	6.82	6.7	1410	10.59	6613.06
1-Apr-02	6.59	8	1358	9.71	6613.94
6-May-02	7.26	7.6	2500	9.68	6613.97
3-Jun-02	6.85	7.9	1750	9.89	6613.76
9-Jul-02	7.26	11.1	1700	10.45	6613.2

TABLE 3-1
RICHARDSON FLAT SURFACE AND GROUNDWATER FIELD DATA

Temp - Degree C, Flow - CFS

RF-7-2					
DATE	Ph	TEMP	CON	FLOW	
4-Apr-01	7.54	3.6	1485	4.18	
7-May-01	8.9	7.2	1520	5.92	
5-Jun-01	7.36	9.3	1091	2.35	
9-Jul-01	7.47	17.6	1067	1.02	
7-Aug-01	7.51	27.3	986	1	
5-Sep-01	7.79	25	1000	1.11	
8-Oct-01	7.49	14.2	1022	1.28	
5-Nov-01	7.02	9.4	992	2.15	
3-Dec-01	8.79	-0.3	1250		not measured due to snow
7-Jan-02	7.09	3.7	944		not measured due to snow
4-Feb-02	6.98	3.5	1106		not measured due to snow
5-Mar-02	6.56	3.3	1181		not measured due to snow
1-Apr-02	7.12	13.8	1180	0.47	flow measured on 4/8/02
2-May-02	7.12	9.8	1196	35.33	
3-Jun-02	6.98	14.4	1046	16.95	
9-Jul-02	7.52	21.2	987		
6-Aug-02	7.35	23.1	1570	low	

RT-14				6623.35	
DATE	Ph	TEMP	CON	LEVEL	ELEV.
5-Jun-01	6.81	12.1	1306	NM	#VALUE!
9-Jul-01	6.88	13.8	1359	NM	#VALUE!
19-Jul-01	7.07	17.4	1263	9.62	6613.73
7-Aug-01	6.83	16.1	1344	NM	#VALUE!
5-Sep-01	6.4		1250	10.24	6613.11
8-Oct-01	6.66	12.1	1320	10.39	6612.96
5-Nov-01	6.65	10.5	1308	10.25	6613.1
3-Dec-01	6.61	1.9	1552	10.1	6613.25
7-Jan-02	6.85	6.8	1387	10.04	6613.31
4-Feb-02	6.76	7.1	1316	10	6613.35
5-Mar-02	6.59	6	1303	9.9	6613.45
1-Apr-02	6.64	7.2	1307	8.23	6615.12
6-May-02	7.11	8.2	2330	8.54	6614.81
3-Jun-02	6.8	8.6	1760	8.84	6614.51
9-Jul-02	7.31	11.6	1770	9.59	6613.76

RF-8				
DATE	Ph	TEMP	CON	FLOW
4-Apr-01	7.36	4	1414	NM
7-May-01	7.3	6.8	1507	NM
5-Jun-01	7.24	9.4	1124	NM
9-Jul-01	7.09	16.9	1111	NM
7-Aug-01	7.42	22.5	1014	NM
5-Sep-01	6.89	13.4	1200	NM
8-Oct-01	6.98	13.8	1150	NM
5-Nov-01	7.04	8	1026	NM
3-Dec-01	6.9	0.6	1118	NM
7-Jan-02	7.18	1	1033	NM
4-Feb-02	Location	Frozen		
5-Mar-02	7.06	3.9	1252	NM
1-Apr-02	7.12	11.1	1219	NM
2-May-02	6.85	7.7	1198	NM
3-Jun-02	6.9	14.4	1070	NM

RT-15				6621.43	
DATE	pH	TEMP	CON	LEVEL	
Dry in all other sampling events					
1-Apr-02	6.5	9.2	1896	5.68	6615.75
6-May-02	7.06	7.2	2550	9.1	6612.33
3-Jun-02	nm	nm	nm	11.4	6610.03

RT-3				
DATE	pH	TEMP	CON	LEVEL
6-May-02	6.98	13.6	2170	6.2

RT-6				
DATE	pH	TEMP	CON	LEVEL
6-May-02	6.98	9.6	4210	6.11

RF-11							
Date	pH	Temp	Con	Flow	D.O. #	D.O. %	ORP
16-Apr-02	7.24	7.3	692	NM	8.17	70	423
6-May-02	7.29	17.1	888	NM			

RF-12								
Date	pH	Temp	Con	Flow	D.O. #	D.O. %	ORP	
16-Apr-02	7.12	6.8	762	NM	8.49	70	422	
6-May-02	7.26	14.6	921	NM				20" of post at SG-2

TABLE 3-1
RICHARDSON FLAT SURFACE AND GROUNDWATER FIELD DATA

Temp - Degree C, Flow - CFS

STAFF GAUGE WATER LEVELS

LOCATION	G. ELEV	4/17/02 - LEVEL	4/17/02 - ELEV.	5/7/02 - LEVEL	5/7/02 - ELEV.	6/3/02 - LEVEL	6/3/02 - ELEV.	7/9/02 - LEVEL	7/9/02 - ELEV.	8/6/02 - LEVEL	8/6/02 - ELEV.
SG-1	6615.59	30.125	6585.465	NM		2.98	6612.61	2.3	6613.29	DRY	
SG-2	6615.16	22.125	6593.035	1.67	6613.49	2.8	6612.36	1.82	6613.34	DRY	
SG-3	6621.48	34.25	6587.21	NM		DRY		DRY		DRY	
SG-4	6594.87	NM		4.87	6590	4.98	6589.89	5.45	6589.42	6.03	6588.84
SG-5	6595.47	NM		2.92	6592.55	3.03	6592.44	3.36	6592.11	3.47	6592
SG-6	6597.43	NM		3.5	6593.93	3.27	6594.16	3.79	6593.64	3.85	6593.58

FLOODPLAIN TAILINGS AREA

WELL	Date	SWL	ELEV.	pH	TEMP	COND	TURB	DO	TDS	ORP
FPT-4A	5/2/02	2.18	6597.94	7.56	12.3	1860	342	4.1	1.2	85
FPT-6-A	5/2/02	0.6	6593.34	7.5	14.7		681	10.21		-105
FPT-7-A	5/2/02	2.45	6591.98	6.81	9	4470	482	5.83		-41
FPT-8-A	5/2/02	1.93	6591.4	7.21	6.7	1960	416	7.98		-84
FPT-2B	5/2/02	3.96	6603.16	7.47	7.8	2440	255			
S-4	5/2/02	2.37	6593.69	7.06	15.1	4130	277	5.96		115
S-5	5/2/02	1.57	6594.49							
S-5	5/6/02	2.33	6593.73							

FLOODPLAIN TAILINGS AREA

SURFACE WATER LOCATION		pH	TEMP	COND	FLOW
FPT-SW-3	5/2/02	7.16	7.2	1229	
FPT--SW-4	5/2/02	7.04	12.3	1219	
FPT-SW-1	5/2/02	7.6	11.2	1181	
FPT-SW-2	5/2/02	7.14	11.6	1173	
PH-SW-1	5/2/02	7.74	12.6	896	3.4

TABLE 3-2
RICHARDSON FLAT SOIL DATA
ONSITE SOILS COVER

Lab #	Date	Sample #	COVER THICKNESS (FEET)
L010670-025	5/9/01	RF-ON-1A 0-2"	NO TAILS
L010670-029	5/9/01	RF-ON-1B 0-2"	NO TAILS
L010670-018	5/9/01	RF-ON-1C 0-2"	1.25 (MIXED TAILS BELOW)
L010670-046	5/9/01	RF-ON-1D 0-2"	1.3
L010670-011	5/9/01	RF-ON-1E 0-2"	0.6
L010670-009	5/8/01	RF-ON-1G 0-2"	1.2
L010670-026	5/9/01	RF-ON-2A 0-2"	NO TAILS
L010670-030	5/9/01	RF-ON-2B 0-2"	NO TAILS
L010670-019	5/9/01	RF-ON-2C 0-2"	1.5
L010670-047	5/9/01	RF-ON-2D 0-2"	1.5
L010670-012	5/9/01	RF-ON-2E 0-2"	1.25
L010670-006	5/8/01	RF-ON-2F 0-2"	4
L010670-001	5/8/01	RF-ON-2G 0-2"	NO TAILS -FILL TO 11'
L010671-011	5/8/01	RF-ON-3A 0-2"	>0.5
L010670-016	5/9/01	RF-ON-3B 0-2"	1
L010670-044	5/9/01	RF-ON-3C 0-2"	0.9
L010671-020	5/9/01	RF-ON-3D 0-2"	1.4
L010671-006	5/8/01	RF-ON-3E 0-2"	2
L010670-007	5/8/01	RF-ON-3F 0-2"	1.1
L010670-002	5/8/01	RF-ON-3G 0-2"	2.5
L010670-037	5/7/01	RF-ON-3H 0-2"	0.5
L010671-015	5/8/01	RF-ON-3I 0-2"	NO TAILS OR DEEPER THAN 1.5
L010670-027	5/8/01	RF-ON-4A 0-2"	0.25
L010670-017	5/8/01	RF-ON-4B 0-2"	0.66
L010671-019	5/8/01	RF-ON-4C 0-2"	0.8
L010671-004	5/8/01	RF-ON-4D 0-2"	0.8
L010670-014	5/8/01	RF-ON-4E 0-2"	1
L010671-002	5/8/01	RF-ON-4F 0-2"	0.6
L010670-003	5/8/01	RF-ON-4G 0-2"	0.6
L010670-038	5/7/01	RF-ON-4H 0-2"	0.5
L010670-066	5/8/01	RF-ON-4I 0-2"	NO TAILS OR DEEPER THAN 1.5
L010670-028	5/8/01	RF-ON-5A 0-2"	NO TAILS
L010671-008	5/8/01	RF-ON-5B 0-2"	1.33
L010670-045	5/8/01	RF-ON-5C 0-2"	NO TAILS
L010671-005	5/8/01	RF-ON-5D 0-2"	1
L010670-015	5/8/01	RF-ON-5E 0-2"	NO TAILS
L010670-008	5/8/01	RF-ON-5F 0-2"	0.6
L010670-005	5/8/01	RF-ON-5G 0-2"	NO TAILS
L010670-039	5/7/01	RF-ON-5H 0-2"	NO TAILS
L010670-010	5/8/01	RF-ON-6D 0-2"	NO TAILS

Table 3-3
Richardson Flat
2003 Phase I and II
Surface and Pore Water
Field Data

Location	pH	Temp	Cond	Notes
Phase I SW (June)				
RFB-SW-SD4	6.92	13.7	1541	Wetland
RFB-SW-SD7	7.15	13.9	1430	Wetland
RFB-SW-SD13	7.55	16	1759	Wetland
RFB-SW-SD17	7.37	16.8	1753	Wetland
RFB-SW-SD18	7.44	21.3	1719	Pond
RFB-SW-SD20	7.4	20.5	1720	Pond
Phase II SW (August)				
RFB-SW-SD13	7.2	16.3	1836	Wetland
RFB-SW-SD17	6.86	16.8	1799	Wetland
RFB-SW-SD18	7.7	25.3	1808	Pond
RFB-SW-SD20	7.8	22	1840	Pond
RFB-SWP-REF	7	21.3	1373	Ref. Site Pond
RFB-SWW-REF	7.3	23.3	1693	Ref. Site Wetland
Phase II PW (August)				
RFB-PW-SD2	6.83	18.9	1331	Wetland
RFB-PW-SD4	6.53	22.5	1480	Wetland
RFB-PW-SD6	6.63	18.4	1436	Wetland
RFB-PW-SD10	6.52	18.2	1910	Wetland
RFB-PW-SD11	6.5	16.3	2570	Wetland
RFB-PW-SD14	6.71	16.1	2220	Wetland
RFB-PW-SD15	7.25	22.9	1590	Wetland
RFB-PW-SD17	7.02	22.5	1595	Wetland
RFB-PW-SD18	7.17	25.6	1874	Pond
RFB-PW-SD20	6.97	26.5	2020	Pond
RFB-PW-REF-PND	6.55	23.5	1349	Ref. Site Pond
RFB-PW-REF-WET	6.51	21.1	1843	Ref. Site Wetland

Table 4-1, Analytical Summary - Surface Water Data, Richardson Flat Remedial Investigation

(units ppm, unless specified)

Date	Sample #	AG	AG(D)	AL	AL(D)	ALK	AS	AS(D)	CA	CATIAN BAL	CD	CD(D)	CL-	COS	COND	CR	CR(D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	MG	MN	MN(D)	NA	NH3/N	NO2/NO3	P	PB	PB(D)	SB	SB(D)	SE	SE(D)	SO4=	TDS	TSS	ZN	ZN(D)	S=
	RF-SW-RF1																																												
4-Apr-01	RF-SW-RF1	<0.005	<0.005	1.8	0.57	84.	<0.005	<0.005	25.	4.6	<0.001	<0.001	15.	<1.0	240.	<0.01	<0.01	<0.005	<0.005	1.2	0.43	85.	84.	0.00024	<0.0002	2.1	5.9	0.006	<0.005	9.7	0.10	0.12	<0.1	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	32.	198.	18.	0.034	0.023	
7-May-01	RF-SW-RF1	<.005	<.005	.078	<.050	121	<.005	<.005	48.	-.06	<.001	<.001	20.	<1	438	<.010	<.010	.015	.016	<.1	<.1	165.	121.	<0.0002	<0.0002	<2	11.	.013	<.005	20.	.20	.29	<.1	.005	.007	<.005	<.005	<.004	<.004	78.	339.	<1	.053	.037	
16-Apr-02	RF-SW-RF1	<0.005	<0.005	0.63	0.12	85	<0.005	<0.005	35	7.2	<0.001	<0.001	19	<1.0	311	<0.010	<0.010	<0.005	<0.005	1	0.092	121	85	<0.0002	<0.0002	2.7	8.1	0.008	<0.005	15	<0.10	0.21	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	39	224	8.9	0.048	0.022	0.087
6-May-02	RF-SW-RF 1	<0.005	<0.005	0.16	<0.050	138	<0.005	<0.005	54	4	<0.001	<0.001	23	<1.0	451	<0.010	<0.010	<0.005	0.01	0.2	<0.10	188	136	<0.0002	<0.0002	2.1	13	0.013	0.008	21	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	72	314	3.7	0.039	0.055	
	RF-SW-RF2																																												
4-Apr-01	RF-SW-RF2	<0.005	<0.005	0.58	0.19	124.	0.005	0.008	44.	2.0	<0.001	<0.001	44.	<1.0	447.	<0.01	<0.01	<0.005	<0.005	0.49	0.20	151.	124.	0.00028	<0.0002	2.4	10.	0.018	0.016	25.	0.18	<0.10	<0.1	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	38.	318.	7.9	0.030	0.027	
7-May-01	RF-SW-RF2	<.005	<.005	.16	<.050	183	<.005	<.005	67.	+1.2	<.001	<.001	83.	<1	657	<.010	<.010	.018	.018	.25	<.1	234.	183.	<0.0002	<0.0002	3.0	16.	.034	.024	37.	.10	<.1	<.1	.005	.005	.006	.010	<.004	<.004	41.	454.	<1	.084	.079	
16-Apr-02	RF-SW-RF2	<0.005	<0.005	0.12	<0.050	144	0.007	0.008	59	5.3	<0.001	<0.001	56	<1.0	545	<0.010	<0.010	<0.005	<0.005	0.32	0.058	206	144	<0.0002	<0.0002	3.1	14	0.028	0.022	29	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	46	368	2.3	0.056	0.049	0.087
6-May-02	RF-SW-RF 2	<0.005	<0.005	<0.050	<0.050	192	0.008	0.008	83	3.2	<0.001	<0.001	124	<1.0	782	<0.010	<0.010	<0.005	<0.005	0.28	<0.10	285	192	<0.0002	<0.0002	3.3	19	0.051	0.048	47	<0.10	<0.10	0.14	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	34	518	1.9	0.095	0.074	
	RF-SW-RF3-2																																												
4-Apr-01	RF-SW-RF3-2	<0.005	<0.005	1.4	0.069	108.	0.009	0.009	39.	1.6	<0.001	<0.001	76.	<1.0	554.	<0.01	<0.01	0.006	0.006	0.85	<0.10	135.	108.	0.00024	0.00022	3.4	9.1	0.061	0.051	45.	0.16	<0.10	<0.1	0.005	<0.005	<0.005	<0.005	<0.004	<0.004	34.	380.	20.	0.098	0.077	
7-May-01	RF-SW-RF3-2	<.005	<.005	<.050	<.050	117	.017	.010	48.	-2.3	<.001	<.001	212.	8.0	927	<.010	<.010	.022	.020	<.1	<.1	171.	109.	<0.0002	<0.0002	3.5	13.	.007	<.005	113.	.22	<.1	<.1	.007	.005	.012	.015	<.004	<.004	40.	572.	<1	.058	.040	
16-Apr-02	RF-SW-RF3	<0.005	<0.005	1	0.06	100	0.017	0.017	47	2.4	<0.001	<0.001	63	<1.0	540	<0.010	<0.010	0.007	0.008	0.86	0.052	157	100	<0.0002	<0.0002	4	9.7	0.06	0.041	40	<0.10	<0.10	<0.10	0.024	<0.005	0.006	0.006	<0.004	<0.004	38	352	18	0.12	0.063	0.093
	RF-SW-RF4																																												
4-Apr-01	RF-SW-RF4	<0.005	<0.005	0.48	0.086	137.	0.006	0.008	66.	<1.0	0.002	<0.001	68.	<1.0	670	<.010	<0.01	0.005	0.007	0.45	<0.10	226.	137.	0.00024	0.00020	2.8	15.	0.25	0.24	37.	0.30	<0.10	<0.1	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	101.	468.	10.	0.86	0.61	
7-May-01	RF-SW-RF4	<.005	<.005	<.050	<.050	260	.006	<.005	200.	-4.2	.001	<.001	83.	<1	1388.	<.010	<.010	.017	.016	<.1	<.1	677.	260.	<0.0002	<0.0002	<2	43.	.44	.46	38.	.30	.14	<.1	<.005	.006	<.005	<.005	<.004	<.004	475.	1082.	19.	2.7	2.6	
5-Jun-01	RF-SW-RF4	<.005	<.005	<.050	<.050	271	0.006	0.005	246	-2.2	0.002	<.001	79	<1	1600	0.049	<.010	<.005	<.005	0.16	<.1	840	271	<0.0002	<0.0002	<2.	55	0.28	0.29	38	0.51	0.14	<.1	<.005	<.005	<.005	<.005	<.004	<.004	606	1316	<1	1.5	1.5	
9-Jul-01	RF-SW-RF4	<.005	<.005	.058	<.050	306.	<.005	<.005	254.	+.4	<.001	<.001	88.	<1	1739.	<.010	<.010	<.005	<.005	<.1	<.1	874.	308.	<0.0002	NA	<2.	58.	.31	.25	40.	.37	<.1	<.10	<.005	<.005	<.005	<.005	<.004	<.004	554.	1397	<1.	1.1	.99	
16-Apr-02	RF-SW-RF4	<0.005	<0.005	0.078	<0.050	104	0.007	<0.005	174	8.5	0.001	<0.001	83	<1.0	1251	<0.010	<0.010	<0.005	<0.005	0.44	<0.010	593	104	<0.0002	<0.0002	2.3	39	1.6	1.5	40	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	361	914	4.7	1.1	0.81	0.17
6-May-02	RF-SW-RF 4	<0.005	<0.005	<0.050	<0.050	256	<0.005	<0.005	219	3.1	0.001	<0.001	89	<1.0	1456	<0.010	<0.010	<0.005	<0.005	0.2	<0.10	744	256	<0.0002	<0.0002	<2.0	48	0.87	0.83	42	0.11	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	433	1109	2.6	1.4	1.1	
3-Jun-02	RF-SW-RF-4						<.005	<.005			<.001	<.001						<.005	<.005															<.005	<.005	<.005	<.005			508	1203	2.2	0.87	0.61	
9-Jul-02	RF-SW-RF4	<0.005	<0.005	<0.050	<0.050	309	0.009	<0.005	280	2.7	<0.001	<0.001	94	<1.0	1830	<0.010	<0.010	0.005	0.005	0.13	<0.10	866	309	<0.0002	<0.0002	<2.0	65	1.6	1.6	46	<0.10	<0.10	0.13	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	711	1493	1.5	0.34	0.36	
	RF-SW-RF5																																												
4-Apr-01	RF-SW-RF5	<0.005	<0.005	0.34	<0.05	134.	0.006	0.005	78.	1.4	0.001	<0.001	74.	<1.0	734	<0.01	<0.01	<0.005	<0.005	0.35	<0.10	258.	134.	0.00028	0.00022	2.7	17.	0.089	0.062	36.	0.11	<0.10	<0.1	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	114.	514.	6.2	0.45	0.38	
7-May-01	RF-SW-RF5	<.005	<.005	<.050	<.050	259	<.005	<.005	240.	-3.5	<.001	<.001	72.	<1	1516.	<.010	<.010	.017	.019	<.1	<.1	814.	259.	<.2	<.2	<2	52.	.11	.11	37.	.15	<.1	<.1	<.005	<.005	<.005	<.005	<.004	<.004	619.	1224.	<1	.90	.88	
5-Jun-01	RF-SW-RF-5	<.005	<.005	0.06	<.050	276	0.006	<.005	270	-5.6	0.005	<.001	83	<1	1720	0.04	<.010	<.005	<.005	0.28	0.67	924	276	<0.0002	NA	<2.	61	0.16	0.2	37	0.5	<.1	<.1	0.027	<.005	<.005	<.005	0.004	<.004	751	1442	<1	0.48	0.47	
9-Jul-01	RF-SW-RF5	.025	<.005	<.050	.061	298.	<.005	<.005	294.	+7.7	<.001	<.001	77.	<1	1814.	<.010	<.010	<.005	<.005	<.1	<.1	1018.	298.	<0.0002	NA	<2.	69.	.52	.51	42.	.39	<.1	<.10	<.005	<.005	<.005	.006	<.004	<.004	573.	1543	<1.	.33	.29	
7-Aug-01	RF-SW-RF5	<.005	<.005	<.050	<.050	297	<.005	<.005	314.	-1.6	<.001	<.001	74.	<1	1980.	<.010	<.010	<.005	<.005	.17	<.1	1082.	297	<0.0002	<0.0002	<2	72.	.32	.31	39.	<.1	.11	<.1	<.005	<.005	<.005	<.005	<.004	<.004	820.	1830.	2.2	.20	.19	
16-Apr-02	RF-SW-RF5	<0.005	<0.005	<0.050	<0.050	228	<0.005	<0.005	205	<1	<0.001	<0.001	61	<1.0	1381	<0.010	<0.010	<0.005	<0.005	0.1	<0.010	697	228	<0.0002	<0.0002	2.3	45	0.6	0.61	38	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	482	1050	2.3	0.41	0.31	0.13
6-May-02	RF-SW-RF 5	<0.005	<0.005	<0.050	<0.050	264	<0.005	<0.005	250	<1	<0.001	<0.001	97	<1.0	1560	<0.010	<0.010	<0.005	<0.005	<0.10	<0.10	847	264	<0.0002	<0.0002	<2.0	54	0.23	0.22	40	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	543	1223	1.8	0.3	0.19	
3-Jun-02	RF-SW-RF-5						<.005	<.005			<.001	<.001						<.005	<.005															<.005	<.005	<.005	<.005			569	1282	<1.0	.21*	0.077	

Table 4-1, Analytical Summary - Surface Water Data, Richardson Flat Remedial Investigation

(units ppm, unless specified)

Date	Sample #	AG	AG(D)	AL	AL(D)	ALK.	AS	AS(D)	CA	CAT/AN BAL.	CD	CD(D)	CL-	CO3	COND	CR	CR(D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	MG	MN	MN(D)	NA	NH3/N	NO2/NO3	P	PB	PB(D)	SB	SB(D)	SE	SE(D)	SO4=	TDS	TSS	ZN	ZN(D)	S=
	RF-SW-RF6-2																																												
4-Apr-01	RF-SW-RF6-2	<0.005	<0.005	0.35	<0.05	153.	<0.005	<0.005	104.	5.0	<0.001	<0.001	69.	<1.0	902	<.010	<0.01	0.010	<0.005	0.34	<0.10	349.	153.	0.00032	<0.0002	2.8	22.	0.86	0.82	35.	0.20	<0.10	<0.1	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	243.	644.	6.4	0.30	0.15	
7-May-01	RF-SW-RF6-2	<.005	<.005	<.050	<.050	220	.009	<.005	215.	-5.5	<.001	<.001	90.	<1	1508.	<.010	<.010	.017	.016	<.1	<.1	729.	220.	<0.0002	<0.0002	<2	47.	.43	.40	47.	.26	<.1	<.1	<.005	.007	.010	<.005	<.004	<.004	<.004	598.	1192.	<1	.20	.11	
5-Jun-01	RF-SW-RF6-2	<.005	<.005	<.050	<.050	190	0.007	<.005	266	-9.4	0.002	<.001	84	<1	1695	0.038	<.010	<.005	<.005	<.1	<.1	930	190	<0.0002	<0.0002	<2	64	0.77	0.76	42	0.84	<.1	<.1	0.013	<.005	<.005	<.005	<.004	<.004	918	1467	1.1	0.096	0.048	
9-Jul-01	RF-SW-RF6-2	.008	<.005	.078	<.050	190.	<.005	<.005	279.	-2.4	<.001	<.001	89.	<1	1137.	<.010	<.010	<.005	<.005	.14	<.1	978.	190.	<0.0002	NA	4.1	66.	2.9	2.9	48.	.16	.19	<.10	<.005	<.005	<.005	<.005	<.004	<.004	821.	1615.	3.2	.070	.043	
7-Aug-01	RF-SW-RF6-2	<.005	<.005	<.050	<.050	253	<.005	<.005	353.	-.02	<.001	<.001	83.	<1	2140.	<.010	<.010	<.005	<.005	<.1	<.1	1182.	253	<0.0002	NA	2.4	73.	5.9	5.8	54.	.22	.34	<.1	<.005	<.005	<.005	<.005	<.004	<.004	939.	1823.	1.8	.10	.11	
7-Aug-01	RF-SW-RF6-2	<.005	<.005	<.050	<.050	253	<.005	<.005	353.	-.02	<.001	<.001	83.	<1	2140.	<.010	<.010	<.005	<.005	<.1	<.1	1182.	253	<0.0002	NA	2.4	73.	5.9	5.8	54.	.22	.34	<.1	<.005	<.005	<.005	<.005	<.004	<.004	939.	1823.	1.8	.10	.11	
6-Oct-01	RF-SW-RF6-2	<0.005	<0.005	<0.050	<0.050	225.	<0.005	<0.005	404.	6.7	<0.001	<0.001	86.	<1.0	2290.	<0.010	<0.010	<0.005	<0.005	0.13	0.098	1363.	225.	<0.0002	<0.0002	3.4	86.	6.6	6.4	58.	0.19	0.36	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	958.	2029.	<1.0	0.065	0.066	
5-Nov-01	RF-SW-RF6-2	<0.005	<0.005	0.058	<0.050	207	<0.005	<0.005	387	-2.3	<0.001	<0.001	100	<1.0	2310	<0.010	<0.010	<0.005	<0.005	0.3	<0.10	1335	207	<0.0002	<0.0002	4.1	90	3.5	3.6	55	<0.1	0.26	<.10	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1170	2110	2.9	0.039	0.033	
3-Dec-01	RF-SW-RF-6-2	<.005	<.005	<.050	<.050	217.	<.005	<.005	398.	-.78	<.001	<.001	100.	<1	2340.	<.010	<.010	.010	<.005	.45	<.10	1355.	217.	<0.0002	<0.0002	3.8	89.	3.3	3.7	57.	.82	.13	<.1	.016	<.005	<.005	<.005	<.004	<.004	1141.	2054.	2.6	.054	.044	
7-Jan-02	RF-SW-R6-2	<.005	<.005	<.050	<.050	274	<.005	<.005	384	5.4	<.001	<.001	75	<1	2200	<.010	<.010	<.005	<.005	0.29	<.10	1309	274	<0.0002	<0.0002	3.9	85	9.5	9.7	50	0.96	0.2	<.1	<.005	<.005	<.005	<.005	<.004	<.004	908	1937	3	0.1	0.075	
4-Feb-02	RF-GW-RT-6-2	<0.005	<0.005	0.05	<0.050	300	<0.005	<0.005	371	3.8	<0.001	<0.001	84	<1.0	2250	<0.010	<0.010	<0.005	<0.005	0.34	0.14	1248	308	<0.0002	<0.0002	3.7	78	12	11	49	0.74	0.2	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	1053	1974	2	0.1	0.01	
5-Mar-02	RF-SW-RF6-2	<0.005	0.005	0.051	<0.050	350	<0.005	<0.005	336	-5.1	<0.001	<0.001	92	<1.0	2180	<0.010	<0.010	<0.005	<0.005	0.14	<0.10	1129	350	<0.0002	<0.0002	3.4	70	8.3	7.9	46	0.27	0.22	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	910	1890	4.2	0.083	0.018	
1-Apr-02	RF-SW-6-2	<0.005	<0.005	<0.050	<0.050	180.	<0.005	<0.005	246.	6.0	<0.001	<0.001	88.	<1.0	1522.	<0.010	<0.010	<0.005	<0.005	0.44	<0.10	812.	180.	<0.0002	<0.0002	3.4	48.	3.2	3.1	40.	0.38	0.15	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	501.	1212.	3.9	0.19	0.066	
16-Apr-02	RF-SW-RF6-2	<0.005	<0.005	0.083	<0.050	202	<0.005	<0.005	193	2.1	<0.001	<0.001	65	<1.0	1334	<0.010	<0.010	<0.005	<0.005	0.18	0.012	654	202	<0.0002	<0.0002	2.9	42	0.9	0.87	37	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	434	1009	3.6	0.17	0.03	0.14
6-May-02	RF-SW-RF 6-2	<0.005	<0.005	<0.050	<0.050	232	<0.005	<0.005	243	3.7	<0.001	<0.001	102	<1.0	1554	<0.010	<0.010	<0.005	<0.005	<0.10	<0.10	869	232	<0.0002	<0.0002	2.5	54	0.82	0.77	42	<0.10	0.1	<0.10	0.008	<0.005	<0.005	<0.005	<0.004	<0.004	834	1220	1.6	0.082	0.032	
3-Jun-02	RF-SW-RF-6-2						<.005	<.005			<.001	<.001						<.005	<.005															0.006	<.005	<.005	<.005			881	1351	1.4	.15*	0.031	
	RF-SW-RF7-2																																												
4-Apr-01	RF-SW-RF7-2	<0.005	<0.005	0.065	<0.05	152.	<0.005	<0.005	130.	1.9	0.005	0.005	254.	<1.0	1484	<0.01	<0.01	0.007	<0.005	0.28	<0.10	467.	152.	0.00032	0.00022	2.8	34.	0.20	0.16	115.	0.17	0.73	<0.1	0.028	<0.005	0.009	0.007	<0.004	<0.004	253.	948.	3.2	1.4	1.3	
7-May-01	RF-SW-RF7-2	<.005	<.005	.10	<.050	145	<.005	<.005	128.	-4.0	.008	.006	269.	<1	1587.	<.010	<.010	.020	.017	.21	<.1	433.	145.	<0.0002	<0.0002	2.5	29.	.21	.21	134.	.26	.18	<.1	.026	.008	.010	.011	<.004	<.004	279.	1007.	1.4	2.1	2.0	
5-Jun-01	RF-SW-RF7-2	<.005	<.005	<.050	<.050	130	0.008	<.005	119	-4.7	0.006	0.003	177	<1	1150	0.036	<.010	<.005	<.005	0.22	<.1	398	130	<0.0002	<0.0002	<2	25	0.36	0.38	66	0.6	<.1	<.1	0.025	<.005	0.012	0.005	<.004	<.004	232	754	1.5	1.5	1.5	
9-Jul-01	RF-SW-RF7-2	.018	<.005	.10	.18	183.	.013	.007	135.	+1.8	.003	.002	126.	<1	1150.	<.010	<.010	<.005	<.005	.29	.12	490.	183.	<0.0002	NA	4.8	37.	.64	.65	48.	.31	<.1	<.10	.013	<.005	.039	.012	.018	<.004	237.	823	2.3	.86	.82	
7-Aug-01	RF-SW-RF7-2	<.005	<.005	<.050	<.050	192	.012	.009	139.	-2.4	.002	.001	106.	<1	1142.	<.010	<.010	.005	<.005	.30	<.1	511.	192	<0.0002	na	2.2	40.	.34	.33	38.	<.1	<.10	<.1	.015	<.005	.006	.006	<.004	<.004	308.	798.	3.3	.43	.39	
5-Sep-01	SW-RF-7-2	<0.005	<0.005	0.075	<0.050	162.	0.011	0.008	145.	1.4	0.002	<0.001	110.	<1.0	1220.	<0.010	<0.010	<0.005	<0.005	0.35	<0.10	531.	162.	<0.0002	<0.0002	3.1	41.	0.45	0.39	48.	<0.10	0.14	<0.10	0.026	<0.005	<0.005	<0.005	<0.004	<0.004	301.	867.	3.2	0.63	0.53	
8-Oct-01	RF-SW-RF7-2	<0.005	<0.005	<0.050	<0.050	174.	0.007	<0.005	163.	6.7	0.0015	<0.001	108.	<1.0	1266.	<0.010	<0.010	<0.005	<0.005	0.28	<0.050	660.	174.	<0.0002	<0.0002	3.1	42.	0.44	0.42	48.	<0.10	<0.10	<0.10	0.014	<0.005	0.005	0.005	<0.004	<0.004	291.	898.	<1.0	0.86	0.82	
5-Nov-01	RF-SW-RF7-2	<0.005	<0.005	0.082	<0.050	205	<0.005	<0.005	149	-0.3	0.003	0.002	109	<1.0	1168	<0.010	<0.010	<0.005	<0.005	0.32	<0.10	532	205	<0.0002	<0.0002	3.7	39	0.29	0.29	49	<0.1	<0.1	<.10	0.017	<0.005	0.007	0.007	<0.005	<0.005	313	827	1.7	1.2	1.3	
3-Dec-01	RF-SW-RF7-2	<.005	<.005	.082	<.050	152.	<.005	<.005	138.	+1.9	.003	.002	130.	8.0	1252.	<.010	<.010	<.005	<.005	.27	.10	494.	144.	<0.0002	<0.0002	2.2	37.	.28	.26	67.	.11	.34	<.1	.014	<.005	.007	.005	<.004	<.004	294.	830.	2.1	1.1	1.1	
7-Jan-02	RF-SW-RF7-2	<.005	<.005	0.063	<.050	162	<.005	<.005	134	4.2	0.002	0.002	75	<1	1053	<.010	<.010	<.005	<.005	0.19	<.10	486	162	<0.0002	<0.0002	2.2	37	0.2	0.21	36	<.10	0.45	<.1	0.007	<.005	0.006	0.006	<.004	<.004	272	714	1.4	0.89	0.66	
4-Feb-02	RF-GW-RT-7-2	<0.005	<0.005	0.1	<0.050	180	<0.005	<0.005	149	2.5	0.002	<0.001	92	<1.0	1227	<0.010	<0.010	<0.005	<0.005	0.2	<0.10	537	180	<0.0002	<0.0002	2.4	40	0.48	0.48	47	<0.10	0.28	<0.10	0.005	<0.005	0.006	0.006	<0.004	<0.004	320	862	<1.0	1.2	1.3	
5-Mar-02	RF-SW-RF7-2	<0.005	<0.005	0.065	<0.050	180	<0.005	<0.005	142	-6.1	0.002	0.002	177	<1.0	1392	<0.010	<0.010	0.005	<0.005	0.25	<0.10	513	180	<0.0002	<0.0002	2.4	39	0.41	0.4	72	<0.10	0.22	<0.10	0.013	<0.005	0.006	0.006	<0.004	<0.004	351	968	1.5	1.1	1.1	
1-Apr-02	RF-SW-RF7-2	<0.005	<0.005	0.17	<0.050	165.	0.005	0.005	134.	<1.0	0.004	0.004	233.	<1.0	1394.	<0.010	<0.010	0.008	0.005	0.57	<0.10	483.	165.	<0.0002	<0.0002	4.3	36.	0.22	0.18	98.	<0.10	0.99	<0.10	0.042	<0.005	0.008	0.008	<0.004	<0.004	230.	869.	4.6	1.2	1.1	
2-May-02	RF-SW-RF 7-2	<0.005	<0.005	0.096	<0.050	145	0.008	<0.005	138	<1	0.004	0.003	232	<1.0	1398	<0.010	<0.010	0.008	<0.005	0.3	<0.10	491	145	<0.0002	<0.0002	2.7	35	0.2	0.17	90	<0.10	0.19	<0.10	0.029	<0.005	0.008	0.007	<0.004	<0.004	231	890	3.3	0.99	0.9	
3-Jun-02	RF-SW-RF-7-2	<.005	<.005	0.07	<.050	150	<.005	<.005	133	<1.0	0.004	<.001	180	<1.0	1284	<.010	<.010	<.005	<.005	0.34	<.10	472	150	<0.0002	<0.0002	<2.0	34	0.33	0.28	71	<.10	0.13	<.10	0.022	0.006	0.012	0.012	<.004	<.004	235	837	2.3	0.77	0.83	
9-Jul-02	RF-SW-RF 7-2	<0.005	<0.005	<0.050	<0.050	165	<0.005	0.008	138	1.2	0.002	0.001	162	<1.0	1230	<0.010	<0.010	0.005	<0.005	0.28	<0.10	514	165	<0.0002	<0.0002	<2.0	42	0.36	0.37	54	<0.10	<0.10	0.19	0.006	<0.005	<0.005	<0.005	<0.004	<0.004	241	838	1.7	0.48	0.51	
6-Aug-02	RF-GW-RT-7-2	<0.005	<0.005	<0.050	<0.050	244.	0.005	0.008	202.	<1	0.002	0.002	320.	20.	1870.	<0.010	<0.010	<0.005	<0.005	0.20	<0.10	718.	224.	<0.0002	<0.0002	2.9	52.	0.69	0.81	100.	<0.10	<0.10	<0.10	0.014	<0.005	0.005	<0.005	<0.004	<0.004	244.	1174.	2.4	0.69	0.65	

Table 4-1, Analytical Summary - Surface Water Data, Richardson Flat Remedial Investigation

(units ppm, unless specified)

Date	Sample #	AG	AG(D)	AL	AL(D)	ALK.	AS	AS(D)	CA	CATIAN BAL.	CD	CD(D)	CL-	COS	COND	CR	CR(D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	MG	MN	MN(D)	NA	NH3/N	NO2/NO3	P	PB	PB(D)	SB	SB(D)	SE	SE(D)	SO4=	TDS	TSS	ZN	ZN(D)	S=
	RF-SW-RF8																																												
4-Apr-01	RF-SW-RF8	<0.005	<0.005	0.059	<0.05	150.	<0.005	<0.005	128.	4.1	0.004	0.003	283.	<1.0	1450	<0.01	<0.01	0.007	<0.005	0.25	<0.10	463.	150.	0.00026	0.00022	2.9	33.	0.15	0.13	110.	0.19	0.58	<0.1	0.023	<0.005	0.009	0.008	<0.004	<0.004	253.	931.	3.2	1.2	1.1	
7-May-01	RF-SW-RF8	<.005	<.005	<.050	<.050	163	<.005	<.005	135.	-1.2	.006	.004	224.	<1	1495.	<.010	<.010	.019	.018	.20	<.1	467.	163.	<0.0002	<0.0002	2.4	31.	.17	.16	120.	.32	.18	<.1	.018	<.005	.011	.009	<.004	<.004	285.	963.	1.5	1.9	1.7	
5-Jun-01	RF-SW-RF-8	<.005	<.005	0.086	<.050	137	0.017	<.005	134	-2.2	0.007	<.001	189	<1	1193	0.043	<.010	<.005	<.005	0.38	0.43	458	137	<0.0002	<0.0002	<2	30	0.34	0.33	63	0.89	<.1	<.1	0.038	<.005	0.01	<.005	0.009	<.004	286	815	3.4	1.2	1.1	
9-Jul-01	RF-SW-RF8	<.005	<.005	.33	<.050	178.	.010	<.005	138.	+.9	.002	<.001	140.	<1	1198.	<.010	<.010	.007	<.005	.68	<.1	492.	178.	<0.0002	NA	3.8	37.	.86	.61	51.	.13	<.1	<.10	.084	<.005	.008	.010	<.004	<.004	244.	858	7.7	.67	.40	
7-Aug-01	RF-SW-RF8	<.005	<.005	<.050	<.050	190	.015	.006	148.	+.73	.001	<.001	95.	<1	1220.	<.010	<.010	.009	<.005	.42	<.1	537.	190	<0.0002	NA	3.1	42.	.33	.32	41.	<.1	<.10	<.1	.030	<.005	.027	.008	<.004	<.004	319.	1003.	4.7	.54	.45	
5-Sep-01	RF-SW-RF8	<0.005	<0.005	0.055	<0.050	186.	0.011	0.008	154.	2.2	0.001	<0.001	116.	<1.0	1302.	<0.010	<0.010	<0.005	<0.005	0.73	<0.10	561.	186.	<0.0002	<0.0002	2.9	43.	0.67	0.65	50.	<0.10	0.30	<0.10	0.022	<0.005	0.006	0.006	<0.004	<0.004	318.	915.	4.0	0.66	0.67	
8-Oct-01	RF-SW-RF8-2	<0.005	<0.005	<0.050	<0.050	186.	0.011	0.009	178.	8.0	0.001	<0.001	116.	<1.0	1352.	<0.010	<0.010	<0.005	<0.005	1.2	0.82	629.	186.	<0.0002	<0.0002	3.3	48.	0.70	0.69	52.	0.31	<0.10	<0.10	0.011	<0.005	0.008	0.005	<0.004	<0.004	306.	942.	<1.0	0.60	0.54	
5-Nov-01	RF-SW-RF8	<0.005	<0.005	0.063	<0.050	200	0.008	<0.005	143	-3	0.002	0.001	119	<1.0	1180	<0.010	<0.010	<0.005	<0.005	0.51	0.21	511	200	<0.0002	<0.0002	3.6	38	0.29	0.3	46	<0.1	<0.1	<.10	0.009	<0.005	0.007	0.008	<0.005	<0.005	313	643	1.7	1	1.1	
3-Dec-01	RF-SW-RF8	<.005	<.005	<.050	<.050	158.	<.005	<.005	140.	-.41	.003	.002	111.	<1	1210.	<.010	<.010	.005	<.005	.22	.10	508.	158.	<0.0002	<0.0002	2.7	38.	.23	.24	53.	<.10	.24	<.1	.009	<.005	.007	.007	<.004	<.004	330.	809.	1.7	1.1	1.1	
7-Jan-02	RF-SW-RF8	<.005	<.005	<.050	<.050	164	<.005	<.005	128	3.5	0.002	0.001	95	<1	1046	<.010	<.010	<.005	<.005	0.15	<.10	462	164	<0.0002	<0.0002	2.1	35	0.12	0.12	37	<.10	0.38	<.1	0.006	<.005	0.007	0.007	<.004	<.004	272	696	<1.	0.9	0.88	
5-Mar-02	SW-RF8	<0.005	<0.005	0.055	<0.050	170	<0.005	<0.005	148	-5	0.002	0.001	194	<1.0	1443	<0.010	<0.010	<0.005	<0.005	0.16	<0.10	534	170	<0.0002	<0.0002	2.4	40	0.28	0.27	78	<0.10	0.22	<0.10	0.006	<0.005	0.006	0.006	<0.004	<0.004	353	993	1	1.1	1.1	
1-Apr-02	RF-SW-RF8	<0.005	<0.005	0.15	<0.050	146.	<0.005	<0.005	141.	5.1	0.003	0.002	216.	<1.0	1447.	<0.010	<0.010	0.006	<0.005	0.51	<0.10	502.	146.	<0.0002	<0.0002	4.3	37.	0.14	0.11	103.	<0.10	1.2	<0.10	0.029	<0.005	0.006	0.007	<0.004	<0.004	226.	917.	4.5	1.1	1.0	
2-May-02	RF-SW-RF 8	<0.005	<0.005	0.059	<0.050	150	<0.005	<0.005	140	<1	0.003	0.002	218	<1.0	1424	<0.010	<0.010	0.006	<0.005	0.2	<0.10	498	150	<0.0002	<0.0002	2.7	38	0.15	0.14	92	<0.10	0.15	<0.10	0.009	<0.005	0.006	0.007	<0.004	<0.004	289	895	1.8	0.95	0.93	
3-Jun-02	RF-SW-RF-8	<.005	<.005	0.13	<.050	158	0.018	<.005	140	<1.0	0.004	<.001	187	<1.0	1325	<.010	<.010	0.01	<.005	0.49	<.10	494	158	<0.0002	<0.0002	<2.0	35	0.27	0.22	73	<.10	<.10	<.10	0.074	<.005	0.015	<.005	<.004	<.004	241	828	4	0.8	0.85	
9-Jul-02	RF-SW-RF8	<0.005	<0.005	0.053	<0.050	193	0.006	0.005	170	5.2	<0.001	<0.001	182	<1.0	1471	<0.010	<0.010	0.005	<0.005	0.42	<0.10	631	193	<0.0002	<0.0002	2.7	50	1.4	1.5	66	<0.10	<0.10	<0.10	0.012	<0.005	<0.005	<0.005	<0.004	<0.004	275	1036	2.6	0.19	0.12	
	RF-SW-RF-11																																												
16-Apr-02	RF-SW-RF-11	<0.005	<0.005	0.077	<0.050	164	0.012	0.011	91	6.3	<0.001	<0.001	84	<1.0	765	<0.010	<0.010	<0.005	<0.005	0.54	0.2	258	164	<0.0002	<0.0002	3.5	22	0.22	0.2	34	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	120	536	3.4	0.28	0.25	0.099
6-May-02	RF-SW-RF 11	<0.005	<0.005	0.067	<0.050	220	0.01	0.008	129	<1	<0.001	<0.001	130	<1.0	1060	<0.010	<0.010	<0.005	<0.005	0.44	<0.10	450	220	<0.0002	<0.0002	3.6	31	0.15	0.15	48	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	176	733	3	0.38	0.31	
	RF-SW-RF12																																												
16-Apr-02	RF-SW-RF12	<0.005	<0.005	0.077	<0.050	180	0.014	0.01	99	2.7	0.001	<0.001	78	<1.0	842	<0.010	<0.010	<0.005	<0.005	0.79	0.2	341	180	<0.0002	<0.0002	3.4	23	0.77	0.71	37	<0.10	<0.10	<0.10	0.007	<0.005	0.005	0.006	<0.004	<0.004	142	585	5.5	0.89	0.71	0.15
6-May-02	RF-SW-RF 12	<0.005	<0.005	<0.050	<0.050	218	0.012	0.008	142	3.6	0.002	<0.001	122	<1.0	1115	<0.010	<0.010	<0.005	<0.005	0.35	<0.10	495	218	<0.0002	<0.0002	3.5	31	1.3	1.2	47				<0.005	<0.005	0.007	0.007	<0.004	<0.004	188	771	4.7	1.7	1.3	

NA - Not Analyzed

Table 4-2, Analytical Summary - Surface Water Data, Low Detection Limits Hg
2001

Sample Identification	Date Collected	Total Hg, ng/L (ppt)*	Dissolved Hg, ng/L (ppt)*
RF-SW-RF-8	4/4/01	30.9	6.14
RF-SW-RF-6-2	4/4/01	5.31	2
RF-SW-RF-1	4/4/01	6.93	4.42
RF-SW-RF-8	5/7/01	23.0	b
RF-SW-RF-6-2	5/7/01	0.86	b
RF-SW-RF-1	5/7/01	1.98	b
RF-SW-RF8	6/20/01	59.0	1.97
RF-SW-RF6-2	6/20/01	1.11[a]	1.46[a]
RF-SW-RF6-2	7/19/01	1.66	0.56
RF-SW-RF8	7/19/01	24.2	2.04
RF-SW-RF8	8/7/01	35.6	1.59
RF-SW-RF6-2	8/7/01	1.38[a]	1.64[a]
RF-SW-RF8	10/8/01	12.2	1.19
RF-SW-RF6-2	10/8/01	1.99	0.99
RF-SW-RF8	11/5/01	12	1.22
RF-SW-RF6-2	11/5/01	1.75	0.88
RF-SW-RF8	12/3/01	15.7	1.12
RF-SW-RF6-2	12/3/01	3.25	0.65
RF-SW-RF6-2	2/4/02	1.69	1.05
RF-SW-RF8	3/5/02	9.4	0.9
RF-SW-RF6-2	3/5/02	1.29	0.84
RF-SW-RF8	4/1/02	46.5	3.85
RF-SW-RF6-2	4/1/02	3.56	0.45
RF-SW-RF8	5/6/02	15.5	1.15
RF-SW-RF6-2	5/6/02	0.81	0.29

Notes: a-dissolved fraction greater than total
a - dissolved fraction greater than total
b - dissolved not analyzed

Sample Identification	Date Collected	Total Hg, ng/L (ppt)*	Dissolved Hg, ng/L (ppt)*
USC-1	11/7/00	51.5	2.24
USC-4	11/7/00	2.08	0.97
USC-6	11/7/00	22.2	1.06
USC-7	11/7/00	32.2	4.07
USC-8	11/7/00	37.4	10
USC-1	5/15/00	113	2.35
USC-4	5/15/00	1.28	1.18
USC-6	5/15/00	42.3	1.5
USC-7	5/15/00	51.9	3.28
USC-8	5/15/00	49.9	4.37
USC-12	5/15/00	155	36.6
USC-15	5/15/00	4.82	2.87

USC-1	Downgradient Silver Creek
USC-4	RF6-2
USC-6	Upgradient Silver Creek
USC-7	Upgradient Silver Creek
USC-8	Upgradient Silver Creek
USC-12	Upgradient Silver Creek
USC-15	Upgradient Silver Creek

Table 4-3
Screening of Dissolved Metal Concentrations in Surface Water

Location	Date	AG [3]	AL [4]	AS [2,4]	CD [1]	CR [1,3]	CU [1]	FE [5]	HG [4]	PB [1]	SB	SE [4]	ZN [1]	HARDNESS Std.=Average
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0013*	*0.23*	*0.015*	*1.0*	*0.000012*	*0.0036*	*No Std.*	*0.005*	*0.138*	*139*
RF1	Apr-01	<0.005	0.57	<0.005	<0.001	<0.01	<0.005	0.43	0.00000442*	<0.005	<0.005	<0.004	0.023	85
RF1	May-01	<0.005	<0.050	<0.005	<0.001	<0.01	0.016	<0.10		0.007	<0.005	<.004	0.037	165
RF1	Apr-02	<0.005	0.12	<0.005	<0.001	<0.010	<0.005	0.092	<0.0002	<0.005	<0.005	<0.004	0.022	121
RF1	May-02	<0.005	<0.050	<0.005	<0.001	<0.010	0.01	<0.10	<0.0002	<0.005	<0.005	<0.004	0.055	186
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0018*	*0.34*	*0.022*	*1.0*	*0.000012*	*0.0058*	*No Std.*	*0.005*	*0.203*	*219*
RF2	Apr-01	<0.005	0.19	0.006	<0.001	<0.01	<0.005	0.2	0.0002	<0.005	<0.005	<0.004	0.027	151
RF2	May-01	<0.005	<0.050	<0.005	<0.001	<0.01	0.016	<0.10	<0.0002	0.005	0.01	<0.004	0.079	234
RF2	*Apr-02*	*<0.005*	*<0.050*	*0.008*	*<0.001*	*<0.010*	*<0.005*	*0.058*	*<0.0002*	*<0.005*	*<0.005*	*<0.004*	*0.049*	*206*
RF2	May-02	<0.005	<0.050	0.008	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	0.074	285
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0022*	*0.42*	*0.028*	*1.0*	*0.000012*	*0.0077*	*No Std.*	*0.005*	*0.254*	*285*
RF3-2	Apr-01	<0.005	0.089	0.009	<0.001	<0.01	0.006	<0.10	0.00022	<0.005	<0.005	<0.004	0.077	135
RF3-2	May-01	<0.005	<0.050	0.01	<0.001	<0.01	0.02	<0.10	<0.0002	0.005	0.015	<0.004	0.04	171
RF3-2	Jun-01	<0.005	<0.050	<0.005	0.001	<0.01	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	7.9	678
RF3-2	*Apr-02*	*<0.005*	*0.06*	*0.017*	*<0.001*	*<0.010*	*0.008*	*0.052*	*<0.0002*	*<0.005*	*0.006*	*<0.004*	*0.063*	*157*
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0043*	*0.88*	*0.060*	*1.0*	*0.000012*	*0.0193*	*No Std.*	*0.005*	*0.545*	*703*
RF4	Apr-01	<0.005	0.086	0.008	<0.001	<0.01	0.007	<0.10	0.0002	<0.005	<0.005	<0.004	0.61	226
RF4	May-01	<0.005	<0.050	<0.005	<0.001	<0.01	0.016	<0.10	<0.0002	0.006	<0.005	<0.004	2.6	677
RF4	Jun-01	<0.005	<0.050	0.005	<0.001	<0.01	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	1.5	840
RF4	Jul-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10		<0.005	<0.005	<0.004	0.99	874
RF4	Apr-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.010	<0.0002	<0.005	<0.005	<0.004	0.81	593
RF4	May-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	1.1	744
RF4	Jun-02			<.005	<.001		<.005			<.005	<.005		0.61	
RF4	Jul-02	<0.005	<0.050	<0.005	<0.001	<0.010	0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	0.36	966
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0050*	*1.04*	*0.071*	*1.0*	*0.000012*	*0.0235*	*No Std.*	*0.005*	*0.647*	*860*
RF5	Apr-01	<0.005	<0.050	0.005	<0.001	<0.01	<0.005	<0.10	0.00022	<0.005	<0.005	<0.004	0.38	258
RF5	May-01	<0.005	<0.050	<0.005	<0.001	<0.01	0.019	<0.10	<0.0002	<0.005	<0.005	<0.004	0.86	614
RF5	Jul-01	0.025	0.061	<0.005	<0.001	<0.01	<0.005	<0.10		<0.005	0.006	<0.004	0.29	1016
RF5	Aug-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10		<0.005	<0.005	<0.004	0.19	1082
RF-5	Jun-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	0.67	<0.0002	<0.005	<0.005	<0.004	0.47	924
RF-5	Jul-01	<.005	0.061	<.005	<.001	<.010	<.005	<.1		<.005	0.006	<.004	0.29	1016
RF-5	Aug-01	<.005	<.050	<.005	<.001	<.010	<.005	<.1	<0.0002	<.005	<.005	<.004	0.19	1082
RF-5	Apr-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.010	<0.0002	<0.005	<0.005	<0.004	0.31	697
RF-5	May-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	0.19	847
RF-5	Jun-02			<.005	<.001		<.005			<.005	<.005		0.077	
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0057*	*1.20*	*0.083*	*1.0*	*0.000012*	*0.0280*	*No Std.*	*0.005*	*0.755*	*1031*
RF6-2	Apr-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10	0.000002	<0.005	<0.005	<0.004	0.15	349
RF6-2	May-01	<0.005	<0.050	<0.005	<0.001	<0.01	0.016	<0.10	<0.0002	0.007	<0.005	<0.004	0.11	729
RF6-2	Jun-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10	0.00000146*	<0.005	<0.005	<0.004	0.046	930
RF6-2	Jul-01	0.006	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10	0.0000056*	<0.005	<0.005	<0.004	0.043	978
RF6-2	Aug-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10	0.00000159*	<0.005	<0.005	<0.004	0.11	1182
RF6-2	Sep-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	0.023	1228
RF6-2	Oct-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	0.098	0.00000099*	<0.005	<0.005	<0.004	0.066	1363
RF6-2	Nov-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10	0.00000088*	<0.005	<0.005	<0.005	0.033	1335
RF6-2	Dec-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10	0.0000065*	<0.005	<0.005	<0.004	0.044	1355
RF6-2	Jan-02	<.005	<.050	<.005	<.001	<.010	<.005	<.10	<0.0002	<.005	<.005	<.004	0.075	1309
RF6-2	Feb-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	0.14	<0.0002	<0.005	<0.005	<0.004	0.01	1248
RF6-2	Mar-02	0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	0.018	1129
RF6-2	Apr-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	0.068	812
RF6-2	*Apr-02*	*<0.005*	*<0.050*	*<0.005*	*<0.001*	*<0.010*	*<0.005*	*0.012*	*<0.0002*	*<0.005*	*<0.005*	*<0.004*	*0.03*	*654*
RF6-2	May-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	0.032	869
RF6-2	Jun-02			<.005	<.001		<.005			<.005	<.005		0.031	

Table 4-3
Screening of Dissolved Metal Concentrations in Surface Water

Location	Date	AG [3]	AL [4]	AS [2,4]	CD [1]	CR [1,2]	CU [1]	FE [5]	HG [4]	PB [1]	SB	SE [4]	ZN [1]	HARDNESS Std.=Average
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0034*	*0.67*	*0.046*	*1.0*	*0.000012*	*0.0140*	*No Std.*	*0.005*	*0.415*	*509*
RF7-2	Apr-01	<0.005	<0.050	<0.005	0.005	<0.01	<0.005	<0.10	**0.22**	<0.005	0.007	<0.004	**1.3**	467
RF7-2	May-01	<0.005	<0.050	<0.005	**0.006**	<0.01	0.017	<0.10	<0.0002	0.006	0.011	<0.004	**2**	433
RF7-2	Jun-01	<0.005	<0.050	<0.005	0.003	<0.01	<0.005	<0.10	<0.0002	<0.005	0.005	<0.004	**1.5**	398
RF7-2	Jul-01	**0.018**	**0.18**	0.007	0.002	<0.01	<0.005	0.12		<0.005	0.012	<0.004	**0.82**	490
RF7-2	Aug-01	<0.005	<.050	0.009	0.001	<0.01	<0.005	<0.10		<0.005	0.006	<0.004	**0.39**	511
RF7-2	Sep-01	<0.005	<0.050	0.008	<0.001	<0.01	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	**0.53**	531
RF7-2	Oct-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.050	<0.0002	<0.005	0.005	<0.004	**0.82**	580
RF7-2	Nov-01	<0.005	<0.050	<0.005	0.002	<0.01	<0.005	<0.10	<0.0002	<0.005	0.007	<0.005	**1.3**	532
RF7-2	Dec-01	<0.005	<0.050	<0.005	0.002	<0.01	<0.005	0.1	<0.0002	<0.005	0.005	<0.004	**1.1**	494
RF7-2	Jan-02	<.005	<.050	<.005	0.002	<.010	<.005	<.10	<0.0002	<.005	0.006	<.004	**0.86**	486
RF7-2	Feb-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	0.006	<0.004	**1.3**	537
RF7-2	Mar-02	<0.005	<0.050	<0.005	0.002	<0.010	<0.005	<0.10	<0.0002	<0.005	0.006	<0.004	**1.1**	513
RF7-2	Apr-02	<0.005	<0.050	0.005	0.004	<0.010	0.005	<0.10	<0.0002	<0.005	0.006	<0.004	**1.1**	483
RF7-2	May-02	<0.005	<0.050	<0.005	0.003	<0.010	<0.005	<0.10	<0.0002	<0.005	0.007	<0.004	**0.9**	491
RF7-2	Jun-02	<.005	<.050	<.005	<.001	<.010	<.005	<.10	<0.0002	0.006	0.012	<.004	**0.63**	472
RF7-2	Jul-02	<0.005	<0.050	0.006	0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	**0.51**	514
RF7-2	Aug-02	<0.005	<0.050	0.006	0.002	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	**0.65**	718
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0035*	*0.68*	*0.046*	*1.0*	*0.000012*	*0.0142*	*No Std.*	*0.005*	*0.420*	*516*
RF8	Apr-01	<0.005	<0.050	<0.005	0.003	<0.01	<0.005	<0.10	0.00000814*	<0.005	0.008	<0.004	**1.1**	453
RF8	May-01	<0.005	<0.050	<0.005	0.004	<0.01	0.016	<0.10	<0.0002	<0.005	0.009	<0.004	**1.7**	467
RF8	Jun-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	0.43	0.00000197*	<0.005	<0.005	<0.004	**1.1**	458
RF8	Jul-01	<0.005	<0.050	<0.005	<0.001	<0.01	<0.005	<0.10	0.00000204*	<0.005	0.01	<0.004	**0.4**	492
RF8	Aug-01	<0.005	<0.050	0.008	<0.001	<0.01	<0.005	<0.10	0.00000159*	<0.005	0.006	<0.004	**0.45**	537
RF8	Sep-01	<0.005	<0.050	0.008	<0.001	<0.01	<0.005	<0.10	<0.0002	<0.005	0.006	<0.004	**0.57**	561
RF8	Oct-01	<0.005	<0.050	0.009	<0.001	<0.01	<0.005	0.62	0.0000019*	<0.005	0.005	<0.004	**0.54**	629
RF8	Nov-01	<0.005	<0.050	<0.005	0.001	<0.01	<0.005	0.21	0.00000122*	<0.005	0.008	<0.005	**1.1**	511
RF8	Dec-01	<0.005	<0.050	<0.005	0.002	<0.01	<0.005	0.1	0.0000012*	<0.005	0.007	<0.004	**1.1**	506
RF8	Jan-02	<.005	<.050	<.005	0.001	<.010	<.005	<.10	<0.0002	<.005	0.007	<.004	**0.88**	462
RF8	Mar-02	<0.005	<0.050	<0.005	0.001	<0.010	<0.005	<0.10	0.0000009*	<0.005	0.006	<0.004	**1.1**	534
RF8	Apr-02	<0.005	<0.050	<0.005	0.002	<0.010	<0.005	<0.10	0.00000385*	<0.005	0.007	<0.004	**1**	502
RF8	May-02	<0.005	<0.050	<0.005	0.002	<0.010	<0.005	<0.10	<0.0002	<0.005	0.007	<0.004	**0.93**	498
RF8	Jun-02	<.005	<.050	<.005	<.001	<.010	<.005	<.10	<0.0002	<.005	<.005	<.004	**0.65**	494
RF8	Jul-02	<0.005	<0.050	0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	**0.12**	631
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0026*	*0.50*	*0.033*	*1.0*	*0.000012*	*0.0097*	*No Std.*	*0.005*	*0.305*	*354*
RF11	Apr-02	<0.005	<0.050	0.011	<0.001	<0.010	<0.005	0.2	<0.0002	<0.005	<0.005	<0.004	**0.25**	258
RF11	May-02	<0.005	<0.050	0.008	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	<0.005	<0.004	**0.31**	450
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0029*	*0.57*	*0.038*	*1.0*	*0.000012*	*0.0113*	*No Std.*	*0.005*	*0.348*	*413*
RF12	Apr-02	<0.005	<0.050	0.01	<0.001	<0.010	<0.005	0.2	<0.0002	<0.005	0.006	<0.004	**0.71**	341
RF12	May-02	<0.005	<0.050	0.008	<0.001	<0.010	<0.005	<0.10	<0.0002	<0.005	0.007	<0.004	**1.3**	485

Dissolved metals in mg/l (ppm)

[1] Screening standard is Chronic Aquatic Wildlife Criteria as adjusted for hardness (Utah Water Quality Standards, R317-2, Table 2.14.3a).

[2] Standard is based on trivalent species, although sample result is for all species.

[3] Screening standard is aquatic Wildlife Criteria, 1-hour average (Utah Water Quality Standards, R317-2, Table 2.14.2), detection limit slightly > standard.

[4] Screening standard is Aquatic Wildlife Criteria, 4-day average (Utah Water Quality Standards, R317-2, Table 2.14.2)

[5] Screening standard is Aquatic Wildlife Criteria, maximum (Utah Water Quality Standards, R317-2, Table 2.14.2)

* - Mercury analysis performed using EPA method 1631 with parts per trillion resolution.

Bold values exceed screening standard.

Table 4-4
Background Surface Water Data

Location	RF1	RF1	RF1	RF1	RF2	RF2	RF2	RF2	Minimum	Maximum	Average	Std. Dev.
Date	4/4/01	5/7/01	4/16/02	5/6/02	4/4/01	5/7/01	4/16/02	5/6/02				
AG	<0.005	<0.005	<0.005	<0.005	<0.005	<.005	<0.005	<0.005	<0.005	<0.005	<0.005	
AG(D)	<0.005	<0.005	<0.005	<0.005	<0.005	<.005	<0.005	<0.005	<0.005	<0.005	<0.005	
AS	<0.005	<.005	<0.005	<0.005	0.005	<.005	0.007	0.008	<0.005	0.008	NC	
AS(D)	<0.005	<.005	<0.005	<0.005	0.006	<.005	0.008	0.008	<0.005	0.008	NC	
CD	<0.001	<.001	<0.001	<.001	<0.001	<.001	<0.001	<.001	<0.001	<0.001	<0.001	
CD(D)	<0.001	<.001	<0.001	<.001	<0.001	<.001	<0.001	<.001	<0.001	<0.001	<0.001	
CR	<0.01	<.010	<0.01	<.010	<0.01	<.010	<0.01	<.010	<0.01	<0.01	<0.01	
CR(D)	<0.01	<.010	<0.01	<.010	<0.01	<.010	<0.01	<.010	<0.01	<0.01	<0.01	
HG	0.00000693*	0.00000198*	<0.0002	<0.0002	0.00028*	<0.0002	<0.0002	<0.0002	0.00000198*	0.00000693*	NC	
HG(D)	0.00000442*	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	0.00000442*	0.00000442*	NC	
PB	<0.005	0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	0.005	NC	
PB(D)	<0.005	0.007	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	0.007	NC	
SB	<0.005	<.005	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	0.006	NC	
SB(D)	<0.005	<.005	<0.005	<0.005	<0.005	0.01	<0.005	<0.005	<0.005	0.01	NC	
SE	<0.004	<.004	<0.004	<.004	<0.004	<.004	<0.004	<.004	<0.004	<0.004	<0.004	
SE(D)	<0.004	<.004	<0.004	<.004	<0.004	<.004	<0.004	<.004	<0.004	<0.004	<0.004	
ZN	0.034	0.053	0.046	0.022	0.03	0.094	0.058	0.049	0.022	0.094	0.048	0.022
ZN(D)	0.023	0.037	0.039	0.055	0.027	0.079	0.095	0.074	0.023	0.095	0.054	0.026

Units ppm
*RF-1 was analyzed using EPA method 1631 for parts per trillion dection limits.
1/2 of LRL used for non-detect values to calculate statistics
NC - not calculated

Table 4-5, Analytical Summary - Floodplain Tailings, Surface and Groundwater Data, Richardson Flat Remedial Investigation

(units ppm, unless specified)

Date	Sample #	AL	AL(D)	ALK.	AS	AS(D)	CA	CAT/AN BAL.	CD	CD(D)	CL-	CO3	COND	CR	CR(D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	MG	MN	MN(D)	NA	NH3/N	NO2/NO3	PB	PB(D)	SB	SB(D)	SE	SE(D)	SO4=	TDS	TSS	ZN	ZN(D)	S=
SURFACE WATER																																										
2-May-02	FPT-SW1	0.062	<0.050	142	<0.005	<0.005	140	<1	0.003	0.002	231	<1.0	1397			0.007	<0.005	0.31	<0.10	496	142	<0.0002	<0.0002	2.9	36	0.19	0.15	94	0.14	0.11	0.032	<0.005	0.008	0.007			257	889	3	0.75	0.65	
2-May-02	FPT-SW501	0.061	<0.050	139	<0.005	<0.005	139	2.1	0.003	0.002	237	<1.0	1396			0.008	<0.005	0.3	<0.10	493	139	<0.0002	<0.0002	2.7	36	0.18	0.15	92	<0.10	0.18	0.029	<0.005	0.007	0.007			269	894	3.3	0.73	0.67	
2-May-02	FPT-SW2	<0.050	<0.050	183	<0.005	<0.005	160	3.3	<0.001	<0.001	212	<1.0	1418			<0.005	<0.005	<0.10	<0.10	575	183	<0.0002	<0.0002	2.3	42	0.035	0.033	75	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005			233	897	<1.0	0.11	0.093	
2-May-02	FPT-SW3	<0.050	<0.050	148	<0.005	<0.005	150	4.1	0.003	0.002	225	<1.0	1448			<0.005	<0.005	0.16	<0.10	534	148	<0.0002	<0.0002	2.7	39	0.17	0.17	99	<0.10	0.16	0.012	<0.005	0.006	0.006			248	906	1.1	0.89	0.94	
2-May-02	FPT-SW4	<0.050	<0.050	184	<0.005	<0.005	168	1.3	<0.001	<0.001	243	<1.0	1465			<0.005	<0.005	<0.10	<0.10	597	184	<0.0002	<0.0002	2.5	43	0.058	0.054	76	0.12	<0.10	<0.005	<0.005	<0.005	<0.005			241	942	<1.0	0.1	0.094	
2-May-02	PH-SW1	0.39	<0.050	162	0.008	0.007	128	4.9	<0.001	<0.001	92	<1.0	1032			<0.005	<0.005	0.4	<0.10	471	162	<0.0002	<0.0002	2.1	37	0.053	0.019	37	0.12	0.79	0.022	<0.005	<0.005	<0.005			231	708	16	0.062	0.028	
FLOOD PLAIN TAILINGS GROUNDWATER																																										
2-May-02	FPT-7A	0.13	<0.050	484	0.79	0.78	688	4.6	0.064	0.06	632	<1.0	4100			0.076	0.021	20	18	2162	484	<0.0002	<0.0002	4.3	113	4.6	4.7	170	0.12	<0.10	0.7	0.009	0.069	0.05			1025	3250	59	23	23	<0.040
2-May-02	FPT-8A	0.29	<0.050	226	0.14	0.12	179	<1	0.004	0.002	274	<1.0	1595			0.039	<0.005	8	4.8	637	226	<0.0002	<0.0002	2.6	46	1.2	1	81	<0.10	<0.10	0.38	<0.005	0.033	0.019			262	1025	116	1.8	1.8	0.12
6-Aug-02	FPT-8A	<0.050	<0.050	283	0.36	0.28	286	1.9	0.002	0.001	555	<1.0	2440			0.007	<0.005	11	10	1028	283	<0.0002	<0.0002	2.6	76	1.1	1.2	106	<0.10	<0.10	0.067	<0.005	0.0555	0.05			208	1597	29	0.93	0.84	
2-May-02	FPT-2B	0.82	<0.050	172	0.036	0.029	277	4.6	0.055	0.055	226	<1.0	1948			0.041	0.027	2.8	1.7	908	172	<0.0002	<0.0002	3.7	52	1.4	1.4	67	0.13	<0.10	0.26	0.12	0.03	0.034			681	1506	29	18	18	0.059
2-May-02	FPT-4A	<0.050	<0.050	174	<0.005	0.005	159	<1	0.052	0.053	214	<1.0	1484			0.048	0.04	<0.10	<0.10	562	174	<0.0002	<0.0002	2.9	40	0.01	0.007	87	0.12	<0.10	0.091	0.069	0.026	0.027			285	962	3	4.8	4.7	<0.040
2-May-02	FPT-S4	0.5	<0.050	160	0.036	0.01	359	6.7	0.41	0.53	629	<1.0	3160			0.2	0.14	0.99	<0.10	1295	160	0.0002	<0.0002	4	97	0.41	0.21	165	0.16	0.31	1.4	0.23	0.083	0.026			847	2244	13	43	48	
6-May-02	FPT-S-5	0.91	<0.050	135	0.027	<0.005	450	<1	0.9	0.81	302	<1	2200	<0.010	<0.010	0.18	0.039	1.5	<0.1	1319	135	0.0068	<0.0002	11	47	0.44	0.54	70			0.85	0.1	0.057	0.025	<0.004	<0.004	885	1709	5.9	91	85	

Notes:
FPT-SW501 is a duplicate of RF-SW-FPT-SW1

Table 4-6
Screening of Floodplain Tailings Area, Surface and Groundwater Metal Concentrations

SURFACE WATER SCREENING

Location	Date	AL(D) [4]	AS(D) [2, 4]	CD(D) [1]	CU(D) [1]	FE(D) [5]	HG(D) [4]	PB(D) [1]	SB(D)	ZN(D) [1]	HARDNESS Std.=Average
Screening Std.		*0.087*	*0.19*	*0.0036*	*0.048*	*1.0*	*0.000012*	*0.0147*	*No Std.*	*0.433*	*536*
FPT-SW1	2-May-02	*<0.050*	*<0.005*	*0.002*	*<0.005*	*0.31*	*<0.0002*	*<0.005*	*0.007*	***0.65***	*498*
FPT-SW2	2-May-02	<0.050	<0.005	<0.001	<0.005	<0.10	<0.0002	<0.005	<0.005	0.093	575
FPT-SW3	2-May-02	<0.050	<0.005	0.002	<0.005	0.16	<0.0002	<0.005	0.006	**0.94**	534
FPT-SW4	2-May-02	<0.050	<0.005	<0.001	<0.005	<0.10	<0.0002	<0.005	<0.005	0.094	597
PH-SW1	2-May-02	<0.050	0.007	<0.001	<0.005	0.4	<0.0002	<0.005	<0.005	0.026	471

Dissolved metals in ppm
[1] Screening standard is Chronic Aquatic Wildlife Criteria as adjusted for hardness (Utah Water Quality Standards, R317-2, Table 2.14.3a).
[2] Standard is based on trivalent species, although sample result is for all species.
[3] Screening standard is aquatic Wildlife Criteria, 1-hour average (Utah Water Quality Standards, R317-2, Table 2.14.2), detection limit slightly > standard.
[4] Screening standard is Aquatic Wildlife Criteria, 4-day average (Utah Water Quality Standards, R317-2, Table 2.14.2)
[5] Screening standard is Aquatic Wildlife Criteria, maximum (Utah Water Quality Standards, R317-2, Table 2.14.2)
Bold values exceed screening standard.

