International Smelting and Refining/Carr Fork Remedial Investigation Report

Draft

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International Smelting and Refining/Carr Fork

Remedial Investigation Report

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International Smelting and Refining/Carr Fork
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DEFINITIONS

AECI	Anderson Engineering Co., Inc.
AERL	ARCO Environmental Remediation, L.L.C.
Anaconda	Anaconda Copper Company (Purchased by the Atlantic Richfield Company in 1975)
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirements
Atlantic Richfield	Atlantic Richfield Company (Formerly aka ARCO)
BLM	United States Bureau of Land Management
BSHW	State of Utah, Bureau of Solid and Hazardous Waste
BYU	Brigham Young University
CAG	Pine Canyon Community Action Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Constituents of Concern
DERR	State of Utah Division of Environmental Response and Remediation
DOGM	State of Utah Division of Oil, Gas, and Mining
DQO	Data Quality Objectives
EPA	United States Environmental Protection Agency
FIT	EPA Field Investigation Team
FS	Feasibility Study
FSP	Field Sampling Plan
HRS	Hazard Ranking System
IS&R	International Smelting and Refining Company
IS&R property	Former IS&R property currently owned by Atlantic Richfield Company
JBR	JBR Environmental Consultants, Inc. (Formerly Known as JBR Consultant Group)
KCC	Kennecott Utah Copper Corporation
LAP	Laboratory Analytical Protocol
MCL	Maximum Contaminant Levels, National Drinking Water Standards
NPL	National Priorities List for Uncontrolled Hazardous Waste Sites
off site	Adjacent properties not owned by Atlantic Richfield
PA	Preliminary Assessment
PARCC	Data Quality Indicators Including Precision, Accuracy and Bias Representativeness, Comparability, and Completeness
PRP	Potential Responsible Party
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
RP	Responsible Party
ROD	Record of Decision
SAP	Sampling Analysis Plan

SCM	Site Conceptual Model
SDWPS	Secondary Drinking Water Protection Standard
SGCM	Site Groundwater Conceptual Model
SI	Site Inspection
Site	IS&R/Carr Fork property and impacted adjacent properties
smelter site	IS&R property currently owned by Atlantic Richfield
SPLP	Synthetic Precipitation Leaching Procedure (Method 1312)
SOW	Scope of Work
TCLP	Toxicity Characteristic Leachate Procedure (Method 1311)
TDS	Total Dissolved Solids
UDEQ	State of Utah Department of Environmental Quality
UDWR	State of Utah Division of Wildlife Resources
USGS	United States Geological Survey
U of U	University of Utah
USU	Utah State University
WIC	Waste Isolation Cell: cell where specified wastes were placed in1986.
WP	Work Plan
1985 Investigation	Atlantic Richfield commissioned site investigation of remaining site wastes and residue impacts to various media. Result of investigation was the 1986 Reclamation/Stabilization Plan

International Smelting and Refining/Carr Fork
Remedial Investigation Report

Executive Summary

This report documents the Remedial Investigation (RI) completed by Atlantic Richfield Company in accordance with the United States Environmental Protection Agency Unilateral Administrative Order CERCLA Docket No. 08-2001-12 for the International Smelting and Refining/Carr Fork Site just east of Tooele, Utah. The Site was listed on the National Priority List (NPL) July 27, 2000.

The IS&R/Carr Fork project Site, which includes approximately 1200 acres and nearby residential areas, is located in Tooele County, Utah. Anaconda (Atlantic Richfield purchased Anaconda in 1976) or one of its wholly owned subsidiaries constructed the IS&R smelter facility in 1910 and operated the plant until final closure in 1972. During operations, the plant produced copper, lead and zinc along with various by-products. The smelter plant was razed shortly after production ceased. During the 1970s Anaconda began development of a new copper processing mill, the Carr Fork Mill, east of the IS&R smelter site in Pine Canyon. After declining copper prices and operational problems made the Carr Fork project unprofitable, Atlantic Richfield discontinued its operation in 1983. After a series of site environmental investigations, Atlantic Richfield, in 1986, reclaimed both the Carr Fork Site and the IS&R Site under a plan approved by the State of Utah, Department of Oil, Gas and Mining.

The chief objective of the RI was to determine the potential risk to human health and the environment of the IS&R/Carr Fork and adjacent land by accomplishing these sub tasks:

- Ascertain the Site status in its current state taking into account reclamation actions completed in 1986;
- Verify previous investigation sample results of the Site prior to reclamation;
- Assay conditions in areas not previously addressed by reclamation efforts, including near-by residential areas.

The RI included both a records search and extensive field sampling. Using the Site Conceptual Model as the guide, the Field Sampling Plan called for sampling site soils, surface water, groundwater and completing Work Area walk-overs to identify areas where future remedial action may be required. A total of **1129 samples** were collected and analyzed during the investigation. Field sampling consisted of 416 soil, 229 sediment, 33 surface water, 49 groundwater, 5 pore water, and 7 slag samples. In addition to samples collected on the former smelter site and surrounding fields, 381 residential yard samples and 9 household dust samples were collected from **74 residential** dwellings in the community of Lincoln, located west of the smelter site. The groundwater portion of the investigation has monitored downgradient wells in Lincoln and Erda.

Soil and sediment samples were analyzed for 23 metals and pH. Water samples were analyzed for the same 23 metals, 4 anions, and 4 physical properties, including all drinking water standards. Throughout the investigation lead and arsenic have been used as indicator metals to gauge the impact of areas from smelter operations. Lead concentrations in soil have ranges as shown below.

Areas covered in 1986:	13 mg/l to 10,000 mg/l
Non-covered Areas:	12 mg/l to 58,100mg/l
Sub-cap Areas:	190 mg/l to 23,000 mg/l

Arsenic concentrations in soil have ranges as shown below:

Areas covered in 1986:	7.2 mg/l to 3,930 mg/l
Non-covered Areas:	3.7 mg/l to 27,700 mg/l
Sub-cap Areas:	26 mg/l to 1,300 mg/l

Lead concentrations (dissolved) in surface water have ranges as shown below:

Pine Canyon Creek:	0.000213 mg/l to 0.00138 mg/l
Surface ponds:	0.0043 mg/l to 0.11 mg/l

Arsenic concentrations in surface water have ranges as shown below:

Pine Canyon Creek:	0.0011 mg/l to 0.00869 mg/l
Surface ponds:	0.0055 mg/l to 0.11mg/l

All analytical results for surface water were found to be within MCL and ambient standards.

Groundwater analytical results for both upgradient and downgradient wells were within MCL standards except in GW-1 (Boys Ranch 6" Well), GW-1B (Boys Ranch 16" Well), GW7 and GW8, where arsenic amounts were elevated at approximately 140 ppb, 219 ppb, 171 ppb and 171 ppb respectively. All of the wells with elevated arsenic are at the base of Pine Canyon.

Several water and soil samples were collected at various locations throughout the Site in an attempt to locate a probable source of the elevated arsenic in the groundwater. None of the testing was successful in locating a significant smelter related source. Because the arsenic level in the Boys Ranch Well has remained consistent since the 1970's, it is quite feasible that the arsenic found in the above referenced wells has a natural source associated with the mineralized Oquirrh range. The extent of the elevated arsenic, based on water quality sampling is estimated to extend approximately 2500 feet beyond the west boundary of the Atlantic Richfield property and does not affect any drinking water supplies.

During Site walk-overs 451 locations were identified and mapped as Areas of Concern (AOC). Ten percent of the areas were sampled for metals and other COC and then all locations were categorized into like groups. The areas of greatest concern are located in areas not previously addressed by reclamation work. Section 3.14 and Appendix I provide a comprehensive summary of AOC, their location, physical characteristics and COC concentration.

The EPA, using data developed during the Remedial Investigation, completed two Baseline Risk Assessments. The human health risk assessment examined potential exposures to site-related COC in soil and indoor dust, groundwater, and in surface water and sediment. Receptors of concern were current and future off-site residents in Work Area 10, on-site visitors hiking, viewing wildlife or on other outings, and on-site wildlife refuge workers. For the residential area there were no health risks associated with exposure to inorganics in soil and house dust, with the exception of lead. The assessment predicted lead may pose a slight health risk for children in 18 of the current residences and for future child residents in an undeveloped parcel in Work Area 10. Section 5 includes a summary of the human health considerations, risk based concentrations, and removal action levels proposed by the EPA for the Site. In July of 2004, EPA issued a Unilateral Administrative Order for a removal action in the Lincoln residential area.

The Baseline Ecological Risk Assessment for the Site was performed by Syracuse Research Corporation for the EPA. Overall, with the exception of certain individual AOC, the RA found minimal remaining impacts to the ecology of the Site.

Surface water and sediments were the principal pathways of concern in the Site Conceptual Model for ecological receptors. The surface water pathway was analyzed by extensive testing of Pine Creek and areas of standing water present on site. Results of water collected from Pine Creek indicate that the COC concentrations in water are below levels of concern.

Water collected from the run off ponds in Work Area No. 3 had concentrations of COC which may cause a risk to aquatic invertebrates. However, as stated in the EcoRA because of the size and temporary nature of the ponds, the extent of the risk is to individual receptors, not the overall aquatic invertebrate population.

The flora of the IS&R Site is characterized by several vegetation associations established on physically undisturbed rangeland and on revegetated smelter and tailings features. The majority of the property is a sagebrush-grass steppe dominated by sagebrush, rubber rabbitbrush, bitterbrush and a variety of grasses and shrubs; plant species that were seeded, as part of the 1986 reclamation work. The reclaimed areas were found to support populations of perennial grasses, shrubs and forbs that display good ground cover, plant diversity and herbaceous production comparable to similar nearby physically undisturbed locations. Areas reclaimed were found to be progressing to more mature successional stages of this plant community.

Fauna at the IS&R Site is represented by various trophic levels that include herbivores, carnivores, and omnivores, both as generalists and specialists.

This report presents the findings and analytical data developed during the remedial investigation. Section 6 includes proposed Remedial Action objectives that will be used to guide the interpretation of the data and prepare remedial alternatives for the Site. Alternatives for remedial options can now be developed and screened based on a comprehensive, validated set of data, which can be used in conjunction with historical data, to determine what future actions need to be completed. The investigation has found that in general the Site reclamation features, as previously constructed, continue to mitigate human health and ecological risks associated with smelting operations that once took place on the Site. The alternatives and feasibility studies should now address remaining potential exposures that have been identified.

1.0 INTRODUCTION

1.1 Purpose of Report

In 1995 the State of Utah performed an investigation of the IS&R Site that identified areas remaining on site which posed potential concerns to nearby residents, visitors and the environment. Based on the State's investigation and subsequent HRS, the EPA ordered Atlantic Richfield, the sole RP, to address site issues in accordance with the CERCLA provisions.

This report has been prepared to present the findings and results of the RI completed on the Site. The RI, completed in accordance with CERCLA provisions, has served as the mechanism for collecting data to characterize site conditions; determine the nature and extent of the waste; evaluate the potential for migration of wastes from the Site, and assess risk to human health and the environment. The objective of the report has been achieved by evaluating historical and operation information about the Site to define areas of concern, potential migration pathways, potential receptors, exposure and constituent toxicity. Surface water, groundwater, surficial soils, historical drainage sediments, ecological communities and visual evidence of former smelter activities have all been researched in depth as part of the investigation. Research has also included examining available public and company records to provide insight about the processes used in the plant operation.

The results and findings of this work will provide the factual information needed to determine potential risk and assess the applicability of alternate remedies for areas considered to have unacceptable risks. This report provides summaries of data collected historically and during the RI. Development of remedial alternatives and analysis of alternatives will be reported in the Feasibility Study Report.

1.1.1 Report Organization

Section 1.0 provides a brief background of the Site, including a site description and how the Site has been divided into Work Areas for purposes of this investigation. Section 1.0 also provides an operational history, a cursory review of waste production, disposal and previous regulatory involvement in the Site. The IS&R Site is somewhat unique in that in 1986 a major reclamation was completed by Atlantic Richfield. To a large extent, this reclamation mitigated the chemical and physical hazards associated with operations. Section 1.0 describes in detail the 1986 reclamation action.

Section 2.0 first presents the Site Conceptual Model as shown in the Project Sampling and Analysis Plan. Pathways shown on the model and migration of COC through those pathways is largely dependent on the physical conditions found at the Site. Site conditions influence the migration of COC from the impacted areas to sensitive receptors, on and off site. Section 2.0 describes the methods and findings of the Site physical features portion of the investigation. The section describes how the investigation first reviewed the known and potential impacts resulting from operations and then addresses how the investigation was tailored to identify and quantify residual COC remaining on site. Findings of the Site physical conditions research, including site meteorology, topography, geology, groundwater, surface water, ecology and regional land use are all discussed in Section 2.0.

Section 3.0 describes the nature and extent of the impacts resulting from the IS&R operation. In this section sampling completed in each Work Area is described and a summary of analytical results is provided. This section also includes an extensive discussion on locations, identified during the Site walkovers as AOC's which may require future attention. The situation which constitutes the concern of each of the areas is described and quantified.

Section 4.0 discusses the conceptual model pathways and their specific application to the IS&R Site. Results from the pathways investigation are provided.

Section 5.0 provides the results and a discussion of the Baseline Risk Assessment. Included in this section is also results from the mineralogy and in vitro studies completed as part of the investigations.

Section 6.0 summarizes the findings, results and provides recommendations for remedial objectives based on investigational findings.

1.2 Site Description

1.2.1 Location

The IS&R /Carr Fork Site is located in Tooele County, Utah on the west flank of the Oquirrh Mountains at the mouth of Pine Canyon, as shown on Figure 1-1, Location Map. The Site is approximately two miles northeast of downtown Tooele. The geographical coordinates are latitude 40°33' and longitude 112°15'. The smelter site covers an area of approximately 1,200 acres and includes mine workings, mill site, smelter area, slag pile, tailing impoundment, settling pond, and landfill area. Nearby residential areas downgradient of the former smelter property are also considered part of the Site for investigational purposes.

Atlantic Richfield in conjunction with UDWR created a conservation easement which encompasses all of the Atlantic Richfield property where the smelter and tailings impoundments once stood.

1.2.2 Work Areas

To facilitate the remedial investigation the project Site was divided into 12 work areas based on historical use and physical characteristics. Individual work areas can be seen in Figure 1-2, Work Area Map. All Work Areas except Work Areas No. 10 and 12 are part of the conservation easement. Work Area descriptions are as follows:

1.2.2.1 Work Area No.1 (WA1) - East Mountain

This 713-acre area includes the property owned by Atlantic Richfield, north of the Pine Canyon drainage. Topographic features range from alluvial foothills on the east end of the area to rangeland towards the west. The foothills are covered with grasses, forbs and clusters of oak brush.

There were few operational activities which took place on this area of the property. Activities included storage of machinery and infiltration of water across the land in the 1970s. IS&R purchased the property primarily to serve as a buffer between the smelter and adjacent private land owners. For several years most of the area was leased to local ranchers for grazing cattle.

The UDWR seeds this area periodically with indigenous grasses to help sustain the wintering big game which the conservation easement's management plan promotes.

1.2.2.2 Work Area No. 2 (WA2) - Slag Pile

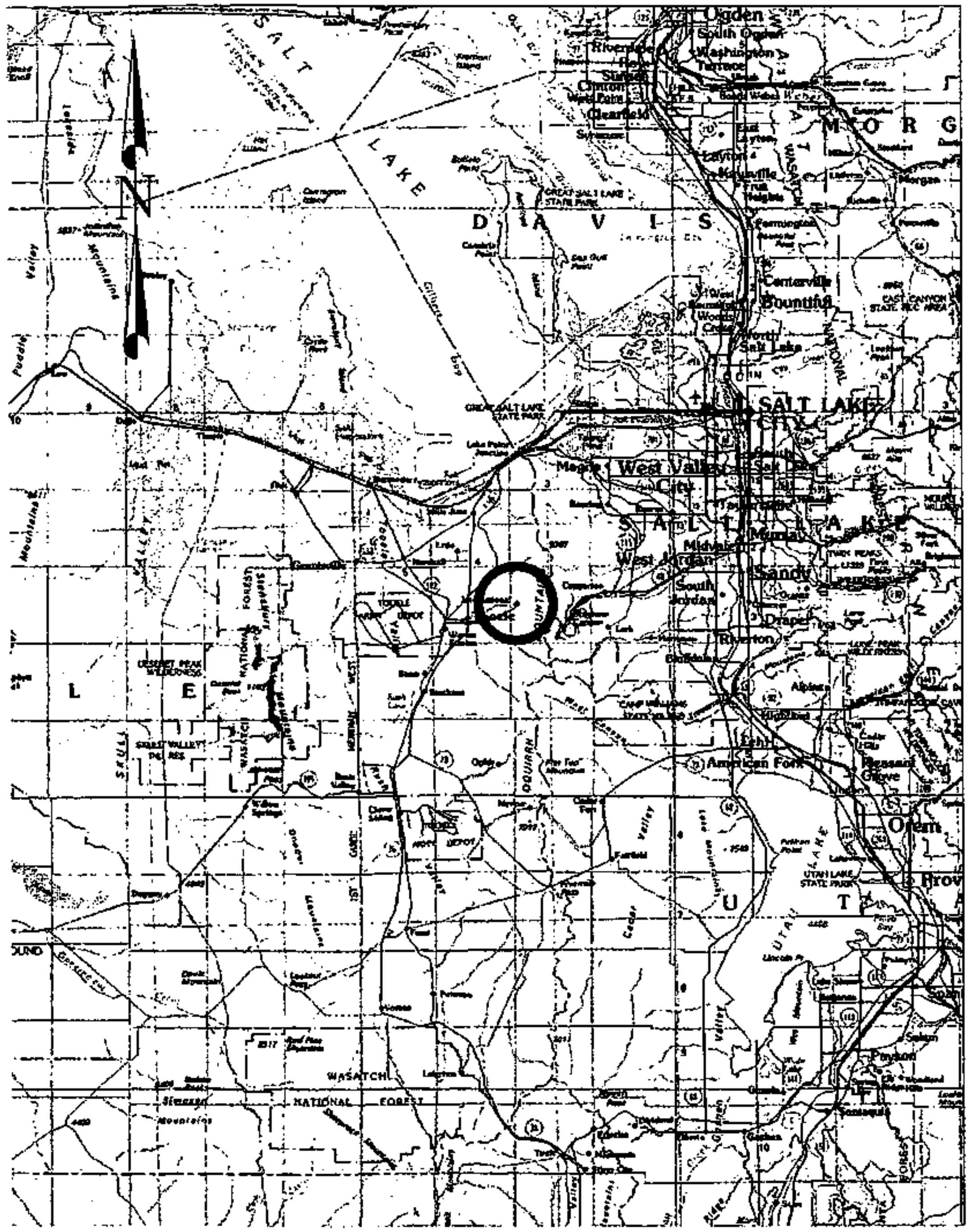
WA2 contains the bulk of the slag material generated by the smelter operation. Of the 37-acre area, 22 surface acres were covered with a clean soil cover in the 1986 reclamation. The deposition of slag created a bench upon which the zinc plant was constructed in 1941. The zinc recovery operation included mining slag material from the pile and processing it to recover metals remaining in the material

1.2.2.3 Work Area No. 3 (WA3) - Smelter Area

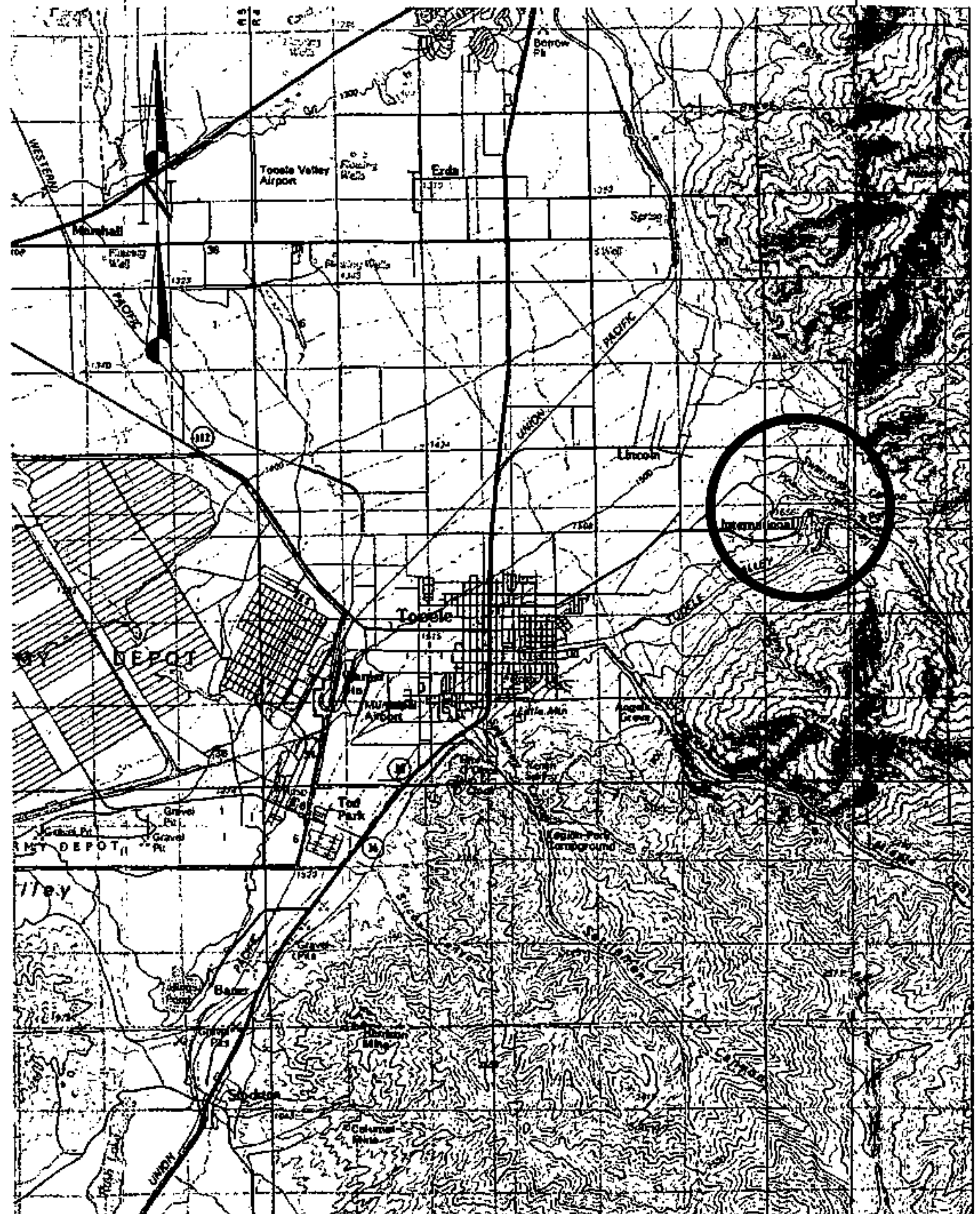
WA3 encompasses 164 acres. This area is the original IS&R plant Site. The work area is divided into the south and north sub-sections by Dry Creek Canyon. Copper processing facilities included storage yards, receiving bins, sampling mill, roaster, reverberatory furnace, converter and casting plant. The lead process included a sintering plant, blast furnace and drossing plant. In addition to the two primary circuits, ancillary structures included concentrating flotation tanks, dust chambers, flue chambers, stacks, power plant, warehouses, assay laboratory and administrative buildings. During the Carr Fork operation period, two landfills were created on the upper flats of WA3.

The IS&R smelter used natural gas, gravity and electricity for energy during the smelting process. The land was developed in a series of terraces, each housing one element of the overall process, allowing gravity to provide a large portion of the energy to move the charge from one process to the next.

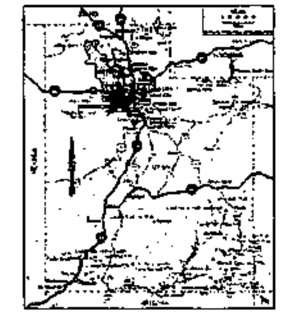
Approximately one-half of the work area, the area where the smelter stood, was capped with clean material during the 1986 reclamation. Today, most of the area is vegetated grass with a few scattered shrubs.



REGIONAL MAP



VICINITY MAP



General Notes

STATE OF UTAH

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

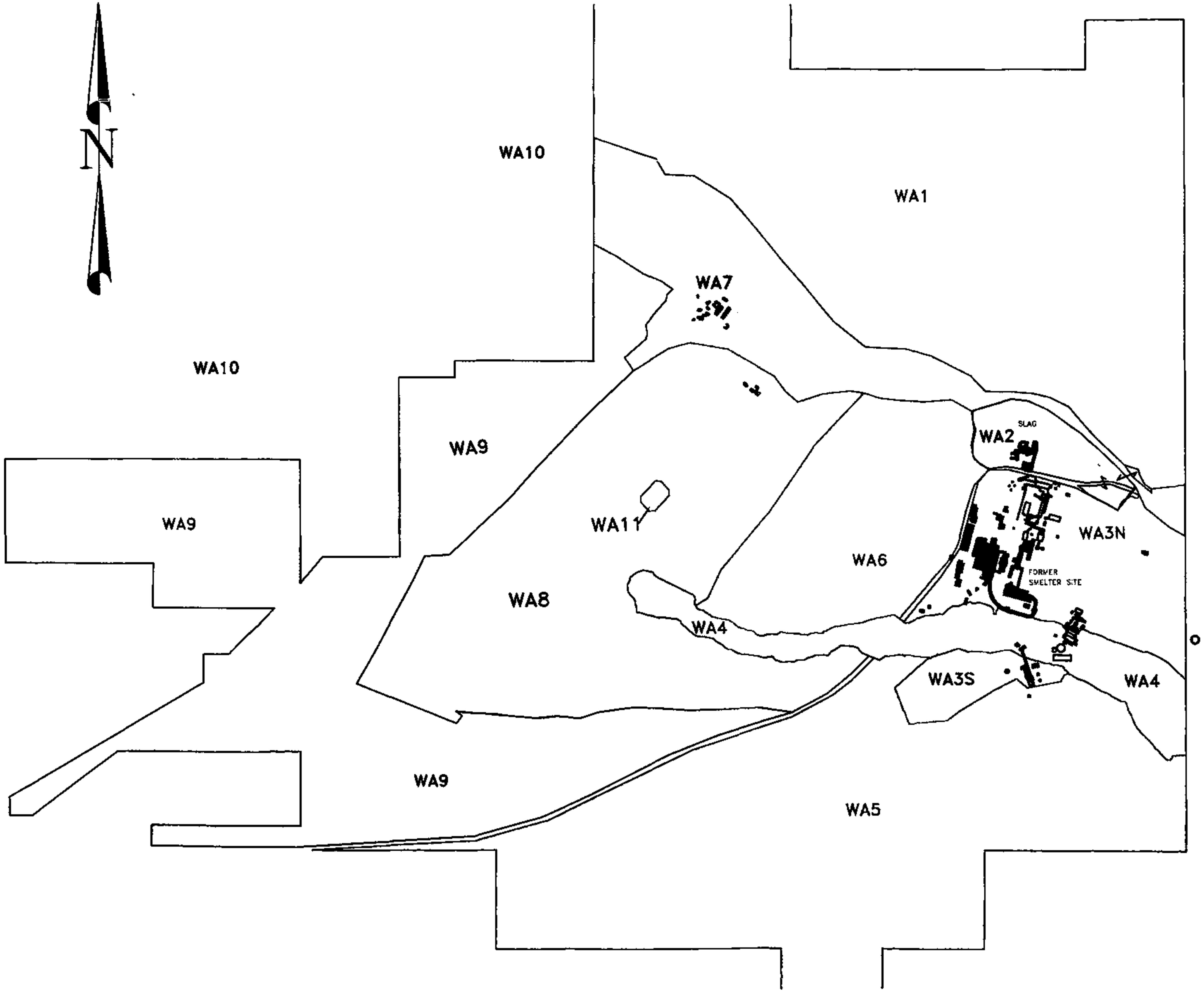
IS&R/CARR FORK

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: GKL
ENGINEER: KC
APPROVED: SA

LOCATION MAP
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069	Sheet	
Date MAR-03	FIGURE 1-1	
Scale NTS		



General Notes

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: GKL
ENGINEER: KC
APPROVED: SA

WORK AREA MAP
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069	Sheet FIGURE 1-2
Date MAR-03	
Scale AS SHOWN	

1.2.2.4 Work Area No. 4 (WA4) - Dry Creek Canyon

WA4 consists of approximately 96 acres and encompasses the Dry Creek drainage from the Kennecott property line on the east to the tailing impoundment on the west. In addition to providing drainage from Dry Canyon, the area also housed flotation tanks, evaporation cells and liquid storage tanks during the smelter operation. In 1986 the cells were removed to accommodate seeding and the drainage channel was redirected and stabilized. Accessible disturbed areas also received a soil cover during the reclamation. In the late 1990s, Atlantic Richfield as part of its on-going maintenance commitment to the Site, placed additional cover over exposed soils in the middle section of the canyon near the county road. Today, vegetation in the area consists of shrubs, grasses, sporadic trees, and large clusters of brush on hillsides.

1.2.2.5 Work Area No. 5 (WA5) - South Mountain side

Similar to WA1, WA5 is Atlantic Richfield owned property and was used as a buffer zone during operations. This 613-acre area is south of the smelter site and east of the county road (Smelter Road). The area is heavily wooded with oak brush, in addition to forbs and grasses. The former Tooele Valley Railroad (the rail that supplied and transported products to and from the plant), crossed through WA5. Reclamation in 1986 was limited to installation of a flood control dike and placement of soil cover over portions of the railroad.

1.2.2.6 Work Area No. 6 (WA6) - Parking Lot/Landfill Area

The 176 acres of smelter area below Smelter Road above the tailing impoundment is designated as WA6. Prior to the Carr Fork Mill and construction of the county road, WA3 and WA6 were contiguous. This lower section of the smelter was used for employee parking, storage and disposal of smelter machinery. The largest disposal area used on site was on the south slope of Pine Canyon, just west of the slag pile. Landfills and other disturbed areas were reclaimed in 1986. The area supports small clusters of trees in the drainages, in addition to the shrubs, forbs and grasses are found throughout.

1.2.2.7 Work Area No. 7 (WA7) - Pine Canyon Drainage

WA7 includes the 176-acre portion of Pine Canyon drainage that is on the Atlantic Richfield property. The slag pile which protrudes into the canyon has been defined as a separate work area, (WA2). Operational activities which took place in the drainage area included waste rock disposal (Elton Tunnel dump), Elton Tunnel access, smelter worker camp, various water storage basins and railroad tracks servicing the Elton Tunnel.

Pine Creek, a perennial stream originating from springs and adits in the canyon, flows down the Pine Canyon drainage. During the Carr Fork mine period, the canyon was used to drain water from the mine workings.

The stream loses water as it travels down the canyon. During most time periods the water completely infiltrates into the ground before exiting the Atlantic Richfield property. During heavy spring runoff, water travels through irrigation ditches and natural drainages towards the northwest.