GROUND WATER SCREENING

Location	Date	AL	AS	CD	CU	FE	HG	MN	PB	SB	ZN
Screening Std.		*0.05-0.2 [2]*	*0.05 [1]*	*0.005 [1]*	*1.3 [3]*	*0.3 [2]*	*0.002 [1]*	*0.05 [2]*	*0.015 [3]*	*0.006*	*5.0 [2]*
FPT-7A	2-May-02	0.13	**0.79**	**0.064**	0.076	**20**	<0.0002	**4.6**	**0.7**	**0.069**	**23**
FPT-8A	2-May-02	**0.29**	**0.14**	0.004	0.039	**8**	<0.0002	**1.2**	**0.38**	**0.033**	**1.8**
FPT-2B	2-May-02	**0.62**	0.036	**0.055**	0.041	**2.8**	<0.0002	**1.4**	**0.26**	**0.03**	**18**
FPT-4A	2-May-02	<0.050	<0.005	**0.052**	0.048	<0.10	<0.0002	0.01	**0.091**	**0.026**	**4.8**
FPT-S4	2-May-02	**0.5**	0.036	**0.41**	0.2	**0.99**	0.0002	**0.41**	**1.4**	**0.083**	**43**
FPT-S-5	6-May-02	**0.91**	0.027	**0.9**	0.18	**1.5**	**0.0066**	**0.44**	**0.85**	**0.057**	**91**

Total metals in ppm.
1 Primary Utah Ground Water Protection Standard (same as National Primary Drinking Water Standards)
2 Secondary National Drinking Water Standard
3 Action Level under Treatment Technique
Bold values exceed screening standard

Table 4-7, Analytical Summary - Groundwater Data, Richardson Flat Remedial Investigation

(units ppm, unless specified)

Date	Sample #	AG	AG(D)	AL	AL(D)	ALK.	AS	AS(D)	CA	CAT/AN BAL	CD	CD(D)	CL-	CO3	COND	CR	CR(D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	MG	MN	MN(D)	NA	NH3/N	NO2/NO3	P	PB	PB(D)	SB	SB(D)	SE	SE(D)	SO4=	TDS	TSS	ZN	ZN(D)	S=	B	S(D)
	RF-GW-RT11																																														
19-Jul-01	RF-GW-RT11	<.005	<.005	.062	<.050	203.	.005	<.005	185.	-3.8	.067	.086	354.	<1	1975.	<.010	<.010	.029	.026	<.10	.14	645.	203.	<0.0002	NA	2.1	45.	.11	.13	138.	<.10	<.1	<.1	.31	.24	.020	.019	.006	.006	345.	1282.	<1	7.1	7.0			
7-Aug-01	RF-GW-RT11	<.005	<.005	<.050	<.050	208	.008	.009	178.	-3.9	.075	.078	344.	<1	1912	<.010	<.010	<.005	<.005	<.1	<.1	622.	208	<0.0002	NA	<2.	43.	.13	.11	127.	<.1	<.10	<.1	.14	.13	.016	.016	<.004	<.004	302	1247.	<1.	6.6	6.6			
5-Sep-01	RF-GW-RT11	<0.005	<0.005	<0.050	<0.050	225.	0.007	0.009	165.	0.42	0.060	0.061	246.	<1.0	1665.	<0.010	<0.010	<0.005	<0.005	<0.10	<0.10	575.	225.	<0.0002	<0.0002	<2.0	39.	0.11	0.10	118.	<0.10	0.13	<0.10	0.089	0.083	0.016	0.016	<0.004	<0.004	279.	1092.	<1.0	6.0	5.9			
8-Oct-01	RF-GW-RT11	<0.005	<0.005	<0.050	<0.050	205.	0.007	0.008	180.	4.1	0.058	0.058	197.	<1.0	1546.	<0.010	<0.010	0.005	0.005	<0.050	<0.050	560.	205.	<0.0002	<0.0002	2.4	39.	0.10	0.095	113.	0.12	<0.10	<0.10	0.096	0.085	0.016	0.015	<0.004	<0.004	287.	998.	<1.0	5.9	5.8			
5-Nov-01	RF-GW-RT11	<0.005	<0.005	0.066	<0.050	242.	0.007	0.006	180.	-0.3	0.058	0.06	187.	<1.0	1486.	<0.010	<0.010	0.01	0.009	0.14	<0.10	564.	242.	<0.0002	<0.0002	2.1	40.	0.093	0.1	88.	<0.1	<0.1	<.10	0.1	0.079	0.015	0.016	<0.005	<0.005	289.	1006.	<1.0	6.	6.3			
3-Dec-01	RF-GW-RT-11	<.005	<.005	<.050	<.050	232.	<.005	<.005	200.	+1.9	.077	.077	262.	<1	1780.	<.010	<.010	.032	.027	.14	.10	705.	232.	<0.0002	<0.0002	<2.	50.	.10	.093	90.	<.10	<.1	<.1	.20	.18	.018	.017	<.004	<.004	295.	1183.	<1.	7.1	7.2			
7-Jan-02	RF-GW-RT11	<.005	<.005	<.050	<.050	230	<.005	0.005	263	-1.6	0.1	0.11	473	<1	2220	<.010	<.010	0.044	0.045	<.10	<.10	929	230	<0.0002	<0.0002	2.3	66	0.09	0.09	118	0.11	<.10	<.1	0.4	0.39	0.019	0.019	0.005	<.004	356	1471	<1.	9	9.2			
4-Feb-02	RF-GW-RT-11	<0.005	<0.005	0.075	<0.050	230	<0.005	0.008	243	0.54	0.097	0.094	440	<1.0	2230	<0.010	<0.010	0.04	0.033	<0.10	<0.10	858	230	<0.0002	<0.0002	2.2	61	0.084	0.077	124	<0.10	<0.10 (a)	<0.10	0.39	0.35	0.018	0.017	0.005	0.005	320	1483	<1.0	8.4	8.3			
5-Mar-02	RF-GW-RT-11	<0.005	<0.005	<0.050	<0.050	221	<0.005	0.007	214	-6.5	0.077	0.084	378	<1.0	2050	<0.010	<0.010	0.025	0.021	<0.10	<0.10	756	221	<0.0002	<0.0002	<2.0	54	0.057	0.054	115	<0.10	<0.10	<0.10	0.28	0.3	0.014	0.015	<0.004	0.004	392	1422	<1.0	7.6	7.9			
1-Apr-02	RF-GW-RT11	<0.005	<0.005	<0.050	<0.050	207.	<0.005	0.006	293	2.3	0.13	0.13	504.	<1.0	2520.	<0.010	<0.010	0.035	0.030	<0.10	<0.10	1035.	207.	<0.0002	<0.0002	2.4	74.	0.055	0.053	139.	<0.10	0.19	<0.10	0.33	0.34	0.016	0.017	<0.004	<0.004	385.	1740.	<1.0	10.	10.			
2-May-02	RF-GW-RT11	<0.005	<0.005	<0.050	<0.050	176	<0.005	0.007	294	3.3	0.14	0.14	667	<1.0	2960	<0.010	<0.010	0.024	0.023	<0.10	<0.10	1036	176	<0.0002	<0.0002	2.6	73	0.051	0.048	200	0.17	0.36	<0.10	0.39	0.34	0.017	0.017	<0.004	0.006	468	1891	1.6	10	10	<0.040	<0.10	<0.10
3-Jun-02	RF-GW-RT-11	<.005	<.005	0.096	<.050	197	0.008	0.008	246	<1.0	0.12	0.1	540	<1.0	2640	<.010	<.010	0.023	0.022	<.10	<.10	865	197	<0.0002	<0.0002	<2.0	61	0.044	0.037	199	<.10	0.1	<.10	0.38	0.34	0.018	0.019	0.004	<.004	379	1771	<1.0	8.6	8.2			
9-Jul-02	RF-GW-RT11	<0.005	<0.005	0.63	0.052	212	0.008	0.008	202	<1	0.071	0.061	408	<1.0	2210	<0.010	<0.010	0.017	0.015	0.42	<0.10	699	212	<0.0002	<0.0002	3.3	48	0.039	0.037	156	<0.10	<0.10	<0.10	0.29	0.27	0.015	0.017	<0.004	<0.004	301	1484	<1.0	4.8	5.6			
6-Aug-02	RF-GW-RT-11	<0.005	<0.005	<0.050	<0.050	211.	0.007	0.010	211.	3.3	0.074	0.077	442.	<1.0	2240.	<0.010	<0.010	0.007	0.006	<0.10	<0.10	735.	211.	<0.0002	<0.0002	2.2	50.	0.056	0.053	162.	<0.10	<0.10	<0.10	0.19	0.18	0.015	0.014	<0.004	<0.004	350.	1415.	<1.0	6.2	6.3			
	RF-GW-RT12																																														
19-Jul-01	RF-GW-RT12	<.005	<.005	.19	<.050	206.	.024	.008	120.	-5.9	.010	.013	136.	<1	1180.	<.010	<.010	<.005	<.005	.51	<.10	415.	206.	0.00052	NA	2.1	28.	3.1	2.8	61.	.23	<.1	<.1	.037	.018	.014	.021	<.004	<.004	248.	805.	52.	8.4	7.3			
7-Aug-01	RF-GW-RT12	<.005	<.005	.62	<.050	202	.037	.025	137.	-.74	.037	.036	129.	<1	1218.	<.010	<.010	.011	<.005	1.3	.35	480.	202	<0.0002	NA	2.1	34.	3.0	2.9	53.	.26	.14	<.1	.076	.019	.041	.028	<.004	<.004	253.	820.	37.6	9.4	9.4			
5-Sep-01	RF-GW-RT12	<0.005	<0.005	2.5	<0.050	280.	0.020	0.011	134.	2.0	0.059	0.056	100.	<1.0	1201.	<0.010	<0.010	0.049	0.008	3.4	<0.1	501.	280.	0.012	<0.0002	2.2	35.	2.1	2.0	50.	0.11	0.36	<0.10	0.39	0.060	0.049	0.037	<0.004	<0.004	194.	787.	22.	9.2	8.6			
8-Oct-01	RF-GW-RT12	<0.005	<0.005	0.56	<0.050	253.	0.017	0.012	145.	5.3	0.048	0.051	90.	<1.0	1152.	<0.010	<0.010	0.018	0.012	0.65	<0.050	510.	253.	0.0015	<0.0002	2.4	38.	1.0	0.81	45.	<0.10	0.22	0.14	0.062	0.020	0.026	0.026	<0.004	<0.004	206.	754.	72.	8.3	7.9			
5-Nov-01	RF-GW-RT12	<0.005	<0.005	0.38	<0.050	247	0.008	0.007	178	-2.4	0.06	0.061	105	<1.0	1349	<0.010	<0.010	0.014	0.009	0.56	<0.10	619	247	0.0013	0.00022	2.5	42	2.3	2.4	49	<0.1	<0.1	<.10	0.048	0.012	0.017	0.016	<0.005	<0.005	396	992	30	10	11			
3-Dec-01	RF-GW-RT-12	<.005	<.005	.14	<.050	217.	<.005	<.005	230.	+1.6	.063	.061	108.	<1	1560	<.010	<.010	.037	.011	1.0	.86	768.	217.	0.001	0.0006	<2.	47.	2.1	2.3	51.	.13	.11	<.1	.034	.008	.012	.011	<.004	<.004	497.	1157.	3.1	14.	14.			
7-Jan-02	RF-GW-RT12	<.005	<.005	0.16	<.050	216	0.009	0.008	254	4	0.037	0.038	149	<1	1724	<.010	<.010	0.013	0.009	10	8.5	832	216	0.0073	0.0054	2.4	48	8.2	8.2	55	0.11	<.10	<.1	0.055	<.005	0.008	0.006	<.004	<.004	490	1339	29	16	16			
4-Feb-02	RF-GW-RT-12	<0.005	<0.005	0.059	<0.050	225	0.015	0.014	201	3.8	0.012	0.012	105	<1.0	1483	<0.010	<0.010	0.006	<0.005	12	9.8	667	225	0.0017	0.00078	2.2	40	6	5.7	51	<0.10	<0.10	<0.10	0.019	<0.005	<0.005	<0.005	<0.004	<0.004	394	1105	19	10	10			
5-Mar-02	RF-GW-RT-12	<0.005	<0.005	0.05	<0.050	240	0.018	0.022	192	-2.3	0.007	0.007	116	<1.0	1440	<0.010	<0.010	0.007	<0.005	10	8.7	633	240	0.0018	0.00078	<2.0	37	4.6	4.2	49	<0.10	<0.10	<0.10	0.014	<0.005	<0.005	<0.005	<0.004	<0.004	414	1067	23	8.9	9.1			
1-Apr-02	RF-GW-RT12	<0.005	<0.005	<0.050	<0.050	98.	<0.005	0.007	395.	5.3	0.075	0.073	242.	<1.0	2470.	<0.010	<0.010	0.008	0.007	14.	13.	1268.	98.	0.0017	0.00094	2.9	68.	5.3	5.0	100.	<0.10	0.42	<0.10	0.008	<0.005	<0.005	<0.005	0.005	0.009	900.	2095.	22.	22.	22.			
2-May-02	RF-GW-RT12	<0.005	<0.005	<0.050	<0.050	89	0.022	0.018	300	<1	0.02	0.02	255	<1.0	2130	<0.010	<0.010	0.012	0.009	19	17	954	89	0.0004	0.0002	3	50	4.9	5.1	109	0.16	<0.10	<0.10	0.019	<0.005	<0.005	<0.005	<0.004	<0.004	765	1626	37	9.2	9.2	<0.040	<0.10	<0.10
3-Jun-02	RF-GW-RT-12	<.005	<.005	0.11	<.050	159	0.036	0.014	234	3.4	0.019	0.013	175	<1.0	1729	<.010	<.010	<.005	<.005	13	9.5	736	159	0.0026	0.0017	<2.0	37	4.2	4.2	84	<.10	<.10	<.10	0.012	<.005	0.007	<.005	<.004	<.004	600	1296	26	8.1	7.6			
9-Jul-02	RF-GW-RT12	<0.005	<0.005	<0.050	<0.050	255	0.008	<0.005	171	<1	0.009	0.011	113	<1.0	1276	<0.010	<0.010	0.009	0.008	1.6	<0.10	555	255	0.0003	<0.0002	<2.0	31	2.8	2.8	49	<0.10	0.13	0.13	0.011	<0.005	<0.005	<0.005	<0.004	<0.004	283	925	1.7	5.7	6.8			
6-Aug-02	RF-GW-RT-12	<0.005	<0.005	<0.050	<0.050	243.	<0.005	<0.005	158.	<1	0.009	0.009	101.	<1.0	1182.	<0.010	<0.010	0.007	0.005	0.50	<0.10	506.	243.	<0.0002	<0.0002	2.3	27.	1.6	1.6	48.	<0.10	0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	265.	800.	<1.0	6.2	6.4			

Table 4-7, Analytical Summary - Groundwater Data, Richardson Flat Remedial Investigation

(units ppm, unless specified)

Date	Sample #	AG	AG(D)	AL	AL(D)	ALK	AS	AS(D)	CA	CAT/AN BAL	CD	CD(D)	CL-	CO3	COND	CR	CR(D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	MG	MN	MN(D)	NA	NH3/N	NO2/NO3	P	PB	PB(D)	SB	SB(D)	SE	SE(D)	SO4=	TDS	TSS	ZN	ZN(D)	S=	B	B(D)
	RF-GW-RT13																																														
19-Jul-01	RF-GW-RT13	<.005	<.005	<.050	.073	292.	<.005	<.005	278.	+.04	<.001	<.001	71.	<1	1678.	<.010	<.010	<.005	<.005	<.10	<.10	926.	292.	<0.0002	NA	<2.	56.	2.5	2.5	25.	<.10	.23	<.1	<.005	.012	<.005	<.005	<.004	<.004	613.	1410.	<1	.014	.018			
7-Aug-01	RF-GW-RT13	<.005	<.005	<.050	<.050	289	<.005	<.005	270.	+2.4	<.001	<.001	56.	<1	1692.	<.010	<.010	<.005	<.005	<.1	<.1	903.	289	<0.0002	NA	<2.	56.	2.6	2.4	25.	<.1	.35	<.1	<.005	<.005	<.005	<.005	<.004	<.004	573.	1316.	1.	<.01	<.01			
5-Sep-01	RF-GW-RT13	<0.005	<0.005	0.097	<0.050	295.	<0.005	<0.005	267.	1.9	<0.001	<0.001	58.	<1.0	1610.	<0.010	<0.010	<0.005	<0.005	<0.10	<0.10	897.	295.	<0.0002	<0.0002	<2.0	56.	2.9	3.1	26.	0.12	0.38	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	570.	1302.	1.2	0.024	0.016			
8-Oct-01	RF-GW-RT13	<0.005	<0.005	<0.050	<0.050	326.	<0.005	<0.005	291.	5.9	<0.001	<0.001	46.	<1.0	1698.	<0.010	<0.010	<0.005	<0.005	<0.050	<0.050	972.	328.	<0.0002	<0.0002	<2.0	60.	3.2	3.1	26.	<0.10	0.61	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	557.	1343.	<1.0	0.018	0.021			
5-Nov-01	RF-GW-RT13	<0.005	<0.005	0.088	<0.050	315	<0.005	<0.005	309	4.9	<0.001	<0.001	60	<1.0	1755	<0.010	<0.010	<0.005	<0.005	<0.10	<0.10	1043	315	<0.0002	<0.0002	<2.0	66	3.1	3.3	29	<0.1	0.98	<.10	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	633	1452	<1.0	<0.01	<0.01			
3-Dec-01	RF-GW-RT13	<.005	<.005	<.050	<.050	317.	<.005	<.005	310.	+3.3	<.001	<.001	71.	<1	1804.	<.010	<.010	<.005	<.005	<.10	<.10	1051.	317.	<0.0002	<0.0002	<2.	67.	3.0	3.1	26.	<.10	1.4	<.1	<.005	<.005	<.005	<.005	<.004	.004	647.	1464.	<1.	.018	<.010			
7-Jan-02	RF-GW-RT13	<.005	<.005	<.050	<.050	394	<.005	<.005	313	8.6	<.001	<.001	51	<1	1717	<.010	<.010	<.005	<.005	0.11	<.10	1076	394	<0.0002	<0.0002	<2.0	72	2.5	2.8	26	0.12	1.3	<.1	<.005	<.005	<.005	<.005	0.022	0.024	536	1449	<1.	0.012	<.010			
4-Feb-02	RF-GW-RT-13	<0.005	<0.005	<0.050	<0.050	310	<0.005	<0.005	289	1.1	<0.001	<0.001	68	<1.0	1643	<0.010	<0.010	<0.005	<0.005	<0.10	<0.10	902	310	<0.0002	<0.0002	<2.0	58	1.9	2	25	<0.10	1.2	<0.10	<0.005	<0.005	<0.005	<0.005	0.009	0.013	561	1306	<1.0	<0.010	<0.010			
5-Mar-02	RF-GW-RT-13	<0.005	<0.005	<0.050	<0.050	317	<0.005	<0.005	256	-1.8	<0.001	<0.001	69	<1.0	1638	<0.010	<0.010	<0.005	<0.005	<0.10	<0.10	861	317	<0.0002	<0.0002	<2.0	54	1.8	1.9	23	<0.10	0.22	<0.10	<0.005	<0.005	<0.005	<0.005	0.008	0.01	564	1331	<1.0	<0.010	<0.010			
1-Apr-02	RF-GW-RT13	<0.005	<0.005	<0.050	<0.050	324.	<0.005	<0.005	293.	7.8	<0.001	<0.001	64.	<1.0	1654.	<0.010	<0.010	<0.005	<0.005	0.15	<0.10	984.	324.	<0.0002	<0.0002	<2.0	61.	2.2	2.1	24.	<0.10	1.2	<0.10	<0.005	<0.005	<0.005	<0.005	0.008	0.012	507.	1341.	<1.0	0.012	<0.010			
6-May-02	RF-GW-RT 13	<0.005	<0.005	0.078	<0.050	296	<0.005	<0.005	380	4.7	<0.001	<0.001	65	<1.0	2050	<0.010	<0.010	<0.005	<0.005	0.13	<0.10	1301	296	<0.0002	<0.0002	<2.0	60	3.7	3.4	26	<0.10	2.8	<0.10	<0.005	<0.005	<0.005	<0.005	0.012	0.014	1110	1794	1.4	0.039	0.037	<0.040		
3-Jun-02	RF-GW-RT-13	<.005	<.005	0.057	<.050	315	<.005	<.005	316	2.8	0.002	<.001	49	<1.0	1825	<.010	<.010	<.005	<.005	<.10	<.10	1057	315	<0.0002	<0.0002	<2.0	65	2.9	2.7	22	<.10	1.3	<.10	<.005	<.005	<.005	<.005	0.007	<.004	807	1516	<1.0	0.01	0.013			
9-Jul-02	RF-GW-RT13	<0.005	<0.005	0.12	0.068	320	<0.005	<0.005	294	1.3	<0.001	<0.001	63	<1.0	1830	<0.010	<0.010	0.006	<0.005	<0.10	<0.10	1001	320	<0.0002	<0.0002	<2.0	65	3.1	2.8	26	<0.10	1	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	0.006	705	1557	<1.0	0.011	0.01			
	RF-GW-RT14																																														
19-Jul-01	RF-GW-RT14	<.005	<.005	<.050	<.050	246.	<.005	<.005	215.	-.47	<.001	<.001	67.	<1	1482.	<.010	<.010	<.005	<.005	.45	.37	731.	246.	<0.0002	NA	<2.	47.	7.4	7.4	35.	<.10	<.1	<.1	<.005	<.005	<.005	<.005	<.004	<.004	497.	1206.	<1	.014	.015			
7-Aug-01	RF-GW-RT14	<.005	<.005	<.050	<.050	238	<.005	<.005	221.	-3.0	<.001	<.001	53.	<1	1540.	<.010	<.010	<.005	<.005	1.1	.67	754.	238	<0.0002	NA	<2.	49.	8.5	7.8	36.	.17	.10	<.1	<.005	<.005	<.005	<.005	<.004	<.004	550.	1217.	3.7	.010	<.01			
5-Sep-01	RF-GW-RT14	<0.005	<0.005	<0.050	<0.050	245.	<0.005	0.006	232.	-4.5	<0.001	<0.001	68.	<1.0	1570.	<0.010	<0.010	<0.005	<0.005	1.3	1.9	794.	245.	<0.0002	<0.0002	<2.0	52.	9.3	9.5	34.	0.11	0.15	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	628.	1271.	4.5	0.012	<0.010			
8-Oct-01	RF-GW-RT14	<0.005	<0.005	0.1	<0.050	247	<0.005	<0.005	244	1.6	<0.001	<0.001	76	<1.0	1538	<0.010	<0.010	<0.005	<0.005	2	1.5	833	247	<0.0002	<0.0002	<2.0	56	8.7	8.7	36	<0.1	<0.1	<.10	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	556	1239	4.2	<0.01	<0.01			
5-Nov-01	RF-GW-RT14	<0.005	<0.005	0.063	<0.050	260	<0.005	<0.005	230	1.2	<0.001	<0.001	79	<1.0	1553	<0.010	<0.010	<0.005	<0.005	1.1	0.8	805	260	<0.0002	<0.0002	<2.0	56	8.9	7.9	31	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	548	1228	2.4	0.017	0.01			
3-Dec-01	RF-GW-RT14	<.005	<.005	<.050	<.050	251.	<.005	<.005	239.	+5.5	<.001	<.001	70.	<1	1552.	<.010	<.010	<.005	<.005	1.4	1.0	820.	251.	<0.0002	<0.0002	2.1	54	9.0	8.5	31.	.29	<.1	<.1	<.005	<.005	<.005	<.005	<.004	<.004	474.	1195.	1.9	1.9	<.010			
7-Jan-02	RF-GW-RT14	<.005	<.005	<.050	<.050	260	<.005	<.005	250	4.8	<.001	<.001	52	16	1585	<.010	<.010	<.005	<.005	1.7	1.2	872	244	<0.0002	<0.0002	<2.0	60	10	9.1	31	0.1	<.10	<.1	<.005	<.005	<.005	<.005	<.004	<.004	533	1282	3.7	<.010	<.010			
5-Mar-02	RF-GW-RT-14	<0.005	<0.005	0.052	<0.050	262	<0.005	<0.005	213	-0.9	<0.001	<0.001	79	<1.0	1508	<0.010	<0.010	<0.005	<0.005	0.8	0.59	752	262	<0.0002	<0.0002	<2.0	53	8	7.6	30	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	485	1202	1.3	0.011	<0.010			
1-Apr-02	RF-GW-RT14	<0.005	<0.005	0.13	<0.050	254.	<0.005	<0.005	259.	6.4	<0.001	<0.001	67.	<1.0	1621.	0.014	<0.010	<0.005	<0.005	0.72	0.30	910.	254.	<0.0002	<0.0002	<2.0	64.	8.3	8.0	33.	<0.10	0.21	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	506.	1291.	2.4	0.43	0.33			
6-May-02	RF-GW-RT 14	<0.005	<0.005	0.072	<0.050	270	<0.005	<0.005	278	5.7	0.002	0.001	74	<1.0	1679	<0.010	<0.010	<0.005	<0.005	0.29	0.1	942	270	<0.0002	<0.0002	<2.0	60	6.8	7.1	35	<0.10	<0.10	<0.10	<0.005	<0.005	0.008	<0.005	<0.004	<0.004	559	1340	2.1	6.9	4.3	<0.040		
3-Jun-02	RF-GW-RT-14	<.005	<.005	<.050	<.050	270	<.005	<.005	267	3	<.001	<.001	83	<1.0	1723	<.010	<.010	<.005	<.005	0.17	0.11	906	270	<0.0002	<0.0002	<2.0	58	7.7	7.5	39	<.10	<.10	<.10	<.005	<.005	<.005	<.005	<.004	<.004	683	1378	<1.0	2	1.4			
9-Jul-02	RF-GW-RT14	<0.005	<0.005	<0.050	<0.050	267	<0.005	<0.005	286	<1	<0.001	<0.001	95	<1.0	1713	<0.010	<0.010	<0.005	<0.005	0.23	0.16	967	267	<0.0002	<0.0002	<2.0	62	7.8	8.3	41	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	674	1360	<1.0	0.38	0.42			
	RF-GW-RT15																																														
1-Apr-02	RF-GW-RT15	<0.005	<0.005	0.054	<0.050	141.	<0.005	<0.005	483.	<1.0	0.12	0.12	6.3	<1.0	2660.	<0.010	<0.010	0.009	0.010	<0.10	<0.10	1688.	141.	<0.0002	<0.0002	4.6	117.	2.4	2.3	23.	<0.10	3.4	<0.10	0.023	0.022	<0.005	0.006	<0.004	0.007	1524.	2717.	1.0	24.	23.			
6-May-02	RF-GW-RT 15	<0.005	<0.005	0.66	<0.050	147	<0.005	<0.005	465	3	0.064	0.062	5.5	<1.0	2240	<0.010	<0.010	0.02	0.011	0.61	<0.10	1600	147	<0.0002	<0.0002	2.5	107	6.8	3.6	19	<0.10	3.9	<0.10	0.079	0.043	0.013	0.009	<0.004	<0.004	1553	2147	6.5	22	16	<0.040		

Table 4-8
Screening of Total Metal Concentrations in Ground Water

Location	Date	AG	AL	AS	CD	CR	CU	FE	HG	MN	PB	SB	SE	ZN
Screening Std.		0.1 [2]	0.05-0.2 [2]	0.05 [1]	0.005 [1]	0.1 [1]	1.3 [3]	0.3 [2]	0.002 [1]	0.05 [2]	0.015 [3]	0.006	0.05 [1]	5.0 [2]
RT-7	Feb-02	<0.005	NA	0.028	0.001	<0.010	0.015	7.7	<0.0002	2.1	0.076	**0.009**	<0.005	0.17
RT-9	Feb-02	<0.005	NA	**0.086**	0.003	**0.29**	0.22	**136**	<0.0002	**9**	**0.4**	**0.21**	<0.005	0.79
RT11	Jul-01	<0.005	0.062	0.006	**0.087**	<0.010	0.029	<0.10	<0.0002	**0.11**	**0.31**	**0.02**	0.006	7.1
RT11	Aug-01	<0.005	<0.050	0.008	**0.075**	<0.010	<0.005	<0.10	<0.0002	**0.13**	**0.14**	**0.016**	<0.004	**6.6**
RT11	Sep-01	<0.005	<0.050	0.007	**0.06**	<0.010	<0.005	<0.10	<0.0002	**0.11**	**0.069**	**0.016**	<0.004	**6**
RT11	Oct-01	<0.005	<0.050	0.007	**0.058**	<0.010	0.005	<0.050	<0.0002	**0.1**	**0.096**	**0.016**	<0.004	**5.9**
RT11	Nov-01	<0.005	0.066	0.007	**0.058**	<0.010	0.01	0.14	<0.0002	**0.093**	**0.1**	**0.015**	<0.005	**6**
RT11	Dec-01	<0.005	<0.050	<0.005	**0.077**	<0.010	0.032	0.14	<0.0002	**0.1**	**0.2**	**0.018**	<0.004	**7.1**
RT11	Jan-02	<.005	<.050	<.005	**0.1**	<.010	0.044	<.10	<0.0002	**0.09**	**0.4**	0.019	0.005	**9**
RT11	Feb-02	<0.005	0.075	<0.005	**0.097**	<0.010	0.04	<0.10	<0.0002	**0.084**	**0.39**	**0.018**	0.005	**8.4**
RT11	Mar-02	<0.005	<0.050	<0.005	**0.077**	<0.010	0.025	<0.10	<0.0002	**0.057**	**0.28**	**0.014**	<0.004	**7.6**
RT11	Apr-02	<0.005	<0.050	<0.005	**0.13**	<0.010	0.035	<0.10	<0.0002	**0.055**	**0.33**	**0.016**	<0.004	**10**
RT11	May-02	<0.005	<0.050	<0.005	**0.14**	<0.010	0.024	<0.10	<0.0002	**0.051**	**0.39**	**0.017**	<0.004	**10**
RT11	Jun-02	<.005	0.098	0.008	**0.12**	<.010	0.023	<.10	<0.0002	0.044	**0.38**	**0.018**	0.004	**8.6**
RT11	Jul-02	<0.005	**0.63**	0.006	**0.071**	<0.010	0.017	**0.42**	<0.0002	0.039	**0.29**	**0.015**	<0.004	**4.8**
RT11	Aug-02	<0.005	<0.050	0.007	**0.074**	<0.010	0.007	<0.10	<0.0002	**0.056**	**0.19**	**0.015**	<0.004	**6.2**
RT12	Jul-01	<0.005	0.19	0.024	**0.01**	<0.010	<0.005	**0.51**	0.00052	**3.1**	**0.037**	**0.014**	<0.004	**8.4**
RT12	Aug-01	<0.005	0.62	0.037	**0.037**	<0.010	0.011	**1.3**	<0.0002	**3**	**0.076**	**0.041**	<0.004	**9.4**
RT12	Sep-01	<0.005	2.5	0.02	**0.059**	<0.010	0.049	**3.4**	**0.012**	**2.1**	**0.39**	**0.049**	<0.004	**9.2**
RT12	Oct-01	<0.005	0.58	0.017	**0.048**	<0.010	0.018	**0.65**	0.0015	**1**	**0.082**	**0.026**	<0.004	**8.3**
RT12	Nov-01	<0.005	0.38	0.008	**0.06**	<0.010	0.014	**0.58**	0.0013	**2.3**	**0.046**	**0.017**	<0.005	**10**
RT12	Dec-01	<0.005	0.14	<0.005	**0.063**	<0.010	0.037	**1**	0.001	**2.1**	**0.034**	**0.012**	<0.004	**14**
RT12	Jan-02	<.005	0.16	0.009	**0.037**	<.010	0.013	**10**	**0.0073**	**8.2**	**0.055**	**0.008**	<.004	**16**
RT12	Feb-02	<0.005	0.059	0.015	**0.012**	<0.010	0.008	**12**	0.0017	**6**	**0.019**	<0.005	<0.004	**10**
RT12	Mar-02	<0.005	0.05	0.018	**0.007**	<0.010	0.007	**10**	0.0018	**4.6**	0.014	<0.005	<0.004	**8.9**
RT12	Apr-02	<0.005	<0.050	<0.005	**0.075**	<0.010	0.008	**14**	0.0017	**5.3**	0.006	<0.005	0.005	**22**
RT12	May-02	<0.005	<0.050	0.022	**0.02**	<0.010	0.012	**19**	0.0004	**4.9**	**0.019**	<0.005	<0.004	**9.2**
RT12	Jun-02	<.005	0.11	0.036	**0.019**	<.010	<.005	**13**	**0.0026**	**4.2**	0.012	**0.007**	<.004	**8.1**
RT12	Jul-02	<0.005	<0.050	0.008	**0.009**	<0.010	0.009	**1.6**	0.0003	**2.8**	0.011	<0.005	<0.004	**5.7**
RT12	Aug-02	<0.005	<0.050	<0.005	**0.009**	<0.010	0.007	**0.5**	<0.0002	**1.6**	<0.005	<0.005	<0.004	**6.2**
RT13	Jul-01	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	**2.5**	<0.005	<0.005	<0.004	0.014
RT13	Aug-01	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	**2.6**	<0.005	<0.005	<0.004	<0.01
RT13	Sep-01	<0.005	0.097	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	**2.9**	<0.005	<0.005	<0.004	0.024
RT13	Oct-01	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.050	<0.0002	**3.2**	<0.005	<0.005	<0.004	0.018
RT13	Nov-01	<0.005	0.088	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	**3.1**	<0.005	<0.005	<0.005	<0.01
RT13	Dec-01	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	**3**	<0.005	<0.005	<0.004	0.018
RT13	Jan-02	<.005	<.050	<.005	<.001	<.010	<.005	0.11	<0.0002	**2.5**	<.005	<.005	0.022	0.012
RT13	Feb-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	**1.9**	<0.005	<0.005	0.009	<0.010
RT13	Mar-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.0002	**1.8**	<0.005	<0.005	0.006	<0.010
RT13	Apr-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	0.15	<0.0002	**2.2**	<0.005	<0.005	0.008	0.012
RT13	May-02	<0.005	0.076	<0.005	<0.001	<0.010	<0.005	0.13	<0.0002	**3.7**	<0.005	<0.005	0.012	0.039
RT13	Jun-02	<.005	0.057	<.005	0.002	<.010	<.005	<.10	<0.0002	**2.9**	<.005	<.005	0.007	0.01
RT13	Jul-02	<0.005	0.12	<0.005	<0.001	<0.010	0.006	<0.10	<0.0002	**3.1**	<0.005	<0.005	<0.004	0.011
RT14	Jul-01	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	**0.45**	<0.0002	**7.4**	<0.005	<0.005	<0.004	0.014
RT14	Aug-01	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	**1.1**	<0.0002	**8.5**	<0.005	<0.005	<0.004	0.01
RT14	Sep-01	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	**1.3**	<0.0002	**9.3**	<0.005	<0.005	<0.004	0.012
RT14	Oct-01	<0.005	<0.050	0.005	<0.001	<0.010	<0.005	**2.7**	<0.0002	**9.9**	<0.005	<0.005	<0.004	0.013
RT14	Nov-01	<0.005	0.1	<0.005	<0.001	<0.010	<0.005	**2**	<0.0002	**8.7**	<0.005	<0.005	<0.005	<0.01
RT14	Dec-01	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	**1.4**	<0.0002	**9**	<0.005	<0.005	<0.004	1.9
RT14	Jan-02	<.005	<.050	<.005	<.001	<.010	<.005	**1.7**	<0.0002	**10**	<.005	<.005	<.004	<.010
RT14	Feb-02	<0.005	0.063	<0.005	<0.001	<0.010	<0.005	**1.1**	<0.0002	**8.9**	<0.005	<0.005	<0.004	0.017
RT14	Mar-02	<0.005	0.052	<0.005	<0.001	<0.010	<0.005	**0.8**	<0.0002	**8**	<0.005	<0.005	<0.004	0.011
RT14	Apr-02	<0.005	0.13	<0.005	<0.001	0.014	<0.005	**0.72**	<0.0002	**8.3**	<0.005	<0.005	<0.004	0.43
RT14	May-02	<0.005	0.072	<0.005	0.002	<0.010	<0.005	**0.29**	<0.0002	**6.6**	<0.005	0.006	<0.004	**6.9**
RT14	Jun-02	<.005	<.050	<.005	<.001	<.010	<.005	0.17	<0.0002	**7.7**	<.005	<.005	<.004	2
RT14	Jul-02	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	0.23	<0.0002	**7.8**	<0.005	<0.005	<0.004	0.38
RT15	Apr-02	<0.005	0.054	<0.005	**0.12**	<0.010	0.009	<0.10	<0.0002	**2.4**	0.023	<0.005	<0.004	**24**
RT15	May-02	<0.005	**0.86**	<0.005	**0.084**	<0.010	0.02	**0.61**	<0.0002	**6.8**	0.079	**0.013**	<0.004	**22**

Total metals in ppm.
1 Primary Utah Ground Water Protection Standard (same as National Primary Drinking Water Standards)
2 Secondary National Drinking Water Standard
3 Action Level under Treatment Technique
Bold values exceed screening standard
NA- Not analyzed

TABLE 4-9
RICHARDSON FLAT SOIL DATA, ONSITE SOILS COVER

all units ppm, except moisture (%)

	Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN	COMMENTS
L010670-025	5/9/01	RF-ON-1A 0-2"			15								37				
L010670-029	5/9/01	RF-ON-1B 0-2"			9.1								44				
L010670-018	5/9/01	RF-ON-1C 0-2"			12								163				
L010670-046	5/9/01	RF-ON-1D 0-2"			10								96				
L010670-011	5/9/01	RF-ON-1E 0-2"			20								336				
L010670-009	5/8/01	RF-ON-1G 0-2"			121								3239				
L010670-026	5/9/01	RF-ON-2A 0-2"			13								49				
L010670-030	5/9/01	RF-ON-2B 0-2"			78								1155				
L010670-019	5/9/01	RF-ON-2C 0-2"			7.8								19				
L010670-047	5/9/01	RF-ON-2D 0-2"			6.4								19				
L010670-067	5/10/01	RF-ON-2D50 0-2"			7.2								20				DUP RF-ON-2D 0-2"
L010670-012	5/9/01	RF-ON-2E 0-2"			32								636				
L010670-013	5/8/01	RF-ON-2E50 0-2"			56								1173				DUP RF-ON-2E 0-2"
L010670-006	5/8/01	RF-ON-2F 0-2"			82								2646				
L010670-001	5/8/01	RF-ON-2G 0-2"			12								59				
L010671-001	5/8/01	RF-ON-2H 0-2"	<5.		<5.	208.	<0.5	23.	14.		<.10		17.		<5.	64.	
L010672-008	05/08/01	RF-ON-2H 6-8"	<5.	22600.	6.		1.	22.	18.	24400.	<.10	20	43.	<5.	<5.	148.	
L010671-014	5/8/01	RF-ON-2H50 0-2"	<5.		<5.	204.	<0.5	22.	13.		<.10		16.		<5.	62.	DUP RF-ON-2H 0-2"
L010671-011	5/8/01	RF-ON-3A 0-2"	<5.		49.	210.	6.	24.	99.		.70		875.		<5.	1010.	
L010670-016	5/9/01	RF-ON-3B 0-2"			50								851				
L010672-006	05/09/01	RF-ON-3B 10-12"	<5.	22400.	22.		1.	20.	53.	27900.	.16	23	206.	<5.	<5.	242.	
L010670-044	5/9/01	RF-ON-3C 0-2"			6.2								15				
L010671-020	5/9/01	RF-ON-3D 0-2"	<5.		46.	255.	3.	24.	81.		.44		515.		<5.	651.	
L010672-003	05/09/01	RF-ON-3D 15-17"	<5.	17600.	46.		4.	25.	88.	28800.	1.5	11	634.	10.	<5.	845.	
L010671-006	5/8/01	RF-ON-3E 0-2"	<5.		<5.	356.	<0.5	20.	20.		<.10		14.		<5.	47.	
L010672-035	05/10/01	RF-ON-3E 15-17"	<5.	21800	7.		<0.5	24.	25.	25100.	<.10	14	33.	<5.	<5.	87.	
L010671-007	5/8/01	RF-ON-3E50 0-2"	<5.		<5.	365.	<0.5	21.	19.		<.10		16.		<5.	52.	DUP RF-ON-3E 0-2"
L010670-007	5/8/01	RF-ON-3F 0-2"			23								231				
L010670-002	5/8/01	RF-ON-3G 0-2"			12								23				
L010670-037	5/7/01	RF-ON-3H 0-2"			7.5								25				
L010671-015	5/8/01	RF-ON-3I 0-2"	<5.		9.	187.	1.	20.	25.		<.10		127.		<5.	209.	
L010670-027	5/8/01	RF-ON-4A 0-2"			81								1350				
L010670-017	5/8/01	RF-ON-4B 0-2"			11								63				
L010671-019	5/8/01	RF-ON-4C 0-2"	<5.		12.	240.	1.	24.	28.		.21		83.		<5.	172.	
L010672-022	5/8/01	RF-ON-4C 8-10"	<5.	18900.	13.		4.	21.	37.	22100.	.78	21	140.	<5.	<5.	273.	
L010671-004	5/8/01	RF-ON-4D 0-2"	<5.		6.	327.	<0.5	22.	27.		<.10		18.		<5.	74.	
L010672-004	5/8/01	RF-ON-4D 8-10"	<5.	21600.	7.		<0.5	23.	29.	29000.	<.10	23	17.	<5.	<5.	86.	
L010670-014	5/8/01	RF-ON-4E 0-2"			7								20				
L010671-002	5/8/01	RF-ON-4F 0-2"	<5.		6.	221.	<0.5	16.	19.		<.10		20.		<5.	64.	

TABLE 4-9
RICHARDSON FLAT SOIL DATA, ONSITE SOILS COVER

all units ppm, except moisture (%)

	Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN	COMMENTS
L010672-002	5/8/01	RF-ON-4F 5-7"	<5.	21900.	8.		2.	19.	26.	25400.	.23	17	47.	<5.	<5.	427.	
L010671-003	5/8/01	RF-ON-4F50 0-2"	<5.		6.	216.	<0.5	16.	29.		<.10		21.		<5.	65.	DUP RF-ON-4F 0-2"
L010670-003	5/8/01	RF-ON-4G 0-2"			6.5								20				
L010672-001	5/8/01	RF-ON-4G 5-7"	<5.	26100.	8.		<0.5	20.	38.	26300	<.10	27	29.	<5.	<5.	100.	
L010670-004	5/8/01	RF-ON-4G50 0-2"			5.5								19				DUP RF-ON-4G 0-2"
L010670-038	5/7/01	RF-ON-4H 0-2"			6								30				
L010672-009	5/7/01	RF-ON-4H 6-8"	<5.	24700.	8.		<0.5	24.	28.	26800.	<.10	24	28.	<5.	<5.	115.	
L010670-066	5/8/01	RF-ON-4I 0-2"			17								344				
L010670-028	5/8/01	RF-ON-5A 0-2"			13								42				
L010671-008	5/8/01	RF-ON-5B 0-2"	<5.		6.	198.	<0.5	21.	25.		<.10		24.		<5.	72.	
L010672-007	5/8/01	RF-ON-5B 16-18"	<5.	18400.	<5.		<0.5	20.	21.	19600.	<.10	27	19.	<5.	<5.	60.	
L010670-045	5/8/01	RF-ON-5C 0-2"			15								159				
L010671-005	5/8/01	RF-ON-5D 0-2"	<5.		5.	175.	<0.5	33.	26.		<.10		33.		<5.	101.	
L010672-005	5/8/01	RF-ON-5D 10-12"	<5.	26100.	5.		<0.5	39.	26.	35800.	<.10	28	13.	<5.	<5.	74.	
L010670-015	5/8/01	RF-ON-5E 0-2"			<5.0								15				
L010670-008	5/8/01	RF-ON-5F 0-2"			12								25				
L010670-005	5/8/01	RF-ON-5G 0-2"			20								333				
L010670-039	5/7/01	RF-ON-5H 0-2"			9.2								52				
L010670-010	5/8/01	RF-ON-6D 0-2"			17								135				

TABLE 4-10
RICHARDSON FLAT SOIL DATA, OFF-SITE SOILS

all results ppm, except moisture (%)

Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN	COMMENTS
5/10/01	RF-OF-T1A 0-2			28								523				
5/10/01	RF-OF-T1A 1-6"			24								418				
5/10/01	RF-OF-T1B 0-2"			12								96				
5/10/01	RF-OF-T1B 1-6"			10								106				
5/10/01	RF-OF-T1C 0-2"	<5.		8.	199.	1.	22.	23.		<.10		62.		<5.	125.	
5/10/01	RF-OF-T1C 1-6"	<5.		9.	188.	1.	21.	25.		<.10		92.		<5.	165.	
5/10/01	RF-OF-T1D 0-2"			8.2								87				
5/10/01	RF-OF-T1D 1-6"			8.7								65				
5/10/01	RF-OF-T1E 0-2"			9.9								62				
5/10/01	RF-OF-T1E 1-6			8.5								55				
5/10/01	RF-OF-T1F 0-2"			11								79				
5/10/01	RF-OF-T1F 1-6"			10								50				
5/10/01	RF-OF-T1G 0-2"			9.1								44				
5/10/01	RF-OF-T1G 1-6"			9.2								49				
5/10/01	RF-OF-T1H 0-2"			10								34				
5/10/01	RF-OF-T1H 1-6"			10								31				
5/10/01	RF-OF-T150E 0-2"			11								65				DUP RF-OF-T1E 0-2"
5/10/01	RF-OF-T150E 1-6"			7.1								31				DUP RF-OF-T1E 1-6"
5/9/01	RF-OF-T2A 0-2"			44								551				
5/9/01	RF-OF-T2A 1-6"			30								391				
5/9/01	RF-OF-T2B 0-2"			13								141				
5/9/01	RF-OF-T2B 1-6"			13								100				
5/9/01	RF-OF-T2C 0-2"			156								4073				
5/9/01	RF-OF-T2C 1-6"			102								2543				
5/9/01	RF-OF-T2D 0-2"			243								5875				
5/9/01	RF-OF-T2D 1-6"			316								6265				
5/9/01	RF-OF-T2E 0-2"			238								5364				
5/9/01	RF-OF-T2E 1-6"			253								4995				
5/9/01	RF-OF-T2F 0-2"	<5.		15.	218.	1.	21.	40.		<.10		194.		<5.	270.	
5/9/01	RF-OF-T2F 1-6"	<5.		6.	246.	<0.5	22.	20.		<.10		19.		<5.	65.	
5/9/01	RF-OF-T2G 0-2"			6.9								19				
5/9/01	RF-OF-T2G 1-6"			8.2								20				
5/9/01	RF-OF-T2H 0-2"	<5.		9.	301.	1.	31.	26.		<.10		62.		<5.	107.	
5/9/01	RF-OF-T2H 1-6"	<5.		7.	305.	<0.5	30.	22.		<.10		34.		<5.	79.	
5/9/01	RF-OF-T2I 0-2"			7.5								57				
5/9/01	RF-OF-T2I 1-6"			7.3								36				

TABLE 4-10
RICHARDSON FLAT SOIL DATA, OFF-SITE SOILS

all results ppm, except moisture (%)

Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN	COMMENTS
5/9/01	RF-OF-T2J 1-6"			9.6								58				
5/9/01	RF-OF-T2J-1 0-2"			7.4								21				
5/9/01	RF-OF-T250F 0-2"	<5.		16.	233.	2.	21.	38.		<.10		189.		<5.	276.	DUP RF-OF-T2F 0-2"
5/9/01	RF-OF-T250F 1-6"	<5.		8.	238.	<0.5	22.	23.		<.10		48.		<5.	102.	RF-OF-T2F 1-6"
5/9/01	RF-OF-T3A 0-2"			8.8								58				
5/9/01	RF-OF-T3A 1-6"			9.8								52				
5/9/01	RF-OF-T3B 0-2"	<5.		47.	236.	43.	21.	112.		3.2		1070.		<5.	1800.	
5/9/01	RF-OF-T3B 1-6"	<5.		27.	215.	16.	20.	67.		3.0		555.		<5.	933.	
5/9/01	RF-OF-T3C 0-2"			10								78				
5/9/01	RF-OF-T3C 1-6			7.2								29				
5/9/01	RF-OF-T3D 0-2"	<5.		8.	409.	1.	20.	35.		.11		73.		<5.	165.	
5/9/01	RF-OF-T3D 1-6"	<5.		7.	413.	1.	23.	32.		<.10		42.		<5.	125.	
5/9/01	RF-OF-T3D 1-6"	<5.		7.	407.	1.	21.	32.		<.10		33.		<5.	111.	
5/9/01	RF-OF-T3E 0-2"			6.4								17				
5/9/01	RF-OF-T3E1-6"			7								18				
5/9/01	RF-OF-T3F 0-2"			7.8								20				
5/9/01	RF-OF-T3F 1-6"			7.1								18				
5/9/01	RF-OF-T3G 0-2"			6.9								31				
5/9/01	RF-OF-T3G 1-6"			6.1								24				
5/9/01	RF-OF-T3H 0-2"			7.1								27				
5/9/01	RF-OF-T3H 1-6"			6.8								27				
5/9/01	RF-OF-T3I 0-2"			9								25				
5/9/01	RF-OF-T3I 1-6"			9.3								25				
5/9/01	RF-OF-T3J 0-2"			7.4								28				
5/9/01	RF-OF-T3J 1-6"			11								66				

TABLE 4-11,
RICHARDSON FLAT SEDIMENT DATA

all units ppm, except moisture (%)

Date	Sample #	AG	AL	AS	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN	COMMENTS
05/11/01	RF-SD-SD1 0-6"	25.	4850	156.	73.	18.	280.	39900.	1.6	32	3490.	72.	8.	12000	
05/11/01	RF-SD-SD2 0-6"	16.	6450	119.	50.	16.	200.	32600.	.77	29	2330.	53.	<5.	8780	
05/11/01	RF-SD-SD3 0-6"	13.	10500	125.	35.	21.	173.	28600.	.32	45	1880.	36.	<5.	6800	
05/11/01	RF-SD-SD4 0-6"	19.	7480	205.	51.	18.	260.	33200.	1.2	34	2840.	65.	6.	9140	
05/11/01	RF-SD-SD5 0-6"	20.	8650	119.	38.	18.	261.	23000.	1.0	33	2650.	97.	<5.	7610	
05/11/01	RF-SD-SD550 0-6"	20.	8240	104.	38.	18.	248.	23100.	.95	44	2660.	93.	5.	7410	DUP RF-SD-SD5 0-6"
05/11/01	RF-SD-SD6 0-6"	14.	20600	101.	18.	30.	211.	27000.	1.5	13	2280.	63.	<5.	2940	

TABLE 4-12
RICHARDSON FLAT SOIL DATA, TAILINGS

all units ppm, except moisture (%)

Date	Sample #	AG	AL	AS	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN	COMMENTS
05/09/01	RF-TA TP1 2'	34.	2320.	148.	14.	8.	338.	34600.	.28	20	1470.	41.	<5.	2110.	1' COVER
05/09/01	RF-TA-TP1 3'	9.	1550.	299.	21.	<5.	528.	77500	.45	26	3920.	18.	<5.	4810	
05/09/01	RF-TA-TP1 4'	24.	2880.	245.	46.	10.	953.	62800	.56	26	10200.	26.	<5.	7820	
05/09/01	RF-TA-TP1 5'	9.	1960.	167.	32.	14.	319.	52600	.57	12	3010.	69.	11.	5930	
05/09/01	RF-TA-TP1 6'	19.	2610	245.	29.	10.	549.	48000.	.76	20	3930.	120.	7.	5830	
05/09/01	RF-TA-TP1 2-6'	16.	2240	210.	22.	7.	446.	55900	.45	22	3440.	30.	<5.	4320	
05/09/01	RF-TA TP2-2'	38.	2150.	235.	30.	16.	462.	28500.	2.8	24	3880.	150.	9.	5910	1' COVER
05/09/01	RF-TA TP2-3'	24.	1330.	417.	23.	12.	217.	29400.	4.9	25	3100.	172.	7.	3590	
05/09/01	RF-TA TP2-4'	18.	1470.	188.	26.	15.	190.	40700.	1.9	21	2490.	95.	9.	4830	
05/09/01	RF-TA TP2-5'	18.	1490.	404.	26.	13.	197.	37200.	3.1	23	2560.	89.	9.	4490	
05/09/01	RF-TA TP2-6'	96.	15600.	371.	87.	111.	1300.	32000.	3.3	34	14700.	312.	17.	15300	
05/09/01	RF-TA TP2-2-6'	46.	4020.	302.	48.	32.	548.	32900.	2.9	29	6060.	167.	11.	7740	
05/09/01	RF-TP-502 3'	34.	1440.	451.	36.	13.	283.	29200.	4.3	29	4260.	247.	7.	5680	DUP RF-TP2-2 3'
05/09/01	RF-TP-502 4'	18.	1380.	166.	25.	14.	192.	34700.	2.5	21	2500.	93.	9.	4540	DUP RF-TP2-2 4'
05/09/01	RF-TP-502 5'	58.	2800.	319.	62.	22.	609.	44800.	7.4	19	6590.	242.	14.	8970	DUP RF-TP2-2 5'
05/09/01	RF-TP-502 6'	66.	12000.	267.	74.	82.	840.	35500.	2.8	32	10900.	187.	13.	12300	DUP RF-TP2-2 6'
05/09/01	RF-TP-502 2'	31.	1930.	280.	29.	16.	409.	34400.	9.7	26	3970.	152.	12.	5600	DUP RF-TP2-2 2'
05/09/01	RF-TP-502 2-6'	42.	2230.	307.	45.	18.	454.	36300.	2.5	27	5090.	193.	11.	7340	DUP RF-TP-2 2-6'
05/09/01	RF-TA-TP3 2'	17.	813.	211.	23.	8.	163.	47500	2.3	20	2750.	86.	18.	3510	1' COVER
05/09/01	RF-TA-TP3 3'	23.	1100.	210.	26.	9.	236.	34200.	1.5	24	3330.	126.	11.	3670	
05/09/01	RF-TA-TP3 4'	37.	1720.	317.	41.	14.	322.	34600.	3.6	29	4900.	216.	10.	6440	
05/09/01	RF-TA-TP3 5'	21.	2440.	199.	34.	22.	242.	47800	.98	20	3170.	85.	12.	6000	
05/09/01	RF-TA-TP3 6'	26.	4080.	192.	59.	39.	331.	47400	1.4	19	5230.	98.	13.	10300	
05/09/01	RF-TA-TP3 2-6'	20.	1770.	217.	32.	18.	227.	45500	1.9	21	3400.	86.	15.	5270	

TABLE 4-13
RICHARDSON FLAT SOIL DATA,
pH

Lab #	Date	Sample #	PH	MEDIA	COMMENTS
L011438-001	05/09/01	RF-TA-TP1 2-6'	7.6	TAILINGS	
L011438-002	05/09/01	RF-TA-TP2 2-6'	7.3	TAILINGS	
L011438-003	05/09/01	RF-TA-TP3 2-6'	7.7	TAILINGS	
L011438-004	05/09/01	RF-TA-TP502 2-6'	7.6	TAILINGS	DUPLICATE RF-TA-TP502 2-6'
L011438-005	05/11/01	RF-SD-SD-1 0-6"	7.1	SEDIMENT	
L011438-006	05/11/01	RF-SD-SD-2 0-6"	7.1	SEDIMENT	
L011438-007	05/11/01	RF-SD-SD-3 0-6"	7	SEDIMENT	
L011438-008	05/11/01	RF-SD-SD-4 0-6"	7	SEDIMENT	
L011438-009	05/11/01	RF-SD-SD-5 0-6"	7.1	SEDIMENT	
L011438-010	05/11/01	RF-SD-SD-550 0-6"	7	SEDIMENT	DUPLICATE RF-SD-SD-550 0-6"
L011438-011	05/11/01	RF-SD-SD-6 0-6"	7.3	SEDIMENT	
L011438-012	06/27/01	RF-TSDD-GL50-18"C	7.6	CLAY	
L011438-013	06/27/01	RF-TSDD-GL56-18"C	7	CLAY	
L011438-014	06/27/01	RF-TSDD-GL5056-19"C	7.1	CLAY	DUPLICATE RF-TSDD-GL5056-19"C
L011438-015	06/27/01	RF-TSDD-GL52-18"C	7.1	CLAY	

TABLE 4-14
RICHARDSON FLAT SOIL DATA,
TAILINGS SOUTH OF THE DIVERSION DITCH

all results ppm, except moisture (%)

Date	Sample #	AG	AL	AS	CD	CR	CU	FE	HG	MOIST.	PB	SB	SE	ZN	comments
6/27/01	RF-TSDD-GL50-6"T	55	3313	459	75	19	692	15720	6.3	17	9060	283	9.0	14650	
6/27/01	RF-TSDD-GL50-18"C	<5	26320	9.7	<.5	28	31	24270	<.10	26	26	<5	<5	125	
6/27/01	RF-TSDD-GL5056-7"T	44	2748	313	39	18	497	11720	4.8	5.3	7129	214	<5	7926	DUPLICATE GL50
6/27/01	RF-TSDD-GL5056-19"C	<5	21130	7.9	1.1	25	25	22940	<.10	19	24	<5	<5	214	DUPLICATE GL50
6/27/01	RF-TSDD-GL52-6"T	77	5874	637	102	30	1208	21770	11	22	21380	505	20	15480	
6/27/01	RF-TSDD-GL52-18"C	<5	22180	6.6	<.5	25	32	22780	<.10	24	19	<5	<5	157	
6/27/01	RF-TSDD-GL53-8"T	120	8373	632	113	33	1323	23200	21	32	21010	423	24	18640	
6/27/01	RF-TSDD-GL53-18"C	<5	23930	7.3	.73	26	34	23110	.16	32	57	<5	<5	200	
6/27/01	RF-TSDD-GL56-6"T	38	2935	264	39	19	467	11260	3.6	4.2	5761	172	<5	7731	
6/27/01	RF-TSDD-GL56-18"C	<5	19950	8.6	7.6	24	28	22080	<.10	21	34	6.3	<5	1306	
6/27/01	RF-TSDD-GL58-14"T	28	5365	276	44	16	305	72660	4.9	7.1	5122	114	20	6520	
6/27/01	RF-TSDD-GL58-20"C	<5	24210	12	1.3	26	32	25200	.29	14	122	<5	<5	236	
6/27/01	RF-TSDD-GL59-10"T	43	4374	426	46	19	798	28080	26	15	7584	334	9.7	10600	
6/27/01	RF-TSDD-GL59-18"C	<5	22870	12	1.9	29	39	24140	1.1	17	85	<5	<5	324	
6/27/01	RF-TSDD-GL62-2.5"T	20	2059	192	40	12	233	30740	1.3	6.9	3123	88	9.2	5865	
6/27/01	RF-TSDD-GL62-3.5"C	<5	32700	7.1	<.5	33	20	26910	<.10	23	21	<5	<5	97	

Notes:
T - Tailings sample
C - Clay sample

TABLE 4-15
RICHARDSON FLAT SOIL DATA, BACKGROUND SOILS

all results ppm

Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	PB	SB	SE	ZN	COMMENTS
5/10/01	RF-BG-BG1			11							47				
5/10/01	RF-BG-BG10	<5.		7.	227.	<0.5	22.	16.		<.10	33.		<5.	96.	
5/10/01	RF-BG-BG1050	<5.		7.	213.	<0.5	23.	15.		<.10	28.		<5.	90.	Duplicate RF-BG-BG10
5/10/01	RF-BG-BG11 0-2"			282							7731				tailings
5/10/01	RF-BG-BG2			8.1							26				
5/10/01	RF-BG-BG3			8.6							22				
5/10/01	RF-BG-BG4			9.2							25				
5/10/01	RF-BG-BG5			11							43				
5/10/01	RF-BG-BG6 0-2"			7							30				
5/10/01	RF-BG-BG7 0-2"			6.9							25				
5/10/01	RF-BG-BG8 0-2"	<5.		14.	265.	1.	20.	29.		.15	84.		<5.	127.	
5/10/01	RF-BG-BG9 0-2"			6.7							98				

TABLE 4-16
RICHARDSON FLAT SOIL DATA, BACKGROUND SOIL DATA

all results ppm

Date	Sample #	AG	AS	BA	CD	CR	CU	HG	PB	SE	ZN	COMMENTS
5/10/01	RF-BG-BG10	<5.	7	227	<0.5	22	16	<.10	33	<5.	96	background sample 0-2" depth
5/10/01	RF-BG-BG8 0-2"	<5.	14	265	1	20	29	0.15	84	<5.	127	background sample 0-2" depth
5/10/01	RF-OF-T1C 0-2"	<5.	8	199	1	22	23	<.10	62	<5.	125	offsite soil sample 0-2" depth
5/9/01	RF-OF-T2F 1-6"	<5.	6	246	<0.5	22	20	<.10	19	<5.	65	offsite soil sample 1-6" depth
5/9/01	RF-OF-T2H 0-2"	<5.	9	301	1	31	26	<.10	62	<5.	107	offsite soil sample 0-2" depth
5/9/01	RF-OF-T2H 1-6"	<5.	7	305	<0.5	30	22	<.10	34	<5.	79	offsite soil sample 1-6" depth
5/9/01	RF-OF-T3D 0-2"	<5.	8	409	1	20	35	0.11	73	<5.	165	offsite soil sample 0-2" depth
5/9/01	RF-OF-T3D 1-6"	<5.	7	407	1	21	32	<.10	33	<5.	111	offsite soil sample 1-6" depth
5/8/01	RF-ON-2H 0-2"	<5.	<5.	208	<0.5	23	14	<.10	17	<5.	64	onsite soil cover sample 0-2" depth
5/8/01	RF-ON-2H 6-8"	<5.	6	0	1	22	18	<.10	43	<5.	148	onsite soil cover sample 6-8" depth
5/8/01	RF-ON-3E 0-2"	<5.	<5.	356	<0.5	20	20	<.10	14	<5.	47	onsite soil cover sample 0-2" depth
5/10/01	RF-ON-3E 15-17"	<5.	7	0	<0.5	24	25	<.10	33	<5.	87	onsite soil cover sample 15-17" depth
5/8/01	RF-ON-4D 0-2"	<5.	6	327	<0.5	22	27	<.10	18	<5.	74	onsite soil cover sample 0-2" depth
5/8/01	RF-ON-4D 8-10"	<5.	7	0	<0.5	23	29	<.10	17	<5.	86	onsite soil cover sample 8-10" depth
5/8/01	RF-ON-4F 0-2"	<5.	6	221	<0.5	16	19	<.10	20	<5.	64	onsite soil cover sample 0-2" depth
5/8/01	RF-ON-4F 5-7"	<5.	8	0	2	19	26	0.23	47	<5.	427	onsite soil cover sample 5-7 depth
5/8/01	RF-ON-4G 5-7"	<5.	8	0	<0.5	20	38	<.10	29	<5.	100	onsite soil cover sample 5-7 depth
5/7/01	RF-ON-4H 6-8"	<5.	8	0	<0.5	24	28	<.10	28	<5.	115	onsite soil cover sample 6-8" depth
5/8/01	RF-ON-5B 0-2"	<5.	6	198	<0.5	21	25	<.10	24	<5.	72	onsite soil cover sample 0-2" depth
5/8/01	RF-ON-5B 16-18"	<5.	<5.	0	<0.5	20	21	<.10	19	<5.	60	onsite soil cover sample 16-18" depth
5/8/01	RF-ON-5D 0-2"	<5.	5	175	<0.5	33	26	<.10	33	<5.	101	onsite soil cover sample 0-2" depth
5/8/01	RF-ON-5D 10-12"	<5.	5	0	<0.5	39	26	<.10	13	<5.	74	onsite soil cover sample 10-12" depth
	Mean		6.6	174.7	1.1	23.4	24.8	0.16	34.3		108.8	
	Std. Dev		2.5	148.4	*	5.3	5.9	*	19.9		77.1	
	95 % confidence		1.0	62.0	*	2.2	2.5	*	8.3		32.2	

* - Above detection limits data set insufficient to calculate

TABLE 4-17
RICHARDSON FLAT SOIL DATA, STUDY AREA BOUNDARY

all results ppm

Sample I.D.	Lead	Arsenic
SAB-1	98.0	12.0
SAB-2	135.0	14.0
SAB-3	75.0	11.0
SAB-4	144.0	12.0
SAB-5	53.0	12.0
SAB-7	165.0	30.0
SAB-8	63.0	23.0
1A	37.0	
1B	44.0	
2A	49.0	
T1B	96.0	12.0
T1C	62.0	8.0
T1D	87.0	8.2
T1E	62.0	9.9
T1F	79.0	11.0
T1G	44.0	9.1
T2B	141.0	13.0
T2G	19.0	6.9
T2H	62.0	9.0
T2I	57.0	7.5
T3A	58.0	8.8
T3C	29.0	10.0
T3D	73.0	8.0
T3E	17.0	6.0
T3F	20.0	7.8
Mean	73.7	11.9
Std.Dev	40.3	5.5
95% Conf.	16.1	2.3