As a result of the perennial nature of the stream, the drainage basin maintains a fairly diverse riparian vegetation community and provides water for the wildlife found on site. The Elton Tunnel dump, the Elton Tunnel adit and other disturbed areas were reclaimed and seeded during the 1986 work and subsequent maintenance activities.

1.2.2.8 Work Area No. 8 (WA8) - Tailing Impoundment

The concentrating facilities at the smelter and the Carr Fork Mill produced tailings during operations. Those tailings were discharged into impoundments at the base of the foothills behind constructed dams. The 431-acre tailing depository and the main tailing dam are designated as WA8. The tailing facilities were covered with clean soil and seeded in 1986. Vegetation in the area includes scattered shrubs, perennial grass, annual forbs and annual grass.

1.2.2.9 Work Area No. 9 (WA9) - Lower Area

The 615 acres of Atlantic Richfield property west and southwest of the tailing dam is included in WA9. Like WA1 and WA5, this area served primarily as a support and buffer zone between plant operations and off site residents and fields. Two borrow areas within WA9 provided the bulk of the cover material for the 1986 reclamation work. Vegetation in the area includes scattered shrubs, perennial grass, annual forbs and annual grass.

1.2.2.10 Work Area No. 10 (WA10) - Lincoln Township

The community of Pine Canyon for the purpose of this investigation is referred to by its former name of Lincoln Township. This designation is used to avoid confusion between the Pine Canyon drainage and the community

The Township of Lincoln, which has approximately 500 residents, and fields adjacent to the community are included in WA10. No previous reclamation has been completed in this work area.

1.2.2.11 Work Area No. 11 (WA11) - Waste Isolation Cell

During the 1986 reclamation, certain acid producing type waste materials located around the Site were consolidated into a newly constructed waste isolation cell in the Carr Fork tailing impoundment. Waste materials were placed in the lined cell and then covered with a thick cap of clean soil. The trapezoidal cell has surface dimensions of 150 ft by 50 ft cell and contains approximately 1050 cubic yards of waste product.

1.2.2.12 Work Area No. 12 (WA12) - Groundwater

The groundwater investigation, including smelter site, Lincoln area and Erda area monitoring wells, has been designated as WA12. No specific boundaries are defined for this investigation, however, in general the area includes the extent of the local and regional aquifer which may have been impacted by smelter and mine operations.

1.3 Site History

1.3.1 Operational History

The Tooele County Historical Society has published a well documented summary on the history of the International Smelter. Portions are included here, with permission, to provide a brief historical background on the smelter operations. (Comp, 1986)

> The state was settled by a group that placed community needs above corporate needs or personal gains, and the impressive list of sites named above indicates, to some extent, the nature of that community's needs and interests. Both agriculture and industry played important roles in Utah's early economic development. The original settlers created a self-sufficient and balanced economy but, after 1869, the dimensions of that economy began to change and the reasons for this change are of great interest. It was the completion of the transcontinental railroad in 1869 that brought significant change to the Utah economy. With the railroad providing cheap transportation, large numbers of newcomers began to exploit the state's mineral wealth. Gold, silver and later copper created boom towns in the mountains as well as a string of imposing mansions in Salt Lake City. As the new mining and smelting industry expanded, it often encroached on the earlier agricultural community; and the continued and increasing success of the newer industry posed a serious threat to older agrarian interest.
>
> Smelting practice before 1900 seldom suffered any form of restraint. What went up the stacks or leaked out of furnaces (this included several acids, toxic dust, unburned hydrocarbons, and large quantities of fly ash and other particulate matter) could be, and usually was, forgotten by the mining interest. A group of farmers in the Salt Lake city area brought suit against all of the smelters in their region, claiming that crops were turning brown and livestock were dying because of smelter pollution. The final decision in the long court fight went in favor of the farmers, and by 1908, all but one of the smelters in the region had closed. The only plant that survived, the Murray plant of the American Smelting and Refining Company (ASRCo), did so by withdrawing from the suit and paying farmers a cash consideration to insure the immunity of the smelter.
>
> The Utah Court decision made cleaner smelter practice and prudent self-protection essential to the survival of any smelter constructed or reopened after 1908. Both the methods and the style of smelting practice in the

Mountain West changed considerably after the 1908 court decision. Any new smelter constructed in the area was forced to consider the needs of the total community.

One example of this new and required combination of social and technological sensitivity was the Tooele Smelter. Tooele was the second copper smelter and the first lead smelter constructed after the historic Utah court decision, and, eventually, the last custom smelter in the Mountain West. Tooele was actually two smelters in one: both copper and lead plants existed on the same site, and both were completed between 1910 and 1915. Operations continued without major modification until January 1972, when rising maintenance costs forced the old plant to shut down. As both the "first" and "last," the Tooele Smelter provides an excellent opportunity to document and study an industry responding to a new social environment.

It would be impossible to discuss fully an installation as large and complex as two smelters sharing the same site. Over three million dollars went into construction and almost 100 different departments were included in the initial budget. The plant became famous for its low manpower requirements, yet it still employed 500 or 600 men throughout the year.

The closure of all but one of the smelters in the Salt Lake City vicinity brought a sudden reduction in local smelting capacity, a reduction that left many small shippers unable to send their ore or concentrate to more distant smelters because of higher transportation costs. The ASRCo responded to this demand by erecting a new copper plant at Garfield, Utah. One contemporary engineer said the smelter was a major undertaking, constructed "at immense expense, at a locality and under conditions guaranteeing it against claims from damages" by what smelter men called "smoke farmers." However, this ASRCo smelting monopoly soon tempted others into the field, among them the International Smelting and Refining Company (International), a division of the Anaconda Copper Company and the builders of the Tooele Smelter.

The existence of surplus ore supplies and the high demand for more smelting capacity was only one of several inducements that brought the International to Utah. Two other factors, again related to the 1908 court decision, made the construction of the Tooele Smelter desirable. First, the salvage possibilities at the shutdown smelters presented a source of cheap structural steel, building materials, and smelter equipment; the Tooele Smelter grew out of the graves of these older plants. It is difficult to estimate the total savings in this regard, but Tooele may have saved as much as 85 percent of original cost by purchasing salvaged machinery and materials. The Utah Consolidated Mining Company reported selling $72,000 worth of structural steel and $92,000 worth of machinery to the new Tooele plant, although the net salvage amounted to only 14 percent of original costs.

A second consideration that made construction feasible was acquisition of a near-perfect smelter site discovered during a thorough topographic survey of the region. Located at the mouth of Pine Canyon in the Oquirrh Mountains 4½ miles east of the town of Tooele, Utah, the sloping topography of the Site facilitated the gravity flow movement of material. Equally important, prevailing winds carried smoke and gas up the canyon and away from inhabited areas. One visiting engineer commented on the utility of the Site and its prevailing winds, predicting that air currents would send "the smoke from the big stack too high to ever again trouble the horizons of men."

As if to insure this optimistic prediction, the company took three precautions. First, International purchased all the ranches near the smelter and secured long-term options on most of the land within a two-mile radius. Outright purchases totaled over 2,000 acres and the cost of purchases and options exceeded $35,000. As a second precaution, the company sent a team of veterinarians and botanists through the surrounding countryside to make a careful examination of agricultural and livestock conditions before the smelter opened. Finally, as a further precaution against possible damage suits, a weather bureau with self-recording instruments for measuring precipitation, wind velocity and direction, barometric pressure, etc., began operation six months before smelting operations started.

The original estimate by International predicted the copper plant would cost $2.7 million to construct. Knowing that any oversight in design or construction could bring damage suits and complete loss, the company assembled a team of its best engineers to design the plant and supervise construction. C.H. Repath, senior engineer for International, designed the Tooele plant and was present during its construction. A.G. McGregor, the mechanical and electrical engineer for Tooele, worked as an assistant superintendent in power plants and as testing engineer fo the Anaconda Copper Company before coming to the Tooele project. After completion of the Tooele Smelter, he formed a partnership with Repath to design smelters in Arizona and elsewhere. E.E. Thum worked as field engineer for Anaconda and was assigned chief civil engineer for the Tooele Smelter in 1908. By 1915, he was Professor of Metallurgy at the University of Cincinnati, and by 1918 the Metallurgical editor of the Chemical and Metallurgical Engineer. J.B. McIntosh worked as a mining engineer until 1900, when he became construction engineer for Anaconda. Tooele was his first assignment as superintendent of construction, but he later went on to perform the same task at three other major smelters in Utah and Arizona.

The first team of engineers involved in the construction of the new plant arrived in December 1908, and immediately began to survey a railroad route from the San Pedro, Los Angeles, and Salt Lake Railroad main line to the smelter site seven miles away. With the completion of this line named the Tooele Valley Railroad, work on the 200-acre smelter site began. The copper plant was the only installation originally anticipated with plans calling for extensive storage bins, a sampling mill, calcining plant, reverberatory furnaces, converters, a power plant, and numerous smaller departments. These structures required a total of 9,900 tons of structural steel, 6,900 furnished by the American Bridge Company of New York, and 3,000 obtained from the Site of the old Highland Boy smelter. The Oscar Daniels Company of Chicago directed construction of the Tooele Smelter, which required over 200,000 cubic yards of excavation by steam shovel and mule team and over 26,000 cubic yards of plain and reinforced concrete. It is some measure of the work involved in smelter construction to note that the 350-foot main smokestack alone required over 1,750,000 bricks for its construction. Severe winter weather and steel shortages delayed construction somewhat, but construction crews consisting of 375 to 600 men helped to speed the process.

As a custom smelter, Tooele could accomplish little without efficient ore-transportation facilities, and the plant incorporated a variety of systems to meet the needs of the shippers it wished to attract. The Tooele Valley Railroad, controlled by the International and completed even before other construction began, had a seven-mile main line of standard gauge connecting with the San Pedro, Los Angeles, and Salt Lake railway. This connection made it possible for mines anywhere in the West to ship their ore to Tooele, and by the early 1920s, as many as 85 or 90 ore cars from all over the West could be found unloading in the Tooele Smelter rail yards. Most of the ore for Tooele, however, came from the vast copper deposits in Bingham Canyon on the other side of the Oquirrh Mountains and arrived via two other transport systems. The first was a private aerial tramway built by the Utah Consolidated Mining Company. The Utah Con was a Bingham Canyon mine that previously shipped its 800 tons of ore per day to the Garfield smelter before the 4½ mile aerial tramway brought the mine 20 miles closer to Tooele than it was to the ASARCo smelter in Garfield.[1] To provide a similar shortcut to other Bingham Canyon shippers, the Utah Metals company drove an 11,000-foot tunnel from the

[1] Research has shown that in 1910 Utah Metals Company drove an 11,000-foot tunnel from the center of the Bingham Canyon mines area into Middle Canyon, within about 8 miles of the smelter site. This tunnel was traversed by a narrow-gage railway, and was envisioned by some to be a new and shorter route fro transporting Bingham Canyon area ores to the new smelter near Tooele. However, no evidence was found to indicate that rail access was ever constructed to the IS&R smelters, or that Bingham Canyon ore was ever transported through this tunnel. In 1913 a water exchange agreement was obtained by Utah Copper wherein potable quality water form springs to the south of Middle Canyon would be piped through the tunnel in exchange for the use of drain water flowing from the tunnel into the Middle Canyon drainage. This tunnel was know as the water tunnel to the present time. In 1937 the Elton Tunnel was driven by National Tunnel and Mines from the Utah-Delaware Mine to a portal just below the IS&R smelter site. The tunnel was 27,000 feet long and was completed in 1941. The Elton Tunnel carried mine de-watering flows to the Pine Canyon drainage and contained an electrical railway which delivered ore from the Bingham area to the IS&R smelter at a reported potential rate of up to 4,000 tons per day.

heart of the Bingham district to a point within 2 miles of the Tooele Smelter. This tunnel could be used by any Bingham shipper and gave Tooele a 17-mile advantage over all other smelters. Once ore arrived at the smelter site, 10 miles of electric industrial track equipped with three 7½-ton and two 18-ton locomotives and 50 cars made quick work of moving an ore flow of up to 4,000 tons per day.

Copper smelting at Tooele remained virtually unchanged from its beginning in 1910 to its final shutdown after World War II. The efficiency of the Tooele Smelter depended heavily on its ability to keep tons of ore and intermediate products moving smoothly through the four stages of a continuous smelting process. Because thorough technical analyses of the copper smelter are available elsewhere, the description presented here will be brief and will concentrate on a simplified account of the process and the materials handling problems solved by the Tooele Smelter.

The four major departments at Tooele –sampling, roasting, reverberatory smelting, and converting – can be followed in the copper flow sheet prepared by the HAER survey team. Sampling actually involved both crushing or milling the ore into pieces, ¼ inch or smaller, and removing a representative sample of the ore for assay by the smelter laboratories. The content or value of the ore sample determined the price paid to the shipper. Ore arrived in railroad cars which unloaded directly into the storage bins in the sample mill. Ore coming in over the aerial tramway was dumped automatically into rail cars that were then hauled to the sampler bins. Discharge gates beneath each bin opened onto a conveyor belt that carried ore to the crushers in the sample mill. After crushing and sampling, ore was discharged onto another conveyor belt running to the storage bins in the roasting building. The sampler building occupied ground space of 58 by 84 feet; its five stories framed with steel, covered with corrugated steel sheets and floored with concrete.

Roaster bins were much like the storage bins at the sampler. Filled by one conveyor, the bins discharged onto a series of other conveyors that made it possible to supply any of the MacDougall roasters automatically. Roasting forced out most of sulphur and water vapor in copper ore by heating the ore until the sulphur ignited and burned away, leaving a new ore-product termed calcine. The MacDougall Roaster consisted of six horizontal levels or hearths. Ore, coal and flux were charged into the top level, spread by circling rabble arms and gradually worked around the hearth to drop down to the next level where the same process repeated. By the time the ore worked down to the bottom level, its temperature was about 600° C. And most of the sulphur and water vapor had been driven off. Tooele installed 32 MacDougalls, each water-cooled, in two steel-frame iron-sheathed building 64 by 162 feet each. Fumes from the roasters ran first through two dust chambers 300 feet long and finally into a 210-foot flue leading to the main smoke stack.

Each MacDougall roaster discharge into bins or hoppers that loaded into calcine dump cars that discharged directly into the reverberatory furnaces (reverbs). The calcine and other ingredients were heated until the once-solid materials became a molten liquid and began to separate into layers (because of differences in specific gravity) of copper and waste or slag. The five reverbs at Tooele, each 19 feet wide and 102 feet long, had a total capacity of over 1,250 tons per day. Because of the high temperatures in the furnaces, each was heavily braced with steel "I" beams. Coal, calcine, and the fluxes were charged into the furnace and an iron silicate slag formed above the "matte" or layer of copper and iron sulfides. Slag, skimmed off the top of the mass, went into slag cars and then to the dump. Matte discharged from the bottom of the furnace into steel launders and troughs leading to the converters. Fumes from the reverbs passed through a 1,200-foot flue to permit dust to settle, and then up the main stack.

Total cost of constructing the copper smelter as of October 1,1910 was $2,413,679. The bill included 39 different budget categories. Utah Governor William Spry ignited the first fire in the reverbs on July 25, 1910 and this "blowing-in" marked the beginning of smelting operations at Tooele. The Utah Society of Engineers paid a formal visit to the smelter in October 1910 and pronounced the site "a new, modern and perfect plant." "The splendid system of transporting ore from the receiving bins to the sampler and from there to the various distributing bins and roasters resulted in one of the cleanest and best arranged plants" the visiting engineers could imagine. Although the general plan at Tooele followed that of the larger International smelter at Washoe, Idaho, the visitors found the standard equipment most admirably arranged and adapted for the elimination of manual labor, and for low operating costs.

As was often the case in the mining and smelting business, things did not work out as well as anticipated, despite the technical success of the plant. It was anticipated that half of the Tooele copper ore supply would come over the aerial tramway from the Utah Con mine in Bingham Canyon. The year 1910 proved to be the year the Utah Con ran out of good copper ore. The Copper Handbook, main journal-encyclopedia of the smelting industry, reported in 1911 that daily tonnages at Tooele were running as low as 150 tons and seldom as high as 550 tons, well below the full smelter capacity of 4,000 tons per day. The handbook pointed out that Tooele was "most excellently designed and equipped." but also that while "technically a masterpiece, it scarcely can be considered a commercial success as yet."

With 2½ million dollars invested in a safe site, extensive transportation facilities, and a relatively clean smelter, the International Smelting and Refining Company was not about to give up. Smelters were generally expected to last at least five years, and sometimes ten, before ore ran out – one year of less-than-full-capacity operation was too great a loss even for a company as big as International. The answer to the problem was lead – lead from the silver-lead ores uncovered in Bingham Canyon, in Park City, and in Tintic; lead concentrates from mines in Idaho and Nevada. By using the same site and much of the same machinery for a new lead smelter, International could break into a new and profitable custom lead smelting business at the same time that it retained the copper smelter. This decision turned out to be a wise one – copper smelting finally collapsed in 1946, but lead smelting continued profitably until 1971, longer than any other custom smelter in the Mountain West.

Managers in the International company, and at Tooele, could not have known that their decision was historic, their main concern was to make the smelter pay. Construction started on 1 March 1911 and the first lead blast furnace was blown in exactly one year later. Construction of a lead smelter by a company primarily engaged in copper-smelting produced a number of important innovations. Retaining the same goals of efficient materials handling and low manual labor requirements, the company introduced many of their copper-smelting methods to lead smelting. The result: "a newcomer in the lead field (was) the first to adapt modern charging methods to lead metallurgy." Lead smelting also created a number of dangerous and visible pollutants and, with damage suits still a possibility – especially since the hills around the smelter were already turning brown and a few horses had been killed as a result of the sulphuric acid, arsenic and other pollutants released into the atmosphere by copper processing – the company adopted new methods of filtration to cut down on pollutants.

Much like copper ores, lead ores were first milled and sampled, then roasted, melted and separated, and then tapped into ingots for shipment to a refinery. Milling and sampling machinery paralleled that used on copper ore, but the last three steps were quite different. Instead of the multiple-hearth MacDougall furnace used to roast copper ore, the Tooele lead operation took advantage of a very new development in lead ore roasting, the Dwight-Lloyd sintering machine. A development of the decade previous to the construction of the Tooele lead smelter, the sintering process consisted of roasting fine ore, thus burning off most of the sulphur and producing a sinter hard enough to be used easily in a blast furnace where very fine or soft material could choke up the necessary air blast. Sintering was first carried out on a batch method in Huntington and Heberlein sintering pots, which required several hours to complete the process. The Dwight-Lloyd machine changed sintering into a continuous process in which ore, automatically supplied to each machine, was spread on a moving belt, ignited by a gas flame, burned as it passed over a forced draft and then automatically discharged into a railroad hopper cars. The ten sintering machines were installed at Tooele by the Dwight-Lloyd Metallurgical Company of New York. Savings in manual labor and the increased efficiency of the process were great. In fact, the original Tooele machines remained in use until the smelter shut down in 1971, and sintering continues to dominate lead smelting practices today.

The blast furnace was substituted for the copper reverberatory furnace and here the Tooele Smelter broke new ground by applying copper techniques to lead smelting. Charging a lead blast furnace usually required the frantic work of thirty to forty men, at Tooele it took four. Sinter and other materials for the furnace arrived on railroad cars that dumped directly into storage bins located above the charging floor of the furnace. To charge a furnace, one simply opened a gate and the charge dropped through two heavy trap doors and into the furnace.

The blast furnace produced three materials – slag, matte, and bullion. Slag ran continuously from the furnace to 12-ton slag cars and thence to the dump. Matte, a thin layer between the slag and bullion, was tapped off and put through converters. Lead bullion went into small railroad cars and then to the drossing plant, where it flowed into large drossing pots in which it was again heated, while air bubbled through it and the resulting slag skimmed off. Once slag no longer formed in the drossing pot, the lead was poured into pigs ready for shipment via railroad to the International refinery at East Chicago, Illinois.

As mentioned earlier, lead smelting created some rather toxic pollutants, which usually were allowed to escape into the atmosphere. Tooele, unwilling to risk damage suits, took every available precaution. The sintering plant produced large volumes of fine dust high in lead content. To capture this dust, sintering fumes first flowed through a 446-foot baffled horizontal flue 6 feet wide and 10 feet high. Inside this flue, the company hung 32,000 steel wires to accelerate the dust-settling process. After leaving the flue, the sinter went to a Cottrell treater, one of the first innovations responding to the antipollution court decisions and one of the first electrostatic precipitators. The Cottrell consisted of a number of long metal tubes about seven inches in diameter with a number 10 insulated copper wire suspended in the center of each tube. Gases from the flue flowed through the tubes and when the wire received a unidirectional electrical charge of between 25,000 and 60,000 volts, the current passed from the wire to the tube, negatively charging the dust particles in the gas and causing them to cling to the sides of the tube. To clean the Cottrell precipitator one simply turned the electricity off, hit the tube, and the collected dust fell to the hoppers below. This dust returned to the blast furnace for reprocessing.

The lead blast furnace employed a different filtration method. After flowing through a 600-foot horizontal flue eight feet by twelve feet and again filled with thousands of wires to slow air movement and accelerate dust settlement, the blast furnace gasses went to what was appropriately named a baghouse. This house, 100 feet long and 54 feet wide, contained 1,440 tubular cotton bags. A fan forced the blast furnace fumes through these bags and then up a 200-foot stack to the atmosphere. To clean the bags, Tooele developed a remote method of simply reversing the air flow several times in succession, thus expanding and collapsing the bags and causing the trapped dust to fall into hoppers below. This dust also went back to the blast furnace for reprocessing.

Power requirements for such a diverse operation as the Tooele Smelter called for a major power plant installation. Housed in a handsome brick structure 240 feet long and 52 feet wide, the plant provided AC and DC electrical power and air compressed at 2½, 15, and 90 pounds per square inch. Two vertical, triple-expansion, Union Iron Works marine engines dominated the center of the building and powered alternating current generators for lighting and electric motors throughout the smelter. Two Nordberg-Corliss steam engines and a Curtis turbine supplied power for the direct current generators used to power the electric railway haulage system and the motors in the numerous overhead cranes. Air compressed to 2½ psi for the lead blast furnace came from two Roots blowers, powered by Corliss engines from the Allis-Chalmers Reliance works. Two large steam engines, one a 350-hp Nordberg, the other a 600-hp Rarig, supplied 15 pound air to the copper and lead converters. To supply air at 90 psi to the sampling mill, blacksmith shop, and for pneumatic tools, the smelter installed a large Westinghouse electric motor and a Laidlaw-Dunn-Gordon steam engine. The power house, which additionally contained a wide variety of smaller pumps, exciters, motors, and its own shop, remained largely unmodified throughout its 60-year history. The old marine engines were torn out in 1924 and one of the Reliance compressor units blew up in 1970, but the power house, like the rest of the Tooele Smelter, achieved longevity that proved its sound engineering.

A decade after its completion, the Tooele Smelter contributed about $20 million annually to the Utah economy and furnished direct employment to approximately 2,000 men. The company paid one-sixth of the taxes in Tooele county, supported five-eights of the county population, and purchased $15 million worth of ore annually, mostly from local mines. The plant annually treated 750,000 tons of ore and produced 72,000 tons of lead, 10,000 tons of copper and numerous by-products, including 9,000,000 ounces of silver.

From 1915 to 1972, the Tooele Smelter had little reason to alter its basic operations. The copper smelter closed in 1946. The lead plant added a few new operations during its history: a pioneering flotation mill to treat lead-zinc sulphide ores in 1924, and a slag treatment plant to recover zinc and lead in 1941. But the basic metallurgical processes and the machinery required to carry them out remained essentially unchanged for sixty years. Eli Steinbeck, retired superintendent with 45 years of service at the Tooele Smelter, called the flexibility demanded by a custom smelter like Tooele "an education for a young metallurgist." He also noted that in its last years, Tooele had become a shoestring operation in which rising maintenance costs at the old plant demanded the best in entrepreneurship and low-cost ingenuity from its operators. Finally, after more than sixty years of continuous operation, maintenance costs exceeded $20,000 per month and the company decided to close the plant.

As an early reaction to anti-pollution court decisions, the Tooele plant demonstrates certain technological and management responses in this area and several significant improvements in smelter practice resulted from the threat posed by damage suits from nearby residents. None of the filtration devices was specifically required by law. Their development and installation sprang from a company decision to protect itself from suspicious or even hostile neighbors, neighbors that included the state supreme court. The Cottrell treater, improved baghouse filtration, better dust settlement in the flues, and cleaner, safer, mechanized materials handling all received favorable comment in the contemporary engineering press. At the same time, the smelter went to great lengths to make sure local farmers either would not, or could not, sue for damages. Weather stations, agricultural surveys, land options and outright purchase helped to protect the plant from the smoke farmers.

By and large, the effort worked. It is true that the foliage covering the canyon hills soon disappeared, but no one lived there anyway. A few horses died of lead when mistakenly pastured too near the smelter, but cattle did quite well on the same pasture. The smelter itself compiled an impressive safety record; and local support, even after the plant shut down, remained quite strong. The company policy of better engineering and thorough self-protection proved to be the successful answer to the anti-pollution sentiments of the Utah farmers and their friends on the bench.

Tooele was an important representative of now-vanishing type of industrial plant, and as such, it deserves the thorough attention of industrial archeologists and others. The HAER team included four architectural students, a student metallurgist, two student engineers, and one historian. They were fortunate in having access to the drawing files and business records of the smelter, and the drawing prepared by the team represent a compilation of those drawings, just as this paper is a compilation from scores of historical sources. The two process flow drawings depict a method long-abandoned, and it required the close cooperation of the historian and metallurgist to prepare accurately even these simple diagrams.

It is impossible to point to a single "landmark" innovation at Tooele. It was, instead, the innovative combination of engineering and entrepreneurship that made Tooele the longest lasting of its kind. With Tooele gone, over thirty mines and other lead recovery operations had to find another market, but few could afford the extra cost of shipping to El Paso, Texas, East Helena, Montana, or Kellogg, Idaho, so they had to cease operation. It is ironic to note that the Tooele Smelter, which grew from the salvaged steel and machinery of earlier smelters, was itself demolished for salvage after it shut down. Tooele had its origins in a new set of rules and a more considerate operating style that remained acceptable standards until the renewed environmental concerns of the 1970s. Lasting far longer than originally anticipated, the construction and demolition dates of the Tooele Smelter mark the beginning and the end of an era in the history of custom smelting in the Mountain West.

From 1974 through 1981 the Anaconda Company constructed and operated a mine and mill known as the Carr Fork operations. The Carr Fork operation was just to the east of the IS&R Smelter in Pine Canyon on approximately 12.5 acres. The Carr Fork operation began processing ore in 1979. Tailings from the Carr Fork operations were transported down Pine Canyon to the original IS&R tailings locations where a new 60-ft high tailing dam along the western edge of the original tailing ponds was constructed, as part of the Carr Fork operation. Because of the short operational duration of the Carr Fork Mill, the Carr Fork tailings encompass only about 64 acres. (Jackson, 1979)

The Carr Fork operation experienced several set backs soon after production began. Eventually the mine was idled in November 1981 while Anaconda waited for more favorable copper prices (JBR, 1986). When the economic feasibility of the operations did not improve, the processing facilities were dismantled, sold and removed from the property. From inception to complete closure the Carr Fork operations lasted from 1974 to 1983. The property which housed the Carr Fork operations (several acres of land east of the smelter site and selected other Carr Fork holdings (see Figure 1-3, Kennecott Land Sale), were sold to Kennecott in October 1985 (JBR, 1986). An abridgement of some of the historical dates for the IS&R/Carr Fork Site is shown on Figure 1-4, Operational Timeline.

The Utah Mined Land Reclamation Act of May 1975, required reclamation for the Carr Fork operations. The IS&R smelter was "pre-law" and did not fall under clean-up requirements of the Act except as affected by post operations. However, Atlantic Richfield voluntarily included both the areas encompassed by the IS&R and Carr Fork operations in its reclamation work.

In 1986 after preliminary studies were conducted by various agencies, Atlantic Richfield evaluated the Site and prepared a reclamation plan for the Site (JBR, 1986). Upon approval to proceed from the State of Utah Division of Oil, Gas and Mining, reclamation actions identified in the plan were completed during the fall and spring of 1986/1987 (Anderson, 1986).

An aerial photo of the Site and various operation and reclamation features are shown on Figure 1-5, 1986 Reclamation Features. The Site was vegetated during the reclamation activities with grasses, forbs and shrubs. Re-seeding of specific areas has been performed as necessary during site maintenance activities since then. Currently the area consists of gently sloping benches interspersed with short, steeper fill slopes. Since 1994, when the State of Utah and Atlantic Richfield signed a conservation easement, the Site has been managed by the UDWR for wildlife habitat and conservation values.

1.3.2 On Site Waste Production, Storage, and Disposal Activities

Operating activities on the Site were comprised of a complex series of processes (see Figure1-6, IS&R Historical Buildings) that functioned during different periods of time, and included the following operations:

- Ore hauling and handling

- Milling and grinding
- Ore concentrating
- Tailings thickening and disposal
- Copper smelting
- Lead smelting
- Slag production and disposal
- Zinc and lead recovery from slag
- Equipment waste parts and other landfill wastes
- Tailing ponds

These processes are identified and discussed, as they relate to each other, in and 2.5.2 "Operational Impacts Investigation Results". Very few official production records, or waste products management and disposal records have survived the demolition and clean up of the Tooele Smelter or Carr Fork Mill sites. Waste production, storage, and disposal for each of the plant functions are briefly discussed and summarized in the following paragraphs. Information presented is based on published articles written about the facility while in production mode and technical information found in these articles.

1.3.2.1 Ore Hauling and Handling

Ore hauling and handling facilities included rail roads, switching yards, ore receiving yard, warming shed, storage bins and retrieval systems. Incoming ore, in most cases, came directly from the mines and therefore was not concentrated. Fines leaking from the ore cars during shipment would have infiltrated into the ballast and road bed, becoming a part of the natural and structural grade fills. Samples were collected during the RI to determine if high concentrations of COC remain within these rights-of-way. Raw and concentrated ores were handled and transported around the Site by the rail lines from 1910 to closure in 1972. Little evidence of a designated waste collection area for this hauling/handling equipment was found during the investigation. However, during development of the Reclamation/Stabilization Plan in 1985 several small piles of equipment debris were found in various areas of the Site. These materials were disposed of in the Carr Fork landfill in 1986.

1.3.2.2 Milling and Grinding

The milling, grinding and sampling operation was adjacent to the ore receiving and storage bins. This operation consisted of crushing and grinding the raw ore to produce fines that could be processed in the flotation concentrators. From 1910 to 1924 the fines were delivered directly to the copper and lead smelters. After 1924, until concentrator closure in 1968, the fines were prepared for processing in the flotation concentrators.

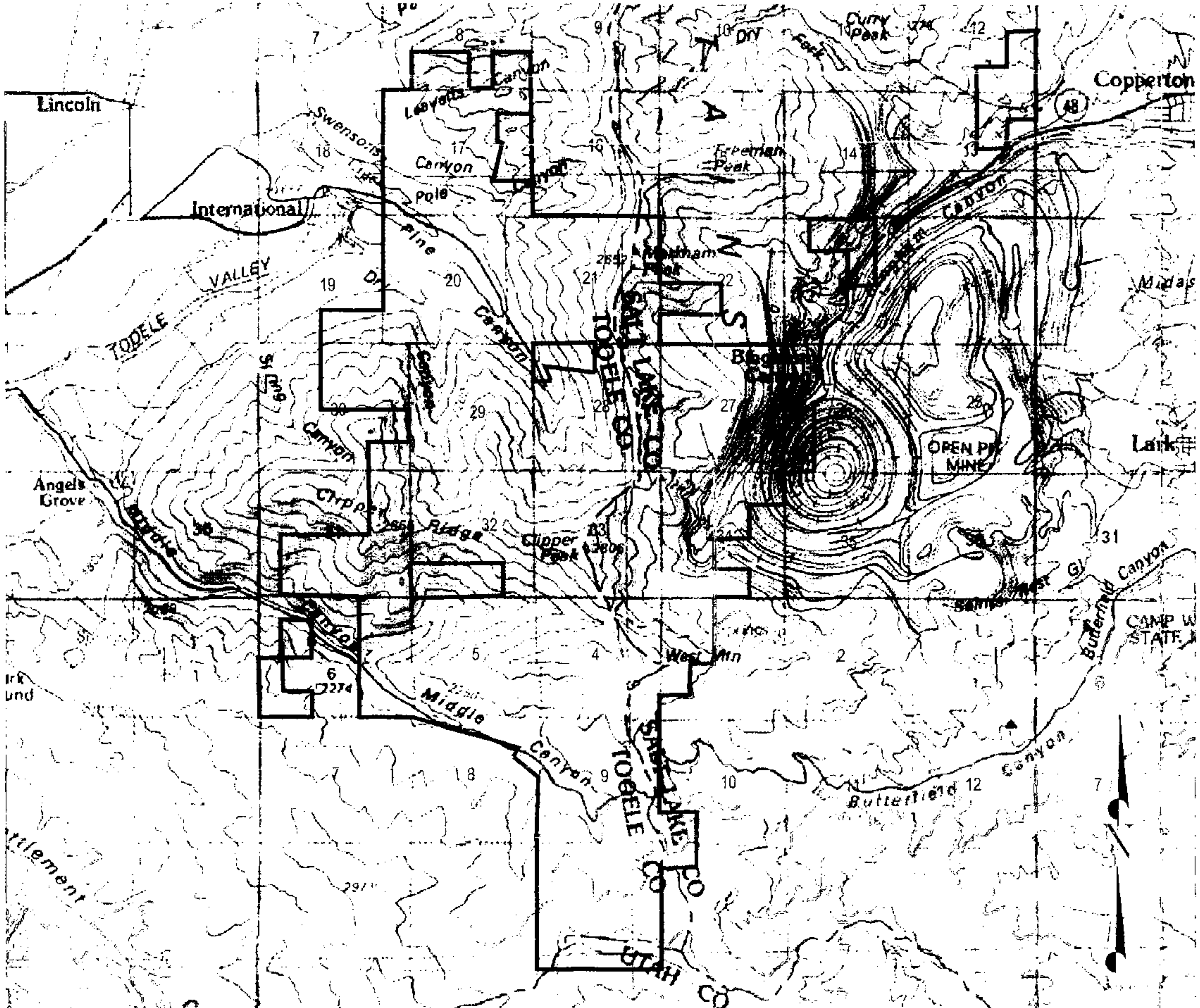
1.3.2.3 Ore Concentration

The Oxide Concentrator was constructed on the south hillside of Dry Canyon, west of the thaw sheds beginning operation in 1924. The Oxide

Color Map(s)

The following pages contain color that does not appear in the scanned images.

To view the actual images, please contact the Superfund Records Center at (303) 312-6473.



General Notes

FORMER ANACONDA PROPERTY SOLD TO KENNECOTT (OCTOBER 1985)

ATLANTIC RICHFIELD CO. BOUNDARY

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

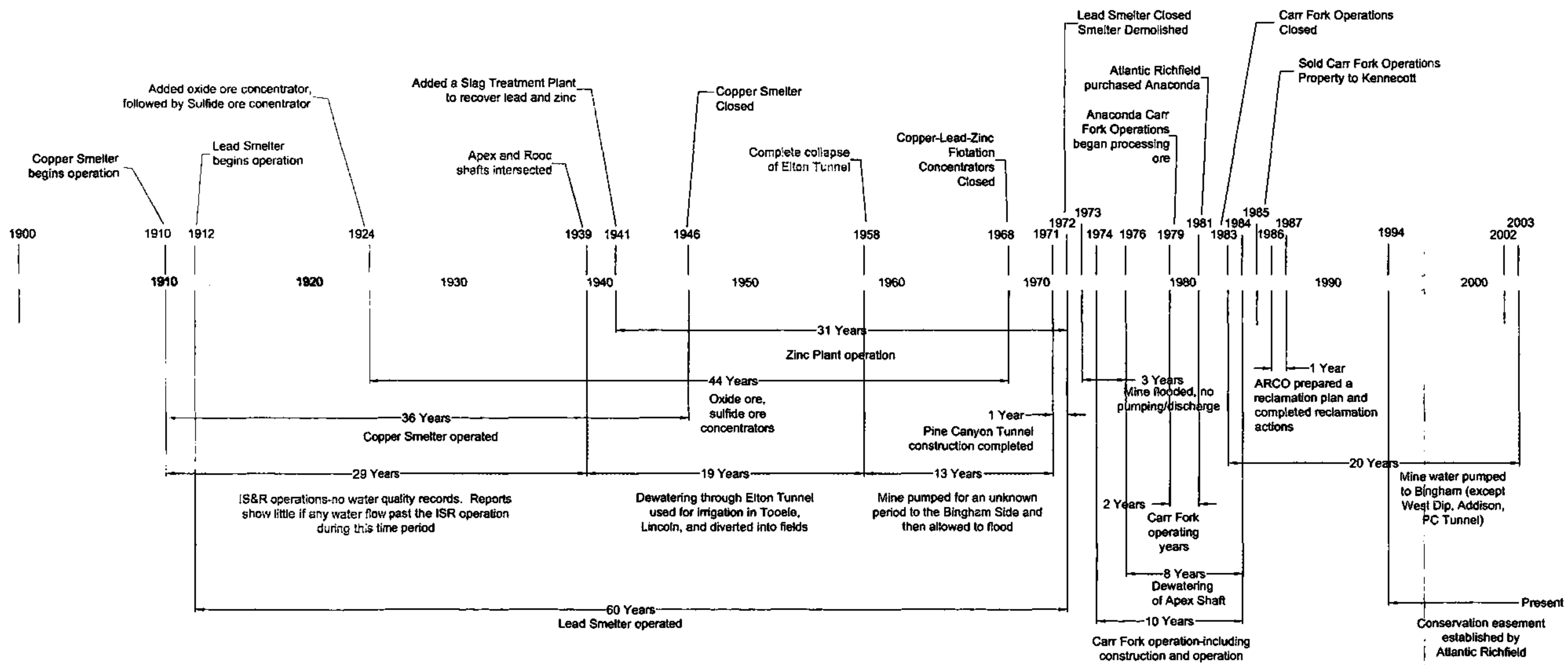
ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: GKL
ENGINEER: KC
APPROVED: SA

KENNECOTT LAND SALE
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date MAR-03
Scale NTS
Sheet FIGURE 1-3

IS&R / CARR FORK TIME LINE



General Notes

—— IS&R/Carr Fork Operations

—— Mine Dewatering

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

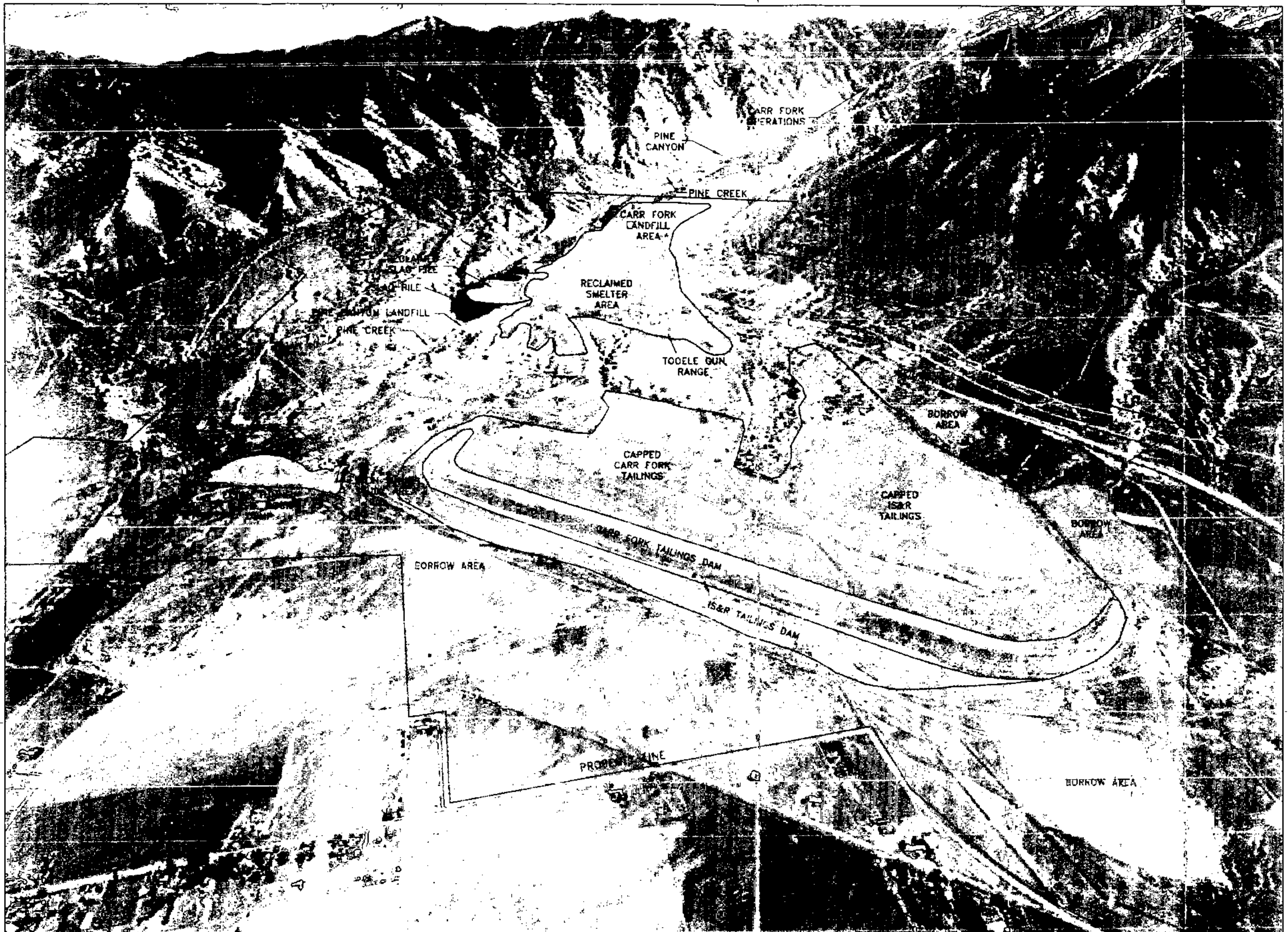
ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: GKL
ENGINEER: KC
APPROVED: SA

OPERATIONAL TIMELINE
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date MAR-03
Scale NTS

FIGURE 1-4



General Notes

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: MSB

ENGINEER: KC

APPROVED: SA

1986 RECLAMATION FEATURES

REMEDIAL INVESTIGATION

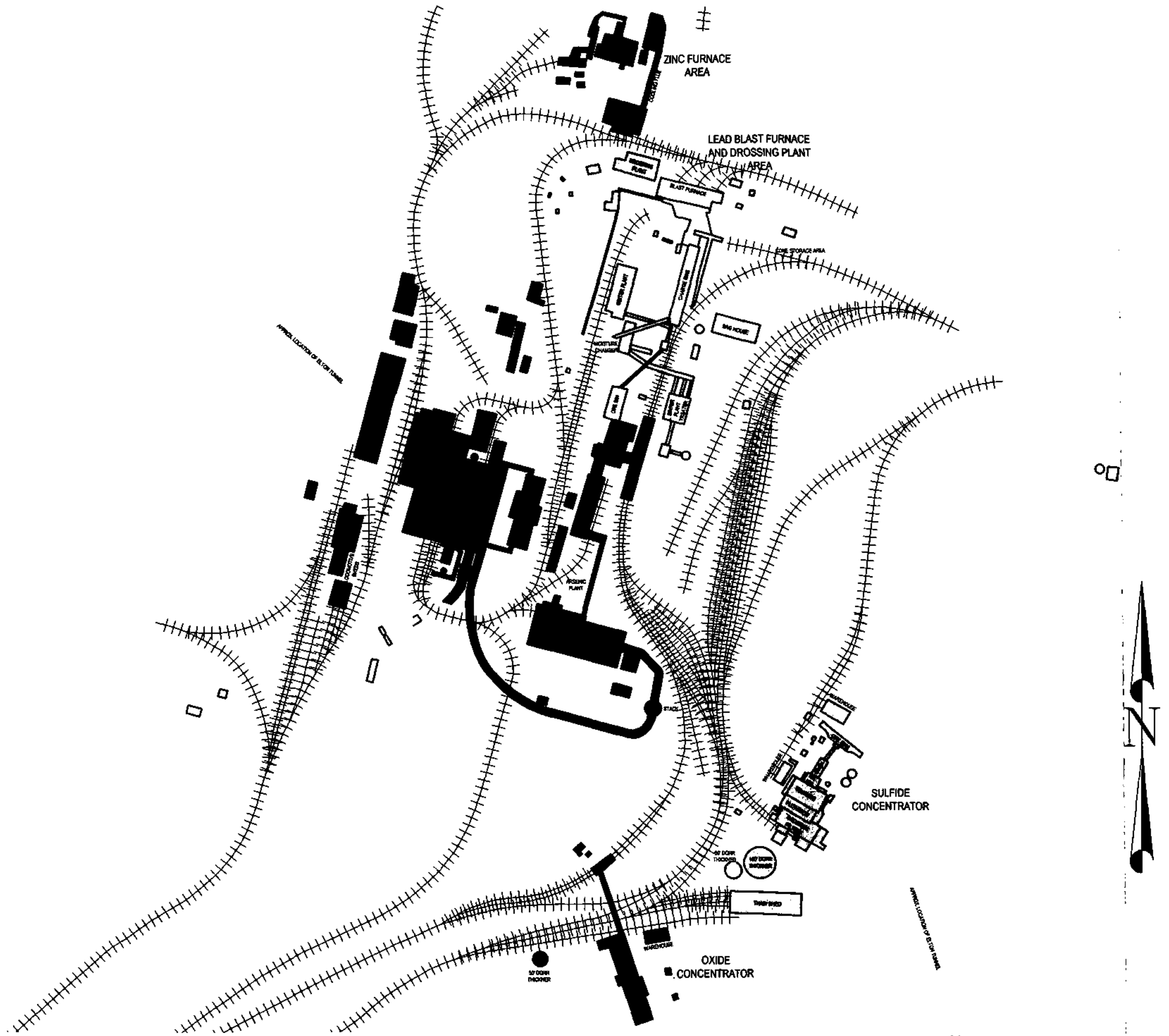
TOOELE, UTAH

Project 97-069

Date MAR-03

Scale NTS

Sheet FIGURE 1-5



General Notes

1910	
1912	
1924	
1928	
1941	
RAILROAD	
CAPPED AREA	

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SA

IS&R HISTORICAL BUILDINGS
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date MAR-03
Scale NTS

FIGURE 1-6

Concentrator was followed by the Sulfide Concentrator which was constructed on the north Dry Canyon hillside, north of the thaw sheds. The major waste by-product produced at the concentrators was tailings; separated from the ore concentrates by flotation technology. Other additions to control and enhance the process efficiency are identified, quantified and discussed in Section 2.5.2, "Operational Impacts Investigation Results". The tailings were transported to the tailing pond hydraulically by pipeline or flume. Tailing deposits, left in place after the concentrators were dismantled, were identified, during the 1985 Investigation, near the out flow of the Oxide Concentrator and between the railroad grades to the west. These areas were found to contain approximately 100 cubic yards of tailing waste. Other wastes found during the 1985 Investigation were several small mounds of ore concentrates and pyritic concentrates alongside the railroad loading spur at the Oxide Concentrator. These feedstocks consist of copper, lead and zinc ore, which had been crushed and ground. Total volume was estimated to be about 195 cubic yards. Also located during the investigation were piles of mill feed and crushed ore at the Sulfide Concentrator Site, representing both sulfide and oxide feedstocks for the Lead, Zinc and Copper process. The total volume of remaining stock piles was estimated to be about 386 cubic yards. All of these wastes were addressed and remediated in 1986 in accordance with the Reclamation/Stabilization Plan.

1.3.2.4 Tailings Thickening and Disposal

Chemical flocculents were added to the tailing mixture and mixed before being delivered to a large clarifier or stilling basin. The flocculents thickened the mixture causing the particles to adhere to each other inducing a faster settling rate. As the tailings settled to the bottom of the clarifier they were mixed with a portion of the process water and transported by pipeline to the tailing pond. At the tailing pond the tailings would separate from the process water and build a sediment delta for permanent storage. The excess process water collected at the clarifier was then returned to the process for reuse. The flocculent compounds are identified and discussed in additional detail in Section 2.4.2 of this Report.

1.3.2.5 Copper and Lead Smelting

The various steps in the copper smelting, and lead smelting processes, including the various charges and process by-product wastes generated during the smelting process are identified and discussed Section 2.5.2 of this report. The by-product wastes collected from bag-houses, flues, stacks and other collecting devices were, reportedly, recycled back into the process flow. Ore and product spillage during the process material handling were also returned to the beginning of the circuit for recovery of residual metals. During the 1985 Investigation, flue and stack dust were found as discrete piles and found spread on the ground surface in the south railroad yard, the lead blast furnace and zinc furnace areas, and in the east part of the smelter site. This material was lead and zinc rich with an estimated total volume of 4,820 cubic yards. Pyrite concentrates were found on the east side of the smelter site and were finely ground. Their volume was estimated to be 1,250 cubic yards. An efflorescent material believed to be roaster-building dust-chamber waste was found in soil fill behind the old roaster wall. The volume was estimated as less than 3 cubic yards. About 10 cubic yards of zinc furnace flue dust was found in drums, in piles, and found spread over the ground. These wastes were stabilized in accordance with the Reclamation/Stabilization Plan.

1.3.2.6 Slag Production and Disposal

The end product of all smelter process wastes other than dust, fume and off-gases is slag. The slag was collected as dross, having been separated from the smelter product metal by natural density separation, and transported to the slag dump in Pine Canyon by large slag buckets mounted on rail cars. The molten slag cooled and solidified into a stable, rock-like, non-metallic product. In addition to slag, fly ash from the on-site powerhouse was also disposed of in the slag pile.

1.3.2.7 Zinc and Lead Recovery from Stored Slag

The by-product wastes generated by the zinc and lead recovery process are identified and discussed in Section 2.5.2. No known disposal area for waste from this process, other than the slag itself, was found during this investigation.

1.3.2.8 Landfill Wastes

The 1985 Investigation identified thee landfill areas on or near the smelter site. The Parking Lot Landfill is in a drainage channel immediately west of the former IS&R parking lot at the west edge of the former smelter site. The landfill was found to extend for a distance of about 700 feet within the drainage. Waste consisted mainly of ceramic crucibles, and other laboratory equipment, bricks, glass, bottles, scrap metals, etc. Some residue dusts were also observed. The Pine Canyon Landfill is located on the south bank of Pine Canyon, immediately west of the main slag pile. This landfill was reported to be the disposal site for scrap metal, smelter components, supplies such as flue pipe, precipitator wires, other types of operating wastes, and residue dusts or waste associated with the equipment. The landfills were included in the Reclamation/Stabilization Plan reclamation work.

The third landfill was the Carr Fork landfill that was created and used by Anaconda during the operation of the Carr Fork mine. This landfill was also used during reclamation for disposal of building debris.

1.3.2.9 Tailing Ponds

The tailing waste ponds contain the largest volume of smelter residues on the Site. The IS&R tailings, as a result of elevated concentrations of oxidized iron, have a yellow to orangish-brown color. The mineralogy of the IS&R tailings varies due to the fact that this smelter was a custom smelter and feed stock ores varied with the type and quality. These tailings cover approximately 210 acres.

1.3.3 Previous Regulatory Involvement

Regulatory agency involvement on the development of the Carr Fork/IS&R Reclamation Project completed in 1987 is documented below.

- Utah Division of Oil, Gas and Mining reviewed a Notice of Intent for the Carr Fork operations and approved the Mining and Reclamation plan for same on March 7, 1980.
- The Conceptual Reclamation/Stabilization Plan (JBR, 1986) for the Site was discussed with the Utah Division of Oil, Gas and Mining and the Division of Environmental Health on July 22, 1985. Reclamation of the remaining buildings and other IS&R Facilities was included as a voluntary action in the Reclamation/Stabilization Plan.
- The Draft Conceptual Reclamation/Stabilization Plan (JBR, 1986) for the Site was submitted to the EPA Region VIII, Utah Division of Oil, Gas and Mining, Utah Division of Environmental Health, and the Tooele County Planning Office for review and comment on August 26, 1985.
- Representatives of the Utah Division of Oil, Gas and Mining and the Division of Environmental Health visited the Site with Atlantic Richfield representatives on September 17 and 24, 1985 to discuss the proposed field investigations and data analyses.
- The final Reclamation/Stabilization Plan for the Site was submitted to the Utah Division of Oil, Gas and Mining, Utah Division of Environmental Health, and the Tooele County Planning Office for review and comment on March 3, 1986.
- The construction of the Reclamation/Stabilization Plan elements was conducted in late 1986 and early 1987. Inspectors from the Utah Division of Oil, Gas and Mining visited the Site during construction.
- Post reclamation monitoring of the Site was performed in 1987, 1988, and 1989. A final report on the monitoring activities was prepared on April 5, 1990 and submitted to the Utah Division of Oil, Gas and Mining (JBR, 1990). This report indicated that the objectives of reclaiming and stabilizing the Site were largely met with some relatively small areas requiring additional grading, which were accomplished the next construction season.
- The Utah Division of Oil, Gas and Mining released Atlantic Richfield of further mining reclamation liability for the Site in 1990.

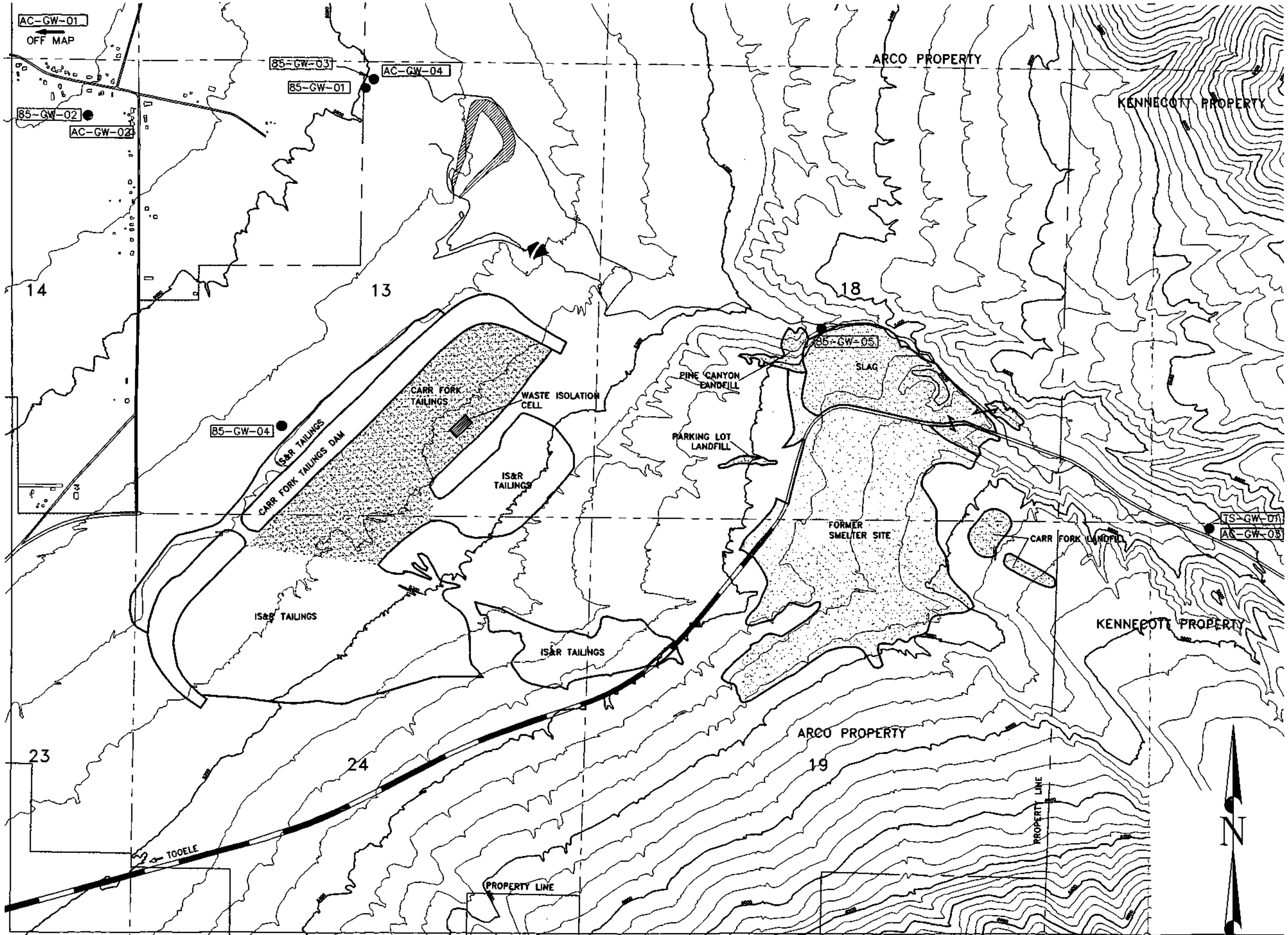
- Atlantic Richfield entered into a conservation easement agreement with the Utah Division of Wildlife Resources in April, 1994 to manage the property for wildlife habitat and conservation values.

Involvement of regulatory agencies in the federal CERCLA process for the Site is documented below.

- The Utah Division of Environmental Health, Bureau of Solid and Hazardous Waste conducted a PA of the Site in March 1984. This PA recommended conducting a full SI.
- The Utah Division of Environmental Health, Bureau of Solid and Hazardous Waste conducted SI of the Site and published their report on August 31,1984.
- The EPA Region VIII FIT conducted additional SI studies in the summer of 1985.
- The HRS scoring package prepared on September 25, 1985 concluded that the total site score was 9.27. This scoring was prepared prior to any reclamation activities completed on the Site in 1986/1987.(Tuesday, 1985)
- From September, 1995 to February, 1996, the Utah Department of Environmental Quality Division, under an agreement with the EPA, conducted an Expanded SI in accordance with EPA guidance for activities at CERCLA sites. This investigation evaluated the Site based on previous samples collected with supplemental on-site sampling completed as part of the investigation. (Sadik-McDonald, 1997)
- The HRS scoring package prepared on February 24, 1999, concluded that the total site score was 58.31.(EPA, 1999)
- April, 1999, EPA proposed to list the IS&R Site on the NPL.
- July 2000, Final listing of the EPA of the IS&R Site on the NPL.
- September 2001, Site Work Plan and Field Sampling and Analysis Plan submitted to the EPA.

1.3.4 Previous Site Characterization Studies

The following paragraphs summarize previous sampling activities and investigations on the Site. Sampling analytical results are included here as: Table 1-1 (Previous Groundwater Sampling Analytical Results), Table 1-2 (Previous Soil Sampling Analytical Results), and Table 1-3 (Previous Surface Water Sampling Analytical Results). Previous sampling locations are shown on Figure 1-7 (Previous Groundwater Sample Locations), Figure 1-8 (Previous Soil Sample Locations), and Figure 1-9 (Previous Surface Water and Sediment Sample Locations). Also, total lead and arsenic concentrations in soil are shown on Figures 1-10 and 1-11. These summaries are not all-inclusive of every study which has been performed on and adjacent to the Site, but attempt to represent the major studies pertaining to the Site.



General Notes

- 1985 GW SAMPLES JBR ENVIRONMENTAL
- 1985 GW SAMPLES ENVIRONMENT & ECOLOGY
- 1995 GW SAMPLES UDEQ

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON
ENGINEERING COMPANY, INC.