Table 4-18, Richardson Flat Analytical Results Summary, Phase I and II Surface and Porewater

units ppm except for Hg - ppb

Date	Sample #	AG	AG(D)	AL	AL(D)	ALK.	AS	AS(D)	B	B(D)	BA	BA(D)	BE	BE(D)	CA(D)	CATIONS BALANCE	CD	CD(D)	CL-	CN-	CO3	CO	CO (D)	COND.	CR	CR(D)	CR+6 (D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG	HG (D)	K(D)	KJEL.-N	MG (D)	MN	MN (D)	NA (D)	NH3N	NO2N O3	P	PB	PB(D)	PH	Se	SB	SB(D)	SE	SE(D)	SO4=	TDS	TOC	TSS	ZN	ZN(D)
	PHASE 1 SURFACE WATER																																																											
3-Jun-03	RFB-SW-SD4	<0.005	<0.005	<0.050	<0.050	200	0.006	0.007	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	207	1.2	<0.001	<0.001	156	<0.004	<2.0	<0.10	<0.10	1664	<0.010	<0.010	<0.005	0.006	0.005	0.24	<0.10	719	200	<0.20	<0.20	<2.0	<0.50	49	0.61	0.58	86	0.24	0.13	<0.10	<0.005	<0.005	7.8		<0.005	0.007	<0.004	<0.004	479	1141	4.6	<1.0	0.71	0.87
3-Jun-03	RFB-SW-SD7	<0.005	<0.005	0.063	<0.050	189	0.006	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	155	2.6	0.003	<0.001	167	<0.004	<2.0	<0.10	<0.10	1401	<0.010	<0.010	<0.005	<0.005	<0.005	1.1	<0.10	539	180	<0.20	<0.20	<2.0	<0.50	37	0.91	0.34	82	<0.10	<0.10	0.22	0.008	<0.005	7.5		<0.005	<0.005	<0.004	<0.004	260	838	3.9	5.3	1.1	0.82
3-Jun-03	RFB-SW-SD13	<0.005	<0.005	<0.050	<0.050	189	<0.005	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	262	3.6	<0.001	<0.001	128	<0.004	<2.0	<0.10	<0.10	1784	<0.010	<0.010	<0.005	0.007	0.006	0.14	<0.10	922	189	<0.20	<0.20	2.6	<0.50	65	2.3	2.2	55	<0.10	<0.10	<0.10	<0.005	<0.005	7.8		<0.005	<0.005	<0.004	<0.004	611	1451	4.9	3.2	0.061	0.023
3-Jun-03	RFB-SW-SD17	<0.005	<0.005	<0.050	<0.050	177	<0.005	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	251	4.8	<0.001	<0.001	108	<0.004	<2.0	<0.10	<0.10	1742	<0.010	<0.010	<0.005	0.007	0.006	0.13	<0.10	900	177	<0.20	<0.20	3.2	<0.50	63	2.2	2	54	0.12	0.18	<0.10	<0.005	<0.005	7.8		<0.005	<0.005	<0.004	<0.004	595	1384	6	4.7	0.036	0.012
3-Jun-03	RFB-SW-SD19	<0.005	<0.005	<0.050	<0.050	149	<0.005	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	230	3.2	<0.001	<0.001	117	<0.004	<2.0	<0.10	<0.10	1874	<0.010	<0.010	<0.005	0.007	0.006	0.12	<0.10	830	149	<0.20	<0.20	2.3	<0.50	62	1.9	1.8	55	<0.10	<0.10	<0.10	<0.005	<0.005	7.9		<0.005	<0.005	<0.004	<0.004	583	1361	6.4	7.3	<0.010	<0.010
3-Jun-03	RFB-SW-SD5019	<0.005	<0.005	<0.050	<0.050	149	<0.005	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	230	4.4	<0.001	<0.001	121	<0.004	<2.0	<0.10	<0.10	1877	<0.010	<0.010	<0.005	0.007	0.006	0.12	<0.10	934	149	<0.20	<0.20	2.3	<0.50	63	1.9	1.8	56	0.14	<0.10	<0.10	<0.005	<0.005	7.5		<0.005	<0.005	<0.004	<0.004	582	1363	7	5.2	<0.010	<0.010
3-Jun-03	RFB-SW-SD20	<0.005	<0.005	<0.050	<0.050	144	<0.005	<0.005	0.1	<0.10	<0.10	<0.10	<0.005	<0.005	237	5	<0.001	<0.001	127	<0.004	<2.0	<0.10	<0.10	1991	<0.010	<0.010	<0.005	0.006	0.006	0.14	<0.10	965	144	<0.20	<0.20	2.4	<0.50	64	1.8	1.8	59	<0.10	<0.10	<0.10	<0.005	<0.005	7.8		<0.005	<0.005	<0.004	<0.004	588	1364	7.2	4.7	<0.010	<0.010
	PHASE II SURFACE WATER																																																												
18-Aug-03	RFB-SW-SD-13	<0.005	<0.005	<0.050	<0.050	212	<0.005	<0.005	0.13	0.1	<0.10	<0.10	<0.005	<0.005	336	6.3	<0.001	<0.001	105	<0.004	<2.0	<0.10	<0.10	2060	<0.010	<0.010	<0.005	<0.005	<0.005	<0.10	<0.10	1150	212	<0.20	<0.20	2.4	0.27	76	4.8	5	64	<0.10	<0.10	<0.10	<0.005	<0.005	8.2		<0.005	<0.005	<0.004	<0.004	769	1917	5.8	4.4	0.03	0.025
18-Aug-03	RFB-SW-SD-5013	<0.005	<0.005	<0.050	<0.050	240	<0.005	<0.005	0.12	0.11	<0.10	<0.10	<0.005	<0.005	334	4.6	<0.001	<0.001	107	<0.004	<2.0	<0.10	<0.10	2080	<0.010	<0.010	<0.005	<0.005	<0.005	<0.10	<0.10	1141	240	<0.20	<0.20	2.3	0.48	75	4.6	4.6	57	0.13	<0.10	<0.10	0.005	<0.005	8		<0.005	<0.005	<0.004	<0.004	777	1748	4.6	6.9	0.036	0.02
18-Aug-03	RFB-SW-SD-17	<0.005	<0.005	<0.050	<0.050	200	<0.005	<0.005	0.14	0.12	<0.10	<0.10	<0.005	<0.005	347	4.4	<0.001	<0.001	107	<0.004	<2.0	<0.10	<0.10	2050	<0.010	<0.010	<0.005	<0.005	<0.005	<0.10	<0.10	1186	200	<0.20	<0.20	3.3	0.34	73	6.1	6.2	57	0.32	0.38	<0.10	<0.005	<0.005	8.2		<0.005	<0.005	<0.004	<0.004	836	1717	10	<1.0	0.025	0.028
18-Aug-03	RFB-SW-SD-19	<0.005	<0.005	<0.050	<0.050	90	<0.005	<0.005	0.16	0.14	<0.10	<0.10	<0.005	<0.005	314	-1.8	<0.001	<0.001	130	<0.004	<2.0	<0.10	<0.10	2160	<0.010	<0.010	<0.005	<0.005	<0.005	0.11	<0.10	1138	90	<0.20	<0.20	3.3	0.55	68	1.2	1.1	63	<0.10	<0.10	<0.10	<0.005	<0.005	7.9		<0.005	<0.005	<0.004	<0.004	1022	1914	11	2	0.019	<0.010
18-Aug-03	RFB-SW-SD-20	<0.005	<0.005	<0.050	<0.050	84	<0.005	<0.005	0.17	0.14	<0.10	<0.10	<0.005	<0.005	324	<1.0	<0.001	<0.001	134	<0.004	<2.0	<0.10	<0.10	2200	<0.010	<0.010	<0.005	<0.005	<0.005	0.10	<0.10	1179	84	<0.20	<0.20	3.1	1.1	60	1.3	1.3	64	0.11	<0.10	<0.10	<0.005	<0.005	7.8		<0.005	<0.005	<0.004	<0.004	1022	1933	12	23	0.022	<0.010
18-Aug-03	RFB-SWW-REF (wetland)	<0.005	<0.005	0.89	<0.050	226	<0.005	<0.005	0.1	<0.10	0.59	0.52	<0.005	<0.005	148	2.1	<0.001	<0.001	425	<0.004	<2.0	<0.10	<0.10	1774	<0.010	<0.010	<0.005	<0.005	<0.005	3.1	<0.10	613	226	<0.20	<0.20	10	0.78	38	5.7	4.1	138	0.2	<0.10	0.56	<0.005	<0.005	7.9		<0.005	<0.005	<0.004	<0.004	8.8	1134	5.8	33	<0.010	<0.010
18-Aug-03	RFB-SWP-REF (pond)	<0.005	<0.005	0.89	<0.050	218	0.008	<0.005	<0.10	<0.10	0.38	0.28	<0.005	<0.005	99	2.1	<0.001	<0.001	307	<0.004	<2.0	<0.10	<0.10	1400	<0.010	<0.010	<0.005	<0.005	<0.005	9.3	1	342	218	<0.20	<0.20	8.3	0.57	23	3.4	3.3	137	0.30*	<0.10	0.4	<0.005	<0.005	7.7		<0.005	<0.005	<0.004	<0.004	16	988	8	127	<0.010	<0.010
	PHASE II PORENWATER																																																											
18-Aug-03	RFB-PW-SD-2	<0.005	<0.005	0.097	<0.050	273.	0.24	0.23	0.12	0.10	<0.10	<0.10	<0.005	<0.005	160.	1.8	0.001	<0.001	182.	<0.004	<2.0	<0.10	<0.10	1378.	<0.010	<0.010	<0.005	0.013	<0.005	20.	17.	505.	273.	0.36	<0.20	2.9	1.9	32.	6.5	6.1	77.	2.0	<0.10	<0.10	0.32	<0.005	8.3	<0.10	0.031	0.010	<0.004	<0.004	221.	946.	7.3	43.	1.3	1.0
18-Aug-03	RFB-PW-SD-4	0.022	<0.005	1.8	<0.050	230.	0.70	0.53	0.14	0.14	0.13	<0.10	<0.005	<0.005	219.	11	0.014	<0.001	153.	<0.004	<2.0	<0.10	<0.10	1486.	<0.010	<0.010	<0.005	0.22	<0.005	15.	9.0	759.	230.	2.8	<0.20	<2.0	0.71	51.	3.9	3.8	64.	<0.10	<0.10	3.7	2.0	<0.005	8.2	<0.10	0.15	0.058	<0.004	<0.004	372.	1140.	9.9	104.	1.4	0.23
18-Aug-03	RFB-PW-SD-9	0.071	<0.005	1.8	<0.050	432.	1.2	0.72	<0.10	<0.10	0.19	0.11	<0.005	<0.005	184.	3.1	0.025	0.005	187.	<0.004	<2.0	<0.10	<0.10	1811.	<0.010	<0.010	<0.005	0.89	0.005	15.	7.8	670.	432.	4.0	<0.20	<2.0	1.2	53.	12.	10.	80.	0.26	<0.10	3.6	15.	0.050	7.9	<0.10	0.56	0.090	0.004	<0.004	165.	1039.	9.5	200.	11.	2.7
18-Aug-03	RFB-PW-SD-10	<0.005	<0.005	<0.050	<0.050	386.	<0.005	<0.005	0.15	0.14	0.13	0.12	<0.005	<0.005	247.	3.5	<0.001	<0.001	298.	<0.004	<2.0	<0.10	<0.10	2060.	<0.010	<0.010	<0.005	<0.005	<0.005	0.67	0.44	970.	380.	<0.20	<0.20	<2.0	0.46	61.	7.1	6.0	83.	<0.10	<0.10	0.30	0.009	<0.005	8.3	4.7	<0.005	<0.005	<0.004	<0.004	289.	1378.	6.0	3.1	0.019	<0.010
18-Aug-03	RFB-PW-SD-5010	<0.005	<0.005	<0.050	<0.050	384.	<0.005	<0.005	0.10	0.15	0.12	0.11	<0.005	<0.005	243.	<1.0	<0.001	<0.001	328.	<0.004	48.	<0.10	<0.10	1972.	<0.010	<0.010	<0.005	<0.005	<0.005	0.70	0.42	865.	310.	<0.20	<0.20	<2.0	0.57	61.	7.0	5.5	83.	<0.10	<0.10	0.30	0.011	<0.005	8.7	0.50	<0.005	<0.005	<0.004	<0.004	272.	1361.	6.7	<1.0	0.029	<0.010
18-Aug-03	RFB-PW-SD-11	0.0088	<0.005	0.77	<0.050	622.	0.040	0.023	0.17	0.17	0.19	<0.10	<0.005	<0.005	466.	-1.4	0.0025	<0.001	244.	<0.004	<2.0	<0.10	<0.10	2920.	<0.010	<0.010	<0.005	0.043	<0.005	10.	16.	1607.	622.	0.80	<0.20	2.8	1.0	113.	2.4	2.0	111.	0.15	<0.10	1.4	0.88	<0.005	8.0	28.	0.024	<0.005	<0.004	<0.004	1115.	2483.	15.	154.	0.27	<0.010
20-Aug-03	RFB-PW-SD-14	<0.005	<0.005	<0.050	<0.050	336.	<0.005	<0.005	0.25	0.24	<0.10	<0.10	<0.005	<0.005	439.	-8.1	<0.001	<0.001	214.	<0.004	<2.0	<0.10	<0.10	2840.	<0.010	<0.010	<0.005	<0.005	<0.005	0.16	0.10	1368.	330.	<0.20	<0.20	<2.0	2.2	64.	6.8	6.8	73.	0.24	<0.10	<0.10	0.009	<0.005	7.7	2.8	<0.005	<0.005	<0.004	<0.004	1094.	2230.	8.7	4.4	<0.010	<0.010
20-Aug-03	RFB-PW-SD-15	<0.005	<0.005	0.41	<0.050	226.	0.012	<0.005	<0.10	<0.10	0.19	0.17	<0.005	<0.005	309.	-3.9	0.0027	<0.001	102.	<0.004	<2.0	<0.10	<0.10	2080.	<0.010	<0.010	<0.005	0.010	<0.005	0.92	<0.10	1086.	220.	<0.20	<0.20	2.7	0.59	78.	24.	24.	50.	0.69	<0.10	0.27	0.21	<0.005	8.0	<0.10	0.007	<0.005	<0.004	<0.004	940.	1804.	5.9	58.	0.59	<0.010
20-Aug-03	RFB-PW-SD-17	<0.005	<0.005	1.1	<0.050	224.	0.047	0.012	<0.10	<0.10	0.10	<0.10	<0.005	<0.005	286.	-8.4	0.005	<0.001	82.	<0.004	<2.0	<0.10	<0.10	1878.	<0.010	<0.010	<0.005	0.024	<0.005	3.1	0.25	1011.	224.	0.22	<0.20	3.9	3.2	73.	20.	17.	58.	3.5	<0.10	1.9	0.33	<0.005	8.0	<0.10	0.019	<0.005	<0.004	<0.004	992.	1706.	8.7	207.	1.2	<0.010
20-Aug-03	RFB-PW-SD-18	<0.005	<0.005	2.0	<0.050	149.	<0.005	<0.005	0.16	0.13	0.11	<0.10	<0.005	<0.005	326.	0.3	<0.001	<0.001	125.	<0.004	<2.0	<0.10	<0.10	2210.	<0.010	<0.010	<0.005	0.008	<0.005	2.0	<0.10	1188.	149.	0.20	<0.20	4.0	2.4	85.	4.0	4.1	95.	1.3	0.13	0.32	0.13	<0.005	7.3	55.	<0.005	<0.005	<0.004	<0.004	783.	1812.	8.9	109.	0.14	<0.010
21-Aug-03	RFB-PW-SD-20	<0.005	<0.005	3.1	<0.050	302.	0.007	<0.005	0.11	<0.10	<0.10	<0.10	<0.005	<0.005	369.	<1.0	<0.005	<0.001	98.	<0.004	<2.0	<0.10	<0.10	2290.	<0.010	<0.010	<0.005	0.007	<0.005	3.8	<0.10	1290.	302.	<0.20	<0.20	4.8	1.8	78.	15.	15.	46.	1.7	<0.10	0.05	0.032	<0.005	7.7	25.	<0.005	<0.005	<0.004	<0.004	988.	1990.	9.7	68.	0.079	<0.010
21-Aug-03	RFB-PW-SD-5020	<0.005	<0.005	3.2	<0.050	304.	0.008	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	362.	-1.4	<0.001	<0.001	98.	<0.004	<2.0	<0.10	<0.10	2290.	<0.010	<0.010	<0.005	0.011	<0.005	3.9	<0.10	1291.	304.	<0.20	<0.20	4.8	1.8	74.	15.	15.	44.	1.8	<0.10	0.08	0.032	<0.005	7.8	22.	<0.005	<0.005	<0.004	<0.004	975.	2007.	9.4	341.	0.078	<0.010
18-Aug-03	RFB-PW-REF-POND	<0.005	<0.005	2.5	<0.050	220.	0.005	<0.005	<0.10	<0.10	0.43	0.32	<0.005	<0.005	101.	<1.0	<0.001	<0.001	308.	<0.004	<2.0	<0.10	<0.10	1418.	<0.010	<0.010	<0.005	<0.005	<0.005	8.9	3.0	361.	220.	<0.20	<0.20	9.0	0.82	24.	4.7	4.3	120.	0.40	<0.10	0.52	0.009	<0.005	7.8		<0.005	<0.005	<0.004	<0.004	14.	670.	4.8	129.	<0.010	<0.010
18-Aug-03	RFB-PW-RF-WET	<0.005	<0.005	1.7	<0.050	330.	0.012	0.011	<0.10	<0.10	0.98	0.85	<0.005	<0.005	170.	-1.8	<0.001	<0.001	558.	<0.004	<2.0	<0.10	<0.10	2270.	<0.010	<0.010	<0.005**	<0.005	<0.005	14.	9.8	630.	330.	<0.20	<0.20	5.8	0.73	46.	18.	18.	170.	0.21	<0.10	1.5	<0.005	<0.005	7.7	<0.10	<0.005	<0.005	<0.004	<0.004	<2.0	1465.	7.2	287.	<0.010	<0.010

Note:
Sample RFB-SW-SD5019 is a duplicate of RFB-SW-SD19
Sample RFB-SW-SD5013 is a duplicate of RFB-SW-SD13
Sample RFB-PW-SD5010 is a duplicate of RFB-PW-SD10

Table 4-19
Screening of Dissolved Metal Concentrations in Ecological Phase I and II Surface Water

Location	Date	AG [3]	AL [4]	AS [2,4]	CD [1]	CR [1,2]	CU [1]	FE [5]	HG [4]	PB [1]	SB	SE [4]	ZN [1]	HARDNESS Std.=Average
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0044*	*0.90*	*0.061*	*1.0*	*0.000012*	*0.0197*	*No Std.*	*0.005*	*0.556*	*719*
SD4 wetland	Jun-03	<0.005	<0.050	0.007	<0.001	<0.010	0.005	<0.10	<0.20	<0.005	0.007	<0.004	**0.67**	719
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0036*	*0.71*	*0.048*	*1.0*	*0.000012*	*0.0148*	*No Std.*	*0.005*	*0.436*	*539*
SD7 wetland	Jun-03	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.20	<0.005	<0.005	<0.004	**0.62**	539
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0058*	*1.21*	*0.084*	*1.0*	*0.000012*	*0.0281*	*No Std.*	*0.005*	*0.758*	*1036*
SD13 wetland	Jun-03	<0.005	<0.050	<0.005	<0.001	<0.010	0.006	<0.10	<0.20	<0.005	<0.005	<0.004	0.023	922
SD13 wetland	Aug-03	*<0.005*	*<0.050*	*<0.005*	*<0.001*	*<0.010*	*<0.005*	*<0.10*	*<0.20*	*<0.005*	*<0.005*	*<0.004*	*0.025*	*1150*
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0057*	*1.20*	*0.083*	*1.0*	*0.000012*	*0.0278*	*No Std.*	*0.005*	*0.751*	*1026*
SD17 wetland	Jun-03	<0.005	<0.050	<0.005	<0.001	<0.010	0.006	<0.10	<0.20	<0.005	<0.005	<0.004	0.012	866
SD-17 wetland	Aug-03	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.20	<0.005	<0.005	<0.004	0.026	1165
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0056*	*1.16*	*0.080*	*1.0*	*0.000012*	*0.0268*	*No Std.*	*0.005*	*0.726*	*985*
SD18 pond	Jun-03	<0.005	<0.050	<0.005	<0.001	<0.010	0.006	<0.10	<0.20	<0.005	<0.005	<0.004	<0.010	830
SD18 pond	Aug-03	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.20	<0.005	<0.005	<0.004	<0.010	1139
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0057*	*1.19*	*0.082*	*1.0*	*0.000012*	*0.0276*	*No Std.*	*0.005*	*0.746*	*1017*
SD20 pond	Jun-03	<0.005	<0.050	<0.005	<0.001	<0.010	0.006	<0.10	<0.20	<0.005	<0.005	<0.004	<0.010	855
SD20 pond	Aug-03	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.20	<0.005	<0.005	<0.004	<0.010	1179
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0034*	*0.68*	*0.046*	*1.0*	*0.000012*	*0.0141*	*No Std.*	*0.005*	*0.418*	*513*
SWW-REF (wetland)	Aug-03	<0.005	<0.050	<0.005	<0.001	<0.010	<0.005	<0.10	<0.20	<0.005	<0.005	<0.004	<0.010	513
Screening Std.		*0.0041*	*0.087*	*0.19*	*0.0026*	*0.49*	*0.032*	*1.0*	*0.000012*	*0.0093*	*No Std.*	*0.005*	*0.296*	*342*
SWP-REF (pond)	Aug-03	*<0.005*	*<0.050*	*<0.005*	*<0.001*	*<0.010*	*<0.005*	*1*	*<0.20*	*<0.005*	*<0.005*	*<0.004*	*<0.010*	*342*

Dissolved metals in mg/l (ppm)

[1] Screening standard is Chronic Aquatic Wildlife Criteria as adjusted for hardness (Utah Water Quality Standards, R317-2, Table 2.14.3a).

[2] Standard is based on trivalent species, although sample result is for all species.

[3] Screening standard is aquatic Wildlife Criteria, 1-hour average (Utah Water Quality Standards, R317-2, Table 2.14.2), detection limit slightly > standard.

[4] Screening standard is Aquatic Wildlife Criteria, 4-day average (Utah Water Quality Standards, R317-2, Table 2.14.2)

[5] Screening standard is Aquatic Wildlife Criteria, maximum (Utah Water Quality Standards, R317-2, Table 2.14.2)

* - Mercury analysis performed using EPA method 1631 with parts per trillion resolution.

Bold values exceed screening standard.

Table 4-20, Richardson Flat Analytical Results Summary, Phase I and II Sediments

units mg/Kg

Date*	Sample #	AG	AL	AS	BA	BE	CD	CO	CR	CU	FE	HG	KJELN	MN	MOIST.	NI	P	PB	PH	S*	SB	SE	TL	TOC	V	ZN
Jun-03	RFB-SED-SD01	30.5	6700	159	173	0.3	52	15	38	255	40300	3.69		2290	39.1	21		3200	6.6	63	67	9.2	4.5		12	13400
Jun-03	RFB-SED-SD02	30.3	11200	202	55	0.5	98	17	49	436	49900	4.74		1910	54.2	23		4800	6.5	113	59	12.1	5.8		22	14500
Aug-03	RFB-SD-SD-2	36.	9226.	273.	181.	<1.0	80.	25.	39.	441.	43640.	6.2	0.29	2067.	55.	27.	2146.	5175.	7.1	462.	112.	<10.	6.4	38.	26.	14380.
Jun-03	RFB-SED-SD03	35.3	17800	137	146	0.8	55	14	33	457	29500	1.49		6710	69	20		2490	6.6	1359	52	6.7	8.7		34	13200
Jun-03	RFB-SED-SD04	56.5	15100	356	208	0.5	58	17	44	563	36000	3.62		3730	58.4	29		5280	6.5	324	72	8	11		27	9340
Jun-03	RFB-SED-SD504	56	15600	235	274	0.5	36	10	27	416	37200	3.2		3900	59.1	18		3360	6.6	32	73	8	11		20	9720
Aug-03	RFB-SD-SD-4	58.	12200.	453.	361.	<1.0	65.	15.	34.	542.	34750.	3.7	0.11	1992.	46.	22.	3024.	8079.	7.5	714.	198.	10.	13.	160.	25.	10680.
Jun-03	RFB-SED-SD05	40.6	6760	447	91	0.3	62	9.7	21	643	59900	1.36		3490	71.5	16		3920	6.7	823	109	6.2	21		7	22600
Jun-03	RFB-SED-SD06	44	24200	422	337	1.2	72	19	42	598	42100	4.02		2730	69.7	30		5240	6.7	824	66	9.8	6.5		48	12100
Aug-03	RFB-SD-SD-6	85.	16770.	450.	281.	<1.0	98.	27.	33.	783.	39060.	4.2	0.64	3710.	73.	33.	2289.	7893.	7.1	117.	158.	<10.	7.6	57.	42.	17230.
Jun-03	RFB-SED-SD07	28	12200	333	137	0.4	83	8.9	28	509	35700	1.23		3460	86.6	16		4430	7.3	1086	73	8.7	15		18	11100
Jun-03	RFB-SED-SD08	31.2	11630	168	146	0.4	24	9	25	418	18800	1.14		6870	85.4	21		3520	6.9	131	103	8.6	21		16	11000
Jun-03	RFB-SED-SD09	56	15500	261	200	0.4	53	26	39	506	33200	3.84		10800	53.6	29		5650	7.2	3925	80	7.5	<2.5**		25	9460
Jun-03	RFB-SED-SD10	56.3	6500	208	224	0.5	37	4.3	24	613	13900	2.06		1740	83.7	14		5860	5.8	303	169	11.9	12		13	6330
Aug-03	RFB-SD-SD10	43.	5402.	331.	447.	<1.0	54.	6.3	14.	539.	27240.	0.48	1.32	8803.	87.	20.	2588.	4477.	7.3	976.	176.	11.	20.	210.	12.	13100.
Jun-03	RFB-SED-SD11	42.3	4700	248	243	0.2	78	14	68	523	17700	3.23		2390	46.1	32		5240	6.8	1114	127	10.6	15		9	9560
Aug-03	RFB-SD-SD-11	73.	6272.	300.	288.	<1.0	73.	17.	33.	529.	23340.	0.96	0.28	2458.	71.	19.	1945.	5259.	7.7	691.	133.	<10.	19.	61.	12.	9522.
Aug-03	RFB-SD-SD-5011	93.	6397.	346.	312.	<1.0	69.	9.1	23.	631.	23740.	0.62	0.47	2489.	72.	15.	2018.	6729.	7.5	658	160.	<10.	23.	68.	14.	9688.
Jun-03	RFB-SED-SD12	17.2	5530	104	156	0.2	42	12	54	218	17000	1.05		4090	34.9	24		2480	6.9	1722	45	4.8	7.1**		11	7190
Jun-03	RFB-SED-SD13	19.1	6030	118	136	0.2	47	11	39	218	23800	1.21		4500	24.3	19		2430	6.7	1231	43	6.8	<5.0**		10	7490
Jun-03	RFB-SED-SD14	26.6	8090	119	28.7	0.2	29	9.9	16	724	55600	0.54		7050	76.5	9		2430	7.3	695	67	6.9	<2.5**		9	6580
Aug-03	RFB-SD-SD-14	44.	7899.	157.	248.	<1.0	35.	13.	17.	668.	48180.	0.36	0.76	10450.	78.	14.	1917.	2595.	7.2	2006.	51.	<10.	11.	95.	12.	5448.
Jun-03	RFB-SED-SD15	20.9	5020	118	527	0.2	34	30	56	124	21100	0.33		61500	43.3	35		1510	6.1	1066	29	3.5	<20**		14	10600
Aug-03	RFB-SD-SD-15	57.	4074.	110.	649.	<1.0	36.	32.	39.	127.	23310.	0.35	0.26	61660.	57.	28.	1818.	1353.	8.0	1163.	41.	42.	38.	57.	12.	10270.
Jun-03	RFB-SED-SD16	35.7	14500	265	90.9	0.4	52	9.9	17	327	46700	0.94		2020	71.9	13		3320	6.5	2594	97	7.5	8.1**		18	15600
Jun-03	RFB-SED-SD17	25.7	6010	55	1490	0.3	6.8	28	46	27	8480	0.05		161000	68.9	28		250	7	<20	27	1.1	<40**		14	9150
Aug-03	RFB-SD-SD-17	18.	6569.	143.	605.	<1.0	44.	43.	48.	148.	21650.	0.26	0.24	70170.	39.	37.	1771.	1417.	8.0	1357.	51.	50.	50.	18.	19.	12580.
Jun-03	RFB-SED-SD18	6.95	17100	36	149	0.5	7.3	12	41	145	20400	0.61		1060	35.9	24		1040	7	2165	15	2.8	<2.5		23	2380
Aug-03	RFB-SD-SD-18	8.8	11430.	46.	105.	<1.0	12.	18.	38.	155.	18790.	0.15	0.40	1923.	57.	27.	1882.	1512.	7.5	1411.	24.	<10.	3.3	44.	26.	3067.
Jun-03	RFB-SED-SD19	10.6	12000	50	128	0.3	8.1	9	25	126	16800	0.78		625	66.9	14		1170	7	680	28	4.9	3.7		16	2430
Jun-03	RFB-SED-SD5019	10	12300	59	119	0.3	12	12	42	181	24100	1.18		818	56.9	22		1520	6.8	734	23	4.9	<2.5		19	2370
Jun-03	RFB-SED-SD20	3.77	9460	50	148	0.4	7.1	13	28	81	20500	0.06		4880	70.2	20		455	6.9	660	15	2.8	5.9		22	2790
Aug-03	RFB-SD-SD-20	1.6	8991.	61.	166.	<1.0	4.3	22.	30.	49.	20290.	0.050	0 32	5354.	59.	26.	1453.	251.	7.6	430.	<10.	<10.	6.5	22.	23.	1871.
Aug-03	RFB-SD-SD-5020	3.6	9222.	62.	165.	<1.0	6.0	21.	30.	64.	24290.	0.041	0.35	6435.	55.	26.	1444.	443	7.5	494.	10.	<10.	6.3	32.	25.	1982.
Aug-03	RFB-SD-REF-POND	<1.0	15930.	10.	459.	<1.0	0.78	20.	30.	31.	30810.	<0.020	0.22	2099.	45.	20.	1631.	39.	7.0	458.	<10.	<10.	<2.5	20.	63.	118.
Aug-03	RFB-SDW-REF	53.	13560.	38.	2562.	<1.0	0.93	68.	33.	30.	53780.	<0.020	0.63	70240.	80.	22.	4817.	82.	7.8	49.	<10.	43.	41.	58.	35.	145.
Aug-03	RFB-SD-REF01	75.	10900.	44.	2194.	<1.0	0.84	68.	21.	20.	61660.	<0.020	0 69	32260	82.	17.	5363.	53.	7.4	35.	<10.	10.	15.	58.	17.	135.

* - Phase I samples collected in June 2003 and Phase II sampes collected in August 2003

Sample RFB-SD-504 is a duplicate of RFB-SD-SD04

Sample RFB-SD-5011 is a duplicate of RFB-SD-SD-11

Sample RFB-SD-5019 is a duplicate of RFB-SD-SD19

Sample RFB-SD-5020 is a duplicate of RFB-SD-SD-20

Table 4-21, Richardson Flat Analytical Results, Sediment Toxicity, 28 Day Hyalella Survival

	Test Day 28		
Test Sample ID	Average Percent Survival (SD)	Average Dry Weight per Hyalella in Milligrams (SD)	Notes
Lab Control	80(22)	0.51(0.10)	Laboratory control sample
RFB-TOX-SD2	0(0) ab	NA	Wetland, Influenced by Silver Creek
RFB-TOX-SD4	0(0) ab	NA	Wetland, Influenced by Silver Creek
RFB-TOX-SD6	0(0) ab	NA	Wetland, Influenced by Silver Creek
RFB-TOX-SD10	88(10)	0.35(0.07) a	Wetland
RFB-TOX-SD11	84(16)	0.38(0.16) a	Wetland
RFB-TOX-SD5011	90(9)	0.38(0.08) a	Duplicate of RFB-TOX-SD11
RFB-TOX-SD14	93(9)	0.35(0.05) a	Wetland
RFB-TOX-SD15	68(20) b	0.19(0.07) ab	Wetland
RFB-TOX-SD17	28(22) ab	0.06(0.03) ab	Wetland
RFB-TOX-SD18	96(5)	0.57(0.11)	Pond
RFB-TOX-SD20	99(4)	0.58(0.12)	Pond
RFB-TOX-SD5020	99(4)	0.43(0.05)	Duplicate of RFB-TOX-SD20
RFB-TOX-Swwref	60(11) ab	0.26(0.11) a	Reference wetland
RFB-TOX-Refpnd	88(10)	0.30(0.08) a	Reference pond

SD = Standard Deviation
a Statistically different compared to the lab control data.
b Statistically different compared to the reference sample RFB-TOX-Refpnd data.

Data from the reference sample RFB-TOX-Swwref was not used for statistical comparison as it did not meet control performance criteria of this study (at least 80% survival at termination).

Table 4-22, Richardson Flat Analytical Results Summary, Phase II Vegetation

units mg/Kg

Date	Sample #	Species	AG	AL	AS	BA	CD	CO	CR	CU	FE	HG	MN	MOIST.	NI	PB	SB	SE	TL	V	ZN
19-Aug-03	RFB-VEG-SD-2	Phalaris arundinacea	<1.0	86	1.5	36	2	<2.5	0.77	14	140	<0.020	92	58	<2.5	28	0.47	<1.0	2.8	<2.5	644
19-Aug-03	RFB-VEG-SD-502	Phalaris arundinacea	<1.0	56	0.74	32	1.1	<2.5	0.53	8.1	99	<0.020	64	62	<2.5	23	0.5	<1.0	3.6	<2.5	540
20-Aug-03	RFB-VEG-SD-4	Eleocharis palustris	<1.0	76	23	11	<0.50	<2.5	<0.50	10	762	<0.020	397	69	<2.5	13	0.77	<1.0	4.5	<2.5	184
20-Aug-03	RFB-VEG-SD-6	Typha latifolia	<1.0	305	16	22	3.5	<2.5	0.84	12	1241	<0.020	2833	80	2.9	107	3.6	<1.0	<2.5	<2.5	903
20-Aug-03	RFB-VEG-SD-10	Juncus balticus	<1.0	21	0.51	20	<0.50	<2.5	<0.50	5.6	64	<0.020	639	56	<2.5	5	0.58	<1.0	<2.5	<2.5	51
20-Aug-03	RFB-VEG-SD-11	Carex aquatilis	<1.0	81	3	21	<0.50	<2.5	0.54	7.2	257	<0.020	345	54	<2.5	8.3	0.56	<1.0	<2.5	<2.5	50
20-Aug-03	RFB-VEG-SD-14	Juncus balticus	<1.0	30	0.53	<2.5	<0.50	<2.5	<0.50	8.5	67	<0.020	129	73	<2.5	2.9	0.25	<1.0	<2.5	<2.5	12
20-Aug-03	RFB-VEG-SD-15	Geum macrophyllum	<1.0	251	5	20	1.9	<2.5	1.1	14	1083	<0.020	1590	64	<2.5	52	2.5	<1.0	2.9	<2.5	535
20-Aug-03	RFB-VEG-17-01	Salix exigua	<1.0	29	0.63	3.6	2.2	<2.5	<0.50	5.9	75	<0.020	320	55	<2.5	4.9	0.54	<1.0	<2.5	<2.5	256
20-Aug-03	RFB-VEG-SD-17-02	Ribes aureum	<1.0	20	<0.50	<2.5	<0.50	<2.5	<0.50	4.4	32	<0.020	14	70	<2.5	2.3	0.23	<1.0	<2.5	<2.5	16
21-Aug-03	RFB-VEG-SD-19	Juncus balticus	<1.0	32	0.58	11	0.67	<2.5	<0.50	6.5	60	<0.020	234	50	<2.5	8.3	1.2	<1.0	<2.5	<2.5	50
21-Aug-03	RFB-VEG-SD-20	Agrostis stolonifera	<1.0	101	1.1	6.2	<0.50	<2.5	<0.50	5.9	167	<0.020	165	54	<2.5	4.4	0.46	<1.0	<2.5	<2.5	37
21-Aug-03	RFB-VEG-POND-01	Myriophyllum exalbescens	1.6	122	4.1	126	<0.50	<2.5	1	3.7	650	<0.020	12680	81	<2.5	7.4	1.1	<1.0	<2.5	<2.5	93
21-Aug-03	RFB-VEG-POND-02	Typha latifolia	<1.0	16	0.64	9.8	<0.50	<2.5	<0.50	2.4	64	<0.020	1680	76	<2.5	2.2	0.29	<1.0	<2.5	<2.5	28
21-Aug-03	RFB-VEG-POND-03	Lemna minor	1.8	716	15	123	1.4	15	2.1	8.5	4246	<0.020	14363	91	6.1	41	3.1	1.5	<2.5	3.4	1299
19-Aug-03	RFB-VEG-REF-01	Carex aquatilis	<1.0	16	<0.50	34	<0.50	<2.5	<0.50	6.7	63	<0.020	735	53	<2.5	7.9	0.81	<1.0	<2.5	<2.5	38
19-Aug-03	RFB-VEG-REF-02	Carex aquatilis	<1.0	25	<0.50	86	<0.50	<2.5	0.67	4	65	<0.020	1216	56	<2.5	6.5	0.72	<1.0	<2.5	<2.5	28
19-Aug-03	RFB-VEG-REF-03	Typha latifolia	<1.0	59	<0.50	72	<0.50	<2.5	<0.50	3.3	148	<0.020	2538	83	<2.5	2	0.22	<1.0	<2.5	<2.5	13
19-Aug-03	RFB-VEG-REF-04	Myriophyllum exalbescens	<1.0	11490	11	657	<0.50	11	7.1	8.4	28250	<0.020	9583	84	9.2	9.5	0.16	<1.0	<2.5	14	62
19-Aug-03	RFB-VEG-REF-05	Lemna minor	<1.0	3925	14	452	<0.50	12	3.1	6.6	19900	<0.020	6990	90	4.4	11	0.71	<1.0	<2.5	7.8	47

Table 4-23, Richardson Flat Analytical Results Summary, Fish, Macroinvertebrates and Snails

units mg/Kg

Date	Sample #	Media	AG	AL	AS	BA	CD	CO	CR	CU	FE	HG	MN	MOIST.	NI	PB	SB	SE	TL	V	ZN
18-Aug-03	RFB-FI-POND 1	Fish	<0.10	75.	0.53	4.4	<0.50	<2.5	<0.50	1.7	151.	<0.020	165.	78	<2.5	7.9	0.17	<1.0	<2.5	<2.5	127.
18-Aug-03	RFB-FI-POND 5001	Duplicate FI-POND-01	<0.10	27.	<0.50	3.3	<0.50	<2.5	<0.50	1.1	81.	<0.020	97.	77	<2.5	2.7	0.10	<1.0	<2.5	<2.5	68.
18-Aug-03	RFB-FI-POND 2	Fish	<0.10	44.	<0.50	4.2	<0.50	<2.5	<0.50	1.3	105.	<0.020	173.	77	<2.5	4.6	0.11	<1.0	<2.5	<2.5	93.
18-Aug-03	RFB-BMI-WETLAND-01	Bugs	<1.0	<20.	1.7	<2.5	<0.50	<2.5	<0.50	3.2	108.*	<0.020	10	89	<2.5	4	0.11	<1.0	<2.5	<2.5	49
19-Aug-03	RFB-BMI-WETLAND-02	Bugs	<1.0	<20.	<0.50	2.7	<0.50	<2.5	<0.50	6	99.*	<0.020	141	86	<2.5	4.5	0.18	<1.0	<2.5	<2.5	44
21-Aug-03	RFB-BMI-POND-01	Bugs	<1.0	<20.	<0.50	<2.5	<0.50	<2.5	<0.50	2.2	29.*	<0.020	23	88	<2.5	1.4	<0.050	<1.0	<2.5	<2.5	26
21-Aug-03	RFB-BMI-POND-5001	Duplicate BMI-POND-01	<1.0	<20.	<0.50	<2.5	<0.50	<2.5	<0.50	2	25.*	<0.020	32	87	<2.5	0.43	<0.050	<1.0	<2.5	<2.5	23
21-Aug-03	RFB-SNAIL-POND-01	Snails	<1.0	21	0.72	16	<0.50	<2.5	<0.50	1.5	122.*	<0.020	1563	81	<2.5	4.8	0.35	<1.0	<2.5	<2.5	20
21-Aug-03	RFB-SNAIL-POND-5001	Duplicate SNAIL-POND-01	<1.0	165	1.4	14	<0.50	<2.5	<0.50	3.1	307.*	<0.020	1189	83	<2.5	15	0.62	<1.0	<2.5	<2.5	201
19-Aug-03	RFB-SNAIL-WETLAND-0	Snails	<1.0	122	3.1	28	<0.50	<2.5	<0.50	4.5	782.*	<0.020	1741	82	<2.5	28	1.1	<1.0	<2.5	<2.5	176
19-Aug-03	RFB-BMI-REF-POND	Bugs, ref pond	<1.0	49	<0.50	6	<0.50	<2.5	<0.50	3.2	202.*	<0.020	23	83	<2.5	0.11	<0.050	<1.0	2.7	<2.5	19
19-Aug-03	RFB-BMI-REF-WETLAND	Bugs, ref wetland	<1.0	28	<0.50	20	<0.50	<2.5	<0.50	9.4	337.*	<0.020	238	87	<2.5	0.16	<0.050	<1.0	<2.5	<2.5	17
19-Aug-03	RFB-SNAIL-REF	Snails, ref site	<1.0	54	0.68	38	<0.50	<2.5	<0.50	1.9	677.*	<0.020	247	82	<2.5	0.18	<0.050	<1.0	<2.5	<2.5	5.3

Table 5-1
Summary of Chemistry Data for Tailings

	Parameter	Range (this study)	Average (this study)	Range (EPA, 1985)	Single Value (EPA, 1993)
Ag	Silver	9-96	28	7.9-26	20.3J
Al	Aluminum	813-15600	2864	484-1410	2960
As	Arsenic	148-417	254	218-328	357J
Ba	Barium			31-86	117
Be	Beryllium			<2	1.2
Ca	Calcium			54200-117000	59200
Cd	Cadmium	14-87	34	53-169	83.0J
Co	Cobalt			<1-4.5	12.6
Cr	Chromium	<5-111	20	6.3-16	12.9J
Cu	Copper	163-1300	420	225-335	454
Fe	Iron	28500-77500	43839	22600-80800	67300
Hg	Mercury	0.28-4.9	1.9	0.94-2.26	3.6J
K	Potassium				917
Mg	Magnesium			11100-13300	10100
Mn	Manganese			1630-5990	2020
Na	Sodium			2230-11300	209NJ
Ni	Nickel			<6-7	
Pb	Lead	1470-14700	4530	2770-4920	5770
Sb	Antimony	18-312	110	31-171	142J
Se	Selenium	<5-18	9	<1-9.4	25.4J
Tl	Thallium			<20	41.7
V	Vanadium			<2-5.4	13
Zn	Zinc	2110-15300	5993	3980-23200	10000
	Moisture (%)	12-34	23	11.1-13.7	
	pH (std. units)	7.3-7.7	7.53		

All values in ppm except as noted

Table 5-2
Summary of Mineralogy Data For Tailings

Mineral	Formula	Approximate %	Level of Crystallinity
Quartz	$Si0_2$	25-50	High
Calcite	$CaCO_3$	5-40	Medium-High
Dolomite	$CaMg(CO_3)_2$	5-25	Medium
Gypsum	$Ca(SO_4)\ (H_2O)_2$	0-5	Medium
Pyrite	FeS_2	<5	Medium
Galena	PbS		Low?
Ankerite	$Ca(FeMg)(CO_3)_2$	0-<5	Medium
Clinochlore	$(Mg_5Al)(SiAl)_4O_{10}(OH)$		Low?
Tosudite	$Na_{0.3}Al_6(SiAl)_8O_{20}(OH)_{10}\ 4H_2O$		Low?
Brushite	$CaPO_3(OH)\ 2H2O$		Low?
Carlosturanite	$Mg_{21}Si_{12}O_{28}(OH)_{34}\ H2O$		Low?
Iron Oxide	Fe_2O_3		Low?

Table 5-3
Synthetic Precipitation Leaching Procedure (SPLP) Results (mg/l)

Lab #	Date	Sample #	AG	AL	AS	CD	CR	CU	FE	HG	PB	PH	SB	SE	ZN
L011438-001	9-May-01	RF-TA-TP1 2-6'	<0.50	0.14	<0.10	0.52	<0.10	3.6	<0.10	<0.50	13	7.6	<0.10	<0.10	60
L011438-002	9-May-01	RF-TA-TP2 2-6'	<0.05	0.12	<0.10	0.55	<0.10	1.8	<0.10	<0.50	12	7.3	0.11	<0.10	65
L011438-003	9-May-01	RF-TA-TP3 2-6'	<0.05	0.11	<0.10	0.44	<0.10	0.25	<0.10	<0.50	11	7.7	<0.10	<0.10	59
L011438-004	9-May-01	RF-TA-TP502 2-6'	<0.05	0.11	<0.10	0.43	<0.10	0.72	<0.10	<0.50	10	7.6	0.13	<0.10	47

Table 5-4
Acid-Base Potential Test Results

Location	Lime %	Neut. Pot T CaCO3/ 1000 Tons	Acid Pot T CaCO3/ 1000 Tons (4)	Acid/Base Pot T CaCO3/ 1000 Tons (4)	Non-Sulfate Sulfur %	Total Sulfur %	HOT H2O Extr. Sulfur %	HCl Extr. Sulfur %	HNO3 Extr. Sulfur %	Residual Sulfur %	Media
RF-TA-TP1, 2-6'	27.1	271	181	90	5.80	6.73	0.93	<0.01	7.60	0.43	Tailings
RF-TA-TP2, 2-6'	19.8	198	112	87	3.57	3.97	0.40	0.07	3.21	0.29	Tailings
RF-TA-TP3, 2-6'	22.4	224	172	52	5.50	5.80	0.30	0.12	5.03	0.35	Tailings
RF-TA-TP502, 2-6' (1)	20.3	203	129	75	4.12	4.42	0.30	<0.01	4.80	0.25	Tailings
RF-SD-SD1, 0-6"	20.1	201	111	90	3.56	4.09	0.53	0.06	2.86	0.64	Sediment
RF-SD-SD2, 0-6"	18.3	183	94	89	3.01	3.51	0.50	0.33	2.25	0.43	Sediment
RF-SD-SD3, 0-6"	19.6	196	90	106	2.87	3.05	0.18	0.55	1.75	0.57	Sediment
RF-SD-SD4, 0-6"	20.3	203	103	100	3.31	3.46	0.15	0.55	2.34	0.42	Sediment
RF-SD-SD5, 0-6"	12.2	122	41	81	1.31	1.53	0.22	<0.01	1.21	0.17	Sediment
RF-SD-SD550, 0-6" (2)	14.9	149	48	102	1.52	1.75	0.23	0.20	1.11	0.21	Sediment
RF-SD-SD6, 0-6"	8.2	82	19	62	0.62	0.66	0.04	<0.01	0.55	0.07	Sediment

Notes:
(1) Sample RF-TA-TP502, 2-6' IS A DUPLICATE OF RF-TA-TP2, 2-6'
(2) Sample RF-SD-SD550, 0-6" IS A DUPLICATE OF RF-SD-SD5, 0-6"
(3) Sample RF-TSDD-GL5056, 19" C IS A DUPLICATE OF RF-TSDD-GL56, 18" C
(4) ABP calculated from Non-Sulfate Sulfur, %

Table 5-5
Cation Exchange Capacity (CEC) Results

Lab No.	Location	CEC (meq/100g)	Media
01-59324-005	RF-SD-SD1, 0-6"	9.22	Sediment
01-59324-006	RF-SD-SD2, 0-6"	14.20	Sediment
01-59324-007	RF-SD-SD3, 0-6"	25.10	Sediment
01-59324-008	RF-SD-SD4, 0-6"	12.70	Sediment
01-59324-009	RF-SD-SD5, 0-6"	23.50	Sediment
01-59324-010	RF-SD-SD550, 0-6" (1)	19.70	Sediment
01-59324-011	RF-SD-SD6, 0-6"	44.50	Sediment
01-59324-012	RF-TSDD-GL50, 18" C	64.20	Clay
01-59324-013	RF-TSDD-GL56, 18" C	36.00	Clay
01-59324-014	RF-TSDD-GL5056, 19" C (2)	35.30	Clay
01-59324-015	RF-TSDD-GL52, 18" C	62.90	Clay
Notes:			
(1) Sample RF-SD-SD550, 0-6" IS A DUPLICATE OF RF-SD-SD5, 0-6"			
(2) Sample RF-TSDD-GL5056, 19" C IS A DUPLICATE OF RF-TSDD-GL56, 18" C			

Table 5-6
Comparison of Mineralogy of Tailings and South Diversion Ditch Sediments

Tailings

Mineral	Formula	Approximate %	Level of Crystallinity
Quartz	SiO_2	25-50	High
Calcite	$CaCO_3$	5-40	Medium-High
Dolomite	$CaMg(CO_3)_2$	5-25	Medium
Gypsum	$Ca(SO_4)\ (H_2O)_2$	0-5	Medium
Pyrite	FeS_2	<5	Medium
Galena	PbS	Reported	Low?
Ankerite	$Ca(FeMg)(CO_3)_2$	0-<5	Medium
Clinochlore	$(Mg_5Al)(SiAl)_4O_{10}(OH)$	Reported	Low?
Tosudite	$Na_{0.3}Al_6(SiAl)_8O_{20}(OH)_{10}\ 4H_2O$	Reported	Low?
Brushite	$CaPO_3(OH)$ 2H2O	Reported Only in TP-2 Dup	Low?
Carlosturanite	$Mg_{21}Si_{12}O_{28}(OH)_{34}$ H2O	Reported Only in TP-2 Dup	Low?
Iron Oxide	Fe_2O_3	Reported Only in TP-3	Low?

Sediments in South Diversion Ditch

Mineral	Formula	Approximate %	Level of Crystallinity
Quartz	SiO_2	30-45	High
Calcite	$CaCO_3$	<5-20	Medium
Dolomite	$CaMg(CO_3)_2$	NR-15	Medium
Pyrite	FeS_2	<5	Low?-Medium
Galena	PbS	None Reported	
Sphalerite	ZnS	NR-<5	Low?-Medium
Clinochlore	$(Mg_5Al)(SiAl)_4O_{10}(OH)$	NR-reported	Low?
Albite	$NaAlSi_3O_8$	Reported	Low?
Anorthite	$CaAl_2Si_2O_8$	NR-Reported	Low?
Sanidine	$KAlSi_3O_8$	Reported Only at SD-6	Low?
Orthoclase	$KAlSi_3O_8$	Reported Only at SD-6	Low?
Paragonite	$NaAl_2(AlSi_3)O_{10}(OH)_2$	Reported Only at SD-1	Low?
Nontronite	$Na_{0.3}Fe_2Si_4O_{10}(OH)_2XH$	NR-Reported	Low?
Ferro-Gedrite	$Fe_5Al_4Si_6O_{22}(OH)_2$	Reported Only at SD-5	Low?
Muscovite	$KAl_2(Si_3Al)O_{10}(OH)_2$	Reported Only at SD-6	Low?
Montmorillonite	$Na_x(AlMg)_2Si_4O_{10}(OH)_2$	Reported Only at SD-6	Low?

? May be present
NR-None Reported

Appendix 1

Preliminary Hydrogeologic Review of Richardson Flats Tailings Site (WESTON, 1999)

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

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Prepared By

Weston Engineering, Inc.
Park City, Utah
and
Laramie, Wyoming

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.

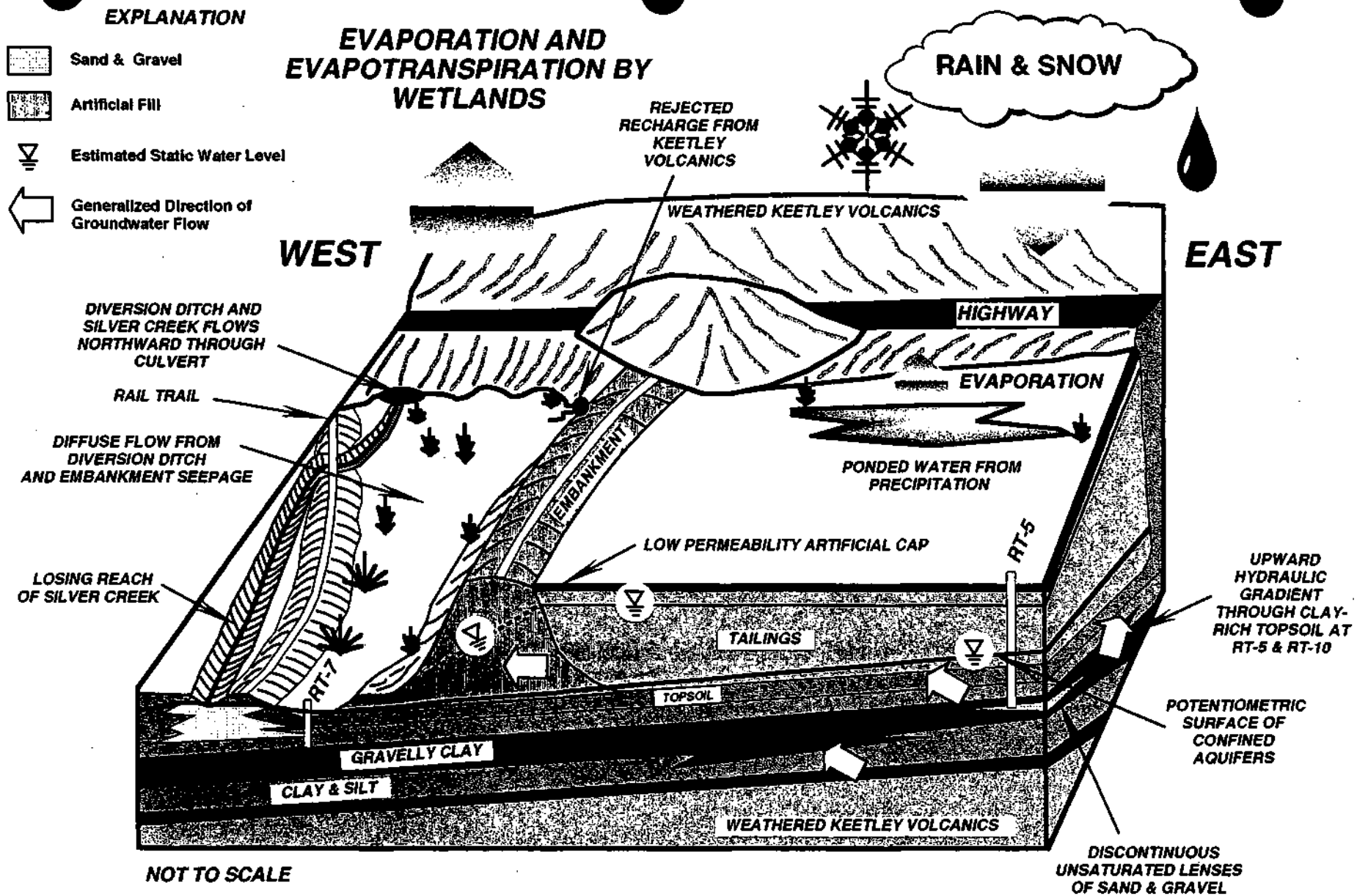
The tailings overlie the topsoil composing the original surface grade. The dark-colored, clay-rich organic topsoil was consistently logged by the various geotechnical and environmental investigations, and serves as the best horizon to correlate between the widely-spaced borings. The pre-tailings topography 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.

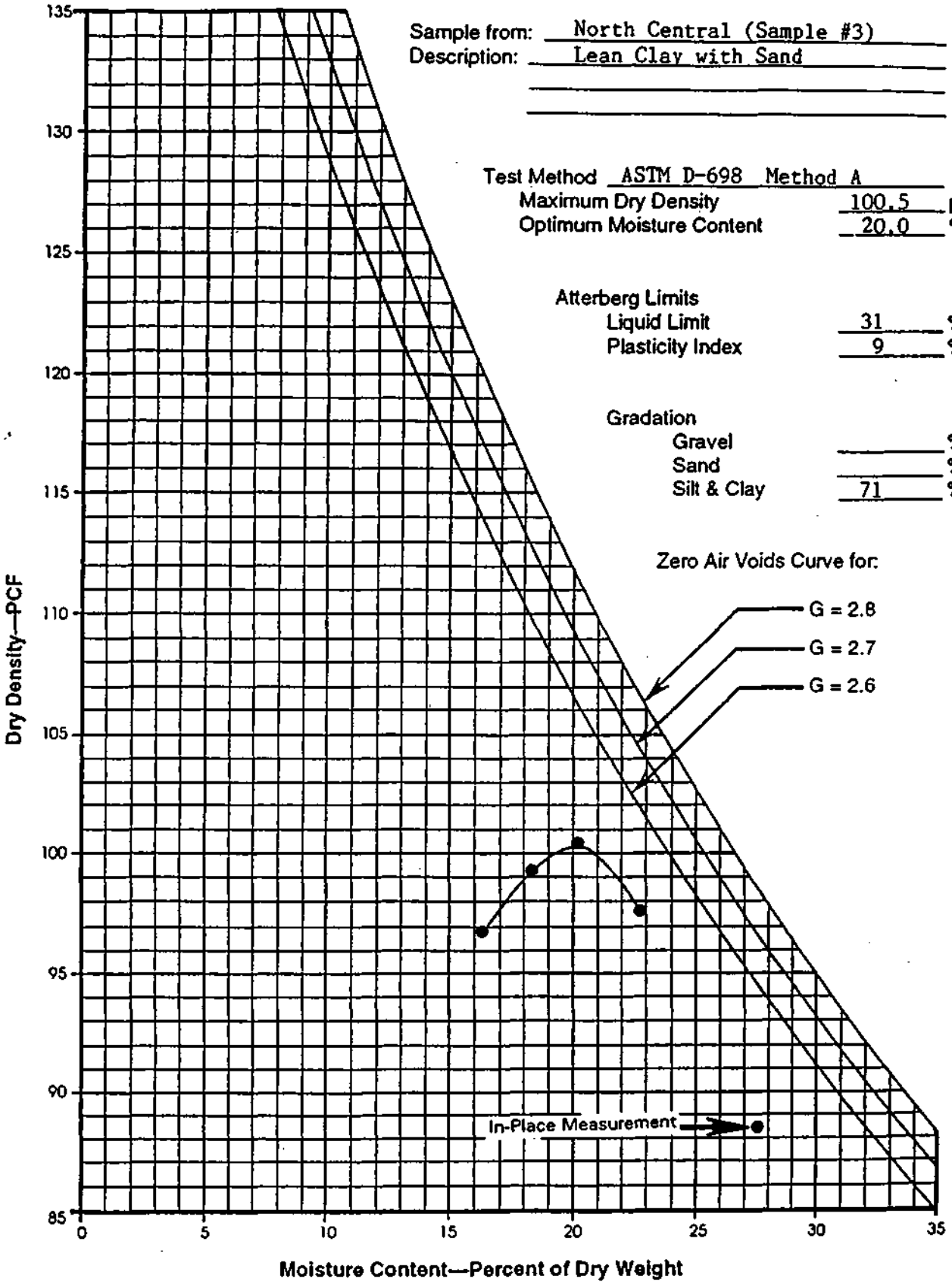
Alluvium. The boring log for the upgradient monitoring well installed by Ecology and Environment (1985; see RT-1 in Attachment No. 1) reveals that water was first encountered at a depth of 17 feet within primarily red-brown clay and gravely sand; deeper drilling encountered yellow-gray clay from 15 to 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



WESTON
GROUNDWATER · ENGINEERING

HYDROGEOLOGIC REVIEW
RICHARDSON FLATS TAILINGS SITE
PRELIMINARY CONCEPTUAL MODEL OF SHALLOW AQUIFER GROUNDWATER FLOW SYSTEM
FIGURE 1

Applied Geotechnical Engineering Consultants, Inc.



Sample from: North Central (Sample #3)
Description: Lean Clay with Sand

Test Method ASTM D-698 Method A

Maximum Dry Density	100.5	pcf
Optimum Moisture Content	20.0	%

Atterberg Limits

Liquid Limit	31	%
Plasticity Index	9	%

Gradation

Gravel		%
Sand		%
Silt & Clay	71	%

Project No. 983806 **COMPACTION TEST RESULTS** Figure 3

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.

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 to the deeper aquifer with lower hydraulic head;
- 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.

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ATTACHMENT NO. 1
BORING LOGS

FIELD LOG OF BORING

PROJECT: Richardson Flats R8-8505-27

BORING NO.: RT-1

DEPTH BELOW LAND SURFACE (feet)	GRAPHIC LOG	DESCRIPTION	SAMPLE INTERVAL	BLOW COUNTS/ 6 in.	COMMENTS
1.5		Topsoil - Dk. Brn, Sandy			
4.0		Dk Red-Brn Sandy, Clayey	5'-7' SS-1		
15		DK Red Brn Gravelly Sand	10-12' SS-2		
23		Pale Yellow-Brn Clay, Sandy, Water @ 17'			
31		Dk Red-Brn Sandy Clay w/ Gravel			
32		Pale Yellow Grey Clay			
34		Dk Red Brn Sandy Clay w/ Gravel			
36		Gravel, Clean, 1/4"-1/2" diam., (Water 10-15gpm)			
38		T.D. Yellow-grey, Clay			

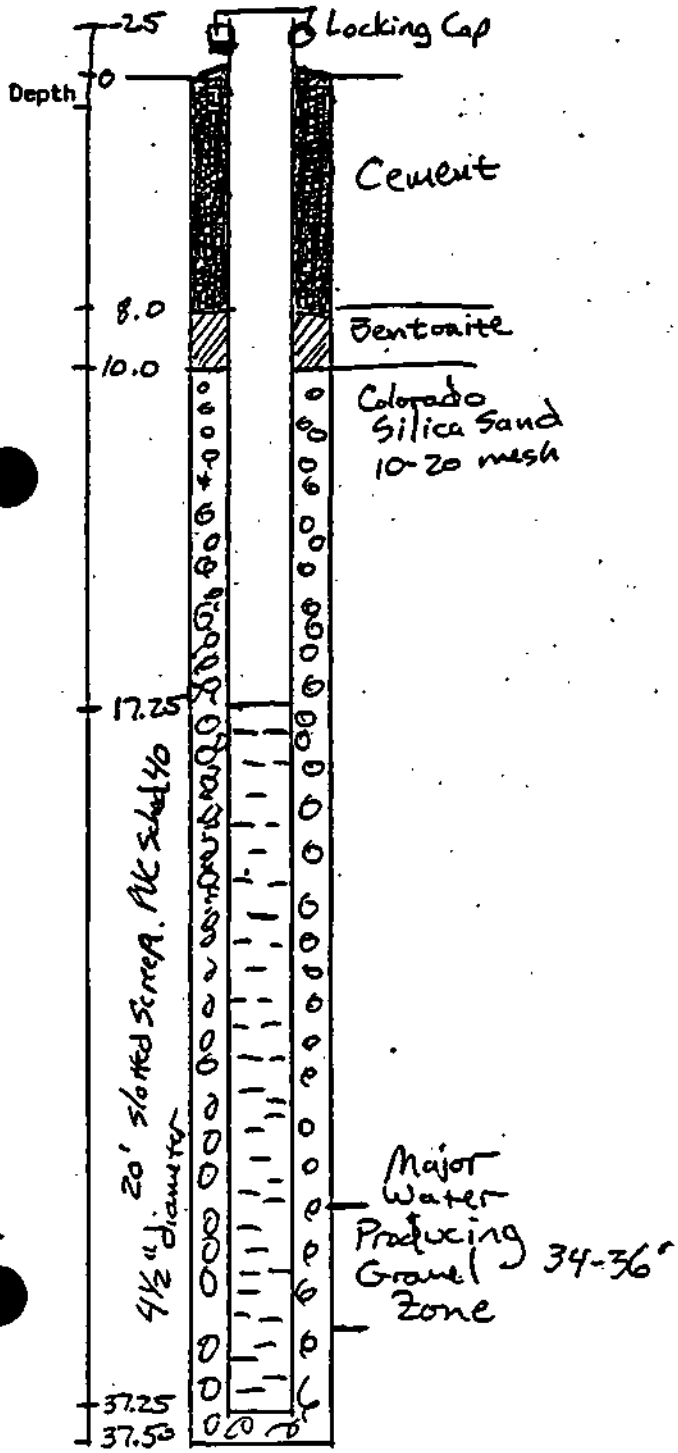
WELL/PIEZOMETER COMPLETION DIAGRAM

Piezometer Number Well # RT-1

Project Richardson Flats R8-8505-27

Aquifer Shallow-Alluvial

Static Water Level ~9'



Geologist Rob Smith

Driller Dave's Drilling - Heber City, UT

Date of Installation 8/1/85

Hole Depth 37.5'

Stickup 2.5'

Protective Casing -2.5' to 2.5' Total 5'

Well Casing -2.5' to 37.5' Total 40'

Top Seal

Cement from 0' to 8'

Bentonite from 8' to 10'

Hole Diameter 7⅞"

Casing Diameter 4½" i.d.

Well Casing Depth 37.25

Screen Diameter 4½" slots =

Centralizers Top of Screen @ 17.5'

Pump Type —

Pump Capacity —

Pump Setting —

Average Pumping —

Remarks Developed by bailing. 185 gallons purged.

DRILLING LOG

Well/Boring Number: Well RT-1 (upgradient)
Project: Richardson Flats Tailings
Project Number: R8-8505-27
Date Started: 8-1-85
Date Completed: 8-1-85

Geologist: Rob Smith
Driller: Dave's Drilling
Geophysical Logger: ——
Permit Number: ——
Property Owner: Park City Mines, Inc.

LOCATION

N. ____
E. ____
Elevation: 6650' ± 10'

SW 1/4 of NE 1/4 of SE 1/4
Section 2 T 2S R 4E
County: Summit State: Utah

Drilling Method: Air Rotary/Casing Drive
Samples: 2 Piezometer
Rig Make and Model: Chicago Pneumatic FCP-7000
Drill Bit Diameter: 7 7/8" (2" splitspoon sampler)

Logs: Res. SP Gam. G-Den. Neut. Calip. Dev. Sonic
Pipe dope used

DRILLING, CORING, BIT AND CASING RECORD

Diameter	Depth From	Depth To	Notes
7 7/8"	0	2	Topsoil
	2	15	Red Brn Sand
	15	23	Yell. Clay
	23	34	Red Sand
	34	38	Gravel

ADDITIVES USED

Depth From	Depth To	Additives

Notes: Two Splitspoon Samples Collected (5-7' + 10-12')
Well completed @ 38', W.L. at ~9'.

RICHARDSON FLATS

ID# UT980952840

BORINGS 1A/1B SERIES

Depth Interval (feet) From	To	Description
0	1.5	CLAYEY SILT: Moderate brown, some dusky brown organic material and fine roots, blocky.
1.5	2.3	CLAYEY SILT: Moderate brown, some dusky brown less organic material and fine roots, firm, damp.
2.3	4.6	CLAYEY SILT: Moderate brown w/ moderate orange pink mottling, stiff, dry.
4.6	4.7	SILTY SAND: Moderate brown, fine to coarse grained, loose, dry to damp.
4.7	11.7	CLAYEY SILT/SILTY CLAY: Moderate brown, 5% sand, stiff, damp to moist, moderate orange pink mottling disappears below 6 feet.
11.7	14.8	SILTY SAND: Moderate brown, fine sand to fine gravel, loose, coarsens with depth, clayey @14.3 to 14.6 feet, damp.
14.8	16	SILTY CLAY: Moderate reddish brown to moderate yellowish brown, firm to very stiff, damp to moist.
16	16.7	CLAYEY SAND AND GRAVEL: Moderate reddish brown, fine sand to fine gravel, 50% silty clay, loose, saturated.
16.7	19	SILTY CLAY: Moderate brown to moderate reddish brown, stiff, damp to moist.
19	22.2	GRAVELLY CLAY: Moderate reddish brown, sandy from 20.2 to 20.8 feet, moist to wet.
22.2	27.5	SILTY CLAY: Moderate yellowish brown, 10% fine to coarse sand, stiff, very stiff @ 25 feet, damp. Lost core from 27 to 31 feet.
27.5	33	CLAYEY GRAVEL: Gravel @ 27.5 feet based on drilling characteristics-clayey gravel from 27.5 to 33 feet.
33	34	CLAY: Yellow brown clay, stiff @ 33 to 34 feet.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 12.80 feet below ground surface on 2/2/99 in RT-1A; 12.65 feet below ground surface on 2/2/99 in RT-1B.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 16.5 to 11.5 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 4 feet. Bentonite chips from 4 feet to ground surface.

FIELD LOG OF BORING

PROJECT: Richardson Flats R8-8505-27

BORING NO.: RT-2 (Tailings)

DEPTH BELOW LAND SURFACE (feet)	GRAPHIC LOG	DESCRIPTION	SAMPLE INTERVAL	BLOW COUNTS/ 6 in.	COMMENTS
0.8		Lt Grey, Sand, No Sulfides, Carbonate			
1.2		Grey Brown, Clay-Silt, Sulfides, Carbonate	SS-3		
1.3		Lt Grey, Sand, No Sulfides, Carbonate	Oxidized		1.0-3.5
3.5		Lt Brown, Clay Silt, Sulfides, Carbonate			
11.0		DK Grey, Sand-Silt, Sulfides, Carbonate	SS-4 red		3.5-7.5
12.5		Lt Brn, Grey, Sand, Gravel, Carbonate + Sulfide		▽12'	
14.0		Lt Grey, Tan, Coarse Sand + Gravel, Carbonate + Sulfide			
16.0		No Recovery			
17.6		Lt Grey-Tan Coarse Sand + Gravel, Carbonate	SS-5 Bottom		12-17.8 w/o 14-16
17.7		DK Grey-Black, Clay, Sulfides			
18.0		DK Brn, Clay-Silt - Native Soil			
22		Gravel - Partial Recovery	SS-6 Water		17.7-18

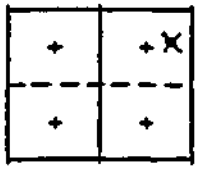
DRILLING LOG

Well/Boring Number Boring RT-2 (Tailings)
Project Richardson Flats Tailings
Project Number R8-8505-27
Date Started 8/2/85
Date Completed 8/2/85

Geologist Rob Smith / D Tweddy
Driller Dave's Drilling
Geophysical Logger —
Permit Number —
Property Owner Park City Mines, Inc.

LOCATION

N. ____
E. ____
Elevation 6600 ± 20



SE 1/4 of NE 1/4 of NE 1/4
Section 2 T 2S R 4E
County Summit State Utah

Drilling Method Air Rotary / Splitspoon Sampler
Samples Piezometer
Rig Make and Model Chicago Pneumatic / CP-7000
Drill Bit Diameter 6" (2" splitspoon)

Logs
Res. SP Gam. G-Den. Neut. Calip. Dev. Sonic
Pipe dope used

DRILLING, CORING, BIT AND CASING RECORD

Diameter	Depth From	Depth To	Notes
6"	0	3.5	Oxidized
	3.5	12.5	Reduced
	12.5	14	Coarse Jig Tails
	16	17.7	Clay Sulfides
	17.7	22	Clay + Gravel

ADDITIVES USED

Depth From	Depth To	Additives

Notes: Four Splitspoon Samples taken
Hole in Tailings Pond
Grouted & Back filled after Sampling
Wet at 12'

RICHARDSON FLATS

EPA ID# UT980952840

BORING RT-3

Depth Interval (feet) From	To	Description
0	0.75	CLAY: Pale reddish-brown, 5% sand, some pebbles and roots, (artificial fill).
0.75	3.7	FINE SAND-TAILINGS: Light olive gray to olive gray, straited, silt, damp to moist @ 2.5 feet.
3.7	7.3	SAND-TAILINGS: Dusky yellow, dry, to increasingly damp and wet @ 6 feet.
7.3	7.8	CLAY: Grayish brown, organic rich, stiff, some roots, moist, (original topsoil).
7.8	9.8	SILTY CLAY: Moderate yellowish brown, firm to stiff, softer in places from 8 to 9.8 feet.
9.8	11	CLAYEY SILT: Grayish-orange, firm to stiff, some white finely crystallive material (kaolinite?) in fractures and pockets, dry to damp.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 4.9 feet below ground surface on 2/2/99.

(3) Plug initial hole with bentonite chips. Direct push new hole to 7 feet. Set 5 feet of 0.010-inch factory-slotted screen from 7 feet to 2 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 1 feet. Bentonite chips to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-4

Depth Interval (feet) From	To	Description
0	1	CLAY: Dusky yellowish brown, organic, soft, roots (artificial fill).
1	2.5	SILT-TAILINGS: Light olive gray.
2.5	5.2	FINE SAND - TAILINGS: Pale yellowish brown, well sorted, dry.
5.2	5.6	FINE SAND AND SILT-TAILINGS: Light brown to pale olive.
5.6	6.2	SILTY CLAY: Dusky brown, organic rich with roots (original top soil).
6.2	7.0	SILTY CLAY: Moderate yellowish brown to light brown, stiff, moist.
7.0	7.4	SILTY CLAY: Grayish-brown, organic rich, soft to firm, with roots, moist to damp.
7.4	8.0	SILTY CLAY: Moderate brown to light brown, stiff to very stiff.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Piezometer was found dry on 2/2/99.

(3) Set 5 feet of 0.010-inch factory slotted screen from 7 to 2 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 2 feet. Bentonite chips to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-5

Depth Interval (feet) From	To	Description
0	0.7	SILTY CLAY: Dusky brown, organic rich, with roots, dry (artificial fill).
0.7	7.0	FINE SAND AND SILT - TAILINGS: Pale olive, dusky yellow, some coarse roots.
7.0	9.0	FINE SAND-TAILINGS: Pale green to dark yellowish brown, damp.
9.0	10.8	FINE SAND - TAILINGS: Medium gray, damp.
10.8	11.8	SILTY CLAY: Dark yellowish brown, organic rich, firm, abundant roots, damp, wet to saturated, (original top soil).
11.8	13	SILTY SAND: Brownish gray, soft, some clay, saturated.
13	14	SANDY CLAY: Greenish-orange, firm, wet, to moist @ 14 feet.
14	15	GRAVELY SAND: Pale reddish brown, compact, silty, damp to moist - not saturated.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 7.30 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 13 feet to 8 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from 13 feet to 7 feet. Bentonite chips to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-6

Depth Interval (feet) From	To	Description
0	0.8	SILTY CLAY: Dusky brown, 5-10% sand, stiff, some roots (artificial fill).
0.8	1.1	CLAYEY SILT-TAILINGS: Light olive gray, soft to firm, damp.
1.1	2.0	FINE SAND-TAILINGS: Light olive gray, dry.
2.0	2.5	SILTY SAND-TAILINGS: Light olive gray, coarse roots, damp.
2.5	6.0	FINE SAND-TAILINGS: Light olive gray to dark yellowish orange.
6.0	14.4	FINE SAND AND SILT-TAILINGS: Medium dark gray, wet.
14.4	15.6	MEDIUM SAND-TAILINGS: Greenish-gray, loose, wet.
15.6	16.0	FINE SAND-TAILINGS: Light olive gray.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 4.87 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 10 to 5 feet; blank 1-inch diameter PVC casing to surface. Natural sand pack to 5 feet. Bentonite chips to surface.

RICHARSON FLATS

ID# UT980952840

BORING RT-7

Depth Interval (feet) From	To	Description
0	6	CLAY: Grayish black, organic rich, soft, spongy, abundant roots, saturated.
6	9.2	GRAVEL: Dark yellowish brown, silty, saturated.
9.2	10.5	GRAVELLY CLAY: Greenish-gray and moderate reddish brown, mottled, firm, damp to moist.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 0.0 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 6 feet to 1 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 1 foot. Bentonite chips to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-8A/B SERIES

Depth Interval (feet) From	To	Description
0	1.2	CLAYEY SILT: Dark reddish brown, organic rich, <5% sand, dry to damp.
1.2	5.3	SILT: Light brown, with moderate orange pink mottling, some coarse roots, dry.
5.3	13.5	SILTY CLAY: Moderate brown, <5% coarse sand, stiff, increasing dampness below 5.3-feet some white material infilling fracture @7 ft; organic material @ 9.3 feet; pebbles @ 12.5 to 12.8 feet; increasingly moist and softer to 13.5, damp.
13.5	15.2	SANDY CLAY: Moderate brown to dark yellowish brown to clayey sand, dark yellowish brown fine sand @ 15.2 feet; 50% fine sand to fine gravel (quartzite and volcanic rock fragments); dry.
15.2	19	SILTY CLAY: Moderate brown, grayish brown organic material @ 16.6 feet, stiff, saturated; yields little free water from 16.6-16.9 feet; moist below 16.9 to 19 feet.
19	21.2	GRAVELLY CLAY: Moderate brown, 25-40% fine sand to fine gravel, moist to wet.
21.2	24	SILTY CLAY: Moderate brown to dark yellowish brown, stiff, w/ 5-10% fine gravel, firm to stiff, moist, moist to wet at 24 feet.
24	26	GRAVELLY CLAY-CLAYEY GRAVEL: Moderate brown, 40-50% fine sand to fine gravel, wet.
26	27	SILTY CLAY: Moderate yellowish brown, firm to stiff, moist.
27	30	SILTY CLAY: Moderate brown, 10-20% fine to coarse sand, soft, compacts easily, blockey.
30	31.7	GRAVELLY CLAY: Moderate brown, 10-20% fine to coarse sand, soft, compacts easily.
31.7	32	SILTY CLAY-CLAYEY SILT: Moderate yellowish brown, 5-10% fine to medium sand, firm to stiff, moist to wet.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 12.30 feet below ground surface in RT-8A; static water level at 12.23 feet below ground surface in RT-8B on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 31 to 26 feet in RT-8B; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from 26 to 25 feet; granular bentonite to surface.
Set 5 feet of 0.010-inch factory-slotted screen from 17 to 22 feet in RT-8A; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from 22 to 16 feet; granular bentonite to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-9

Depth Interval (feet) From	To	Description
0	1.9	SILT: Dusky yellowish brown, organic rich, occasional pebble, dry.
1.9	2.3	SILT: Moderate brown, compact, dry.
2.3	6.0	FINE SAND: Dark yellowish orange, medium gravel, silty @ 5 feet, loose, dry.
6.0	9.6	GRAVELLY SILT: Moderate yellowish brown to moderate brown, 10-20% coarse sand to fine gravel, organic rich layer @ 6.6 feet, loose to firm, dry.
9.6	10.5	SILTY GRAVEL: Moderate yellowish brown, loose, dry.
10.5	11	GRAVEL: Very pale orange, coarse, dry.
11	13.2	GRAVELLY SILT: Moderate yellowish brown, silty gravel, medium sand to medium gravel.
13.2	15.4	GRAVELLY SILT: Moderate reddish brown to dark reddish brown, dry.
15.4	16.0	GRAVELLY SILT: Dark yellowish brown, loose, dry.
16.0	21.8	SILTY GRAVEL: Moderate yellowish brown, saturated and sandy at approximately 19.75 to 21.8, cobble @ 17 feet, then sharp contact and dry below.
21.8	23	GRAVEL: Moderate reddish brown, silty, clayey, moist.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 18.03 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 23 to 18 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 17 feet. Bentonite chips from 4 feet to ground surface.

RICHARDSON FLATTS

EPA ID# UT980952840

BORING RT-10

Depth Interval (feet) From	To	Description
0	2.1	CLAY: Black, organic rich, soft to firm, plastic, moist.
2.1	2.8	SILTY CLAY: Dusky yellowish brown, with 15% medium to coarse sand, firm, damp.
2.8	3.6	SANDY SILT: Dark yellowish brown to moderate yellowish brown, 25 to 40% fine sand, some clay, damp to moist.
3.6	6.3	SILTY SAND: Moderate yellowish brown, loose, well sorted, some coarse sand @ 6.3 feet, increasingly saturated with depth.
6.3	6.6	CLAY: Pale yellowish brown, firm plastic, wet.
6.6	8.0	SILTY SAND: Pale yellowish brown, loose, fine to medium sand, saturated.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 1.1 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 8 feet to 3 feet, blank 1-inch diameter PVC casing to surface. 10x20 sand pack from 3 to 2 feet; granular bentonite chips to surface.