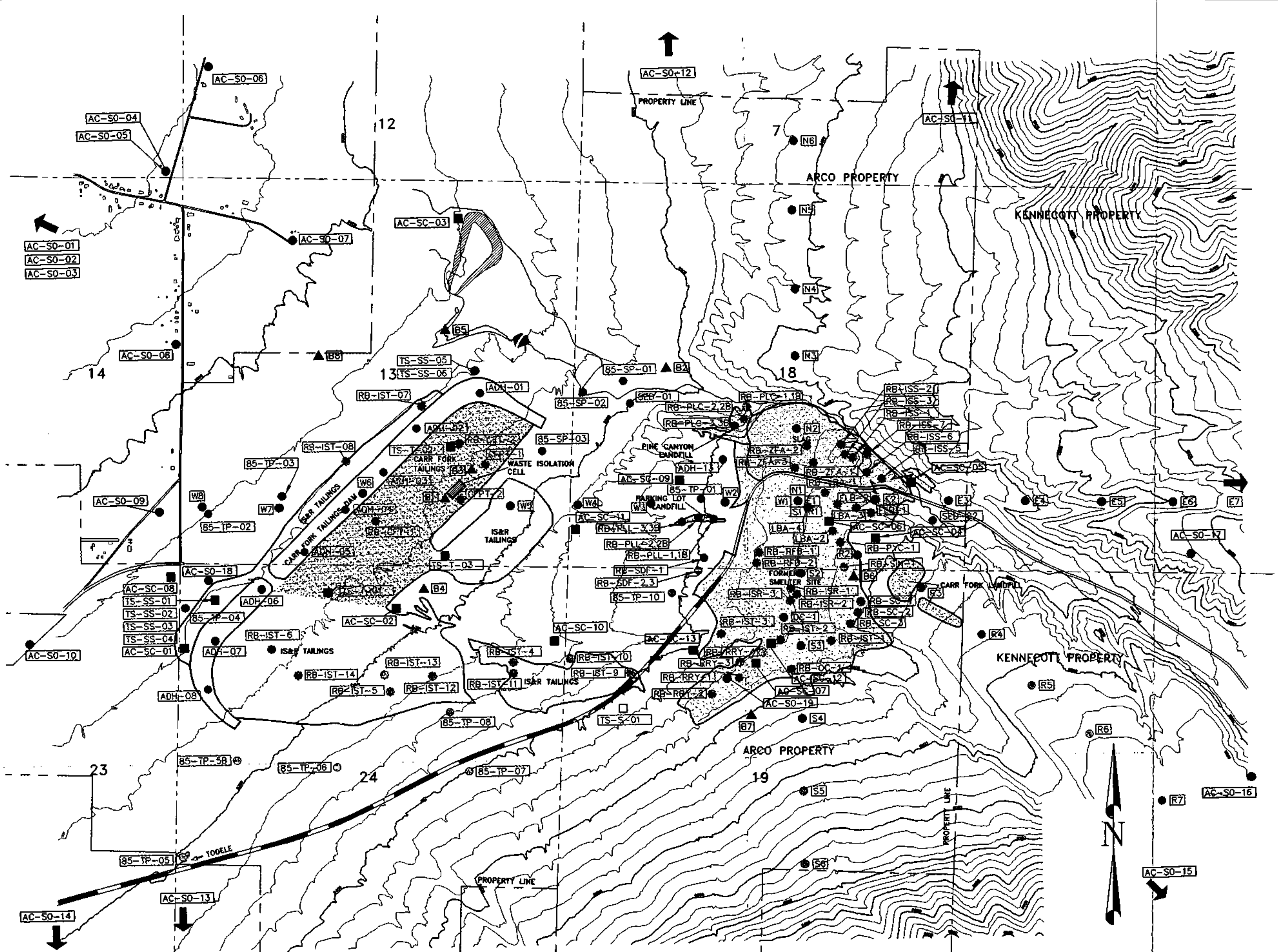
DRAWN BY: AF
ENGINEER:
APPROVED:

PREVIOUS GROUNDWATER SAMPLE LOCATIONS

REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069-04
Date MAR-03
Scale NTS

FIGURE 1-7



General Notes

- 1985 WASTE MATERIALS JBR CONSULTANTS
- 1985 SUBSURFACE SOIL JBR CONSULTANTS
- 1985 SURFACE SOIL JBR CONSULTANTS
- 1985 SUBSURFACE SOIL ECOLOGY AND ENVIRONMENT
- 1985 TAILINGS SAMPLES ECOLOGY AND ENVIRONMENT
- 1985 BACKGROUND SAMPLE ECOLOGY AND ENVIRONMENT
- 1995 SUBSURFACE SOIL UDEQ
- 1995 SEDIMENT UDEQ
- 1995 SURFACE SOIL UDEQ
- 1995 SOIL BORING AND LYSIMETER LOCATIONS UDEQ

No.	Revision/Issue	Date
1	Revision 1	06/03

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

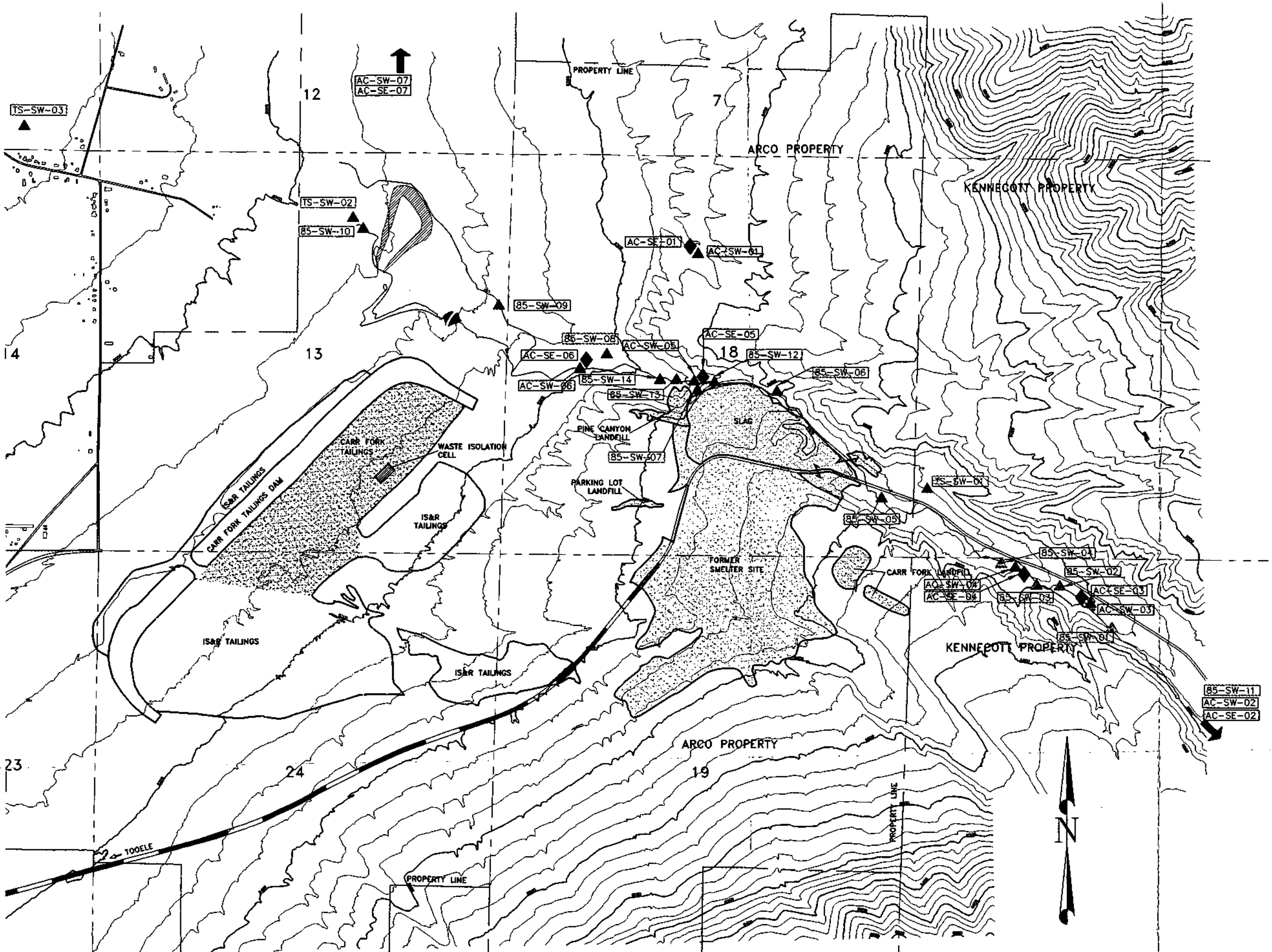
DRAWN BY: AF
ENGINEER: KC
APPROVED: SA

PREVIOUS SOIL SAMPLE LOCATIONS

REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069-04
Date MAR-03
Scale NTS

FIGURE 1-8



General Notes

- ▲ 1985 SURFACE WATER JBR CONSULTANTS
- ▲ 1985 SURFACE WATER ENVIRONMENT AND ECOLOGY
- ▲ 1995 SURFACE WATER UDEQ
- ◆ 1995 SEDIMENT UDEQ

No.	Revision/Issue	Date
1	Revision 1	06/03

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SA

PREVIOUS SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS

REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069-04
Date MAR-03
Scale NTS

FIGURE 1-9

TARGET SHEET
EPA REGION VIII
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 2024001

SITE NAME: INTERNATIONAL SMELTING & REFINING

DOCUMENT DATE: 08/01/2004

DOCUMENT NOT SCANNED

Due to one of the following reasons:

- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☑ OVERSIZED
- ☐ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

FIGURE 1-10 PREVIOUS SOIL TOTAL LEAD CONCENTRATIONS
FIGURE 1-11 PREVIOUS SOIL TOTAL ARSENIC CONCENTRATIONS

Contact the Superfund Records Center to view available document.
(303) 312-6473

Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Aluminum		Arsenic		Antimony		Barium		Beryllium		Cadmium		Cobalt		Chromium	
Sample Fraction				Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Groundwater Results																			
GW-02	Sagers Well - Lincoln	10/7/71	Anaconda	0.32		<0.001								<0.05				<0.10	
GW-02	Sagers Well - Lincoln	5/17/72	Anaconda	1.95		0.025								<0.005				<0.01	
K	16" Well - Boys Ranch	5/18/72	Anaconda	0.24		0.419								<0.005				<0.01	
K	16" Well - Boys Ranch	5/25/72	Anaconda											0.01					
GW-02	Sagers Well - Lincoln	6/26/72	Anaconda											0.02					
GW-02	Sagers Well - Lincoln	7/3/72	Anaconda	1										<0.05				<0.10	
K	16" Well - Boys Ranch	7/6/72	Anaconda	1		0.353								<0.05				<0.10	
GW-02	Sagers Well - Lincoln	7/6/72	Anaconda											0.014					
K	16" Well - Boys Ranch	8/14/72	Anaconda	0.1						0.31				0.005					
K	16" Well - Boys Ranch	8/15/72	Anaconda	0.02										0.006					
K	16" Well - Boys Ranch	8/18/72	Anaconda																
GW-02	Sagers Well - Lincoln	8/18/72	Anaconda																
K	16" Well - Boys Ranch	8/30/72	Anaconda	0.1						0.31				0.005					
GW-02	Sagers Well - Lincoln	8/30/72	Anaconda	0.03		0.04				0.2				0.002					
K	16" Well - Boys Ranch	8/31/72	Anaconda	1.29		0.587								<0.005				<0.01	
K	16" Well - Boys Ranch	9/20/72	Anaconda	0.04						0.28									
K	16" Well - Boys Ranch	10/9/72	Anaconda	0.02						0.25									
K	16" Well - Boys Ranch	11/8/72	Anaconda	0.01						0.2									
K	16" Well - Boys Ranch	12/4/72	Anaconda	0.01						0.01									
K	16" Well - Boys Ranch	12/9/72	Anaconda	0.01						0.24									
K	16" Well - Boys Ranch	1/22/73	Anaconda							0.02									
K	16" Well - Boys Ranch	2/12/73	Anaconda	0.02		0.25								0.001				0.008	
K	16" Well - Boys Ranch	2/12/73	Anaconda	0.01		0.18				0.02				0.003					
K	16" Well - Boys Ranch	3/2/73	Anaconda	0.05		0.12								0.002				0.004	
K	16" Well - Boys Ranch	3/6/73	Anaconda	0.01		0.2				0.02				0.002					
K	16" Well - Boys Ranch	4/6/73	Anaconda	0.01		0.289								0.001				0.005	
K	16" Well - Boys Ranch	5/11/73	Anaconda	0.03		0.18								0.002				<0.001	
K	16" Well - Boys Ranch	6/1/73	Anaconda	0.02		0.17								0.001				0.003	
K	16" Well - Boys Ranch	7/2/73	Anaconda			0.21								0.006					
K	16" Well - Boys Ranch	8/1/73	Anaconda	0.003		0.35								0.003				0.004	
K	16" Well - Boys Ranch	2/1/74	Anaconda				0.082								0.004				
GW-02	Sagers Well - Lincoln	7/11/74	Anaconda				0.001								0.005				
K	16" Well - Boys Ranch - 11:35 AM	8/21/74	Anaconda			0.46								0.006					
K	16" Well - Boys Ranch - 10:00 PM	8/21/74	Anaconda			0.49								0.006					
K	16" Well - Boys Ranch - 8:00 AM	8/22/74	Anaconda			0.43								0.006					
K	16" Well - Boys Ranch	1/8/75	Anaconda																
GW-02	Sagers Well - Lincoln	10/31/77	Anaconda				0.001								0.005				
GW-03	6" Well - Boys Ranch	10/31/77	Anaconda				0.038								<0.004				
GW-02	Sagers Well - Lincoln	6/8/78	Anaconda																
GW-02	Sagers Well - Lincoln - 1st Bail	8/22/79	Anaconda			0.002													
GW-02	Sagers Well - Lincoln - After Bail	8/22/79	Anaconda			0.002													
GW-03	6" Well - Boys Ranch - 1st Bail	8/23/79	Anaconda			0.007													
GW-03	6" Well - Boys Ranch - After Bail	8/23/79	Anaconda			0.005													
GW-01	Tailings Dam Well	2/10/81	Anaconda			0.001				0.07				<0.001				<0.01	
GW-03	6" Well - Boys Ranch - 1st Bail	2/11/81	Anaconda			0.004				0.06				<0.001				<0.01	
GW-03	6" Well - Boys Ranch - After Bail	2/11/81	Anaconda			0.001				0.12				<0.001				<0.01	
GW-02	Sagers Well - Lincoln - 1st Bail	2/13/81	Anaconda			0.002								<0.001				<0.01	
Drinking Water Maximum Contamintant Levels (ppm)							**0.05**	**0.006**			**2**	**0.004**		**0.005**					**0.1**

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Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Copper		Iron		Lead		Manganese		Mercury		Nickel		Selenium		Silver	
Sample Fraction				Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Groundwater Results																			
GW-02	Sagers Well - Lincoln	10/7/71	Anaconda	<0.05				<0.10		0.45						<0.02		<0.05	
GW-02	Sagers Well - Lincoln	5/17/72	Anaconda	0.025		36	<0.02	0.048		0.46								<0.10	
K	16" Well - Boys Ranch	5/18/72	Anaconda	0.012		3.7	<0.02	0.029		0.065								<0.10	
K	16" Well - Boys Ranch	5/25/72	Anaconda	0.01		0.39	0.2			0.09									
GW-02	Sagers Well - Lincoln	6/26/72	Anaconda			3.25	1.8			0.35									
GW-02	Sagers Well - Lincoln	7/3/72	Anaconda	<0.05		0.7		<0.10		<0.05		<0.0002						<0.05	
K	16" Well - Boys Ranch	7/6/72	Anaconda	<0.05		4.8	0.25	<0.10		<0.05		0.002						<0.05	
GW-02	Sagers Well - Lincoln	7/6/72	Anaconda			3.1	1.2			0.31									
K	16" Well - Boys Ranch	8/14/72	Anaconda	0.01		0.6	0.25			0.12						0.7			
K	16" Well - Boys Ranch	8/15/72	Anaconda	0.01		2.95	0.5	0.05		0.08									
K	16" Well - Boys Ranch	8/18/72	Anaconda																
GW-02	Sagers Well - Lincoln	8/18/72	Anaconda																
K	16" Well - Boys Ranch	8/30/72	Anaconda	0.01		0.6	0.25			0.12						0.7			
GW-02	Sagers Well - Lincoln	8/30/72	Anaconda	0.01			0.15												
K	16" Well - Boys Ranch	8/31/72	Anaconda	0.031		<0.02		0.05		0.31				0.012					
K	16" Well - Boys Ranch	9/20/72	Anaconda	0.01			0.51	0.1		0.23						0.21			
K	16" Well - Boys Ranch	10/9/72	Anaconda	0.04		7.5	0.16	0.13		0.25						0.25			
K	16" Well - Boys Ranch	11/8/72	Anaconda				0.15	0.05		0.22						0.14			
K	16" Well - Boys Ranch	12/4/72	Anaconda				0.13	0.02		0.16						0.1			
K	16" Well - Boys Ranch	12/9/72	Anaconda				0.14	0.09		0.2						0.013			
K	16" Well - Boys Ranch	1/22/73	Anaconda				0.12	0.01		0.1						0.05			
K	16" Well - Boys Ranch	2/12/73	Anaconda	0.009		0.02		0.018		0.031				0.01				0.004	
K	16" Well - Boys Ranch	2/12/73	Anaconda	0.02			0.13	0.01		0.1						0.04			
K	16" Well - Boys Ranch	3/2/73	Anaconda	0.013		0.02		0.015		0.022				0.009				0.004	
K	16" Well - Boys Ranch	3/6/73	Anaconda	0.02			0.08	0.01		0.06						0.05		0.002	
K	16" Well - Boys Ranch	4/6/73	Anaconda	0.011		0.2		0.015		0.065				0.006				0.003	
K	16" Well - Boys Ranch	5/11/73	Anaconda	0.011		0.02		0.11		0.017				0.006				0.003	
K	16" Well - Boys Ranch	6/1/73	Anaconda	0.012		<0.02		0.02		0.01				<0.01				0.001	
K	16" Well - Boys Ranch	7/2/73	Anaconda	0.039		0.03		0.045		0.05								<0.002	
K	16" Well - Boys Ranch	8/1/73	Anaconda	0.016		0.05		0.033		0.015				0.008				<0.002	
K	16" Well - Boys Ranch	2/1/74	Anaconda		0.016		0.02		0.014		0.195								0.014
GW-02	Sagers Well - Lincoln	7/11/74	Anaconda		0.033		0.04		0.015		0.147								0.004
K	16" Well - Boys Ranch - 11:35 AM	8/21/74	Anaconda	0.01		0.05		0.014		0.014								0.01	
K	16" Well - Boys Ranch - 10:00 PM	8/21/74	Anaconda	0.033		0.03		0.014		0.014								0.006	
K	16" Well - Boys Ranch - 8:00 AM	8/22/74	Anaconda	0.017		0.01		0.025		0.014								0.006	
K	16" Well - Boys Ranch	1/8/75	Anaconda		0.02														
GW-02	Sagers Well - Lincoln	10/31/77	Anaconda		0.016		0.31		0.03		0.129								0.002
GW-03	6" Well - Boys Ranch	10/31/77	Anaconda		0.021		0.15		0.028		0.063								<0.004
GW-02	Sagers Well - Lincoln	6/8/78	Anaconda																
GW-02	Sagers Well - Lincoln - 1st Bail	8/22/79	Anaconda	0.071		0.187				0.01								0.001	
GW-02	Sagers Well - Lincoln - After Bail	8/22/79	Anaconda	0.071		0.006				0.337								0.001	
GW-03	6" Well - Boys Ranch - 1st Bail	8/23/79	Anaconda	0.013		0.09		0.006		0.648								0.001	
GW-03	6" Well - Boys Ranch - After Bail	8/23/79	Anaconda	0.025		0.1		0.006		0.638								0.001	
GW-01	Tailings Dam Well	2/10/81	Anaconda	0.03		0.17		<0.001		0.68								<0.001	
GW-03	6" Well - Boys Ranch - 1st Bail	2/11/81	Anaconda	0.02		0.08		<0.001		0.01								<0.001	
GW-03	6" Well - Boys Ranch - After Bail	2/11/81	Anaconda	0.02		0.12		<0.001		0.3								<0.001	
GW-02	Sagers Well - Lincoln - 1st Bail	2/13/81	Anaconda	0.02		0.09		<0.001		1.28								<0.001	
Drinking Water Maximum Contamintant Levels (ppm)				1.3				0.015				0.002		0.1		0.05			

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Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Thallium		Vanadium		Zinc		Calcium		Magnesium		Sodium		Sulfate	
Sample Fraction				Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Groundwater Results																	
GW-02	Sagers Well - Lincoln	10/7/71	Anaconda					<0.05		29		49		24		256	
GW-02	Sagers Well - Lincoln	5/17/72	Anaconda					0.06		122		59		25		387	
K	16" Well - Boys Ranch	5/18/72	Anaconda					0.035		148		66		30		404	
K	16" Well - Boys Ranch	5/25/72	Anaconda					0.1		81.8		53		35.1		114.8	
GW-02	Sagers Well - Lincoln	6/26/72	Anaconda					0.08		122.5		51.4		26.2		257.7	
GW-02	Sagers Well - Lincoln	7/3/72	Anaconda					<0.05		136		66		66		337	
K	16" Well - Boys Ranch	7/6/72	Anaconda					<0.05		145		65		100		382	
GW-02	Sagers Well - Lincoln	7/6/72	Anaconda					0.02		120		56.4		25		260	
K	16" Well - Boys Ranch	8/14/72	Anaconda					0.08		110		55		46		239	
K	16" Well - Boys Ranch	8/15/72	Anaconda					0.02		118		51.3		88		460	
K	16" Well - Boys Ranch	8/18/72	Anaconda							198		104				776	
GW-02	Sagers Well - Lincoln	8/18/72	Anaconda							130		35				360	
K	16" Well - Boys Ranch	8/30/72	Anaconda					0.08		110		55		46		239	
GW-02	Sagers Well - Lincoln	8/30/72	Anaconda					0.1		112		66		20		310	
K	16" Well - Boys Ranch	8/31/72	Anaconda					0.043		128		61		50		351	
K	16" Well - Boys Ranch	9/20/72	Anaconda					0.1		116		58		42		305	
K	16" Well - Boys Ranch	10/9/72	Anaconda					0.1		107		60		48		300	
K	16" Well - Boys Ranch	11/8/72	Anaconda					0.05		110		50		50.3		280	
K	16" Well - Boys Ranch	12/4/72	Anaconda					0.02		107.2		44.4		57.3		257	
K	16" Well - Boys Ranch	12/9/72	Anaconda					0.06		107		51		50		277	
K	16" Well - Boys Ranch	1/22/73	Anaconda					0.01		107.2		44.8		66.9		252.5	
K	16" Well - Boys Ranch	2/12/73	Anaconda					0.025		110		43		44		247	
K	16" Well - Boys Ranch	2/12/73	Anaconda					0.02		110		41.7		48		245	
K	16" Well - Boys Ranch	3/2/73	Anaconda					0.02		107		44		45		253	
K	16" Well - Boys Ranch	3/6/73	Anaconda					0.02		113		38.5		45		230	
K	16" Well - Boys Ranch	4/6/73	Anaconda					0.12		100		42		45		230	
K	16" Well - Boys Ranch	5/11/73	Anaconda					0.045		108		44		50		258	
K	16" Well - Boys Ranch	6/1/73	Anaconda					0.01		107		46		46		246	
K	16" Well - Boys Ranch	7/2/73	Anaconda					0.042		110		44		47		240	
K	16" Well - Boys Ranch	8/1/73	Anaconda					0.04		120		45		47		250	
K	16" Well - Boys Ranch	2/1/74	Anaconda						0.12		120		43		45		240
GW-02	Sagers Well - Lincoln	7/11/74	Anaconda						0.17		130		54		38		320
K	16" Well - Boys Ranch - 11:35 AM	8/21/74	Anaconda							108		40		44.8			
K	16" Well - Boys Ranch - 10:00 PM	8/21/74	Anaconda							104		40		46.2			
K	16" Well - Boys Ranch - 8:00 AM	8/22/74	Anaconda							110		40		47.6			
K	16" Well - Boys Ranch	1/8/75	Anaconda														260
GW-02	Sagers Well - Lincoln	10/31/77	Anaconda						0.043		120		52		40		320
GW-03	6" Well - Boys Ranch	10/31/77	Anaconda						0.047		102		46		46		260
GW-02	Sagers Well - Lincoln	6/8/78	Anaconda								120		58		39		300
GW-02	Sagers Well - Lincoln - 1st Bail	8/22/79	Anaconda					0.01		36		10		5.1		12	
GW-02	Sagers Well - Lincoln - After Bail	8/22/79	Anaconda					0.009		150		76		39.9		288	
GW-03	6" Well - Boys Ranch - 1st Bail	8/23/79	Anaconda							133		66		43		210	
GW-03	6" Well - Boys Ranch - After Bail	8/23/79	Anaconda							132		70		46.1		234	
GW-01	Tailings Dam Well	2/10/81	Anaconda					0.03		116		48		40.5		328	
GW-03	6" Well - Boys Ranch - 1st Bail	2/11/81	Anaconda					0.02		91		39		41.5		216	
GW-03	6" Well - Boys Ranch - After Bail	2/11/81	Anaconda					0.16		93		40		44.8		228	
GW-02	Sagers Well - Lincoln - 1st Bail	2/13/81	Anaconda					0.002		116		47		41.8		305	
Drinking Water Maximum Contamintant Levels (ppm)				**0.002**												**1000**	

ANDERSON
ENGINEERING COMPANY INC.

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Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Potassium		Nitrite	Nitrate	Bicarbonate	CO_2	Carbonate	Chloride	CO_3 solids	Flouride	Phosphorus	Silica	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Turbidity (NTU)
Sample Fraction				Total	Dissolved													
Groundwater Results																		
GW-02	Sagers Well - Lincoln	10/7/71	Anaconda	4.3			0.3				33					185		
GW-02	Sagers Well - Lincoln	5/17/72	Anaconda	1.8			1.54				35					275		
K	16" Well - Boys Ranch	5/18/72	Anaconda	3.4			2.27				55					260		
K	16" Well - Boys Ranch	5/25/72	Anaconda	2.97			0.85				66					240		
GW-02	Sagers Well - Lincoln	6/26/72	Anaconda	1.68			0.48				42					220		
GW-02	Sagers Well - Lincoln	7/3/72	Anaconda	2.01			1.13				36					296		
K	16" Well - Boys Ranch	7/6/72	Anaconda	3.34			2.94				52					277		
GW-02	Sagers Well - Lincoln	7/6/72	Anaconda	1.55			0.49				45					220		
K	16" Well - Boys Ranch	8/14/72	Anaconda	3			0.88				62					242		
K	16" Well - Boys Ranch	8/15/72	Anaconda	5.36			0.96				50					120		
K	16" Well - Boys Ranch	8/18/72	Anaconda				1.70				15.1							
GW-02	Sagers Well - Lincoln	8/18/72	Anaconda				1.08				38.6							
K	16" Well - Boys Ranch	8/30/72	Anaconda	3			0.88				62					242		
GW-02	Sagers Well - Lincoln	8/30/72	Anaconda	1.7			1.4				38					224		
K	16" Well - Boys Ranch	8/31/72	Anaconda	3.1			3.28				54					240		
K	16" Well - Boys Ranch	9/20/72	Anaconda	3.2			1.15				58					238		
K	16" Well - Boys Ranch	10/9/72	Anaconda	3.8			1.05				56					222		
K	16" Well - Boys Ranch	11/8/72	Anaconda	7.09			1.06				52					210		
K	16" Well - Boys Ranch	12/4/72	Anaconda	4.4			1.1				48					220		
K	16" Well - Boys Ranch	12/9/72	Anaconda	7.1			1.1				52					214		
K	16" Well - Boys Ranch	1/22/73	Anaconda	5.26			1.05				48					242		
K	16" Well - Boys Ranch	2/12/73	Anaconda	2.8			3.87				56					230		
K	16" Well - Boys Ranch	2/12/73	Anaconda	3.2			2.86				42					244		
K	16" Well - Boys Ranch	3/2/73	Anaconda	2.7			3.73				39					228		
K	16" Well - Boys Ranch	3/6/73	Anaconda	2.45			2.37				42					242		
K	16" Well - Boys Ranch	4/6/73	Anaconda	2.9			3.89				36					218		
K	16" Well - Boys Ranch	5/11/73	Anaconda	2.5			4.52				40					225		
K	16" Well - Boys Ranch	6/1/73	Anaconda	3.05			3.80				40					230		
K	16" Well - Boys Ranch	7/2/73	Anaconda					260			40		0.5			209	450	
K	16" Well - Boys Ranch	8/1/73	Anaconda	3.7			3.93	270			41		0.5			221	480	
K	16" Well - Boys Ranch	2/1/74	Anaconda		3.6			190			38		0.47			153	470	
GW-02	Sagers Well - Lincoln	7/11/74	Anaconda		2.5			240			38		0.36			200	540	
K	16" Well - Boys Ranch - 11:35 AM	8/21/74	Anaconda	2.78			3.96				36.8					214		
K	16" Well - Boys Ranch - 10:00 PM	8/21/74	Anaconda	2.7			4.29				37.4					218		
K	16" Well - Boys Ranch - 8:00 AM	8/22/74	Anaconda	2.73			4.50				38.7					218		
K	16" Well - Boys Ranch	1/8/75	Anaconda					270			39	15	0.6			218	440	
GW-02	Sagers Well - Lincoln	10/31/77	Anaconda		2.2			240			31		0.49			200	510	
GW-03	6" Well - Boys Ranch	10/31/77	Anaconda		3.2	8.9		220			30		0.56			177	450	
GW-02	Sagers Well - Lincoln	6/8/78	Anaconda		1.6			300			39		0.1		13	250	540	
GW-02	Sagers Well - Lincoln - 1st Bail	8/22/79	Anaconda	13			0.99				7.4					99		
GW-02	Sagers Well - Lincoln - After Bail	8/22/79	Anaconda	2.47			2.24				43.1					185		
GW-03	6" Well - Boys Ranch - 1st Bail	8/23/79	Anaconda	2.01			1.94				57.1					205		
GW-03	6" Well - Boys Ranch - After Bail	8/23/79	Anaconda	1.97			1.86				54.6					214		
GW-01	Tailings Dam Well	2/10/81	Anaconda	3.4			1.23				34.65					240		
GW-03	6" Well - Boys Ranch - 1st Bail	2/11/81	Anaconda	2.6			2.10				40.65					220		
GW-03	6" Well - Boys Ranch - After Bail	2/11/81	Anaconda	2.7			2.42				41.98					216		
GW-02	Sagers Well - Lincoln - 1st Bail	2/13/81	Anaconda	2.9			2.60				41.98					226		
Drinking Water Maximum Contamintant Levels (ppm)						**1**	**10**						**4**					

ANDERSON

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Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Conductivity (umhos/cm)	TDS	pH (pH Units)	Boron	Chromium (hex)	Molybdenum	Sulfide	Oil/Grease	TOC	Ammonia	Cyanide	Hydroxide	Phosphate	TSS
Sample Fraction																	
Groundwater Results																	
GW-02	Sagers Well - Lincoln	10/7/71	Anaconda		424	7.42											
GW-02	Sagers Well - Lincoln	5/17/72	Anaconda			7.72											
K	16" Well - Boys Ranch	5/18/72	Anaconda			7.45											
K	16" Well - Boys Ranch	5/25/72	Anaconda		675	7.85											
GW-02	Sagers Well - Lincoln	6/26/72	Anaconda		769	7.5											
GW-02	Sagers Well - Lincoln	7/3/72	Anaconda			7.78											
K	16" Well - Boys Ranch	7/6/72	Anaconda		680	7.63											
GW-02	Sagers Well - Lincoln	7/6/72	Anaconda		774	7.5											
K	16" Well - Boys Ranch	8/14/72	Anaconda		808	7.65											
K	16" Well - Boys Ranch	8/15/72	Anaconda		917	7.55											
K	16" Well - Boys Ranch	8/18/72	Anaconda		1416	8.45											
GW-02	Sagers Well - Lincoln	8/18/72	Anaconda		810	7.67											
K	16" Well - Boys Ranch	8/30/72	Anaconda		808	7.65											
GW-02	Sagers Well - Lincoln	8/30/72	Anaconda		819	7.6											
K	16" Well - Boys Ranch	8/31/72	Anaconda			8.05											
K	16" Well - Boys Ranch	9/20/72	Anaconda		869	7.7											
K	16" Well - Boys Ranch	10/9/72	Anaconda		846	7.7											
K	16" Well - Boys Ranch	11/8/72	Anaconda		803	7.5											
K	16" Well - Boys Ranch	12/4/72	Anaconda		784.8	7.5											
K	16" Well - Boys Ranch	12/9/72	Anaconda		803	7.5											
K	16" Well - Boys Ranch	1/22/73	Anaconda		810	7.5											
K	16" Well - Boys Ranch	2/12/73	Anaconda			7.8											
K	16" Well - Boys Ranch	2/12/73	Anaconda		784	7.85											
K	16" Well - Boys Ranch	3/2/73	Anaconda			7.8											
K	16" Well - Boys Ranch	3/6/73	Anaconda		763	7.85											
K	16" Well - Boys Ranch	4/6/73	Anaconda			8.13											
K	16" Well - Boys Ranch	5/11/73	Anaconda			7.93											
K	16" Well - Boys Ranch	6/1/73	Anaconda			8.25											
K	16" Well - Boys Ranch	7/2/73	Anaconda			7.4											
K	16" Well - Boys Ranch	8/1/73	Anaconda			7.9											
K	16" Well - Boys Ranch	2/1/74	Anaconda			7.8											
GW-02	Sagers Well - Lincoln	7/11/74	Anaconda			7.7											
K	16" Well - Boys Ranch - 11:35 AM	8/21/74	Anaconda		630	8											
K	16" Well - Boys Ranch - 10:00 PM	8/21/74	Anaconda		690	8.3											
K	16" Well - Boys Ranch - 8:00 AM	8/22/74	Anaconda		660	8											
K	16" Well - Boys Ranch	1/8/75	Anaconda			8											
GW-02	Sagers Well - Lincoln	10/31/77	Anaconda			7.6											
GW-03	6" Well - Boys Ranch	10/31/77	Anaconda			7.6											
GW-02	Sagers Well - Lincoln	6/8/78	Anaconda	980			0.05										
GW-02	Sagers Well - Lincoln - 1st Bail	8/22/79	Anaconda		148	8.1											
GW-02	Sagers Well - Lincoln - After Bail	8/22/79	Anaconda		728	7.4											
GW-03	6" Well - Boys Ranch - 1st Bail	8/23/79	Anaconda		680	7.9											
GW-03	6" Well - Boys Ranch - After Bail	8/23/79	Anaconda		704	7.9											
GW-01	Tailings Dam Well	2/10/81	Anaconda		656	7.8											338
GW-03	6" Well - Boys Ranch - 1st Bail	2/11/81	Anaconda		616	7.4											542
GW-03	6" Well - Boys Ranch - After Bail	2/11/81	Anaconda		672	7.4											2786
GW-02	Sagers Well - Lincoln - 1st Bail	2/13/81	Anaconda		816	7.1											0.84
Drinking Water Maximum Contamintant Levels (ppm)					2000									0.2			

ANDERSON
ENGINEERING COMPANY INC.

Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Aluminum		Arsenic		Antimony		Barium		Beryllium		Cadmium		Cobalt		Chromium	
Sample Fraction				Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Groundwater Results																			
GW-02	Sagers Well - Lincoln - After Bail	2/13/81	Anaconda			0.004								<0.001				<0.01	
GW-03	6" Well - Boys Ranch	6/24/82	Anaconda			0.12				0.115				<0.001				0.006	
GW-03	6" Well - Boys Ranch - After 4 Hours	6/24/82	Anaconda			0.165				0.18				0.003				0.008	
GW-01	Tailings Dam Well	6/24/82	Anaconda			<0.001				0.02				<0.001				0.007	
GW-01	Tailings Dam Well - After 8 Hours	6/24/82	Anaconda			<0.001				0.025				<0.001				0.005	
GW-01	Tailings Dam Well - After 8 Hours	7/12/82	Anaconda			<0.001				0.025				<0.001				0.005	
98	Seep at base of slag pile	5/30/84	DERR			<0.05				<0.05		<0.01		0.02		<0.1		<0.1	
103	Boys Ranch Tap Water-Spring Source	5/30/84	DERR	<0.1		0.0015				<0.05		<0.01		<0.01		<0.1		<0.02	
GW-03	6" Well - Boys Ranch	12/10/84	Anaconda			<0.001				0.14				<0.001				0.7	
GW-02	Sagers Well - Lincoln	12/18/84	Anaconda				<0.001								<0.001				
GW-01	Tailings Dam Well	12/20/84	Anaconda			<0.001				0.15				<0.001				0.005	
GW-01	Pine Canyon - East of Site	7/9/85	E&E INC.	<0.03	<0.03	<0.005	<0.005	<0.005	<0.005	0.066	0.067	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
GW-01	16" Well - Boys Ranch	9/24/85	JBR				<0.01				0.1				<0.005				<0.005
GW-01	16" Well - Boys Ranch	9/24/85	USGS				<0.01				0.1				<0.005				<0.005
GW-02	Sagers Well - Lincoln	9/24/85	JBR				<0.01				0.08				<0.005				<0.005
GW-02	Sagers Well - Lincoln	9/24/85	USGS				<0.01				0.08				<0.005				<0.005
GW-03	6" Well - Boys Ranch	9/24/85	JBR				<0.01				0.08				<0.005				0.015
GW-04	Tailings Dam Well	9/24/85	JBR				<0.01				0.113				<0.005				0.015
GW-05	RB-PCL-02 Spring	9/24/85	JBR				<0.01				<0.005				0.188				0.015
GW-03	6" Well - Boys Ranch	9/25/85	USGS				<0.01				0.08				<0.005				0.015
AGW-4A	Tailings Dam Well	11/5/85	JBR				<0.01				0.095				<0.005				<0.005
AGW-4B	Tailings Dam Well	11/5/85	JBR				<0.01				0.1				<0.005				<0.005
AGW-4C	Tailings Dam Well	11/5/85	JBR				<0.01				0.13				<0.005				<0.005
AGW-4D	Tailings Dam Well	11/5/85	JBR				<0.01				0.12				<0.005				<0.005
AGW-4E	Tailings Dam Well	11/5/85	JBR				0.01				0.095				<0.005				<0.005
AGW-4F	Tailings Dam Well	11/5/85	JBR				<0.01				0.115				<0.005				<0.005
AGW-4G	Tailings Dam Well	11/5/85	JBR				<0.01				0.11				<0.005				<0.005
GW-01	16" Well - Boys Ranch	11/20/85	JBR (UBTL)																
GW-02	Sagers Well - Lincoln	11/20/85	JBR (UBTL)																
GW-03	6" Well - Boys Ranch	11/20/85	JBR (UBTL)																
GW-04	Tailings Dam Well	11/20/85	JBR (UBTL)																
GW-05	RB-PCL-02 Spring	11/20/85	JBR (UBTL)																
AC-GW-01	USGS Well - Lincoln	09/13/95	UDEQ	0.074	0.0605	<0.003 J	<0.003	<0.0525	<0.0525	0.0377	0.0366	<0.0004	<0.0004	<0.0028	<0.0028	<0.0043	<0.0043	<0.0057	<0.0057
AC-GW-02	Sagers Well - Lincoln	09/14/95	UDEQ	0.0382	0.0585	<0.003 J	<0.003 J	<0.0525	<0.0525	0.0264	0.0258	<0.0004	<0.0004	<0.0028	<0.0028	<0.0043	<0.0043	<0.0057	<0.0057
GW-02	Sagers Well - Lincoln	09/14/95	USGS																
AC-GW-03	Eastern Site Property Line	09/18/95	UDEQ	0.403	0.0429	0.0058	<0.0046	<0.0525	<0.0525	0.109	0.106	0.00043	<0.0004	<0.0028	<0.0028	<0.0043	<0.0043	<0.0057	<0.0057
GW-03	6" Well - Boys Ranch	09/19/95	USGS																
AC-GW-04	6" Well - Boys Ranch	09/25/95	UDEQ	0.0865	0.0704	0.151 J	0.15 J	<0.0525	<0.0525	0.0436	0.0444	<0.0004	<0.0004	<0.0028	<0.0028	<0.0043	<0.0043	<0.0057	<0.0057
Lysimeter Results																			
AC-LY-03	Carr Fork Tailings	10/03/95	UDEQ	0.358		<0.02		<0.0271		0.0607		<0.0028		<0.0035		0.0132		<0.0045	
AC-LY-05	Northwest Corner Tailings Berm	10/16/95	UDEQ	0.337		0.0087		<0.0271		0.0574		0.0023		<0.0035		0.0144		<0.0045	
AC-LY-06	East Side - Lead Smelter Site	10/16/95	UDEQ	0.56		1.86		<0.0271		0.0581		0.0043		116		1.33		<0.0045	
AC-LY-04	South IS&R Tailings	11/30/95	UDEQ	0.0319		0.0158		<0.0271		0.0424		<0.0003		<0.0035		0.0761		<0.0045	
AC-LY-02	North Side of Pine Creek	02/20/96	UDEQ	0.0184 J		<0.0077 J		<0.0025		0.0674		<0.0001		<0.0039		0.0019 J		<0.0006	
AC-LY-07	Above Dry Creek	02/20/96	UDEQ	0.0152 J		<0.0073 J		<0.0025		0.0568		<0.0001		0.0042		0.0037 J		<0.0006	
AC-LY-08	Borrow Pit - West of Berm	02/20/96	UDEQ	0.0345 J		<0.01 J		<0.0025		0.042		<0.0001		<0.0039		<0.0014 J		0.00061	
Drinking Water Maximum Contamintant Levels (ppm)							**0.05**	**0.006**		**2**		**0.004**		**0.005**				**0.1**	

ANDERSON

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Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Copper		Iron		Lead		Manganese		Mercury		Nickel		Selenium		Silver	
Sample Fraction				Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Groundwater Results																			
GW-02	Sagers Well - Lincoln - After Bail	2/13/81	Anaconda	0.02		0.09		<0.001		1.22								<0.001	
GW-03	6" Well - Boys Ranch	6/24/82	Anaconda	0.01		54.7	21.45	0.032		0.56		<0.0002		<0.001		0.023		<0.001	
GW-03	6" Well - Boys Ranch - After 4 Hours	6/24/82	Anaconda	0.03		54.1	24.65	0.217		1.83		<0.0002		0.017		0.02		<0.001	
GW-01	Tailings Dam Well	6/24/82	Anaconda	0.02		2.73	1.45	0.104		0.16		<0.0002		<0.001		<0.001		<0.001	
GW-01	Tailings Dam Well - After 8 Hours	6/24/82	Anaconda	0.02		0.42	0.31	0.012		0.025		<0.0002		<0.001		0.002		<0.001	
GW-01	Tailings Dam Well - After 8 Hours	7/12/82	Anaconda	0.02		0.42	0.31	0.012		0.025		<0.0002		<0.0001		0.002		<0.001	
98	Seep at base of slag pile	5/30/84	DERR					0.11				<0.0001				<0.005		0.01	
103	Boys Ranch Tap Water-Spring Source	5/30/84	DERR	0.035		<0.03		<0.1		<0.01		<0.0001		<0.1		<0.0005		<0.01	
GW-03	6" Well - Boys Ranch	12/10/84	Anaconda	0.17		10.2	4.5	0.005		0.1		<0.0002		0.05		<0.001		<0.0010	
GW-02	Sagers Well - Lincoln	12/18/84	Anaconda		0.68				0.015		0.66								<0.001
GW-01	Tailings Dam Well	12/20/84	Anaconda	0.02		1.29	1.08	0.035		0.04		<0.0002		0.06		<0.001		<0.0010	
GW-01	Pine Canyon - East of Site	7/9/85	E&E INC.	<0.005	<0.005	0.142	<0.01	<0.03	<0.03	<0.005	<0.005	<0.0001	<0.0001	<0.03	<0.03	<0.005	<0.005	<0.005	<0.005
GW-01	16" Well - Boys Ranch	9/24/85	JBR		<0.005		2.2				0.448		<0.0002		0.013		<0.002		<0.005
GW-01	16" Well - Boys Ranch	9/24/85	USGS		<0.005		2.2		0.008		0.45		<0.0002				<0.002		<0.005
GW-02	Sagers Well - Lincoln	9/24/85	JBR		<0.005		0.243				0.175		<0.0002		0.028		<0.002		<0.005
GW-02	Sagers Well - Lincoln	9/24/85	USGS		<0.005		0.24		<0.005		0.17		<0.0002				<0.002		<0.005
GW-03	6" Well - Boys Ranch	9/24/85	JBR		<0.005		0.295				0.065		<0.0002		0.018		<0.002		<0.005
GW-04	Tailings Dam Well	9/24/85	JBR		<0.005		0.155				0.038		<0.0002		<0.005		<0.002		<0.005
GW-05	RB-PCL-02 Spring	9/24/85	JBR		0.088		0.105				0.01		<0.0002		0.045		0.002		<0.005
GW-03	6" Well - Boys Ranch	9/25/85	USGS		<0.005		0.3		<0.005		0.065		<0.0002				<0.002		<0.005
AGW-4A	Tailings Dam Well	11/5/85	JBR		<0.005		0.283		<0.01		<0.005		<0.0002		<0.005		<0.002		<0.005
AGW-4B	Tailings Dam Well	11/5/85	JBR		<0.005		0.245		<0.01		<0.005		<0.0002		<0.005		<0.002		<0.005
AGW-4C	Tailings Dam Well	11/5/85	JBR		<0.005		0.125		<0.01		<0.005		<0.0002		<0.005		<0.002		<0.005
AGW-4D	Tailings Dam Well	11/5/85	JBR		<0.005		0.13		<0.01		<0.005		<0.0002		<0.005		<0.002		<0.005
AGW-4E	Tailings Dam Well	11/5/85	JBR		<0.005		0.208		<0.01		<0.005		<0.0002		<0.005		<0.002		<0.005
AGW-4F	Tailings Dam Well	11/5/85	JBR		<0.005		0.195		<0.01		<0.005		<0.0002		<0.005		<0.002		<0.005
AGW-4G	Tailings Dam Well	11/5/85	JBR		<0.005		0.264		<0.01		<0.005		<0.0002		<0.005		<0.002		<0.005
GW-01	16" Well - Boys Ranch	11/20/85	JBR (UBTL)						0.008										
GW-02	Sagers Well - Lincoln	11/20/85	JBR (UBTL)						<0.005										
GW-03	6" Well - Boys Ranch	11/20/85	JBR (UBTL)						<0.005										
GW-04	Tailings Dam Well	11/20/85	JBR (UBTL)						<0.005										
GW-05	RB-PCL-02 Spring	11/20/85	JBR (UBTL)						0.37										
AC-GW-01	USGS Well - Lincoln	09/13/95	UDEQ	<0.0032	<0.0032	1.49	<0.0236	0.0086	0.0011 J	0.0063	0.0039	<0.0002	<0.0002	<0.0102	<0.0102	<0.0025 J	<0.0024 J	<0.0083	<0.0083
AC-GW-02	Sagers Well - Lincoln	09/14/95	UDEQ	<0.0032	<0.0032	<0.0236	<0.0236	0.004 J	0.0032 J	<0.0037	<0.0037	<0.0002	<0.0002	<0.0102	<0.0102	<0.0045 J	<0.0054 J	<0.0083	<0.0083
GW-02	Sagers Well - Lincoln	09/14/95	USGS				0.015				0.003								
AC-GW-03	Eastern Site Property Line	09/18/95	UDEQ	<0.0032	<0.0032	2.36	0.0379	0.004	<0.0027	0.0334	0.0051	<0.0002	<0.0002	<0.0102	<0.0102	0.0034	0.0045	<0.0083	<0.0083
GW-03	6" Well - Boys Ranch	09/19/95	USGS				0.004				0.002								
AC-GW-04	6" Well - Boys Ranch	09/25/95	UDEQ	<0.0032	<0.0032	0.451	<0.0236	0.0037	0.0035	0.0111	0.004	<0.0002	<0.0002	<0.0102	<0.0102	0.0194 J	0.0189 J	<0.0083	<0.0083
Lysimeter Results																			
AC-LY-03	Carr Fork Tailings	10/03/95	UDEQ	0.0138		<0.0073		<0.0029		1.25		<0.0002		<0.01		0.01 J		<0.0066	
AC-LY-05	Northwest Corner Tailings Berm	10/16/95	UDEQ	0.0163		<0.0069		<0.0029		0.212 J		<0.0002		<0.0075		<0.015 J		<0.0066 J	
AC-LY-06	East Side - Lead Smelter Site	10/16/95	UDEQ	0.141		<0.009		<0.0029		65.9 J		<0.0002		0.417		0.182 J		<0.0066 J	
AC-LY-04	South IS&R Tailings	11/30/95	UDEQ	0.0114		0.0119		<0.0029		23		<0.0002		0.151		0.021		<0.0066	
AC-LY-02	North Side of Pine Creek	02/20/96	UDEQ	0.0066 J		<0.0119 J		<0.0016		0.125		<0.0001		0.0251 J		0.0347		<0.0007	
AC-LY-07	Above Dry Creek	02/20/96	UDEQ	0.0041 J		<0.0173 J		<0.0016		0.301		<0.0001		0.0312 J		0.006		<0.0007	
AC-LY-08	Borrow Pit - West of Berm	02/20/96	UDEQ	0.0088 J		0.0742		<0.0016		<0.0215 J		<0.0001		0.0208 J		0.0033		<0.0007	
Drinking Water Maximum Contamintant Levels (ppm)				**1.3**				**0.015**				**0.002**		**0.1**		**0.05**			

ANDERSON ENGINEERING COMPANY INC.

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Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Thallium		Vanadium		Zinc		Calcium		Magnesium		Sodium		Sulfate	
Sample Fraction				Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Groundwater Results																	
GW-02	Sagers Well - Lincoln - After Bail	2/13/81	Anaconda					0.002		115		45		41.5		316	
GW-03	6" Well - Boys Ranch	6/24/82	Anaconda					0.03		109		44.9		44		284	
GW-03	6" Well - Boys Ranch - After 4 Hours	6/24/82	Anaconda					0.14		131		53.5		47.5		383	
GW-01	Tailings Dam Well	6/24/82	Anaconda					2.09		96.5		49.6		38.5		265	
GW-01	Tailings Dam Well - After 8 Hours	6/24/82	Anaconda					2.4		119		46		39		237	
GW-01	Tailings Dam Well - After 8 Hours	7/12/82	Anaconda					2.4		119		46		39		237	
98	Seep at base of slag pile	5/30/84	DERR							108		44		46		303	
103	Boys Ranch Tap Water-Spring Source	5/30/84	DERR			<0.3		0.095		70		35		69		80	
GW-03	6" Well - Boys Ranch	12/10/84	Anaconda					2.68		89.6		33.12		59		164	
GW-02	Sagers Well - Lincoln	12/18/84	Anaconda						6.5		83		36		41		220
GW-01	Tailings Dam Well	12/20/84	Anaconda					5.39		14.4		32.4		76		168	
GW-01	Pine Canyon - East of Site	7/9/85	E&E INC.	<0.1	<0.1	<0.01	<0.01	0.034	0.027	71	73	38	38	30	31	0.117	0.117
GW-01	16" Well - Boys Ranch	9/24/85	JBR						0.1		42.9		42.6		71		145
GW-01	16" Well - Boys Ranch	9/24/85	USGS						0.1		43		43		71		150
GW-02	Sagers Well - Lincoln	9/24/85	JBR						0.03		63.8		43.9		71		340
GW-02	Sagers Well - Lincoln	9/24/85	USGS						0.035		64		44		71		340
GW-03	6" Well - Boys Ranch	9/24/85	JBR						0.033		68.9		42.8		75		290
GW-04	Tailings Dam Well	9/24/85	JBR						0.03		68.6		36.8		84		340
GW-05	RB-PCL-02 Spring	9/24/85	JBR						4.59		69.7		59		119		520
GW-03	6" Well - Boys Ranch	9/25/85	USGS						0.033		69		43		75		290
AGW-4A	Tailings Dam Well	11/5/85	JBR						0.83		64.8		34.6		49.8		199
AGW-4B	Tailings Dam Well	11/5/85	JBR						0.83								
AGW-4C	Tailings Dam Well	11/5/85	JBR						0.68		65.1		35.1		50.2		235
AGW-4D	Tailings Dam Well	11/5/85	JBR						0.68								
AGW-4E	Tailings Dam Well	11/5/85	JBR						0.65		65.3		34.2		50.1		232
AGW-4F	Tailings Dam Well	11/5/85	JBR						0.63		64.9		34.8		49.8		208
AGW-4G	Tailings Dam Well	11/5/85	JBR						0.68		64.9		34.4		48.7		208
GW-01	16" Well - Boys Ranch	11/20/85	JBR (UBTL)														
GW-02	Sagers Well - Lincoln	11/20/85	JBR (UBTL)														
GW-03	6" Well - Boys Ranch	11/20/85	JBR (UBTL)														
GW-04	Tailings Dam Well	11/20/85	JBR (UBTL)														
GW-05	RB-PCL-02 Spring	11/20/85	JBR (UBTL)														
AC-GW-01	USGS Well - Lincoln	09/13/95	UDEQ	<0.001 J	<0.001 J	<0.0033	<0.0033	0.924	0.895	112	113	35.3	35.3	52.1	52	370	
AC-GW-02	Sagers Well - Lincoln	09/14/95	UDEQ	<0.001 J	<0.001 J	<0.0033	<0.0033	1.11	1.12	98	99.6	40.5	40.9	32.8	33.1	200	
GW-02	Sagers Well - Lincoln	09/14/95	USGS								92		38		31		180
AC-GW-03	Eastern Site Property Line	09/18/95	UDEQ	<0.0043	<0.0043	<0.0066	<0.0035	0.0481	0.0334	57.5	61.7	31.3	33.2	25.5	26.9	91	
GW-03	6" Well - Boys Ranch	09/19/95	USGS								85		39		36		170
AC-GW-04	6" Well - Boys Ranch	09/25/95	UDEQ	0.0014	<0.001	<0.0033	0.0064	1.09	1.08	88.3	90.2	41	41.8	38.9	40	150 J	
Lysimeter Results																	
AC-LY-03	Carr Fork Tailings	10/03/95	UDEQ	<0.0027		0.287		<0.0082		590		36.1		80.8 J		1700 J	
AC-LY-05	Northwest Corner Tailings Berm	10/16/95	UDEQ	<0.0021		0.193		<0.0082		554 J		137 J		244		1800 J	
AC-LY-06	East Side - Lead Smelter Site	10/16/95	UDEQ	<0.0021		0.344		459		300 J		92.9 J		63.8		3400 J	
AC-LY-04	South IS&R Tailings	11/30/95	UDEQ	<0.0021		0.176		0.0834		476		747		406		4300 J	
AC-LY-02	North Side of Pine Creek	02/20/96	UDEQ	<0.0023		0.392		0.0058 J		139 J		35.9 J		49.7		264	
AC-LY-07	Above Dry Creek	02/20/96	UDEQ	<0.0023		0.183		0.0321 J		119 J		32.4 J		50.7		140 J	
AC-LY-08	Borrow Pit - West of Berm	02/20/96	UDEQ	<0.0023		0.288		0.0111 J		129 J		20.6 J		70.2		192	
Drinking Water Maximum Contamintant Levels (ppm)				**0.002**												**1000**	

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Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Potassium		Nitrite	Nitrate	Bicarbonate	CO_2	Carbonate	Chloride	CO_3 solids	Flouride	Phosphorus	Silica	Alkalinity as $CaCO_3$	Hardness as $CaCO_3$	Turbidity (NTU)
Sample Fraction				Total	Dissolved													
Groundwater Results																		
GW-02	Sagers Well - Lincoln - After Bail	2/13/81	Anaconda	3.1			2.53				41.32					221		
GW-03	6" Well - Boys Ranch	6/24/82	Anaconda	1.85		0.25	3.41				43.7					231.1		
GW-03	6" Well - Boys Ranch - After 4 Hours	6/24/82	Anaconda	2.1		0.31	3.74				40.1					235.2		
GW-01	Tailings Dam Well	6/24/82	Anaconda	1.71		<0.01	0.26				30.2					210.4		
GW-01	Tailings Dam Well - After 8 Hours	6/24/82	Anaconda	1.6		0.19	0.45				38.8					268		
GW-01	Tailings Dam Well - After 8 Hours	7/12/82	Anaconda	1.6		0.19	0.45				38.8					268		
98	Seep at base of slag pile	5/30/84	DERR	25		<1.01	2.41	188	8	0	80	92	1.22	<0.01	12	154	450	15
103	Boys Ranch Tap Water-Spring Source	5/30/84	DERR	3		<0.01	0.4	386	20	0	50	190	0.08	<0.01	14	317	320	0.2
GW-03	6" Well - Boys Ranch	12/10/84	Anaconda	6.5		<0.01	2.55				41					267		
GW-02	Sagers Well - Lincoln	12/18/84	Anaconda		8.5			260			43		0.3			217	360	
GW-01	Tailings Dam Well	12/20/84	Anaconda	5.4		0.02	0.11				35					117		
GW-01	Pine Canyon - East of Site	7/9/85	E&E INC.															
GW-01	16" Well - Boys Ranch	9/24/85	JBR		4.94	0.011	0.66	240		0	43.8		0.2		3.46	197	328	
GW-01	16" Well - Boys Ranch	9/24/85	USGS		4.9	0.67		240			44		0.2		3.5	200	280	
GW-02	Sagers Well - Lincoln	9/24/85	JBR		2.18	0.007	0.36	241		0	42.1		0.09		5.9	198	427	
GW-02	Sagers Well - Lincoln	9/24/85	USGS		2.2	0.36		240			42		0.09		5.9	200	340	
GW-03	6" Well - Boys Ranch	9/24/85	JBR		2.18	0.017	0.17	242		0	47.5		0.26		6.59	199	395	
GW-04	Tailings Dam Well	9/24/85	JBR		1.98	0.016	0.76	130		0	41.7		0.04		9.45	106	365	
GW-05	RB-PCL-02 Spring	9/24/85	JBR		61	0.007	0.52	142		0	61.7		1.52		5.11	116	662	
GW-03	6" Well - Boys Ranch	9/25/85	USGS		2.2	0.17		240			48		0.26		6.6	200	350	
AGW-4A	Tailings Dam Well	11/5/85	JBR		2.55			208		0	35.2		0.38		9.5	172	362	
AGW-4B	Tailings Dam Well	11/5/85	JBR															
AGW-4C	Tailings Dam Well	11/5/85	JBR		2.56			188		0	35.6		0.47		9.81	154	377	
AGW-4D	Tailings Dam Well	11/5/85	JBR															
AGW-4E	Tailings Dam Well	11/5/85	JBR		2.62			185		0	34.8		0.49		9.38	152	378	
AGW-4F	Tailings Dam Well	11/5/85	JBR		2.55			202		0	34.6		0.39		9.52	199	385	
AGW-4G	Tailings Dam Well	11/5/85	JBR		2.58			204		0	36		0.49		9.38	167	387	
GW-01	16" Well - Boys Ranch	11/20/85	JBR (UBTL)															
GW-02	Sagers Well - Lincoln	11/20/85	JBR (UBTL)															
GW-03	6" Well - Boys Ranch	11/20/85	JBR (UBTL)															
GW-04	Tailings Dam Well	11/20/85	JBR (UBTL)															
GW-05	RB-PCL-02 Spring	11/20/85	JBR (UBTL)															
AC-GW-01	USGS Well - Lincoln	09/13/95	UDEQ	1.92	1.91	<0.1	3											
AC-GW-02	Sagers Well - Lincoln	09/14/95	UDEQ	1.41	1.62	<0.1 J	2.7 J											
GW-02	Sagers Well - Lincoln	09/14/95	USGS		1.6	2.5					34		<.1	<.01	12	226	390	
AC-GW-03	Eastern Site Property Line	09/18/95	UDEQ	1.4	1.38	<0.1	1.6											
GW-03	6" Well - Boys Ranch	09/19/95	USGS		1.8	2.9					42		<.1	0.04	12	223	370	
AC-GW-04	6" Well - Boys Ranch	09/25/95	UDEQ	1.88	1.99	<0.1	3.1											
Lysimeter Results																		
AC-LY-03	Carr Fork Tailings	10/03/95	UDEQ	26.5		0.25 J	2.5											
AC-LY-05	Northwest Corner Tailings Berm	10/16/95	UDEQ	16.9 J		<0.1	4.7											
AC-LY-06	East Side - Lead Smelter Site	10/16/95	UDEQ	176 J		0.62 J	50											
AC-LY-04	South IS&R Tailings	11/30/95	UDEQ	62.1		0.66 J	6.7											
AC-LY-02	North Side of Pine Creek	02/20/96	UDEQ	9.22		<0.1	27.2											
AC-LY-07	Above Dry Creek	02/20/96	UDEQ	4.72		<0.1	<0.1											
AC-LY-08	Borrow Pit - West of Berm	02/20/96	UDEQ	7.23		0.31	16.1											
Drinking Water Maximum Contamintant Levels (ppm)						**1**	**10**						**4**					

ANDERSON

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Table 1-1
Previous Groundwater and Lysimeter Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Conductivity (umhos/cm)	TDS	pH (pH Units)	Boron	Chromium (hex)	Molybdenum	Sulfide	Oil/Grease	TOC	Ammonia	Cyanide	Hydroxide	Phosphate	TSS
Sample Fraction																	
Groundwater Results																	
GW-02	Sagers Well - Lincoln - After Bail	2/13/81	Anaconda		708	7.1											768
GW-03	6" Well - Boys Ranch	6/24/82	Anaconda		699	7.3											
GW-03	6" Well - Boys Ranch - After 4 Hours	6/24/82	Anaconda		830	7.4											
GW-01	Tailings Dam Well	6/24/82	Anaconda		610	7.6											
GW-01	Tailings Dam Well - After 8 Hours	6/24/82	Anaconda		646	7.1											
GW-01	Tailings Dam Well - After 8 Hours	7/12/82	Anaconda		646	7.1											
98	Seep at base of slag pile	5/30/84	DERR	1135	760	7.6		<0.005							0		
103	Boys Ranch Tap Water-Spring Source	5/30/84	DERR	900	520	7.5		<0.005	<0.1						0		
GW-03	6" Well - Boys Ranch	12/10/84	Anaconda		550	7.45											
GW-02	Sagers Well - Lincoln	12/18/84	Anaconda			7.5											
GW-01	Tailings Dam Well	12/20/84	Anaconda		398	8.45											
GW-01	Pine Canyon - East of Site	7/9/85	E&E INC.														
GW-01	16" Well - Boys Ranch	9/24/85	JBR	770	480	7.22	0.018	<0.005	<0.01	<0.05		20	<0.1	<0.002	0	0.011	
GW-01	16" Well - Boys Ranch	9/24/85	USGS			7.2	0.02										
GW-02	Sagers Well - Lincoln	9/24/85	JBR	904	625	7.15	0.025	<0.005	<0.01	<0.05		49	<0.1	<0.002	0	<0.01	
GW-02	Sagers Well - Lincoln	9/24/85	USGS			7.1	0.03										
GW-03	6" Well - Boys Ranch	9/24/85	JBR	870	594	7.06	<0.01	<0.01	<0.01	<0.05		<1	<0.1	0.003	0	0.089	
GW-04	Tailings Dam Well	9/24/85	JBR	860	575	7.27	0.038	<0.01	<0.01	<0.05		90	<0.1	<0.002	0	0.032	
GW-05	RB-PCL-02 Spring	9/24/85	JBR	1500	1150	7.25	0.012	<0.01	<0.01	<0.05		1.8	<0.1	<0.002	0	0.032	
GW-03	6" Well - Boys Ranch	9/25/85	USGS	870		7.1	0.01										
AGW-4A	Tailings Dam Well	11/5/85	JBR	850	628	7.31	0.2		<0.01						0		
AGW-4B	Tailings Dam Well	11/5/85	JBR						<0.01								
AGW-4C	Tailings Dam Well	11/5/85	JBR	840	622	7.32	0.25		<0.01						0		
AGW-4D	Tailings Dam Well	11/5/85	JBR						<0.01								
AGW-4E	Tailings Dam Well	11/5/85	JBR	850	618	7.33	0.24		<0.01						0		
AGW-4F	Tailings Dam Well	11/5/85	JBR	840	635	7.31	0.27		<0.01						0		
AGW-4G	Tailings Dam Well	11/5/85	JBR	850	580	7.35	0.22		<0.01						0		
GW-01	16" Well - Boys Ranch	11/20/85	JBR (UBTL)														
GW-02	Sagers Well - Lincoln	11/20/85	JBR (UBTL)														
GW-03	6" Well - Boys Ranch	11/20/85	JBR (UBTL)														
GW-04	Tailings Dam Well	11/20/85	JBR (UBTL)														
GW-05	RB-PCL-02 Spring	11/20/85	JBR (UBTL)														
AC-GW-01	USGS Well - Lincoln	09/13/95	UDEQ														
AC-GW-02	Sagers Well - Lincoln	09/14/95	UDEQ														
GW-02	Sagers Well - Lincoln	09/14/95	USGS	870		7.3	0.07										
AC-GW-03	Eastern Site Property Line	09/18/95	UDEQ														
GW-03	6" Well - Boys Ranch	09/19/95	USGS	850		7.4	0.08										
AC-GW-04	6" Well - Boys Ranch	09/25/95	UDEQ														
Lysimeter Results																	
AC-LY-03	Carr Fork Tailings	10/03/95	UDEQ														
AC-LY-05	Northwest Corner Tailings Berm	10/16/95	UDEQ														
AC-LY-06	East Side - Lead Smelter Site	10/16/95	UDEQ														
AC-LY-04	South IS&R Tailings	11/30/95	UDEQ														
AC-LY-02	North Side of Pine Creek	02/20/96	UDEQ														
AC-LY-07	Above Dry Creek	02/20/96	UDEQ														
AC-LY-08	Borrow Pit - West of Berm	02/20/96	UDEQ														
Drinking Water Maximum Contamintant Levels (ppm)					2000									0.2			