ATTACHMENT NO. 2
X-RAY DIFFRACTION DATA

Analysis of Soil Samples/United Park City Mines Company

Prepared for: Weston Engineering, Inc.
P.O. Box 6037
Laramie, WY 82072
(307) 745-6118

Sample shipped from Park City, UT

Prepared by: Dr. Norbert Swoboda-Colberg
Dept. of Geology & Geophysics
University of Wyoming
P.O. Box 3006

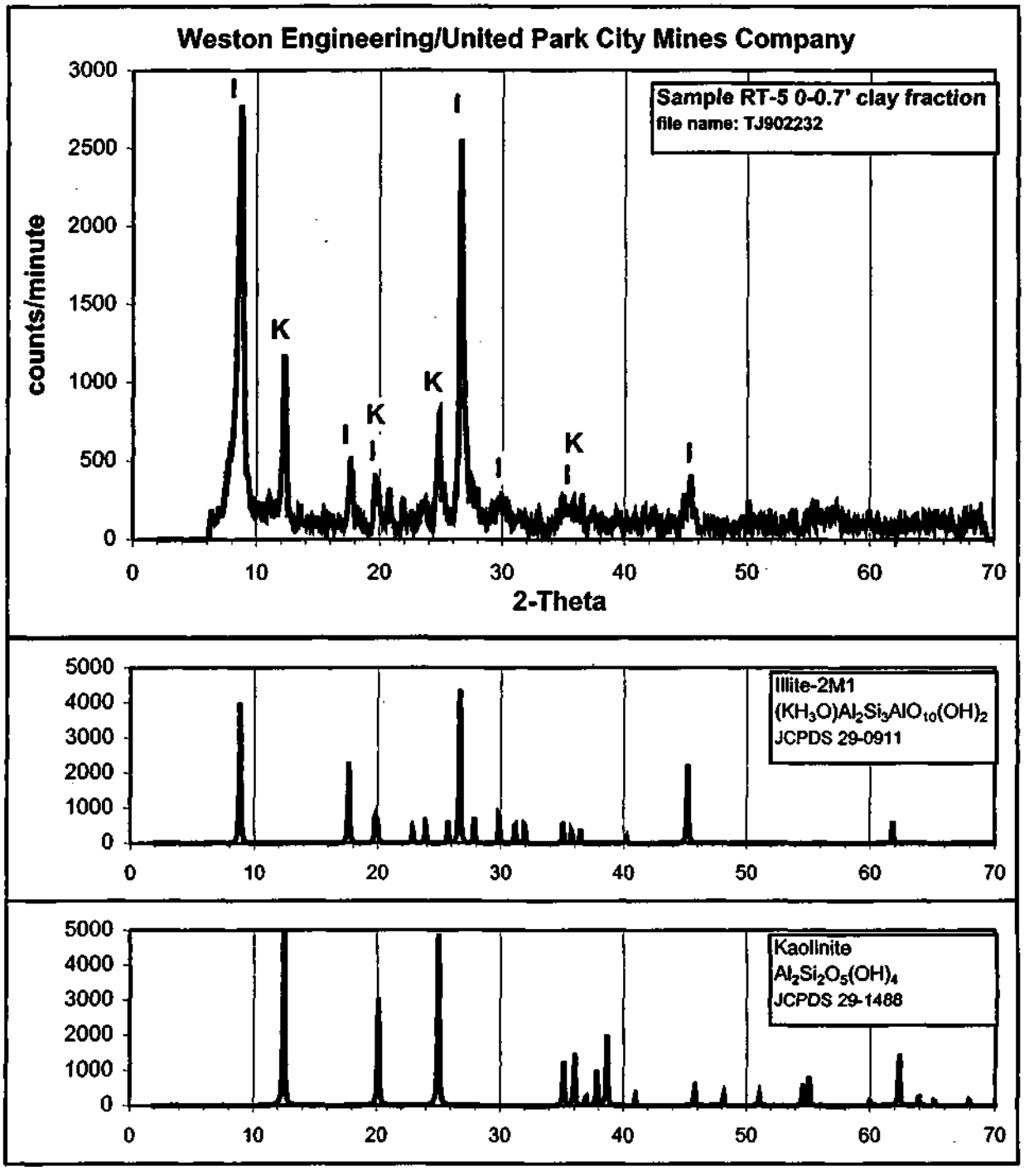
Samples: Boring RT-5, 0-0.7 feet
Boring RT-5, 11 feet
Boring RT-5, 13.5 feet
Sampled at Park City, UT on 2/15/99
Ref.: Bill Loughlin

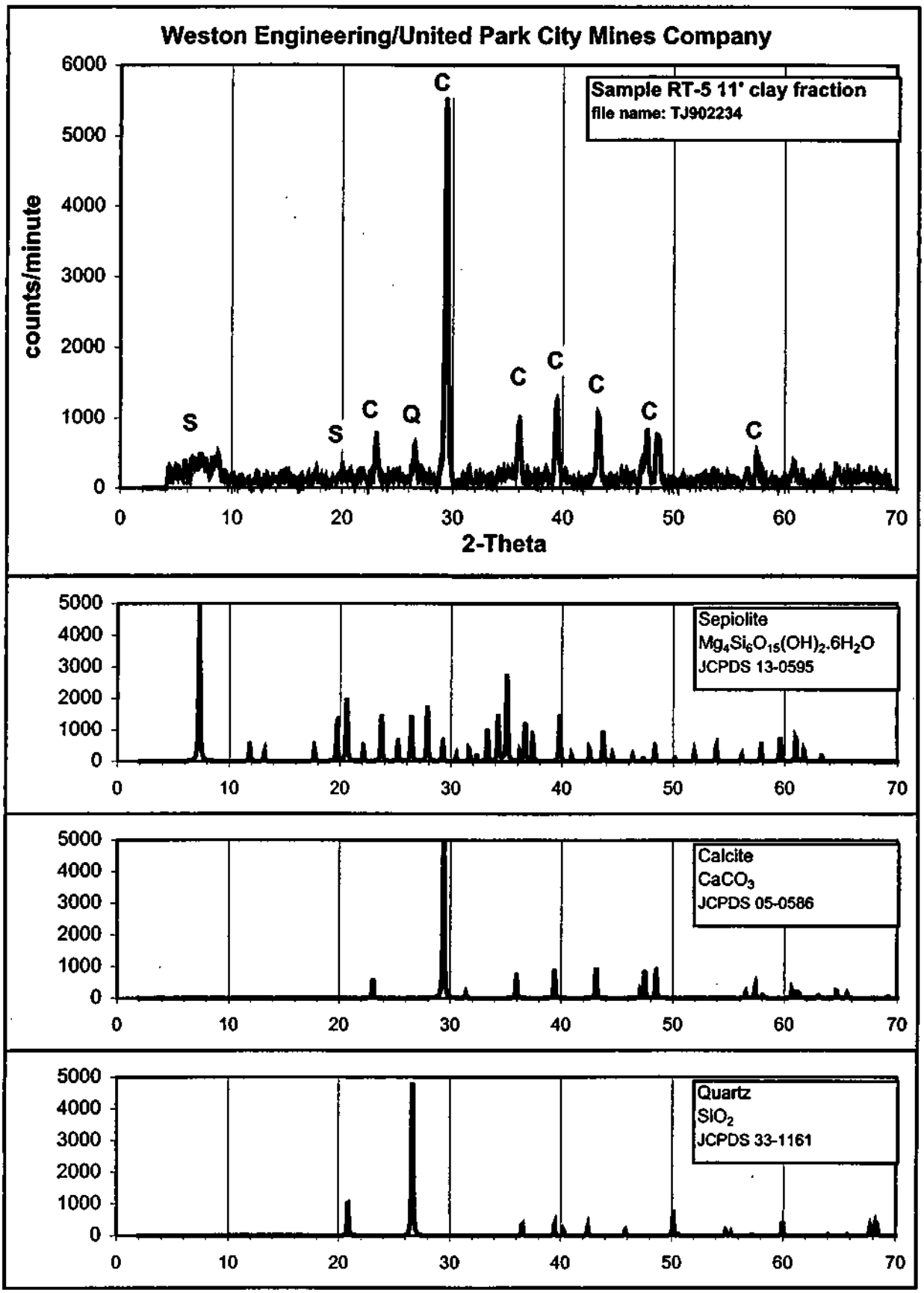
Sample Prep.: Samples were treated according to standard procedures for clay analyses in soils. Samples were treated with peroxide (removal of organic material) and size fractionated to enrich clay fraction.

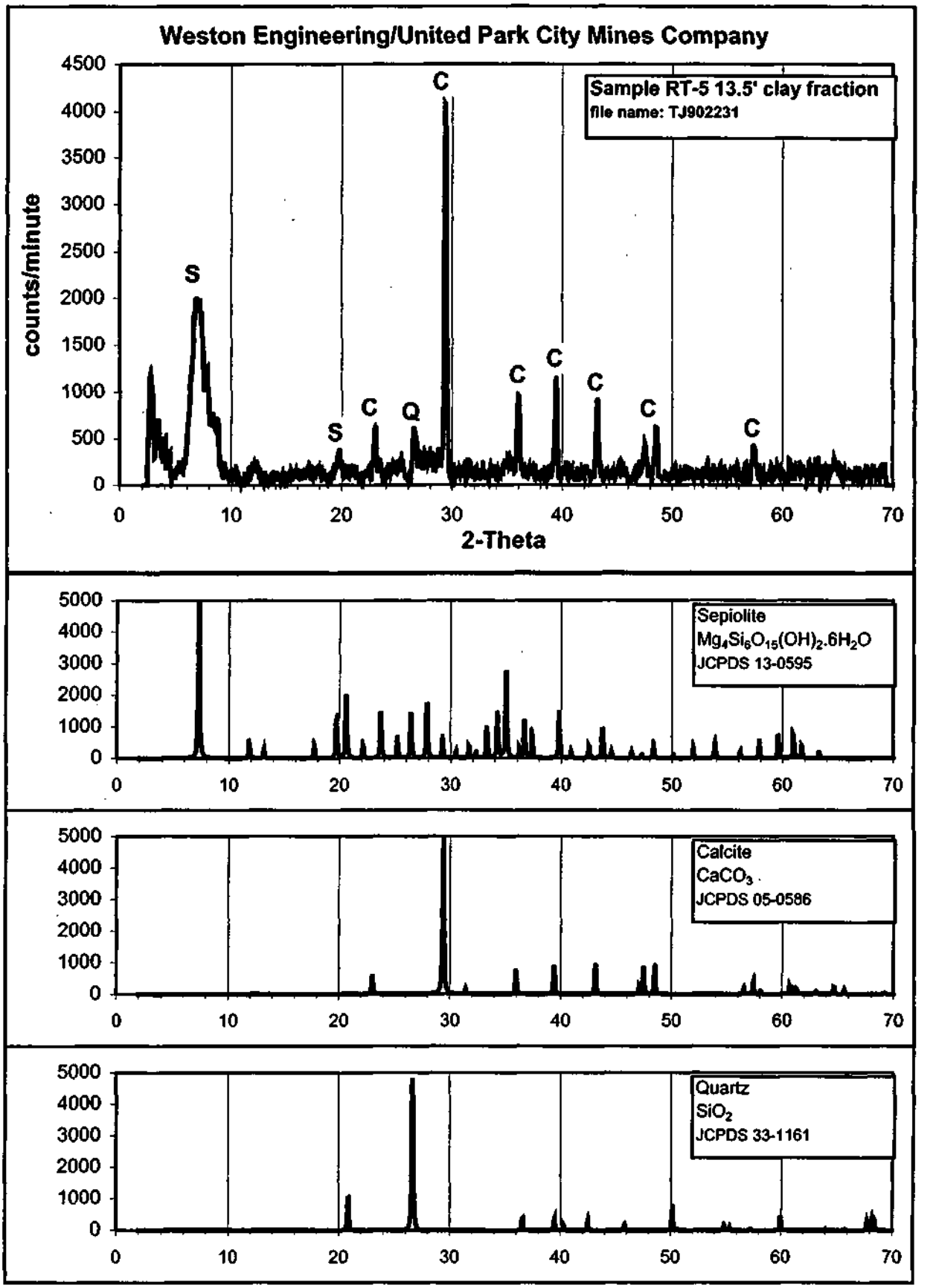
Summary: The two deeper samples (11 and 13.5 feet) were visually very different; the sample from 11 feet depth was relatively organic rich soil, while the sample from 13.5 feet was mostly made up of clay and silt. However, the two samples are very similar in the composition of their clay fraction. In both samples the clay fraction consists of sepiolite, a magnesium silicate, and calcite (calcium carbonate).

The surface sample (0-0.7 feet) has a clay composition which is completely different from that of the deeper samples. In the surface sample, the clay fraction is made up of illite (a potassium aluminum silicate) and kaolinite (an aluminum silicate).

Special Note: Sepiolite, the clay mineral identified in the deeper samples, is a relatively rare clay mineral and would not be expected to be found in the Park City area, although it is not entirely impossible. 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.


Weston Engineering/United Park City Mines Company
Sample RT-5 0-0.7' clay fraction
file name: TJ902232
counts/minute
2-Theta
Illite-2M1
$(KH_3O)Al_2Si_3AlO_{10}(OH)_2$
JCPDS 29-0911
Kaolinite
$Al_2Si_2O_5(OH)_4$
JCPDS 29-1488


Weston Engineering/United Park City Mines Company
Sample RT-5 11' clay fraction
file name: TJ902234
counts/minute
2-Theta
S
S
C
Q
C
C
C
C
C
C
Sepiolite
$Mg_4Si_6O_{15}(OH)_2.6H_2O$
JCPDS 13-0595
Calcite
$CaCO_3$
JCPDS 05-0586
Quartz
SiO_2
JCPDS 33-1161


Weston Engineering/United Park City Mines Company
Sample RT-5 13.5' clay fraction
file name: TJ902231
counts/minute
2-Theta
S
S
C
Q
C
C
C
C
C
C
Sepiolite
$Mg_4Si_6O_{15}(OH)_2.6H_2O$
JCPDS 13-0595
Calcite
$CaCO_3$
JCPDS 05-0586
Quartz
SiO_2
JCPDS 33-1161

ATTACHMENT NO. 3
ARTIFICIAL FILL CAP PERMEABILITY DATA

Applied Geotechnical Engineering Consultants, Inc.

January 12, 1999

Confidential and Privileged: Attorney-Client and Work Product Privilege

LeBoeuf, Lamb, Greene & MacRae, L.L.P.
100 Kearns Building
136 South Main Street
Salt Lake City, UT 84101

Attention: Brad Merrill

Subject: Permeability Testing
United Park City Mines/Richardson Flats Property
Summit County, Utah
Project No. 983806

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to test the soil for classification and permeability on the Richardson Flats property in Summit County, Utah.

FIELD SAMPLING

On December 2, 1998, a representative of AGEC visited the site and tested the soil in its in situ condition for moisture content and dry density. Listed below is a summary of the approximate locations and the in-place moisture content and dry density:

Location No.	Location	Moisture Content (%)	Dry Density (pcf)
1	Main Embankment West	27.5	87.7
2	West Central	26.7	88.7
3	North Central	27.7	88.5

Samples were obtained of the soil immediately beneath the area tested for moisture content and density. These samples were returned to the laboratory for classification testing. The samples are classified as lean clay with sand. The laboratory test results are summarized on Figures 1, 2 and 3.

600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • FAX (801) 566-6493

PERMEABILITY TESTING

Two of the samples were remolded in the laboratory to their in-place moisture content and density. The samples were then tested in a triaxial permeameter to determine the permeability. Listed below is a summary of the laboratory test results:

Sample No.	Sample Location	Permeability (cm/sec)
2	West Central	7×10^{-8}
3	North Central	3×10^{-8}

These two samples were tested with the anticipation that they would provide the boundaries of the highest and lowest of the three samples obtained.

If you have any questions or if we can be of further service, please call.

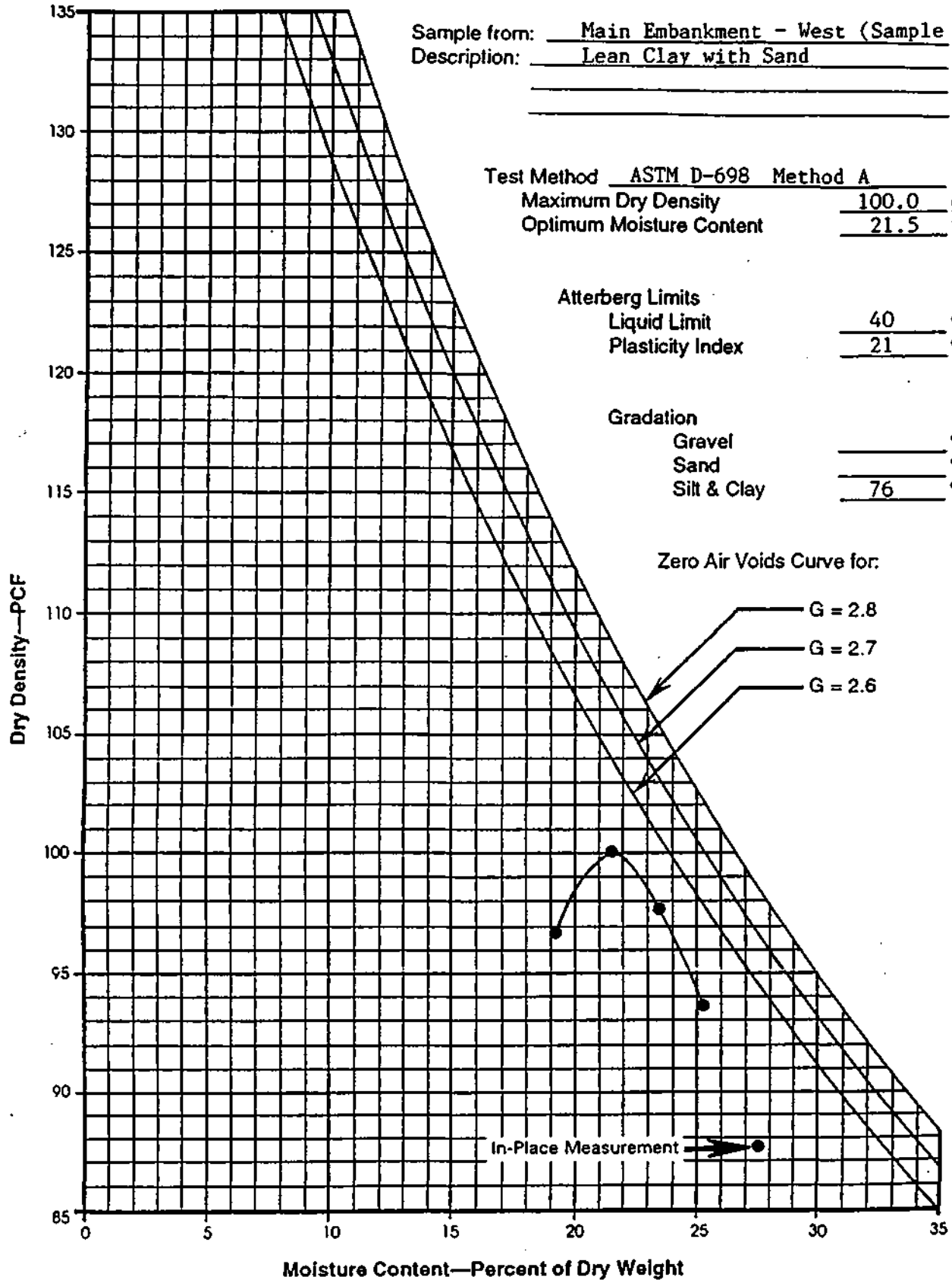
Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

James E. Nordquist, P.E.

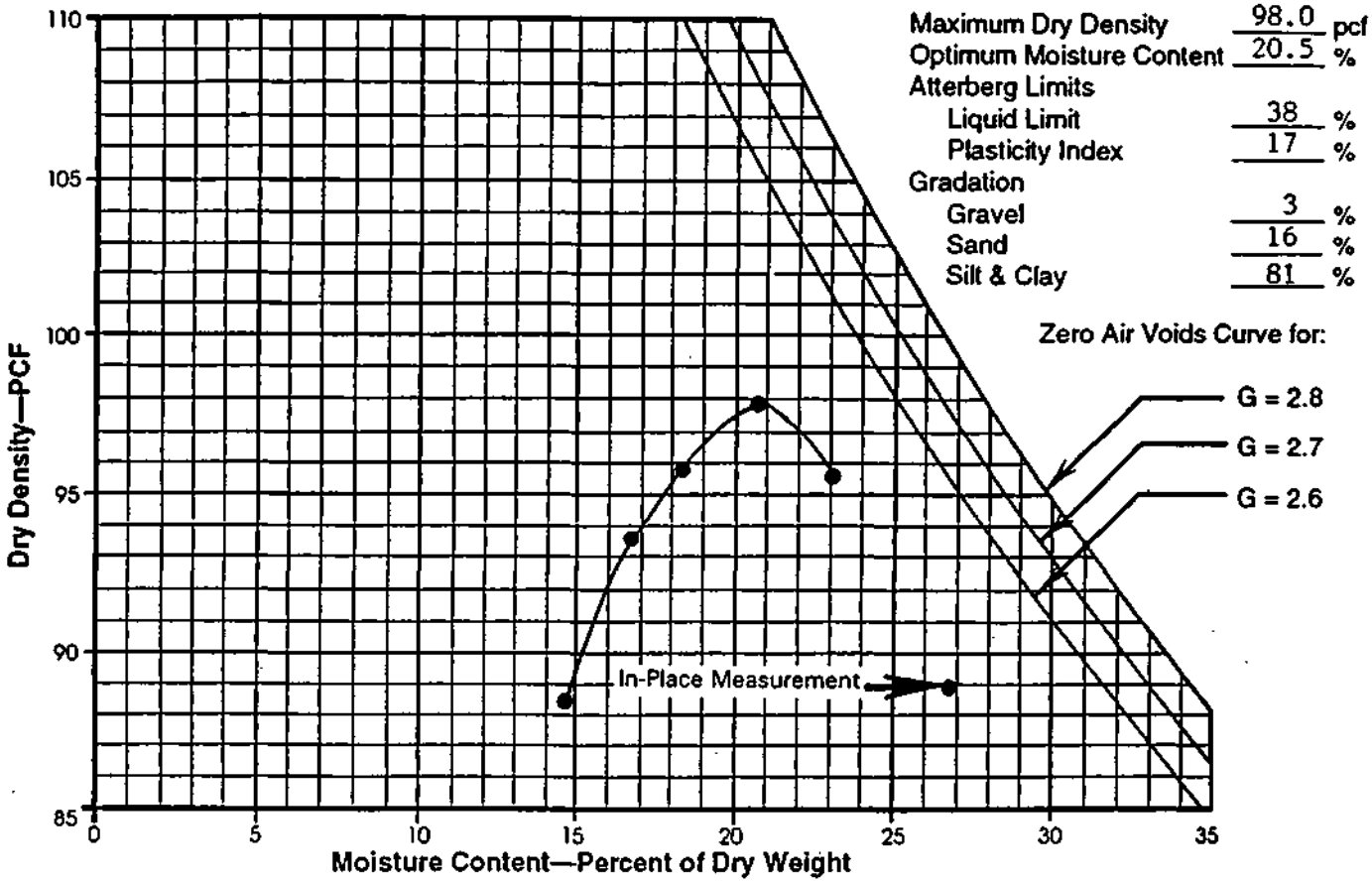
JEN/js

Applied Geotechnical Engineering Consultants, Inc.



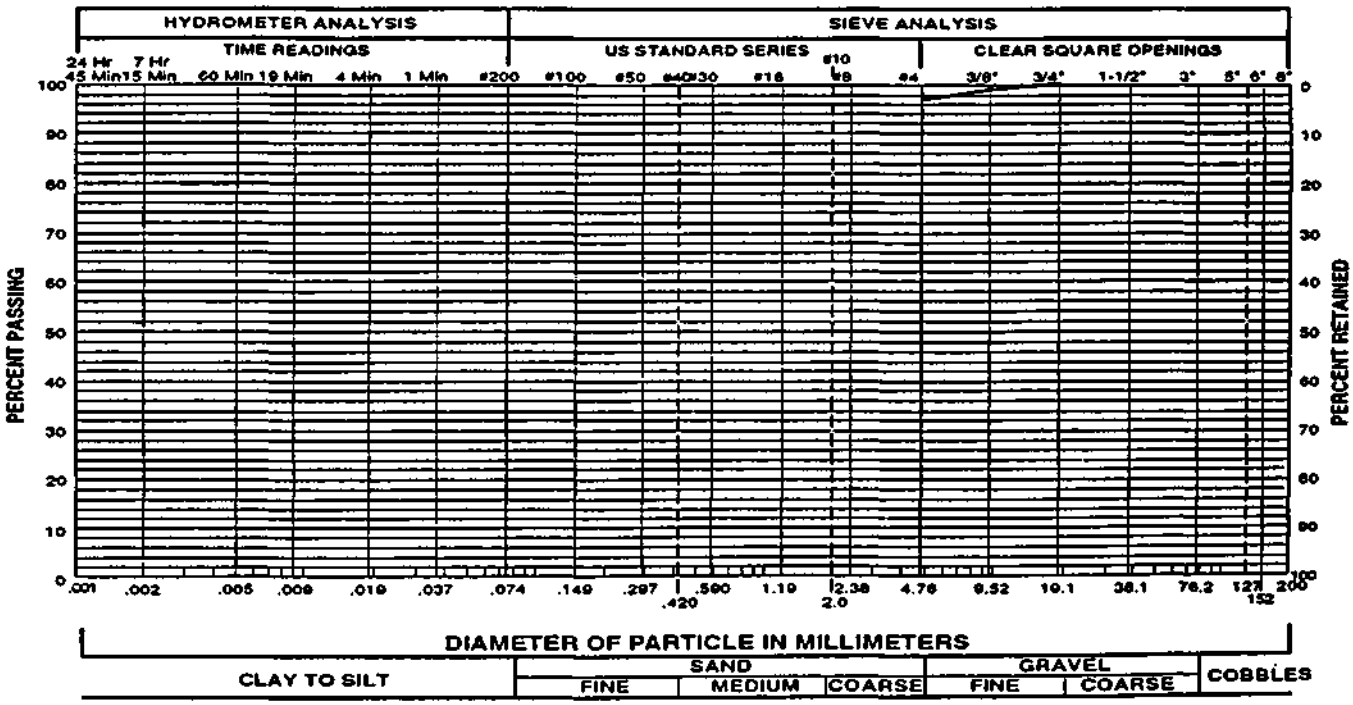
Project No. 983806 **COMPACTION TEST RESULTS** Figure 1

Applied Geotechnical Engineering Consultants, Inc.



Compaction Test Procedure ASTM D-698 Method A

Sample of: Lean Clay with Sand From: West Central (Sample #2)



Project No. 983806

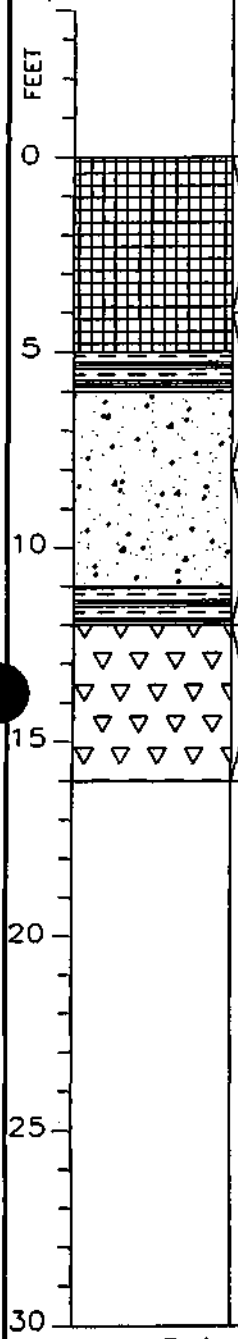
GRADATION & COMPACTION TEST RESULTS

Figure 2

Appendix 2

Monitoring Well and Soil Boring Logs

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	BORING ID: RF-BH-1
	PROJECT: RICHARDSON FLAT	START DATE: 5/7/01
	LOGGED BY: T. LEEDS	END DATE: 5/7/01
	SAMPLE ID: NA	

GRAPHIC LOG	SAMPLES	LITHOLOGIC DESCRIPTION/ COMMENTS
Depth FEET / LITHOLOGY	INTERVAL / RECOVERY / SAMPLE ID	
	3" / 24" / 32" / 18" — NO SAMPLES COLLECTED	0-5' - FILL: RAILROAD/ROAD BASE MATERIAL 4-8'- 12" RECOVERY - BLACK-DARK GRAY CLAY, MOD PLASTIC, SLIGHTLY SILTY, SLIGHTLY STIFF, DAMP 12" RECOVERY - MULTICOLORED GRAVELS, SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 1", DRY 8-12'- 24" RECOVERY - GRAVEL A/A, WET 8" RECOVERY - GREEN CLAY, TIGHT, OCCASIONAL MICA, DAMP 12'- 16' 18" RECOVERY - REDBROWN-MULTICOLORED, SLIGHTLY SANDY, SILTY CLAY-CLAYEY SAND, TIGHT, SOME OXIDIZED, OCCASIONALLY GRAVELY, DAMP, WEATHERED VOLCANICS

Boring

Total Depth: 16'

Boring Diameter: 2"

Drilling Method: DIRECT PUSH

Drilling Co: EARTHCORE

Depth to 1st Water: 8'

Abandonment: BENTONITE CHIPS

NOTES:

UPGRADIENT
EAST SIDE OF RAIL TRAIL, 12' SOUTH OF STOP SIGN

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	BORING ID: RF-BH-2
	PROJECT: RICHARDSON FLAT	START DATE: 5/7/01
	LOGGED BY: T. LEEDS	END DATE: 5/7/01
	SAMPLE ID: NA	

GRAPHIC LOG	SAMPLES			LITHOLOGIC DESCRIPTION/ COMMENTS
Depth FEET / LITHOLOGY	INTERVAL	RECOVERY	SAMPLE ID	
0			NO SAMPLES COLLECTED	0-6' - FILL: RAILROAD/ROAD BASE MATERIAL
		0		
5		12"		4-8'- 12" RECOVERY - MULTICOLORED GRAVELS, SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 1", WET
10		0		8'- 16' NO RECOVERY
15		0		
20				
25				
30				

Boring

Total Depth: 16'

Boring Diameter: 2"

Drilling Method: DIRECT PUSH

Drilling Co: EARTHCORE

Depth to 1st Water: 4'

Abandonment: BENTONITE CHIPS

NOTES:

UPGRADIENT
EAST SIDE OF RAIL TRAIL, 10' NORTH OF GATE

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	BORING ID: RF-BH-3 (REDRILL BH-2)
	PROJECT: RICHARDSON FLAT	START DATE: 5/7/01
	LOGGED BY: T. LEEDS	END DATE: 5/7/01
	SAMPLE ID: NA	

GRAPHIC LOG	SAMPLES	LITHOLOGIC DESCRIPTION/ COMMENTS
Depth LITHOLOGY FEET	INTERVAL RECOVERY SAMPLE ID	
0	NO SAMPLES COLLECTED	0-1' - TOPSOIL
5	0	4-8'- 18" RECOVERY - MULTICOLORED GRAVELS, SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 1", WET
10	18"	8-12'- 10" RECOVERY - GRAVEL A/A, WET
15	10"	12'-16' 20" RECOVERY - REDBROWN-MULTICOLORED, SLIGHTLY SANDY, SILTY CLAY-CLAYEY SAND, TIGHT, SOME OXIDIZED, OCCASIONALLY GRAVELY, DAMP, WEATHERED VOLCANICS
20	20"	
25		
30		

Boring

Total Depth: 16'

Boring Diameter: 2"

Drilling Method: DIRECT PUSH

Drilling Co: EARTHCORE

Depth to 1st Water: 8'

Abandonment: BENTONITE CHIPS

NOTES:

UPGRADIENT
EAST SIDE OF RAIL TRAIL, 12' SOUTH OF STOP SIGN
REDRILL BH-2 DUE TO POOR RECOVERY IN BH-2

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	BORING ID: RF-BH-4
	PROJECT: RICHARDSON FLAT	START DATE: 5/7/01
	LOGGED BY: T. LEEDS	END DATE: 5/7/01
	SAMPLE ID: NA	

GRAPHIC LOG	SAMPLES			LITHOLOGIC DESCRIPTION/ COMMENTS
Depth FEET / LITHOLOGY	INTERVAL	RECOVERY	SAMPLE ID	
0			NO SAMPLES COLLECTED	0-1' - TOPSOIL
5		0		4-8'- 18" RECOVERY - MULTICOLORED GRAVELS WITH INTERFINGERED FINE TO MEDIUM SANDS, GRAVEL CONTAINS SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 1", WET
10		6"		8-12'- 16" RECOVERY - GRAVEL A/A, WET
15		16"		12'-16' 3" RECOVERY - GREEN CLAY, PLASTIC SOME MICA 9" RECOVERY - REDBROWN-MULTICOLORED, SLIGHTLY SANDY, SILTY CLAY-CLAYEY SAND, TIGHT, SOME OXIDIZED, OCCASIONALLY GRAVELY, DAMP, WEATHERED VOLCANICS, WET
20		12"		
25				
30				

Boring

Total Depth: 16'

Boring Diameter: 2"

Drilling Method: DIRECT PUSH

Drilling Co: EARTHCORE

Depth to 1st Water: 4'

Abandonment: BENTONITE CHIPS

NOTES:

UPGRADIENT
AT GATE 7' EAST ON EAST SIDE

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	BORING ID: RF-BH-5
	PROJECT: RICHARDSON FLAT	START DATE: 5/7/01
	LOGGED BY: T. LEEDS	END DATE: 5/7/01
	SAMPLE ID: NA	

GRAPHIC LOG	SAMPLES			LITHOLOGIC DESCRIPTION/ COMMENTS
Depth FEET / LITHOLOGY	INTERVAL	RECOVERY	SAMPLE ID	
0			NO SAMPLES COLLECTED	0-1' - RAILROAD FILL
5		0		4-8'- 24" RECOVERY - MULTICOLORED GRAVELS WITH INTERFINGERED FINE TO MEDIUM SANDS, GRAVEL CONTAINS SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 1", WET
10		24"		8-12'- 16" RECOVERY - GRAVEL A/A, WET 8" RECOVERY GREEN CLAY, PLASTIC, SOME MICA
15		24"		12'-16' 12" RECOVERY - REDBROWN CLAY, PLASTIC, DAMP 12" RECOVERY - REDBROWN-MULTICOLORED, SLIGHTLY SANDY, SILTY CLAY-CLAYEY SAND, TIGHT, SOME OXIDIZED, OCCASIONALLY GRAVELY, DAMP, WEATHERED VOLCANICS, WET
20				
25				
30				

Boring

Total Depth: 16'

Boring Diameter: 2"

Drilling Method: DIRECT PUSH

Drilling Co: EARTHCORE

Depth to 1st Water: 4'

Abandonment: BENTONITE CHIPS

NOTES:

UPGRADIENT
10' NORTH OF GATE WEST OF TRAIL NEAR CREEK

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	BORING ID: RF-BH-6
	PROJECT: RICHARDSON FLAT	START DATE: 5/8/01
	LOGGED BY: T. LEEDS	END DATE: 5/8/01
	SAMPLE ID: NA	

GRAPHIC LOG	SAMPLES			LITHOLOGIC DESCRIPTION/ COMMENTS
Depth FEET / LITHOLOGY	INTERVAL	RECOVERY	SAMPLE ID	
0			NO SAMPLES COLLECTED	0-4'- 24" RECOVERY - REDBROWN CLAYEY SAND GRADING INTO GREY SANDY GRAVEL (TAILINGS), WITH OCCASIONAL PYRITE TO GRAVELLY SAND, OCC 1-2" SAND LENSES, CONTAINS TAILINGS MATERIAL, WET, UPPER MOST 2' PRIMARILY COMPOSED OF TAILINGS
5		24"		4-8'- 18" RECOVERY - MULTICOLORED GRAVELS WITH INTERFINGERED FINE TO MEDIUM SANDS, GRAVEL CONTAINS SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 1", WET 6" RECOVERY - GREEN CLAY, OCCASIONAL SANDY, OCC OXIDIZED ZONES, MOD PLASTIC, SLIGHTY STIFF, DAMP
10		0		8-12'- NOT SAMPLED NO RECOVERY
15		36"		12'-16' 4" RECOVERY - GREEN CLAY A/A GRADING INTO 32" RECOVERY - REDBROWN-MULTICOLORED, SLIGHTLY SANDY, SILTY CLAY-CLAYEY SAND, TIGHT, SOME OXIDIZED, OCCASIONALLY GRAVELY, DAMP, WEATHERED VOLCANICS, WET NOTE: REDRILL @12' PRODUCED 4' WET SAND SLUFF, FINE GRAINED- OCC MEDIUM GRAINED WITH OCC MICA FLOWING/HEAVING SAND
20				
25				
30				

Boring

Total Depth: 16'

Boring Diameter: 1"

Drilling Method: DIRECT PUSH

Drilling Co: EARTHCORE

Depth to 1st Water: 6"

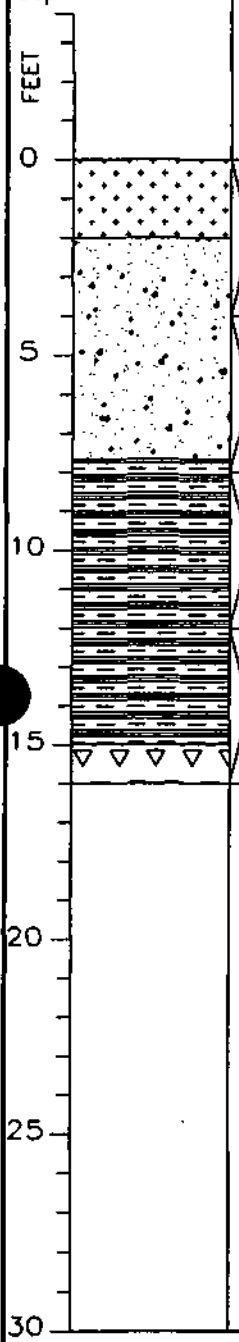
Abandonment: BENTONITE CHIPS

NOTES:

UPGRADIENT
NORTH OF RAIL TRAIL
WESTERNMOST BORING

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	BORING ID: RF-BH-7
	PROJECT: RICHARDSON FLAT	START DATE: 5/8/01
	LOGGED BY: T. LEEDS	END DATE: 5/8/01
	SAMPLE ID: NA	

GRAPHIC LOG	SAMPLES	LITHOLOGIC DESCRIPTION/ COMMENTS



INTERVAL	RECOVERY	SAMPLE ID
	12"	NO SAMPLES COLLECTED
	24"	
	36"	
	48"	

0-4'-
12" RECOVERY - REDBROWN CLAYEY SAND GRADING INTO GREY SANDY GRAVEL (TAILINGS), WITH OCCASIONAL PYRITE TO CLAYEY, GRAVELLY SAND, OCC 1-2" SAND LENSES, CONTAINS TAILINGS MATERIAL, WET, UPPER MOST 2' PRIMARILY COMPOSED OF TAILINGS

4-8'-
18" RECOVERY - MULTICOLORED GRAVELS WITH INTERFINGERED FINE TO MEDIUM SANDS, GRAVEL CONTAINS SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 1", WET
6" RECOVERY - GREEN CLAY, OCCASIONAL SANDY, OCC OXIDIZED ZONES, MOD PLASTIC, SLIGHTY STIFF, DAMP

8-12'-
36" RECOVERY - GREEN CLAY A/A

12'-16'
36" RECOVERY - GREEN CLAY A/A GRADING INTO
12" RECOVERY - REDBROWN-MULTICOLORED, SLIGHTLY SANDY, SILTY CLAY-CLAYEY SAND, TIGHT, SOME OXIDIZED, OCCASIONALLY GRAVELY, DAMP; WEATHERED VOLCANICS, WET

NOTE: HOLE CAVED/SLUFFED AFTER PIPE REMOVAL

Boring

Total Depth: 16'

Boring Diameter: 1"

Drilling Method: DIRECT PUSH

Drilling Co: EARTHCORE

Depth to 1st Water: 6"

Abandonment: BENTONITE CHIPS

NOTES:

UPGRADIENT
NORTH OF RAIL TRAIL
MIDDLE BORING

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	BORING ID: RF-BH-8
	PROJECT: RICHARDSON FLAT	START DATE: 5/8/01
	LOGGED BY: T. LEEDS	END DATE: 5/8/01
	SAMPLE ID: NA	

GRAPHIC LOG	SAMPLES			LITHOLOGIC DESCRIPTION/ COMMENTS
Depth FEET	LITHOLOGY	INTERVAL	RECOVERY	SAMPLE ID	
0				NO SAMPLES COLLECTED	0-4'- 24" RECOVERY - REDBROWN CLAYEY SAND GRADING INTO GREY SANDY GRAVEL (TAILINGS), WITH OCCASIONAL PYRITE TO CLAYEY, GRAVELLY SAND, OCC 1-2" SAND LENSES, CONTAINS TAILINGS MATERIAL, WET, UPPER MOST 2' PRIMARILY COMPOSED OF TAILINGS
5			24"		4-8'- 3" RECOVERY - MULTICOLORED GRAVELS WITH INTERFINGERED FINE TO MEDIUM SANDS, GRAVEL CONTAINS SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 1", WET
10			3"		8-12'- 12" RECOVERY - GRAVEL A/A 12" RECOVERY - GREEN CLAY, MOD PLASTIC, STIFF, OCCASIONALLY SANDY, TIGHT
15			24"		12'-16' 36" RECOVERY - GREEN CLAY A/A
20			36"		
25					
30					

Boring

Total Depth: 16'

Boring Diameter: 1"

Drilling Method: DIRECT PUSH

Drilling Co: EARTHCORE

Depth to 1st Water: 6"

Abandonment: BENTONITE CHIPS

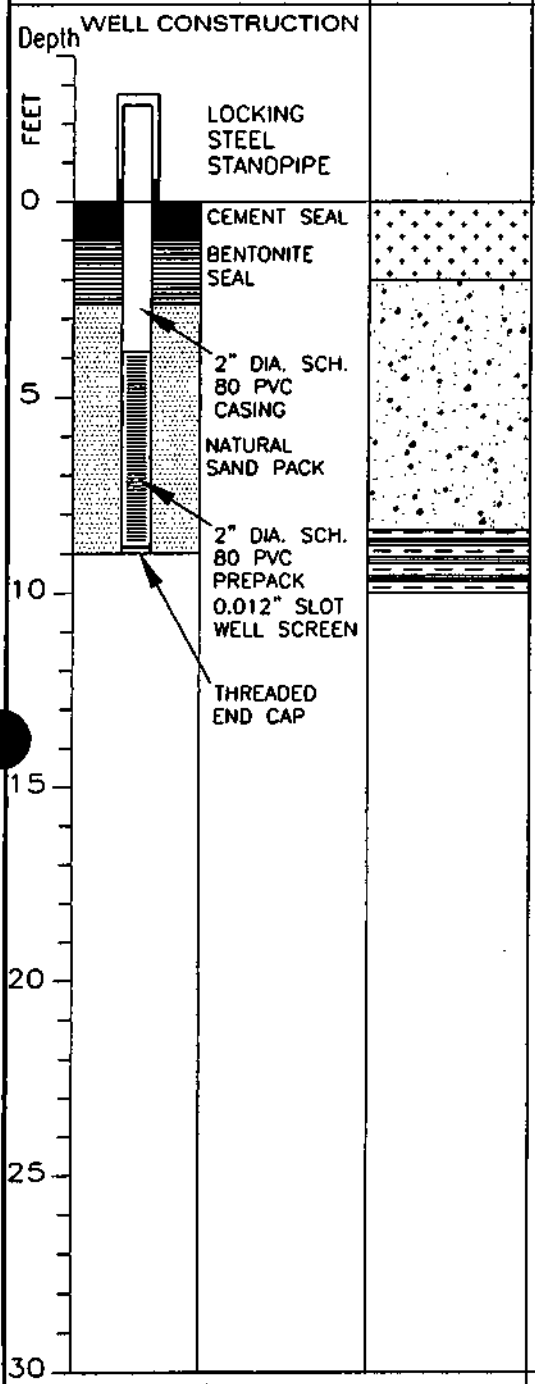
NOTES:

UPGRADIENT
NORTH OF RAIL TRAIL
EASTERMOST BH NEAR EDGE OF SILT FENCE

RESOURCE MANAGEMNET CONSULTANTS

CLIENT: UPCM	Boring/Monitor Well ID: RT-11
PROJECT: RICHARDSON FLAT	Start Date: 5/29/01 Completion Date: 5/29/01
LOGGED BY: T. LEEDS	Location: NORTH OF RAIL TRAIL Grade Elev:
SAMPLE ID: NA	Top Casing Elevation: Static Depth to Water:

GRAPHIC LOG | LITHOLOGY | LITHOLOGIC DESCRIPTION/ COMMENTS



0-2' - TAILINGS, GRAY, SANDY, OCCASIONALLY OXIDIZED

2'-8.5' - REDBROWN CLAYEY, GRAVELLY SAND, OCCASIONAL 1"-2" SAND LENSES

8.5'-10' - GREEN CLAY

WELL WAS INSTALLED ADJACENT TO RF-BH-8
GEOLOGY BASED ON RF-BH-8 GEOLOGY

Boring

Total Depth: 9'

Boring Diameter: 8.25'

Drilling Method: HOLLOW STEM AUGER

Drilling Co: EARTHCORE

Depth to 1st Water:

Abandonment: NA

NOTES:

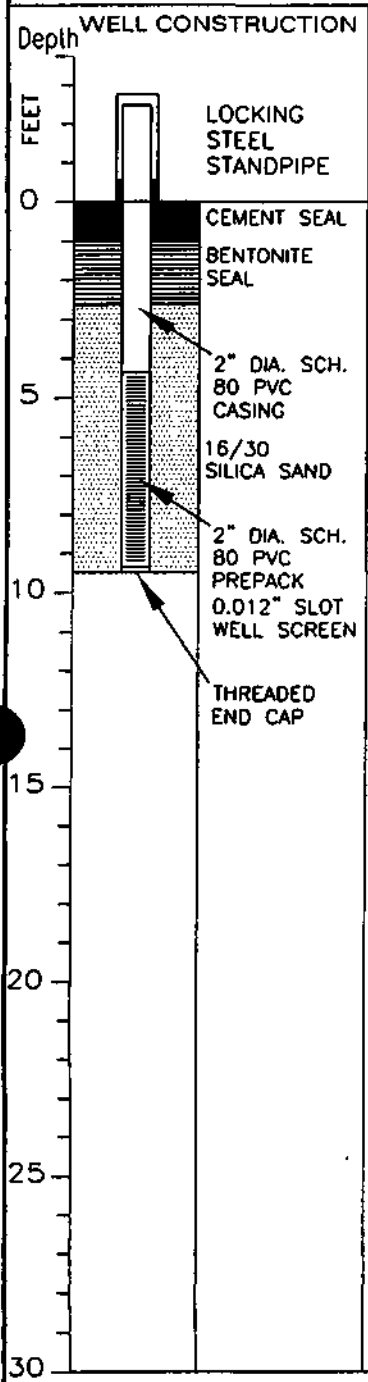
UPGRADIENT WELL

Well

Total Well Depth: 9'
Surface Completion: STANDPIPE
Casing: SCH. 80 PVC
Screen: 0.01 SLOT
Bottom Cap: THREADED

RESOURCE MANAGEMNET CONSULTANTS

CLIENT: UPCM	Boring/Monitor Well ID: RT-12
PROJECT: RICHARDSON FLAT	Start Date: 5/29/01 Completion Date: 5/29/01
LOGGED BY: T. LEEDS	Location: EAST OF RAIL TRAIL Grade Elev:
SAMPLE ID: NA	Top Casing Elevation: Static Depth to Water:

GRAPHIC LOG	LITHOLOGY	LITHOLOGIC DESCRIPTION/ COMMENTS
		
		0-1' - TOPSOIL
		1-9.5'- MULTICOLORED GRAVELS, SOME SANDY MATERIAL, SOME OXIDIZED, GRAVEL UP TO 3", WET
		WELL WAS INSTALLED ADJACENT TO RF-BH-3 GEOLOGY BASED ON RF-BH-3 GEOLOGY

Boring

Total Depth: 9.5'

Boring Diameter: 8.25'

Drilling Method: HOLLOW STEM AUGER

Drilling Co: EARTHCORE

Depth to 1st Water: 5.8'

Abandonment: NA

NOTES:

DOWNGEADIENT WELL

Well

Total Well Depth: 9.5'

Surface Completion: STANDPIPE

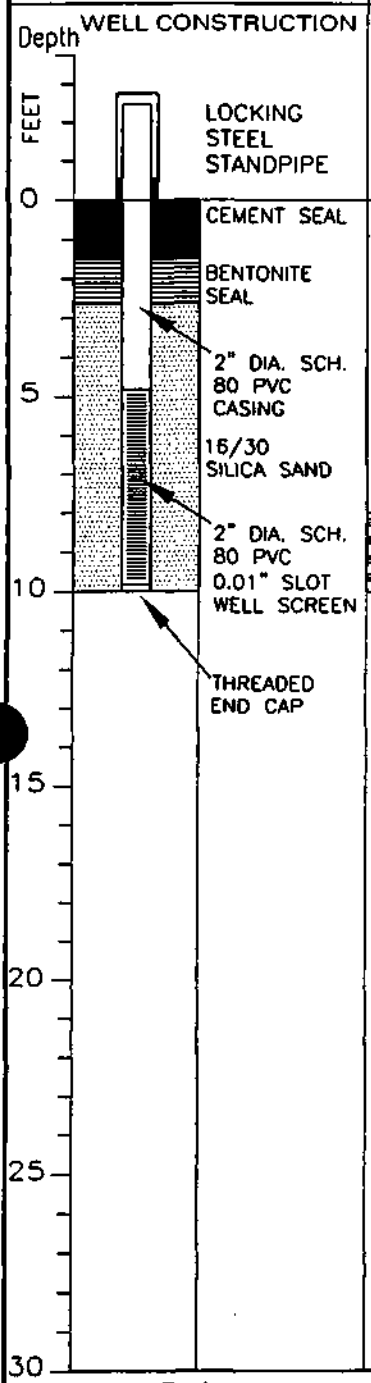
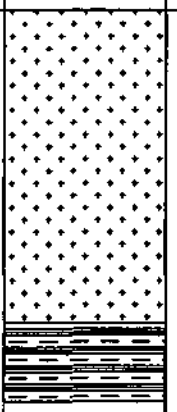
Casing: SCH. 80 PVC

Screen: 0.01 SLOT

Bottom Cap: THREADED

RESOURCE MANAGEMNET CONSULTANTS

CLIENT: UPCM	Boring/Monitor Well ID: RT-13
PROJECT: RICHARDSON FLAT	Start Date: 5/29/01 Completion Date: 5/29/01
LOGGED BY: T. LEEDS	Location: SOUTH OF DIVERSION DITCH Grade Elev:
SAMPLE ID: NA	Top Casing Elevation: Static Depth to Water:

GRAPHIC LOG	LITHOLOGY	LITHOLOGIC DESCRIPTION/ COMMENTS
		0-8' - TAILINGS, GRAY, SANDY, OCCASIONALLY OXIDIZED 8'-10' - BROWN CLAY WELL WAS INSTALLED ADJACENT TO BACKHOE EXCAVATED TEST PIT GEOLOGY BASED ON TEST PIT ASSESSMENT

Boring

Total Depth: 10'

Boring Diameter: 8.25'

Drilling Method: HOLLOW STEM AUGER

Drilling Co: EARTHCORE

Depth to 1st Water: 5.8'

Abandonment: NA

NOTES:

SOUTH OF DIVERSION DITCH

MIDDLE WELL

Well

Total Well Depth: 10'

Surface Completion: STANDPIPE

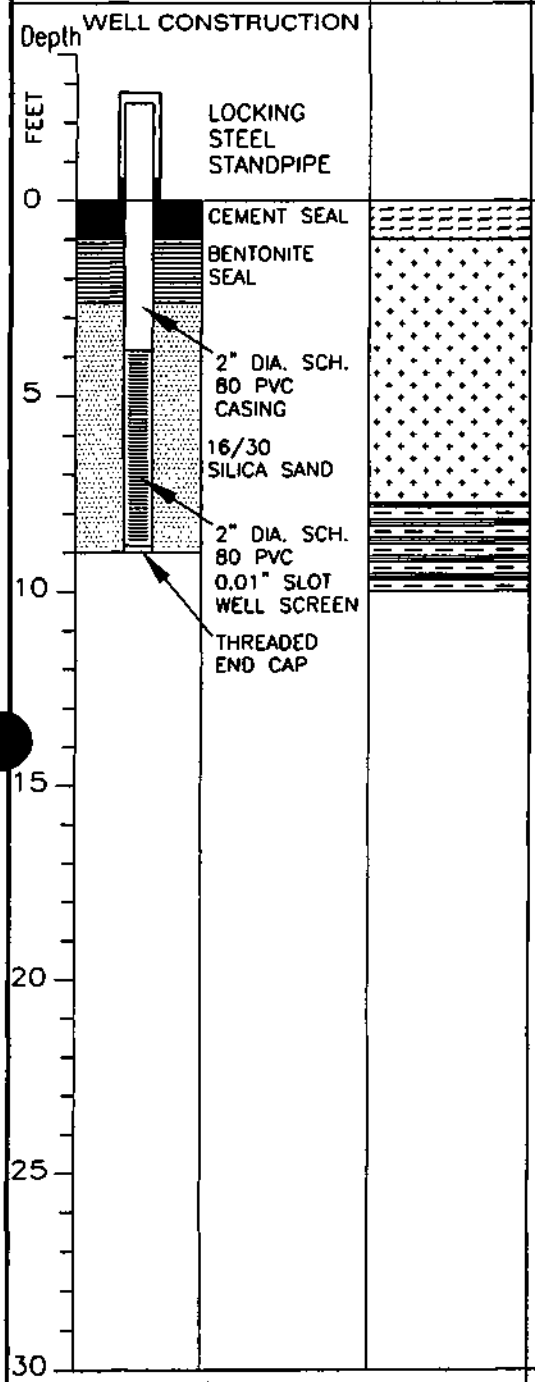
Casing: SCH. 80 PVC

Screen: 0.01 SLOT

Bottom Cap: THREADED

RESOURCE MANAGEMNET CONSULTANTS	CLIENT: UPCM	Boring/Monitor Well ID: RT-14
	PROJECT: RICHARDSON FLAT	Start Date: 5/11/01 Completion Date: 5/11/01
	LOGGED BY: T. LEEDS	Location: SOUTH OF DIVERSION DITCH Grade Elev:
	SAMPLE ID: NA	Top Casing Elevation: Static Depth to Water: 5.8' BGS

GRAPHIC LOG	LITHOLOGY	LITHOLOGIC DESCRIPTION/ COMMENTS



0-1'- TOPSOIL, BROWN CLAYEY LOAM

1'-8.5' - TAILINGS, GRAY, SANDY, OCCASIONALLY OXIDIZED

8.5'-10' - BROWN CLAY

WELL WAS INSTALLED ADJACENT TO BACKHOE EXCAVATED TEST PIT
GEOLOGY BASED ON TEST PIT ASSESSMENT

Boring

Total Depth: 9'

Boring Diameter: 8.25'

Drilling Method: HOLLOW STEM AUGER

Drilling Co: EARTHCORE

Depth to 1st Water: 5.8'

Abandonment: NA

NOTES:

SOUTH OF DIVERSION DITCH

EAST WELL

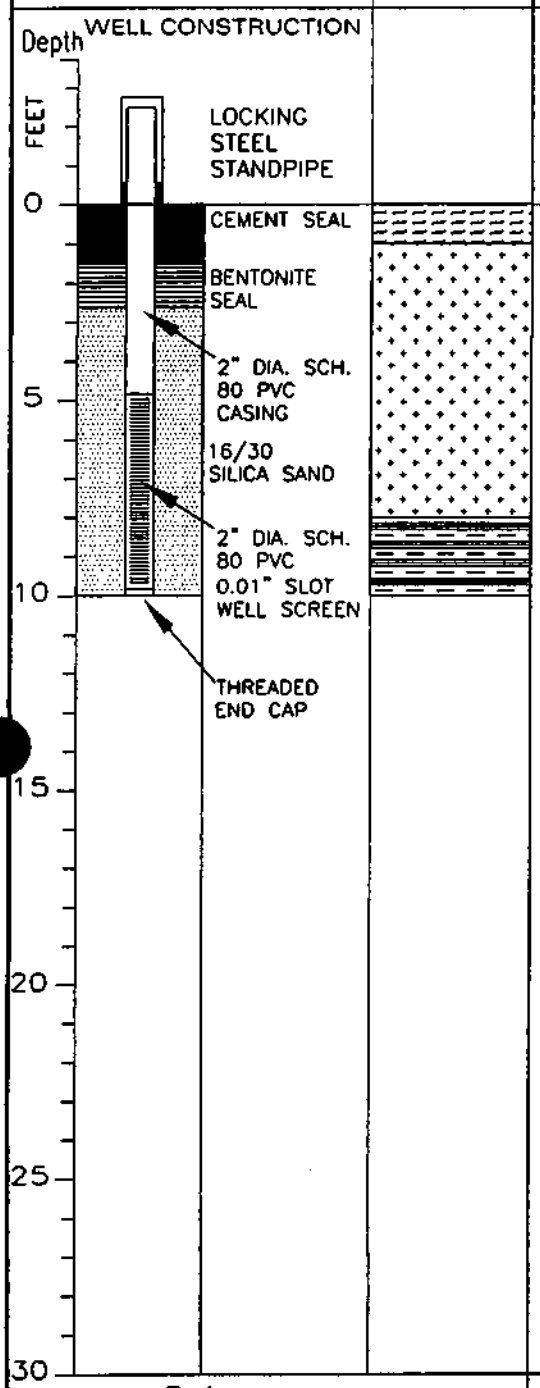
Well

Total Well Depth: 9'
Surface Completion: STANDPIPE
Casing: SCH. 80 PVC
Screen: 0.01 SLOT
Bottom Cap: THREADED

RESOURCE MANAGEMNET CONSULTANTS

CLIENT: UPCM	Boring/Monitor Well ID: RT-15
PROJECT: RICHARDSON FLAT	Start Date: 5/29/01 Completion Date: 5/29/01
LOGGED BY: T. LEEDS	Location: SOUTH OF DIVERSION DITCH Grade Elev:
SAMPLE ID: NA	Top Casing Elevation: Static Depth to Water:

GRAPHIC LOG	LITHOLOGY	LITHOLOGIC DESCRIPTION/ COMMENTS



0-1' - TOPSOIL

1'-8' - TAILINGS, GRAY, SANDY, OCCASIONALLY OXIDIZED

8'-10' - BROWN CLAY

WELL WAS INSTALLED ADJACENT TO BACKHOE EXCAVATED TEST PIT
GEOLOGY BASED ON TEST PIT ASSESSMENT

Boring

Total Depth: 10'

Boring Diameter: 8.25'

Drilling Method: HOLLOW STEM AUGER

Drilling Co: EARTHCORE

Depth to 1st Water: DRY

Abandonment: NA

NOTES:

SOUTH OF DIVERSION DITCH

EAST WELL

Well

Total Well Depth: 10'
Surface Completion: STANDPIPE
Casing: SCH. 80 PVC
Screen: 0.01 SLOT
Bottom Cap: THREADED

Appendix 3

Hydrogeologic Review of Richardson Flat Tailings Site
(MWH, 2002)

HYDROGEOLOGIC REVIEW
OF RICHARDSON FLAT TAILINGS SITE

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

EPA ID# UT980952840

March 20, 2002

Prepared For

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SCOPE OF THIS REPORT

The purpose of this report is to revise the conceptual hydrogeologic model of the Richardson Flat site focusing on the occurrence and movement of groundwater that was developed by Weston Engineering, Inc. (WESTON, 1999a). The mutually-agreed upon scope of work between LeBOEUF, LAMB, GREENE & MacRAE, L.L.P. and Montgomery Watson Harza (MWH) involved the following tasks:

- Complete a well survey using the Utah Department of Water Rights database;
- Incorporate water level data collected by Weston Engineering, Inc. and Environmental Resource Management Consultants into the site conceptual model;
- Incorporate wetlands delineation data collected by the Jack Johnson Company into the site conceptual model;
- Review the files maintained by the Utah Department of Environmental Quality, Division of Drinking Water for Drinking Water Source Protection Plans prepared for water sources located along the Silver Creek drainage;
- Assist United Park City Mines Company and their contractors with interpreting the hydrogeology of the site as new geologic and hydrologic data are collected; and
- Prepare a summary report incorporating the new data into the site conceptual model which can be included in the Focused Remedial Investigation report prepared by United Park City Mines Company and their contractors.

SITE INVESTIGATIONS COMPLETED SINCE 1999

Additional investigations were designed to build upon rather than duplicate previous work efforts completed by WESTON (1999a). Environmental Resource Management Consultants (RMC) followed a Sampling and Analysis Plan developed for a Focused Remedial Investigation. Five new monitoring wells were installed for sampling of groundwater. Surface water, soil, tailings, and sediments were also sampled as part of this study.

WESTON and RMC continued monitoring water levels in the piezometers installed during their 1999 investigation. The Jack Johnson Company (Jack Johnson) installed approximately 90 test pits as part of a limited wetlands delineation investigation (Jack Johnson, 2000). Water quality investigations were independently developed by RMC and are not included herein.

HYDROGEOLOGIC SETTING OF RICHARDSON FLAT

Location

Richardson Flat is located in Sections 1 and 2, Township 2 South, Range 4 East in Summit County, Utah. The tailings impoundment is located over 400 feet from Silver Creek, a perennial stream draining the Park City area where other historic tailings ponds were located (see Mason, 1989). Figure 1 presents the site location.

Structural Geology

Richardson Flat lies within the Idaho-Utah-Wyoming thrust belt. Mapping by Bromfield and Crittenden (1971) place no faults near Richardson Flat (see Figure 2). However, subsurface mapping by Bromfield and Crittenden (1971) and groundwater exploration drilling in Browns Canyon indicate that well-indurated Mesozoic and Paleozoic limestones, sandstones, and shales were apparently deformed by the Frog Valley Thrust which subcrops beneath nearly 1,000 feet of Keetley Volcanic rocks in the Richardson Flat area (see Figure 2).

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

EPA records indicate that the Richardson Flat tailings pond was apparently constructed prior to 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; 1985; 1993).

Geotechnical borings, small-diameter piezometers, monitoring wells, and groundwater exploration borings were installed in the vicinity of Richardson Flat using direct-push, hollow stem auger methods, and rotary methods by WESTON (1999a), Montgomery Watson (2000a) and by RMC for the Focused Remedial Investigation. The lithologic information indicated the following materials, from top to bottom, comprise the stratigraphy of the tailings pond and nearby areas.

- Clay-rich artificial fill capping the impounded tailings varies in thickness from 0.5 to greater than 10 feet;
- Fine-grained sand tailings approximately 16 to 18 feet thick in the central portion of the tailings pond, and perhaps thicker in the north-central area of the pond;
- 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;
- Two-to-ten feet of sand and gravel mixed with abundant fine-grained materials;
- 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;

- 500 to 1,000 feet of moderately hard and fractured volcaniclastic rocks composing the Tertiary sedimentary rocks and Keetley Volcanic rocks; and

- Several thousand feet of shale, claystone, limestone, sandstone and quartzite comprising the Mesozoic and Paleozoic rocks.

Artificial Cap. Material for the artificial cap was derived from the weathered volcanic rocks on the low hills north of the tailings impoundment or construction excavation material from building in Park City. WESTON (1999a) used X-ray diffraction (XRD) techniques to better characterize the mineralogy of the fine-grained sediments overlying and underlying the tailings. XRD results for the sample of the artificial fill capping the tailings found from 0 to 0.7 feet in boring RT-5 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.

Tailings. The tailings overlie the topsoil composing the original surface grade. 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. Ecology and Environment (1985) reported approximately 18 feet of tailings in boring RT-2. The interface between the projected topsoil and tailings along the northern portion of the tailings pond area remains uncertain, as depicted on Figures 3 and 4. However, the available data indicate that the thickness of the tailings varies from approximately 10 to 18 feet across the impoundment and perhaps thicker along the north-central area of the pond (see Figure 3).

Native Soil Beneath Tailings. The dark-colored, clay-rich organic topsoil was consistently logged by the various geotechnical, environmental investigations, and wetlands delineation, as ranging from two-to-five feet in thickness. The consistent color and texture of the native soil serves as the best horizon to correlate between the widely-spaced borings and test pits (see Figure 4).

WESTON (1999a) found that the sample of the clay-rich organic topsoil found below the tailings at approximately 11 feet in depth in boring RT-5, in addition to the underlying sandy clay found between 13 and 14 feet in boring RT-5, 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 derived from weathering of granitic or volcanic bedrock.

On the basis of the boring logs developed by Dames and Moore (1973; 1974), several feet of organic rich topsoil may underlie the tailings along the northern boundary of the impoundment. Given the small size of the drainage basin located around the eastern, northern and southern boundaries of Richardson Flat, it is reasonable to assume the hydraulic gradients for this basins were shallow, resulting in a low energy stream capable of maintaining a small sized bed load. In contrast, Silver Creek has a much larger drainage basin capable of entraining larger sized debris. A reasonable interpretation of the apparent channel fill located along the northern boundary of the impoundment depicted on the lower right side of Figure 3 focuses on a wetland or bog as reflected by several feet of organic rich material before burial by the tailings. Of course, this interpretation is speculative, and is acknowledged as such by the numerous questions marks on this part of the section.

Quaternary unconsolidated deposits. Unconsolidated deposits consist of Quaternary sands, gravel, and clay derived from weathering of local volcanic bedrock. Richardson Flat is located on material mapped by Bromfield and Crittenden (1971) as unconsolidated older Quaternary

alluvium. Examination of Figures 3 and 4 indicate the gravelly clay, clay, and silt layers comprising the older alluvium approach 20 feet in thickness beneath Richardson Flat, and thicken to nearly 150 feet within 1,500 feet north along Silver Creek (see Figure 5). A 10-foot thick veneer of younger alluvium probably mantles the stream beds of most subsidiary drainages.

Tertiary sedimentary rocks. Crittenden and others (1966) describe this unit as a mixture of tan to red mudstone and tuff with layers of cobble to boulder conglomerate. Bromfield and Crittenden (1971) note that boulders of Nugget Sandstone are common. Bryant (1990; 1992) also notes distinctive fragments of Nugget Sandstone and describes this unit as boulder, cobble, and pebble conglomerate containing clasts derived from Mesozoic and upper Paleozoic formations. This unit interfingers with and underlies the Keetley Volcanic rocks.

Keetley Volcanics. Extrapolation of the available surface geologic mapping, coupled with the drilling data in nearby Browns Canyon, indicates that Richardson Flat is located on at least 500 feet of Keetley Volcanics. Bromfield and Crittenden (1971) describe the Keetley Volcanics as consisting of intermediate laharic breccias with less common flow breccias and interlayered tuffs. As depicted on Figures 5 and 6, local drilling data indicate the weakly-consolidated andesite breccias are interlayered with clay derived from weathering of the tuffs and other volcanic rocks. These sedimentary layers are more numerous toward the base of this unit and consist of quartzite, limestone, siltstone, and shale.

Exotic blocks. Exotic blocks are composed principally of extensively brecciated Mesozoic sedimentary rocks and are considered to be part of the Keetley Volcanic rocks (Bromfield and Crittenden, 1971). The Mesozoic sedimentary units in the exotic blocks include the Nugget Sandstone, the members of the Ankareh Formation, the Thaynes Formation and the Weber Quartzite. Bromfield and Crittenden (1971) mapped exotic blocks in the vicinity of Richardson Flat ranging from a few tens to over 1,000 feet in diameter. Exotic blocks were encountered in several wells and exploratory borings drilled in the vicinity of Richardson Flat.

Mesozoic and Paleozoic rocks. The well-cemented Mesozoic and Paleozoic siltstones, claystones, limestones, and shale do not outcrop in Richardson Flat. These rocks are mantled by at least 500 feet of Keetley Volcanic rocks and the younger Quaternary sands, gravels, and clay derived from weathering of the older volcanic bedrock. Rather than provide an extensive description of the individual stratigraphic units, the generalized hydrogeologic descriptions of these rocks are provided in the following section.

Hydrogeologic Overview

Figures 3 and 4 provide conceptual hydrogeologic cross sections summarizing the local distribution of the various lithologies by integrating the historic test pits, borings, piezometers, and monitoring wells. Examination of the historic boring and well logs in the area indicated that at least five groundwater systems may be found in the Richardson Flat area:

- The impounded tailings under unconfined conditions;
- Shallow alluvium with a seasonally perched water table;
- Deeper alluvium composed of confined sand and gravel aquifer(s) mixed with abundant fine-grained materials;
- The underlying and adjacent fractured Keetley volcanic rocks; and
- The deeper fractured Mesozoic and Paleozoic rocks.

Impounded Tailings. Based on the test boring installed by Ecology and Environment (1985) and confirmed by WESTON (1999a), the tailings are partially saturated. Water level measurements made during the 1973 and 1974 design phases of the tailings pond development, coupled with the 1985 and later water level measurements, indicate that the lower 15 feet of the tailings remain saturated.

As depicted on Figure 4, seasonal water levels in the tailings vary from 2.5 to 5.5 feet. Tailings saturation increases during the months of April and May when snowmelt occurs. The seasonal increase in the water levels in the tailings is more pronounced in the central part of the tailings, as depicted on Figure 4. WESTON (1999a) reported that percolation tests completed on selected samples of the artificial fill indicated low permeabilities, thus limiting direct downward infiltration of precipitation. However, the areal distribution of the artificial fill is variable which may allow some infiltration of precipitation into the tailings.

Alluvium. WESTON (1999a) followed by Jack Johnson (2000) and RMC (this study) indicated the alluvium is composed of both unconfined and confined aquifers. The unconfined aquifers include the clay-rich organic topsoil and the gravels and sands located along Silver Creek. WESTON determined that at least three deeper confined aquifers are found beneath the unconfined aquifers.

Hydrologic Role of Clay-rich Organic Topsoil. The hydrologic role of the clay-rich topsoil varies with the seasons. The topsoil serves as a shallow perched water table aquifer with transient storage during the spring and summer when snowmelt occurs. The topsoil becomes unsaturated during late summer to early spring once the snowmelt-derived groundwater held in temporary storage discharges to the wetlands. On the basis of comparing water levels in the topsoil to water levels in the piezometers, the perched water table does not appear to be in direct hydraulic connection with deeper water bearing zones, indicating that the shallow soils are composed of horizons with low vertical hydraulic conductivity to limit direct downward infiltration.

For example, Jack Johnson (2000) installed approximately 90 test pits as part of a wetlands delineation study completed south of the tailings impoundment (see Figure 1). This study was completed in July after the snow cover melted. Water was reported in several test pits installed to depths approaching six feet. Jack Johnson observed that the water found in these pits was apparently perched on a well cemented and hard soil horizon logged as "caliche" found at approximately three feet in depth.

Conversely, the WESTON (1999a) study was conducted in January with abundant snow cover where no free water was observed in any of the cores retrieved from the borings located in the same area as the wetlands delineation study. The lack of water in the clay-rich organic topsoil observed by WESTON (1999a) supports the observation of transient storage of groundwater derived from snowmelt in the upper portions of the clay-rich topsoil.

Groundwater stored in the upper portions of the topsoil is not in direct hydraulic communication with groundwater stored in the deeper water bearing strata. Comparison of the groundwater elevations in the test pits installed by Jack Johnson (2000) during the early summer months to groundwater elevations in the piezometers installed by WESTON (1999a) collected during the same season substantiate the lack of direct hydraulic connection between the seasonally perched water stored in the clay-rich topsoil and the deeper clayey sand and gravel aquifers within the alluvium. Piezometers RT-1A/B were located in the same area of the wetlands delineation study. The elevation of the water table in the wetlands test pits near RT-1A/B was approximately 6633 feet as opposed to the elevation of the groundwater in the piezometers RT-1A/B that approached 6625 feet. These data indicate the topsoil has some layers with low vertical hydraulic

conductivity which limits direct downward hydraulic communication between the ground surface and deeper water bearing strata.

WESTON (1999a) determined that the deeper portions of clay-rich organic topsoil apparently have low vertical hydraulic conductivity which effectively confines groundwater stored in the deeper clayey sand and gravel strata within the deeper alluvium from the ground surface. For example, WESTON (1999a) found that the clay-rich topsoil effectively confined groundwater stored in the deeper silty sand encountered by piezometer RT-10 located approximately 2,900 feet south of the impounded tailings (see Figure 1). The boring log for RT-10 reported that the initial 3.6 feet of fine-grained, organic-rich clay and silt soils were partially saturated. RT-10 was completed with screen across from sandy silts and silty sands found from 3 feet to 8 feet in depth. The reported depths to water in the completed piezometer remained above the interface between topsoil and the underlying silty sand until the piezometer was destroyed (see Attachment No. 2).

Examination of the boring log for RT-5 indicates the original topsoil was found at 10.8 feet in depth and the overlying tailings were damp. Deeper drilling found the topsoil damp, becoming increasingly saturated with depth. The underlying silty sand was saturated. The sandy clay beneath the silty sand was moist, yet the deeper gravelly sand found at 14 feet was only damp to moist. The depth to water at RT-5 has consistently been found between 4.82 and 8.99 feet below the ground surface, ranging from approximately 1.81 to 5.98 feet above the interface between the unsaturated tailings and the original topsoil encountered 10.8 feet below ground surface. These data indicate the topsoil has some layers with low vertical hydraulic conductivity which limits direct upward hydraulic communication between the deeper water bearing strata and the ground surface.

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 Figure 3 reveals the first water bearing intervals in piezometers RT-1A/B and RT-8A/AB located south of the tailings impoundment are 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.

WESTON (1999a) reported that the hydraulic communication between the shallow and deeper water bearing intervals is poor. WESTON reported 0.4 feet of head difference between the shallow and deeper aquifers in the vicinity of RT-1A/B (see Figure 7). The hydraulic gradient between these aquifers is downward at this location. Examination of the depth to water in nested piezometers RT-8A/B summarized on Figure 7 indicates a consistent difference in water levels regardless of the season. Likewise, the water levels in the piezometer series RT-8A/B indicate a similar hydrologic relationship with the exception that the hydraulic gradient between the deeper and shallow aquifer is upward (see Figure 3 cross section A-A').

The upward hydraulic gradient between the deeper and shallower aquifers continues northward ultimately discharging into the diversion ditch. As depicted on Figure 3, the depth to water in wells RT-13 and RT-14 approaches the upper limit of the topsoil. The bottom of the diversion ditch is below the elevation of the potentiometric surface and thus serves as the local hydrologic sink for the shallow aquifer system.

Seasonal Variations in Water Levels. As depicted on Figure 7, water levels in the alluvium vary seasonally. Seasonal increases in water levels occur during March and April. Seasonal changes vary from a few to several feet. The larger variations typically occur during normal wet

years; the lower variations occur during the recent drought. Mason (1989) also observed the water levels varying seasonally in monitoring wells completed in the unconsolidated fill near the Silver Creek tailings site, with the seasonal high occurring during March and April.

The water level changes observed in piezometers completed in the tailings impoundment and along Silver Creek reflect seasonal variations in the volume of water stored in the unconfined aquifers. Conversely, the water level changes in wells tapping the deeper confined aquifers within the alluvium reflect the transient pressure associated with changes in the hydraulic head in the recharge area of these aquifers. Recalling the downward hydraulic gradient imposed by the nearly six feet of head between the clay-rich organic soil and the piezometers in areas located south of the tailings impoundment suggests the recharge area for the deeper confined aquifers is located south of Richardson Flat.