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
100	Tailings material from tailings pond	5/30/84	DERR	Total Metals			475	105	48	21	26.5			7400	0.85	1.5	31.5	
102	Old smelter site	5/30/84	DERR	Total Metals			1950	98.5	11.6	7.5	25			8700		1.5	8.3	
104	Upgradient (wind) soil surface sample	5/30/84	DERR	Total Metals			18.5	73	2.1	6.5	17.5			106.5	0.08	<0.25	0.7	
105	Slag composite	5/30/84	DERR	Total Metals			393	285	35.2	36.1	11.9	2540		10700	<0.01	<20.5	5.7	
95a	Scraping off slag brick	5/30/84	DERR	Total Metals			410	7.8	15.1	2.2	150			1720	0.08	<21.8	2	
95b	Slag brick	5/30/84	DERR	Total Metals			6040	33.11	25.7	42.6	1780			8410	0.13	<24.7	68.8	
R1	1-6	1985	JBR	DTPA Extraction Analysis	1		<0.2		60			170	2	825				3
R1	1-12	1985	JBR	DTPA Extraction Analysis	1		<0.2		135			130	2	210				10
R1	1-18	1985	JBR	DTPA Extraction Analysis	2		<0.2		10			5	2	9				3
R1	1-24	1985	JBR	DTPA Extraction Analysis	2		<0.2		135			3	3	4				2
R1	1-36	1985	JBR	DTPA Extraction Analysis	1		<0.2		105			14	3	325				9
R1	1-48	1985	JBR	DTPA Extraction Analysis	2		<0.2		100			16	5	510				20
R1	1-6	1985	JBR	Saturated Paste Analysis			0.03		11.7			29.5		4.6				
R1	1-12	1985	JBR	Saturated Paste Analysis			0.01		15.85			2.85		0.44				
R1	1-18	1985	JBR	Saturated Paste Analysis			<0.01		5.95			0.81		0.15				
R1	1-24	1985	JBR	Saturated Paste Analysis			0.02		18.45			1.2		0.26				
R1	1-36	1985	JBR	Saturated Paste Analysis			0.02		19.6			1.59		0.46				
R1	1-48	1985	JBR	Saturated Paste Analysis			0.03		10.25			0.45		0.32				
R1	1-6	1985	JBR	Total Acid Analysis	2.6		1375		440			4950	4	55600				1420
R1	1-12	1985	JBR	Total Acid Analysis	3.7		80		390			770	1.75	4880				3340
R1	1-18	1985	JBR	Total Acid Analysis	2.85		14		210			45	1.4	505				1710
R1	1-24	1985	JBR	Total Acid Analysis	2.95		14		230			40	1.35	410				2350
R1	1-36	1985	JBR	Total Acid Analysis	2.5		110		200			255	1.35	2250				1810
R1	1-48	1985	JBR	Total Acid Analysis	2.55		110		190			275	1.5	3380				1180
R2	2-6	1985	JBR	Total Acid Analysis	14060		5.94		22.9			2720	21100	957				520
R2	2-12	1985	JBR	Total Acid Analysis	18200		4.9		110			239	19400	179				1030
R2	2-18	1985	JBR	Total Acid Analysis	14760		3.46		3.98			44.9	18240	226				714
R2	2-24	1985	JBR	Total Acid Analysis	11640		2.36		<0.2			15.5	12950	80.9				248
R2	2-36	1985	JBR	Total Acid Analysis	9320		1.68		<0.2			9.2	11030	39				202
R2	2-48	1985	JBR	Total Acid Analysis	9990		8.57		9.66			130	13290	651				376
R3	3-6	1985	JBR	DTPA Extraction Analysis	80		0.6		30			210	105	135				45
R3	3-12	1985	JBR	DTPA Extraction Analysis	4		<0.2		30			30	85	35				60
R3	3-18	1985	JBR	DTPA Extraction Analysis	20		<0.2		2			8	150	35				100
R3	3-24	1985	JBR	DTPA Extraction Analysis	3		<0.2		1			4	380	35				75
R3	3-36	1985	JBR	DTPA Extraction Analysis	3		<0.2		<1			4	260	25				60
R3	3-48	1985	JBR	DTPA Extraction Analysis	2		<0.2		1			8	175	45				75
R3	3-6	1985	JBR	Saturated Paste Analysis			0.04		1.52			0.4		0.22				
R3	3-12	1985	JBR	Saturated Paste Analysis			0.03		0.8			2.6		0.28				
R3	3-18	1985	JBR	Saturated Paste Analysis			0.06		0.31			0.4		0.13				
R3	3-24	1985	JBR	Saturated Paste Analysis			0.06		0.13			0.38		0.22				
R3	3-36	1985	JBR	Saturated Paste Analysis			0.02		0.03			0.23		0.25				
R3	3-48	1985	JBR	Saturated Paste Analysis			0.03		0.02			0.34		0.03				
R3	3-6	1985	JBR	Total Acid Analysis	4.75		270		45			590	2	2160				800
R3	3-12	1985	JBR	Total Acid Analysis	5.3		25		35			85	2.2	135				710
R3	3-18	1985	JBR	Total Acid Analysis	3.05		17		1			30	1.3	105				275
R3	3-24	1985	JBR	Total Acid Analysis	2		10		<1.0			25	0.95	95				145
R3	3-36	1985	JBR	Total Acid Analysis	2.15		8		<1.0			15	0.92	55				125
R3	3-48	1985	JBR	Total Acid Analysis	3.4		18		<1.0			30	1.55	155				260
R4	4-6	1985	JBR	DTPA Extraction Analysis	30		<0.2		25			120	80	85				40
R4	4-12	1985	JBR	DTPA Extraction Analysis	4		<0.2		1			8	135	13				80
R4	4-18	1985	JBR	DTPA Extraction Analysis	4		<0.2		<1.0			5	160	13				100
R4	4-24	1985	JBR	DTPA Extraction Analysis	3		<0.2		<1.0			2	85	8				35

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Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
100	Tailings material from tailings pond	5/30/84	DERR	Total Metals			0.75								7.8			
102	Old smelter site	5/30/84	DERR	Total Metals			0.5								3.1			
104	Upgradient (wind) soil surface sample	5/30/84	DERR	Total Metals			<0.5								5.9			
105	Slag composite	5/30/84	DERR	Total Metals			1.8											
95a	Scraping off slag brick	5/30/84	DERR	Total Metals			<0.4											
95b	Slag brick	5/30/84	DERR	Total Metals			0.6											
R1	1-6	1985	JBR	DTPA Extraction Analysis	190													
R1	1-12	1985	JBR	DTPA Extraction Analysis	270													
R1	1-18	1985	JBR	DTPA Extraction Analysis	450													
R1	1-24	1985	JBR	DTPA Extraction Analysis	470													
R1	1-36	1985	JBR	DTPA Extraction Analysis	360													
R1	1-48	1985	JBR	DTPA Extraction Analysis	280													
R1	1-6	1985	JBR	Saturated Paste Analysis	41.5													
R1	1-12	1985	JBR	Saturated Paste Analysis	51													
R1	1-18	1985	JBR	Saturated Paste Analysis	26.5													
R1	1-24	1985	JBR	Saturated Paste Analysis	97													
R1	1-36	1985	JBR	Saturated Paste Analysis	92.5													
R1	1-48	1985	JBR	Saturated Paste Analysis	26.5													
R1	1-6	1985	JBR	Total Acid Analysis	14700													
R1	1-12	1985	JBR	Total Acid Analysis	4050													
R1	1-18	1985	JBR	Total Acid Analysis	3100													
R1	1-24	1985	JBR	Total Acid Analysis	3250													
R1	1-36	1985	JBR	Total Acid Analysis	3000													
R1	1-48	1985	JBR	Total Acid Analysis	2790													
R2	2-6	1985	JBR	Total Acid Analysis	1040													
R2	2-12	1985	JBR	Total Acid Analysis	1160													
R2	2-18	1985	JBR	Total Acid Analysis	290													
R2	2-24	1985	JBR	Total Acid Analysis	47													
R2	2-36	1985	JBR	Total Acid Analysis	31													
R2	2-48	1985	JBR	Total Acid Analysis	228													
R3	3-6	1985	JBR	DTPA Extraction Analysis	140													
R3	3-12	1985	JBR	DTPA Extraction Analysis	250													
R3	3-18	1985	JBR	DTPA Extraction Analysis	10													
R3	3-24	1985	JBR	DTPA Extraction Analysis	9													
R3	3-36	1985	JBR	DTPA Extraction Analysis	5													
R3	3-48	1985	JBR	DTPA Extraction Analysis	5													
R3	3-6	1985	JBR	Saturated Paste Analysis	6.9													
R3	3-12	1985	JBR	Saturated Paste Analysis	7.2													
R3	3-18	1985	JBR	Saturated Paste Analysis	1.51													
R3	3-24	1985	JBR	Saturated Paste Analysis	0.6													
R3	3-36	1985	JBR	Saturated Paste Analysis	1.76													
R3	3-48	1985	JBR	Saturated Paste Analysis	0.13													
R3	3-6	1985	JBR	Total Acid Analysis	500													
R3	3-12	1985	JBR	Total Acid Analysis	510													
R3	3-18	1985	JBR	Total Acid Analysis	45													
R3	3-24	1985	JBR	Total Acid Analysis	40													
R3	3-36	1985	JBR	Total Acid Analysis	35													
R3	3-48	1985	JBR	Total Acid Analysis	55													
R4	4-6	1985	JBR	DTPA Extraction Analysis	190													
R4	4-12	1985	JBR	DTPA Extraction Analysis	7													
R4	4-18	1985	JBR	DTPA Extraction Analysis	4													
R4	4-24	1985	JBR	DTPA Extraction Analysis	2													

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
R4	4-36	1985	JBR	DTPA Extraction Analysis	4		<0.2		<1.0			5	160	8				85
R4	4-48	1985	JBR	DTPA Extraction Analysis	4		<0.2		1			7	110	15				50
R4	4-6	1985	JBR	Saturated Paste Analysis			0.04		0.03			0.32		0.06				
R4	4-12	1985	JBR	Saturated Paste Analysis			0.06		0.05			0.41		0.43				
R4	4-18	1985	JBR	Saturated Paste Analysis			0.07		0.01			0.33		0.02				
R4	4-24	1985	JBR	Saturated Paste Analysis			0.09		0.03			0.53		0.1				
R4	4-36	1985	JBR	Saturated Paste Analysis			0.05		0.03			0.51		0.06				
R4	4-48	1985	JBR	Saturated Paste Analysis			0.05		0.02			0.32		0.03				
R4	4-6	1985	JBR	Total Acid Analysis	5.55		45		40			255	2.35	285				820
R4	4-12	1985	JBR	Total Acid Analysis	5.3		13		<1.0			30	2.15	50				660
R4	4-18	1985	JBR	Total Acid Analysis	4.4		10		<1.0			20	2	45				550
R4	4-24	1985	JBR	Total Acid Analysis	5		13		<1.0			14	2.4	30				525
R4	4-36	1985	JBR	Total Acid Analysis	3.95		7		<1.0			18	1.8	30				360
R4	4-48	1985	JBR	Total Acid Analysis	3.65		10		<1.0			25	1.65	45				330
R5	5-6	1985	JBR	DTPA Extraction Analysis	100		0.6		12			70	220	140				45
R5	5-12	1985	JBR	DTPA Extraction Analysis	9		<0.2		3			10	205	25				120
R5	5-18	1985	JBR	DTPA Extraction Analysis	5		<0.2		1			6	130	16				65
R5	5-24	1985	JBR	DTPA Extraction Analysis	4		<0.2		<1.0			2	80	5				40
R5	5-36	1985	JBR	DTPA Extraction Analysis	3		<0.2		<1.0			2	65	6				30
R5	5-48	1985	JBR	DTPA Extraction Analysis	3		<0.2		<1.0			3	70	8				25
R5	5-6	1985	JBR	Saturated Paste Analysis			0.06		0.08			0.18		0.07				
R5	5-12	1985	JBR	Saturated Paste Analysis			0.04		0.04			0.2		0.05				
R5	5-18	1985	JBR	Saturated Paste Analysis			0.23		0.04			0.17		0.06				
R5	5-24	1985	JBR	Saturated Paste Analysis			0.17		0.03			0.13		0.05				
R5	5-36	1985	JBR	Saturated Paste Analysis			0.14		0.02			0.09		0.04				
R5	5-48	1985	JBR	Saturated Paste Analysis			0.16		0.02			0.15		0.12				
R5	5-6	1985	JBR	Total Acid Analysis	4.85		120		18			200	2	370				515
R5	5-12	1985	JBR	Total Acid Analysis	4.8		15		5			35	1.9	75				495
R5	5-18	1985	JBR	Total Acid Analysis	4.85		12		2			25	2	55				620
R5	5-24	1985	JBR	Total Acid Analysis	5.25		7		<1.0			14	1.9	70				475
R5	5-36	1985	JBR	Total Acid Analysis	4.6		6		<1.0			12	1.8	60				430
R5	5-48	1985	JBR	Total Acid Analysis	4.2		7		<1.0			14	1.45	35				340
R6	6-6	1985	JBR	DTPA Extraction Analysis	35		0.2		8			6	55	10				40
R6	6-12	1985	JBR	DTPA Extraction Analysis	7		<0.2		1			2	40	7				30
R6	6-18	1985	JBR	DTPA Extraction Analysis	4		<0.2		<1.0			1	35	5				25
R6	6-24	1985	JBR	DTPA Extraction Analysis	4		<0.2		<1.0			1	25	3				15
R6	6-36	1985	JBR	DTPA Extraction Analysis	3		<0.2		<1.0			1	20	4				9
R6	6-48	1985	JBR	DTPA Extraction Analysis	4		<0.2		<1.0			2	25	9				12
R6	6-6	1985	JBR	Saturated Paste Analysis			0.12		0.02			0.1		<0.01				
R6	6-12	1985	JBR	Saturated Paste Analysis			0.07		0.02			0.15		0.02				
R6	6-18	1985	JBR	Saturated Paste Analysis			0.05		0.01			0.08		0.03				
R6	6-24	1985	JBR	Saturated Paste Analysis			0.08		0.02			0.13		0.02				
R6	6-36	1985	JBR	Saturated Paste Analysis			0.09		0.02			0.12		0.06				
R6	6-48	1985	JBR	Saturated Paste Analysis			0.08		0.02			0.11		0.2				
R6	6-6	1985	JBR	Total Acid Analysis	4.85		160		13			20	1.8	45				890
R6	6-12	1985	JBR	Total Acid Analysis	4.9		35		2			15	1.8	30				525
R6	6-18	1985	JBR	Total Acid Analysis	4.8		25		<1.0			12	1.75	25				385
R6	6-24	1985	JBR	Total Acid Analysis	4.35		10		<1.0			10	1.5	30				325
R6	6-36	1985	JBR	Total Acid Analysis	3.9		13		<1.0			8	1.3	100				240
R6	6-48	1985	JBR	Total Acid Analysis	2.55		20		<1.0			11	0.9	35				165
R7	7-6	1985	JBR	Total Acid Analysis	13680		13.9		21.1			3080	16070	716				841
R7	7-12	1985	JBR	Total Acid Analysis	15110		9.5		1.4			53.6	17250	107				733

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Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
R4	4-36	1985	JBR	DTPA Extraction Analysis	4													
R4	4-48	1985	JBR	DTPA Extraction Analysis	5													
R4	4-6	1985	JBR	Saturated Paste Analysis	0.36													
R4	4-12	1985	JBR	Saturated Paste Analysis	4.1													
R4	4-18	1985	JBR	Saturated Paste Analysis	0.08													
R4	4-24	1985	JBR	Saturated Paste Analysis	0.27													
R4	4-36	1985	JBR	Saturated Paste Analysis	0.2													
R4	4-48	1985	JBR	Saturated Paste Analysis	0.18													
R4	4-6	1985	JBR	Total Acid Analysis	4709													
R4	4-12	1985	JBR	Total Acid Analysis	75													
R4	4-18	1985	JBR	Total Acid Analysis	50													
R4	4-24	1985	JBR	Total Acid Analysis	50													
R4	4-36	1985	JBR	Total Acid Analysis	40													
R4	4-48	1985	JBR	Total Acid Analysis	40													
R5	5-6	1985	JBR	DTPA Extraction Analysis	90													
R5	5-12	1985	JBR	DTPA Extraction Analysis	25													
R5	5-18	1985	JBR	DTPA Extraction Analysis	5													
R5	5-24	1985	JBR	DTPA Extraction Analysis	1													
R5	5-36	1985	JBR	DTPA Extraction Analysis	1													
R5	5-48	1985	JBR	DTPA Extraction Analysis	3													
R5	5-6	1985	JBR	Saturated Paste Analysis	1.28													
R5	5-12	1985	JBR	Saturated Paste Analysis	0.4													
R5	5-18	1985	JBR	Saturated Paste Analysis	0.25													
R5	5-24	1985	JBR	Saturated Paste Analysis	0.21													
R5	5-36	1985	JBR	Saturated Paste Analysis	0.13													
R5	5-48	1985	JBR	Saturated Paste Analysis	0.21													
R5	5-6	1985	JBR	Total Acid Analysis	305													
R5	5-12	1985	JBR	Total Acid Analysis	125													
R5	5-18	1985	JBR	Total Acid Analysis	75													
R5	5-24	1985	JBR	Total Acid Analysis	55													
R5	5-36	1985	JBR	Total Acid Analysis	40													
R5	5-48	1985	JBR	Total Acid Analysis	45													
R6	6-6	1985	JBR	DTPA Extraction Analysis	70													
R6	6-12	1985	JBR	DTPA Extraction Analysis	7													
R6	6-18	1985	JBR	DTPA Extraction Analysis	2													
R6	6-24	1985	JBR	DTPA Extraction Analysis	1													
R6	6-36	1985	JBR	DTPA Extraction Analysis	1													
R6	6-48	1985	JBR	DTPA Extraction Analysis	3													
R6	6-6	1985	JBR	Saturated Paste Analysis	0.15													
R6	6-12	1985	JBR	Saturated Paste Analysis	0.12													
R6	6-18	1985	JBR	Saturated Paste Analysis	0.08													
R6	6-24	1985	JBR	Saturated Paste Analysis	0.13													
R6	6-36	1985	JBR	Saturated Paste Analysis	0.1													
R6	6-48	1985	JBR	Saturated Paste Analysis	0.14													
R6	6-6	1985	JBR	Total Acid Analysis	200													
R6	6-12	1985	JBR	Total Acid Analysis	60													
R6	6-18	1985	JBR	Total Acid Analysis	50													
R6	6-24	1985	JBR	Total Acid Analysis	40													
R6	6-36	1985	JBR	Total Acid Analysis	40													
R6	6-48	1985	JBR	Total Acid Analysis	35													
R7	7-6	1985	JBR	Total Acid Analysis	1240													
R7	7-12	1985	JBR	Total Acid Analysis	98.7													

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
R7	7-18	1985	JBR	Total Acid Analysis	15200		4.18		<0.2			19.6	17100	58.1				628
R7	7-24	1985	JBR	Total Acid Analysis	16550		3.41		<0.2			13.2	18270	38.3				604
R7	7-36	1985	JBR	Total Acid Analysis	14160		5.66		<0.2			9.8	14470	33.5				351
R7	7-48	1985	JBR	Total Acid Analysis	15990		10.4		<0.2			35.2	14910	106				434
S-01	Dry Creek Outlet	7/9/85	E&E INC.	Total Metals	14200	<20	300	181	33	10	18	577	19200	1600	1.76	<20	5.5	819
SS-01	Dike: SW Corner	7/9/85	E&E INC.	Total Metals	5700	97	3980	30	51	6.6	41	361	71500	9200	0.6	7.2	28	2760
SS-02	Dike: SW Corner	7/9/85	E&E INC.	Total Metals	12300	100	2620	18	55	7.5	44	540	53500	9160	0.7	6.7	24	4930
SS-03	Dike: SW Corner	7/9/85	E&E INC.	Total Metals	1850	61	1230	21	41	2.8	23	381	67900	4840	0.57	4.6	40	9490
SS-04	Dike: SW Corner, under tailings	7/9/85	E&E INC.	Total Metals	10100	1.3	22	96	5.6	4.2	12	21	10600	107	0.15	<0.9	<0.9	370
SS-05	Dike: NE Corner	7/9/85	E&E INC.	Total Metals	2840	<0.9	8.1	21	1.3	1.7	5.3	2.8	4150	17	<0.01	<0.9	<0.9	176
SS-06	Dike: NE Corner	7/9/85	E&E INC.	Total Metals	4810	<0.7	12	36	2.1	2.5	8.9	5.1	5910	24	<0.01	<0.1	<0.7	235
T-01	Tailings Pond South	7/9/85	E&E INC.	Total Metals	11400	<14	200	129	30	13	16	1540	38100	1100	1.05	<14	5	866
T-02	Tailings Pond North	7/9/85	E&E INC.	Total Metals	4590	<20	124	35	29	15	39	1190	74400	173	0.17	<20	3	742
T-03	Tailings Pond Central	7/9/85	E&E INC.	Total Metals	1540	<150	1320	43	21	3.4	11	266	47700	3760	0.3	<150	3.5	1560
RB-PCL-01	Pine Creek Landfill Surface Sample	8/23/85	JBR	EP Toxicity Analysis			0.22	0.03	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-PCL-01	Pine Creek Landfill	8/23/85	JBR	PH Testing														
RB-PCL-01	Pine Creek Landfill Surface Sample	8/23/85	JBR	Total Acid Analysis			140		10			2730		125	70	10	4.8	
RB-PCL-02	Pine Creek Landfill Surface Sample	8/23/85	JBR	EP Toxicity Analysis			<0.1	0.07	1.54		0.01			1.07	0.0003	<0.5	<0.5	
RB-PCL-02	Pine Creek Landfill	8/23/85	JBR	PH Testing														
RB-PCL-02	Pine Creek Landfill Surface Sample	8/23/85	JBR	Total Acid Analysis			385		145			1000		4950	2860	10	14.8	
RB-PCL-03	Pine Creek Landfill Surface Sample	8/23/85	JBR	EP Toxicity Analysis			0.285	0.37	0.34		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-PCL-03	Pine Creek Landfill	8/23/85	JBR	PH Testing														
RB-PCL-03	Pine Creek Landfill Surface Sample	8/23/85	JBR	Total Acid Analysis			25		45			125		300	420	<1	0.7	
RB-PLL-01	Parking Lot Landfill	8/23/85	JBR	EP Toxicity Analysis			0.175	0.07	0.03		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-PLL-01	Parking Lot Landfill	8/23/85	JBR	PH Testing														
RB-PLL-01	Parking Lot Landfill	8/23/85	JBR	Total Acid Analysis			30		11			60		80	150	<1	0.7	
RB-PLL-02	Parking Lot Landfill	8/23/85	JBR	EP Toxicity Analysis			0.32	0.2	0.17		<0.01			<0.5	0.0006	<0.5	<0.5	
RB-PLL-02	Parking Lot Landfill	8/23/85	JBR	PH Testing														
RB-PLL-02	Parking Lot Landfill	8/23/85	JBR	Total Acid Analysis			510		140			2090		13800	980	1	28	
RB-PLL-03	Parking Lot Landfill	8/23/85	JBR	EP Toxicity Analysis			0.141	0.09	0.03		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-PLL-03	Parking Lot Landfill	8/23/85	JBR	PH Testing														
RB-PLL-03	Parking Lot Landfill	8/23/85	JBR	Total Acid Analysis			5		12			440		130	130	<1	0.5	
RB-RFB-01	Reverbratory-furnace Bins	8/26/85	JBR	EP Toxicity Analysis			0.1	0.01	<0.1		<0.01			<0.5	0.0001	<0.5	<0.5	
RB-RFB-01	Reverbratory-furnace Bins	8/26/85	JBR	PH Testing														
RB-RFB-01	Reverbratory-furnace Bins	8/26/85	JBR	Total Acid Analysis			12		215			561000		99800	450	14600	2820	
RB-RFB-02	Reverbratory-furnace Bins	8/26/85	JBR	EP Toxicity Analysis			0.106	0.04	0.16		<0.01			0.63	<0.0001	<0.5	<0.5	
RB-RFB-02	Reverbratory-furnace Bins	8/26/85	JBR	PH Testing														
RB-RFB-02	Reverbratory-furnace Bins	8/26/85	JBR	Total Acid Analysis			6450		95			69700		21850	1200	140	183.4	
RB-SDF-01	South Drainage Ferricrete	8/26/85	JBR	EP Toxicity Analysis			<0.1	0.28	0.66		<0.01			1.22	0.0007	<0.5	<0.5	
RB-SDF-01	South Drainage Ferricrete	8/26/85	JBR	PH Testing														
RB-SDF-01	South Drainage Ferricrete	8/26/85	JBR	Total Acid Analysis			3450		370			8720		27350	4580	250	100.5	
RB-SDF-02	South Drainage Ferricrete	8/26/85	JBR	EP Toxicity Analysis			<0.1	0.08	0.15		<0.01			3.01	<0.0001	<0.5	<0.5	
RB-SDF-02	South Drainage Ferricrete	8/26/85	JBR	PH Testing														
RB-SDF-02	South Drainage Ferricrete	8/26/85	JBR	Total Acid Analysis			1100		70			29800		89100	860	30	252	
RB-SDF-03	South Drainage Ferricrete	8/26/85	JBR	EP Toxicity Analysis			0.182	0.17	<0.1		<0.01			2.74	<0.0001	<0.5	<0.5	
RB-SDF-03	South Drainage Ferricrete	8/26/85	JBR	PH Testing														
RB-SDF-03	South Drainage Ferricrete	8/26/85	JBR	Total Acid Analysis			2600		35			20300		32650	390	70	214.5	
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	EP Toxicity Analysis			0.181	0.01	<0.1		<0.01			<0.5	<0.0001	0.53	<0.5	
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	PH Testing														
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	Total Acid Analysis			64700		460			398000		73500	1010	1600	1198	
RB-ZFA-02	Zinc Furnace Area	8/26/85	JBR	EP Toxicity Analysis			<0.1	0.07	0.5		<0.01			20.25	0.0001	<0.5	<0.5	
RB-ZFA-02	Zinc Furnace Area	8/26/85	JBR	PH Testing														

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
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J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
R7	7-18	1985	JBR	Total Acid Analysis	60.8													
R7	7-24	1985	JBR	Total Acid Analysis	56.1													
R7	7-36	1985	JBR	Total Acid Analysis	43.4													
R7	7-48	1985	JBR	Total Acid Analysis	73.3													
S-01	Dry Creek Outlet	7/9/85	E&E INC.	Total Metals	748	3600	<2.0		3860	609	17	<20	33					
SS-01	Dike: SW Corner	7/9/85	E&E INC.	Total Metals	4160	51600	<1.8			2510	11	<18	21					
SS-02	Dike: SW Corner	7/9/85	E&E INC.	Total Metals	6070	42000	<1.6			3280	16	<16	24					
SS-03	Dike: SW Corner	7/9/85	E&E INC.	Total Metals	3390	36600	<1.7			1930	17	<18	4.5					
SS-04	Dike: SW Corner, under tailings	7/9/85	E&E INC.	Total Metals	532	2550	<1.8			366	7.9	<18	18					
SS-05	Dike: NE Corner	7/9/85	E&E INC.	Total Metals	40	859	<1.9			<190	<6	<19	7.8					
SS-06	Dike: NE Corner	7/9/85	E&E INC.	Total Metals	32	18400	<1.5			215	8	<15	11					
T-01	Tailings Pond South	7/9/85	E&E INC.	Total Metals	3360	28700	<1.4		6700	1910	24	<14	22					
T-02	Tailings Pond North	7/9/85	E&E INC.	Total Metals	541	84000	<1.9		10900	752	25	<18	17					
T-03	Tailings Pond Central	7/9/85	E&E INC.	Total Metals	964	45500	<1.5		2590	847	<5	<16	7.2					
RB-PCL-01	Pine Creek Landfill Surface Sample	8/23/85	JBR	EP Toxicity Analysis														
RB-PCL-01	Pine Creek Landfill	8/23/85	JBR	PH Testing												6.19	5.92	
RB-PCL-01	Pine Creek Landfill Surface Sample	8/23/85	JBR	Total Acid Analysis	7950													
RB-PCL-02	Pine Creek Landfill Surface Sample	8/23/85	JBR	EP Toxicity Analysis														
RB-PCL-02	Pine Creek Landfill	8/23/85	JBR	PH Testing												6.08	3.41	
RB-PCL-02	Pine Creek Landfill Surface Sample	8/23/85	JBR	Total Acid Analysis	6130													
RB-PCL-03	Pine Creek Landfill Surface Sample	8/23/85	JBR	EP Toxicity Analysis														
RB-PCL-03	Pine Creek Landfill	8/23/85	JBR	PH Testing												2.94	6.91	
RB-PCL-03	Pine Creek Landfill Surface Sample	8/23/85	JBR	Total Acid Analysis	350													
RB-PLL-01	Parking Lot Landfill	8/23/85	JBR	EP Toxicity Analysis														
RB-PLL-01	Parking Lot Landfill	8/23/85	JBR	PH Testing												3.94	6.1	
RB-PLL-01	Parking Lot Landfill	8/23/85	JBR	Total Acid Analysis	480													
RB-PLL-02	Parking Lot Landfill	8/23/85	JBR	EP Toxicity Analysis														
RB-PLL-02	Parking Lot Landfill	8/23/85	JBR	PH Testing												3.64	6.31	
RB-PLL-02	Parking Lot Landfill	8/23/85	JBR	Total Acid Analysis	2590													
RB-PLL-03	Parking Lot Landfill	8/23/85	JBR	EP Toxicity Analysis														
RB-PLL-03	Parking Lot Landfill	8/23/85	JBR	PH Testing												2.65	5.55	
RB-PLL-03	Parking Lot Landfill	8/23/85	JBR	Total Acid Analysis	290													
RB-RFB-01	Reverbratory-furnace Bins	8/26/85	JBR	EP Toxicity Analysis														
RB-RFB-01	Reverbratory-furnace Bins	8/26/85	JBR	PH Testing												5.94	7.62	
RB-RFB-01	Reverbratory-furnace Bins	8/26/85	JBR	Total Acid Analysis	2900													
RB-RFB-02	Reverbratory-furnace Bins	8/26/85	JBR	EP Toxicity Analysis														
RB-RFB-02	Reverbratory-furnace Bins	8/26/85	JBR	PH Testing												5.33	1.98	
RB-RFB-02	Reverbratory-furnace Bins	8/26/85	JBR	Total Acid Analysis	6120													
RB-SDF-01	South Drainage Ferricrete	8/26/85	JBR	EP Toxicity Analysis														
RB-SDF-01	South Drainage Ferricrete	8/26/85	JBR	PH Testing												5.68	7.01	
RB-SDF-01	South Drainage Ferricrete	8/26/85	JBR	Total Acid Analysis	7230													
RB-SDF-02	South Drainage Ferricrete	8/26/85	JBR	EP Toxicity Analysis														
RB-SDF-02	South Drainage Ferricrete	8/26/85	JBR	PH Testing												4.34	5.47	
RB-SDF-02	South Drainage Ferricrete	8/26/85	JBR	Total Acid Analysis	14450													
RB-SDF-03	South Drainage Ferricrete	8/26/85	JBR	EP Toxicity Analysis														
RB-SDF-03	South Drainage Ferricrete	8/26/85	JBR	PH Testing												2.9	5.12	
RB-SDF-03	South Drainage Ferricrete	8/26/85	JBR	Total Acid Analysis	13550													
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	EP Toxicity Analysis														
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	PH Testing												6.29	7.46	
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	Total Acid Analysis	22500													
RB-ZFA-02	Zinc Furnace Area	8/26/85	JBR	EP Toxicity Analysis														
RB-ZFA-02	Zinc Furnace Area	8/26/85	JBR	PH Testing												5.37	6.28	

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
RB-ZFA-02	Zinc Furnace Area	8/26/85	JBR	Total Acid Analysis			3450		235			3360		71000	780	310	51.2	
RB-ZFA-03	Zinc Furnace Area	8/26/85	JBR	EP Toxicity Analysis			<0.1	0.09	0.14		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-ZFA-03	Zinc Furnace Area	8/26/85	JBR	PH Testing														
RB-ZFA-03	Zinc Furnace Area	8/26/85	JBR	Total Acid Analysis			1100		315			8980		26650	490	200	42.6	
ADH-02	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			<0.01		0.08	0.06	0.03	0.09		0.08	0.0001			
ADH1-03	North End of Dike	8/28/85	JBR	Saturated Paste Analysis			<0.01		0.06	0.05	<0.01	0.02		0.09	0.0003			
ADH11-03	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			0.02		0.01	<0.01	<0.01	<0.01		0.03	<0.0001			
ADH12-01	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			0.02		0.03	0.02	0.01	0.01		0.16	<0.0001			
ADH13-02	West of Slag Pile	8/28/85	JBR	Saturated Paste Analysis			0.01		<0.01	0.01	<0.01	<0.01		0.03	<0.0001			
ADH2-02	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			<0.01		0.04	0.02	<0.01	<0.01		0.03	0.0003			
ADH2-04	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			<0.01		0.02	0.02	<0.01	<0.01		<0.01	0.0003			
ADH3-03	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			0.03		0.04	0.05	0.03	<0.01		0.05	<0.0001			
ADH5-04	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			<0.01		0.1	0.15	0.03	0.03		0.22	0.0002			
ADH6-01	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			<0.01		0.05	0.07	0.01	<0.01		0.09	0.0004			
ADH6-03	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			0.01		0.04	0.04	0.01	0.01		0.16	0.0005			
ADH6-04	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis			<0.01		0.02	0.05	<0.01	0.01		0.14	0.0005			
ADH7-10-12	South End of Dike	8/28/85	JBR	Saturated Paste Analysis			0.03		0.05	0.12	0.02	0.03		0.21	0.0001			
RB-IST-01	IS&R Tailings	8/28/85	JBR	PH Testing														
RB-IST-01	IS&R Tailings	8/28/85	JBR	Total Acid Analysis			10430		16			220		13050	370	5	93.7	
RB-IST-01	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis			6.4	0.03	0.23		0.031			1.03	0.0002	<0.5	<0.5	
RB-IST-02	IS&R Tailings	8/28/85	JBR	PH Testing														
RB-IST-02	IS&R Tailings	8/28/85	JBR	Total Acid Analysis			3900		12			1730		33100	6700	20	162.6	
RB-IST-02	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis			<0.1	0.04	0.02		<0.01			<0.5	0.0001	<0.5	<0.5	
RB-IST-03	IS&R Tailings	8/28/85	JBR	PH Testing														
RB-IST-03	IS&R Tailings	8/28/85	JBR	Total Acid Analysis			6950		10			175		7400	900	2	78.4	
RB-IST-03	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis			1.505	0.03	0.02		<0.01			2.2	0.0003	<0.5	<0.5	
RB-IST-04	IS&R Tailings	8/28/85	JBR	PH Testing														
RB-IST-04	IS&R Tailings	8/28/85	JBR	Total Acid Analysis			190		5			140		110	370	1	0.9	
RB-IST-04	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis			0.201	<0.01	0.02		<0.01			<0.5	0.0001	<0.5	<0.5	
RB-IST-05	IS&R Tailings	8/28/85	JBR	PH Testing														
RB-IST-05	IS&R Tailings	8/28/85	JBR	Total Acid Analysis			650		11			505		6250	360	2	64.6	
RB-IST-05	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis			<0.1	0.03	0.07		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-IST-06	IS&R Tailings	8/28/85	JBR	PH Testing														
RB-IST-06	IS&R Tailings	8/28/85	JBR	Total Acid Analysis			880		70			570		7750	360	2	61	
RB-IST-06	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis			<0.1	0.04	0.11		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-IST-07	IS&R Tailings	8/28/85	JBR	PH Testing														
RB-IST-07	IS&R Tailings	8/28/85	JBR	Total Acid Analysis			1600		19			990		7100	510	2	13.6	
RB-IST-07	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis			<0.1	0.02	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
BW-ISS-01	Slag Pile	8/29/85	JBR	EP Toxicity Analysis			<0.1	0.08	0.15		<0.01			2.6	<0.0001	<0.5	<0.5	
BW-ISS-01	Slag Pile	8/29/85	JBR	PH Testing														
BW-ISS-01	Slag Pile	8/29/85	JBR	Total Acid Analysis			350		40			3780		13100	200	5	17	
BW-ISS-02	Slag Pile	8/29/85	JBR	EP Toxicity Analysis			<0.1	0.04	<0.1		<0.01			0.81	<0.0001	<0.5	<0.5	
BW-ISS-02	Slag Pile	8/29/85	JBR	PH Testing														
BW-ISS-02	Slag Pile	8/29/85	JBR	Total Acid Analysis			110		40			3570		10650	140	8	19.4	
RB-CFT-01	Carr Fork Tailings	8/29/85	JBR	PH Testing														
RB-CFT-01	Carr Fork Tailings	8/29/85	JBR	Total Acid Analysis			29900		8			950		345	40	<1	3.2	
RB-CFT-01	Carr Fork Tailings	8/29/85	JBR	EP Toxicity Analysis			<0.1	0.02	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-CFT-02	Carr Fork Tailings	8/29/85	JBR	PH Testing														
RB-CFT-02	Carr Fork Tailings	8/29/85	JBR	Total Acid Analysis			19300		6			735		75	<20	3	1.2	
RB-CFT-02	Carr Fork Tailings	8/29/85	JBR	EP Toxicity Analysis			<0.1	0.01	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
RB-IST-08	IS&R Tailings	8/29/85	JBR	PH Testing														
RB-IST-08	IS&R Tailings	8/29/85	JBR	Total Acid Analysis			810		85			2640		17800	430	3	108.4	

ANDERSON ENGINEERING COMPANY INC.

6/4/03 7:54

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
RB-ZFA-02	Zinc Furnace Area	8/26/85	JBR	Total Acid Analysis	426000													
RB-ZFA-03	Zinc Furnace Area	8/26/85	JBR	EP Toxicity Analysis														
RB-ZFA-03	Zinc Furnace Area	8/26/85	JBR	PH Testing												6.17	6.75	
RB-ZFA-03	Zinc Furnace Area	8/26/85	JBR	Total Acid Analysis	235000													
ADH-02	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	0.33										5.92			
ADH1-03	North End of Dike	8/28/85	JBR	Saturated Paste Analysis	0.12										6.58			
ADH11-03	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	<0.01										7.74			
ADH12-01	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	0.33										7.44			
ADH13-02	West of Slag Pile	8/28/85	JBR	Saturated Paste Analysis	0.07										7.47			
ADH2-02	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	0.01										6.99			
ADH2-04	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	<0.01										7.01			
ADH3-03	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	0.02										7.08			
ADH5-04	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	2.81										7.35			
ADH6-01	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	0.48										6.7			
ADH6-03	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	0.18										7.24			
ADH6-04	Impoundment Dike	8/28/85	JBR	Saturated Paste Analysis	0.12										7.4			
ADH7-10-12	South End of Dike	8/28/85	JBR	Saturated Paste Analysis	0.76										7.68			
RB-IST-01	IS&R Tailings	8/28/85	JBR	PH Testing												1.99	1.24	58625
RB-IST-01	IS&R Tailings	8/28/85	JBR	Total Acid Analysis	1925													
RB-IST-01	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis														
RB-IST-02	IS&R Tailings	8/28/85	JBR	PH Testing												3.11	1.82	7040
RB-IST-02	IS&R Tailings	8/28/85	JBR	Total Acid Analysis	950													
RB-IST-02	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis														
RB-IST-03	IS&R Tailings	8/28/85	JBR	PH Testing												2.23	1.32	40000
RB-IST-03	IS&R Tailings	8/28/85	JBR	Total Acid Analysis	480													
RB-IST-03	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis														
RB-IST-04	IS&R Tailings	8/28/85	JBR	PH Testing												3.28	2.69	2565
RB-IST-04	IS&R Tailings	8/28/85	JBR	Total Acid Analysis	160													
RB-IST-04	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis														
RB-IST-05	IS&R Tailings	8/28/85	JBR	PH Testing												2.89	2.82	3560
RB-IST-05	IS&R Tailings	8/28/85	JBR	Total Acid Analysis	1080													
RB-IST-05	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis														
RB-IST-06	IS&R Tailings	8/28/85	JBR	PH Testing												5.89	5.33	11900
RB-IST-06	IS&R Tailings	8/28/85	JBR	Total Acid Analysis	11250													
RB-IST-06	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis														
RB-IST-07	IS&R Tailings	8/28/85	JBR	PH Testing												5.6	6	3115
RB-IST-07	IS&R Tailings	8/28/85	JBR	Total Acid Analysis	4480													
RB-IST-07	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis														
BW-ISS-01	Slag Pile	8/29/85	JBR	EP Toxicity Analysis														
BW-ISS-01	Slag Pile	8/29/85	JBR	PH Testing												2.55	5.28	
BW-ISS-01	Slag Pile	8/29/85	JBR	Total Acid Analysis	62600													
BW-ISS-02	Slag Pile	8/29/85	JBR	EP Toxicity Analysis														
BW-ISS-02	Slag Pile	8/29/85	JBR	PH Testing												5.96	5.34	
BW-ISS-02	Slag Pile	8/29/85	JBR	Total Acid Analysis	68500													
RB-CFT-01	Carr Fork Tailings	8/29/85	JBR	PH Testing												5.83	5.32	2625
RB-CFT-01	Carr Fork Tailings	8/29/85	JBR	Total Acid Analysis	145													
RB-CFT-01	Carr Fork Tailings	8/29/85	JBR	EP Toxicity Analysis														
RB-CFT-02	Carr Fork Tailings	8/29/85	JBR	PH Testing												6.45	6.4	2330
RB-CFT-02	Carr Fork Tailings	8/29/85	JBR	Total Acid Analysis	80													
RB-CFT-02	Carr Fork Tailings	8/29/85	JBR	EP Toxicity Analysis														
RB-IST-08	IS&R Tailings	8/29/85	JBR	PH Testing												6.12	4.11	4185
RB-IST-08	IS&R Tailings	8/29/85	JBR	Total Acid Analysis	14650													

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
RB-IST-08	IS&R Tailings	8/29/85	JBR	EP Toxicity Analysis			<0.1	0.06	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
BW-ISS-03	Slag Pile	8/30/85	JBR	EP Toxicity Analysis			<0.1	0.09	<0.1		<0.01			<0.5	0.0001	<0.5	<0.5	
BW-ISS-03	Slag Pile	8/30/85	JBR	PH Testing														
BW-ISS-03	Slag Pile	8/30/85	JBR	Total Acid Analysis			380		11			1730		8900	110	4	6.8	
RB-LBA-01	Lead Blast Area	8/30/85	JBR	Total Acid Analysis			1200		530			1570		22300	1840	130	32.6	
RB-LBA-01	Lead Blast Area	8/30/85	JBR	PH Testing														
RB-LBA-01	Lead Blast Area	8/30/85	JBR	EP Toxicity Analysis			1.481	0.05	1.78		<0.01			<0.5	0.0002	<0.5	<0.5	
RB-OC-01	Ore Concentrates	8/30/85	JBR	Total Acid Analysis			2200		145			595		37600	280	15	83.2	
RB-OC-01	Ore Concentrates	8/30/85	JBR	PH Testing														
RB-OC-01	Ore Concentrates	8/30/85	JBR	EP Toxicity Analysis			<0.1	0.09	1.26		<0.01			2.88	<0.0001	<0.5	<0.5	
RB-PYC-01	Pyrite Concentrates	8/30/85	JBR	Total Acid Analysis			1000		20			145		11300	820	130	64	
RB-PYC-01	Pyrite Concentrates	8/30/85	JBR	PH Testing														
RB-PYC-01	Pyrite Concentrates	8/30/85	JBR	EP Toxicity Analysis			<0.1	<0.01	0.13		0.011			3.11	0.0001	<0.5	<0.5	
RB-RRY-01	Railroad Yard	8/30/85	JBR	EP Toxicity Analysis			<0.1	0.15	<0.1		<0.01			<0.5	0.0001	<0.5	<0.5	
RB-RRY-01	Railroad Yard	8/30/85	JBR	PH Testing														
RB-RRY-01	Railroad Yard	8/30/85	JBR	Total Acid Analysis			850		270			770		41600	1020	15	95.6	
RB-RRY-02	Railroad Yard	8/30/85	JBR	EP Toxicity Analysis			<0.1	<0.01	1.03		<0.01			5.5	<0.0001	<0.5	<0.5	
RB-RRY-02	Railroad Yard	8/30/85	JBR	PH Testing														
RB-RRY-02	Railroad Yard	8/30/85	JBR	Total Acid Analysis			1020		400			3820		96800	220	4	392	
RB-RRY-03	Railroad Yard	8/30/85	JBR	EP Toxicity Analysis			<0.1	0.03	0.88		0.011			3.24	<0.0001	<0.5	<0.5	
RB-RRY-03	Railroad Yard	8/30/85	JBR	PH Testing														
RB-RRY-03	Railroad Yard	8/30/85	JBR	Total Acid Analysis			1450		60			23600		9650	310	20	404	
RB-RRY-04	Railroad Yard	8/30/85	JBR	EP Toxicity Analysis			<0.1	<0.01	0.33		<0.01			10.29	0.0002	<0.5	<0.5	
RB-RRY-04	Railroad Yard	8/30/85	JBR	PH Testing														
RB-RRY-04	Railroad Yard	8/30/85	JBR	Total Acid Analysis			6590		500			18800		88500	150	40	526	
RB-SC-01	Sulfide Concentrator	8/30/85	JBR	PH Testing														
RB-SC-01	Sulfide Concentrator	8/30/85	JBR	Total Acid Analysis			685		12			20300		4150	250	9	15.2	
RB-SC-01	Sulfide Concentrator	8/30/85	JBR	EP Toxicity Analysis			1.635	<0.01	<0.1		0.028			0.44	<0.0001	<0.5	<0.5	
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	PH Testing														
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	Total Acid Analysis			4200		445			1920		17750	280	2	267.5	
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	EP Toxicity Analysis			<0.1	0.01	1.93		0.012			1.29	0.0001	<0.5	<0.5	
RB-SC-03	Sulfide Concentrator	8/30/85	JBR	PH Testing														
RB-SC-03	Sulfide Concentrator	8/30/85	JBR	Total Acid Analysis			600		390			780		98800	240	2	469	
RB-SC-03	Sulfide Concentrator	8/30/85	JBR	EP Toxicity Analysis			0.165	<0.01	0.36		0.01			2.84	<0.0001	<0.5	<0.5	
RB-SIN-01	Central Smelter	8/30/85	JBR	Total Acid Analysis			1500		560			1890		36500	3890	4	145	
RB-SIN-01	Central Smelter	8/30/85	JBR	PH Testing														
RB-SIN-01	Central Smelter	8/30/85	JBR	EP Toxicity Analysis			<0.1	0.02	<0.1		0.01			<0.5	<0.0001	<0.5	<0.5	
IST-09	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis			<0.1	0.02	0.14		0.013			1.59	0.0004	<0.5	<0.5	
IST-09	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis			<0.5		2.17		1.01			1.02	0.0008	<0.5	<0.01	
IST-09	IS&R Tailings	10/1/85	JBR	Total Acid Analysis			305		6			145		760	1670	6	10.2	
IST-10	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis			<0.1	<0.01	<0.1		0.018			0.67	0.0007	<0.5	<0.5	
IST-10	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis			1.2		0.35		9.2			1.7	0.0006	<0.5	<0.01	
IST-10	IS&R Tailings	10/1/85	JBR	Total Acid Analysis			75		4			105		285	770	5	10	
IST-11	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis			<0.1	0.02	<0.1		0.018			<0.5	0.0003	<0.5	<0.5	
IST-11	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis			<0.5		0.06		0.02			0.16	0.0002	<0.5	<0.01	
IST-11	IS&R Tailings	10/1/85	JBR	Total Acid Analysis			435		30			710		9150	680	6	22.2	
IST-12	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis			1.226	0.03	<0.1		0.025			<0.5	0.0001	<0.5	<0.5	
IST-12	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis			180		0.65		27.6			2.62	0.0003	0.5	0.02	
IST-12	IS&R Tailings	10/1/85	JBR	Total Acid Analysis			690		7			240		7650	660	5	82.7	
IST-13	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis			<0.1	0.03	<0.1		0.018			<0.5	0.0007	<0.5	<0.5	
IST-13	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis			0.75		2.85		23.1			0.41	0.0005	<0.5	<0.01	
IST-13	IS&R Tailings	10/1/85	JBR	Total Acid Analysis			830		5			460		4880	760	6	45.3	

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
RB-IST-08	IS&R Tailings	8/29/85	JBR	EP Toxicity Analysis														
BW-ISS-03	Slag Pile	8/30/85	JBR	EP Toxicity Analysis														
BW-ISS-03	Slag Pile	8/30/85	JBR	PH Testing												5.13	5.8	
BW-ISS-03	Slag Pile	8/30/85	JBR	Total Acid Analysis	47300													
RB-LBA-01	Lead Blast Area	8/30/85	JBR	Total Acid Analysis	6250													
RB-LBA-01	Lead Blast Area	8/30/85	JBR	PH Testing												4.77	5.21	
RB-LBA-01	Lead Blast Area	8/30/85	JBR	EP Toxicity Analysis														
RB-OC-01	Ore Concentrates	8/30/85	JBR	Total Acid Analysis	14950													
RB-OC-01	Ore Concentrates	8/30/85	JBR	PH Testing												5.58	5.78	
RB-OC-01	Ore Concentrates	8/30/85	JBR	EP Toxicity Analysis														
RB-PYC-01	Pyrite Concentrates	8/30/85	JBR	Total Acid Analysis	1580													
RB-PYC-01	Pyrite Concentrates	8/30/85	JBR	PH Testing												2.44	1.2	
RB-PYC-01	Pyrite Concentrates	8/30/85	JBR	EP Toxicity Analysis														
RB-RRY-01	Railroad Yard	8/30/85	JBR	EP Toxicity Analysis														
RB-RRY-01	Railroad Yard	8/30/85	JBR	PH Testing												6.55	6.01	
RB-RRY-01	Railroad Yard	8/30/85	JBR	Total Acid Analysis	19500													
RB-RRY-02	Railroad Yard	8/30/85	JBR	EP Toxicity Analysis														
RB-RRY-02	Railroad Yard	8/30/85	JBR	PH Testing												6.19	5.07	
RB-RRY-02	Railroad Yard	8/30/85	JBR	Total Acid Analysis	57800													
RB-RRY-03	Railroad Yard	8/30/85	JBR	EP Toxicity Analysis														
RB-RRY-03	Railroad Yard	8/30/85	JBR	PH Testing												5.73	5.47	
RB-RRY-03	Railroad Yard	8/30/85	JBR	Total Acid Analysis	80300													
RB-RRY-04	Railroad Yard	8/30/85	JBR	EP Toxicity Analysis														
RB-RRY-04	Railroad Yard	8/30/85	JBR	PH Testing												5.99	5.56	
RB-RRY-04	Railroad Yard	8/30/85	JBR	Total Acid Analysis	52300													
RB-SC-01	Sulfide Concentrator	8/30/85	JBR	PH Testing												2.35	1.66	
RB-SC-01	Sulfide Concentrator	8/30/85	JBR	Total Acid Analysis	1150													
RB-SC-01	Sulfide Concentrator	8/30/85	JBR	EP Toxicity Analysis														
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	PH Testing												2.23	2.44	
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	Total Acid Analysis	69400													
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	EP Toxicity Analysis														
RB-SC-03	Sulfide Concentrator	8/30/85	JBR	PH Testing												2.46	1.34	
RB-SC-03	Sulfide Concentrator	8/30/85	JBR	Total Acid Analysis	54500													
RB-SC-03	Sulfide Concentrator	8/30/85	JBR	EP Toxicity Analysis														
RB-SIN-01	Central Smelter	8/30/85	JBR	Total Acid Analysis	51600													
RB-SIN-01	Central Smelter	8/30/85	JBR	PH Testing												5.91	4.06	
RB-SIN-01	Central Smelter	8/30/85	JBR	EP Toxicity Analysis														
IST-09	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis														
IST-09	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis	18.1										4.53			
IST-09	IS&R Tailings	10/1/85	JBR	Total Acid Analysis	125													
IST-10	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis														
IST-10	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis	5.89										2.3			
IST-10	IS&R Tailings	10/1/85	JBR	Total Acid Analysis	25													
IST-11	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis														
IST-11	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis	0.25										5.4			
IST-11	IS&R Tailings	10/1/85	JBR	Total Acid Analysis	3560													
IST-12	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis														
IST-12	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis	111										1.95			
IST-12	IS&R Tailings	10/1/85	JBR	Total Acid Analysis	565													
IST-13	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis														
IST-13	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis	193										2.3			
IST-13	IS&R Tailings	10/1/85	JBR	Total Acid Analysis	640													

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
IST-14	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis			<0.1	0.03	0.1		0.013			<0.5	0.0003	<0.5	<0.5	
IST-14	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis			<0.5		0.46		0.51			0.19	0.0002	<0.5	0.01	
IST-14	IS&R Tailings	10/1/85	JBR	Total Acid Analysis			655		40			660		5020	370	3	41.8	
PLL-1B	Parking Lot Landfill	10/1/85	JBR	EP Toxicity Analysis			<0.1	0.12	0.34		<0.01			6.25	0.0003	<0.5	<0.5	
PLL-1B	Parking Lot Landfill	10/1/85	JBR	Saturated Paste Analysis			<0.5		0.56			0.04		0.28	0.0002	<0.5	0.01	
PLL-1B	Parking Lot Landfill	10/1/85	JBR	Total Acid Analysis			1570		110			6600		24800	2130	19	118	
PLL-2B	Parking Lot Landfill	10/1/85	JBR	EP Toxicity Analysis			<0.1	0.06	0.18		<0.01			1.09	0.0002	<0.5	<0.5	
PLL-2B	Parking Lot Landfill	10/1/85	JBR	Saturated Paste Analysis			<0.5		0.72			0.05		0.15	0.0197	<0.5	0.01	
PLL-2B	Parking Lot Landfill	10/1/85	JBR	Total Acid Analysis			1750		180			11600		61800	1270	10	72.6	
PLL-3B	Parking Lot Landfill	10/1/85	JBR	EP Toxicity Analysis			<0.1	0.07	<0.1		<0.01			<0.5	0.0003	<0.5	<0.5	
PLL-3B	Parking Lot Landfill	10/1/85	JBR	Saturated Paste Analysis			<0.5		2.16			1.81		0.03	0.001	<0.5	<0.01	
PLL-3B	Parking Lot Landfill	10/1/85	JBR	Total Acid Analysis			95		13			390		530	540	2	0.5	
RB-ISR-01	Copper Roaster/Dust Chamber	10/9/85	JBR	PH Testing														
RB-ISR-01	Copper Roaster/Dust Chamber	10/9/85	JBR	Total Acid Analysis			10450		620			52600		10900	18990	20	90.8	
RB-ISR-01	Copper Roaster/Dust Chamber	10/9/85	JBR	EP Toxicity Analysis			9.45	0.03	41.82		0.083			0.8	0.047	1.5	<0.5	
S2-06	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	4		0.5		6			300	85	170				6
S2-06	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis			0.28		0.09	0.04	<0.01	0.43		1.48	0.0003			
S2-06	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	4.35%		2900		35			2450	4.30%	10650				285
S2-12	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	13		<0.2		2			400	65	12				11
S2-12	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis			0.19		0.05	0.02	<0.01	0.44		1.12	<0.0001			
S2-12	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	5.85%		235		5			1220	2.30%	860				460
S2-18	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	4		<0.2		6			600	5	<1.0				3
S2-18	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis			0.02		0.04	<0.01	<0.01	0.56		0.12	<0.0001			
S2-18	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	5.70%		20		10			1440	2.20%	195				810
S2-24	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	3		<0.2		11			500	18	1				19
S2-24	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis			<0.01		0.06	0.02	<0.01	0.39		0.06	<0.0001			
S2-24	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	5.50%		25		16			910	2.15%	80				710
S2-36	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	3		<0.2		45			70	25	6				18
S2-36	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis			<0.01		0.12	<0.01	<0.01	0.22		0.07	<0.0001			
S2-36	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	5.90%		20		80			205	2.25%	250				480
S2-48	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	3		<0.2		40			90	35	14				14
S2-48	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis			<0.01		0.24	<0.01	<0.01	0.15		0.09	0.0001			
S2-48	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	4.60%		170		60			365	2.20%	860				405
S3-12	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	7		<0.2		20			90	35	130				70
S3-12	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis			0.02		0.4	0.02	<0.01	0.27		0.2	<0.0001			
S3-12	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	6.55%		175		50			560	2.90%	1340				690
S3-18	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	2		<0.2		130			30	8	5				45
S3-18	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis			0.01		0.87	0.01	<0.01	0.18		0.04	<0.0001			
S3-18	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	5.60%		10		290			150	2.55%	95				1310
S3-24	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	2		<0.2		155			4	10	19				4
S3-24	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis			0.01		0.26	<0.01	<0.01	0.03		<0.01	0.0003			
S3-24	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	5.90%		12		280			40	2.75%	200				500
S3-36	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	1		<0.2		13			4	12	40				6
S3-36	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis			0.02		0.42	0.02	<0.01	0.02		0.03	<0.0001			
S3-36	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	6.55%		17		230			45	2.65%	285				485
S3-48	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	1		<0.2		95			25	13	640				15
S3-48	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis			0.02		0.46	<0.01	0.01	0.04		0.05	0.0001			
S3-48	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	5.70%		230		220			265	2.70%	2570				605
S3-6A	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	4		<0.2		40			100	20	950				15
S3-6A	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis			0.02		0.58	0.01	<0.01	0.21		0.28	<0.0001			
S3-6A	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	4.70%		1225		160			1150	3.90%	8410				980
S3-6B	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	3		<0.2		55			100	12	940				13