Keetley Volcanics. The underlying weathered and unweathered Keetley Volcanic rocks typically have low hydraulic conductivities 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 Figure 1). Dames & Moore (1974) further report the clayey material grades with some sand and dense clayey sand indicative of highly weathered volcanic breccia.

Yields from wells tapping the Keetley Volcanic rocks vary considerably in the Silver Creek area. Fractured andesite breccias within the Keetley Volcanics are the dominant water-bearing unit in wells yielding large volumes of water. Park City Municipal Corporation installed a test well approximately one mile northwest of the tailings pond (see Figures 2 and 5). The well was drilled 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) indicating 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).

Volcanic clays within the Keetley Volcanic rocks serve as confining units. Examination of Figure 5 reveals that water supply wells located downstream from Richardson Flat develop groundwater stored in andesite breccias. Static water levels in these wells rise above the volcanic clay confining layer. Likewise, water supply wells developing groundwater from the Keetley Volcanic rocks located north of Richardson Flat have reported static water levels at elevations above volcanic clay strata, with some wells flowing at the ground surface (see Figure 6). For example, the Star Pointe Ranch Well No. 15B located approximately four miles north of Richardson Flat yielded 1,200 gpm during a multi-day pumping test (see Figure 2). Eckhoff, Watson, & Preator (1997) calculated a transmissivity of 3,500 ft^2/day and a storativity ranging from 10^{-5} to 10^{-7} confirming that groundwater stored in the Keetley Volcanic rocks is under confined conditions. Likewise, well Atkinson Special Service District (ASSD) No. 10 flows at the ground surface, indicating the low vertical permeability of the volcanic clays in the Keetley Volcanic rocks (see Figure 6).

Water quality samples collected from Public Water System wells tapping the Keetley Volcanic rocks along the Silver Creek drainage meet the Utah Division of Drinking Water standards for drinking water. Water quality analyses for the Star Pointe Ranch Well No. 15B indicated a total dissolved solids (TDS) concentration of 222 milligrams per liter (mg/l; Eckhoff, Watson, &

Preator, 1997). Groundwater exploration wells located approximately one mile northeast of Richardson Flat in Browns Canyon also yielded water with a TDS concentration less than 500 mg/l (Montgomery Watson, 2000b). Nearby springs also discharge water at approximately four to eight gpm with low total dissolved solids from these volcanic rocks (Holmes and others, 1986; Downhour and Brooks, 1996).

Mesozoic and Paleozoic Rocks. The purpose of this section is to address (1) the potential for tailings at Richardson Flat to impact water users in the Mesozoic and Paleozoic rock units, and (2) the general characteristics of these units as water bearing strata. The water-bearing characteristics of the Mesozoic and Paleozoic rocks which underlie the Quaternary deposits and Keetley Volcanic rocks in the vicinity of Richardson Flat have been described by Ashland and others (1996) and Holmes and others (1986). Rather than provide a lengthy description of the individual strata, Table I provides a brief summary of the hydrogeologic characteristics of these rock units.

While no wells penetrate the Mesozoic and Paleozoic rocks beneath Richardson Flat, it is unlikely that water stored in the tailings at Richardson Flat has a direct hydraulic connection with the underlying bedrock aquifers given the available hydrogeologic information. However, a comprehensive groundwater exploration program targeting these rocks subcropping beneath the Keetley Volcanic rocks was initiated in Browns Canyon located northeast of Richardson Flat by Montgomery Watson (2000). Figure 2 provides a location map and hydrogeologic summary of the exploration drilling program. Important observations derived from this program include (1) groundwater stored in the overlying Keetley Volcanic rocks is not hydraulically connected to groundwater stored in the deeper Mesozoic and Paleozoic rocks, (2) groundwater stored in the Keetley Volcanic rocks is less mineralized than groundwater stored in the Mesozoic and Paleozoic rocks, and (3) groundwater stored in the Paleozoic rocks is apparently old.

Hydraulic Connection Between Aquifer Systems

Water level measurements collected during the drilling of the Browns Canyon exploration wells revealed no direct hydraulic communication between the Keetley Volcanic rocks and deeper Mesozoic and Paleozoic rocks. As depicted on Figures 2 and 5, the elevation of the static water level in the Keetley Volcanic rocks was over 100 feet higher in the American Environmental Well than that measured in the Browns Canyon Exploration Well No. 3 open to the Weber Quartzite. Monitoring of the air-lift production during drilling revealed a nearly three-fold increase in TDS as the borehole encountered the Weber Quartzite. Age dating of the water developed from the Weber Quartzite determined no elevated tritium, indicating the groundwater was not exposed to the atmosphere after 1953. Additional age dating investigations using Carbon 14 (C_{14}) indicated an age of 15,800 years before present.

Likewise, Browns Canyon Exploration Well No. 2 targeted the subcropping Thaynes Limestone. The borehole flowed to the ground surface after penetrating the interface between the Keetley Volcanic rocks and deeper Thaynes Limestone. The TDS of the water increased from 476 mg/l to 3,930 mg/l with deeper drilling (Montgomery Watson, 2000b). Aquifer interference testing designed to determine the possible hydrologic connection between a large capacity well completed in the fractured Thaynes Limestone and the underlying unconsolidated sediments along Silver Creek confirmed this apparent lack of hydraulic communication between the shallow alluvial and deeper aquifer systems near the Silver Creek tailings site (see Mason, 1989, p. 33). All of these data indicate no direct hydraulic connection between groundwater stored in the alluvium, Keetley Volcanic rocks, and the deeper Mesozoic and Paleozoic rocks.

GROUNDWATER OCCURRENCE AND CIRCULATION MODEL

Hydraulic Gradients and Groundwater Flow Directions

No regional water table or potentiometric surface maps have been compiled for the watershed adjacent to Richardson Flat. The lack of wells tapping a hydraulically unique aquifer system, coupled with the limited distribution of hydrologic data that were collected during a specific season in the area precludes precise definition of local hydraulic gradients and flow directions; consequently, only an overview of the local groundwater circulation patterns can be estimated.

While the data distribution is less than ideal, generalized trends in groundwater flow can be surmised from the available information. Figure 8 provides a potentiometric contour map of the water table aquifer derived from (1) the depths to water in the test pits used to delineate the wetlands located south of the tailings impoundment as reported by Jack Johnson (2000), (2) historic water levels in a monitoring well located near the historic Park City landfill as reported by WESTON (1999a), (3) surveyed surface water elevations as reported by WESTON (1999a), (4) estimated water level elevations in the recently installed wells RT-12, RT-13, RT-14, and RT-15, (5) representative water level elevations in piezometers located in the tailings impoundment and adjacent to the tailings impoundment, and (6) topographic elevations along the stretch of Silver Creek located west of the tailings impoundment.

Recalling the transient storage of groundwater in the topsoil, coupled with the seasonal changes of water levels in the various piezometers, the presented water level elevations may be representative of typical early summer conditions and may be in error of ± five feet.

WESTON (1999a) examined the potentiometric surface elevations collected during the 1999 investigation and showed that groundwater in the water table flows from areas of higher hydraulic head located south of the tailings pond northward to areas of lower hydraulic head. Examination of Figure 8 reveals that the shallow groundwater mimics the local topography moving generally from southwest to northeast towards the wetlands located south of the tailings impoundment. Groundwater moving further north towards the impoundment is captured by the drainage ditch, as indicated by the estimated elevations of the water table in piezometers RT-8 A/B and RT-5, and wells RT-13 and RT-14. Captured groundwater eventually discharges to the wetlands located below the tailings impoundment.

Groundwater moving from northeast to southwest moves under the topsoil underlying the tailings impoundment and is eventually captured by the southern diversion ditch which is entrenched through the topsoil. Some of this groundwater may also discharge into the tailings impoundment. Groundwater stored in the tailings impoundment moves northwesterly towards the embankment under a relatively flat hydraulic gradient. The steep hydraulic gradient across the embankment indicates that the hydraulic conductivity of the embankment materials is less than the hydraulic conductivity of the tailings stored in the impoundment.

On the basis of the seasonal low 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. Examination of Figure 7 reveals that the water levels in RT-7 remain relatively unchanged throughout the seasons, and water levels in RT-9 generally reflect minor changes in stream levels indicating the hydrologic regime remains consistent regardless of the time of year. 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 Figure 9).

TABLE I
GENERALIZED WATER-BEARING CHARACTERISTICS OF MESOZOIC AND PALEOZOIC ROCKS IN THE VICINITY OF RICHARDSON FLAT, SUMMIT COUNTY, UTAH

Geologic Unit	Hydrogeologic Role	Comments
Twin Creek Limestone	Aquitard & Aquifer	Several stratigraphic members serving as both aquifers separated by aquitards. Source of supply for several Snyderville Basin water companies. No wells completed near Richardson Flat.
Nugget Formation	Aquifer	Source of supply for Snyderville Basin water companies. No wells completed near Richardson Flat.
Ankareh Formation	Aquitard & Aquifer	Primarily shales. Ashland and others (1996) report the Gartra Grit member may serve as limited aquifer. Middle Valley Exploration Boring No. 1 yielded water with calculated TDS = 1,200 mg/l.
Thaynes Formation	Aquitard & Aquifer	Primary source of supply for Park City Municipal Corporation wells. Primary target for Browns Canyon Exploration Well No. 2. TDS = 2,200 mg/l.
Woodside Shale	Aquitard	Lower part of the Woodside Shale is an aquitard; fine-grained sandstones in middle and upper part may produce sufficient groundwater for domestic purposes.
Park City Formation	Aquifer	Principal water supply for Oakley City located approximately 15 miles east. Target interval Browns Canyon Exploration Well No. 1. TDS = 660 mg/l/
Weber Formation	Aquifer	Serves as the principal source of water and produces several thousand gpm to various drain tunnels near Park City. Primary target for Browns Canyon Exploration Well No. 3. TDS = 3,930 mg/l. No tritium detected. C_{14} age = 15,800 before present.
Round Valley Formation	Aquitard	Test well drilling at Oakley City indicated low permeability limestones and siltstones.
Doughnut Formation	Aquitard/ Aquifer	Claystones serve as local confining bed.
Humbug Formation	Aquifer	Test well drilling at Oakley City indicated an aquifer with potable water quality. No wells completed near Richardson Flat.

No flow measurements have been collected along Silver Creek for this investigation. However, on the basis of limited water level elevations measured near Silver Creek, the stream may be a gaining flow along the reach near Highway 40. On the basis of limited surveyed water level elevations measured west of the embankment, a losing reach may occur as Silver Creek approaches the embankment area.

Brooks and others (1998) provide a generalized groundwater flow direction that parallels the alignment of Silver Creek located west of Richardson Flat. An overall hydraulic gradient of 0.019 directed towards North 32° East was extrapolated from a regional potentiometric map of the unconsolidated sediments and volcanic rocks provided by Holmes and others (1986) for areas located north of Richardson Flat. However, Brooks and others (1998) also indicate a hydraulic gradient directed towards North 32° West along the Silver Creek drainage near the Star Pointe Ranch Well No. 15B.

Generalized Groundwater Flow Model

The hydrogeologic conceptual model of the Richardson Flat area developed by WESTON (1999a) was further developed by the supplemental geologic and hydrologic data collected since 1999. As depicted on Figure 9, precipitation and snowmelt 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. While the clay-rich organic topsoil temporarily stores groundwater perched on a layer of well cemented, low permeability caliche, it also serves as a confining layer for groundwater stored in deeper aquifers based on the six feet of water level difference between these water bearing units. Seasonal water level changes in the deeper confined aquifers reflect the pressure transient associated with seasonal increases in hydraulic head in the recharge area located south of Richardson Flat. Seasonal changes in the degree of saturation in the tailings reflect influx of snowmelt.

On the basis of stream flow measurements by Holmes and others (1986), surveyed water level measurements completed during the study by WESTON (1999a), and the seasonal water level measurements summarized in 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 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 seasonal high 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 0.04 (see Figure 4). Assuming that the

seasonal high water level data within the impounded tailings reasonably reflects worst case conditions, first-order approximations of seepage rates across the tailings embankment can be made with hydraulic conductivity data derived from percolation tests completed by Dames & Moore (1973; 1974; 1980) and Applied Geotechnical Engineering Consultants, Inc. (1999). A summary of the hydraulic conductivity data for various earth materials located in and near the tailings embankment is provided in Table II.

WESTON (1999a) incorporated a range of values 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 248 located north of the impounded tailings. Using the best available estimates of hydraulic gradients, WESTON (1999a) estimated the seepage across the tailings embankment using the Darcy equation:

$$Q=Kia$$

where **Q** is the volumetric flow rate per unit area per unit time; **K** is the saturated hydraulic conductivity; **a** = cross-sectional area perpendicular to flow; 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 III.

Based on these simple calculations, WESTON's estimates of the seepage rates across the embankment face ranged 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 Figure 3).

TABLE II
HYDRAULIC CONDUCTIVITY MEASUREMENTS OF RICHARDSON FLAT MATERIALS
SUMMIT COUNTY, UTAH

Media	Sample Location	Hydraulic Conductivity (ft/year)
Artificial Fill Cap	See Figure 1	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 WESTON (1999a).
** Test Pit Locations and data from Dames & Moore (1973; 1974) - See Figure 1.
*** UPCMC = United Park City Mines Co. Well Numbering System for embankment wells – See Figure 1.
Adapted from WESTON (1999a).

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. WESTON (1999a) assumed that the triangular-shaped land area located west of the embankment and Silver Creek approached 5.5 acres in size and integrated the estimates of evaporation by Dames & Moore (1973) which yielded 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 that first-order approximations for evapotranspiration approach 12,000 gallons per day. WESTON (1999) examined the available color aerial photography of the Richardson Flat area which indicated 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, WESTON (1999a) estimated a range of wetlands consumptive use from 2,400 to 12,000 gallons per day.

On the basis of the simple water budget, most if not all of the calculated seepage through the embankment is either lost by evaporation or consumed by the wetlands located below the embankment.

DOWNGRADIENT WELL INVENTORY

An inventory of wells was completed for the Silver Creek watershed downstream from the Prospector Square area for purposes of identifying users of groundwater downgradient from Richardson Flat. The watershed approach to identifying nearby groundwater users was implemented because (1) the complex geology of the area precludes the use of the conventional fixed radius approach, (2) the boundaries of the watershed can be easily defined, and (3) the watershed provides a more conservative definition of downstream groundwater users. Figure 10 depicts the boundaries of the inventoried area which encompasses approximately 12 square miles.

Twenty six wells and two springs were identified within the watershed near Richardson Flat using the Utah Department of Water Rights database along with unpublished information and local knowledge of the area (see Figure 10). Nearby test wells and public water supply wells located outside the watershed were also inventoried due to the importance of the data in developing the conceptual hydrogeologic model (for example, see Summit County Service Area No. 3 and the Park City Municipal Corporation wells). Attachment No. 1 provides a listing of the wells identified north of Richardson Flat.

With the exception of the monitoring well located south of Richardson Flat which was installed by Ecology and Environment, serving as agent for the Environmental Protection Agency, all wells are deeper than 150 feet and develop water stored in the Keetley and deeper aquifers (see Figures 5 and 6). Examination of the driller's logs on file with the Utah Department of Water Rights, coupled with interviews with local drilling contractors, reveals that the reason no wells develop water from the alluvium is due to the low productivity of these unconsolidated aquifers. The only wells tapping the alluvium and colluvium overlying the Keetley Volcanics include the various piezometers and monitoring wells in the vicinity of Richardson Flat.

State of Utah Drinking Water Source Protection Rule for Public Water System Wells

According to Theis (1940), all water developed through wells is balanced by a loss of water somewhere. The loss is largely from capturing water storage in an aquifer. Estimates of the capture area associated with public water supply wells is required by the Drinking Water Source Protection (DWSP) Rule UAC R309-600 managed by the Utah Division of Drinking Water. According to the 1997 Source Protection User's Guide prepared by the Division of Drinking Water, a source protection area is the "*... surface and subsurface area around a well, spring, or tunnel through which contaminants are reasonably likely to move toward and contaminate the [drinking water] source.*" Two methods are allowed under UAC R309-600 to determine this area: (1) the Preferred Delineation Procedure; and (2) the Optional Two-Mile Radius Delineation Procedure. The Preferred Delineation Procedure is usually selected because it uses local hydrogeologic conditions to determine the drinking water source protection (DWSP) area and it is more accurate than the Optional Two-Mile Delineation Procedure. The four protection zones delineated by the Preferred Delineation Procedure include:

- **Zone One** - the area within a 100-foot radius around the wellhead, spring, or tunnel collection area;

- **Zone Two** - the 250-day time-of-travel (TOT), the boundary of the aquifer(s) which supplies water to the source, or the groundwater divide, whichever is closer;
- **Zone Three** - the area within a 3-year TOT to the source, the boundary of the aquifer(s) which supplies water to the source, or the groundwater divide, whichever is closer; and
- **Zone Four** - the area within a 15-year TOT to the source, the boundary of the aquifer(s) which supplies water to the source, or the groundwater divide, whichever is closer.

TABLE III
CALCULATED SEEPAGE RATES ACROSS
RICHARDSON FLAT 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 Figure 1.
Adapted from WESTON (1999a).

Zone One - 100-Foot Fixed-Radius Accident Prevention Zone. Zone One is a 100-foot fixed radius from the wellhead or collection area of the spring and is referred to as the accident prevention zone. Its purpose is to prevent accidents and to protect the wellhead.

Zone Two - 250-day Attenuation Zone. Zone Two is sometimes referred to as the attenuation zone. Its purpose is to reduce concentrations of pathogenic microorganisms and some chemicals to levels below maximum contaminant levels before groundwater reaches a well, spring or tunnel. Zone Two represents a moderate level of protection.

Zone Three - 3-year Waiver Criteria Zone. Zone Three is a three-year groundwater time-of-travel to the well referred to as the waiver criteria zone. This zone has been established to provide a basis for granting monitoring wavers in the future.

Zone Four - 15-year Remedial Action Zone. Zone Four is defined as the 15-year groundwater time-of-travel to a well, spring or tunnel referred to as the remedial action zone. Its purpose is to provide protection to the drinking water source and to afford sufficient time for remediation or developing a new source in case of a contamination incident.

Delineation of DWSP Zones for Nearby Public Water Supply Wells

Zones Two, Three, and Four can be determined through analytical calculations, numerical flow models, hydrogeologic mapping, or a combination of these methods. The 250-day (Zone Two), 3-year (Zone Three), and 15-year (Zone Four) TOT areas for many of the public water supply wells were defined using the EPA Wellhead Protection Area (WHPA) Model, Version 2.2, dated September 1993 (Blandford and Huyakorn, 1993) which yield a circular to elliptical shaped capture area. Capture areas delineated using hydrogeologic mapping typically yields an irregularly shaped DWSP Zone (see Montgomery Watson, 2000a; 2001a,b,c and WESTON, 1998a,b; 2000).

Figure 10 depicts the 15-year groundwater TOT for the public water supplies located in the vicinity of Richardson Flat. Note than none of the DWSP Zones for public water supplies extend across Richardson Flat, further substantiating the fact that it is unlikely that the public is consuming groundwater in contact with water stored in the tailings impoundment.

CONCLUSIONS

The following conclusions were reached on the basis of the WESTON (1999a) study and subsequent hydrogeologic investigations in the Richardson Flat area:

- The tailings are partially saturated;
- The tailings are deposited on the naturally occurring pre-tailings topsoil;
- The organic-rich clayey pre-tailings topsoil functions as a seasonally perched aquifer;
- The organic-rich clayey topsoil also serves as an effective confining layer for downward infiltration or upward movement of groundwater from deeper water bearing strata;
- Laterally continuous clay strata are found within the Keetley Volcanic rocks and are derived from deposition of fine-grained volcanics and weathering;
- On the basis of water level measurements, pumping tests, flowing wells, differences in water quality and temperatures, the clay strata serve as effective confining layers between aquifer(s);
- Groundwater flows from areas of higher hydraulic head located south of the tailings pond northward to areas of lower hydraulic head along the diversion ditch;
- 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);
- There is no apparent hydraulic connection between groundwater stored in the tailings and the underlying aquifer(s) within the Keetley Volcanic rocks developed as a groundwater supply by downstream Public Water Systems;

- There is no apparent hydraulic connection between groundwater stored in the Keetley Volcanic rocks and the underlying aquifer(s) within the Mesozoic and Paleozoic rocks;
- 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;
- Pumping wells serving Public Water Systems along Silver Creek do not capture groundwater stored in the Keetley Volcanic rocks underlying Richardson Flat;
- 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
- Water level changes within the tailings impoundment correspond to the seasons and probably reflect infiltration of precipitation due to the thin artificial cover.

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ATTACHMENT NO. 1
WELL INVENTORY

SILVER CREEK DRAINAGE WELL INVENTORY

Map No.	Owner	Type	T	R	Sec	1/4-1/4	Year	Depth	Aquifer Tapped by Well	DTW	Rate	Comments
1	Pivotal Promontory	Test	1S	4E	13	dcc	1993	405	Keetley Volcanics		X	
2	Mountain Regional SSD	Public Supply			13	ada	2000	900	Keetley Volcanics	201	449	3 Mile Canyon
3a	Mountain Regional SSD	Observation			14	bdb	1996	605	Keetley Volcanics, Alluvium	40	300	
3b	Mountain Regional SSD	Public Supply			14	bdb	1996	745	Keetley Volcanics, Alluvium	36.35	1200	Well 15B
4	Snyderville Basin	Industrial			15	acc	1986	291	Keetley Volcanics	7	110	WWTP
5	Stevens, Harold	Domestic			15	dba	1977	150	Keetley Volcanics, Alluvium	75	20	
6	Sinclair (Bates)	Industrial/ Public Supply			15	bcb	1992	205	Keetley Volcanics, Alluvium	10	13	Gas Station
7	Mountain Regional SSD	Public Supply			21	ddd	1992	840	Twin Creek Ls.	226	800	Atkinson No. 2
33	High Valley WC	Public Supply			21	aac	1964	550	Keetley Volcanics	65	100	HWWC No. 1
8	Mountain Regional SSD	Public Supply			22	cdd	1978	370	Keetley Volcanics	45		Atkinson No. 1
9	Mountain Regional SSD	Public Supply			22	acd	1999	320	Keetley Volcanics	16	130	Atkinson No.3
10	Mountain Regional SSD	Public Supply			22	abb	1999	415	Keetley Volcanics	1.5	400	Atkinson No.10
11	Schofield	Test			22	abb	1996	420	Keetley Volcanics	10	50	
12	Mountain Regional SSD	Test			22	bdb	1999	420	Keetley Volcanics	11.5	X	abandoned
13	Pivotal Promontory	Test			24	cdc	1992	600	Keetley Volcanics	378	10	
14	Pivotal Promontory	Test			24	bda	1992	600	Keetley Volcanics	500		
15	Mountain Regional SSD	Test			25	cca	2000	1,150	Keetley Volcanics, Thaynes Fm.	Flowing	X	abandoned
16	Mountain Regional SSD	Test			25	dbb	2000	1,560	Keetley Volcanics, Ankareh Fm.	315	X	abandoned
17	Summit Water	Test			27	bbd	1994	600	Keetley Volcanics	332	100	
18	Mountain Regional SSD	Test			27	bcb	1992	830	Keetley Volcanics	226	800	**
19	Summit Water	Test			27	bdb	1994	600	Keetley Volcanics	169	15	
20	Summit Water	Test			27	cab	1994	420	Keetley Volcanics	173	105	
21	Park City SSD	Test			34	ddd	1996	1,000	Keetley Volcanics	140	160	
22	Utah Power and Light	Industrial/ Public Supply			35	dba	1974	320	Keetley Volcanics	25	50	UP&L
23	Monroc, Inc	Industrial			35	dbd	1980	300	Keetley Volcanics	43	80	
24	Geneva Well	Industrial			35	dbb	1981	451	Keetley Volcanics	21	75	
25	Stanley, Larry	Domestic			35	bab	1993	320	Keetley Volcanics	145	30	
26	Burbidge Properties	Industrial			35	dbd	2000	485	Keetley Volcanics	40.7	15	
27	USWest	Industrial			35	dbd	1985	195	Keetley Volcanics			
31	Pivotal Promontory	Test			36	aca	2000	1,085	Keetley Volcanics, Park City Fm.	300	X	abandoned
32	Mountain Regional SSD	Test			36	dac	2000	1,935	Keetley Volcanics, Weber Quartzite	362	X	abandoned
28	Wortley, Ray	Domestic	2S	4E	2	cbd	1943	220	Keetley Volcanics	42	30	
29	Butkovich, Anthony	Domestic			2	cba	1962	222	Keetley Volcanics	55		
30	Env. Protection Agency	Monitoring			2	dda	1999	37.5	Alluvium	10	X	RT-1
A	Silver Creek Irrigation	Irrigation	1S	4E	10	ddd	n/a	n/a	Keetley Volcanics, Alluvium	n/a	16	Pace Spring
B	Silver Creek Irrigation	Irrigation			35	aca	n/a	n/a	Keetley Volcanics	n/a	6-8	Homer Spring

* References: Division of Water Rights Records, Supplemented by Montgomery Watson (2000) for Mountain Regional Water SSD Wells and Pivotal Promontory Wells.

** Possible filling error. Reported data is the same as well No. 7.

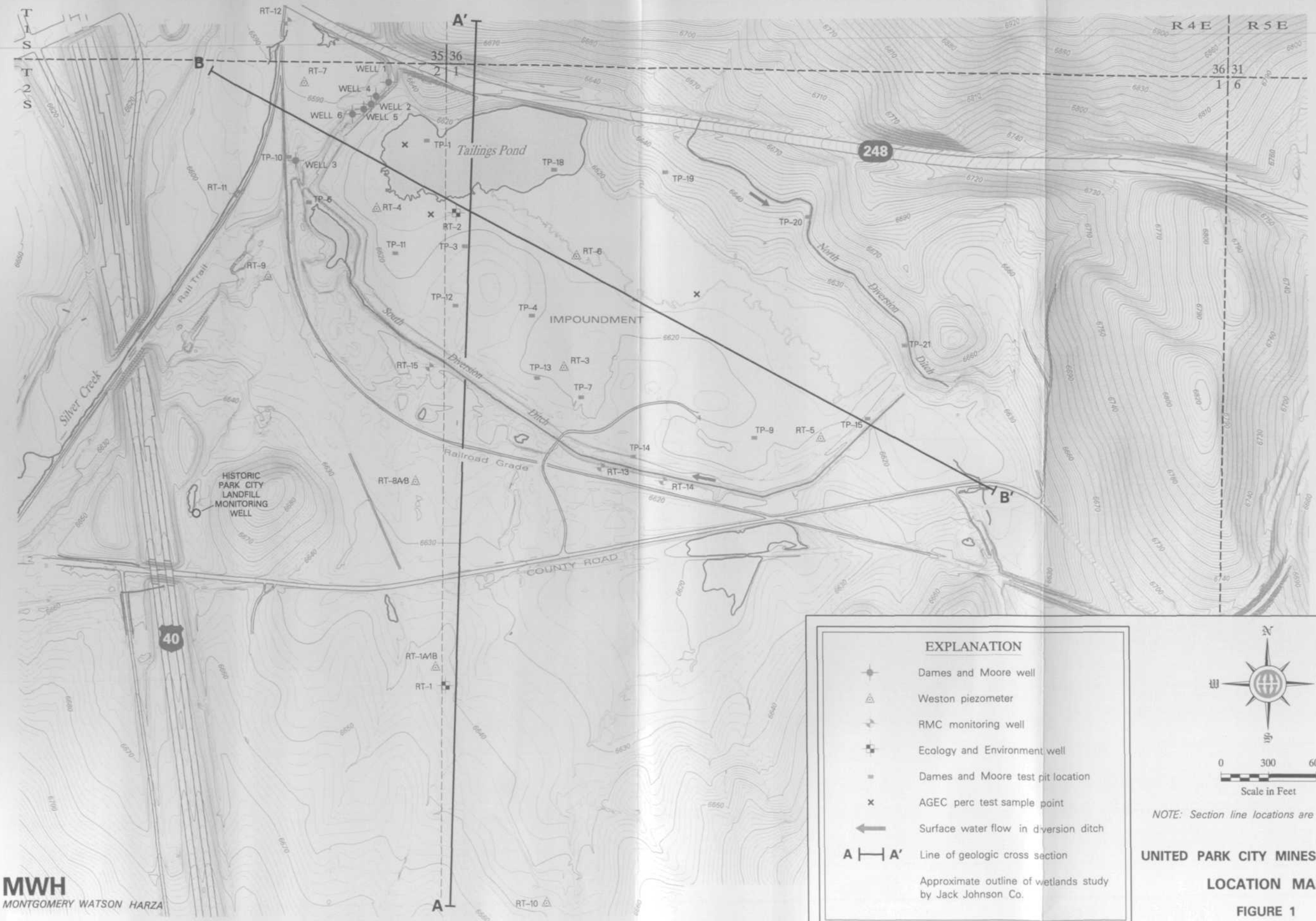
ATTACHMENT NO. 2
SUMMARY OF WATER LEVELS IN PIEZOMETERS AND MONITORING WELLS

RICHARDSON FLAT TAILINGS SITE
WATER LEVEL SUMMARY

LOCATION	GROUND ELEVATION (FEET, MSL)	DEPTH TO WATER (FEET BELOW GROUND SURFACE) 2/2/99	3/9/99	5/14/99	7/16/99	10/2/99	11/15/99	12/14/99	1/11/00	2/10/00	3/27/00	4/26/00	5/25/00
RT-1	NO DATA	11.6	10	4.37	9.24	11.67	12.16	12.40	12.67	12.66	10.95	10.08	11.15
RT-1A	6640.6	12.8	10.70	6.44	10.47	12.82	13.25	13.55	NM	NM	NM	NM	NM
RT-1B	6640.04	12.65	10.59	6.35	10.53	12.97	13.30	13.70	NM	13.75	11.89	12.07	12.56
RT-2	NO DATA												
RT-3	6616.95	4.9	3.43	0.25	4.25	5.0	5.18	5.30	5.34	4.43	3.13	4.18	4.37
RT-4	6617.07	DRY	DRY	4.56	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
RT-5	6621.39	7.3	6.35	4.82	7.46	8.21	8.50	8.99	7.72	7.31	5.91	6.14	6.85
RT-6	6616.95	4.87	3.80	0.58	4.39	5.6	5.12	5.90	5.96	4.86	3.35	4.86	4.98
RT-7	6689.28	0	0.24	0	0	0	0	0	NM	0.05	0.04	0.01	0.02
RT-8A	6627.71	12.3	10.48	4.86	9.88	12.50	12.96	13.10	13.43	13.35	11.36	10.10	11.42
RT-8B	6627.97	12.23	10.31	4.33	9.6	12.20	12.59	12.84	13.11	13.05	10.90	10.06	11.05
RT-9	6620.55	18.03	16.84	14.78	17.12	17.80	17.9	18.35	18.09	17.87	19.71	17.45	17.71
RT-10	6650.45	1.1	0.77	0.41	2.44	3.35	NM	NM	NM	NM	NM	NM	NM
WELL NO. 1	6604.1	3.86**	3.78	3.25	3.6	4.0	4.02	4.20	4.12	3.97	3.77	3.98	3.85
WELL NO. 2	6596.9									NM	NM	4.15	NM
WELL NO. 3	6596.4	1.45**	1.8	1.26	1.63	1.7	1.69	1.59	1.73	1.49	1.38	1.42	1.46

LOCATION	GROUND ELEVATION (FEET, MSL)	DEPTH TO WATER (FEET BELOW GROUND SURFACE) 7/6/00	8/2/00	8/30/00	9/28/00	11/9/00	11/29/00	1/9/01	2/16/01	3/9/01	11/8/01	11/8/01	2/4/02	COMMENTS
RT-1	NO DATA	12.59	13.25	15.52	16.08	14.35	14.47	4.69	4.82	14.87	NM	NM	NM	unable to locate due to snow cover
RT-1A	6640.6	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	unable to locate due to snow cover
RT-1B	6640.04	14.12	14.67	15.33	15.57	NM	NM	NM	NM	NM	NM	NM	NM	unable to locate due to snow cover
RT-2	NO DATA													
RT-3	6616.95	5.01	5.19	5.50	5.67	4.93	5.08	5.22	5.28	5.12	5.74	5.19	5.58	
RT-4	6617.07	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	
RT-5	6621.39	7.75	7.92	8.08	8.67	8.06	7.93	7.75	7.78	7.69	8.88	8.08	NM	
RT-6	6616.95	5.72	5.85	5.92	6.58	NM	NM	NM	NM	NM	NM	NM	NM	unable to locate due to snow cover
RT-7	6689.28	0	0	0	0	0	0	0	0	0	0.88	0	0.02	
RT-8A	6627.71	12.71	13.50	14.27	14.75	15.3	15.09	15.00	14.87	14.58	14.59	14.89	14.88	
RT-8B	6627.97	12.34	13.21	14.00	14.42	14.79	14.81	14.77	14.63	14.39	14.39	14.66	14.76	
RT-9	6620.55	18.16	18.42	18.79	20.96	18.37	18.49	18.54	18.44	21.76	18.48	NM	18.78	
RT-10	6650.45	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	
WELL NO. 1	6604.1	4.68	5.02	4.83	4.50	4.41	4.4	NM	4.33	3.95	NM	NM	NM	
WELL NO. 2	6596.9	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	
WELL NO. 3	6596.4	2.18	2.88	2.21	1.75	NM	NM	NM	NM	NM	NM	NM	NM	unable to locate due to snow cover

NOTES: *(1) Ponded and surface water observations are estimated only and reflect lateral distance to water feature.*
(2) February, May, July, and October 1999 measurements by Todd Jarvis; May, July, August, and September 2000 samples by Laura Wetherbee; November 2000, January, February, and March 2001 samples by Brenda Rencher; all others by Bill Loughlin of Weston Engineering, Inc. November 2001 and later measurements by Resource Management Consultants
(3) Well Nos. 1 and 3 for 2/2/99 were measured on 11/24/98
NM = Not measured



UNITED PARK CITY MINES COMPANY

LOCATION MAP

FIGURE 1

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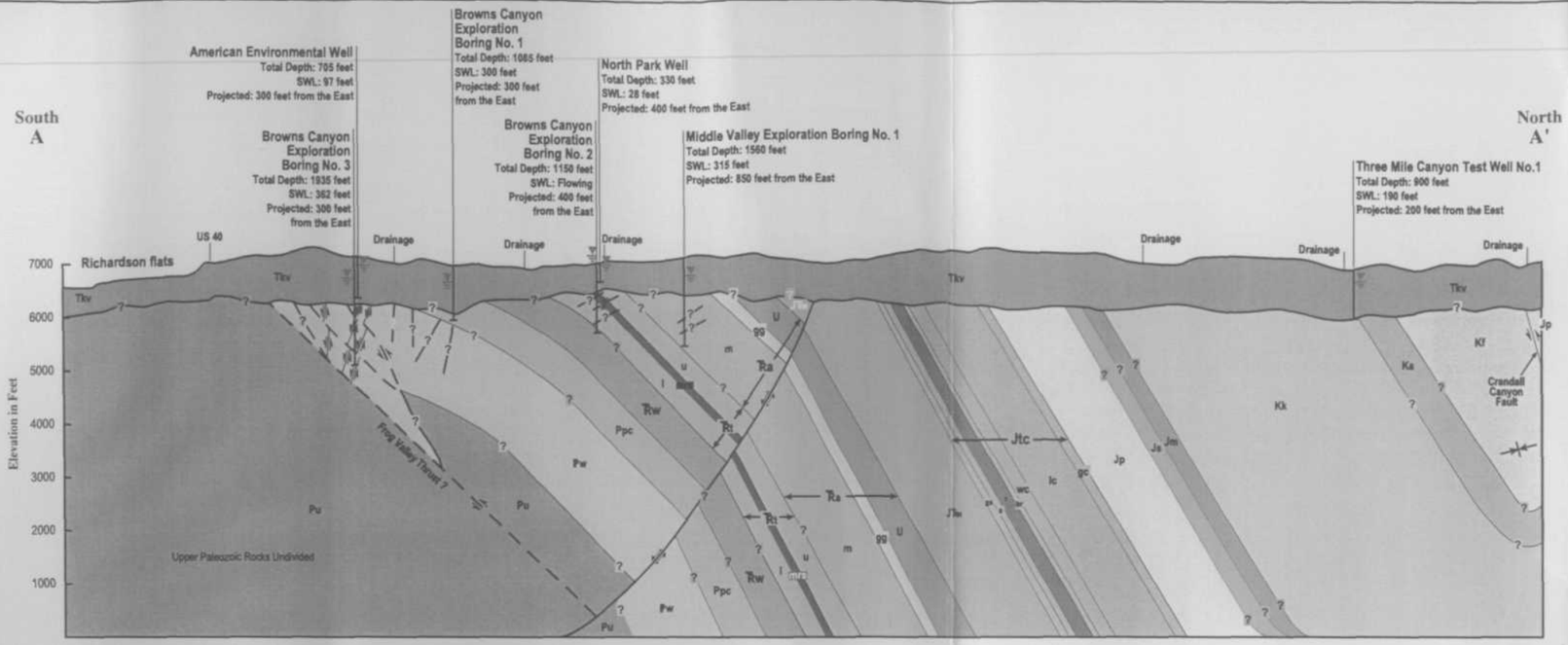
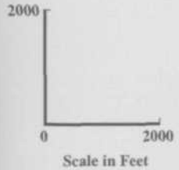
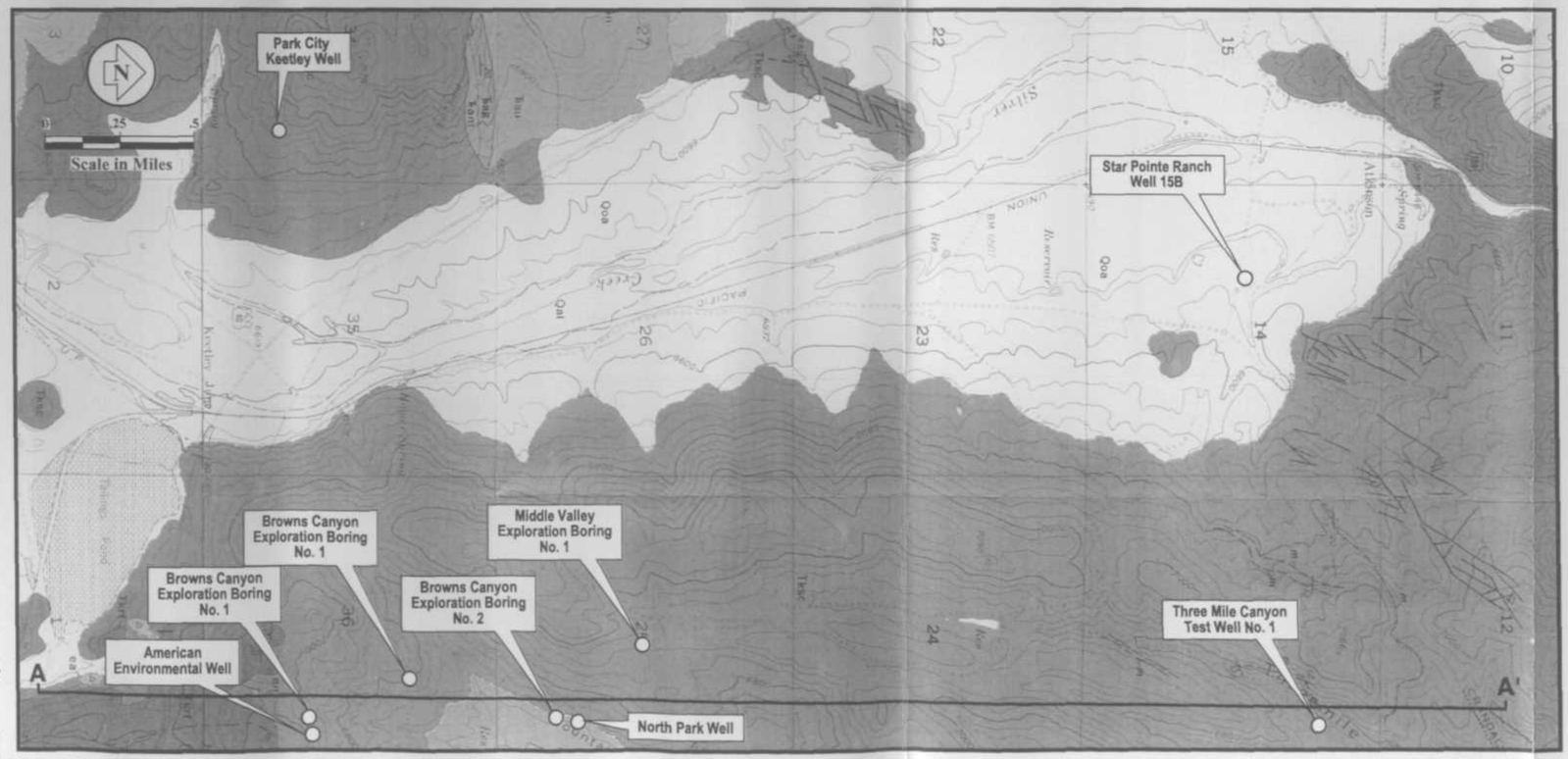






EXPLANATION

SWL	Static Water Level
	Static Water Level
	Fault with relative motion, Dashed where inferred, Question mark where uncertain
—?—	Fault/Joint
	Axis of Syncline
Tkv	Keetley Volcanics
Kf	Frontier Formation
Ka	Aspen Shale
Kk	Kelvin Formation
Jm	Morrison Formation
Js	Stump Formation
Jp	Preuss Sandstone
Jtc	Twin Creek Limestone
gc	Giraffe Creek Member
lc	Leeds Creek Member
wc	Watton Creek Member
br	Boundary Ridge Member
r	Rich Member
s	Slideroock Member
gs	Gypsum Spring Member
JTRn	Nugget Sandstone
Ra	Ankareh Formation
u	Upper Member
gg	Gartra Grit Member
m	Mahogany Member
Rt	Thaynes Formation
u	Upper Thaynes
mrs	Middle Red Shale
l	Lower Thaynes
Rw	Woodside Shale
Ppc	Park City Formation
Pw	Weber Quartzite
Pu	Undivided Upper Paleozoic Rocks (Park City Formation, Weber Quartzite, Round Valley Limestone, Doughnut Formation, and Humbug Formation)

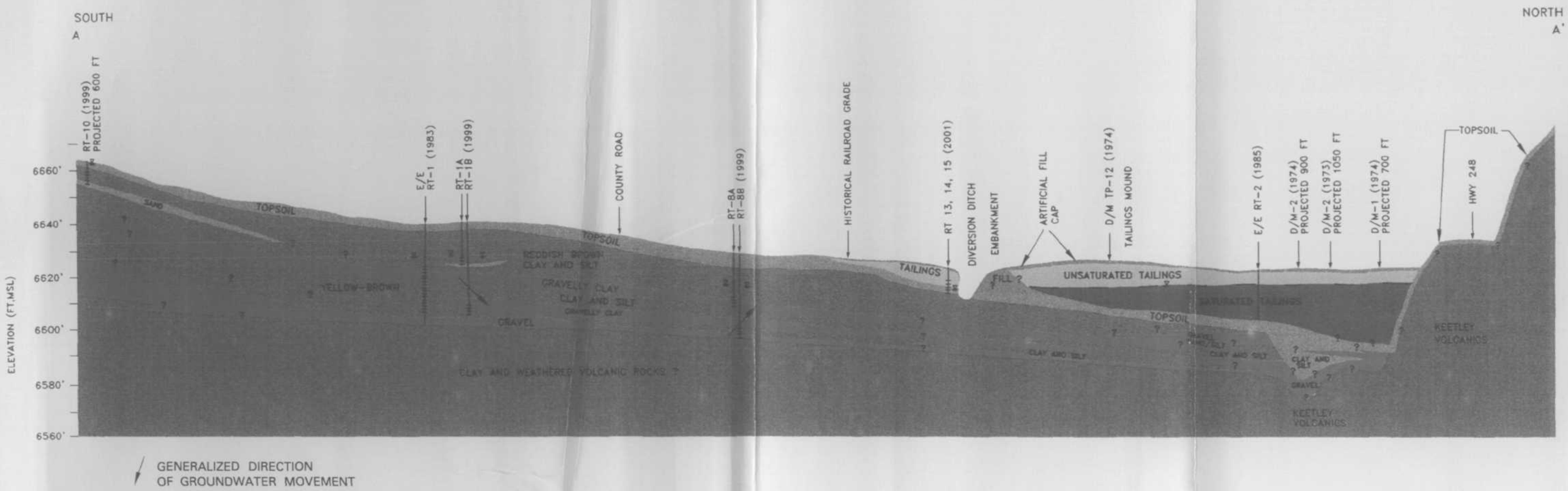
Modified from Montgomery Watson, 2000.

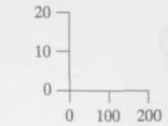
Base map taken from Bromfield and Crittenden, 1971.

MWH
MONTGOMERY WATSON HARZA

PROJECT NO. 1650236.092180 03/14/02 SLC

UNITED PARK CITY MINES COMPANY
GENERALIZED GEOLOGIC CROSS SECTION A–A'
FIGURE 2





SCALE IN FEET
10 X Vertical Exaggeration

UNITED PARK CITY MINES COMPANY

NORTH–SOUTH CONCEPTUAL HYDROLOGIC CROSS SECTION

FIGURE 3

MWH
MONTGOMERY WATSON HARZA

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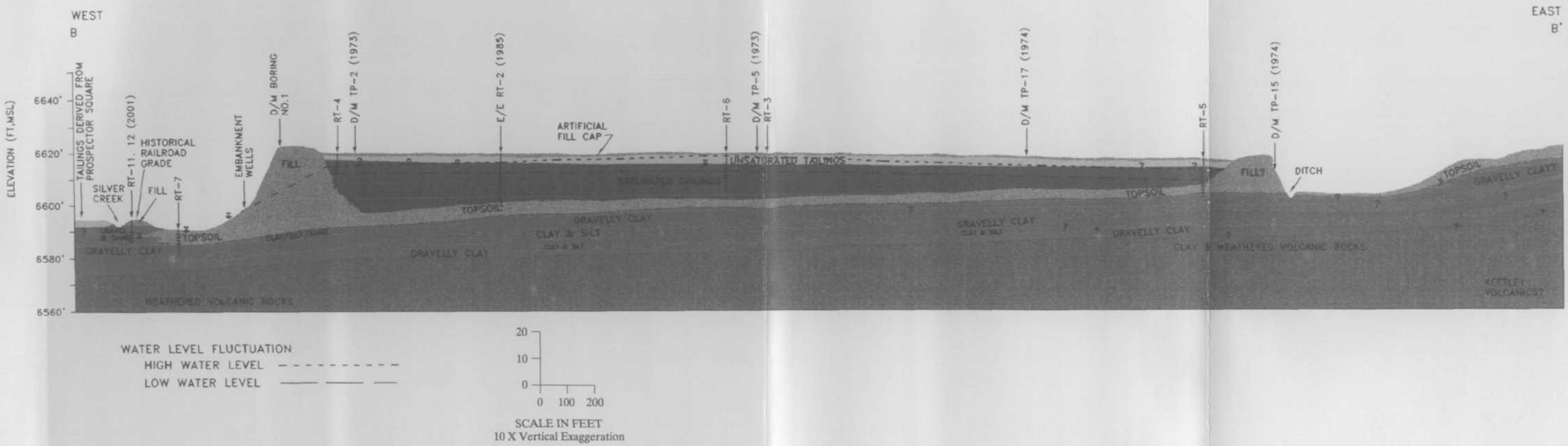

MWH
MONTGOMERY WATSON HARZA

UNITED PARK CITY MINES COMPANY

EAST-WEST CONCEPTUAL HYDROLOGIC CROSS SECTION

FIGURE 4

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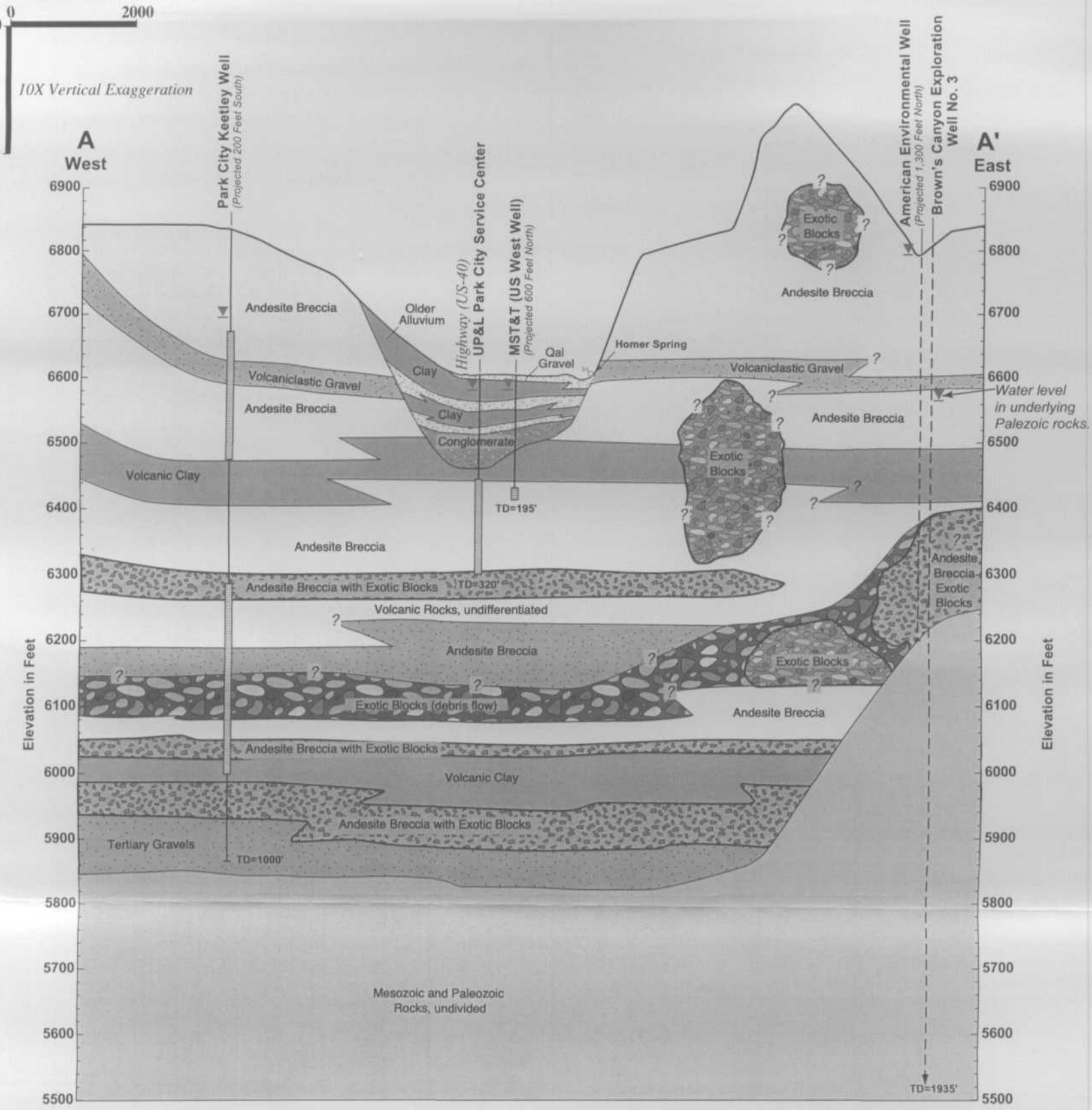
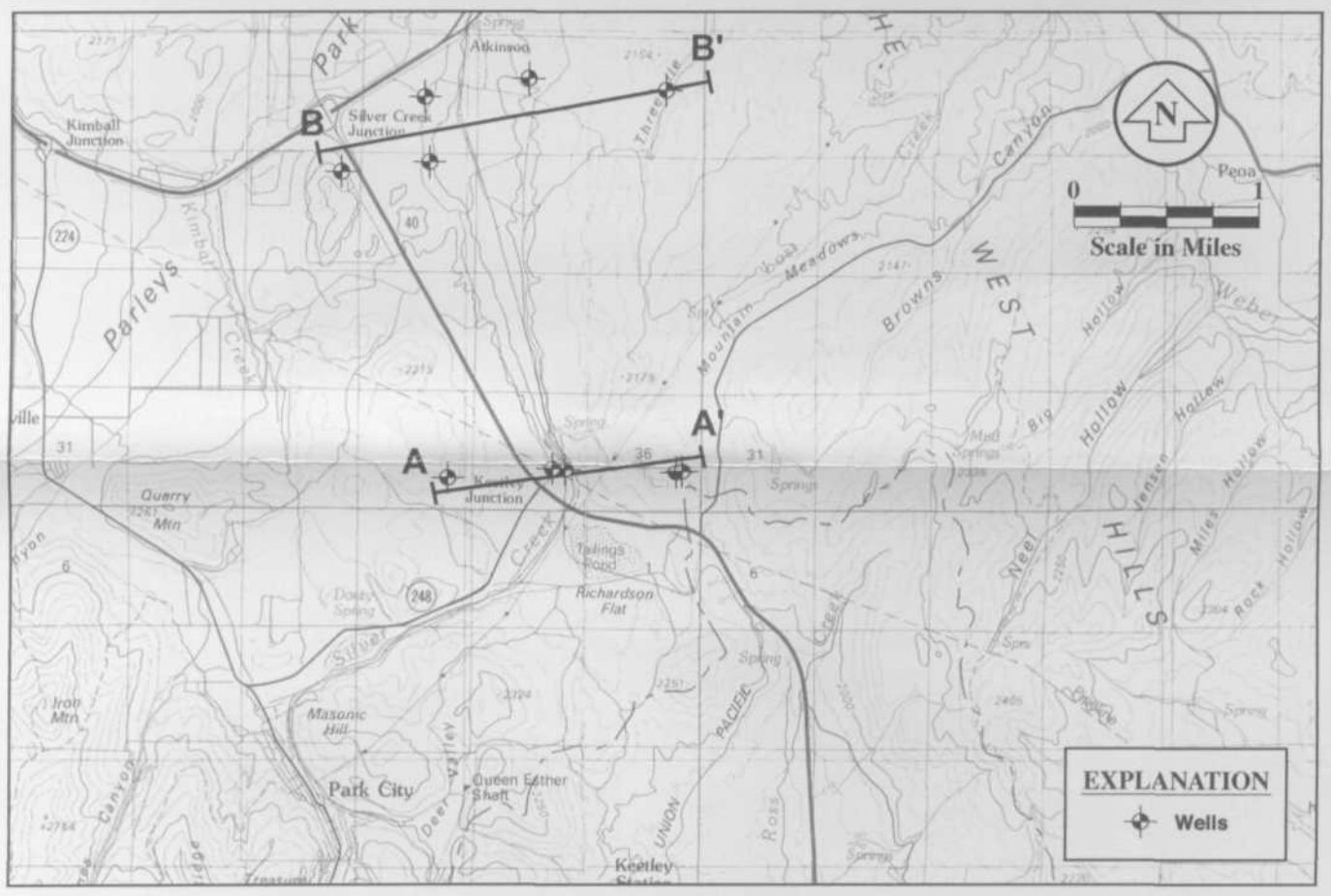
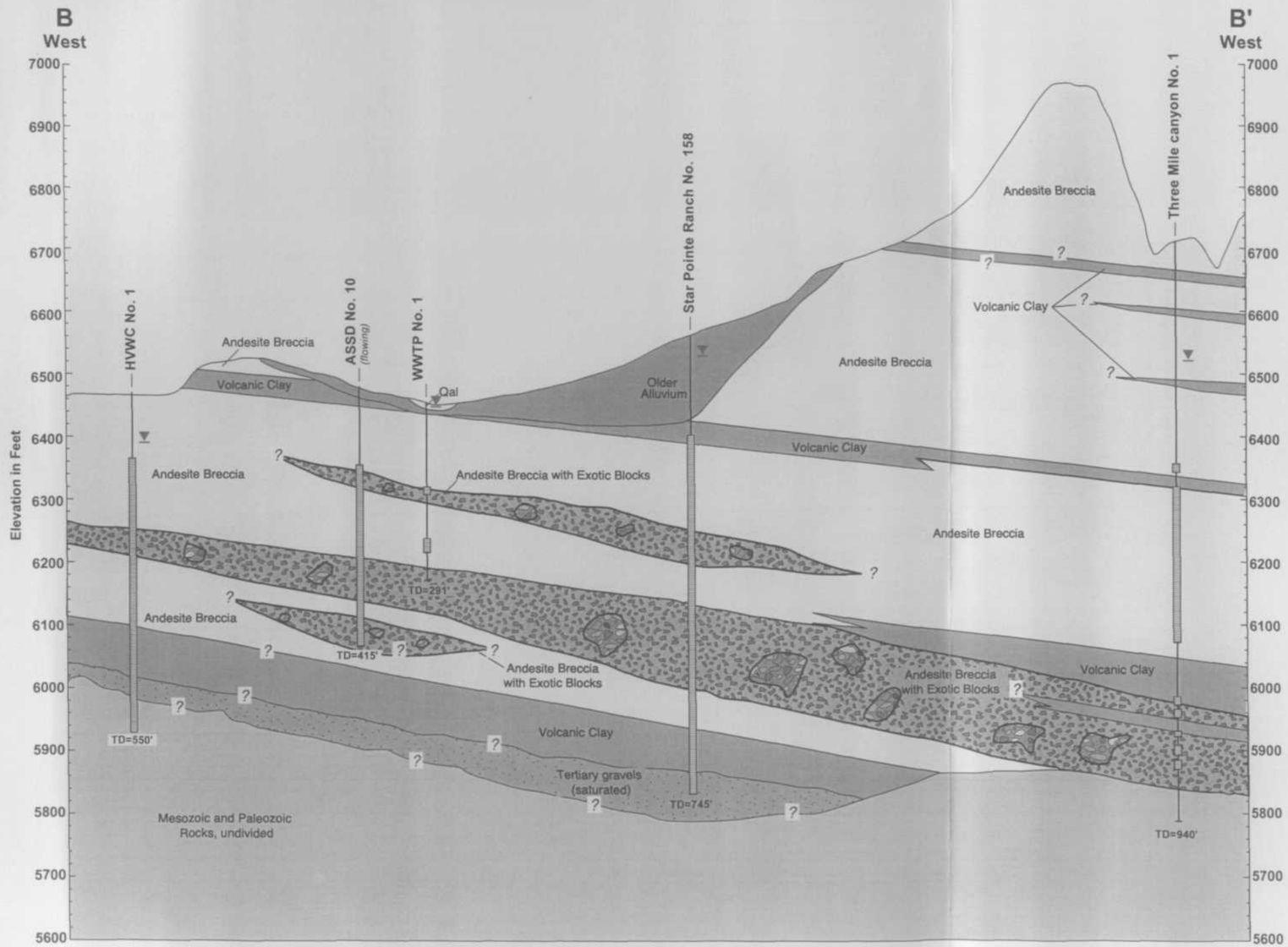




Location Map

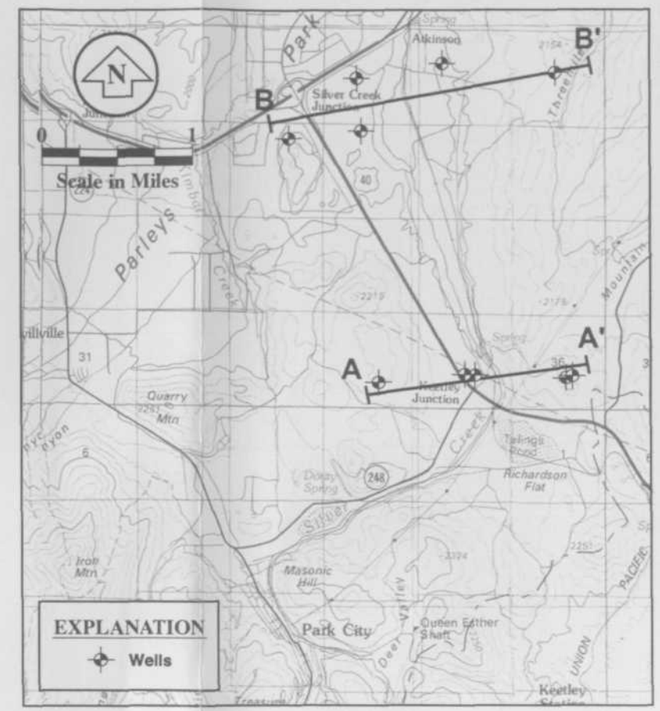
MWH
MONTGOMERY WATSON HARZA

UNITED PARK CITY MINES COMPANY
GENERALIZED GEOLOGIC CROSS SECTION A–A'
FIGURE 5



Horizontal Scale in Feet
0 2000

Vertical Scale in Feet
0 200
10X Vertical Exaggeration

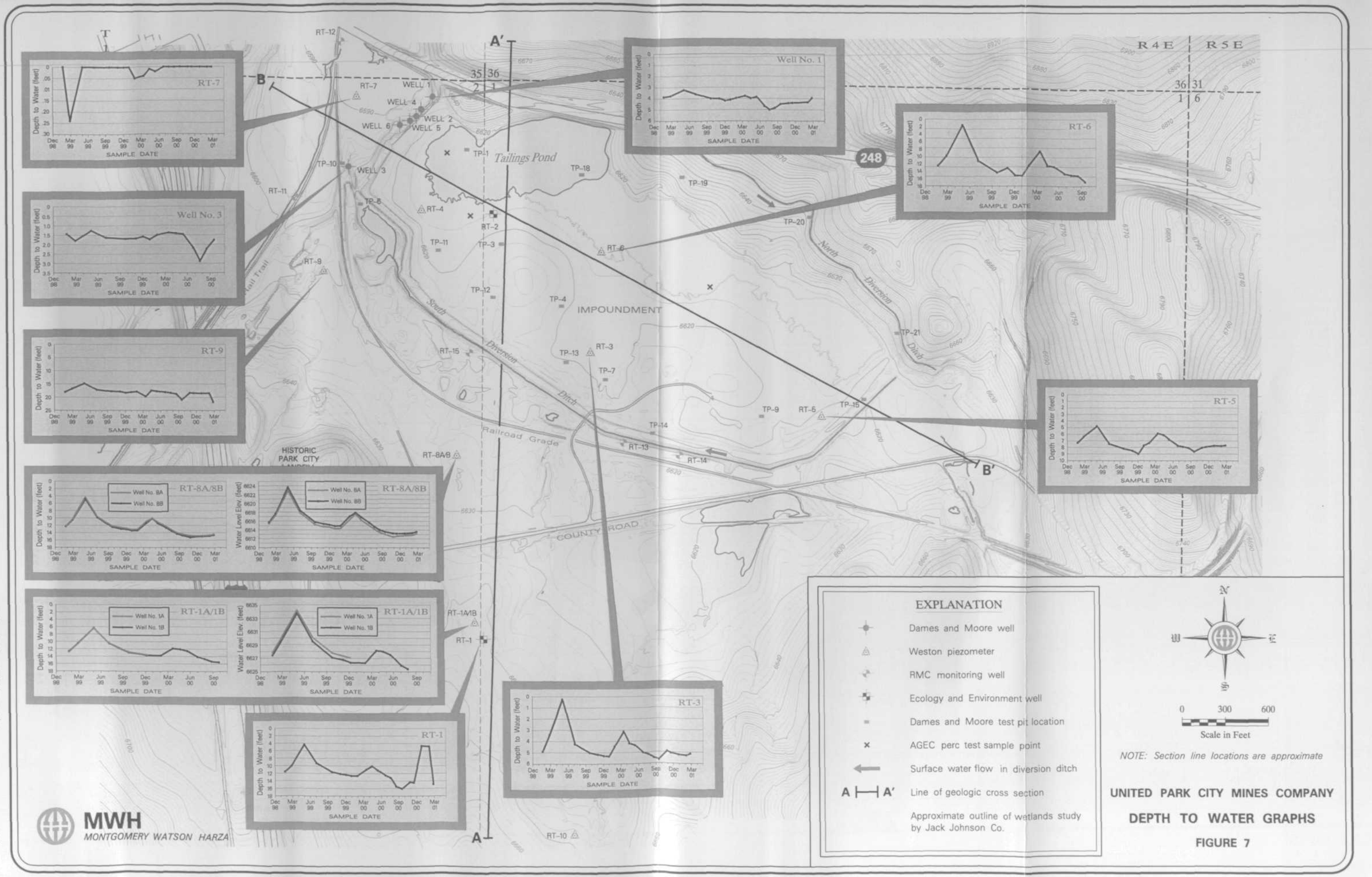


Location Map

PROJECT NO. 1650236.092180 03/14/02 SLC

MWH
MONTGOMERY WATSON HARZA

UNITED PARK CITY MINES COMPANY
GENERALIZED GEOLOGIC
CROSS SECTION B–B'
FIGURE 6



UNITED PARK CITY MINES COMPANY

DEPTH TO WATER GRAPHS

FIGURE 7

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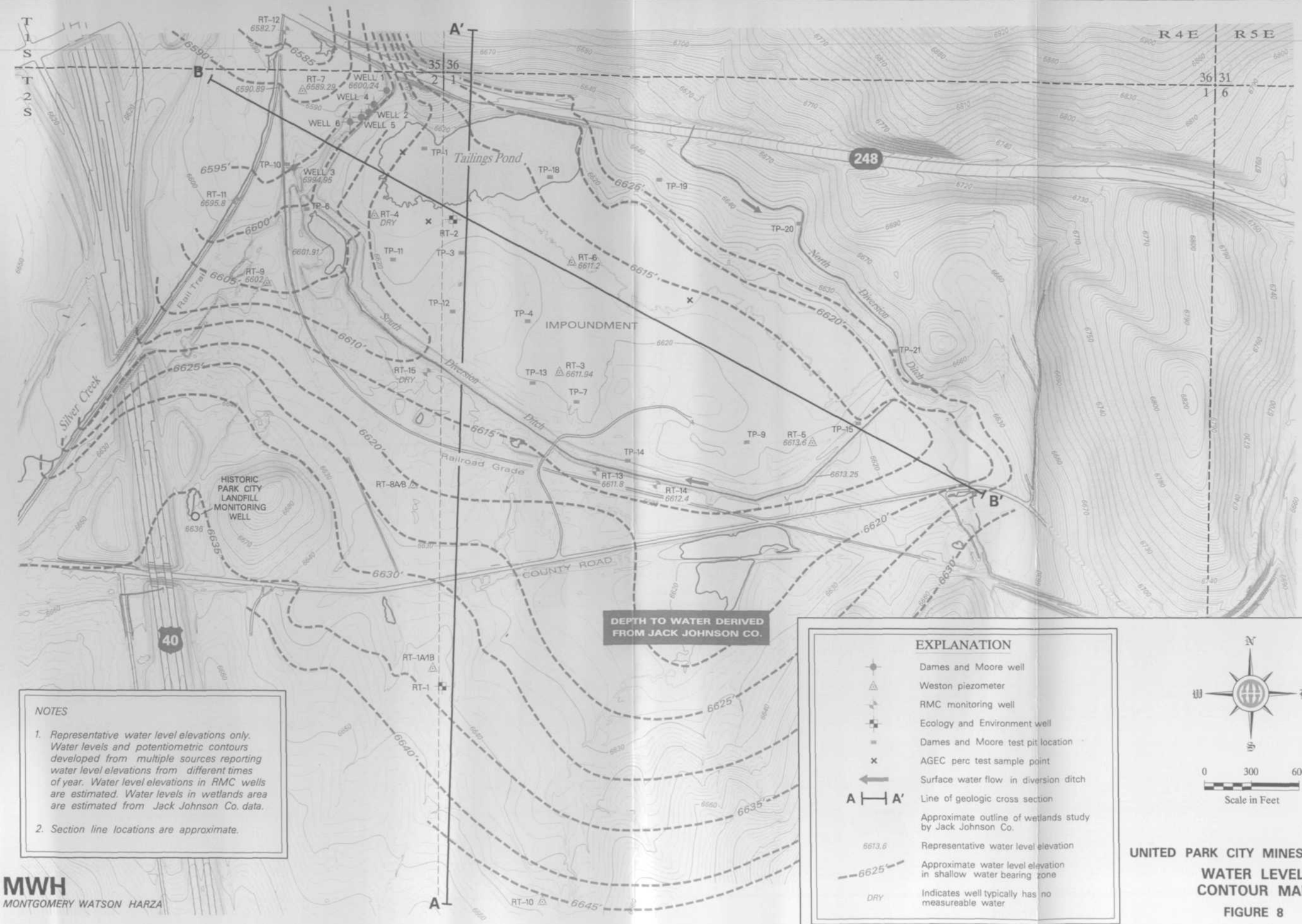

NOTES

1. Representative water level elevations only. Water levels and potentiometric contours developed from multiple sources reporting water level elevations from different times of year. Water level elevations in RMC wells are estimated. Water levels in wetlands area are estimated from Jack Johnson Co. data.
2. Section line locations are approximate.

EXPLANATION

- Dames and Moore well
- Weston piezometer
- RMC monitoring well
- Ecology and Environment well
- Dames and Moore test pit location
- AGEC perc test sample point
- Surface water flow in diversion ditch
- A — A' Line of geologic cross section
- Approximate outline of wetlands study by Jack Johnson Co.
- 6613.6 Representative water level elevation
- 6625' Approximate water level elevation in shallow water bearing zone
- DRY Indicates well typically has no measureable water

N
W E
S

0 300 600
Scale in Feet

UNITED PARK CITY MINES COMPANY

WATER LEVEL CONTOUR MAP

FIGURE 8

MWH
MONTGOMERY WATSON HARZA

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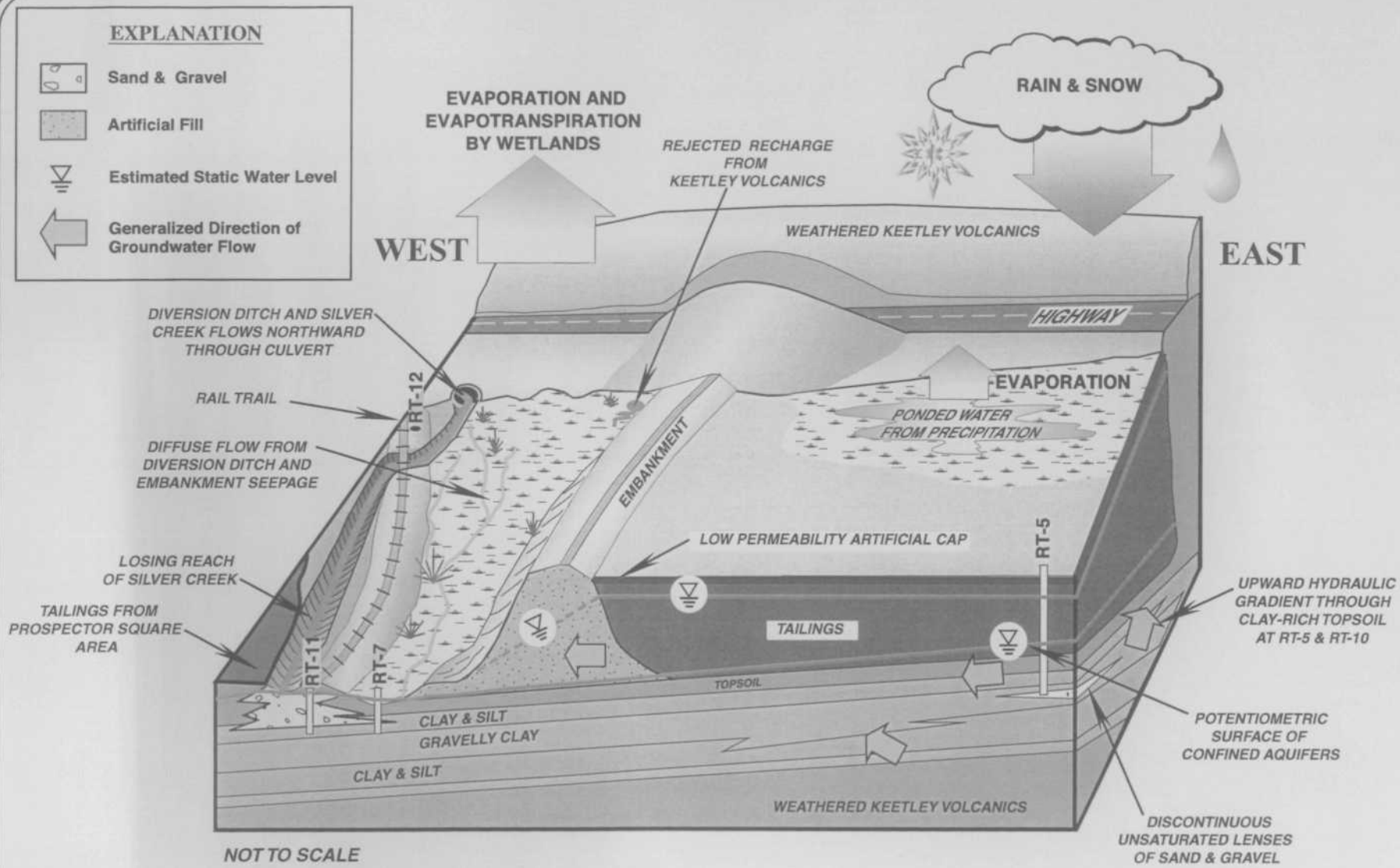
PROJECT NO. 1970955.010101.ai 12/21/02 SLC



Modified after Weston, 1999.

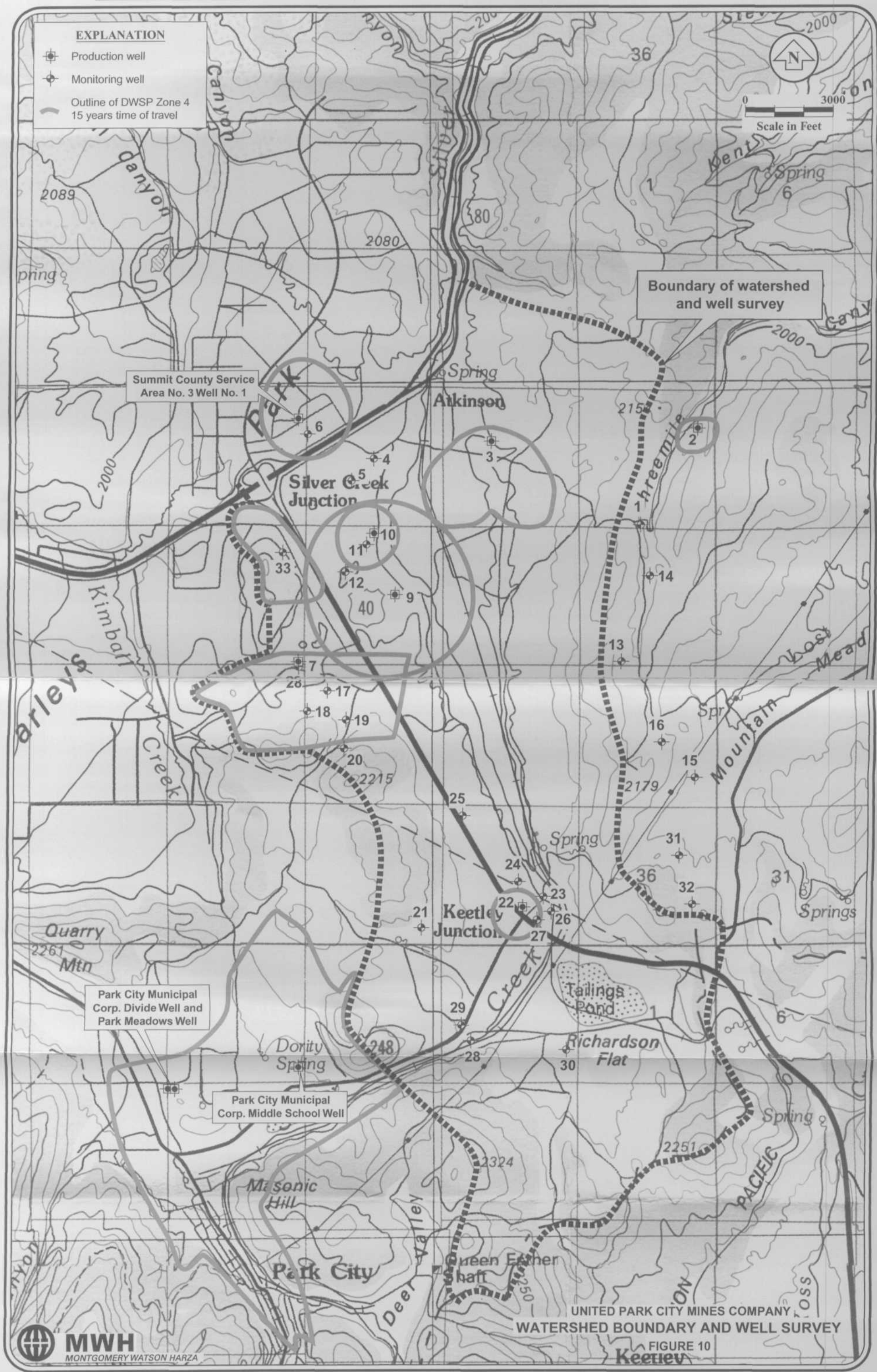
MWH
MONTGOMERY WATSON HARZA

UNITED PARK CITY MINES COMPANY

CONCEPTUAL MODEL OF SHALLOW AQUIFER GROUNDWATER FLOW SYSTEM

FIGURE 9

PROJECT NO. 1650236.092180.ai 03/14/02 SLC



ADDENDUM TO HYDROGEOLOGIC REVIEW OF RICHARDSON FLATS TAILINGS SITE FOCUSED RI/FS REPORT

Groundwater Budget

Groundwater flows from areas of high hydraulic head to low hydraulic head. On the basis of the limited potentiometric surface map depicted on Figure 8, groundwater stored in the shallow aquifers within the Richardson Flats area is recharged in the highlands defining the topographic divide depicted on Figure 10 and flows towards the tailings pond and diversion trench, ultimately discharging to Silver Creek.

Richardson Flats comprises an area encompassing approximately 79,830,000 square feet (2.86 square miles) where recharge can occur. Recalling that the hydraulic gradients of the aquifers converge on the tailings pond indicates that recharge probably does not occur in the vicinity of tailings pond with the exception of a minor leakage through the soil cover on the tailings. Correcting the area potentially available for aquifer recharge indicates subtracting the approximately 4,140,000 square feet composing the tailings area yields 75,690,000 square feet.

Brooks and others (1998) and Holmes and others (1986) indicate that 10 to 20% of the average annual precipitation in the Snyderville Basin area is recharged to the various aquifers. The meteorological data for the area summarized in Section 3.1.2 of this report indicates that precipitation in the vicinity of Richardson Flats ranges from 17.27 to 21.44 inches per year. On the basis of the changes in water level measurements in the piezometers located near Richardson Flats as depicted on Figure 7, the bulk of the precipitation apparently recharges the various aquifers over a four month period occurring during February to June.

Integrating the average of the reported precipitation of 19.36 inches with the 10% recharge rate, coupled with the approximately 76,000,000 square feet of potentially available recharge area and the observation that the bulk of the recharge occurs over a four month period yields a discharge rate of 526 gallons per minute (gpm) for the Richardson Flats area. Recalling that the discharge area is located near Silver Creek suggests that the measurement of surface water flow in the diversion ditch may reflect the discharge rate from the Richardson Flats area. While the data distribution is less than ideal, the one flow measurement captured during April 2001 yielded flows approaching 438 gpm (see Table 3-1). The mass balance between the calculated recharge rate and the measured discharge rate is good.

Appendix 4

Tailings South of the Diversion Ditch Test Pit Logs

TEST PIT: GL-1

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6" - TOPSOIL
	6"-4' - TAILINGS
5	4'-6' BROWN CLAY
10	
12	

TEST PIT: GL-2

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-2' - TOPSOIL
	2'-6' - LIGHT BROWN NATIVE CLAY SOIL
5	
	NO TAILINGS
10	
12	

TEST PIT: GL-3

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6" - TOPSOIL
	6"-3' - TAILINGS
5	3'-6' BROWN CLAY
10	
12	

TEST PIT: GL-4

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6" - TOPSOIL
	6"-4.5' - TAILINGS
5	4.5'-6' - BROWN CLAY
10	
12	

TEST PIT: GL-5

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	
	0-5' - REDBROWN NATIVE CLAYEY SOIL
5	
	NO TAILINGS
10	
12	

TEST PIT: GL-6

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-2.5' - TAILINGS
	2.5'-4' - BROWN CLAY
5	
10	
12	

UNITED PARK CITY MINES

TAILINGS SOUTH OF DIVERSION DITCH DELINEATION TEST PITS

RESOURCE MANAGEMENT CONSULTANTS
8138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

January 2002

ri-tsdd-logs.dwg

TEST PIT: GL-7

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-4' - TOPSOIL
	4'-4.5" - REDBROWN NATIVE CLAY SOIL
5	
	NO TAILINGS
10	
12	

TEST PIT: GL-8

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-5' - RED BROWN NATIVE CLAY SOIL
5	
	NO TAILINGS
10	
12	

TEST PIT: GL-9

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6' - RED BROWN NATIVE CLAY SOIL
5	
	NO TAILINGS
10	
12	

TEST PIT: GL-10

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-2' - TOPSOIL
5	2'-6' REDBROWN NATIVE CLAY SOIL
	NO TAILINGS
10	
12	

TEST PIT: GL-11

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6" - TOPSOIL
	6"-2.5' - TAILINGS
	2.5'-4' - BROWN CLAY
5	
10	
12	

TEST PIT: GL-12

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6" - TOPSOIL
	6"-6' - REDBROWN NATIVE CLAY SOIL
5	
	NO TAILINGS
10	WATER @ 64"
12	

UNITED PARK CITY MINES

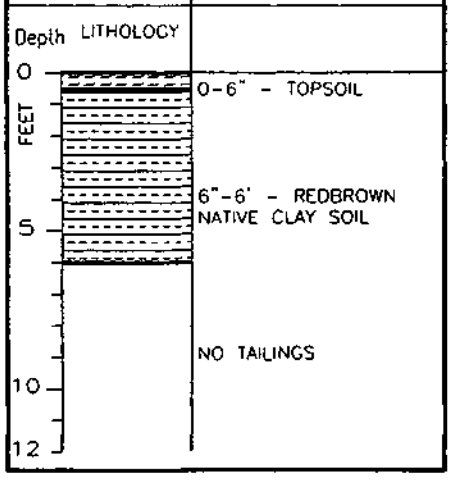
TAILINGS SOUTH OF DIVERSION DITCH DELINEATION TEST PITS

RESOURCE MANAGEMENT CONSULTANTS
6138 SOUTH STATE ST.
SUITE 2A
MIDVALE, UT 84047
801-255-2626

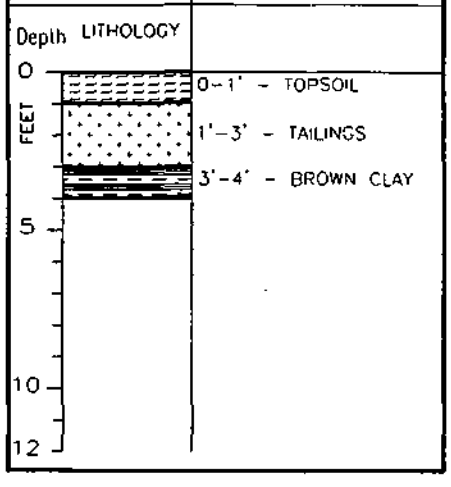
January 2002

ri-tsdd-logs.dwg

TEST PIT: GL-13



TEST PIT: GL-14



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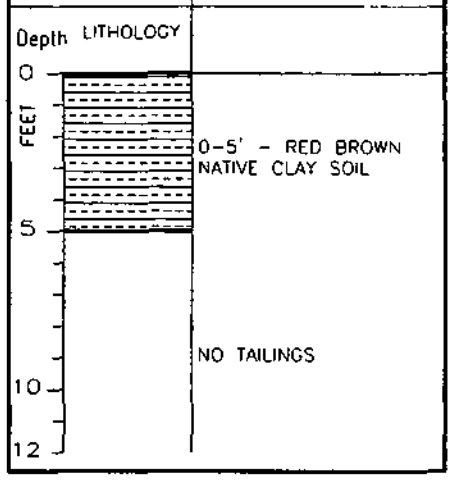

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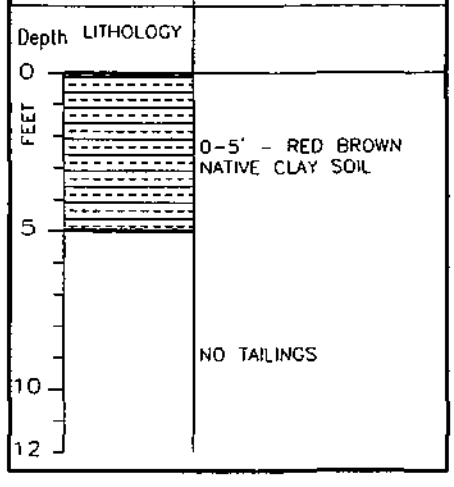

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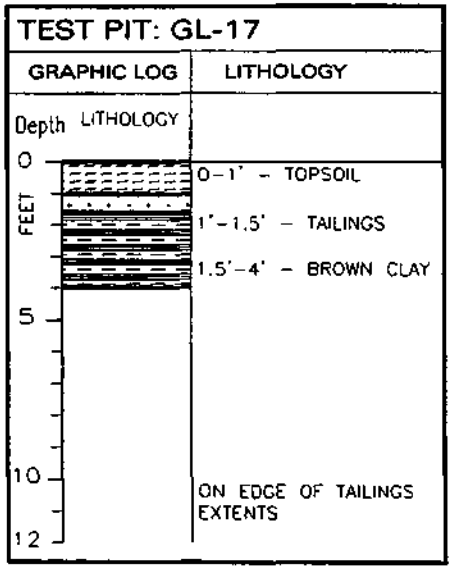

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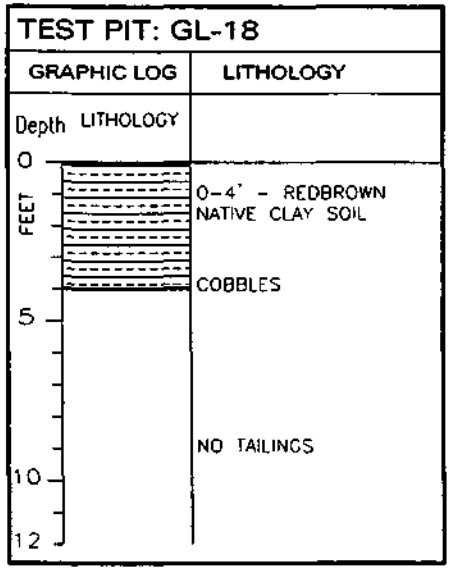

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TAILINGS SOUTH OF DIVERSION DITCH DELINEATION TEST PITS

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TEST PIT: GL-19

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-2' - TAILINGS
	2'-3' - BROWN CLAY
5	
10	
12	

TEST PIT: GL-20

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1.5' - TOPSOIL
	1.5'-5' - TAILINGS SOME CLAY SLIME
5	5'-6' - BROWN CLAY
10	
12	

TEST PIT: GL-21

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-8' - RED BROWN NATIVE CLAY SOIL WITH COBBLES AND POSSIBLE TAILINGS INCLUSIONS (IMPORTED/DISTURBED)
5	
10	
12	

TEST PIT: GL-22

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-4' - TOPSOIL
	4'-6' - REDBROWN NATIVE CLAY, SOME GRAVEL
5	
	NO TAILINGS
10	WATER @ 4' GOOD INFLOWS
12	

TEST PIT: GL-23

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-5' - RED BROWN NATIVE CLAY SOIL WITH POSSIBLE TAILINGS INCLUSIONS (IMPORTED/DISTURBED)
5	
10	
12	

TEST PIT: GL-24

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-5' - TAILINGS
5	5'-6' - BROWN CLAY
10	WATER @ 5'
12	

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TEST PIT: GL-25

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-2.5' - TOPSOIL
	2.5'-4' - REDBROWN NATIVE CLAY SOIL
5	
	NO TAILINGS
10	WATER @ 32"
12	

TEST PIT: GL-26

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-2.5' - TAILINGS
	2.5'-4' - BROWN-BLACK CLAY
5	
10	WATER @ 30"
12	

TEST PIT: GL-27

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-4' - REDBROWN NATIVE CLAY SOIL
5	
	NO TAILINGS
10	
12	

TEST PIT: GL-28

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-2.5' - TAILINGS
	2.5'-4' - REDBROWN NATIVE CLAY SOIL
5	
10	
12	

TEST PIT: GL-29

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-1.5' - TAILINGS
	1.5'-4' - BROWN CLAY
5	
10	ON EDGE OF TAILINGS EXTENTS
12	

TEST PIT: GL-30

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-4' - REDBROWN NATIVE CLAY SOIL
5	
	NO TAILINGS
10	
12	

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TEST PIT: GL-31

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-2' - TOPSOIL
	2'-3' - REDBROWN NATIVE CLAY SOIL
5	
10	NO TAILINGS
12	

TEST PIT: GL-32

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-2' - TOPSOIL
	2'-5' - REDBROWN NATIVE CLAY SOIL
5	
10	NO TAILINGS
12	

TEST PIT: GL-33

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-1.5' - TAILINGS
	1.5'-4' - RED CLAY
5	
10	ON EDGE OF TAILINGS EXTENTS
12	

TEST PIT: GL-34

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1.5' - TOPSOIL
	1.5'-1.5' - REDBROWN NATIVE CLAY SOIL
5	
10	NO TAILINGS
12	

TEST PIT: GL-35

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-5' - REDBROWN NATIVE CLAY SOIL
5	
10	NO TAILINGS
12	

TEST PIT: GL-36

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1.5" - TOPSOIL WITH REDBROWN CLAY
	1.5'-2' - TAILINGS
	2'-4' - RED CLAY
5	
10	ON EDGE OF TAILINGS EXTENTS
12	

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TEST PIT: GL-37

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1.5" - TOPSOIL WITH REDBROWN CLAY
	1.5'-2.5' - TAILINGS
	2.5'-4' - RED CLAY
5	
10	ON EDGE OF TAILINGS EXTENTS
12	

TEST PIT: GL-38

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-4' - REDBROWN NATIVE CLAY SOIL
5	
10	NO TAILINGS
12	

TEST PIT: GL-39

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-3' - TAILINGS
	3'-4.5' - BLACK CLAY
5	
10	
12	

TEST PIT: GL-40 (TSDD-4)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-11' - TAILINGS
5	
	WATER @9'
10	
12	

TEST PIT: GL-41 (TSDD-5)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-11.5' - TAILINGS INCLUDES RAILROAD FILL
5	
10	WATER @ 11.5'
12	11.5'-12' - BROWN CLAY

TEST PIT: GL-42 (TSDD-6)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-10' - TAILINGS INCLUDES RAILROAD FILL AND CLAY ZONES
5	
10	WATER @ 10.0'
	10'-12' - BROWN-BLACK CLAY
12	

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TEST PIT: GL-43 (TSDD-7)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-11.5' - TAILINGS INCLUDES RAILROAD FILL AND CLAY ZONES
5	WATER @ 8.0'
10	9.0'-10' - BROWN-BLACK CLAY
12	

TEST PIT: GL-44 (TSDD-8)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6" - TOPSOIL
	6"-3.5' - TAILINGS, INCLUDES CLAY SLIMES
5	3.5'-6' - REDBROWN CLAY
10	
12	

TEST PIT: GL-45 (TSDD-9)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6" - TOPSOIL
	6"-6.5' - TAILINGS
5	WATER @ 6'
	6.5'-8' - BROWN CLAY
10	
12	

TEST PIT: GL-46 (TSDD-10)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-5.0' - TAILINGS
5	5'-6' - BROWN CLAY
10	
12	

TEST PIT: GL-47 (TSDD-1)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1.5' - BROWN CLAY FILL
	1.5-3' - TAILINGS
	3-3.5' - BROWN CLAY
5	WATER @ 3'
10	
12	

TEST PIT: GL-48 (TSDD-2)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6' - REDBROWN CLAY FILL WITH COBBLES GRADING TO ALLUVIUM
5	WATER @ 5.5'
	3" TAILINGS @ 6'
	6.25'-8' - BLACK CLAY
10	
12	

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TEST PIT: GL-49 (TSDD-3)

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0–6'	0–6' – REDBROWN CLAY FILL
6'–7'	6'–7' – TAILINGS
7'–8'	7'–8' – BLACK CLAY

FEET: 0, 5, 10, 12

TEST PIT: GL-50

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0–1.0'	0–1.0' – TAILINGS
1'–3'	1'–3' – BROWN CLAY

FEET: 0, 5, 10, 12

TEST PIT: GL-51

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0–3'	0–3' – BROWN CLAY
	NO TAILINGS

FEET: 0, 5, 10, 12

TEST PIT: GL-52

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0–1'	0–1' – TAILINGS
1'–3'	1'–3' – BROWN CLAY

FEET: 0, 5, 10, 12

TEST PIT: GL-53

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0–6"	0–6" – BROWN CLAY
6"–1'	6"–1' – TAILINGS
1'–3'	1'–3' – BROWN CLAY

FEET: 0, 5, 10, 12

TEST PIT: GL-54

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0–3'	0–3' – BROWN CLAY
	NO TAILINGS

FEET: 0, 5, 10, 12

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TEST PIT: GL-55

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-2' - BROWN CLAY
	2'-4' - REDBROWN CLAY
5	
	NO TAILINGS
10	
12	

TEST PIT: GL-56

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1.0' - TAILINGS
	1'-3' - BROWN CLAY
5	
10	
12	

TEST PIT: GL-57

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-3' - BROWN CLAY
5	
10	NO TAILINGS BELOW SURFACE, POSSIBLE THIN VENEER ON SURFACE
12	

TEST PIT: GL-58

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-1' - TOPSOIL
	1'-2' - TAILINGS
	2'-4' - REDBROWN CLAY
5	
10	
12	

TEST PIT: GL-59

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-6" - FILL
	6"-1' - TAILINGS
	1'-3' - BROWN CLAY
5	
10	
12	

TEST PIT: GL-60

GRAPHIC LOG	LITHOLOGY
Depth LITHOLOGY	
0 FEET	0-5' - FILL
5	
10	
12	

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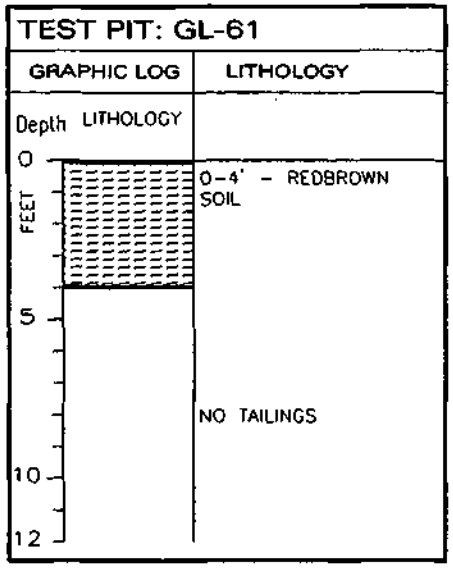

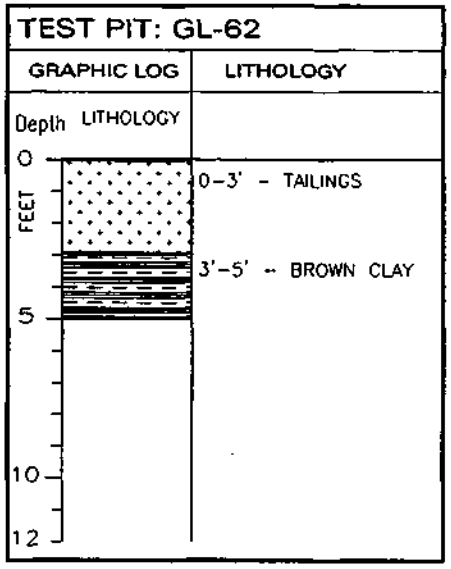

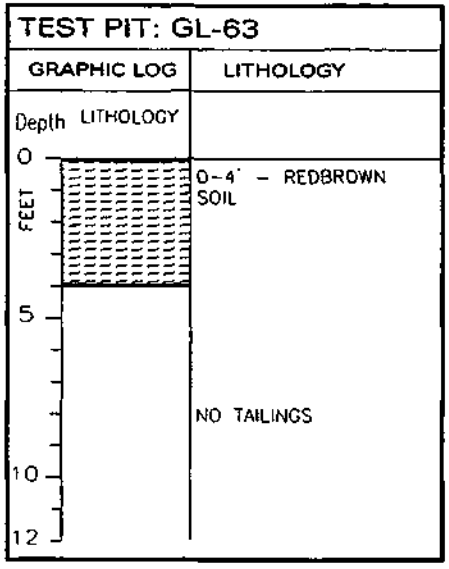

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Appendix 5

Analytical Results and Data Quality Assessment

Hard copy of laboratory reports will be provided upon request.

DATA QUALITY ASSESSMENT

Richardson Flat Tailings Site
Focused Remedial Investigation

INTRODUCTION

This report presents the results of the data quality assessment of analytical data for samples collected between April 4, 2001 and August 6, 2002 for the Focused Remedial Investigation at the Richardson Flat Tailings Site near Park City, Utah. The sampling activities followed the Sampling and *Analysis Plan for the Richardson Flat Remedial Investigation (SAP)* (Environmental Resource Management Consultants dba RMC, February 20, 2001).

The data quality assessment process evaluates whether the specific requirements for an intended use have been fulfilled and ensures that the results conform to the user's needs. This report summarizes the review of sampling and analysis to assess conformance with QC requirements for this project. This data evaluation is presented in terms of the PARCC criteria and is based on the *U.S. EPA Functional Guidelines for Inorganic Data Review* (U.S. EPA, 1994), *Guidance for the Data Quality Assessment Process* (EPA QA/G-9), and on the quality control limits established by the analytical laboratory or as specified by the specific analytical method. The analytical results were evaluated against data quality objectives (DQOs), which are quantitative and qualitative statements that specify data quality and are expressed in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC). Tables 1 and 3 of the SAP describe the DQOs and QA/QC goals for this project. Table 4 of the SAP presents the data validation and verification requirements for this project.

Consistent with the SAP, discussion of analytical results in this report will be grouped by media and site area into the following categories:

- Background Soils
- Off-Site Soils
- On-Site Soils Cover
- Sediment
- Tailings
- Tailings South of the Diversion Ditch
- Groundwater
- Surface Water.

American Environmental Consultants (AEC) Laboratory in Salt Lake City and Frontier Geosciences Inc. (mercury only) performed the analyses.

As specified in Table 4 of the SAP, data were assessed according to the following steps:

1. Were samples collected according to established locations and frequencies?
2. Were samples collected and handled following established procedures?
3. Were appropriate analytical methods used?
4. Were holding times and laboratory reporting limits met?
5. Did field duplicate results meet acceptance criteria?
6. Did field QC samples (field blanks, equipment/rinsate blanks) meet acceptance criteria?

7. Did laboratory QC samples (method blanks, laboratory control samples (LCS), matrix spike (MS) and matrix spike duplicate (MSD) samples, cation/anion balance for water samples) meet acceptance criteria?
8. Were appropriate steps taken to ensure the accuracy of data reduction, including reducing data transfer errors in the preparation of summary data tables and maps.

The following sections of this report summarize the data validation results following the list of data validation and verification steps listed above. The final section of this report summarizes the data validation results in terms of PARCC criteria, including completeness calculations expressing the percent complete of valid data compared to the total number of samples collected. This section also makes recommendations for suggested alterations to the sampling and analysis program to improve data collection and analytical protocols in the event additional sampling is conducted.

Tables 1 through 8 summarize the samples collected, sample dates, parameters analyzed, and laboratory sample numbers and related laboratory QC batch numbers. The laboratory analytical reports, including the laboratory quality control data, are provided in Appendix 4 of the Focused RI Report.

SAMPLING LOCATIONS AND FREQUENCIES

Samples were generally collected at the locations and frequencies specified in the SAP. For some media, the number of samples collected exceeded the numbers specified in the SAP. In some cases, additional metals not specified in the SAP, such as aluminum, barium and iron, were added to the analyte lists. In a few cases, specified parameters such as CEC and Acid-Base Potential were also analyzed.

Background Soils

Background soil samples were collected at the 11 locations not affected by tailings deposition specified in the SAP. Two of the samples were analyzed for the complete list of metals (Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn) and nine samples were analyzed only for arsenic and lead. The parameters analyzed are consistent with the SAP that specified that all of the samples be analyzed for arsenic and lead and 20 percent be analyzed for all RCRA metals plus copper and zinc. Eight additional samples, SAB-1 through SAB-8, were collected September 9, 2001 and analyzed for arsenic and lead to provide additional background data.

Off-Site Soils

Off-site soil samples were collected at 55 locations along three transects compared to the approximately 32 locations along three transects specified in the SAP. Ten of the samples were analyzed for the complete list of metals (Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn) and 45 samples were analyzed only for arsenic and lead.

On-Site Soils Cover

On-site soil samples were collected at 52 locations compared to the approximately 42 locations specified in the SAP. Ten of the samples were analyzed for the complete list of metals (Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn), eleven of the samples were analyzed for the complete metals list plus aluminum and iron, and the remaining 31 samples were analyzed only for arsenic and lead. As specified in the SAP, all samples were to be analyzed for arsenic and lead with 20 percent of the samples collected analyzed for the complete metals list.

Sediment

Sediment samples were collected at the six locations specified in the SAP. However, the "surface samples" specified in the SAP were not collected because the upper 4 to 5 inches was generally covered by roots and vegetation. Samples collected at the six locations were a composite of any sediment available between 0 and 6 inches. All of the samples were analyzed for the complete list of metals (Ag, As, Cd, Cr, Cu, Hg, Pb, Se, Zn) plus aluminum and iron. The specified parameter CEC was also analyzed.

Tailings

Tailings samples were collected at 18 locations along compared to the three locations within the impoundment specified in the SAP. All tailings samples were analyzed for the complete list of metals (Ag, As, Cd, Cr, Cu, Hg, Pb, Se, Zn) plus aluminum and iron. Specified parameters such as CEC and Acid-Base Potential were also analyzed.

Tailings South of the Diversion Ditch

Tailings and the associated underlying clay samples from south of the diversion ditch were collected at 7 locations. The SAP specified that samples be collected at about 10 percent of the locations that were visually inspected. A total of 63 locations were visually inspected. All tailings samples were analyzed for the complete list of metals (Ag, As, Cd, Cr, Cu, Hg, Pb, Se, Zn) plus aluminum and iron.

Groundwater

Sixteen rounds of groundwater samples (6/5/01, 7/19/01, 8/7/01, 9/5/01, 10/8/01, 11/5/01, 12/3/01, 1/7/02, 2/4/02, 3/5/02, 4/1/02, 5/2/02, 5/6/02, 6/3/02, 7/9/02, 8/6/02) have been collected from five newly installed monitoring wells and three existing piezometers. All of the samples were analyzed for the complete list of parameters specified in Table 2 of the SAP.

Surface Water

Seventeen rounds of surface water samples (4/4/01, 5/7/01, 6/5/01, 7/9/01, 8/7/01, 9/5/01, 10/8/01, 11/5/01, 12/3/01, 1/7/02, 2/4/02, 3/5/02, 4/1/02, 5/2/02, 5/6/02, 6/3/02, 7/9/02) have been collected from between three and eight locations compared to a minimum of five locations specified in the SAP. From September 2001 through March 2002, some of the locations sampled in the spring (such as RF1, RF2, RF3-2, RF4, RF5 along the South Diversion Ditch), could not be sampled because the locations were dry. All of the samples were analyzed for the complete list of parameters specified in Table 2 of the SAP. However, only total mercury, as opposed to both total and dissolved mercury, was analyzed by Method 1631B during the 5/7/01 round for samples from RF-1, RF-6-2, and RF-8.

SAMPLE COLLECTION AND HANDLING

With few exceptions, samples were collected and handled in accordance with the procedures described in the SAP. Sample collection and handling procedures were discussed at a readiness review meeting and verified in the field by the Project QA Officer during several field audits. Sample collection and handling procedures were documented in field notes and chain-of-custody/laboratory request forms.

Frontier Geosciences reported that samples for mercury analysis on 6/5/01, 7/19/01, 8/7/01, and 9/5/01 were received at elevated temperatures compared to the less than 4 °C specified in the SAP. The temperatures reported by Frontier ranged from 7.7 °C to ambient. The slightly

elevated temperature of these samples should not compromise the quality of the samples and analyses. Although the field team was aware of this problem and packed extra ice during later rounds, even the extra ice in the small coolers used was inadequate. Once the field team began to use a larger cooler filled with ice in multiple double bags, samples were received by the Frontier at temperatures less than 4 °C.

During an initial data quality assessment 7/10/01, severe problems with field duplicates were discovered for the groundwater sampling round collected 6/5/01. Although discussed below under field duplicate results, the results indicated problems with turbid samples due to incomplete well development, problems with sampling methodology, and improper sample splitting procedures. Corrective actions, including the use of peristaltic pumps in lieu of bailers and more methodical splitting procedures, were recommended to the Project Manager and Field Team Leader by the QA Officer. Since instituting the changes, analytical and field duplicate results for later rounds indicate that low turbidity samples are now being collected with excellent duplicate performance.

ANALYTICAL METHODS

The EPA-approved analytical methods listed in Table 2 of the SAP were used in all cases. The laboratory performed internal laboratory calibration checks according to the method-specified protocols. Case narratives were compiled in the analyst's logbook, in digestion logs, and as raw data. Except for the cases noted below, all required analytical methods specified in the SAP were run.

Sediment

Analysis for CEC was performed using USDA handbook 60 Method 19.

Tailings

Analysis for CEC was performed using USDA handbook 60 Method 19, SPLP was performed using EPA Methods 1312 and 3010 and Acid/Base Potential was run using EPA Methods 670/2-74-070 and 600/2-78/084 Modified.

Surface Water

Only total mercury, as opposed to both total and dissolved mercury, was analyzed by Method 1631B during the 5/7/01 round for samples from RF-1, RF-6-2, and RF-8.

HOLDING TIMES AND LABORATORY REPORTING LIMITS

Holding time reflects the length of time after sample collection that a sample or extract remains representative of environmental conditions. Holding times were compared to standard method-specific holding times accepted by the EPA as listed in Table 2 of the SAP. Data for samples that were extracted and analyzed within holding time criteria are considered representative. For samples that were extracted or analyzed outside of holding criteria, the sample data are qualitatively evaluated to determine the potential effect of the holding time violation on sample representativeness. All holding times were met for all analytical parameters.

The reporting limits specified in the SAP (Table 2) were met in all cases by the laboratories.

FIELD DUPLICATE SAMPLES

Two types of duplicate samples were collected during this project: blind field duplicates and splits collected by EPA's contractor CDM Federal Programs Corporation. Results for the splits were reported and compared to the samples collected by RMC in the Technical Oversight Report prepared by CDM (July 2001). In addition, AEC Laboratories was asked to reanalyze two off-site soil samples as an additional check on laboratory performance.

Field Duplicates

Field duplicate samples were collected at a frequency at the 10 percent of sample load specified in the SAP, except for surface water samples for mercury analysis by Method 1631B for which no duplicates were collected. Table 9 shows the frequency calculation on a media/area-specific basis.

Overall the field duplicate results were good. However, some of the calculated relative percent differences (RPDs) exceeded acceptance criteria. For the most part, the high RPDs were limited to tailings samples where heterogeneity problems are expected. However, as mentioned above, serious problems were identified from the field duplicate samples collected with the first groundwater sampling round on 6/5/01. Minor problems were also identified in the surface water sampling round on 5/6/02.

Tables 10 to 17 summarize the relative percent difference (RPD) calculations for the duplicates collected for each media or sampling area. Duplicate results that exceed the QA/QC goal of 35 percent (if > 5 times LRL) or +/- LRL (if < 5 times LRL) are noted in bold. The field duplicate results are discussed below on a media/area basis.

Background Soils. As shown on Table 10, all (100 percent) of the RPDs for background samples met acceptance criteria.

Off-Site Soils. As shown in Table 11, most (90.9 percent) of the RPDs for off-site soils samples met acceptance criteria. However, one cadmium result, two lead results, and one zinc result exceeded the criteria. A combination of incomplete sample homogenization or media heterogeneity may explain these elevated RPDs. For example, if a small component of tailings was present in some of these samples, it might be difficult to adequately split the samples to obtain similar results for tailings related metals like cadmium, lead, and zinc.

On-Site Soils. As shown in Table 12, most (91.7 percent) of the RPDs for on-site soils cover samples met acceptance criteria. However, one arsenic result, one copper result, and one lead result exceeded the criteria. A combination of incomplete sample homogenization or media heterogeneity may explain these elevated RPDs. For example, if a small component of tailings was present in some of these samples, it might be difficult to adequately split the samples to obtain similar results for tailings related metals like arsenic, copper, and lead.

Sediment. As shown on Table 13, all (100 percent) of the RPDs for sediment samples met acceptance criteria.

Tailings. As shown in Table 14, most (70 percent) of the RPDs for tailings samples met acceptance criteria. However, about 30 percent of the time, RPDs for tailings samples do not meet acceptance criteria. The poor RPDs are not confined to a few metals, but are seen across most duplicate sets and metals. This result is not surprising, given the heterogeneous nature of the tailings and the apparent difficulty in adequately homogenizing the samples in the field. In light of the highly heterogeneous nature of this media, the RPD results are actually quite good.

Tailings South of the Diversion Ditch. As shown in Table 15, most (83.3 percent) of the RPDs for on-site soils cover samples met acceptance criteria. However, about 17 percent of the time, RPDs for these tailings samples do not meet acceptance criteria. This result is not surprising, given the heterogeneous nature of the tailings and the difficulty in adequately homogenizing the samples in the field. In light of the highly heterogeneous nature of this media, the RPD results are actually quite good.

Groundwater. With the exception of the duplicate set for the 6/5/01 groundwater sampling round, the RPDs for groundwater duplicate samples all easily met acceptance criteria. The duplicate set for the first groundwater sampling round in June was very poor (see Table 16) indicating improper splitting of turbid samples.

The groundwater duplicate issue has two parts. The first is that it is apparent that the sample was not carefully split in the field (i.e., systematically filling both bottles at the sample time as water was withdrawn with the bailer). Although both samples were apparently very turbid, the duplicate had two times the TSS as the sample (1,350 mg/l compared to 700 mg/l) resulting in all the total metals results being much higher (by 2 to 3 times) in the duplicate sample, while the filtered dissolved results were all excellent. **This result reflects poorly on the whole round of groundwater samples and data from this sampling round should be considered unacceptable and not used for evaluating site conditions or risk**. The second part is that all the samples are quite turbid for proper groundwater samples (TSS ranges from 100 to 2,450 mg/l) suggesting that the wells were not really developed adequately. Continuing to use a bailer results in a continuing surging acting that is probably just bringing more fines into the filter pack and then the well. Developing and sampling with a less aggressive method, such as a peristaltic pump with dedicated tubing should produce much less turbid samples. Producing less turbid samples should also minimize the sensitivity of the duplicate results to sample splitting problems. A peristaltic pump was subsequently used to further develop and then sample the wells. Turbidity (as indicated by TSS values between <1 and 52 mg/l) was much lower in later sampling rounds and duplicate results were excellent.

Surface Water. With few exceptions, the RPDs for the surface water samples collected to date met the acceptance criteria. As shown in Table 17, there are sporadic cases where RPDs exceeded acceptable criteria, but nothing to discredit the analytical results. A minor problem was identified for the RPD results for Mn, Mn(D), TDS, TSS, and Zn(D) on 5/6/02. The high RPDs may be a result of not properly splitting the sample in the field. A large discrepancy exists in the TSS results for the sample and the duplicate (1,223 mg/l compared to 2.7 mg/l), which may be evident of not carefully splitting the sample.

EPA Splits

EPA's oversight contractor, CDM Federal, collected splits of two background samples, 12 off-site soil samples, ten on-site soil cover samples, one sediment sample, three tailings samples, and two surface water samples. The results were reported in the *Technical Oversight Report* prepared by CDM (July, 2001). This report provides a though comparison of the UPCM and CDM results for the split samples. CDM concluded that 87 percent of the solids (soil and tailings) results were acceptable. CDM found that lead and zinc were the only chemicals to have low acceptability (68 percent and 69 percent, respectively). Water samples collected by CDM were collected at a later time and should not be considered splits, therefore, they cannot be used to determine if UPCM/RMC samples are representative of site conditions.

CDM offered the following explanation of the differences seen between the UPCM/RMC and CDM data:

Many of the samples with criteria outside the acceptable range were most likely due to the fact that the sample was a mixture of tailings and soil (e.g. taken at the interface between the two media). Because these two materials may have very different concentrations of analytes, the mixture was very heterogeneous and homogeneity may not have been accomplished in the field. Also due to the heterogeneity of the material it is difficult to determine what concentrations of analytes are actually representative of site conditions. Another possible explanation is that each lab used a different method in analyzing soil (CDM Federal used Method 6020 and UPCM/RMC used Method 6010). This analytical difference did not have an effect on other chemicals, however it cannot be ruled out as a possible contributor to the differences seen in the data.

Although the heterogeneous nature of the samples and incomplete homogenization in the field likely accounts for some of the differences between the split samples, differences in the preparation, digestion or analytical methods used at AEC Laboratory and CDM's Laboratory probably accounts for most of the differences. As discussed above under Field Duplicates, with the exception of the tailings samples which exceeded acceptance criteria up to about 30 percent of the time, the duplicate results for other solid samples (on-site soils, off-site soils, sediment) were generally good. As shown in Figure 1, a scatter plot comparing the UPCM and CDM metals results, the UPCM metals results are almost always higher than the CDM results suggesting a consistent positive bias that must be related to laboratory procedures rather than the difficulties of field homogenization. If the issue were field homogenization, you would expect essentially no bias, with approximately equal number of cases of UPCM results higher than CDM results and CDM results higher than UPCM results.

After discussing this issue with Jeff Montera (CDM) and Vince Keller (AEC Labs), our conclusion is that the consistent positive bias is due primarily to differences in samples preparation. According to Mr. Keller, AEC's standard internal procedure for preparing soil and tailings samples is to: (1) dry about 100 gm of sample; (2) sieve (#10/2 mm) and homogenize several 100 gm; (3) grind 50 to 100 gm of sample; and (4) use 1 to 2 gm of sample in EPA 3010 digestion process. According to Mr. Montera, CDM's laboratory did not dry, sieve, or grind the samples prior to EPA 3010 digestion. This difference in pre-digestion preparation would result in the UPCM samples being much more homogenized and finer grained, which would allow for a greater surface area for the acid used in the digestion process to react. This would result in higher metals values.

The only other difference in the laboratory procedures, both laboratories using the EPA 3050 digestion, is the analytical method: UPCM used Method 6010 (ICP) while CDM used Method 6020 (ICP MS). According to Vince Keller, AEC Lab has seen good consistency between these methods although the 3050 digestion process results in excess hydrochloric acid which needs to be diluted before the extract is injected into the mass spectrometer for Method 6020 which could cause some dilution error. Therefore, because the digestion process is identical and analytical method is unlikely to cause such a consistent bias, it makes sense that the pre-digestion procedures are the main cause of the differences between the split samples.

The UPCM results are certainly representative of site conditions, and probably can be considered as maximum values. Where the results affect critical site decisions such as defining remediation areas based on action levels, a strategy should be formulated as to which preparation procedures should be used. The impact of using positively biased results in risk calculations should also be considered.

Repeat Analysis

AEC Laboratories was asked to reanalyze two off-site soil samples (RF-OF-T2A 0-2" and RF-OF-T2A 1-6") as an additional check on laboratory performance. For RF-OF-T2A 0-2", the following results were obtained: arsenic, 44 ppm in the original analysis and 45 ppm in the

reanalysis (RPD = 2.2%); lead, 551 ppm in the original analysis and 645 ppm in the reanalysis (RPD = 15.7%). For RF-OF-T2A 1-6", the following results were obtained: arsenic, 30 ppm in the original analysis and 31 ppm in the reanalysis (RPD = 3.3%); lead, 391 ppm in the original analysis and 403 ppm in the reanalysis (RPD = 3.0%). The results of the reanalysis show excellent reproducibility.

FIELD QC SAMPLES

No field QC blanks were collected during this project. Because disposal or dedicated equipment was used at all sampling locations, no equipment/rinsate blanks were required.

LABORATORY QC SAMPLES

AEC Laboratory analyzed matrix spike/matrix spike duplicate, method (prep) blank, and laboratory control samples for each sample batch to evaluate data quality. The frequency of MS/MSD samples met the goal of five percent specified in the revised SAP.

Frontier Geosciences analyzed matrix spike and matrix spike duplicate, method blank, and laboratory control samples for the each batch of samples for mercury analysis to evaluate data quality.

Laboratory Control Samples. Laboratory control samples were analyzed for each laboratory sample batch by each laboratory. All of the recoveries for the laboratory control samples were within method-specified control limits with one minor discrepancy.
As noted on the analytical report, the LCS spike recoveries for aluminum and iron associated with the tailings south of the diversion ditch batch were slightly elevated, but still within the 95 percent confidence interval for the Environmental Resource Associates reference material (ERA 247), the EPA approved provider of reference material. Results for this sample batch can be considered acceptable.

Matrix Spike Samples. A matrix spike sample was analyzed for each laboratory sample batch by AEC Laboratory. All of the spike recoveries for matrix spike samples were within method-specified control limits with one exception: the matrix spike result for antimony for the tailings south of the diversion ditch batch were outside the acceptance limits (52% recovery compared to a lower acceptance limit of 80%). According to AEC Laboratory (Vince Keller, personal communication), low spike recovery is not atypical of antimony results using the 3050 digestion method, and in fact, the method description indicates that 50 to 60% recovery is typical for antimony using this digestion method. Given the adequate antimony spike recoveries in the associated LCS sample, the antimony values can be considered acceptable. Laboratory RPDs for MS/MSDs were all well within method-specified control limits indicating good precision.

One set of matrix spike and matrix spike duplicate samples was analyzed for each batch of samples analyzed by Frontier Geosciences. All of the spike recoveries and MS/MSD RPDs were well within method-specified control limits.

Method (Prep) Blanks. A method or prep blank sample was analyzed for each laboratory sample batch. No analytes were detected in any of the method blanks analyzed by AEC Laboratories indicating that no laboratory contamination was present. Only extremely low concentrations of mercury were detected in method blanks analyzed by Frontier Geosciences. The mean concentration of mercury in three blanks analyzed for each sample batch ranged from 0.1 to 0.13 ng/l (ppt) compared to the EPA 1631 MDL of 0.20 ng/l (ppt).

Cation/Anion Balance

AEC Laboratory calculated cation/anion balances for all water samples where List 3 parameters were analyzed. The cation/anion balances for these samples are all within +/- 10 percent with the exception of one sample on 5/6/02 (13.5 %), indicating good major ion balances. This result indicates that the major ion data can be used with a high degree of confidence.

DATA REDUCTION

For the purposes of developing a database and preparing summary tables for reports, all laboratory data was transferred from the laboratory in electronic form.

DATA VALIDATION SUMMARY

This section summarizes the data validation results in terms of PARCC (Precision, Accuracy, Representativeness, Comparability, and Completeness) criteria, including completeness calculations expressing the percent complete of valid data compared to the total number of samples collected. These results are then compared to the project QA/QC goals (Table 3 of SAP).

PARCC Criteria Summary

Precision. Based on the results of the field duplicates, laboratory duplicates, and matrix spike/matrix spike duplicate results, with the exception of groundwater data for the first round (6/5/01) the water data are precise. The available data along with other measurements of precision indicate that the data can be used with a high degree of confidence. **Data from the first groundwater sampling round should be considered unacceptable and not used for evaluating site conditions or risk.**

Based on the results of the field duplicates, laboratory duplicates, and matrix spike/matrix spike duplicate results, the soil and sediment data are precise. The available data along with other measurements of precision indicate that the data can be used with a high degree of confidence.

Based on the field duplicate results, the tailing (and tailings south of the diversion ditch) results are representative of site conditions but should be considered as order-of-magnitude estimates of metals concentrations at any particular location due to the heterogeneous nature of this media.

Accuracy. Based on the percent recoveries of the MS/MSD and laboratory control samples, the data can be considered accurate. The data can be used with a high degree of confidence with the exception of tailings values. The tailings results are representative of site conditions, but because of their inherent heterogeneity, at any particular location they probably represent order-of-magnitude estimates.

Representativeness. Based on the results of the holding time review, method blank data, and blind field duplicate sample data evaluation, with the exception of groundwater data for the first round (6/5/01) the water data for this project can be considered representative of water quality conditions at the site. **Data from the first groundwater sampling round should be considered unacceptable and not used for evaluating site conditions or risk.**

Based on the results of the holding time review, method blank data, and blind field duplicate sample data evaluation, the soil and sediment data are precise. The available data along with other measurements of precision indicate that the data can be used with a high degree of confidence.

Based on the field duplicate results, the tailing (and tailings south of the diversion ditch) results are representative of site conditions but should be considered as order-of-magnitude estimates of metals concentrations at any particular location due to the heterogeneous nature of this media.

Comparability. Standard methods of sample collection and standard units of measure were used during this project. The analyses performed by the laboratory were in accordance with current SW-846 and other U.S. EPA methodology.

Completeness. Based on the results of the data validation, all data are considered valid without qualification except: (1) the metals values for tailings samples which should be considered as order-of-magnitude estimates; (2) the groundwater results from the first round of sampling (6/5/01) which should **be considered unacceptable and not used for evaluating site conditions or risk**.

Although the tailings values are considered order-of-magnitude estimates due to the heterogeneous nature of the media, they are still considered valid data that can be used to interpret environmental conditions. Therefore, sampling and analytical completeness is 99.6 percent (after subtracting the invalid groundwater samples from 6/5/01), indicating that the completeness goal of 90 percent was met for the project (see Table 18).

Recommendations for Future Sampling

The following issues should be considered prior to future sampling activities:

1. Agree on a common sample preparation method for any future soil, tailings, and sediment samples.

2. Review the field homogenization and splitting procedures to ensure that the procedures are adequate considering the nature of the materials sampled.

Figure 1
Comparison Between CDM and UPCM Metals Results

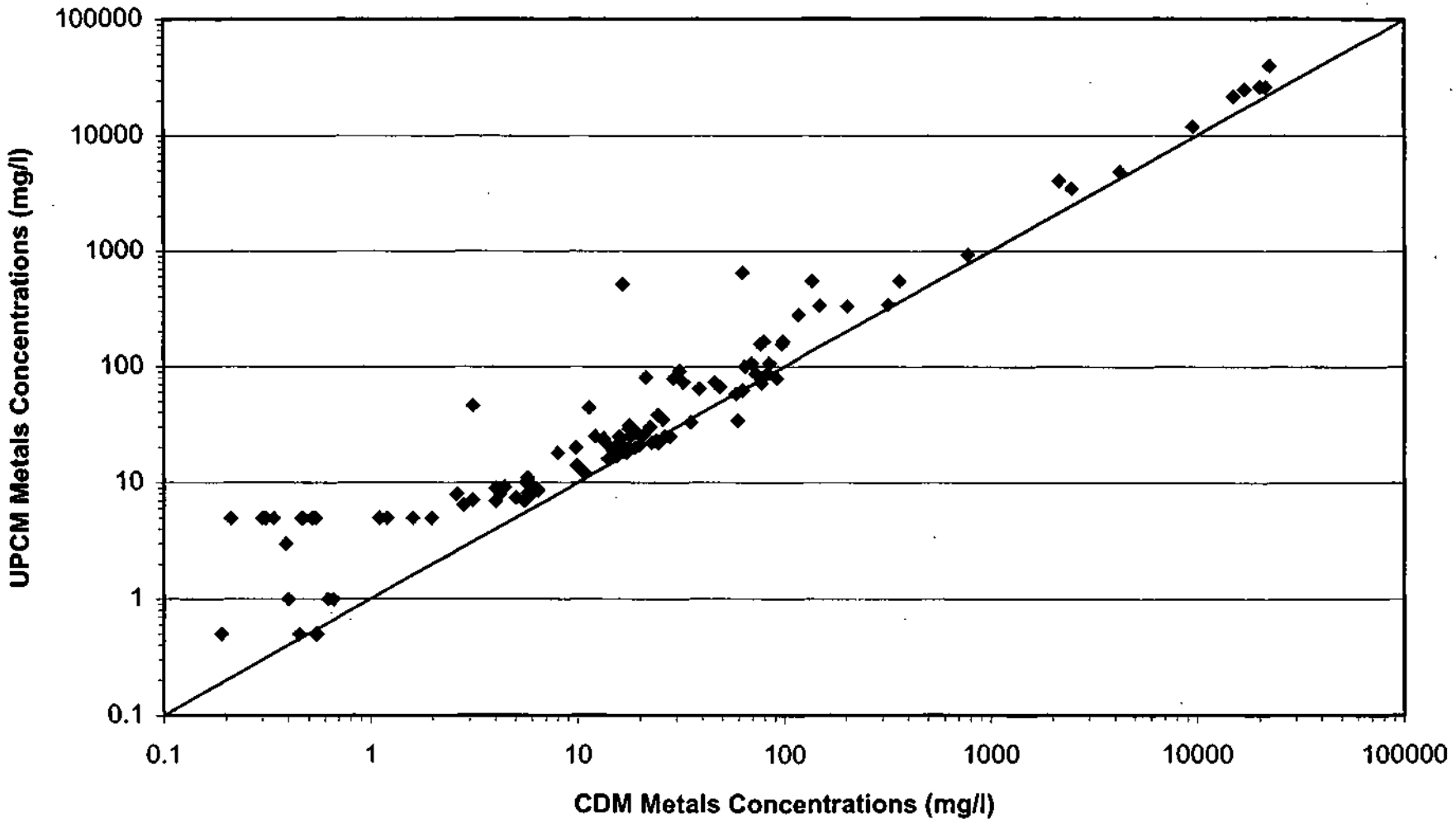

TABLE 1
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
BACKGROUND SOILS

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010670-078	WG010490	5/10/01	RF-BG-BG6 0-2"	As, Pb	
L010670-079	WG010490	5/10/01	RF-BG-BG7 0-2"	As, Pb	
L010670-080	WG010490	5/10/01	RF-BG-BG9 0-2"	As, Pb	
L010670-081	WG010490	5/10/01	RF-BG-BG11 0-2"	As, Pb	
L010670-082	WG010490	5/10/01	RF-BG-BG1	As, Pb	
L010670-083	WG010490	5/10/01	RF-BG-BG2	As, Pb	
L010670-084	WG010490	5/10/01	RF-BG-BG3	As, Pb	
L010670-085	WG010490	5/10/01	RF-BG-BG4	As, Pb	
L010670-086	WG010490	5/10/01	RF-BG-BG5	As, Pb	
L010671-027	WG010513	5/10/01	RF-BG-BG8 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-028	WG010513	5/10/01	RF-BG-BG10	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-029	WG010513	5/10/01	RF-BG-BG1050	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	DUP RF-BG-BG10
L011286-001	WG010894	9/5/01	SAB-5	As, Pb	
L011286-002	WG010894	9/5/01	SAB-4	As, Pb	
L011286-003	WG010894	9/5/01	SAB-3	As, Pb	
L011286-004	WG010894	9/5/01	SAB-7	As, Pb	
L011286-005	WG010894	9/5/01	SAB-2	As, Pb	
L011286-006	WG010894	9/5/01	SAB-8	As, Pb	
L011286-007	WG010894	9/5/01	SAB-6	As, Pb	
L011286-008	WG010894	9/5/01	SAB-1	As, Pb	

TABLE 2
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
OFF-SITE SOILS

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010670-020	WG010490	5/9/01	RF-OF-T2J 1-6"	As, Pb	
L010670-021	WG010490	5/9/01	RF-OF-T2I 0-2"	As, Pb	
L010670-022	WG010490	5/9/01	RF-OF-T2G 1-6"	As, Pb	
L010670-023	WG010490	5/9/01	RF-OF-T2J-1 0-2"	As, Pb	
L010670-024	WG010490	5/9/01	RF-OF-T2G 0-2"	As, Pb	
L010670-031	WG010490	5/9/01	RF-OF-T3J 0-2"	As, Pb	
L010670-032	WG010490	5/9/01	RF-OF-T3E 0-2"	As, Pb	
L010670-033	WG010490	5/9/01	RF-OF-T3I 0-2"	As, Pb	
L010670-035	WG010490	5/9/01	RF-OF-T3C 0-2"	As, Pb	
L010670-036	WG010490	5/9/01	RF-OF-T3C 1-6	As, Pb	
L010670-040	WG010490	5/9/01	RF-OF-T3G 0-2"	As, Pb	
L010670-041	WG010490	5/9/01	RF-OF-T3G 1-6"	As, Pb	
L010670-042	WG010490	5/9/01	RF-OF-T3E1-6"	As, Pb	
L010670-043	WG010490	5/9/01	RF-OF-T3F 1-6"	As, Pb	
L010670-048	WG010490	5/9/01	RF-OF-T3H 0-2"	As, Pb	
L010670-049	WG010490	5/9/01	RF-OF-T3A 1-6"	As, Pb	
L010670-050	WG010490	5/9/01	RF-OF-T3I 1-6"	As, Pb	
L010670-051	WG010490	5/9/01	RF-OF-T3J 1-6"	As, Pb	
L010670-052	WG010490	5/9/01	RF-OF-T3H 1-6"	As, Pb	
L010670-053	WG010490	5/9/01	RF-OF-T3A 0-2"	As, Pb	
L010670-054	WG010490	5/9/01	RF-OF-T3F 0-2"	As, Pb	
L010670-055	WG010490	5/9/01	RF-OF-T2I 1-6"	As, Pb	
L010670-056	WG010490	5/9/01	RF-OF-T2E 1-6"	As, Pb	
L010670-057	WG010490	5/9/01	RF-OF-T2E 0-2"	As, Pb	
L010670-058	WG010490	5/9/01	RF-OF-T2D 1-6"	As, Pb	
L010670-059	WG010490	5/9/01	RF-OF-T2A 0-2"	As, Pb	
L010670-060	WG010490	5/9/01	RF-OF-T2A 1-6"	As, Pb	
L010670-061	WG010490	5/9/01	RF-OF-T2B 1-6"	As, Pb	
L010670-062	WG010490	5/9/01	RF-OF-T2D 0-2"	As, Pb	
L010670-063	WG010490	5/9/01	RF-OF-T2B 0-2"	As, Pb	
L010670-064	WG010490	5/9/01	RF-OF-T2C 0-2"	As, Pb	
L010670-065	WG010490	5/9/01	RF-OF-T2C 1-6"	As, Pb	
L010670-068	WG010490	5/10/01	RF-OF-T1H 0-2"	As, Pb	
L010670-069	WG010490	5/10/01	RF-OF-T1E 0-2"	As, Pb	
L010670-070	WG010490	5/10/01	RF-OF-T1D 0-2"	As, Pb	

TABLE 2
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
OFF-SITE SOILS

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010670-071	WG010490	5/10/01	RF-OF-T150E 1-6"	As, Pb	DUP RF-OF-T1E 1-6"
L010670-072	WG010490	5/10/01	RF-OF-T150E 0-2"	As, Pb	DUP RF-OF-T1E 0-2"
L010670-073	WG010490	5/10/01	RF-OF-T1F 0-2"	As, Pb	
L010670-074	WG010490	5/10/01	RF-OF-T1G 1-6"	As, Pb	
L010670-075	WG010490	5/10/01	RF-OF-T1G 0-2"	As, Pb	
L010670-076	WG010490	5/10/01	RF-OF-T1F 1-6"	As, Pb	
L010670-077	WG010490	5/10/01	RF-OF-T1H 1-6"	As, Pb	
L010670-087	WG010490	5/10/01	RF-OF-T1B 1-6"	As, Pb	
L010670-088	WG010490	5/10/01	RF-OF-T1A 1-6"	As, Pb	
L010670-089	WG010490	5/10/01	RF-OF-T1B 0-2"	As, Pb	
L010670-090	WG010490	5/10/01	RF-OF-T1E 1-6	As, Pb	
L010670-091	WG010490	5/10/01	RF-OF-T1A 0-2	As, Pb	
L010670-092	WG010490	5/10/01	RF-OF-T1D 1-6"	As, Pb	
L010671-009	WG010513	5/9/01	RF-OF-T2H 1-6"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-010	WG010513	5/9/01	RF-OF-T2H 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-012	WG010513	5/9/01	RF-OF-T3D 1-6"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-013	WG010513	5/9/01	RF-OF-T3B 1-6"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-016	WG010513	5/9/01	RF-OF-T350D 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	DUP RF-OF-T3D 0-2"
L010671-017	WG010513	5/9/01	RF-OF-T3B 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-018	WG010513	5/9/01	RF-OF-T3D 1-6"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	DUP RF-OF-T3D 1-6"
L010671-021	WG010513	5/9/01	RF-OF-T3D 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-022	WG010513	5/9/01	RF-OF-T250F 1-6"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	DUP RF-OF-T2F 1-6"
L010671-023	WG010513	5/9/01	RF-OF-T2F 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-024	WG010513	5/9/01	RF-OF-T250F 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	DUP RF-OF-T2F 0-2"
L010671-025	WG010513	5/9/01	RF-OF-T2F 1-6"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-026	WG010513	5/10/01	RF-OF-T1C 1-6"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-030	WG010513	5/10/01	RF-OF-T1C 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	

TABLE 3
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
ONSITE SOILS COVER

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010671-001	WG010513	5/8/01	RF-ON-2H 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-002	WG010513	5/8/01	RF-ON-4F 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-003	WG010513	5/8/01	RF-ON-4F50 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	DUP RF-ON-4F 0-2"
L010671-004	WG010513	5/8/01	RF-ON-4D 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-005	WG010513	5/8/01	RF-ON-5D 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-006	WG010513	5/8/01	RF-ON-3E 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-007	WG010513	5/8/01	RF-ON-3E50 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	DUP RF-ON-3E 0-2"
L010671-008	WG010513	5/8/01	RF-ON-5B 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-011	WG010513	5/8/01	RF-ON-3A 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-014	WG010513	5/8/01	RF-ON-2H50 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	DUP RF-ON-2H 0-2"
L010671-015	WG010513	5/8/01	RF-ON-3I 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-019	WG010513	5/8/01	RF-ON-4C 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010671-020	WG010513	5/9/01	RF-ON-3D 0-2"	Ag, As, Ba, Cd, Cr, Cu, Hg, Pb, Se, Zn	
L010672-001	WG010531	5/8/01	RF-ON-4G 5-7"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-002	WG010531	5/8/01	RF-ON-4F 5-7"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-003	WG010531	5/9/01	RF-ON-3D 15-17"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-004	WG010531	5/8/01	RF-ON-4D 8-10"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-005	WG010531	5/8/01	RF-ON-5D 10-12"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-006	WG010531	5/9/01	RF-ON-3B 10-12"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-007	WG010531	5/8/01	RF-ON-5B 16-18"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-008	WG010531	5/8/01	RF-ON-2H 6-8"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-009	WG010531	5/7/01	RF-ON-4H 6-8"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-022	WG010531	5/8/01	RF-ON-4C 8-10"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	
L010672-035	WG010531	5/10/01	RF-ON-3E 15-17"	Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Se, Zn	

TABLE 3
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
ONSITE SOILS COVER

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010670-001	WG010490	5/8/01	RF-ON-2G 0-2"	As, Pb	
L010670-002	WG010490	5/8/01	RF-ON-3G 0-2"	As, Pb	
L010670-003	WG010490	5/8/01	RF-ON-4G 0-2"	As, Pb	
L010670-004	WG010490	5/8/01	RF-ON-4G50 0-2"	As, Pb	DUP RF-ON-4G 0-2"
L010670-005	WG010490	5/8/01	RF-ON-5G 0-2"	As, Pb	
L010670-006	WG010490	5/8/01	RF-ON-2F 0-2"	As, Pb	
L010670-007	WG010490	5/8/01	RF-ON-3F 0-2"	As, Pb	
L010670-008	WG010490	5/8/01	RF-ON-5F 0-2"	As, Pb	
L010670-009	WG010490	5/8/01	RF-ON-1G 0-2"	As, Pb	
L010670-010	WG010490	5/8/01	RF-ON-6D 0-2"	As, Pb	
L010670-011	WG010490	5/9/01	RF-ON-1E 0-2"	As, Pb	
L010670-012	WG010490	5/9/01	RF-ON-2E 0-2"	As, Pb	
L010670-013	WG010490	5/8/01	RF-ON-2E50 0-2"	As, Pb	DUP RF-ON-2E 0-2"
L010670-014	WG010490	5/8/01	RF-ON-4E 0-2"	As, Pb	
L010670-015	WG010490	5/8/01	RF-ON-5E 0-2"	As, Pb	
L010670-016	WG010490	5/9/01	RF-ON-3B 0-2"	As, Pb	
L010670-017	WG010490	5/8/01	RF-ON-4B 0-2"	As, Pb	
L010670-018	WG010490	5/9/01	RF-ON-1C 0-2"	As, Pb	
L010670-019	WG010490	5/9/01	RF-ON-2C 0-2"	As, Pb	
L010670-025	WG010490	5/9/01	RF-ON-1A 0-2"	As, Pb	
L010670-026	WG010490	5/9/01	RF-ON-2A 0-2"	As, Pb	
L010670-027	WG010490	5/8/01	RF-ON-4A 0-2"	As, Pb	
L010670-028	WG010490	5/8/01	RF-ON-5A 0-2"	As, Pb	
L010670-029	WG010490	5/9/01	RF-ON-1B 0-2"	As, Pb	
L010670-030	WG010490	5/9/01	RF-ON-2B 0-2"	As, Pb	
L010670-037	WG010490	5/7/01	RF-ON-3H 0-2"	As, Pb	
L010670-038	WG010490	5/7/01	RF-ON-4H 0-2"	As, Pb	
L010670-039	WG010490	5/7/01	RF-ON-5H 0-2"	As, Pb	
L010670-044	WG010490	5/9/01	RF-ON-3C 0-2"	As, Pb	
L010670-045	WG010490	5/8/01	RF-ON-5C 0-2"	As, Pb	
L010670-046	WG010490	5/9/01	RF-ON-1D 0-2"	As, Pb	
L010670-047	WG010490	5/9/01	RF-ON-2D 0-2"	As, Pb	
L010670-066	WG010490	5/8/01	RF-ON-4I 0-2"	As, Pb	
L010670-067	WG010490	5/10/01	RF-ON-2D50 0-2"	As, Pb	DUP RF-ON-2D 0-2"

TABLE 4
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
SEDIMENT

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010672-036	WG010531	05/11/01	RF-SD-SD1 0-6"	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010672-037	WG010531	05/11/01	RF-SD-SD2 0-6"	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010672-038	WG010531	05/11/01	RF-SD-SD3 0-6"	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010672-039	WG010531	05/11/01	RF-SD-SD4 0-6"	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010672-040	WG010531	05/11/01	RF-SD-SD5 0-6"	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010672-041	WG010531	05/11/01	RF-SD-SD550 0-6"	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	DUP RF-SD-SD5 0-6"
L010672-042	WG010531	05/11/01	RF-SD-SD6 0-6"	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	

TABLE 5
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
TAILINGS

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010672-010	WG010531	05/09/01	RF-TA-TP3 2'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	1' COVER
L010672-011	WG010531	05/09/01	RF-TA-TP3 3'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-012	WG010531	05/09/01	RF-TA-TP3 4'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-013	WG010531	05/09/01	RF-TA-TP3 5'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-014	WG010531	05/09/01	RF-TA-TP3 6'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-015	WG010531	05/09/01	RF-TA-TP3 2-6'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-016	WG010531	05/09/01	RF-TP-502 2'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	DUP RF-TP2-2 2'
L010672-017	WG010531	05/09/01	RF-TP-502 3'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	DUP RF-TP2-2 3'
L010672-018	WG010531	05/09/01	RF-TP-502 4'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	DUP RF-TP2-2 4'
L010672-019	WG010531	05/09/01	RF-TP-502 5'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	DUP RF-TP2-2 5'
L010672-020	WG010531	05/09/01	RF-TP-502 6'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	DUP RF-TP2-2 6'
L010672-021	WG010531	05/09/01	RF-TP-502 2-6'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	DUP RF-TP-2 2-6'
L010672-023	WG010531	05/09/01	RF-TA TP2-2'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	1' COVER
L010672-024	WG010531	05/09/01	RF-TA TP2-3'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-025	WG010531	05/09/01	RF-TA TP2-4'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-026	WG010531	05/09/01	RF-TA TP2-5'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-027	WG010531	05/09/01	RF-TA TP2-6'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-028	WG010531	05/09/01	RF-TA TP2-2-6'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-029	WG010531	05/09/01	RF-TA TP1 2'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	1' COVER
L010672-030	WG010531	05/09/01	RF-TA-TP1 3'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-031	WG010531	05/09/01	RF-TA-TP1 4'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-032	WG010531	05/09/01	RF-TA-TP1 5'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-033	WG010531	05/09/01	RF-TA-TP1 6'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	
L010672-034	WG010531	05/09/01	RF-TA-TP1 2-6'	Ag, Al,As,Cd,Cr,Cu,Fe,Hg,Pb,Sb,Se,Zn	

TABLE 6
RICHARDSON FLAT DATA QUALITY ASSESSMENT
TAILINGS SOUTH OF THE DIVERSION DITCH

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010940-001	WG010670	6/27/01	RF-TSDD-GL62-2.5"T	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-002	WG010670	6/27/01	RF-TSDD-GL62-3.5"C	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-003	WG010670	6/27/01	RF-TSDD-GL53-8"T	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-004	WG010670	6/27/01	RF-TSDD-GL53-18"C	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-005	WG010670	6/27/01	RF-TSDD-GL56-6"T	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-006	WG010670	6/27/01	RF-TSDD-GL5056-7"T	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	DUP GL50
L010940-007	WG010670	6/27/01	RF-TSDD-GL5056-19"C	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	DUP GL50
L010940-008	WG010670	6/27/01	RF-TSDD-GL58-14"T	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-009	WG010670	6/27/01	RF-TSDD-GL59-10"T	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-010	WG010670	6/27/01	RF-TSDD-GL50-6"T	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-011	WG010670	6/27/01	RF-TSDD-GL50-18"C	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-012	WG010670	6/27/01	RF-TSDD-GL52-6"T	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-013	WG010670	6/27/01	RF-TSDD-GL52-18"C	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-014	WG010670	6/27/01	RF-TSDD-GL56-18"C	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-015	WG010670	6/27/01	RF-TSDD-GL58-20"C	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	
L010940-016	WG010670	6/27/01	RF-TSDD-GL59-18"C	Ag, Al, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, Se, Zn	

TABLE 7
RICHARDSON FLAT DATA QUALITY ASSESSMENT
GROUNDWATER

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010789-004	WG010555	6/5/01	RF-GW-RT11	See Below	
L010789-005	WG010555	6/5/01	RF-GW-RT5011	See Below	DUP RF-GW-RT11
L010789-006	WG010555	6/5/01	RF-GW-RT12	See Below	
L010789-011	WG010555	6/5/01	RF-GW-RT13	See Below	
L010789-012	WG010555	6/5/01	RF-GW-RT14	See Below	
L011034-001	WG010712	7/19/01	RF-GW-RT11	See Below (except Hg(D))	
L011034-002	WG010712	7/19/01	RF-GW-RT5011	See Below (except Hg(D))	DUP RF-GW-RT11
L011034-003	WG010712	7/19/01	RF-GW-RT12	See Below (except Hg(D))	
L011034-004	WG010712	7/19/01	RF-GW-RT13	See Below (except Hg(D))	
L011034-005	WG010712	7/19/01	RF-GW-RT14	See Below (except Hg(D))	
L011153-001	WG010787	8/7/01	RF-GW-RT5011	See Below (except Hg(D))	DUP RF-GW-RT11
L011153-002	WG010787	8/7/01	RF-GW-RT11	See Below (except Hg(D))	
L011153-003	WG010787	8/7/01	RF-GW-RT12	See Below (except Hg(D))	
L011153-004	WG010787	8/7/01	RF-GW-RT13	See Below (except Hg(D))	
L011153-005	WG010787	8/7/01	RF-GW-RT14	See Below (except Hg(D))	
L011274-003	WG010886	9/5/01	RF-GW-RT11	See Below	
L011274-007	WG010886	9/5/01	RF-GW-RT12	See Below	
L011274-004	WG010886	9/5/01	RF-GW-RT13	See Below	
L011274-005	WG010886	9/5/01	RF-GW-5013	See Below	DUP RF-GW-RT13
L011274-006	WG010886	9/5/01	RF-GW-RT14	See Below	
L011407-005	WG010992	10/08/01	RF-GW-RT11	See Below	
L011407-006	WG010992	10/08/01	RF-GW-RT5011	See Below	DUP RF-GW-RT11
L011407-007	WG010992	10/08/01	RF-GW-RT12	See Below	
L011407-008	WG010992	10/08/01	RF-GW-RT13	See Below	
L011407-009	WG010992	10/08/01	RF-GW-RT14	See Below	
L011505-002	WG011050	11/05/01	RF-GW-RT11	See Below	
L011505-003	WG011050	11/05/01	RF-GW-RT5011	See Below	DUP RF-GW-RT11
L011505-001	WG011050	11/05/01	RF-GW-RT12	See Below	
L011505-009	WG011050	11/05/01	RF-GW-RT13	See Below	
L011505-008	WG011050	11/05/01	RF-GW-RT14	See Below	
L011611-004	WG011143	12/03/01	RF-GW-RT-11	See Below	
L011611-006	WG011143	12/03/01	RF-GW-RT5011	See Below	DUP RF-GW-RT11
L011611-005	WG011143	12/03/01	RF-GW-RT-12	See Below	
L011611-007	WG011143	12/03/01	RF-GW-RT13	See Below	
L011611-009	WG011143	12/03/01	RF-GW-RT14	See Below	
L020010-005	WG020023	01/07/02	RF-GW-RT11	See Below	
L020010-006	WG020023	01/07/02	RF-GW-RT12	See Below	
L020010-007	WG020023	01/07/02	RF-GW-RT13	See Below	
L020010-008	WG020023	01/07/02	RF-GW-RT14	See Below	
L020010-009	WG020023	01/07/02	RF-GW-RT5011	See Below	DUP RF-GW-RT11
L020060-005	WG020078	02/04/02	RF-GW-RT-11	See Below	
L020060-006	WG020078	02/04/02	RF-GW-RT-5011	See Below	DUP RF-GW-RT11
L020060-007	WG020078	02/04/02	RF-GW-RT-12	See Below	
L020060-002	WG020078	02/04/02	RF-GW-RT-13	See Below	
L020060-001	WG020078	02/04/02	RF-GW-RT-14	See Below	
L020160-005	WG020148	03/05/02	RF-GW-RT-11	See Below	
L020160-006	WG020148	03/05/02	RF-GW-RT-5011	See Below	DUP RF-GW-RT11
L020160-007	WG020148	03/05/02	RF-GW-RT-12	See Below	
L020160-008	WG020148	03/05/02	RF-GW-RT-13	See Below	
L020160-009	WG020148	03/05/02	RF-GW-RT-14	See Below	
L020227-005	WG020204	04/01/02	RF-GW-RT11	See Below	
L020227-006	WG020204	04/01/02	RF-GW-RT-5011	See Below	DUP RF-GW-RT11
L020227-007	WG020204	04/01/02	RF-GW-RT12	See Below	
L020227-008	WG020204	04/01/02	RF-GW-RT13	See Below	
L020227-009	WG020204	04/01/02	RF-GW-RT14	See Below	
L020227-010	WG020204	04/01/02	RF-GW-RT15	See Below	
L020228-001	WG020204	04/01/02	RF-RT-7	See Below	
L020311-001	WG020279	05/02/02	RF-GW-RT11	See Below	

TABLE 7
RICHARDSON FLAT DATA QUALITY ASSESSMENT
GROUNDWATER

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L020311-002	WG020279	05/02/02	RF-GW-RT5011	See Below	DUP RF-GW-RT11
L020311-003	WG020279	05/02/02	RF-GW-RT12	See Below	
L020312-007	WG020280	05/02/02	FPT-7A	See Below except Ag	
L020312-008	WG020280	05/02/02	FPT-8A	See Below except Ag	
L020312-009	WG020280	05/02/02	FPT-2B	See Below except Ag	
L020312-010	WG020280	05/02/02	FPT-4A	See Below except Ag	
L020312-011	WG020280	05/02/02	FPT-S4	See Below except Ag	
L020324-005	WG020283	05/06/02	RF-GW-RT 3	See Below	
L020324-002	WG020283	05/06/02	RF-GW-RT 6	See Below	
L020324-006	WG020283	05/06/02	RF-GW-RT 13	See Below	
L020324-007	WG020283	05/06/02	RF-GW-RT 5013	See Below	DUP RF-GW-RT13
L020324-004	WG020283	05/06/02	RF-GW-RT 14	See Below	
L020324-001	WG020283	05/06/02	RF-GW-RT 15	See Below	
L020324-003	WG020283	05/06/02	FPT-S-5	See Below except Ag	
L020406-003	WG020439	06/03/02	RF-GW-RT-11	See Below	
L020406-007	WG020439	06/03/02	RF-GW-RT-5011	See Below	DUP RF-GW-RT11
L020406-004	WG020439	06/03/02	RF-GW-RT-12	See Below	
L020406-005	WG020439	06/03/02	RF-GW-RT-13	See Below	
L020406-006	WG020439	06/03/02	RF-GW-RT-14	See Below	
L020535-003	WG020510	07/09/02	RF-GW-RT11	See Below	
L020535-004	WG020510	07/09/02	RF-GW-5011	See Below	DUP RF-GW-RT11
L020535-006	WG020510	07/09/02	RF-GW-RT12	See Below	
L020535-002	WG020510	07/09/02	RF-GW-RT13	See Below	
L020535-001	WG020510	07/09/02	RF-GW-RT14	See Below	
L020617-002	WG020553	08/06/02	RF-GW-RT-11	See Below	
L020617-003	WG020553	08/06/02	RF-GW-RT-5011	See Below	DUP RF-GW-RT11
L020617-001	WG020553	08/06/02	RF-GW-RT-12	See Below	
L020618-001	WG020552	08/06/02	FPT-8A	See Below (except Ag,Ag(D), Cr,Cr(D),Sb(D),Se,Se(D)	
Parameters: Ag,Ag(D),Al,Al(D),ALK,As,As(D),Ca,Cd,Cd(D),Cl,CO3,Cr,Cr(D),Cond,Cu,Cu(D),Fe,Fe(D),Hardness,					
Hg,Hg(D),K,Mg,Mn,Mn(D),Na,NH3/N,NO2/NO3,P,Pb,Pb(D),Sb,Sb(D),Se,Se(D),SO4,TDS,TSS,Zn,Zn(D)					

TABLE 8
RICHARDSON FLAT DATA QUALITY ASSESSMENT
SURFACE WATER

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L010443-001	WG010280	4/4/01	RF-SW-RF1	See Below	
L010443-002	WG010280	4/4/01	RF-SW-RF2	See Below	
L010443-003	WG010280	4/4/01	RF-SW-RF3-2	See Below	
L010443-004	WG010280	4/4/01	RF-SW-RF4	See Below	
L010443-005	WG010280	4/4/01	RF-SW-RF504	See Below	DUP RF-SW-RF4
L010443-006	WG010280	4/4/01	RF-SW-RF5	See Below	
L010443-007	WG010280	4/4/01	RF-SW-RF6-2	See Below	
L010443-008	WG010280	4/4/01	RF-SW-RF7-2	See Below	
L010443-009	WG010280	4/4/01	RF-SW-RF8	See Below	
L010626-001	WG010486/396	5/7/01	RF-SW-RF1	See Below	
L010626-002	WG010486/396	5/7/01	RF-SW-RF2	See Below	
L010626-003	WG010486/396	5/7/01	RF-SW-RF3-2	See Below	
L010626-004	WG010486/396	5/7/01	RF-SW-RF4	See Below	
L010626-005	WG010486/396	5/7/01	RF-SW-RF5	See Below	
L010626-006	WG010486/396	5/7/01	RF-SW-RF6-2	See Below	
L010626-007	WG010486/396	5/7/01	RF-SW-RF504	See Below	DUP RF-SW-RF4
L010626-008	WG010486/396	5/7/01	RF-SW-RF7-2	See Below	
L010626-009	WG010486/396	5/7/01	RF-SW-RF8	See Below	
L010789-001	WG010555	6/5/01	RF-SW-RF-8	See Below	
L010789-002	WG010555	6/5/01	RF-SW-RF7-2	See Below	
L010789-003	WG010555	6/5/01	RF-SW-RF6-2	See Below	
L010789-007	WG010555	6/5/01	RF-SW-RF-5	See Below	
L010789-008	WG010555	6/5/01	RF-SW-RF4	See Below	
L010789-009	WG010555	6/5/01	RF-SW-RF504	See Below	DUP RF-SW-RF4
L010789-010	WG010555	6/5/01	RF-SW-RF3-2	See Below	
L010993-001	WG010679	7/9/01	RF-SW-RF-8	See Below (except Hg(D))	
L010993-002	WG010679	7/9/01	RF-SW-RF7-2	See Below (except Hg(D))	
L010993-003	WG010679	7/9/01	RF-SW-RF6-2	See Below (except Hg(D))	
L010993-004	WG010679	7/9/01	RF-SW-RF-5	See Below (except Hg(D))	
L010993-005	WG010679	7/9/01	RF-SW-RF4	See Below (except Hg(D))	
L010993-006	WG010679	7/9/01	RF-SW-RF504	See Below (except Hg(D))	DUP RF-SW-RF4
L011153-006	WG010787	8/7/01	RF-SW-RF8	See Below (except Hg(D))	
L011153-007	WG010787	8/7/01	RF-SW-RF7-2	See Below (except Hg(D))	
L011153-008	WG010787	8/7/01	RF-SW-RF6-2	See Below (except Hg(D))	
L011153-009	WG010787	8/7/01	RF-SW-RF505	See Below (except Hg(D))	DUP RF-SW-RF5
L011153-010	WG010787	8/7/01	RF-SW-RF5	See Below (except Hg(D))	
L011274-001	WG010886	9/5/01	SW-RF-6-002	See Below	DUP SW-RF-6-2
L011274-008	WG010886	9/5/01	RF-SW-RF-6-2	See Below (except Hg(D))	
L011274-002	WG010886	9/5/01	SW-RF-7-2	See Below	
L011274-009	WG010886	9/5/01	RF-SW-RF8	See Below	
L011407-001	WG010992	10/08/01	RF-SW-RF8-2	See Below	
L011407-002	WG010992	10/08/01	RF-SW-RF7-2	See Below	
L011407-003	WG010992	10/08/01	RF-SW-RF6-2	See Below	
L011407-004	WG010992	10/08/01	RF-SW-RF6-502	See Below	DUP RF-SW-RF6-2
L011505-005	WG011050	11/05/01	RF-SW-RF6-2	See Below	
L011505-006	WG011050	11/05/01	RF-SW-RF6-502	See Below	DUP RF-SW-RF6-2
L011505-007	WG011050	11/05/01	RF-SW-RF7-2	See Below	
L011505-004	WG011050	11/05/01	RF-SW-RF8	See Below	
L011611-001	WG011143	12/03/01	RF-SW-RF-6-2	See Below	
L011611-008	WG011143	12/03/01	RF-SW-RF6-502	See Below	DUP SW-RF-6-2
L011611-002	WG011143	12/03/01	RF-SW-RF7-2	See Below	
L011611-003	WG011143	12/03/01	RF-SW-RF8	See Below	
L020010-001	WG020023	01/07/02	RF-SW-R6-2	See Below	
L020010-002	WG020023	01/07/02	RF-SW-RF7-2	See Below	
L020010-003	WG020023	01/07/02	RF-SW-RF8	See Below	
L020010-004	WG020023	01/07/02	RF-SW-R6-502	See Below	DUP SW-R6-2
L020060-003	WG020078	02/04/02	RF-GW-RT-6-2	See Below	
L020060-004	WG020078	02/04/02	RF-GW-RT-6-502	See Below	DUP SW-RF-6-2
L020060-008	WG020078	02/04/02	RF-GW-RT-7-2	See Below	
L020160-001	WG020148	03/05/02	RF-SW-RF6-2	See Below	
L020160-002	WG020148	03/05/02	RF-SW-RE6-502	See Below	DUP SW-RF-6-2

TABLE 8
RICHARDSON FLAT DATA QUALITY ASSESSMENT
SURFACE WATER

Lab #	QA Batch #	Date	Sample #	Parameters	Comments
L020160-003	WG020148	03/05/02	RF-SW-RF7-2	See Below	
L020160-004	WG020148	03/05/02	SW-RF8	See Below	
L020227-001	WG020204	04/01/02	RF-SW-6-2	See Below	
L020227-002	WG020204	04/01/02	RF-SW-506-2	See Below	DUP SW-RF-6-2
L020227-003	WG020204	04/01/02	RF-SW-RF7-2	See Below	
L020227-004	WG020204	04/01/02	RF-SW-RF8	See Below	
L020265-001	WG020239	04/16/02	RF-SW-RF1	See Below	
L020265-002	WG020239	04/16/02	RF-SW-RF2	See Below	
L020265-003	WG020239	04/16/02	RF-SW-RF3	See Below	
L020265-004	WG020239	04/16/02	RF-SW-RF4	See Below	
L020265-005	WG020239	04/16/02	RF-SW-RF504	See Below	DUP RF-SW-RF4
L020265-009	WG020239	04/16/02	RF-SW-RF5	See Below	
L020265-006	WG020239	04/16/02	RF-SW-RF6-2	See Below	
L020265-007	WG020239	04/16/02	RF-SW-RF-11	See Below	
L020265-008	WG020239	04/16/02	RF-SW-RF12	See Below	
L020310-001	WG020278	05/02/02	RF-SW-RF 7-2	See Below	
L020310-002	WG020278	05/02/02	RF-SW-RF 8	See Below	
L020312-001	WG020280	05/02/02	FPT-SW1	See Below (except Ag,Ag(D),Cr,Cr(D),P,Se,Se(D))	
L020312-002	WG020280	05/02/02	FPT-SW501	See Below (except Ag,Ag(D),Cr,Cr(D),P,Se,Se(D))	DUP RF-SW-FPT-S
L020312-003	WG020280	05/02/02	FPT-SW2	See Below (except Ag,Ag(D),Cr,Cr(D),P,Se,Se(D))	
L020312-004	WG020280	05/02/02	FPT-SW3	See Below (except Ag,Ag(D),Cr,Cr(D),P,Se,Se(D))	
L020312-005	WG020280	05/02/02	FPT-SW4	See Below (except Ag,Ag(D),Cr,Cr(D),P,Se,Se(D))	
L020312-006	WG020280	05/02/02	PH-SW1	See Below (except Ag,Ag(D),Cr,Cr(D),P,Se,Se(D))	
L020324-012	WG020283	05/06/02	RF-SW-RF 1	See Below	
L020324-011	WG020283	05/06/02	RF-SW-RF 2	See Below	
L020324-010	WG020283	05/06/02	RF-SW-RF 4	See Below	
L020324-015	WG020283	05/06/02	RF-SW-RF 5	See Below (except Sb)	
L020324-009	WG020283	05/06/02	RF-SW-RF 504	See Below	DUP RF-SW-RF5
L020324-008	WG020283	05/06/02	RF-SW-RF 6-2	See Below	
L020324-013	WG020283	05/06/02	RF-SW-RF 11	See Below	
L020324-014	WG020283	05/06/02	RF-SW-RF 12	See Below	
L020407-004	WG020439	06/03/02	RF-SW-RF-4	As,As(D),Cd,Cd(D),Cu,Cu(D),Pb,Pb(D),Sb,Sb(D),SO4,TDS,TSS,Zn,Zn(D))	
L020407-003	WG020439	06/03/02	RF-SW-RF-5	As,As(D),Cd,Cd(D),Cu,Cu(D),Pb,Pb(D),Sb,Sb(D),SO4,TDS,TSS,Zn,Zn(D))	
L020407-001	WG020439	06/03/02	RF-SW-RF-6-2	As,As(D),Cd,Cd(D),Cu,Cu(D),Pb,Pb(D),Sb,Sb(D),SO4,TDS,TSS,Zn,Zn(D))	
L020407-002	WG020439	06/03/02	RF-SW-RF-6-502	As,As(D),Cd,Cd(D),Cu,Cu(D),Pb,Pb(D),Sb,Sb(D),SO4,TDS,TSS,Zn,Zn(D))	DUP RF-SW-RF-6-
L020406-002	WG020439	06/03/02	RF-SW-RF-7-2	See Below	
L020406-001	WG020439	06/03/02	RF-SW-RF-8	See Below	
L020535-007	WG020510	07/09/02	RF-SW-RF4	See Below	
L020535-008	WG020510	07/09/02	RF-SW-RF 7-2	See Below	
L020535-009	WG020510	07/09/02	RF-SW-RF 507-2	See Below	DUP RF-SW-RF-7-
L020535-005	WG020510	07/09/02	RF-SW-RF8	See Below	
L020617-004	WG020553	08/06/02	RF-GW-RT-7-2	See Below	
Parameters: Ag,Ag(D),Al,Al(D),ALK,As,As(D),Ca,Cd,Cd(D),Cl,CO3,Cr,Cr(D),Cond,Cu,Cu(D),Fe,Fe(D),Hardness,					
Hg,Hg(D),K,Mg,Mn,Mn(D),Na,NH3/N,NO2/NO3,P,Pb,Pb(D),Sb,Sb(D),Se,Se(D),SO4,TDS,TSS,Zn,Zn(D)					

TABLE 9
RICHARDSON FLAT DATA QUALITY ASSESSMENT
FIELD DUPLICATE FREQUENCY

Media/Area	# Samples	# Dups	Frequency (%)
Background Samples (As, Pb)	17	0	0.0
Background Samples (All Metals)	2	1	50.0
Off-Site Samples (As, Pb)	45	2	4.4
Off-Site Samples (All Metals)	10	4	40.0
On-Site Soils Cover (As, Pb)	31	3	9.7
On-Site Soils Cover (All Metals)	10	3	30.0
On-Site Soils Cover (All Metals + Al, Fe)	11	0	0.0
Soils (Combined)	*126*	*13*	*10.3*
Sediment	6	1	16.7
Tailings	18	6	33.3
Tailings South of Diversion Ditch	14	2	14.3
Groundwater (6/5/01)	4	1	25.0
Groundwater (7/19/01)	4	1	25.0
Groundwater (8/7/01)	4	1	25.0
Groundwater (9/5/01)	4	1	25.0
Groundwater (10/8/01)	4	1	25.0
Groundwater (11/5/01)	4	1	25.0
Groundwater (12/3/01)	4	1	25.0
Groundwater (1/7/02)	4	1	25.0
Groundwater (2/4/02)	4	1	25.0
Groundwater (3/5/02)	4	1	25.0
Groundwater (4/1/01)	6	1	16.7
Groundwater (5/2/02)	2	1	50.0
Groundwater (5/6/02)	5	1	20.0
Groundwater (6/3/02)	4	1	25.0
Groundwater (7/9/02)	4	1	25.0
Groundwater (8/6/02)	3	1	33.3
	64	*16*	*25.0*
Surface Water (4/4/01)	8	1	12.5
Surface Water (5/7/01)	8	1	12.5
Surface Water (6/5/01)	6	1	16.7
Surface Water (7/9/01)	5	1	20.0
Surface Water (8/7/01)	4	1	25.0
Surface Water (9/5/01)	3	1	33.3
Surface Water (10/8/01)	3	1	33.3
Surface Water (11/5/01)	3	1	33.3
Surface Water (12/3/01)	3	1	33.3
Surface Water (1/7/02)	3	1	33.3
Surface Water (2/4/02)	2	1	50.0
Surface Water (3/5/02)	3	1	33.3
Surface Water (4/1/01)	3	1	33.3
Surface Water (4/16/01)	8	1	12.5
Surface Water (5/2/02)	7	1	14.3
Surface Water (5/6/02)	7	1	14.3
Surface Water (6/3/02)	5	1	20.0
Surface Water (7/9/02)	3	1	33.3
Surface Water (8/6/02)	1	0	0.0
	85	*18*	*21.2*

TABLE 10
RICHARDSON FLAT FIELD DUPLICATE RESULTS
BACKGROUND SOILS

Lab #	Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	PB	SB	SE	ZN
L010671-028	5/10/01	RF-BG-BG10	<5.		7.	227.	<0.5	22.	16.		<.10	33.		<5.	96.
L010671-029	5/10/01	RF-BG-BG1050	<5.		7.	213.	<0.5	23.	15.		<.10	28.		<5.	90.
		RPD (%)	NC		0.0	6.4	NC	4.4	6.5		NC	16.4		NC	6.5
Results in ppm, unless indicated otherwise.															
NC - Not Calculated															

TABLE 11
RICHARDSON FLAT FIELD DUPLICATE RESULTS
OFF-SITE SOILS

Lab #	Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN
L010670-069	5/10/01	RF-OF-T1E 0-2"			9.9								62			
L010670-072	5/10/01	RF-OF-T150E 0-2"			11								65			
		RPD (%)			10.5								4.7			
L010670-090	5/10/01	RF-OF-T1E 1-6			8.5								55			
L010670-071	5/10/01	RF-OF-T150E 1-6"			7.1								31			
		RPD (%)			17.9								**55.8**			
L010671-023	5/9/01	RF-OF-T2F 0-2"	<5.		15.	218.	1.	21.	40.		<.10		194.		<5.	270.
L010671-024	5/9/01	RF-OF-T250F 0-2"	<5.		16.	233.	2.	21.	38.		<.10		189.		<5.	276.
		RPD (%)	NC		6.5	6.7	**66.7**	0.0	5.1		NC		2.6		NC	2.2
L010671-025	5/9/01	RF-OF-T2F 1-6"	<5.		6.	246.	<0.5	22.	20.		<.10		19.		<5.	65.
L010671-022	5/9/01	RF-OF-T250F 1-6"	<5.		8.	238.	<0.5	22.	23.		<.10		48.		<5.	102.
		RPD (%)	NC		28.6	3.3	NC	0.0	14.0		NC		**86.6**		NC	**44.3**
L010671-012	5/9/01	RF-OF-T3D 1-6"	<5.		7.	413.	1.	23.	32.		<.10		42.		<5.	125.
L010671-018	5/9/01	RF-OF-T3D 1-6"	<5.		7.	407.	1.	21.	32.		<.10		33.		<5.	111.
		RPD (%)	NC		0.0	1.5	0.0	9.1	0.0		NC		24.0		NC	11.9
L010671-021	5/9/01	RF-OF-T3D 0-2"	<5.		8.	409.	1.	20.	35.		.11		73.		<5.	165.
L010671-016	5/9/01	RF-OF-T350D 0-2"	<5.		8.	383.	1.	21.	34.		.11		66.		<5.	152.
		RPD (%)	NC		0.0	6.6	0.0	4.9	2.9		0.0		10.1		NC	8.2
Results in ppm, unless indicated otherwise.																
NC - Not Calculated																

TABLE 12
RICHARDSON FLAT FIELD DUPLICATE RESULTS
ON-SITE SOILS COVER

Lab #	Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	PB	SB	SE	ZN
L010670-047	5/9/01	RF-ON-2D 0-2"			6.4							19			
L010670-067	5/10/01	RF-ON-2D50 0-2"			7.2							20			
		RPD (%)			11.8							5.1			
L010670-012	5/9/01	RF-ON-2E 0-2"			32							636			
L010670-013	5/8/01	RF-ON-2E50 0-2"			56							1173			
		RPD (%)			54.5							59.4			
L010671-001	5/8/01	RF-ON-2H 0-2"	<5.		<5.	208.	<0.5	23.	14.		<.10	17.		<5.	64.
L010671-014	5/8/01	RF-ON-2H50 0-2"	<5.		<5.	204.	<0.5	22.	13.		<.10	16.		<5.	62.
		RPD (%)	NC		NC	1.9	NC	4.4	7.4		NC	6.1		NC	3.2
L010671-006	5/8/01	RF-ON-3E 0-2"	<5.		<5.	356.	<0.5	20.	20.		<.10	14.		<5.	47.
L010671-007	5/8/01	RF-ON-3E50 0-2"	<5.		<5.	365.	<0.5	21.	19.		<.10	16.		<5.	52.
		RPD (%)	NC		NC	2.5	NC	4.9	5.1		NC	13.3		NC	10.1
L010671-002	5/8/01	RF-ON-4F 0-2"	<5.		6.	221.	<0.5	16.	19.		<.10	20.		<5.	64.
L010671-003	5/8/01	RF-ON-4F50 0-2"	<5.		6.	216.	<0.5	16.	29.		<.10	21.		<5.	65.
		RPD (%)	NC		0.0	2.3	NC	0.0	41.7		NC	4.9		NC	1.6
L010670-003	5/8/01	RF-ON-4G 0-2"			6.5							20			
L010670-004	5/8/01	RF-ON-4G50 0-2"			5.5							19			
		RPD (%)	NC		16.7							5.1			
Results in ppm, unless indicated otherwise.															
NC - Not Calculated															

TABLE 13
RICHARDSON FLAT FIELD DUPLICATE RESULTS
SEDIMENT

Lab #	Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN
L010672-040	05/11/01	RF-SD-SD5 0-6"	20.	8650	119.		38.	18.	261.	23000.	1.0	33	2650.	97.	<5.	7610
L010672-041	05/11/01	RF-SD-SD550 0-6"	20.	8240	104.		38.	18.	248.	23100.	.95	44	2660.	93.	5.	7410
		RPD (%)	0.0	4.9	13.5		0.0	0.0	5.1	0.4	5.1	28.6	0.4	4.2	NC	2.7
Results in ppm, unless indicated otherwise.																
NC - Not Calculated																

TABLE 14
RICHARDSON FLAT FIELD DUPLICATE RESULTS
TAILINGS

Lab #	Date	Sample #	AG	AL	AS	BA	CD	CR	CU	FE	HG	MOIST	PB	SB	SE	ZN
L010672-023	05/09/01	RF-TA TP2-2'	38.	2150.	235.		30.	16.	462.	28500.	2.8	24	3880.	150.	9.	5910
L010672-016	05/09/01	RF-TP-502 2'	31.	1930.	280.		29.	16.	409.	34400.	9.7	26	3970.	152.	12.	5600
		RPD (%)	20.3	10.8	17.5		3.4	0.0	12.2	18.8	**110.4**	8.0	2.3	1.3	28.6	5.4
L010672-028	05/09/01	RF-TA TP2-2-6'	46.	4020.	302.		48.	32.	548.	32900.	2.9	29	6060.	167.	11.	7740
L010672-021	05/09/01	RF-TP-502 2-6'	42.	2230.	307.		45.	18.	454.	36300.	2.5	27	5090.	193.	11.	7340
		RPD (%)	9.1	**57.3**	1.6		6.5	**56.0**	18.8	9.8	14.8	7.1	17.4	14.4	0.0	5.3
L010672-024	05/09/01	RF-TA TP2-3'	24.	1330.	417.		23.	12.	217.	29400.	4.9	25	3100.	172.	7.	3590
L010672-017	05/09/01	RF-TP-502 3'	34.	1440.	451.		36.	13.	283.	29200.	4.3	29	4260.	247.	7.	5680
		RPD (%)	34.5	7.9	7.8		**44.1**	8.0	26.4	0.7	13.0	14.8	31.5	**35.8**	0.0	**45.1**
L010672-025	05/09/01	RF-TA TP2-4'	18.	1470.	188.		26.	15.	190.	40700.	1.9	21	2490.	95.	9.	4830
L010672-018	05/09/01	RF-TP-502 4'	18.	1380.	166.		25.	14.	192.	34700.	2.5	21	2500.	93.	9.	4540
		RPD (%)	0.0	6.3	12.4		3.9	6.9	1.0	15.9	27.3	0.0	0.4	2.1	0.0	6.2
L010672-026	05/09/01	RF-TA TP2-5'	18.	1490.	404.		26.	13.	197.	37200.	3.1	23	2560.	89.	9.	4490
L010672-019	05/09/01	RF-TP-502 5'	58.	2800.	319.		62.	22.	609.	44800.	7.4	19	6590.	242.	14.	8970
		RPD (%)	**105.3**	**61.1**	23.5		**81.8**	**51.4**	**102.2**	18.5	**81.9**	19.0	**88.1**	**92.4**	43.5	**66.6**
L010672-028	05/09/01	RF-TA TP2-6'	96.	15600.	371.		87.	111.	1300.	32000.	3.3	34	14700.	312.	17.	15300
L010672-020	05/09/01	RF-TP-502 6'	66.	12000.	267.		74.	82.	840.	35500.	2.8	32	10900.	187.	13.	12300
		RPD (%)	**37.0**	26.1	32.6		16.1	30.1	**43.0**	10.4	16.4	6.1	29.7	**50.1**	26.7	21.7

Results in ppm, unless indicated otherwise.
NC - Not Calculated

TABLE 15
RICHARDSON FLAT FIELD DUPLICATE RESULTS
TAILINGS SOUTH OF THE DIVERSION DITCH

Lab #	Date	Sample #	AG	AL	AS	CD	CR	CU	FE	HG	MOIST.	PB	SB	SE	ZN
L010940-010	6/27/01	RF-TSDD-GL50-6"T	55	3313	459	75	19	692	15720	6.3	17	9060	283	9.0	14650
L010940-006	6/27/01	RF-TSDD-GL5056-7"T	44	2748	313	39	18	497	11720	4.8	5.3	7129	214	<5	7926
		RPD (%)	22.2	18.6	37.8	63.2	5.4	32.8	29.2	27.0	104.9	23.9	27.8	NC	59.6
L010940-011	6/27/01	RF-TSDD-GL50-18"C	<5	26320	9.7	<.5	28	31	24270	<.10	26	26	<5	<5	125
L010940-007	6/27/01	RF-TSDD-GL5056-19"C	<5	21130	7.9	1.1	25	25	22940	<.10	19	24	<5	<5	214
		RPD (%)	NC	21.9	20.5	NC	11.3	21.4	5.6	NC	31.1	8.0	NC	NC	52.5
Results in ppm, unless indicated otherwise.															
NC - Not Calculated															

TABLE 18
RICHARDSON FLAT FIELD DUPLICATE SUMMARY
GROUNDWATER

Lab #	Date	Sample #	AG	AG(D)	AL	AL(D)	ALK.	AS	AS(D)	CA	CATION BAL.	CD	CD(D)	CL-	CO3	COND.	CR	CR(D)	CU	CU(D)
		Units	ppm	ppm	ppm	ppm	ppm CaCO3	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm CaCO3	umhos/cm2	ppm	ppm	ppm	ppm
L010789-004	6/5/01	RF-GW-RT11	.070	<.005	18	<.050	180	.33	.085	243.	-1.0	.71	.13	452.	<1	2510	.054	<.010	.87	<.005
L010789-005	6/5/01	RF-GW-RT5011	.18	<.005	4.0	<.050	201	.06	.005	248.	-.5	.34	.13	480	<1	2530	.10	<.010	2.4	<.005
		RPD (%)	88.3	NC	191.6	NC	8.8	88.1	0.0	2.0		47.2	0.0	8.1	NC	0.8	59.7	NC	88.1	NC
L011034-001	7/18/01	RF-GW-RT11	<.005	<.005	.082	<.050	203	.008	<.005	185	-3.0	.087	.088	364.	<1	1875	<.010	<.010	.029	.078
L011034-002	7/18/01	RF-GW-RT5011	<.005	<.005	.071	<.050	202	.008	<.005	187.	-4.5	.085	.087	327	<1	1875	<.010	<.010	.030	.078
		RPD (%)	NC	NC	14.9	NC	0.5	0.0	NC	1.1		2.3	1.1	10.7	NC	0.0	NC	NC	3.4	7.4
L011153-001	8/7/01	RF-GW-RT5011	<.005	<.005	<.050	<.050	209	.008	.008	185	-.1	.078	.077	311	<1	1908	<.010	<.010	.008	.005
L011153-002	8/7/01	RF-GW-RT11	<.005	<.008	<.050	<.050	208	.008	.008	178	-3.8	.075	.078	284	<1	1912	<.010	<.010	<.005	<.005
		RPD (%)	NC	NC	NC	NC	0.5	11.0	11.0	3.8		1.8	1.3	10.1	NC	0.2	NC	NC	NC	NC
L011274-004	9/5/01	RF-GW-RT13	<0.005	<0.005	0.087	<0.050	286	<0.005	<0.005	287.	1.8	<0.001	<0.001	58.	<1.0	1818	<0.010	<0.010	<0.005	<0.005
L011274-005	9/5/01	RF-GW-5013	<0.005	<0.005	<0.050	<0.050	302	<0.005	<0.005	288.	-2.3	<0.001	<0.001	58	<1.0	1847	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	NC	NC	2.2	NC	NC	0.4		NC	NC	1.7	NC	2.2	NC	NC	NC	NC
L011407-005	10/8/01	RF-GW-RT11	<0.005	<0.005	<0.050	<0.050	205.	0.007	0.008	180	4.1	0.058	0.066	183	<1.0	1548.	<0.010	<0.010	0.005	0.005
L011407-008	10/8/01	RF-GW-RT6011	<0.005	<0.005	<0.050	<0.050	210	0.007	0.008	158.	8.0	0.058	0.067	200	<1.0	1548	<0.010	<0.010	0.006	<0.005
		RPD (%)	NC	NC	NC	NC	2.4	0.0	0.0	8.8		0.0	1.7	1.5	NC	0.0	NC	NC	0.0	NC
L011505-002	11/5/01	RF-GW-RT11	<0.005	<0.005	0.088	<0.050	243	0.007	0.006	188	-0.5	0.054	0.08	181	<1.0	1485	<0.010	<0.010	0.01	0.008
L011505-003	11/5/01	RF-GW-RT5011	<0.005	<0.005	0.087	<0.050	242	0.009	0.008	183	-0.1	0.058	0.081	177	<1.0	1484	<0.010	<0.010	0.011	0.009
		RPD (%)	NC	NC	1.0	NC	0.0	25.0	8.8	1.2		8.8	1.7	6.5	NC	0.1	NC	NC	8.5	NC
L011611-004	12/3/01	RF-GW-RT-11	<.005	<.005	<.050	<.050	232	<.005	<.005	200	1.9	0.077	0.077	282	<1	1780	<.010	<.010	0.032	0.027
L011611-008	12/3/01	RF-GW-RT5011	<.005	<.005	<.050	<.050	251	<.005	<.005	201	2.8	0.072	0.078	246	<1	1772	<.010	<.010	0.028	0.028
		RPD (%)	NC	NC	NC	NC	7.3	NC	NC	0.5		6.1	1.3	8.7	NC	0.7	NC	NC	20.7	3.8
L020010-005	1/7/02	RF-GW-RT11	<.005	<.005	<.050	<.050	230	<.005	0.005	280	-1.6	0.1	0.11	473	<1	2220	<.010	<.010	0.044	0.045
L020010-009	1/7/02	RF-GW-RT5011	<.005	<.005	<.050	<.050	242	<.005	<.005	282	-0.72	0.1	0.11	438	<1	2220	<.010	<.010	0.044	0.047
		RPD (%)	NC	NC	NC	NC	5.1	NC	NC	0.4		0.0	0.0	7.7	NC	0.0	NC	NC	NC	NC
L020080-005	2/4/02	RF-GW-RT-11	<0.005	<0.005	0.075	<0.050	230	<0.005	0.008	243	0.54	0.087	0.094	440	<1.0	2230	<0.010	<0.010	0.04	0.039
L020080-008	2/4/02	RF-GW-RT-5011	<0.005	<0.005	0.053	<0.050	218	<0.005	0.008	242	4.5	0.084	0.094	483	<1.0	2240	<0.010	<0.010	0.037	0.039
		RPD (%)	NC	NC	34.4	NC	5.3	NC	0.0	0.4		3.1	0.0	11.4	NC	0.4	NC	NC	7.8	0.0
L020180-005	3/5/02	RF-GW-RT-11	<0.005	<0.005	<0.050	<0.050	221	<0.005	0.007	214	-5.5	0.077	0.084	378	<1.0	3050	<0.010	<0.010	0.075	0.071
L020180-008	3/5/02	RF-GW-RT-5011	<0.005	<0.005	<0.050	<0.050	225	<0.005	0.007	213	-5.3	0.077	0.083	371	<1.0	2870	<0.010	<0.010	0.075	0.077
		RPD (%)	NC	NC	NC	NC	1.8	NC	0.0	0.5		0.0	1.2	1.9	NC	1.0	NC	NC	0.0	8.7
L020227-005	4/1/02	RF-GW-RT11	<0.005	<0.005	<0.050	<0.050	207	<0.005	0.008	283.	2.9	0.13	0.13	504	<1.0	2520	<0.010	<0.010	0.035	0.030
L020227-008	4/1/02.	RF-GW-RT-5011	<0.005	<0.005	<0.050	<0.050	208.	<0.005	0.008	282.	1.2	0.13	0.13	480	<1.0	2520	<0.010	<0.010	0.035	0.030
		RPD (%)	NC	NC	NC	NC	0.5	NC	0.0	0.3		0.0	0.0	1.8	NC	0.0	NC	NC	0.0	0.0
L020311-001	5/2/02	RF-GW-RT11	<0.005	<0.005	<0.050	<0.050	175	<0.005	0.007	284	3.3	0.14	0.14	887	<1.0	2980	<0.010	<0.010	0.034	0.023
L020311-002	5/2/02	RF-GW-RT5011	<0.005	<0.005	<0.050	<0.050	170	0.006	0.008	283	3.2	0.14	0.14	882	<1.0	2980	<0.010	<0.010	0.034	0.021
		RPD (%)	NC	NC	NC	NC	3.5	NC	15.4	0.7		0.0	0.0	2.2	NC	0.0	NC	NC	0.0	9.1
L020324-006	5/8/02	RF-GW-RT 13	<0.005	<0.005	0.078	<0.050	288	<0.005	<0.005	380	4.7	<0.001	<0.001	85	<1.0	2850	<0.010	<0.010	<0.005	<0.005
L020324-007	5/8/02	RF-GW-RT 5013	<0.005	<0.005	0.083	<0.050	284	<0.005	<0.005	383	8.8	<0.001	<0.001	85	<1.0	2850	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	25.7	NC	1.4	NC	NC	1.0		NC	NC	0.0	NC	0.0	NC	NC	NC	NC
L020408-003	6/3/02	RF-GW-RT-11	<.005	<.005	0.080	<.050	187	0.008	0.008	248	<1.0	0.12	0.1	540	<1.0	2840	<.010	<.010	0.023	0.027
L020408-007	6/3/02	RF-GW-RT-5011	<.005	<.005	<.050	<.050	183	0.008	0.005	247	<1.0	0.11	0.11	577	<1.0	2840	<.010	<.010	0.025	0.027
		RPD (%)	NC	NC	NC	NC	2.1	28.6	18.7	0.4		NC	8.5	7.4	NC	0.0	NC	NC	8.3	0.0
L020535-003	7/8/02	RF-GW-RT11	<0.005	<0.005	0.03	0.052	212	0.008	0.008	202	<1	0.071	0.081	408	<1.0	2210	<0.010	<0.010	0.017	0.016
L020535-004	7/8/02	RF-GW-5011	<0.005	<0.005	<0.050	0.058	215	0.008	0.008	218	3.7	0.071	0.082	437	<1.0	2210	<0.010	0.012	0.017	0.018
		RPD (%)	NC	NC	NC	10.8	1.4	0.0	0.0	7.8	NC	0.0	1.2	6.8	NC	0.0	NC	NC	0.0	8.5
L020817-002	8/6/02	RF-GW-RT-11	<0.005	<0.005	<0.050	<0.050	211	0.007	0.010	211	3.3	0.074	0.077	442	<1.0	2240	<0.010	<0.010	0.007	0.008
L020817-008	8/6/02	RF-GW-RT-5011	<0.005	<0.005	<0.050	<0.050	213	0.006	0.010	211.	2.4	0.075	0.077	447	<1.0	2240.	<0.010	<0.010	0.007	0.008
		RPD (%)	NC	NC	NC	NC	0.9	15.4	0.0	0.0	31.6	1.3	0.0	1.1	NC	0.0	NC	NC	0.0	0.0

Lab #	Sample #	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	MG	MN	MN(D)	NA	NH3N	NO2/NO3	P	PB	PB(D)	SB	SB(D)	SE	SE(D)	SO4	TDS	TSS	ZN	ZN(D)
	Units	ppm	ppm	ppm	ppm CaCO3	ppb	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
L010789-004	RF-GW-RT11	18	<1	870	180	75	<.2	2.8	64.	1.2	.84	169.	1.0	.21	1.4	16	.098	.33	.014	.028	<.004	504	1142	708	18.	9.8
L010789-005	RF-GW-RT5011	58.	<1	881	207	180	<.2	3.3	65.	7.3	.72	171	.30	.21	.8	.41	.081	.08	.014	.028	<.004	493	1031	1257.	28.	8.8
	RPD (%)	102.8	NC	1.3	8.8	86.4	NC	17.0	1.8	88.8	15.4	3.0	84.1	0.0	88.2	82.8	3.4	77.2	8.8	30.7	NC	2.2	5.0	55.1	41.0	2.1
L011034-001	RF-GW-RT11	<.10	.14	845	203	<.2		2.1	45	.11	.12	139	<.10	<.1	<.1	.31	.24	.020	.018	.008	.008	345	1287	<1	7.1	7.0
L011034-002	RF-GW-RT5011	<.10	<.10	840	202.	.22		2.7	44	.11	.11	143	<.10	<.1	<.1	.32	.28	.021	.020	.005	.005	329	1280	<1	7.0	7.1
	RPD (%)	NC	NC	0.6	0.5	NC		25.0	2.2	0.0	8.7	2.8	NC	NC	NC	3.2	8.0	4.8	6.1	18.2	18.2	4.8	0.8	NC	1.4	1.4
L011153-001	RF-GW-RT5011	<1	<1	843	208	<.2		<7	44.	.13	.11	132.	<.1	.11	<.1	.15	.12	.018	.018	<.004	<.004	301	1290	1.2	8.6	8.7
L011153-002	RF-GW-RT11	<1	<1	872	208	<.2		<7	45	.13	.11	137	<.1	<.10	<.1	.14	.13	.018	.018	<.004	<.004	302	1347	<1.	8.8	8.8
	RPD (%)	NC	NC	3.3	0.5	NC		NC	2.3	0.0	0.0	3.8	NC	NC	NC	6.9	0.0	0.0	0.0	NC	NC	3.3	4.2	NC	0.0	1.5
L011274-004	RF-GW-RT13	<0.10	<0.10	887	295	<0.2	<0.2	<7.8	58.	2.9	3.1	26.	0.12	0.38	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	570	1302	1.2	0.024	0.018
L011274-005	RF-GW-5013	<0.10	<0.10	890	302.	<0.3	<0.2	<7.8	58	2.7	2.8	26	<0.10	0.38	<0.10	0.007	<0.005	<0.005	<0.005	<0.004	<0.004	647	1347	1.2	0.017	0.015
	RPD (%)	NC	NC	0.3	2.3	NC	NC	NC	0.0	7.1	6.7	0.0	NC	5.4	NC	NC	NC	NC	NC	NC	NC	12.7	3.8	0.0	34.1	0.5
L011407-005	RF-GW-RT11	<0.050	<0.050	560	206	<0.20	<0.20	2.4	30	0.10	0.086	113	0.12	<0.10	<0.10	0.090	0.085	0.015	0.015	<0.004	<0.004	387	898	<1.0	5.8	5.8
L011407-008	RF-GW-RT6011	<0.050	<0.050	558	210	<0.20	<0.20	2.2	30	0.088	0.084	112	0.11	<0.10	<0.10	0.089	0.077	0.014	0.015	<0.004	<0.004	381	1804	<1.0	5.8	5.8
	RPD (%)	NC	NC	0.7	2.4	NC	NC	8.7	2.6	2.0	1.1	0.8	8.7	NC	NC	8.7	9.9	6.6	0.0	NC	NC	9.5	8.6	NC	1.7	0.0
L011505-002	RF-GW-RT11	0.14	<0.10	584	243	<0.2	<0.2	2.1	40	0.093	0.1	88	<0.1	<0.1	<.10	0.1	0.078	0.015	0.018	<0.005	<0.005	288	1008	<1.0	8	8.2
L011505-003	RF-GW-RT5011	0.17	<0.10	572	242	0.22	<0.2	2.1	41	0.088	0.1	88	<0.1	<0.1	<.10	0.18	0.081	0.015	0.017	<0.005	<0.005	210	1001	<1.0	8.1	8.2
	RPD (%)	NC	NC	1.4	0.8	NC	NC	0.0	2.5	4.4	0.0	1.1	NC	NC	NC	46.2	2.5	0.0	6.1	NC	NC	7.0	0.7	NC	1.7	0.0
L011611-004	RF-GW-RT-11	0.14	0.1	705	232	<.2	<.2	<2	58	0.1	0.083	80	<.10	<.1	<.1	0.2	0.11	0.018	0.017	<.004	<.004	395	1183	<1	7.1	7.2
L011611-008	RF-GW-RT5011	<.10	<.10	710	251	<.2	<.2	<2	51	0.1	0.085	80	0.14	<.1	<.1	0.19	0.11	0.017	0.018	<.004	<.004	371	1148	<1.	7	7.1
	RPD (%)	NC	NC	0.7	7.8	NC	NC	NC	2.0	0.0	2.1	0.0	NC	NC	NC	6.1	0.0	5.7	5.7	NC	NC	6.5	1.7	NC	1.4	1.4
L020010-005	RF-GW-RT11	<.10	<.10	920	230	<.2	<.2	2.3	66	0.09	0.09	111	0.11	<.10	<.1	0.4	0.38	0.018	0.018	0.005	<.004	350	1471	<1	8	9.2
L020010-009	RF-GW-RT5011	<.10	<.10	975	242	<.3	<.2	2.5	66	0.087	0.08	115	0.11	0.12	<.1	0.41	0.4	0.019	0.018	0.005	<.004	348	1518	<1	8.7	8.8
	RPD (%)	NC	NC	8.4	5.1	NC	NC	8.3	0.0	3.4	0.0	4.3	0.0	NC	NC	7.5	2.5	0.0	0.0	0.0	NC	7.0	3.0	NC	3.4	3.3
L020080-005	RF-GW-RT-11	<0.10	<0.10	850	230	<0.0002	<0.0002	2.2	61	0.084	0.077	124	<0.10	0.10 (+	<0.10	0.39	0.35	0.018	0.017	0.005	0.005	320	1463	<1.0	8.4	8.3
L020080-008	RF-GW-RT-5011	0.14	<0.10	851	218	<0.0002	<0.0002	2.1	60	0.08	0.078	120	<0.10	0.12	<0.10	0.39	0.35	0.018	0.017	0.005	0.005	352	1488	<1.0	8.2	8.3
	RPD (%)	NC	NC	0.8	8.3	NC	NC	4.7	1.7	4.8	1.3	3.2	NC	NC	NC	0.0	0.0	0.0	0.0	0.0	0.0	9.5	0.2	NC	2.4	0.0
L020180-005	RF-GW-RT-11	<0.10	<0.10	755	221	<0.0002	<0.0002	<2.0	64	0.087	0.054	115	<0.10	<0.10	<0.10	0.28	0.3	0.014	0.015	<0.004	0.004	392	1422	<1.0	7.8	7.9
L020180-008	RF-GW-RT-5011	<0.10	<0.10	757	225	<0.0002	<0.0002	<2.0	65	0.057	0.055	115	<0.10	<0.10	<0.10	0.28	0.3	0.014	0.015	<0.004	0.004	398	1409	<1.0	7.8	7.8
	RPD (%)	NC	NC	0.3	1.8	NC	NC	NC	1.8	0.0	1.8	0.0	NC	NC	NC	3.5	0.0	0.0	0.0	NC	0.0	1.8	0.9	NC	0.0	0.0
L020227-005	RF-GW-RT11	<0.10	<0.10	1035.	207	<0.0002	<0.0002	2.4	74.	0.053	0.053	130	<0.10	0.18	<0.10	0.33	0.34	0.018	0.017	<0.004	<0.004	385	1740	<1.0	10	10
L020227-008	RF-GW-RT-5011	0.36	<0.10	1030	208	<0.0002	<0.0002	2.5	73	0.080	0.053	130	<0.10	0.37	<0.10	0.34	0.33	0.018	0.017	<0.004	<0.004	415.	1740	<1.0	11.	10
	RPD (%)	NC	NC	0.5	0.5	NC	NC	4.1	1.4	[illegible]	0.0	0.0	NC	64.3	NC	3.0	3.0	0.0	0.0	NC	NC	7.5	0.3	NC	9.5	0.0
L020311-001	RF-GW-RT11	<0.10	<0.10	1036	175	<0.0002	<0.0002	2.8	72	0.061	0.048	200	0.17	0.38	<0.10	0.38	0.34	0.017	0.017	<0.004	0.008	488	1891	1.8	10	10
L020311-002	RF-GW-RT5011	<0.10	<0.10	1070	170	<0.0002	<0.0002	2.8	72	0.058	0.045	208	<0.10	0.34	<0.10	0.38	0.35	0.017	0.017	<0.004	0.008	455	1874	<1.0	10	10
	RPD (%)	NC	NC	0.7	3.5	NC	NC	7.4	1.4	14.5	8.5	3.0	NC	5.7	NC	0.0	2.8	0.0	0.0	NC	0.0	2.0	4.3	NC	0.0	0.0
L020324-006	RF-GW-RT 13	0.13	<0.10	1301	288	<0.0002	<0.0002	<2.0	80	3.7	3.4	28	<0.10	2.8	<0.10	<0.005	<0.005	<0.005	<0.005	0.012	0.014	1110	1784	1.4	0.030	0.037
L020324-007	RF-GW-RT 5013	0.1	<0.10	1280	284	<0.0002	<0.0002	<2.0	78	3.7	3.3	28	<0.10	2.7	<0.10	<0.005	<0.005	<0.005	<0.005	0.013	0.014	1205	1826	<1.0	0.034	<0.010
	RPD (%)	26.1	NC	1.4	1.4	NC	NC	NC	1.3	0.0	3.0	0.0	NC	3.6	NC	NC	NC	NC	NC	NC	NC	8.2	1.6	NC	13.7	NC
L020408-003	RF-GW-RT-11	<.10	<.10	885	187	<.20	<.20	<2.0	81	0.044	0.037	188	<.10	0.1	<.10	0.38	0.34	0.018	0.019	0.004	<.004	378	1771	<1.0	8.8	8.2
L020408-007	RF-GW-RT-5011	<.10	<.10	884	183	<.20	<.20	<2.0	80	0.043	0.037	188	<.10	<.10	<.10	0.38	0.34	0.018	0.017	<.004	<.004	373	1720	<1.0	8	8.2
	RPD (%)	NC	NC	0.1	2.1	NC	NC	NC	1.7	2.3	0.0	3.0	NC	NC	NC	0.0	0.0	0.0	11.1	NC	NC	1.0	2.8	NC	7.7	0.0
L020535-003	RF-GW-RT11	0.43	<0.10	688	212	<0.0007	<0.0002	9.3	48	0.039	0.037	150	<0.10	<0.10	<0.10	0.29	0.27	0.015	0.017	<0.004	<0.004	301	1484	<1.0	4.8	5.8
L020535-004	RF-GW-5011	<0.10	<0.10	754	215	<0.0007	<0.0007	8.8	51	0.043	0.037	154	<0.10	0.13	<0.10	0.3	0.28	0.015	0.017	<0.004	<0.004	338	1488	<1.0	4.8	5.7
	RPD (%)	NC	NC	7.8	1.4	NC	NC	28.8	6.1	9.8	0.0	2.8	NC	NC	NC	3.4	3.8	0.0	0.0	NC	NC	23.4	1.1	NC	0.0	1.8
L020817-002	RF-GW-RT-11	<0.10	<0.10	725.	211	<0.0002	<0.0002	2.2	50.	0.050	0.053	183	<0.10	<0.10	<0.10	0.19	0.19	0.015	0.014	<0.004	<0.004	350	1410	<1.0	8.7	6.3
L020817-008	RF-GW-RT-5011	<0.10	<0.10	534	213	<0.0002	<0.0002	2.4	50	0.057	0.057	183	<0.10	<0.10	<0.10	0.20	0.18	0.015	0.014	<0.004	<0.004	378	1418	<1.0	8.3	6.3
	RPD (%)	NC	NC	31.7	0.9	NC	NC	8.7	0.0	1.8	1.8	0.0	NC	NC	NC	5.1	0.0	0.0	0.0	NC	NC	7.1	0.7	NC	1.8	0.0

NC - Not Calculated

TABLE 17
RICHARDSON FLATS FIELD DUPLICATE RESULTS
SURFACE WATER

Lab #	Date	Sample #	AG	AG(D)	AL	AL(D)	ALK	AS	AS(D)	CA	CATI AN BAL	CD	CD(D)	CL-	CO3	COND.	CR	CR(D)	CU	CU(D)
		Units:	ppm	ppm	ppm	ppm	ppm CaCO3	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm CaCO3	umhos/cm2	ppm	ppm	ppm	ppm
L010443-004	4/4/01	RF-SW-RF4	<0.005	<0.005	0.48	0.089	137	0.008	0.008	66	<1.0	0.007	<0.001	68	<1.0	670	<0.01	<0.01	0.005	0.007
L010443-007	4/4/01	RF-SW-RF504	<0.005	<0.005	0.47	0.069	130	0.008	0.007	65	1.0	0.002	<0.001	71	<1.0	672	<0.01	<0.01	<0.005	<0.005
		RPD (%)	NC	NC	2.1	21.9	5.2	0.0	13.3	1.5		0.0	NC	4.3	NC	0.3	NC	NC	NC	NC
L010626-004	5/7/01	RF-SW-RF4	<.005	<.005	<.050	<.050	280	.006	<.005	200	-6.2	.001	<.001	83	<1	1385	<.010	<.010	.017	.019
L010626-007	5/7/01	RF-SW-RF504	<.005	<.005	.052	<.050	255	<.005	<.005	221	-3.0	.001	<.001	73	<1	1378	<.010	<.010	.018	.017
		RPD (%)	NC	NC	NC	NC	1.9	NC	NC	0.5		0.0	NC	12.8	NC	0.8	NC	NC	5.7	8.1
L010789-007	6/5/01	RF-SW-RF4	<.005	<.005	<.050	<.050	271	.008	.005	240	-2.2	.002	<.001	78	<1	1600	.049	<.010	<.005	<.005
L010789-008	6/5/01	RF-SW-RF504	<.005	<.005	<.050	<.050	274	.005	.005	241	-4.1	<.001	<.001	75	<1	1599	.047	<.010	<.005	<.005
		RPD (%)	NC	NC	NC	NC	1.4	48.2	0.0	2.1		NC	NC	5.2	NC	0.1	4.2	NC	NC	NC
L010993-005	7/9/01	RF-SW-RF4	<.005	<.005	.058	<.050	308	<.005	<.005	254	-4	<.001	<.001	88	<1	1739	<.010	<.010	<.005	<.005
L010993-009	7/9/01	RF-SW-RF504	<.005	<.005	<.050	<.050	308	<.005	<.005	285	<1.0	<.001	<.001	82	<1	1669	<.010	<.010	<.005	<.005
		RPD (%)	NC	NC	NC	NC	0.0	NC	NC	11.5		NC	NC	7.1	NC	4.1	NC	NC	NC	NC
L011153-009	8/7/01	RF-SW-RF505	<.005	<.005	<.050	<.050	288	<.005	<.005	314	-.14	<.001	<.001	67	<1	1982	<.010	<.010	.008	<.005
L011153-010	8/7/01	RF-SW-RF5	<.005	<.005	<.050	<.050	287	<.005	<.005	314	-1.0	<.001	<.001	74	<1	1980	<.010	<.010	<.005	<.005
		RPD (%)	NC	NC	NC	NC	0.3	NC	NC	0.0		NC	NC	9.9	NC	0.1	NC	NC	NC	NC
L011274-001	9/5/01	SW-RF-6-002	<0.005	<0.005	0.10	<0.050	245	<0.005	<0.005	342	-2.8	<0.00	<0.001	88	<1.0	2220	<0.010	<0.010	<0.005	<0.005
L011274-008	9/5/01	RF-SW-RF-6-2	<0.005	<0.005	0.067	<0.050	252	<0.005	<0.005	344	-3.8	<0.00	<0.001	88	<1.0	2190	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	39.5	NC	2.8	NC	NC	0.6		NC	NC	0.0	NC	1.4	NC	NC	NC	NC
L011407-003	10/9/01	RF-SW-RF6-2	<0.005	<0.005	<0.050	<0.050	225	<0.005	<0.005	404	6.7	<0.00	<0.001	88	<1.0	2290	<0.010	<0.010	<0.005	<0.005
L011407-004	10/9/01	RF-SW-RF6-50	<0.005	<0.005	<0.050	<0.050	226	<0.005	<0.005	397	6.5	<0.00	<0.020	93	<1.0	2300	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	NC	NC	0.4	NC	NC	1.7		NC	NC	5.8	NC	0.4	NC	NC	NC	NC
L011505-005	11/5/01	RF-SW-RF6-2	<0.005	<0.005	0.058	<0.050	207	<0.005	<0.005	387	-2.3	<0.00	<0.001	100	<1.0	2310	<0.010	<0.010	<0.005	<0.005
L011505-006	11/5/01	RF-SW-RF6-50	<0.005	<0.005	0.07	<0.050	224	0.008	<0.005	397	0.3	<0.00	<0.001	98	<1.0	2310	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	22.2	NC	7.9	NC	NC	2.6		NC	NC	2.0	NC	0.0	NC	NC	NC	NC
L011611-001	12/3/01	RF-SW-RF-6-2	<.005	<.005	<.050	<.050	217	<.005	<.005	395	-.75	<.001	<.001	100	<1	2340	<.010	<.010	.010	<.005
L011611-002	12/3/01	RF-SW-RF6-50	<.005	<.005	<.050	<.050	230	<.005	<.005	394	-1.1	<.001	<.001	98	<1	2350	<.010	<.010	<.005	<.005
		RPD (%)	NC	NC	NC	NC	8.4	NC	NC	0.5		NC	NC	2.0	NC	0.4	NC	NC	NC	NC
L020010-001	1/7/02	RF-SW-R6-2	<.005	<.005	<.050	<.050	274	<.005	<.005	384	5.4	<.001	<.001	75	<1	2200	<.010	<.010	<.005	<.005
L020010-004	1/7/02	RF-SW-R6-502	<.005	<.005	<.050	<.050	282	<.005	<.005	364	6.1	<.001	<.001	77	<1	2140	<.010	<.010	<.005	<.005
		RPD (%)	NC	NC	NC	NC	2.9	NC	NC	5.3		NC	NC	2.6	NC	2.8	NC	NC	NC	NC
L020050-003	2/4/02	RF-GW-RI-6-2	<0.005	<0.005	0.05	<0.050	309	<0.005	<0.005	371	3.8	<0.00	<0.001	84	<1.0	2250	<0.010	<0.010	<0.005	<0.005
L020050-004	2/4/02	RF-GW-RI-6-50	<0.005	<0.005	0.05	<0.050	300	<0.005	<0.005	378	2.1	<0.00	<0.001	78	<1.0	2200	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	0.0	NC	2.0	NC	NC	1.8		NC	NC	7.4	NC	2.2	NC	NC	NC	NC
L020160-005	3/5/02	RF-GW-RI-11	<0.005	<0.005	<0.050	<0.050	221	<0.005	0.007	214	-5.5	0.077	0.084	578	<1.0	2050	<0.010	<0.010	0.025	0.021
L020160-006	3/5/02	RF-GW-RI-501	<0.005	<0.005	<0.050	<0.050	225	<0.005	0.007	213	-5.3	0.077	0.083	571	<1.0	2070	<0.010	<0.010	0.025	0.022
		RPD (%)	NC	NC	NC	NC	1.8	NC	NC	0.5		0.0	1.2	1.2	NC	1.0	NC	NC	0.0	4.7
L020227-001	4/1/02	RF-SW-6-2	<0.005	<0.005	<0.050	<0.050	190	<0.005	<0.005	249	8.0	<0.00	<0.001	88	<1.0	1522	<0.010	<0.010	<0.005	<0.005
L020227-007	4/1/02	RF-SW-506-2	<0.005	<0.005	<0.050	<0.050	186	<0.005	<0.005	240	5.3	<0.00	<0.001	93	<1.0	1524	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	NC	NC	2.1	NC	NC	2.5		NC	NC	5.5	NC	0.1	NC	NC	NC	NC
L020265-004	4/16/02	RF-SW-RF4	<0.005	<0.005	0.078	<0.050	104	0.007	<0.005	174	0.5	0.001	<0.001	83	<1.0	1251	<0.010	<0.010	<0.005	<0.005
L020265-005	4/16/02	RF-SW-RF504	<0.005	<0.005	0.091	<0.050	228	0.007	<0.005	175	<1	0.001	<0.001	88	<1.0	1253	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	15.4	NC	73.8	0.0	NC	0.6		0.0	NC	5.8	NC	0.2	NC	NC	NC	NC
L020312-001	5/2/02	FPT-SW1			0.062	<0.050	142	<0.005	<0.005	149	<1	0.003	0.002	231	<1.0	1397			0.007	<0.005
L020312-002	5/2/02	FPT-SW501			0.061	<0.050	139	<0.005	<0.005	148	2.1	0.003	0.002	237	<1.0	1395			0.008	<0.005
		RPD (%)	NC	NC	1.6	NC	2.1	NC	NC	0.7		0.0	NC	2.6	NC	0.1	NC	NC	13.3	NC
L020324-015	5/8/02	RF-SW-RF 5	<0.005	<0.005	<0.050	<0.050	264	<0.005	<0.005	250	<1	<0.00	<0.001	97	<1.0	1560	<0.010	<0.010	<0.005	<0.005
L020324-020	5/8/02	RF-SW-RF 504	<0.005	<0.005	<0.050	<0.050	258	<0.005	<0.005	221	1.7	0.001	<0.001	108	<1.0	1458	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	NC	NC	2.3	NC	NC	12.5		NC	NC	10.7	NC	6.9	NC	NC	NC	NC
L020407-001	6/3/02	RF-SW-RF-6-2						<.005	<.005			<.001	<.001						<.005	<.005
L020407-002	6/3/02	RF-SW-RF-6-502						<.005	<.005			<.001	<.001						<.005	<.005
		RPD (%)	NC	NC	NC	NC	NC	NC	NC	NC		NC	NC	NC	NC	NC	NC	NC	NC	NC
L020535-008	7/9/02	RF-SW-RF 7-2	<0.005	<0.005	<0.050	<0.050	165	<0.005	0.005	136	1.2	0.002	0.001	182	<1.0	1239	<0.010	<0.010	0.005	<0.005
L020535-009	7/9/02	RF-SW-RF 507	<0.005	<0.005	<0.050	<0.050	163	0.006	0.005	142	2.7	0.002	0.001	183	<1.0	1226	<0.010	<0.010	<0.005	<0.005
		RPD (%)	NC	NC	NC	NC	1.2	NC	0.0	4.3		0.0	0.0	0.6	NC	0.3	NC	NC	NC	NC

Lab #	Sample #	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	MG	MN	MN(D)	NA	NH3-N	NO2/NO3	P	PB	PB(D)	SB	SB(D)	SE	SE(D)	SO4	TDS	TSS	ZN	ZN(D)
	Units:	ppm	ppm	ppm	ppm CaCO3	ppb	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
L010443-004	RF-SW-RF4	0.45	<0.10	226	137	0.24	0.20	2.8	15	0.25	0.24	37	0.30	<0.10	<0.1	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	101	466	10	0.66	0.61
L010443-007	RF-SW-RF504	0.50	<0.10	222	130	0.24	0.22	2.6	15	0.25	0.24	34	0.17	<0.10	<0.1	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	101	462	10	0.66	0.60
	RPD (%)	10.5	NC	1.8	5.2	0.0	9.5	7.4	0.0	0.0	0.0	8.5	55.3	NC	NC	NC	NC	NC	NC	NC	NC	0.0	0.9	0.0	0.0	1.7
L010626-004	RF-SW-RF4	<.1	<.1	877	280	<.2	<.2	<2	43	.44	.46	.38	.30	.14	<.1	<.005	.008	<.005	<.005	<.004	<.004	475	1082	19	.27	.29
L010626-007	RF-SW-RF504	.11	<.1	877	255	<.2	<.2	<2	43	.44	.45	.39	.27	.11	<.1	<.005	<.005	.006	<.005	<.004	<.004	479	1055	<1	.26	.25
	RPD (%)	NC	NC	0.0	1.9	NC	NC	NC	0.0	0.0	2.2	2.6	10.5	NC	NC	NC	NC	NC	NC	NC	NC	0.8	2.5	NC	3.8	3.9
L010789-007	RF-SW-RF4	.16	<.1	840	271	<.2	<.2	<2	55	.28	.29	.38	.51	.14	<.1	<.005	<.005	<.005	<.005	<.004	<.004	806	1316	<1	.15	.15
L010789-008	RF-SW-RF504	.40	<.1	824	276	<.2	<.2	<2	54	.28	.28	.37	.56	.14	<.1	<.005	<.005	<.005	<.005	<.004	<.004	826	1317	<1	.15	.14
	RPD (%)	85.7	NC	1.9	1.8	NC	NC	NC	1.8	0.0	3.5	9.3	0.0	NC	NC	NC	NC	NC	NC	2.2	0.1	3.2	0.0	6.8	0.0	0.9
L010993-005	RF-SW-RF4	<.1	<.1	874	308	<.2		<2	58	.31	.25	.40	.37	<.1	<.10	<.005	<.005	<.005	<.005	<.004	<.004	554	1397	<1	.11	.099
L010993-009	RF-SW-RF504	<.1	<.1	955	308	.48		<2	59	.33	.25	.38	<.10	<.1	<.10	<.005	<.005	<.005	<.005	<.004	<.004	550	1399	<1	.082	.075
	RPD (%)	NC	NC	8.8	0.0	NC		NC	1.7	6.3	0.0	5.1	NC	NC	NC	NC	NC	NC	NC	NC	NC	1.1	0.3	NC	29.2	26.3
L011153-009	RF-SW-RF505	<.1	<.1	1089	288	<.2		<2	74	.30	.32	.38	<.1	.12	<.1	<.005	<.005	.009	<.005	<.004	<.004	802	1554	3.2	.18	.20
L011153-010	RF-SW-RF5	.17	<.1	1082	287	<.2		<2	72	.32	.31	.38	<.1	.11	<.1	<.005	<.005	<.005	<.005	<.004	<.004	820	1630	2.2	.20	.19
	RPD (%)	NC	NC	0.6	0.3	NC		NC	2.7	6.5	3.2	2.6	NC	NC	NC	NC	NC	NC	NC	NC	NC	2.2	2.1	37.0	10.5	5.1
L011274-001	SW-RF-6-002	0.18	<0.10	1227	245	<0.2	<0.2	2.9	78	8.1	9.2	58	0.14	1.4	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	1059	1938	3.4	0.18	0.025
L011274-008	RF-SW-RF-6-2	<0.10	<0.10	1228	252	<0.2	<0.2	2.8	78	8.9	9.2	58	<0.10	0.22	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	1089	1964	4.0	0.12	0.023
	RPD (%)	NC	NC	0.1	2.8	NC		NC	0.0	9.4	0.0	0.0	NC	145.7	NC	NC	NC	NC	NC	NC	NC	2.8	1.4	15.2	40.0	12.2
L011407-003	RF-SW-RF6-2	0.13	0.098	1363	225	<0.20	<0.20	3.4	86	6.6	6.4	58	0.19	0.38	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	958	2029	<1.0	0.065	0.058
L011407-004	RF-SW-RF6-50	0.14	0.10	1337	226	<0.20	<0.20	3.2	84	6.5	6.4	58	0.20	0.20	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	947	2000	<1.0	0.066	0.054
	RPD (%)	7.4	NC	1.9	0.4	NC	NC	NC	2.4	1.5	0.0	0.0	NC	62.1	NC	NC	NC	NC	NC	NC	NC	NC	1.3	NC	1.5	0.9
L011505-005	RF-SW-RF6-2	0.3	<0.10	1335	207	<0.2	<0.2	4.1	92	3.5	3.8	55	<0.1	0.29	<10	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1170	2110	2.9	0.039	0.033
L011505-006	RF-SW-RF6-50	1.5	<0.10	1359	224	<0.2	<0.2	4.7	91	6	3.8	61	<0.1	0.26	<10	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	1170	2056	1.8	0.051	0.035
	RPD (%)	133.3	NC	2.1	7.9	NC	NC	13.6	1.1	52.6	0.0	10.3	NC	10.9	NC	NC	NC	NC	NC	NC	NC	0.0	2.6	46.8	26.7	5.9
L011611-001	RF-SW-RF-6-2	.45	<.10	1255	217	<.2	<.2	3.8	89	3.3	3.7	57	.82	.13	<.1	.010	<.005	<.005	<.005	<.004	<.004	1141	2054	2.8	.054	.044
L011611-002	RF-SW-RF6-50	.20	<.10	1251	236	<.2	<.2	3.7	89	3.7	3.7	55	.51	.13	<.1	<.005	<.005	<.005	<.005	<.004	<.004	1130	2068	2.1	.047	.042
	RPD (%)	76.9	NC	0.3	8.4	NC	NC	2.7	0.0	11.4	0.0	3.6	46.6	0.0	NC	NC	NC	NC	NC	NC	NC	1.0	0.7	21.3	13.0	4.7
L020010-001	RF-SW-R6-2	0.28	<.10	1309	274	2.99a	3.55a	3.9	85	9.5	9.7	50	0.95	0.2	<.1	<.005	<.005	<.005	<.005	<.004	<.004	908	1937	3	0.1	0.075
L020010-004	RF-SW-R6-502	0.18	<.10	645	282	<.2	<.2	3.8	79	9.7	9.3	48	0.97	0.2	<.1	<.005	<.005	<.005	<.005	<.004	<.004	801	1917	2.9	0.098	0.067
	RPD (%)	45.8	NC	67.0	2.9	NC	NC	2.6	7.3	2.1	4.2	4.1	NC	0.0	NC	NC	NC	NC	NC	NC	NC	12.5	1.0	3.4	2.0	11.3
L020050-003	RF-GW-RI-6-2	0.34	0.14	1248	306	0.000	<0.000	3.7	78	12	11	49	0.74	0.2	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	1053	1974	2	0.1	0.01
L020050-004	RF-GW-RI-6-50	0.26	0.15	1269	300	0.000	<0.000	3.8	78	12	11	51	0.81	0.28	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	1046	1997	1.4	0.098	0.011
	RPD (%)	26.7	6.9	1.7	2.0	NC	NC	2.7	1.3	0.0	0.0	4.0	9.0	33.3	NC	NC	NC	NC	NC	NC	NC	0.7	1.2	35.3	2.0	9.5
L020160-005	RF-GW-RI-11	<0.10	<0.10	755	221	0.000	<0.000	<2.0	54	0.057	0.054	115	<0.10	<0.10	<0.10	0.28	0.3	0.014	0.015	<0.004	0.004	392	1422	<1.0	7.8	7.8
L020160-006	RF-GW-RI-501	<0.10	<0.10	757	225	0.000	<0.000	<2.0	55	0.057	0.055	115	<0.10	<0.10	<0.10	0.29	0.3	0.014	0.015	<0.004	0.004	396	1409	<1.0	7.8	7.9
	RPD (%)	NC	NC	0.3	1.8	NC	NC	NC	1.8	0.0	1.8	0.0	NC	NC	NC	3.5	0.0	0.0	0.0	NC	0.0	1.0	0.9	NC	0.0	0.0
L020227-001	RF-SW-6-2	0.44	<0.10	812	190	0.000	<0.000	3.4	48	3.2	3.1	40	0.38	0.15	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	501	1212	3.9	0.19	0.055
L020227-007	RF-SW-506-2	0.41	<0.10	794	186	0.000	<0.000	3.9	48	3.2	3.1	38	0.40	0.18	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	488	1204	3.2	0.19	0.056
	RPD (%)	NC	NC	2.2	2.1	NC	NC	5.7	0.0	0.0	0.0	5.1	5.1	18.2	NC	NC	NC	NC	NC	NC	NC	2.6	0.7	19.7	0.0	0.0
L020265-004	RF-SW-RF4	0.44	<0.010	593	104	0.000	<0.000	2.3	39	1.9	1.5	40	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	361	914	4.7	1.1	0.81
L020265-005	RF-SW-RF504	0.53	0.019	597	228	0.000	<0.000	2.4	39	1.9	1.5	41	<0.10	<0.10	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	357	912	4.1	1.1	0.82
	RPD (%)	18.6	NC	0.7	73.8	NC	NC	4.3	0.0	0.0	0.0	2.5	NC	NC	NC	NC	NC	NC	NC	NC	NC	1.1	0.2	13.6	0.0	1.2
L020312-001	FPT-SW1	0.31	<0.10	498	142	0.000	<0.000	2.9	38	0.19	0.15	94	0.14	0.11		0.032	<0.005	0.008	0.007			257	899	3	0.75	0.65
L020312-002	FPT-SW501	0.3	<0.10	493	139	0.000	<0.000	2.7	38	0.18	0.15	92	<0.10	0.18		0.029	<0.005	0.007	0.007			259	894	3.3	0.73	0.67
	RPD (%)	3.3	NC	1.0	2.1	NC	NC	7.1	0.0	5.4	0.0	2.2	NC	48.3	NC	9.8	NC	13.3	0.0	NC	NC	4.4	0.6	9.5	2.7	3.0
L020324-015	RF-SW-RF 5	<0.10	<0.10	847	264	0.000	<0.000	<2.0	54	0.23	0.22	40	<0.10	<0.10	<0.10	<0.005	<0.005		<0.005	<0.005	<0.004	<0.00	543	1223	13	0.3
L020324-020	RF-SW-RF 504	0.24	<0.10	747	258	0.000	<0.000	<2.0	48	0.06	0.06	41	<0.10	0.1	<0.10	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	484	1113	2.7	1.4	1.2
	RPD (%)	NC	NC	12.5	2.3	NC	NC	NC	11.8	116.6	118.2	2.5	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	69.0	180.1	25.0	120.0
L020407-001	RF-SW-RF-6-2															0.008	<.005	<.005	<.005			681	1351	14	0.15	0.031
L020407-002	RF-SW-RF-6-502															<.005	<.005	<.005	<.005			680	1365	2.9	0.099	0.031
	RPD (%)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.1	1.0	80.0	61.0	0.0
L020535-008	RF-SW-RF 7-2	0.28	<0.10	514	165	0.000	<0.000	<2.0	42	0.38	0.37	54	<0.10	<0.10	0.18	0.005	<0.005	<0.005	<0.005	<0.004	<0.004	241	836	17	0.49	0.51
L020535-009	RF-SW-RF 507	0.28	<0.10	538	163	0.000	<0.000	<2.0	44	0.38	0.37	50	<0.10	<0.10	<0.10	0.005	<0.005	<0.005	<0.005	<0.004	<0.004	237	841	21	0.37	0.51
	RPD (%)	0.0	NC	4.2	1.2	NC	NC	NC	4.7	0.0	0.0	7.7	NC	NC	NC	18.2	NC	NC	NC	NC	NC	1.7	0.6	21.1	21.7	0.0

NC - Not Calculated

TABLE 18
RICHARDSON FLAT DATA QUALITY ASSESSMENT
COMPLETENESS SUMMARY

Media/Area	# Samples / Category	# Parameters / Sample	Total Number Data	Number of Invalid Data	Total Number of Valid Data
Background Samples (As, Pb)	17	2	34	0	34
Background Samples (All Metals)	2	10	500	0	500
Off-Site Samples (As, Pb)	45	2	4	0	4
Off-Site Samples (All Metals)	10	10	100	0	100
On-Site Soils Cover (As, Pb)	31	2	6	0	6
On-Site Soils Cover (All Metals)	10	10	100	0	100
On-Site Soils Cover (All Metals + Al, Fe)	11	12	109	0	109
Sediment	6	12	200	0	200
Tailings	18	12	67	0	67
Tailings South of Diversion Ditch	14	12	86	0	86
Groundwater (6/5/01)	4	41	1025	164	861
Groundwater (7/19/01)	4	41	1025	0	1025
Groundwater (8/7/01)	4	41	1025	0	1025
Groundwater (9/5/01)	3	41	1367	0	1367
Groundwater (10/8/01)	4	41	1025	0	1025
Groundwater (11/5/01)	4	41	1025	0	1025
Groundwater (12/3/01)	4	41	1025	0	1025
Groundwater (1/7/02)	4	41	1025	0	1025
Groundwater (2/4/02)	4	41	1025	0	1025
Groundwater (3/5/02)	4	41	1025	0	1025
Groundwater (4/1/01)	6	41	683	0	683
Groundwater (5/2/02)	2	41	2050	0	2050
Groundwater (5/6/02)	5	41	820	0	820
Groundwater (6/3/02)	4	41	1025	0	1025
Groundwater (7/9/02)	4	41	1025	0	1025
Groundwater (8/6/02)	3	41	1367	0	1367
Surface Water (4/4/01)	8	41	513	0	513
Surface Water (5/7/01)	8	41	513	0	513
Surface Water (6/5/01)	7	41	586	0	586
Surface Water (7/9/01)	5	41	820	0	820
Surface Water (8/7/01)	4	41	1025	0	1025
Surface Water (9/5/01)	4	41	1025	0	1025
Surface Water (10/8/01)	3	41	1367	0	1367
Surface Water (11/5/01)	3	41	1367	0	1367
Surface Water (12/3/01)	3	41	1367	0	1367
Surface Water (1/7/02)	3	41	1367	0	1367
Surface Water (2/4/02)	2	41	2050	0	2050
Surface Water (3/5/02)	3	41	1367	0	1367
Surface Water (4/1/01)	3	41	1367	0	1367
Surface Water (4/16/01)	8	41	513	0	513
Surface Water (5/2/02)	7	41	586	0	586
Surface Water (5/6/02)	7	41	586	0	586
Surface Water (6/3/02)	5	41	820	0	820
Surface Water (7/9/02)	3	41	1367	0	1367
Surface Water (8/6/02)	1	41	4100	0	4100
			41469	164	41305
				Total Completeness (%)	**99.6**

ECOLOGICAL DATA QUALITY ASSESSMENT – PHASE I AND II

Richardson Flat Tailings Site
Focused Remedial Investigation

INTRODUCTION

This report presents the results of the data quality assessment of analytical data for samples collected between June 3, 2003 and June 5, 2003 (Phase I) and August 18, 2003 and August 21, 2003 (Phase II) for the Focused Remedial Investigation at the Richardson Flat Tailings Site near Park City, Utah. The sampling activities followed the *Sampling and Analysis Plan for the Determination of The Nature and Effects of Heavy Metals Within The Wetland and Pond Areas at Richardson Flat (SAP)* (Resource Management Consultants (RMC), May 13, 2003).

The data quality assessment process evaluates whether the specific requirements for an intended use have been fulfilled and ensures that the results conform to the user's needs. This report summarizes the review of sampling and analysis to assess conformance with QC requirements for this project. This data evaluation is presented in terms of the PARCC criteria and is based on the *U.S. EPA Functional Guidelines for Inorganic Data Review* (U.S. EPA, 1994), *Guidance for the Data Quality Assessment Process* (EPA QA/G-9), and on the quality control limits established by the analytical laboratory or as specified by the specific analytical method. The analytical results were evaluated against data quality objectives (DQOs), which are quantitative and qualitative statements that specify data quality and are expressed in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC). Table 4.1 of the SAP presents the data validation and verification requirements for this project. Tables 5.0 and 8.0 of the SAP describe the DQOs and QA/QC goals for this project.

As stated in the SAP, sampling occurred in two phases. Phase I consisted of sediment and surface water sampling. Phase II consisted of biological sample collection such as sediment toxicity, sediment pore water, plants, macroinvertebrates, and fish. Based on the Phase I results, additional sediment and surface water samples were also collected. American Environmental Consultants (AEC) Laboratory in Salt Lake City performed the analyses.

Discussion of analytical results in this report will be grouped by media and site area into the following categories:

- Sediment
- Surface Water
- Pore Water
- Vegetation
- Fish
- Macroinvertebrates (bugs, snails).

As specified in Table 5.0 of the SAP, data were assessed according to the following steps:

1. Were samples collected according to established locations and frequencies?
2. Were samples collected and handled following established procedures?
3. Were appropriate analytical methods used?
4. Were holding times and laboratory reporting limits met?

5. Did field duplicate results meet acceptance criteria?
6. Did field QC samples (field blanks, equipment/rinsate blanks) meet acceptance criteria?
7. Did laboratory QC samples (method blanks, laboratory control samples (LCS), matrix spike (MS) and matrix spike duplicate (MSD) samples, cation/anion balance for water samples) meet acceptance criteria?
8. Were appropriate steps taken to ensure the accuracy of data reduction, including reducing data transfer errors in the preparation of summary data tables and maps.

The following sections of this report summarize the data validation results following the list of data validation and verification steps listed above. The final section of this report summarizes the data validation results in terms of PARCC criteria, including completeness calculations expressing the percent complete of valid data compared to the total number of samples collected. This section also makes recommendations for alterations to the sampling and analysis program to improve data collection and analytical protocols in the event additional sampling is conducted.

Tables 1 through 6 summarize the samples collected, sample dates, parameters analyzed, and laboratory sample numbers and related laboratory QC batch numbers. Tables 7 through 13 summarize the Relative Percent Difference (RPD) between normal and field duplicate samples collected. The laboratory analytical reports, including the laboratory quality control data, are provided in Appendix 5 of the Focused RI Report.

SAMPLING LOCATIONS AND FREQUENCIES

Samples were generally collected at the locations and frequencies specified in the SAP. For some media, the number of samples collected exceeded the numbers specified in the SAP.

Sediment

Sediment samples were collected at a depth of 0 to 10 centimeters at the 20 locations for Phase I as specified in the SAP. Thirteen additional sediment samples were collected during Phase II. Phase I and Phase II sampling events occurred in June 2003 and August 2003, respectively. All of the samples were analyzed for the complete list of metals (Ag, Al, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Pb, Sb, Se, Tl, V, Zn) plus total phosphorus, Total Organic Carbon (TOC), and moisture content.

Surface Water

Two rounds of surface water samples (June 2003 and August 2003) were collected from the wetland and pond areas as specified in the SAP. Six samples from different locations during Phase I and 8 samples as part of Phase II were collected. Samples were collected from locations RF-13, RF-17, RF-18, and RF-20 during both phases. All of the samples were analyzed for the complete list of parameters specified in Table 4.1 of the SAP.

Pore Water

During Phase II, sediment pore water samples were collected using a micro-push point at locations specified after the nature and extent sampling (Phase I) was complete. Sample locations were based on results from the contaminated sediment and surface water analyses. Fourteen pore water samples were collected and analyzed for parameters specified in Table 4.1 of the SAP.

Vegetation

During Phase II, plant tissue samples were collected from 19 locations similar to sediment and surface water sample locations. The plant tissue was analyzed for metals (Ag, Al, As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Se, Tl, V, Zn) and moisture content.

Fish

Fish tissue samples were collected from the pond area during Phase II. The SAP stated that samples would also be collected from the wetland area and two stations at the reference sites. Only two composite fish samples were collected from the pond. The fish tissue was analyzed for metals (Ag, Al, As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Se, Tl, V, Zn) and moisture content.

Bugs

During Phase II, eight benthic macroinvertebrate samples were collected from the on-site pond and wetland and reference station. The tissue samples were analyzed for metals (Ag, Al, As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Se, Tl, V, Zn) and moisture content.

SAMPLE COLLECTION AND HANDLING

With few exceptions, samples were collected and handled in accordance with the procedures described in the SAP. Sample collection and handling procedures were documented in field notes and chain-of-custody/laboratory request forms.

All samples received by AEC Laboratory were delivered to the laboratory to allow for timely analysis and within the required temperature range.

Several problems surfaced during the review of the calculated relative percent differences (RPD) of the field duplicates. The calculated RPD for several parameters exceeded the acceptance criteria for all media. For the most part, the high RPDs were limited to the Phase I sediment samples and Phase II vegetation, fish tissue, and macroinvertebrate tissue samples. A detailed discussion is provided in the *Field Duplicate Samples* section below. The high calculated RPD may be a result of the heterogeneous nature of the sampled media and difficulty splitting samples.

ANALYTICAL METHODS

The EPA-approved analytical methods listed in Table 4.1 of the SAP were used in most cases. Exceptions are noted below.

The laboratory performed internal laboratory calibration checks according to the method-specified protocols. Case narratives were compiled in the analyst's logbook, in digestion logs, and as raw data. Except for the cases noted below, all required analytical methods specified in the SAP were run.

Sediment

For sediment samples, EPA Method 6010B was used rather than the experimental Hydride AA for antimony analysis in both Phase I and Phase II sampling events. The

same laboratory reporting limit of 0.05 ppm was achieved using EPA Method 6010B. EPA Method 6010B is an approved method while Hydride AA is an experimental method and is not an approved method.

Surface Water/Pore Water

For surface water and pore water samples, EPA Method 200.7 was used rather than 6010B or 200.8 for B, Ba, Be and Method 6010B replaced 6020 for metal analysis. Both are approved EPA methods.

Fish Tissue/Macroinvertebrates

EPA Method 6010B replaced Hydride AA for antimony analysis in fish tissue and macroinvertebrate tissue samples. As stated above, EPA Method 6010B is an approved method for antimony analysis and the laboratory was able to achieve the desired reporting limit of 0.05 ppm listed in the SAP.

HOLDING TIMES AND LABORATORY REPORTING LIMITS

Holding time reflects the length of time after sample collection that a sample or extract remains representative of environmental conditions. Holding times were compared to standard method-specific holding times accepted by the EPA as listed in Table 4.1 of the SAP. Data for samples that were extracted and analyzed within holding time criteria are considered representative. For samples that were extracted or analyzed outside of holding criteria, the sample data are qualitatively evaluated to determine the potential effect of the holding time violation on sample representativeness. Almost all holding times were met for the analytical parameters.

After comparison of holding times with those stated in Table 4.1 of the SAP, a few exceedances occurred during Phase II sampling event. For surface water samples, the laboratory stated that the CR(VI) holding time of 1 day was exceeded by one month, but it was later determined through a conversation with the laboratory coordinator, Vincent Keller, that this was a transcript error in the report. The laboratory will issue a revised laboratory report indicating the holding time was not exceeded.

Mercury analysis for the vegetation samples took 42 days to analyze, exceeding the 28-day holding time. The sample was collected on 8/19/2003 and digested on 9/25/2003 then analyzed on 9/30/2003. The date digestion occurred still exceeds the allowable holding time by 9 days. The laboratory neglected to flag these data as "may be subject to bias." The mercury data will be rejected based on the exceeded holding time.

For Phase II sediment analysis, the laboratory pH reading was taken within 46 days exceeding the 28 days allowed. It is assumed that the pH is stable and would not have changed during the extended holding time; therefore the sediment data are acceptable. In the same sampling event, the total sulfides analysis for sediments was reported as 10 days after the allowable holding time. After discussion with Vincent Keller, the date reported is the actual analysis date rather than the capture date. The sulfides were precipitated from the sediment sample and captured in a stable state within the 7-day allowable holding time; therefore the data are acceptable.

The reporting limits reported by the laboratory were different than those specified in the SAP (Table 4.1) in some cases. The quality control reporting limits stated in the analytical data report from American Environmental Consultants varied for several parameters. Differences are summarized below for each media. Although stated reporting

limits were greater than those listed in the SAP, in most cases, parameters were detected at concentrations considerably higher than AEC reporting limits; therefore it is not an issue.

Phase	Parameter	SAP Table 4.1 Limit (ppm)	AEC Reporting Limit (ppm)
Sediments			
Phase I	As	0.5	1
Phase II	As	0.5	5
Phase II	Ag	0.05	1.0
Phase II	Be	0.1	0.2
Phase I	Fe	4	6
Phase I	Mn	0.05	3
Phase II	Mn	0.05	0.5
Phase I	Ni	2.5	3
Phase I	Pb	0.05	1
Phase II	Pb	0.05	0.5
Phase I	Sb	0.05	2
Phase II	Sb	0.05	2.5
Phase II	Se	0.05	10
Phase I	V	2.5	3
Phase I	Zn	0.05	3
Surface Water			
Phase I & Phase II	ALK, CO3, HCO3	1.0	2.0
Phase I	KJEL-N	0.1	0.5
Phase I	TOC	0.5	1.0
Phase II	Ca	2.0	1.0
Phase II	Mn	2.0	1.0
Pore Water			
Phase I & Phase II	ALK, CO3, HCO3	1.0	2.0
Phase II	Ca	2.0	1.0
Phase II	Mn	2.0	1.0
Vegetation			
Phase II	Ag	0.02	1.0
Phase II	Cr	0.02	0.5
Fish			
Phase II	Ag	0.02	0.1
Phase II	Al	1.0	10
Phase II	Fe	0.5	5.0
Macroinvertebrates			
Phase II	Ag	0.02	1.0
Phase II	Al	1.0	20
Phase II	Cr	0.2	0.5
Phase II	Cu	0.1	0.2
Phase II	Fe	0.5	10

FIELD DUPLICATE SAMPLES

Blind field duplicates were collected during both Phase I and Phase II sampling events. No split samples were collected by UDEQ or EPA. As stated in the SAP, the frequency of duplicate collection was one sample for every ten normal samples. Table 7 summarizes the calculated field duplicate frequency for all media. All frequencies exceeded 10 percent except the vegetation samples, which was only 5 percent. Nineteen plant tissue samples were collected with one field duplicate.

Overall the field duplicate results were good. However, some of the calculated relative percent differences (RPDs) exceeded acceptance criteria. For the most part, the high RPDs were limited to the Phase I sediment samples in which more than 6 to 7 parameters exceeded 35 percent for both duplicates. Phase II sediment samples showed improvement with only 3 to 4 parameters exceeding 35 percent. The calculated RPDs for surface water were excellent with only Kjeldahl N and Total Suspended Solids (TSS) exceeding criteria at 56 and 44 percent, respectively. The calculated RPDs for pore water also had minimal exceedances for both duplicate samples. However, calculated RPDs for vegetation, fish tissue, and macroinvertebrates exceeded criteria for several parameters. The SAP indicates that the acceptance criteria of less than 35 percent only applies to soil, water, and sediments.

Tables 8 to 13 summarize the relative percent difference (RPD) calculations for the duplicates collected for each media or sampling area. Duplicate results that exceed the QA/QC goal of 35 percent (if > 5 times LRL) or +/- LRL (if < 5 times LRL) are noted in bold.

FIELD QC SAMPLES

No field QC blanks were collected during this project. Because disposable or dedicated equipment was used at all sampling locations, no equipment/rinsate blanks were required.

LABORATORY QC SAMPLES

AEC Laboratory analyzed matrix spike/matrix spike duplicate, method (prep) blank, and laboratory control samples for each sample batch to evaluate data quality. The frequency of MS/MSD samples met the goal of five percent specified in the SAP.

Laboratory Control Samples. Laboratory control samples were analyzed for each laboratory sample batch. All of the recoveries for the laboratory control samples were within method-specified control limits with two minor discrepancies. As noted on the analytical report, the LCS recoveries for Ag and Se in the sediment and macroinvertebrate tissue samples were outside the recovery limits of 75 to 125 percent. The recovery of Ag in the one sediment sample was 64%. The recovery of Se in one macroinvertebrate tissue sample was 66%.

Matrix Spike Samples. A matrix spike sample was analyzed for each laboratory sample batch by AEC Laboratory. Spike recoveries for matrix spike samples were within method-specified control limits with the following exceptions:

Sediments: The matrix spike recovery results of 136% for Ba and 69% for Sb in the Phase I LCS sample were outside the acceptance limits of 75 to 125 percent. For Phase II, both Ba and Sb recovery results were again slightly outside the limits with recoveries of 73% and 70%, respectively. The laboratory RPD for Phase I MS/MSDs exceeded acceptance criteria for Cu with 39%.

Vegetation: The matrix spike recovery results of 134% for As and 136% for Se were outside the acceptance limits of 75 to 125 percent.

Macroinvertebrates: The matrix spike recovery results for As, Fe, Se, and Tl were outside the acceptance limits (59%, 143%, 70%, and 72%, respectively). The laboratory RPD for MS/MSDs exceeded acceptance criteria for Fe with 46.3%.

Although there were minor exceedances of laboratory control samples acceptance criteria and MS/MSD control limits in few cases, data can be considered acceptable and considered representative of site conditions.

Method (Prep) Blanks. A method or prep blank sample was analyzed for each laboratory sample batch. No analytes were detected in any of the method blanks analyzed by AEC Laboratories indicating that no laboratory contamination was present.

Cation/Anion Balance

AEC Laboratory calculated cation/anion balances for all water samples where List 3 parameters were analyzed. The cation/anion balances for these samples are all within +/- 10 percent with the exception of one pore water sample on 8/18/03, which had a balance of 11 percent. These results indicate that the major ion data can be used with a high degree of confidence.

DATA REDUCTION

For the purposes of developing a database and preparing summary tables for reports, all laboratory data were transferred from the laboratory in electronic form.

DATA VALIDATION SUMMARY

This section summarizes the data validation results in terms of PARCC (Precision, Accuracy, Representativeness, Comparability, and Completeness) criteria, including completeness calculations expressing the percent complete of valid data compared to the total number of samples collected. These results are then compared to the project QA/QC goals (Table 3 of SAP). Table 14 provides a completeness summary.

PARCC Criteria Summary

Precision. Based on the results of the field duplicates, laboratory duplicates, and matrix spike/matrix spike duplicate results, data are precise. The available data along with other measurements of precision indicate that the data can be used with a high degree of confidence.

Accuracy. Based on the percent recoveries of the MS/MSD and laboratory control samples, the data can be considered accurate with the exception of mercury analysis for vegetation samples, which exceeded holding times. The data can be used with a high degree of confidence. The mercury data for vegetation samples should be flagged as estimated values, "which may be subject to bias."

Representativeness. Based on the results of the holding time review, method blank data, and blind field duplicate sample data evaluation, with the exception of mercury for vegetation samples, can be considered representative of conditions at the site.

Comparability. Standard methods of sample collection and standard units of measure were used during this project. The analyses performed by the laboratory were in accordance with current SW-846 and other U.S. EPA methodology.

Completeness. Based on the results of the data validation, all data are considered valid without qualification except: mercury data for vegetation samples, which should be considered as order-of-magnitude estimates.

TABLE 1
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
SEDIMENT

Lab #	QA Batch #	Date	Sample #	*Parameters	Comments
L030255-001	WG030262	06/04/03	RFB-SED-SD01	See Below (plus KJEL-N)	
L030255-002	WG030262	06/04/03	RFB-SED-SD02	See Below (plus KJEL-N)	
L030255-003	WG030262	06/04/03	RFB-SED-SD03	See Below (plus KJEL-N)	
L030255-004	WG030262	06/04/03	RFB-SED-SD04	See Below (plus KJEL-N)	
L030255-005	WG030262	06/04/03	RFB-SED-SD05	See Below (plus KJEL-N)	
L030255-006	WG030262	06/04/03	RFB-SED-SD504	See Below (plus KJEL-N)	DUP RFB-SED-SD04
L030255-007	WG030262	06/04/03	RFB-SED-SD06	See Below (plus KJEL-N)	
L030255-008	WG030262	06/04/03	RFB-SED-SD07	See Below (plus KJEL-N)	
L030255-009	WG030262	06/04/03	RFB-SED-SD08	See Below (plus KJEL-N)	
L030255-010	WG030262	06/05/03	RFB-SED-SD20	See Below (plus KJEL-N)	
L030255-011	WG030262	06/05/03	RFB-SED-SD19	See Below (plus KJEL-N)	
L030255-012	WG030262	06/05/03	RFB-SED-SD5019	See Below (plus KJEL-N)	DUP RFB-SED-SD19
L030255-013	WG030262	06/05/03	RFB-SED-SD18	See Below (plus KJEL-N)	
L030255-014	WG030262	06/05/03	RFB-SED-SD11	See Below (plus KJEL-N)	
L030255-015	WG030262	06/05/03	RFB-SED-SD12	See Below (plus KJEL-N)	
L030255-016	WG030262	06/05/03	RFB-SED-SD09	See Below (plus KJEL-N)	
L030255-017	WG030262	06/05/03	RFB-SED-SD10	See Below (plus KJEL-N)	
L030255-018	WG030262	06/05/03	RFB-SED-SD13	See Below (plus KJEL-N)	
L030255-019	WG030262	06/05/03	RFB-SED-SD14	See Below (plus KJEL-N)	
L030255-020	WG030262	06/05/03	RFB-SED-SD16	See Below (plus KJEL-N)	
L030255-021	WG030262	06/05/03	RFB-SED-SD15	See Below (plus KJEL-N)	
L030255-022	WG030262	06/05/03	RFB-SED-SD17	See Below (plus KJEL-N)	
L030440-001	WG030417	08/18/03	RFB-SD-SD-4	See Below	
L030440-002	WG030417	08/18/03	RFB-SD-SD-2	See Below	
L030440-003	WG030417	08/18/03	RFB-SD-SD-6	See Below	
L030440-004	WG030417	08/19/03	RFB-SD-SD-11	See Below	
L030440-005	WG030417	08/19/03	RFB-SD-SD-10	See Below	
L030440-006	WG030417	08/19/03	RFB-SD-SD-5011	See Below	DUP RFB-SD-SD-11
L030440-007	WG030417	08/19/03	RFB-SD-REF-POND	See Below	

TABLE 1
RICHARDSON FLAT SOIL DATA QUALITY ASSESSMENT
SEDIMENT

Lab #	QA Batch #	Date	Sample #	*Parameters	Comments
L030440-008	WG030417	08/19/03	RFB-SDW-REF	See Below	
L030440-009	WG030417	08/19/03	RFB-SD-REF01	See Below	
L030440-010	WG030417	08/20/03	RFB-SD-SD-14	See Below	
L030440-011	WG030417	08/20/03	RFB-SD-SD-15	See Below	
L030440-012	WG030417	08/20/03	RFB-SD-SD-17	See Below	
L030440-013	WG030417	08/20/03	RFB-SD-SD-18	See Below	
L030440-014	WG030417	08/21/03	RFB-SD-SD-20	See Below	
L030440-015	WG030417	08/21/03	RFB-SD-SD-5020	See Below	DUP RFB-SD-SD-20
Notes: *Parameters: Ag, Al, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Hg, Mn, Moist, Ni, P, Pb, pH, PSD, S, Sb, Se, Tl, TOC, V, Zn					

TABLE 2
RICHARDSON FLAT DATA QUALITY ASSESSMENT
SURFACE WATER

Lab #	QA Batch #	Date	Sample #	*Parameters	Comments
L030246-001	WG030247	6/3/03	RFB-SW-SD4	See Below	
L030246-002	WG030247	6/3/03	RFB-SW-SD7	See Below	
L030246-003	WG030247	6/3/03	RFB-SW-SD13	See Below	
L030246-004	WG030247	6/3/03	RFB-SW-SD17	See Below	
L030246-005	WG030247	6/3/03	RFB-SW-SD18	See Below	
L030246-006	WG030247	6/3/03	RFB-SW-SD5018	See Below	DUP RFB-SW-SD18
L030246-007	WG030247	6/3/03	RFB-SW-SD20	See Below	
L030439-001	WG030471	8/18/03	RFB-SW-SD-20	See Below	
L030439-002	WG030471	8/18/03	RFB-SW-SD-18	See Below	
L030439-003	WG030471	8/18/03	RFB-SW-SD-13	See Below	
L030439-004	WG030471	8/18/03	RFB-SW-SD-5013	See Below	DUP RFB-SW-SD-13
L030439-005	WG030471	8/18/03	RFB-SW-SD-17	See Below	
L030439-006	WG030471	8/18/03	RFB-RN-1	See Below	
L030439-007	WG030471	8/19/03	RFB-SWW-REF	See Below	
L030439-008	WG030471	8/19/03	RFB-SWP-REF	See Below	
L030439-009	WG030471	8/19/03	RFB-SW-RN-2	See Below	
Note: *Parameters: Ag,Ag(D),Al,Al(D),ALK,As,As(D),B, B(D), Ba,Ba(D),Be,Be(D),Ca,CAT/AN BAL,Cd,Cd(D),Cl,Cn,Co,Co(D),CO3,COND,Cr,Cr(D),Cr+6(D)					
Cu,Cu(D),Fe,Fe(D),Hardness,HCO3,Hg,Hg(D),K(D),KJEL-N,Mg(D),Mn,Mn(D),Na(D),NH3/N,NO2/NO3,P,Pb,Pb(D),pH,Sb,Sb(D),Se,Se(D),SO4,					

TABLE 3
RICHARDSON FLAT QUALITY DATA ASSESSMENT
PORE WATER

Lab #	QA Batch #	Date	Sample #	*Parameters	Comments
L030438-001	WG030471	8/18/03	RFB-PW-SD-2	See Below	
L030438-002	WG030471	8/18/03	RFB-PW-SD-6	See Below	
L030438-003	WG030471	8/18/03	RFB-PW-SD-4	See Below	
L030438-004	WG030471	8/19/03	RFB-PW-SD-11	See Below	
L030438-005	WG030471	8/19/03	RFB-PW-SD-10	See Below	
L030438-006	WG030471	8/19/03	RFB-PW-REF-POND	See Below	
L030438-007	WG030471	8/19/03	RFB-PW-SD-5010	See Below	DUP RFB-PW-SD-10
L030438-008	WG030471	8/19/03	RFB-PW-RF-WET	See Below	
L030438-009	WG030471	8/20/03	RFB-PW-SD-14	See Below	
L030438-010	WG030471	8/20/03	RFB-PW-SD-15	See Below	
L030438-011	WG030471	8/20/03	RFB-PW-SD-17	See Below	
L030438-012	WG030471	8/20/03	RFB-PW-SD-18	See Below	
L030438-013	WG030471	8/20/03	RFB-RN-3	See Below	
L030438-014	WG030471	8/21/03	RFB-PW-SD-20	See Below	
L030438-015	WG030471	8/21/03	RFB-PW-SD-5020	See Below	DUP RFB-PW-SD-20
L030438-016	WG030471	8/21/03	RFB-RN4	See Below	

Note: *Parameters: Ag,Ag(D),Al,Al(D),ALK,As,As(D),B, B(D), Ba,Ba(D),Be,Be(D),Ca,CAT/AN BAL,Cd,Cd(D),Cl,Cn,Co,Co(D),CO3,COND,Cr,Cr(D),Cr+6(D), Cu,Cu(D),Fe,Fe(D),Hardness,HCO3,Hg,Hg(D),K(D),KJEL-N,Mg(D),Mn,Mn(D),Na(D),NH3/N,NO2/NO3,P,Pb,Pb(D),pH,S,Sb,Sb(D),Se,Se(D),SO4, TDS,TOC,TSS,Zn,Zn(D)

TABLE 4
RICHARDSON FLAT QUALITY DATA ASSESSMENT
VEGETATION

Lab #	QA Batch #	Date	Sample #	*Parameters	Comments
L030450-001	WG030453	08/19/03	RFB-VEG-SD-2	See Below	
L030450-002	WG030453	08/19/03	RFB-VEG-SD-502	See Below	DUP RFB-VEG-SD-2
L030450-003	WG030453	08/19/03	RFB-VEG-REF-01	See Below	
L030450-004	WG030453	08/19/03	RFB-VEG-REF-02	See Below	
L030450-005	WG030453	08/19/03	RFB-VEG-REF-05	See Below	
L030450-006	WG030453	08/19/03	RFB-VEG-SD-03	See Below	
L030450-007	WG030453	08/19/03	RFB-VEG-REF-04	See Below	
L030450-008	WG030453	08/20/03	RFB-VEG-SD-4	See Below	
L030450-009	WG030453	08/20/03	RFB-VEG-SD-6	See Below	
L030450-010	WG030453	08/20/03	RFB-VEG-SD-10	See Below	
L030450-011	WG030453	08/20/03	RFB-VEG-SD-11	See Below	
L030450-012	WG030453	08/20/03	RFB-VEG-SD-14	See Below	
L030450-013	WG030453	08/20/03	RFB-VEG-SD-15	See Below	
L030450-014	WG030453	08/20/03	RFB-VEG-17-01	See Below	
L030450-015	WG030453	08/20/03	RFB-VEG-17-02	See Below	
L030450-016	WG030453	08/21/03	RFB-VEG-SD-19	See Below	
L030450-017	WG030453	08/21/03	RFB-VEG-SD-20	See Below	
L030450-018	WG030453	08/21/03	RFB-VEG-POND-01	See Below	
L030450-019	WG030453	08/21/03	RFB-VEG-POND-02	See Below	
L030450-020	WG030453	08/21/03	RFB-VEG-POND-03	See Below	

Notes: *Parameters: Ag, Al, As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Mn, Moist, Ni, Pb, Sb, Se, Tl, V, Zn

TABLE 5
RICHARDSON FLAT QUALITY DATA ASSESSMENT
FISH

Lab #	QA Batch #	Date	Sample #	*Parameters	Comments
L030441-001	WG-30418	08/18/03	RFB-FI-POND-1	See Below	
L030441-002	WG-30418	08/18/03	RFB-FI-POND-2	See Below	
L030441-003	WG-30418	08/18/03	RFB-FI-POND-5001	See Below	DUP RFB-FI-POND-1

Notes: *Parameters: Ag, Al, As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Mn, Moist, Ni, Pb, Sb, Se, Tl, V, Zn

TABLE 6
RICHARDSON FLAT QUALITY DATA ASSESSMENT
MACROINVERTEBRATES

Lab #	QA Batch #	Date	Sample #	*Parameters	Comments
L030451-001	WG030424	08/18/03	RFB-BM1-WETLAND-01	See Below	
L030451-002	WG030424	08/19/03	RFB-BM1-REF-POND	See Below	
L030451-003	WG030424	08/19/03	RFB-BM1-WETLAND-02	See Below	
L030451-004	WG030424	08/19/03	RFB-BM1-REF-WETLAND	See Below	
L030451-005	WG030424	08/21/03	RFB-BM1-POND-01	See Below	
L030451-006	WG030424	08/21/03	RFB-BM1-POND-5001	See Below	DUP RFB-SNAIL-POND-01
L030451-007	WG030424	08/21/03	RFB-SNAIL-POND-01	See Below	
L030451-008	WG030424	08/21/03	RFB-SNAIL-POND-5001	See Below	DUP RFB-SNAIL-POND-01
L030451-009	WG030424	08/19/03	RFB-SNAIL-WETLAND-01	See Below	
L030451-010	WG030424	08/19/03	RFB-SNAIL-REF	See Below	

Notes: *Parameters: Ag, Al, As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Mn, Moist, Ni, Pb, Sb, Se, Tl, V, Zn

TABLE 7
RICHARDSON FLAT DATA QUALITY ASSESSMENT
FIELD DUPLICATE FREQUENCY

Media/Area	# Samples	# Dups	Frequency (%)
Sediment (6/2003)	20	2	10.0
Sediment (8/2003)	13	2	15.4
Sediments (Combined)	*33*	*4*	*12.1*
Surface Water (6/2003)	6	1	16.7
Surface Water (8/2003)	8	1	12.5
Surface Water (Combined)	*14*	*2*	*14.3*
Pore Water (8/2003)	14	2	14.3
Vegetation (8/2003)	19	1	5.3
Fish Tissue (8/2003)	2	1	50.0
Macroinvertebrate/bugs (8/2003)	8	2	25.0

TABLE 8
RICHARDSON FLAT FIELD DUPLICATE RESULTS
SEDIMENT

Lab #	Date*	Sample #	AG	AL	AS	BA	BE	CD	CO	CR	CU	FE	HG	KJEL/N	MN	MOIST.	NI	P	PB	PH	S=	SB	SE	TL	TOC	V	ZN
L030255-004	Jun-03	RFB-SED-SD04	56.5	15100	356	208	0.5	58	17	44	563	36000	3.62	3000	3730	58.4	29	2300	5280	6.5	324	72	8	11		27	9340
L030255-008	Jun-03	RFB-SED-SD504	56	15600	235	274	0.5	36	10	27	416	37200	3.2	4000	3900	59.1	18	2200	3360	6.6	32	73	8	11		20	9720
		RPD (%)	0.9	3.3		27.4	0.0				30.0	3.3	12.3	28.6	4.5	1.2		4.4		1.5		1.4	0.0	0.0		29.8	4.0
L030255-011	Jun-03	RFB-SED-SD19	10.6	12000	50	128	0.3	8.1	9	25	126	16800	0.78	4300	625	66.9	14	1800	1170	7	680	28	4.9	3.7		16	2430
L030255-012	Jun-03	RFB-SED-SD5019	10	12300	59	119	0.3	12	12	42	181	24100	1.18	4500	818	56.9	22	1800	1520	6.8	734	23	4.9	<2.5		19	2370
		RPD (%)	5.8	2.5	16.5	7.3	0.0		28.6					4.5	26.7	16.2		0.0	26.0	2.9	7.6	19.6	0.0	NC		17.1	2.5
L030440-004	Aug-03	RFB-SD-SD-11	73.	6272.	300.	288.	<1.0	73.	17.	33.	529.	23340.	0.96	0.28	2458.	71.	19.	1945.	5259.	7.7	691.	133	<10.	19.	61.	12.	9522.
L030440-006	Aug-03	RFB-SD-SD-5011	93.	6397.	348.	312.	<1.0	69.	9.1	23.	631.	23740.	0.62	0.47	2489.	72.	15.	2016.	6729.	7.5	658.	160.	<10.	23.	68.	14.	9668.
		RPD (%)	24.1	2.0	14.2	8.0	NC	5.6			17.6	1.7		50.7	1.3	1.4	23.5	3.7	24.5	2.6	4.9	18.4	NC	19.0	10.9	15.4	1.7
L030440-014	Aug-03	RFB-SD-SD-20	1.6	8991.	61.	166.	<1.0	4.3	22.	30.	49.	20290.	0.050	0.32	5354.	59.	26.	1453.	251.	7.6	430	<10.	<10.	6.5	22	23.	1871.
L030440-015	Aug-03	RFB-SD-SD-5020	3.6	9222.	62.	165.	<1.0	6.0	21.	30.	64.	24290.	0.041	0.35	6435.	55.	26.	1444.	443.	7.5	494.	10.	<10	6.3	32.	25.	1982.
		RPD (%)		2.5	1.6	0.6	NC	33.0	4.7	0.0	26.5	17.9	19.8	9.0	18.3	7.0	0.0	0.6		1.3	13.9	NC	NC	3.1		8.3	5.8

Results in ppm, unless indicated otherwise.
NC - Not Calculated

TABLE 9
RICHARDSON FLAT FIELD DUPLICATE RESULTS
SURFACE WATER

Lab #	Date	Sample #	AG	AG(D)	AL	AL(D)	ALK.	AS	AS(D)	B	B(D)	BA	BA(D)	BE	BE(D)	CA
		Units:	ppm	ppm	ppm	ppm	ppm CaCO3	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
L030246-005	3-Jun-03	RFB-SW-SD18	<0.005	<0.005	<0.050	<0.050	148	<0.005	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	230
L030246-006	3-Jun-03	RFB-SW-SD5018	<0.005	<0.005	<0.050	<0.050	148	<0.005	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005	<0.005	230
		RPD (%)	NC	NC	NC	NC	0.0	NC	NC	NC	NC	NC	NC	NC	NC	0.0
L030439-003	18-Aug-03	RFB-SW-SD-13	<0.005	<0.005	<0.050	<0.050	212	<0.005	<0.005	0.13	0.1	<0.10	<0.10	<0.005	<0.005	336
L030439-004	18-Aug-03	RFB-SW-SD-5013	<0.005	<0.005	<0.050	<0.050	240	<0.005	<0.005	0.12	0.11	<0.10	<0.10	<0.005	<0.005	334
		RPD (%)	NC	NC	NC	NC	12.4	NC	NC	8.0	9.5	NC	NC	NC	NC	0.6

NC - Not Calculated

TABLE 9
RICHARDSON FLAT FIELD DUPLICATE RESULTS
SURFACE WATER

CAT/AN BAL.	CD	CD(D)	CL-	CN-	CO3	CO	CO (D)	COND.	CR	CR(D)	CR+6 (D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG
%	ppm	ppm	ppm	ppm	ppm CaCO3	ppm	ppm	umhos/ cm2	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm CaCO3	ppb
3.2	<0.001	<0.001	117	<0.004	<2.0	<0.10	<0.10	1674	<0.010	<0.010	<0.005	0.007	0.006	0.12	<0.10	830	148	<0.20
4.4	<0.001	<0.001	121	<0.004	<2.0	<0.10	<0.10	1677	<0.010	<0.010	<0.005	0.007	0.006	0.12	<0.10	834	148	<0.20
31.6	NC	NC	3.4	NC	NC	NC	NC	0.2	NC	NC	NC	NC	NC	0.0	NC	0.5	0.0	NC
6.3	<0.001	<0.001	105	<0.004	<2.0	<0.10	<0.10	2060	<0.010	<0.010	<0.005	<0.005	<0.005	<0.10	<0.10	1150	212	<0.20
4.6	<0.001	<0.001	107	<0.004	<2.0	<0.10	<0.10	2090	<0.010	<0.010	<0.005	<0.005	<0.005	<0.10	<0.10	1141	240	<0.20
31.2	NC	NC	1.9	NC	NC	NC	NC	1.4	NC	NC	NC	NC	NC	NC	NC	0.8	12.4	NC

TABLE 9
RICHARDSON FLAT FIELD DUPLICATE RESULTS
SURFACE WATER

HG(D)	K	KJEL-N	MG (D)	MN	MN(D)	NA (D)	NH3/N	NO2/ NO3	P	PB	PB(D)	PH	SB	SB(D)	SE	SE(D)	SO4=	TDS
ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm		ppm	ppm	ppm	ppm	ppm	ppm
<0.20	2.3	<0.50	62	1.9	1.8	55	<0.10	<0.10	<0.10	<0.005	<0.005	7.6	<0.005	<0.005	<0.004	<0.004	583	1361
<0.20	2.3	<0.50	63	1.9	1.8	56	0.14	<0.10	<0.10	<0.005	<0.005	7.5	<0.005	<0.005	<0.004	<0.004	562	1353
NC	0.0	NC	1.6	0.0	0.0	1.8	NC	NC	NC	NC	NC	1.3	NC	NC	NC	NC	3.7	0.6
<0.20	2.4	0.27	75	4.9	5	56	<0.10	<0.10	<0.10	<0.005	<0.005	8.2	<0.005	<0.005	<0.004	<0.004	768	1817
<0.20	2.3	0.48	75	4.6	4.6	57	0.13	<0.10	<0.10	0.005	<0.005	8	<0.005	<0.005	<0.004	<0.004	777	1749
NC	4.3	56.0	0.0	6.3	8.3	1.8	NC	NC	NC	NC	NC	2.5	NC	NC	NC	NC	1.2	3.8

TABLE 9
RICHARDSON FLAT FIELD DUPLICATE RESULTS
SURFACE WATER

TOC	TSS	ZN	ZN(D)
ppm	ppm	ppm	ppm
6.4	7.3	<0.010	<0.010
7	5.2	<0.010	<0.010
9.0	33.6	NC	NC
5.9	4.4	0.03	0.025
4.6	6.9	0.035	0.02
24.8	44.2	15.4	22.2

TABLE 10
RICHARDSON FLAT FIELD DUPLICATE RESULTS
PORE WATER

Lab #	Date	Sample #	AG	AG(D)	AL	AL(D)	ALK.	AS	AS(D)	B	B(D)	BA	BA(D)	BE
		Units:	ppm	ppm	ppm	ppm	ppm CaCO3	ppm	ppm	ppm	ppm	ppm	ppm	ppm
L030438-005	19-Aug-03	RFB-PW-SD-10	<0.005	<0.005	<0.050	<0.050	366.	<0.005	<0.005	0.15	0.14	0.13	0.12	<0.005
L030438-007	19-Aug-03	RFB-PW-SD-5010	<0.005	<0.005	<0.050	<0.050	364.	<0.005	<0.005	0.16	0.15	0.12	0.11	<0.005
		RPD (%)	NC	NC	NC	NC	0.5	NC	NC	6.5	6.9	8.0	8.7	NC
L030438-014	21-Aug-03	RFB-PW-SD-20	<0.005	<0.005	3.1	<0.050	302.	0.007	<0.005	0.11	<0.10	<0.10	<0.10	<0.005
L030438-015	21-Aug-03	RFB-PW-SD-5020	<0.005	<0.005	3.2	<0.050	304.	0.006	<0.005	<0.10	<0.10	<0.10	<0.10	<0.005
		RPD (%)	NC	NC	3.2	NC	0.7	15.4	NC	NC	NC	NC	NC	NC

NC - Not Calculated

TABLE 10
RICHARDSON FLAT FIELD DUPLICATE RESULTS
PORE WATER

Lab #	BE(D)	CA	CAT/AN BAL.	CD	CD(D)	CL-	CN-	CO3	CO	CO (D)	COND.
	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm CaCO3	ppm	ppm	umhos/ cm2
L030438-005	<0.005	247.	3.3	<0.001	<0.001	286.	<0.004	<2.0	<0.10	<0.10	2050.
L030438-007	<0.005	243.	<1.0	<0.001	<0.001	325.	<0.004	48.	<0.10	<0.10	1972.
	NC	1.6	NC	NC	NC	12.8	NC	NC	NC	NC	3.9
L030438-014	<0.005	388.	<1.0	<0.005	<0.001	88.	<0.004	<2.0	<0.10	<0.10	2290.
L030438-015	<0.005	382.	-1.4	<0.001	<0.001	96.	<0.004	<2.0	<0.10	<0.10	2290.
	NC	1.6	NC	NC	NC	8.7	NC	NC	NC	NC	0.0

NC - Not Calculated

TABLE 10
RICHARDSON FLAT FIELD DUPLICATE RESULTS
PORE WATER

Lab #	CR	CR(D)	CR+6 (D)	CU	CU(D)	FE	FE(D)	HARD	HCO3	HG	HG(D)	K	KJEL-N	MG (D)	MN
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm CaCO3	ppb	ppb	ppm	ppm	ppm	ppm
L030438-005	<0.010	<0.010	<0.005	<0.005	<0.005	0.67	0.44	870.	366.	<0.20	<0.20	<2.0	0.45	61.	7.1
L030438-007	<0.010	<0.010	<0.005	<0.005	<0.005	0.70	0.42	855.	316.	<0.20	<0.20	<2.0	0.57	61.	7.0
	NC	NC	NC	NC	NC	4.4	4.7	1.7	14.7	NC	NC	NC	23.5	0.0	1.4
L030438-014	<0.010	<0.010	<0.005	0.007	<0.005	3.8	<0.10	1280.	302.	<0.20	<0.20	4.8	1.8	76.	15.
L030438-015	<0.010	<0.010	<0.005	0.011	<0.005	3.9	<0.10	1261.	304.	<0.20	<0.20	4.9	1.8	74.	15.
	NC	NC	NC	44.4	NC	2.6	NC	1.5	0.7	NC	NC	2.1	0.0	2.7	0.0

NC - Not Calculated

TABLE 10
RICHARDSON FLAT FIELD DUPLICATE RESULTS
PORE WATER

Lab #	MN(D)	NA (D)	NH3/N	NO2/ NO3	P	PB	PB(D)	PH	S=
	ppm	ppm	ppm	ppm	ppm	ppm	ppm		ppm
L030438-005	6.6	93.	<0.10	<0.10	0.39	0.008	<0.005	8.3	4.7
L030438-007	6.5	93.	<0.10	<0.10	0.36	0.011	<0.005	8.7	0.50
	1.5	0.0	NC	NC	8.0	31.6	NC	4.7	
L030438-014	15.	45.	1.7	<0.10	0.65	0.032	<0.005	7.7	25.
L030438-015	15.	44.	1.6	<0.10	0.66	0.032	<0.005	7.8	22.
	0.0	2.2	NC	NC	1.5	0.0	NC	1.3	12.8

NC - Not Calculated

TABLE 10
RICHARDSON FLAT FIELD DUPLICATE RESULTS
PORE WATER

Lab #	SB	SB(D)	SE	SE(D)	SO4=	TDS	TOC	TSS	ZN	ZN(D)
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
L030438-005	<0.005	<0.005	<0.004	<0.004	286.	1378.	5.6	3.1	0.019	<0.010
L030438-007	<0.005	<0.005	<0.004	<0.004	272.	1361.	6.7	<1.0	0.028	<0.010
	NC	NC	NC	NC	5.0	1.2	17.9	NC	38.3	NC
L030438-014	<0.005	<0.005	<0.004	<0.004	969.	1990.	8.7	66.	0.078	<0.010
L030438-015	<0.005	<0.005	<0.004	<0.004	975.	2007.	5.4	241.	0.078	<0.010
	NC	NC	NC	NC	0.6	0.9	[illegible]	[illegible]	0.0	NC

NC - Not Calculated

TABLE 11
RICHARDSON FLAT FIELD DUPLICATE RESULTS
VEGETATION

Lab #	Date	Sample #	Species	AG	AL	AS	BA	CD	CO	CR	CU	FE	HG	MN	MOIST.	NI	PB	SB	SE	TL	V	ZN
L030450-001	19-Aug-03	RFB-VEG-SD-2	Phalaris arundinacea	<1.0	66	1.5	38	2	<2.5	0.77	14	140	<0.020	92	58	<2.5	28	0.47	<1.0	2.8	<2.5	644
L030450-002	19-Aug-03	RFB-VEG-SD-502	Phalaris arundinacea	<1.0	56	0.74	32	1.1	<2.5	0.53	6.1	99	<0.020	64	62	<2.5	23	0.5	<1.0	3.6	<2.5	540
			RPD (%)	NC			11.8		NC	36.9		34.3	NC		6.7	NC	19.6	6.2	NC	25.0	NC	17.6

Results in ppm, unless indicated otherwise.
NC - Not Calculated

TABLE 12
RICHARDSON FLAT FIELD DUPLICATE RESULTS
FISH TISSUE

Lab #	Date	Sample #	AG	AL	AS	BA	CD	CO	CR	CU	FE	HG	MN	MOIST.	NI	PB	SB	SE	TL	V	ZN
L030441-001	18-Aug-03	RFB-FI-POND 1	<0.10	75.	0.63	4.4	<0.50	<2.5	<0.50	1.7	151.	<0.020	165.	78	<2.5	7.9	0.17	<1.0	<2.5	<2.5	127.
L030441-003	18-Aug-03	RFB-FI-POND 500	<0.10	27.	<0.50	3.3	<0.50	<2.5	<0.50	1.1	81.	<0.020	97.	77	<2.5	2.7	0.10	<1.0	<2.5	<2.5	68.
		RPD (%)	NC		NC	28.6	NC	NC	NC			NC		1.3	NC			NC	NC	NC	

Results in ppm, unless indicated otherwise.
NC - Not Calculated

TABLE 13
RICHARSON FLAT
FIELD DUPLICATE RESULTS
MACROINVERTEBRATES

Lab #	Date	Sample #	AG	AL	AS	BA	CD	CO	CR	CU	FE	HG	MN	MOIST.	NI	PB	SB	SE	TL	V	ZN
L030451-005	21-Aug-03	RFB-BMI-POND-01	<1.0	<20.	<0.50	<2.5	<0.50	<2.5	<0.50	2.2	29	<0.020	23	88	<2.5	1.4	<0.050	<1.0	<2.5	<2.5	26
L030451-006	21-Aug-03	RFB-BMI-POND-5001	<1.0	<20.	<0.50	<2.5	<0.50	<2.5	<0.50	2	25	<0.020	32	87	<2.5	0.43	<0.050	<1.0	<2.5	<2.5	23
		RPD (%)	NC	NC	NC	NC	NC	NC	NC	9.5	14.8	NC	32.7	1.1	NC	[redacted]	NC	NC	NC	NC	12.2
L030451-007	21-Aug-03	RFB-SNAIL-POND-01	<1.0	21	0.72	16	<0.50	<2.5	<0.50	1.5	122	<0.020	1563	81	<2.5	4.8	0.35	<1.0	<2.5	<2.5	20
L030451-008	21-Aug-03	RFB-SNAIL-POND-5001	<1.0	165	1.4	14	<0.50	<2.5	<0.50	3.1	307	<0.020	1189	83	<2.5	15	0.62	<1.0	<2.5	<2.5	201
		RPD (%)	NC	[redacted]	[redacted]	13.3	NC	NC	NC	[redacted]	[redacted]	NC	27.2	2.4	NC	[redacted]	[redacted]	NC	NC	NC	[redacted]

Results in ppm, unless indicated otherwise.
NC - Not Calculated

TABLE 14
RICHARDSON FLAT DATA QUALITY ASSESSMENT
COMPLETENESS SUMMARY

Media/Area	# Samples / Category	# Parameters / Sample	Total Number Data	Number of Invalid Data	Total Number of Valid Data
Sediment (6/2003)	20	24	120	0	120
Sediment (8/2003)	13	25	192	0	192
Surface Water (6/2003)	6	56	933	0	933
Surface Water (8/2003)	8	56	700	0	700
Pore Water (8/2003)	14	57	407	0	407
Vegetation (8/2003)	19	19	100	19	81
Fish Tissue (8/2003)	2	19	950	0	950
Macroinvertebrate/bugs (8/2003)	8	19	238	0	238
			3640	19	3621
				Total Completeness (%)	99.5

Appendix 6

Sediment Toxicity Test Report

SUMMARY REPORT

TOXICITY EVALUATION OF SEDIMENT WITH *Hyalella azteca* FOR RMC PROJECT (United Park City Mines)

Submitted to:
RMC
8138 South State Street, Suite 2A
Midvale, UT 84047

Report # 13814.6100

Study Director: Arthur E. Putt

Springborn Smithers Laboratories
790 Main Street
Wareham, Massachusetts 02571-1075

October 10, 2003

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Table 2. Summary of the survival and growth of *Hyalella azteca* after a 28-day exposure. 10

EXECUTIVE SUMMARY

The following is a summary of testing performed with the freshwater amphipod (*Hyalella azteca*) to evaluate sediment for RMC Project United Park City Mines. Fourteen test samples were collected between August 18 to 21, 2003 and shipped on August 25, 2003 by RMC personnel. The test samples were identified as: RFB-TOX-SD15, RFB-TOX-SD4, RFB-TOX-SD11, RFB-TOX-SD17, RFB-TOX-SD20, RFB-TOX-SD2, RFB-TOX-Swwref, RFB-TOX-SD6, RFB-TOX-SD18, RFB-TOX-5020, RFB-TOX-SD14, RFB-TOX-5011, RFB-TOX-SD10 and RFB-TOX-Refpnd. These samples were received at Springborn Smithers on August 26, 2003. All containers of individual samples were combined, homogenized and then wet pressed through a 2-mm sieve.

In addition, Springborn Smithers prepared an artificial sediment that was used as the laboratory control sediment. The artificial sediment was prepared by mixing 8.5% sphagnum peat, 20% kaolin clay and 71.5% industrial sand (with >50% of the particles between 50 and 200 microns).

The test method used during the conduct of this study followed the "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates, 2nd Edition", Test Method 100.4 (U.S. EPA 2000). The test method followed during the conduct of this test is attached in Appendix I.

One 96-hour reference test with *Hyalella azteca* was initiated on September 17, 2003. Potassium chloride was the reference toxicant used. The population of organisms used to initiate the reference test was from the same population of organisms used to initiate all of test sediments. The 96-hour LC50 for potassium chloride and *H. azteca* as calculated to be 270 mg potassium chloride/L. Appendix II contains the control chart for this reference test and previously conducted reference tests. The reference test conducted September 17, 2003 fell within the acceptable 2 standard deviation range established from the calculated LC50 values.

A summary of the Day 0 and Day 28 water quality characteristics of overlying water during the 28-day subchronic test with *Hyalella azteca* are presented in Table 1. Water quality remained acceptable throughout the 28-day exposure period. Dissolved oxygen, pH and temperature

measurements were made by inserting the measuring probe in the respective vessel and moving the probe gently to prevent agitation of the sediment or disturbing the organisms. Dissolved oxygen concentrations were greater than or equal to 4.8 mg/L throughout the study in all exposure vessels and safely above the required concentration of 2.5 mg/L. Ammonia concentrations, measured during the exposure, were ≤ 0.40 mg/L in all samples and were safely below levels where toxicity is observed. Water temperature measured daily in exposure vessels ranged from 22 to 24°C.

A summary of the *Hyalella azteca* survival and growth during the 28-day subchronic test is presented in Table 2. The mean percent laboratory control survival and growth (measured as dry weight) at test termination was 80% and 0.51 mg per amphipod, respectively and met the minimum performance criteria for this type of test. The mean percent survival and growth of the two reference samples, RFB-TOX-Swwref and RFB-TOX-Refpnd was 60 and 88% and 0.26 and 0.30 mg per amphipod respectively and only the results from the RFB-TOX-Refpnd sample met the minimum performance criteria for this type of test. Based on these results, only the RFB-TOX-Refpnd data was used for statistical comparison with the other samples.

The mean percent survival among amphipods in the sediment samples RFB-TOX-SD15, -SD11, -SD20, -SD18, –SD5020, -SD14, SD5011, -SD10 and -Refpnd ranged from 68 to 99% and were statistically comparable to the survival observed among the control organisms (80%). The mean percent survival in the remaining samples (RFB-TOX-SD4, -SD17, -SD2, Swwref and SD-06) ranged from 0 to 60% and were significantly reduced compared to the survival observed among the control organisms. Compared to the survival observed in the reference sample RFB-TOX-Refpnd (88%), mean amphipod survival in samples RFB-TOX-SD15, -SD4, -SD17, -SD2, Swwref and SD-06 ranged from 0 to 68% and were significantly reduced.

The mean dry weight among amphipods in the sediment samples RFB-TOX-SD20, -SD18 and -SD5020 ranged from 0.43 to 0.58 mg per amphipod and were statistically comparable to the growth observed among the control organisms (0.51 mg per amphipod). The mean dry weight in the remaining samples (RFB-TOX-SD15, -SD11, -SD17, -Swwref, -SD14, -SD5011, -SD10 and -Refpnd) ranged from 0.06 to 0.38 mg per amphipod and were significantly reduced compared to the growth observed among the control organisms. Growth was not recorded in

test samples RFB-TOX-SD4, -SD2 and –SD6 as no surviving amphipods were recovered in these samples at test termination. Compared to the growth observed in the reference sample RFB-TOX-Refpnd (0.30 mg per amphipod), mean amphipod growth in samples RFB-TOX-SD15 and -SD17 were 0.19 and 0.06 mg per amphipod, respectively, and were significantly reduced.

Conclusions

Results of the samples tested established that the Laboratory Control organism survival and growth were within the range of acceptance criteria. The survival and growth effects seen in the amphipod test are thus reliable. Of the fourteen sediment samples tested, only RFB-TOX-SD20, -SD18 and SD5020 did not illicit significant reductions in amphipod survival and/or growth compared to either the lab control or RFB-TOX-Refpnd data. Significant adverse effects (i.e., 0% survival) was observed in the sediment samples RFB-TOX-SD4, -SD2 and –SD6.

SUMMARY OF TEST CONDITIONS

28-Day Sediment Toxicity Tests with *Hyalella azteca*

DATE SAMPLES RECEIVED:	August 26, 2003
TEST DATES:	August 29, 2003 to September 26, 2003
TEST TYPE:	Whole-sediment toxicity test with renewal of overlying water
TEMPERATURE:	22 to 24°C
PHOTOPERIOD:	16 hours light, 8 hours dark (39 to 69 footcandles)
TEST CHAMBER SIZE:	300 mL
SEDIMENT VOLUME:	100 mL
OVERLYING WATER VOLUME:	175 mL
RENEWAL OF TEST SOLUTIONS:	2-volume additions/day
AGE OF TEST ORGANISMS:	8 days old at start of test
NUMBER OF ORGANISMS PER TEST CHAMBER:	10
NUMBER OF REPLICATE TEST CHAMBERS PER TREATMENT:	8
NUMBER ORGANISMS/SAMPLE:	80
FEEDING:	1.0 mL of YCT daily per vessel
AERATION:	None
TEST CONCENTRATION:	100% (no dilutions)
TEST DURATION:	28 days
ENDPOINTS:	Survival and growth (amphipod dry weight)
TEST ACCEPTABILITY:	Minimum mean control survival of 80%

Table 1. Water quality summary for the *Hyalella azteca* 28-day exposure.

Sample Identification	Dissolved Oxygen (mg/L)		pH		Ammonia as N (mg/L)	
	Day 0	Day 28	Day 0	Day 28	Day 0	Day 28
Lab Control	8.2-8.7	6.2-6.8	6.9-7.0	7.4	0.12	0.24
RFB-TOX-SD15	7.5-7.9	5.4-6.6	7.1-7.2	7.4-7.5	<0.10	<0.10
RFB-TOX-SD4	7.8-8.0	6.3-6.7	7.0	7.4-7.5	<0.10	<0.10
RFB-TOX-SD11	7.9-8.3	4.8-6.5	7.1-7.2	7.5-7.6	<0.10	<0.10
RFB-TOX-SD17	8.0-8.6	6.4-6.7	7.2-7.3	7.4-7.5	0.11	<0.10
RFB-TOX-SD20	8.6-9.0	5.7-6.5	7.0-7.2	7.7-8.0	0.19	<0.10
RFB-TOX-SD2	8.0-8.8	6.5-6.9	7.1	7.4	<0.10	<0.10
RFB-TOX-Swwref	7.8-8.4	5.2-6.6	7.4-7.5	7.2-7.4	0.33	<0.10
RFB-TOX-SD6	8.0-8.5	4.8-6.4	7.1	7.2-7.3	<0.10	0.15
RFB-TOX-SD18	7.4-8.1	5.0-6.7	7.1-7.2	7.5-7.6	<0.10	0.40
RFB-TOX-5020	7.8-8.4	6.4-7.0	7.1-7.2	7.6-8.0	0.32	<0.10
RFB-TOX-SD14	7.9-8.4	6.5-7.0	7.1	7.3-7.4	0.11	<0.10
RFB-TOX-5011	8.0-8.5	5.9-6.5	7.2-7.3	7.3-7.4	0.11	<0.10
RFB-TOX-SD10	7.8-8.6	6.7-6.7	7.2	7.2-7.4	0.16	<0.10
RFB-TOX-Refpnd	7.8-8.4	6.1-6.8	7.1-7.2	7.1-7.3	0.16	<0.10

Sample Identification	Alkalinity (mg/L as CaCO3)		Hardness (mg/L as CaCO3)		Conductivity (µmhos/cm)	
	Day 0	Day 28	Day 0	Day 28	Day 0	Day 28
Lab Control	34	34	56	44	190	170
RFB-TOX-SD15	28	34	76	52	250	180
RFB-TOX-SD4	38	34	60	48	230	180
RFB-TOX-SD11	50	42	112	56	350	190
RFB-TOX-SD17	32	32	68	44	230	180
RFB-TOX-SD20	40	42	68	56	250	190
RFB-TOX-SD2	44	38	64	52	250	180
RFB-TOX-Swwref	38	34	68	48	280	180
RFB-TOX-SD6	50	34	72	48	230	170
RFB-TOX-SD18	40	38	76	48	240	180
RFB-TOX-5020	44	40	84	52	300	180
RFB-TOX-SD14	42	30	96	44	310	180
RFB-TOX-5011	56	40	120	52	360	190
RFB-TOX-SD10	46	32	76	44	260	170
RFB-TOX-Refpnd	38	30	56	44	230	170

Table 2. Summary of the survival and growth of *Hyalella azteca* after a 28-day exposure.

Sample Identification	Mean Percent Survival (Standard Deviation)	Mean Dry Weight in mg/organism (Standard Deviation)
Lab Control	80(22)	0.51(0.10)
RFB-TOX-SD15	68(20) b	0.19(0.07) ab
RFB-TOX-SD4	0(0) ab	NA
RFB-TOX-SD11	84(16)	0.38(0.16) a
RFB-TOX-SD17	28(22) ab	0.06(0.03) ab
RFB-TOX-SD20	99(4)	0.58(0.12)
RFB-TOX-SD2	0(0) ab	NA
RFB-TOX-Swwref	60(11) ab	0.26(0.11) a
RFB-TOX-SD6	0(0) ab	NA
RFB-TOX-SD18	96(5)	0.57(0.11)
RFB-TOX-SD5020	99(4)	0.43(0.05)
RFB-TOX-SD14	93(9)	0.35(0.05) a
RFB-TOX-SD5011	90(9)	0.38(0.08) a
RFB-TOX-SD10	88(10)	0.35(0.07) a
RFB-TOX-Refpnd	88(10)	0.30(0.08) a

SD = Standard Deviation.

a Statistically different ($p \leq 0.050$) compared to the Lab Control data.

b Statistically different ($p \leq 0.050$) compared to the reference sample RFB-TOX-Refpnd data.

Data from the reference sample RFB-TOX-Swwref was not used for statistical comparison as it did not meet control performance criteria of this study (at least 80% survival at termination).

REFERENCES

U.S. EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates, 2nd Edition. U.S. Environmental Protection Agency. Office of Research and Development. EPA/600/R-99/064.

APPENDIX I

28-Day Toxicity Test with Freshwater Amphipod (*Hyalella azteca*) to Meet U.S. EPA Guidelines.

1.0 INTRODUCTION

The objective of this study is to determine the chronic toxicity of a contaminated sediment sample(s) to the amphipod (*Hyalella azteca*) during a 28-day exposure. Amphipods are exposed to the sediment sample to assess survival and growth on test day 28. The methods (Springborn Smithers Laboratories test method No.: SED-Ha-123) in this study plan meet those described in the document entitled "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates, Second Edition", Test Method 100.4 (U.S. EPA, 2000).

2.0 MATERIALS AND METHODS

2.1 Test System

2.1.1 Species

The freshwater invertebrate, *Hyalella azteca,* is the species used in this test. Test organisms will be 7 to 8 days old at initiation of the test. Amphipods will be obtained by removing adult amphipods from culture tanks and placing them in 9.5 liter aquaria with approximately 8L of water, 7 to 8 days prior to test initiation. Young produced by these isolated adults will then be removed and pipetted into holding containers until test initiation. Amphipods will not be used if >5 % mortality is observed during the 48 hours prior to test initiation.

2.1.2 Source

Hyalella azteca cultures will be maintained at Springborn Smithers Laboratories. Amphipods will be cultured in 20 liter glass aquaria (containing approximately 10-L of culture water) under flow-through conditions. Water used to culture the amphipods is similar to the overlying water used during the 28-day test. Culture water will be maintained at 23 ± 1 °C.

2.1.3 Feeding

While being maintained in the culture prior to the test, adult and juvenile amphipods will be fed once daily. They will be fed a combination of Yeast, Cerophyl® and Flaked Fish food Suspension (YCT) and a unicellular green algae *Ankistrodesmus falcatus.* During testing, 1.0 mL of YCT Suspension will be added daily to each test vessel. If food collects on the sediment surface during testing, feeding will be suspended for one or more days.

2.1.4 Handling

Wide-bore pipets will be used to transfer the amphipods, taking care to minimize possible stress due to handling. Amphipods that are damaged or dropped during transfer will not be used.

2.2 Physical System

2.2.1 Sediment

Sediment samples should be shipped overnight to Springborn Smithers Laboratories after collection. Upon receipt at Springborn Smithers, sample containers will be inspected for leakage or damage and the sample identity recorded. If storage is required, the samples will be refrigerated at approximately 4 °C. In addition, if possible, a sediment sample will be collected from an uncontaminated location near the site of interest to be used as reference sediment. Laboratory control sediment, prepared or collected by Springborn Smithers Laboratories, will be included in the test to evaluate performance of the test organisms and exposure system. Prior to use, each sediment sample will be sieved through a 2 mm stainless steel sieve to remove large particles. The test will be initiated within 14 days of sediment collection.

2.2.2 Test Vessels

The test vessels used in the static-renewal toxicity test will be 300-mL glass beakers which are chemically clean. Each test vessels has a 2 cm hole cut on the top portion of the vessel and is covered with 40-mesh Nitex® screen for drainage. Each vessel will contain 100 mL (approximately 2 cm layer) of sediment and 175 mL of overlying water. Test vessels will be cleaned by an appropriate method to remove residue of test substance previously used (i.e., acid to remove metals and bases; detergents and organic solvents to remove organic compounds) and rinsed several times using diluent water.

2.2.3 Overlying Water

Water from a 100 meter bedrock well is pumped to a concrete reservoir where it is supplemented on demand with untreated, unchlorinated, Town of Wareham well water. The water is characterized with a normal pH range of 6.9 to 7.7, a total hardness of 40 to 60 mg/L and a specific conductance of 110 to 160 µmhos/cm. The pH, total hardness, alkalinity, and specific conductance of this water will be monitored weekly at a central location in the laboratory to assure that these parameters are within the normal, acceptable ranges. Total hardness and alkalinity will be determined according to *Standard Methods for the Water and Wastewater*, (APHA, 1995).

The quality of the water is judged by periodic analyses of representative samples conducted to ensure the absence of potential toxicants, including pesticides, PCBs and selected toxic metals, at concentrations which may be harmful to the amphipods, as well as the ability of amphipod cultures to survive and reproduce in the water free of stress. TOC analyses will be conducted once a month in the overlying water source.

2.3 Test Procedures:

2.3.1 Test Concentration

Eight replicates will be maintained for each sediment sample consisting of 100% whole sediment sample (no dilutions). A common reference control, conducted with eight replicates, may be used to evaluate the survival and growth potential of the test organism in a non-contaminated sediment. In addition, laboratory control sediment, prepared or collected by Springborn Smithers Laboratories, will be used to evaluate the survival and growth potential of the test organisms. The laboratory control sediment will also be conducted with eight replicates. Ten amphipods (7 to 8 days old) per replicate (80 organisms per sediment sample or control) will be used to initiate the test.

2.3.2 Test Initiation

The day before test initiation (day -1), test sediment, reference and laboratory control sediment will be added to the replicate test vessels and the overlying water will be added. Each sediment sample will be thoroughly homogenized prior to addition to the replicate exposure vessels. The water will be added gently to prevent suspension of the sediment layer in the water column. This period allows the sediment and water to equilibrate prior to addition of the test organisms. Delivery of the overlying water will be initiated the day prior to test initiation using the automated water delivery system.

Amphipods (7 to 8 days old) will be removed from the holding vessels (see section 2.1.1). Ten amphipods will be impartially selected and pipetted into a replicate test or control vessel. This procedure will be repeated until all vessels contain ten amphipods.

2.3.3 Renewal of Overlying Water

During the 10-day study, the overlying water will be renewed by adding two volume additions (i.e., 350 mL) per day using an intermittent delivery system in combination with a calibrated water-distribution system (Zumwalt et al., 1994). The intermittent delivery system will be calibrated to provide 1 liter of water per cycle to the water-distribution system, which subsequently provides 50 mL of water per cycle to each replicate test chamber. The water delivery system cycles 7 times per day, providing 2 volume additions every 24 hours. Delivery of two volume replacements per day is sufficient to provide consistent and acceptable water quality characteristics throughout the duration of the 28-day exposure.

2.3.4 Photoperiod

The test vessels will be located in an area illuminated to a light intensity of 30 to 100 footcandles using a combination of fluorescent bulbs. A 16-hour light, 8-hour dark photoperiod will be maintained with an automatic timer. Sudden transitions from light to dark and vice versa will be avoided.

2.3.5 Measurement of Water Quality Variables

Total hardness, alkalinity, specific conductance, and ammonia will be determined at the beginning and end of the test in the overlying water from a composite sample from all twelve replicate vessels. The composite sample will be taken from 1 to 2 cm from the sediment surface using a pipet. In addition, specific conductance will be measured weekly thereafter until test termination from a composite sample. Dissolved oxygen, pH and temperature will be measured in all replicate vessels at test initiation and test termination of the test (day 28). Dissolved oxygen and temperature will also be monitored daily in one alternating replicate during the course of the study (test days 1 to 27). In addition, temperature will be monitored continuously in the water bath using a minimum-maximum thermometer. Readings of temperature extremes will be recorded daily.

2.3.6 Dissolved Oxygen

Total dissolved oxygen will not be allowed to drop below 2.5 mg/L during the study. Aeration (with oil-free air) or increased water renewal rate will be initiated to raise and maintain the dissolved oxygen concentration at or above 2.5 mg/L.

2.3.7 Temperature

Water temperature of the test solutions will be maintained at 23 °C by conducting the study in a temperature controlled water bath at the appropriate test temperature. The mean daily temperature must be 23 ± 1 °C. The instantaneous temperature must be 23 ± 1 °C.

2.3.8 Biological Data

Daily observations of organism behavior (e.g., sublethal effects) and characteristics of sediment and overlying water will also be observed and recorded daily.

Survival and growth (dry weight) of the amphipods will be determined in each of the eight replicate exposure vessels on test day 28 by sieving the sediment to remove all surviving amphipods. The growth of surviving amphipods will be recorded by pooling surviving amphipods from each replicate vessel and drying at 60• C for 24 hours. Pooled amphipods will be weighed on a calibrated analytical balance to the nearest 0.01 mg.

2.3.9 Test Acceptability Requirements

Mean survival and growth of the amphipods in the laboratory control must be ≥ 80% and ≥ 0.15 mg per amphipod, respectively, at test day 28.

Hardness, alkalinity and ammonia in the overlying water should not vary by more than 50% during the sediment exposure (day 0 to 28).

3.0 STATISTICAL ANALYSES

The mean survival and growth of organisms exposed in each test sediment and reference control sample will be tested for normality and homogeneity of variance. If the data set passes these two tests, then a parametric method (e.g., ANOVA 2-Sample T-Test or Dunnett's Test) will be used to evaluate the results of the mean survival and growth of each test sample for significant adverse effects. If the data set fails the test for normality and homogeneity of variance, then a non-parametric method (e.g., Steel's Many-One Rank Test) will be used to determine significant adverse effects. If necessary, mean survival values will be transformed (e.g., arcsine square).

4.0 REPORTING

The raw data and the final summary report will be reviewed by the Study Director. The test results will be presented in an outline format on a per sample basis.

5.0 REFERENCES

APHA, AWWA, WPCF. 1995. Standard Methods for the Examination of Water and Wastewater. 19th Edition, Washington, D.C.

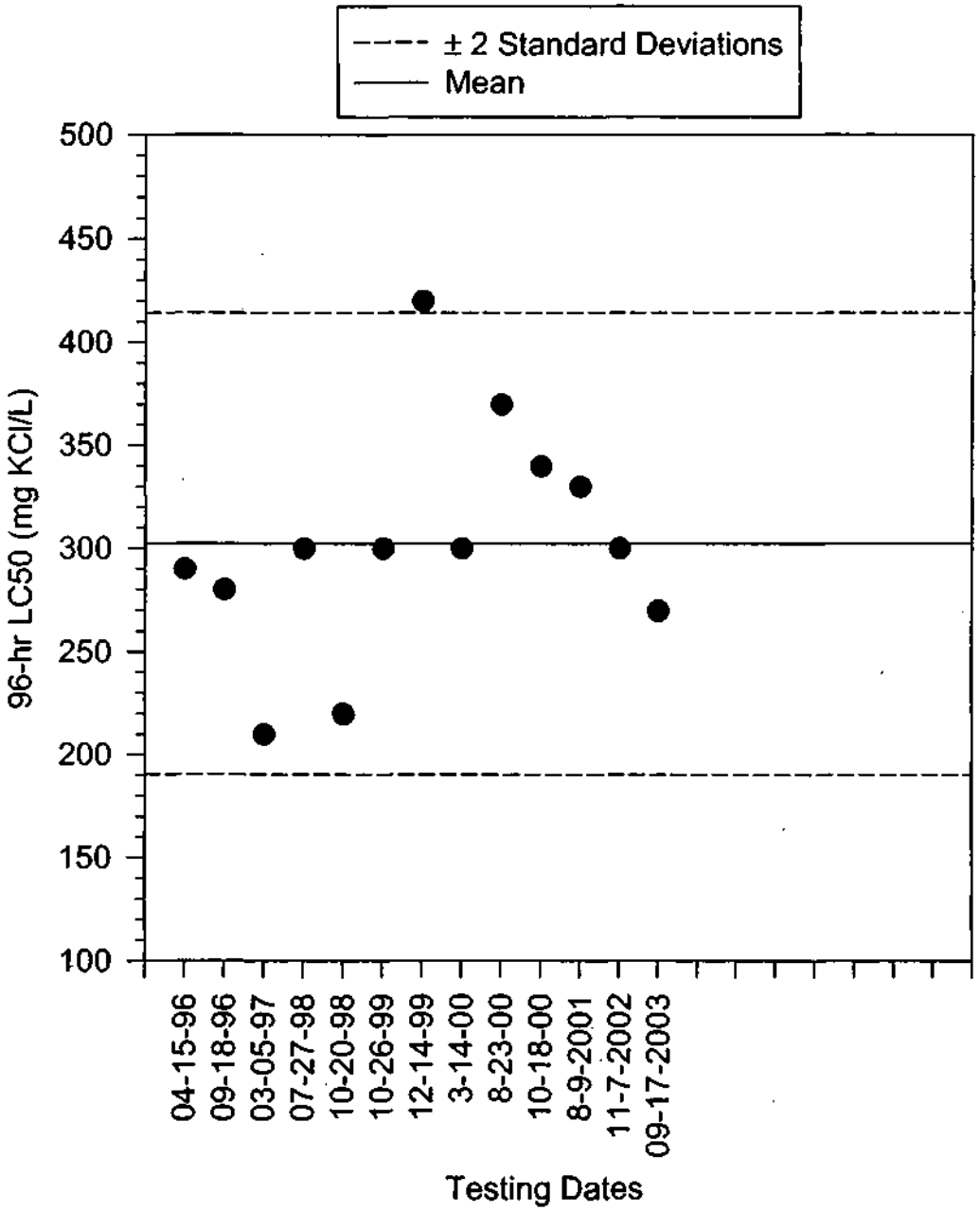
U.S. EPA. 1975. Methods for Acute Toxicity Tests with Fish, Macroinvertebrates, and Amphibians. Ecological Research Series (EPA-660/3-75-009). 61 pp.

U.S. EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. Second Edition. U.S. Environmental Protection Agency. March 2000. Office of Research and Development. EPA/600/R-99/064.

Zumwalt, D.C., F.J. Dwyer, I.E. Greer and C.G. Ingersoll. 1994. A water-renewal system that accurately delivers small volumes of water to exposure chambers. Environmental Toxicology and Chemistry. pgs. 1311-1314.

APPENDIX II

Summary of Hyalella azteca Reference Testing with Potassium Chloride



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10/10/03
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