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
IST-14	IS&R Tailings	10/1/85	JBR	EP Toxicity Analysis														
IST-14	IS&R Tailings	10/1/85	JBR	Saturated Paste Analysis	28.2										5.4			
IST-14	IS&R Tailings	10/1/85	JBR	Total Acid Analysis	6210													
PLL-1B	Parking Lot Landfill	10/1/85	JBR	EP Toxicity Analysis														
PLL-1B	Parking Lot Landfill	10/1/85	JBR	Saturated Paste Analysis	7.3										5.6			
PLL-1B	Parking Lot Landfill	10/1/85	JBR	Total Acid Analysis	4430													
PLL-2B	Parking Lot Landfill	10/1/85	JBR	EP Toxicity Analysis														
PLL-2B	Parking Lot Landfill	10/1/85	JBR	Saturated Paste Analysis	8.25										5.75			
PLL-2B	Parking Lot Landfill	10/1/85	JBR	Total Acid Analysis	1170													
PLL-3B	Parking Lot Landfill	10/1/85	JBR	EP Toxicity Analysis														
PLL-3B	Parking Lot Landfill	10/1/85	JBR	Saturated Paste Analysis	39.9										5.65			
PLL-3B	Parking Lot Landfill	10/1/85	JBR	Total Acid Analysis	310													
RB-ISR-01	Copper Roaster/Dust Chamber	10/9/85	JBR	PH Testing												2.81	2.17	
RB-ISR-01	Copper Roaster/Dust Chamber	10/9/85	JBR	Total Acid Analysis	7390													
RB-ISR-01	Copper Roaster/Dust Chamber	10/9/85	JBR	EP Toxicity Analysis														
S2-06	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	25													
S2-06	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis	0.83										6.64			
S2-06	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	1560													
S2-12	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	10													
S2-12	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis	0.49										6.92			
S2-12	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	175													
S2-18	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	12													
S2-18	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis	0.4										7.04			
S2-18	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	185													
S2-24	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	35													
S2-24	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis	0.49										7.13			
S2-24	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	190													
S2-36	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	130													
S2-36	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis	1.06										6.84			
S2-36	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	390													
S2-48	South Transect #2 Boring	10/15/85	JBR	DTPA Extraction Analysis	190													
S2-48	South Transect #2 Boring	10/15/85	JBR	Saturated Paste Analysis	2.8										6.86			
S2-48	South Transect #2 Boring	10/15/85	JBR	Total Acid Analysis	545													
S3-12	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	45													
S3-12	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis	1.65										5.68			
S3-12	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	685													
S3-18	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	260													
S3-18	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis	2.1										6.11			
S3-18	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	1260													
S3-24	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	160													
S3-24	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis	0.26										6.76			
S3-24	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	815													
S3-36	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	100													
S3-36	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis	0.16										7.05			
S3-36	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	535													
S3-48	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	80													
S3-48	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis	0.12										2.19			
S3-48	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	1130													
S3-6A	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	70													
S3-6A	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis	2.7										6.54			
S3-6A	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	3420													
S3-6B	South Transect #3 Boring	10/15/85	JBR	DTPA Extraction Analysis	90													

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
S3-6B	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis			0.02		0.86	0.03	<0.01	0.2		0.54	0.0003			
S3-6B	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	4.15%		1460		210			1270	4.20%	10350				890
TA-1	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			1.55		4.6	1.19	0.19	7.69		2.1	0.001			
TA-12	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.14		0.4	0.26	0.11	7.99		0.44	0.0007			
TA-18A	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.19		0.19	0.31	0.09	8.48		0.35	0.0002			
TA-18B	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.06		0.22	0.29	0.09	8.25		0.3	0.0005			
TA-24A	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.12		0.2	0.36	0.11	10		0.27	0.0004			
TA-24B	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.07		0.23	0.29	0.07	7.25		0.12	0.0009			
TA-36A	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.26		0.18	0.53	0.16	13.7		0.3	0.0006			
TA-36B	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.14		0.21	0.4	0.15	11.35		0.26	0.0007			
TA-6A	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.75		0.68	0.33	0.08	10.15		0.79	0.0055			
TA-6B	Smelter Site	10/15/85	JBR	Saturated Paste Analysis			0.21		0.56	0.28	0.09	7.59		0.56	0.0004			
PIT #1	Borrow Pit #1	10/18/85	JBR	Saturated Paste Analysis			<0.01		0.02	<0.01	<0.01	0.06		0.02	0.0004			
SED FAN #1	East of Sediment Ponds	10/18/85	JBR	Saturated Paste Analysis			<0.01		0.16	0.02	<0.01	0.07		0.04	0.0002			
SED P-1 MET	Sediment Pond 1	10/18/85	JBR	Saturated Paste Analysis			<0.01		0.07	0.05	0.02	0.08		0.11	<0.0001			
SED P-2 MET	Sediment Pond 2	10/18/85	JBR	Saturated Paste Analysis			<0.01		0.04	0.03	<0.01	0.16		0.09	<0.0001			
SED P-2 PERT	Sediment Pond 2	10/18/85	JBR	Saturated Paste Analysis			<0.01		0.02	0.04	0.01	0.16		0.09	<0.0001			
SED P-3 MET	Sediment Pond 3	10/18/85	JBR	Saturated Paste Analysis			0.01		<0.01	<0.01	<0.01	0.06		<0.01	<0.0001			
TE-2-0-12	Transect 2000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.03		0.12	0.04	0.02	<0.01		0.16	0.0001			
TE-3-0-12	Transect 3000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.11		0.01	<0.01	0.01	0.03		0.11	0.0001			
TE-4-0-12	Transect 4000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.14		<0.01	<0.01	<0.01	0.04		0.2	0.0001			
TE-5-0-12	Transect 5000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.14		<0.01	<0.01	<0.01	0.02		0.12	0.0002			
TE-6-0-12	Transect 6000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.12		0.02	0.01	<0.01	0.04		0.19	0.0003			
TE-7-0-12	Transect 7000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.1		0.01	<0.01	<0.01	0.01		0.06	<0.0001			
TN-4-0-12	Transect 4000' North of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.14		<0.01	0.02	<0.01	<0.01		0.06	<0.0001			
TN-5-0-12	Transect 5000' North of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.07		0.01	0.01	<0.01	0.02		0.03	0.001			
TN-6-0-12	Transect 6000' North of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.1		<0.01	<0.01	<0.01	0.01		0.03	0.0001			
TS-4-0-12	Transect 4000' South of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.25		0.01	0.02	<0.01	0.02		0.05	0.0002			
TS-5-0-12	Transect 5000' South of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.17		0.01	0.03	<0.01	0.02		0.03	0.0002			
TS-6-0-12	Transect 6000' South of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.16		0.01	<0.01	<0.01	0.07		0.05	0.0002			
TW-2-0-12	Transect 2000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.03		0.53	0.05	0.01	0.05		0.1	<0.0001			
TW-3-0-12	Transect 3000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.07		0.06	0.02	0.01	0.01		0.03	<0.0001			
TW-4-0-12	Transect 4000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.02		0.28	0.01	<0.01	0.13		0.05	<0.0001			
TW-7-0-12	Transect 7000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.05		0.06	<0.01	0.01	0.05		<0.01	<0.0001			
TW-8-0-12	Transect 8000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis			0.04		0.02	<0.01	<0.01	0.06		0.03	<0.0001			
ISR-02	Copper Roaster/Dust Chamber	11/1/85	JBR	EP Toxicity Analysis			<0.1	<0.01	0.68		0.018			1.75	0.0081	<0.5	<0.5	
ISR-02	Copper Roaster/Dust Chamber	11/1/85	JBR	Saturated Paste Analysis			<0.5		388.8			305		3.8	0.0123	<0.5	<0.01	
ISR-02	Copper Roaster/Dust Chamber	11/1/85	JBR	Total Acid Analysis			8450		35			4100		19100	98450	300	102	
ISR-03	Copper Roaster/Dust Chamber	11/1/85	JBR	EP Toxicity Analysis			<0.1	0.02	0.98		<0.01			1.49	0.0006	<0.5	<0.5	
ISR-03	Copper Roaster/Dust Chamber	11/1/85	JBR	Saturated Paste Analysis			<0.5		192			5320		4.48	0.0147	2.35	<0.01	
ISR-03	Copper Roaster/Dust Chamber	11/1/85	JBR	Total Acid Analysis			505		95			3400		4900	3120	16	8.6	
ISS-04 (+80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis			0.231	0.24	0.1		<0.01			1.83	0.0003	<0.5	<0.5	
ISS-04 (+80)	Slag Pile	11/1/85	JBR	Total Acid Analysis			175		60			1930		8800	380	25	10.1	
ISS-04 (-80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis			<0.1	2.5	3.23		0.02			52.54	0.0108	<0.5	<0.5	
ISS-04 (-80)	Slag Pile	11/1/85	JBR	Saturated Paste Analysis			<0.5		0.31			4.85		0.05	0.0042	0.85	<0.01	
ISS-04 (-80)	Slag Pile	11/1/85	JBR	Total Acid Analysis			585		210			3200		20700	1550	185	53.5	
ISS-05 (+80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis			<0.1	0.09	<0.1		<0.01			1.57	<0.0001	<0.5	<0.5	
ISS-05 (+80)	Slag Pile	11/1/85	JBR	Total Acid Analysis			190		35			3500		14500	90	30	14.9	
ISS-05 (-80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis			0.19	0.06	2.51		0.02			12	0.0004	0.17	<0.5	
ISS-05 (-80)	Slag Pile	11/1/85	JBR	Total Acid Analysis			1210		170			10400		37800	2470	235	97.5	
ISS-06 (+80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis			<0.1	0.04	<0.1		<0.01			0.66	<0.0001	<0.5	<0.5	
ISS-06 (+80)	Slag Pile	11/1/85	JBR	Total Acid Analysis			265		40			3700		11600	100	17	12.3	

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
S3-6B	South Transect #3 Boring	10/15/85	JBR	Saturated Paste Analysis	2.9										6.41			
S3-6B	South Transect #3 Boring	10/15/85	JBR	Total Acid Analysis	4640													
TA-1	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	27.5										2.51			
TA-12	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	4.45										2.63			
TA-18A	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	5.6										2.69			
TA-18B	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	4.4										2.69			
TA-24A	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	5.25										3.01			
TA-24B	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	4.2										2.71			
TA-36A	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	7.35										2.73			
TA-36B	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	6.5										5.12			
TA-6A	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	6.2										2.55			
TA-6B	Smelter Site	10/15/85	JBR	Saturated Paste Analysis	4.5										2.64			
PIT #1	Borrow Pit #1	10/18/85	JBR	Saturated Paste Analysis	0.56										7.33			
SED FAN #1	East of Sediment Ponds	10/18/85	JBR	Saturated Paste Analysis	9.55										7.04			
SED P-1 MET	Sediment Pond 1	10/18/85	JBR	Saturated Paste Analysis	0.39										7			
SED P-2 MET	Sediment Pond 2	10/18/85	JBR	Saturated Paste Analysis	0.19										7.09			
SED P-2 PERT	Sediment Pond 2	10/18/85	JBR	Saturated Paste Analysis	0.12										7.13			
SED P-3 MET	Sediment Pond 3	10/18/85	JBR	Saturated Paste Analysis	0.02										7.42			
TE-2-0-12	Transect 2000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.71										7.26			
TE-3-0-12	Transect 3000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.09										7.52			
TE-4-0-12	Transect 4000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.13										7.23			
TE-5-0-12	Transect 5000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.14										7			
TE-6-0-12	Transect 6000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.33										6.87			
TE-7-0-12	Transect 7000' East of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.29										7.17			
TN-4-0-12	Transect 4000' North of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.12										7.14			
TN-5-0-12	Transect 5000' North of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.07										7.06			
TN-6-0-12	Transect 6000' North of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.12										6.87			
TS-4-0-12	Transect 4000' South of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.15										6.8			
TS-5-0-12	Transect 5000' South of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.11										6.72			
TS-6-0-12	Transect 6000' South of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.22										6.28			
TW-2-0-12	Transect 2000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis	15.2										5.22			
TW-3-0-12	Transect 3000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis	1.55										5.97			
TW-4-0-12	Transect 4000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis	8.63										5.67			
TW-7-0-12	Transect 7000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.71										6.81			
TW-8-0-12	Transect 8000' West of Smelter	10/18/85	JBR	Saturated Paste Analysis	0.16										6.84			
ISR-02	Copper Roaster/Dust Chamber	11/1/85	JBR	EP Toxicity Analysis														
ISR-02	Copper Roaster/Dust Chamber	11/1/85	JBR	Saturated Paste Analysis	661										3.4			
ISR-02	Copper Roaster/Dust Chamber	11/1/85	JBR	Total Acid Analysis	1200													
ISR-03	Copper Roaster/Dust Chamber	11/1/85	JBR	EP Toxicity Analysis														
ISR-03	Copper Roaster/Dust Chamber	11/1/85	JBR	Saturated Paste Analysis	1880										4.4			
ISR-03	Copper Roaster/Dust Chamber	11/1/85	JBR	Total Acid Analysis	1560													
ISS-04 (+80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis														
ISS-04 (+80)	Slag Pile	11/1/85	JBR	Total Acid Analysis	34100													
ISS-04 (-80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis														
ISS-04 (-80)	Slag Pile	11/1/85	JBR	Saturated Paste Analysis	5.35										5.6			
ISS-04 (-80)	Slag Pile	11/1/85	JBR	Total Acid Analysis	22800													
ISS-05 (+80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis														
ISS-05 (+80)	Slag Pile	11/1/85	JBR	Total Acid Analysis	45800													
ISS-05 (-80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis														
ISS-05 (-80)	Slag Pile	11/1/85	JBR	Total Acid Analysis	40500													
ISS-06 (+80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis														
ISS-06 (+80)	Slag Pile	11/1/85	JBR	Total Acid Analysis	69200													

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
ISS-06 (-80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis			<0.1	<0.01	0.16		<0.01			8.13	0.0001	<0.5	<0.5	
ISS-06 (-80)	Slag Pile	11/1/85	JBR	Total Acid Analysis			1620		65			9700		24800	320	30	65.8	
ISS-07	Slag Pile	11/1/85	JBR	EP Toxicity Analysis			<0.1	<0.01	0.14		0.013			2.76	0.0001	<0.5	<0.5	
ISS-07	Slag Pile	11/1/85	JBR	Saturated Paste Analysis			0.5		33.7			20.8		1.62	0.0014	3.5	0.01	
ISS-07	Slag Pile	11/1/85	JBR	Total Acid Analysis			310		45			3100		10080	400	30	13.2	
IST-1B	IS&R Tailings	11/1/85	JBR	EP Toxicity Analysis			0.886	0.03	0.17		0.032			<0.5	<0.0001	<0.5	<0.5	
IST-1B	IS&R Tailings	11/1/85	JBR	Total Acid Analysis			4800		9			720		14700	230	40	65.4	
IST-2B	IS&R Tailings	11/1/85	JBR	EP Toxicity Analysis			<0.1	0.02	<0.1		0.025			<0.5	<0.0001	<0.5	<0.5	
IST-2B	IS&R Tailings	11/1/85	JBR	Total Acid Analysis			110		3			195		240	720	15	6.9	
PYC-1B	Pyrite Concentrates	11/1/85	JBR	EP Toxicity Analysis			0.925	<0.01	<0.1		0.018			1.55	<0.0001	<0.5	<0.5	
PYC-1B	Pyrite Concentrates	11/1/85	JBR	Total Acid Analysis			630		15			190		20900	1230	10	75.2	
ZFA-1B	Zinc Furnace Area	11/1/85	JBR	Total Acid Analysis			3540		580			346000		66200	245	4840	840	
ZFA-1B	Zinc Furnace Area	11/1/85	JBR	EP Toxicity Analysis			0.688	0.27	1.73		0.02			13.75	<0.0001	0.52	<0.5	
CTFP1-01	Carr Fork Tailings	11/5/85	JBR	EP Toxicity Analysis			<0.1	0.21	<0.1		0.013			<0.5	<0.0001	<0.5	<0.5	
CTFP1-01	Carr Fork Tailings	11/5/85	JBR	Total Acid Analysis			60		5			950		155	120	3	0.8	
CTFP1-02	Carr Fork Tailings	11/5/85	JBR	EP Toxicity Analysis			<0.1	0.17	<0.1		0.03			<0.5	0.0001	<0.5	<0.5	
CTFP1-02	Carr Fork Tailings	11/5/85	JBR	Total Acid Analysis			100		4			840		95	80	3	0.9	
CTFP2-01	Carr Fork Tailings	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.16	<0.1		0.025			<0.5	0.0001	<0.5	<0.5	
CTFP2-01	Carr Fork Tailings	11/6/85	JBR	Total Acid Analysis			95		3			1040		75	<20	8	1.4	
CTFP2-02	Carr Fork Tailings	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.14	<0.1		0.02			<0.5	<0.0001	<0.5	<0.5	
CTFP2-02	Carr Fork Tailings	11/6/85	JBR	Total Acid Analysis			75		4			1040		20	<20	8	1.6	
ELB-01	Eastern Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis			<0.1	<0.01	0.45		0.02			2.41	0.0001	<0.5	<0.5	
ELB-01	Eastern Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis			231		44.2			1490		4.16	0.0007	0.88	<0.01	
ELB-01	Eastern Lead Blast Area	11/6/85	JBR	Total Acid Analysis			740		15			750		141000	1040	80	77.8	
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis			<0.1	<0.01	4.99		<0.01			44.02	0.0019	<0.5	<0.5	
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis			<0.5		38.5			10.5		4.25	0.0014	<0.5	<0.01	
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	Total Acid Analysis			3650		2130			18500		106000	1740	1450	236	
LBA-02	Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.14	0.1		<0.01			<0.5	0.0002	<0.5	<0.5	
LBA-02	Lead Blast Area	11/6/85	JBR	Total Acid Analysis			430		70			760		7080	2140	15	14.8	
LBA-03	Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.2	0.18		<0.01			0.86	0.0004	<0.5	<0.5	
LBA-03	Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis			<0.5		0.29			0.02		0.11	0.0006	<0.5	0.01	
LBA-03	Lead Blast Area	11/6/85	JBR	Total Acid Analysis			320		30			380		2280	710	11	5.1	
LBA-04	Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.02	5.07		<0.01			42.5	0.009	<0.5	<0.5	
LBA-04	Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis			<0.5		20.1			0.12		1.15	0.0016	<0.5	<0.01	
LBA-04	Lead Blast Area	11/6/85	JBR	Total Acid Analysis			2850		1340			8550		93000	1690	215	242	
PCL-04-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.02	1.45		0.013			8.25	0.0005	<0.5	<0.5	
PCL-04-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			3950		610			9500		50200	3380	300	138.5	
PCL-04-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.09	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
PCL-04-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			85		50			230		750	900	10	2.4	
PCL-04-03	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.08	<0.1		<0.01			1.16	<0.0001	<0.5	<0.5	
PCL-04-03	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			18		2			15		65	80	<1	0.6	
PCL-04-04	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.14	<0.1		<0.01			<0.5	0.0002	<0.5	<0.5	
PCL-04-04	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			25		2			22		85	20	<1	0.4	
PCL-05-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.07	1.01		<0.01			6	0.0008	<0.5	<0.5	
PCL-05-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			3860		620			7550		31600	1630	205	90.8	
PCL-05-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.12	<0.1		<0.01			<0.5	0.0001	<0.5	<0.5	
PCL-05-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			40		20			145		510	460	3	1.5	
PCL-05-03	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.04	<0.1		<0.01			<0.5	0.0003	<0.5	<0.5	
PCL-05-03	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			19		<1			15		45	90	<1	0.3	
PCL-06-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.1	1.12		<0.01			7.95	<0.0001	<0.5	<0.5	
PCL-06-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			10200		520			16100		96800	130	430	240	
PCL-06-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			0.205	0.02	0.33		0.018			<0.5	<0.0001	<0.5	<0.5	

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
ISS-06 (-80)	Slag Pile	11/1/85	JBR	EP Toxicity Analysis														
ISS-06 (-80)	Slag Pile	11/1/85	JBR	Total Acid Analysis	57200													
ISS-07	Slag Pile	11/1/85	JBR	EP Toxicity Analysis														
ISS-07	Slag Pile	11/1/85	JBR	Saturated Paste Analysis	6690										5.3			
ISS-07	Slag Pile	11/1/85	JBR	Total Acid Analysis	45600													
IST-1B	IS&R Tailings	11/1/85	JBR	EP Toxicity Analysis														
IST-1B	IS&R Tailings	11/1/85	JBR	Total Acid Analysis	1330													
IST-2B	IS&R Tailings	11/1/85	JBR	EP Toxicity Analysis														
IST-2B	IS&R Tailings	11/1/85	JBR	Total Acid Analysis	115													
PYC-1B	Pyrite Concentrates	11/1/85	JBR	EP Toxicity Analysis														
PYC-1B	Pyrite Concentrates	11/1/85	JBR	Total Acid Analysis	1610													
ZFA-1B	Zinc Furnace Area	11/1/85	JBR	Total Acid Analysis	28300													
ZFA-1B	Zinc Furnace Area	11/1/85	JBR	EP Toxicity Analysis														
CTFP1-01	Carr Fork Tailings	11/5/85	JBR	EP Toxicity Analysis														
CTFP1-01	Carr Fork Tailings	11/5/85	JBR	Total Acid Analysis	120													
CTFP1-02	Carr Fork Tailings	11/5/85	JBR	EP Toxicity Analysis														
CTFP1-02	Carr Fork Tailings	11/5/85	JBR	Total Acid Analysis	80													
CTFP2-01	Carr Fork Tailings	11/6/85	JBR	EP Toxicity Analysis														
CTFP2-01	Carr Fork Tailings	11/6/85	JBR	Total Acid Analysis	100													
CTFP2-02	Carr Fork Tailings	11/6/85	JBR	EP Toxicity Analysis														
CTFP2-02	Carr Fork Tailings	11/6/85	JBR	Total Acid Analysis	215													
ELB-01	Eastern Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis														
ELB-01	Eastern Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis	6110										2.15			
ELB-01	Eastern Lead Blast Area	11/6/85	JBR	Total Acid Analysis	1420													
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis														
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis	182										3.85			
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	Total Acid Analysis	68500													
LBA-02	Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis														
LBA-02	Lead Blast Area	11/6/85	JBR	Total Acid Analysis	17600													
LBA-03	Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis														
LBA-03	Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis	1.02										6.91			
LBA-03	Lead Blast Area	11/6/85	JBR	Total Acid Analysis	750													
LBA-04	Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis														
LBA-04	Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis	50.5										6.32			
LBA-04	Lead Blast Area	11/6/85	JBR	Total Acid Analysis	46500													
PCL-04-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-04-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	27500													
PCL-04-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-04-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	1380													
PCL-04-03	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-04-03	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	120													
PCL-04-04	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-04-04	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	140													
PCL-05-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-05-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	59500													
PCL-05-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-05-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	1150													
PCL-05-03	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-05-03	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	105													
PCL-06-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-06-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	43700													
PCL-06-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
PCL-06-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			1090		50			5080		1480	<20	18	8.9	
PCL-06-03	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.04	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
PCL-06-03	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			45		6			110		380	180	5	1.2	
PCL-07-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.14	0.51		<0.01			2.78	<0.0001	<0.5	<0.5	
PCL-07-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			4660		750			13900		45500	150	160	150.6	
PCL-08-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.11	1.21		0.01			8.7	0.0009	<0.5	<0.5	
PCL-08-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			5350		1140			28600		83800	480	270	310	
PCL-08-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.06	<0.1		0.013			<0.5	<0.0001	<0.5	<0.5	
PCL-08-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			60		10			95		370	70	6	1.2	
PCL-09-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.08	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
PCL-09-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			90		18			560		1120	410	10	3.8	
PCL-09-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.35	1.45		<0.01			14.85	0.0021	<0.5	<0.5	
PCL-09-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			4870		640			16500		48900	770	340	186	
PCL-09-03	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis			<0.1	0.26	<0.1		<0.01			<0.5	<0.0001	<0.5	<0.5	
PCL-09-03	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis			240		20			170		610	450	10	2.5	
1-12	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	3.70%		80		390			770	1.75%	4880				3340
1-12	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis			0.01		15.85	0.04	0.02	2.85		0.44	0.0003			
1-12	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	1		<0.2		135			130	2	210				10
1-18	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	2.85%		14		210			45	1.40%	505				1710
1-18	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis			<0.01		5.95	0.03	0.01	0.81		0.15	0.0005			
1-18	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	2		<0.2		10			5	2	9				3
1-24	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	2.95%		14		230			40	1.35%	410				2350
1-24	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis			0.02		18.45	0.04	0.02	1.26		0.26	0.0005			
1-24	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	2		<0.2		135			3	3	4				2
1-36	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	2.50%		110		200			255	1.35%	3350				1810
1-36	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis			0.02		19.6	0.04	0.02	1.59		0.46	0.003			
1-36	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	1		<0.2		105			14	3	325				9
1-48	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	2.55%		110		190			275	1.50%	3380				1180
1-48	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis			0.03		10.25	0.03	<0.01	0.45		0.32	0.0009			
1-48	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	2		<0.2		100			16	5	510				20
1-6	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	2.60%		1375		440			4950	4.00%	55600				1420
1-6	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis			0.03		11.7	0.13	0.03	29.5		4.6	0.0265			
1-6	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	1		<0.2		60			170	2	825				3
3-12	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		30			30	85	35				60
3-12	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	5.30%		25		35			85	2.20%	135				710
3-12	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis			0.03		0.8	0.06	0.03	2.6		0.2	0.002			
3-18	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	20		<0.2		2			8	150	35				100
3-18	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	3.05%		17		1			30	1.30%	105				275
3-18	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis			0.06		0.3	0.03	0.03	0.46		0.13	0.0008			
3-24	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	3		<0.2		1			4	380	35				75
3-24	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	2.00%		10		<1			25	0.95%	95				145
3-24	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis			0.06		0.13	0.02	0.04	0.38		0.22	0.0006			
3-36	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	3		<0.2		<1			4	260	25				60
3-36	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	2.15%		8		<1			15	0.92%	55				125
3-36	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis			0.02		0.03	0.05	0.05	0.23		0.25	0.0005			
3-48	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	2		<0.2		1			8	175	45				75
3-48	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	3.40%		18		<1			30	1.55%	155				260
3-48	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis			0.03		0.02	0.03	<0.01	0.34		0.03	<0.0001			
3-6	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	80		0.6		30			210	105	135				45
3-6	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	4.75%		270		45			590	2.00%	2160				800
3-6	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis			0.04		1.52	0.03	<0.01	0.4		0.22	0.0006			
4-12	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	5.30%		13		<1			30		50				680

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
PCL-06-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	4530													
PCL-06-03	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-06-03	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	465													
PCL-07-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-07-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	37600													
PCL-08-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-08-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	75500													
PCL-08-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-08-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	620													
PCL-09-01	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-09-01	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	1520													
PCL-09-02	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-09-02	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	27800													
PCL-09-03	Pine Creek Landfill Boring	11/6/85	JBR	EP Toxicity Analysis														
PCL-09-03	Pine Creek Landfill Boring	11/6/85	JBR	Total Acid Analysis	840													
1-12	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	4050													
1-12	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis	51										6			
1-12	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	270													
1-18	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	3100													
1-18	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis	26.5										6.03			
1-18	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	450													
1-24	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	3250													
1-24	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis	97										5.77			
1-24	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	470													
1-36	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	3000													
1-36	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis	92.5										5.76			
1-36	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	360													
1-48	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	2790													
1-48	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis	26.5										5.52			
1-48	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	280													
1-6	Transect #1 Boring	11/12/85	JBR	Total Acid Analysis	14700													
1-6	Transect #1 Boring	11/12/85	JBR	Saturated Paste Analysis	41.5										4.69			
1-6	Transect #1 Boring	11/12/85	JBR	DTPA Extraction Analysis	190													
3-12	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	250													
3-12	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	510													
3-12	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis	7.2										5.27			
3-18	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	10													
3-18	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	45													
3-18	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis	1.51										5.24			
3-24	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	9													
3-24	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	40													
3-24	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis	0.6										5.8			
3-36	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	5													
3-36	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	35													
3-36	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis	1.76										6.32			
3-48	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	5													
3-48	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	55													
3-48	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis	0.13										7.1			
3-6	Transect #3 Boring	11/12/85	JBR	DTPA Extraction Analysis	140													
3-6	Transect #3 Boring	11/12/85	JBR	Total Acid Analysis	500													
3-6	Transect #3 Boring	11/12/85	JBR	Saturated Paste Analysis	6.9										5.11			
4-12	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	75													

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
4-12	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis			0.06		0.05	0.1	0.07	0.41		0.43	0.0006			
4-12	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		1			8		13				80
4-18	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	4.40%		10		<1			20		45				550
4-18	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis			0.07		0.01	0.05	0.01	0.33		0.02	0.0001			
4-18	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		<1			5		13				100
4-24	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	5.00%		13		<1			14		30				525
4-24	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis			0.09		0.03	0.03	0.01	0.53		0.1	0.0005			
4-24	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	3		<0.2		<1			2		8				35
4-36	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	3.95%		7		<1			18		30				360
4-36	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis			0.05		0.03	0.02	0.02	0.51		0.06	0.0002			
4-36	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		<1			5		8				85
4-48	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	3.65%		10		<1			25		45				330
4-48	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis			0.05		0.02	0.03	0.02	0.32		0.03	0.0001			
4-48	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		1			7		15				50
4-6	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	5.55%		45		40			255		285				820
4-6	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis			0.04		0.03	0.01	<0.01	0.32		0.06	0.0004			
4-6	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	30		<0.2		25			120		85				40
5-12	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	4.80%		15		5			35	1.90%	75				495
5-12	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis			0.04		0.04	0.01	<0.01	0.2		0.05	0.0001			
5-12	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	9		<0.2		3			10	205	25				120
5-18	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	4.85%		12		2			25	2.00%	55				620
5-18	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis			0.23		0.04	0.01	<0.01	0.17		0.06	0.001			
5-18	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	5		<0.2		1			6	130	16				65
5-24	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	5.25%		7		<1			14	1.90%	70				475
5-24	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis			0.17		0.03	<0.01	<0.01	0.13		0.06	0.0007			
5-24	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		<1			2	80	5				40
5-36	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	4.60%		6		<1			12	1.80%	60				430
5-36	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis			0.14		0.02	0.01	<0.01	0.09		0.04	0.0002			
5-36	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	3		<0.2		<1			2	65	6				30
5-48	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	4.20%		7		<1			14	1.45%	35				340
5-48	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis			0.16		0.02	0.02	<0.01	0.15		0.13	0.0002			
5-48	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	3		<0.2		<1			3	70	8				25
5-6	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	4.85%		120		18			200	2.00%	370				515
5-6	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis			0.06		0.08	0.01	<0.01	0.18		0.07	0.0002			
5-6	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	100		0.6		12			70	220	140				45
6-12	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	4.90%		35		2			15	1.80%	30				
6-12	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis			0.07		0.02	0.02	<0.01	0.15		0.02	0.0001			
6-12	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	7		<0.2		1			2	40	7				30
6-18	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	4.80%		25		<1			12	1.75%	25				
6-18	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis			0.05		0.01	0.01	<0.01	0.08		0.03	0.0002			
6-18	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		<1			1	35	5				25
6-24	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	4.35%		10		<1			10	1.50%	30				
6-24	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis			0.08		0.02	0.02	<0.01	0.13		0.01	0.0002			
6-24	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		<1			1	25	3				15
6-36	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	3.90%		13		<1			8	1.30%	100				
6-36	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis			0.09		0.02	<0.01	<0.01	0.12		0.06	0.0001			
6-36	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	3		<0.2		<1			1	20	4				9
6-48	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	2.55%		20		<1			11	0.90%	35				
6-48	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis			0.08		0.02	0.02	0.01	0.11		0.2	0.0009			
6-48	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		<1			2	25	9				12
6-6	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	4.85%		160		13			20	1.80%	45				
6-6	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis			0.12		0.02	0.01	<0.01	0.1		<0.01	0.0005			

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
4-12	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis	4.1										6.6			
4-12	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	7													
4-18	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	50													
4-18	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis	0.08										6.93			
4-18	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	4													
4-24	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	50													
4-24	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis	0.27										6.89			
4-24	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	2													
4-36	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	40													
4-36	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis	0.2										6.75			
4-36	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	4													
4-48	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	40													
4-48	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis	0.12										6.75			
4-48	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	5													
4-6	Transect #4 Boring	11/12/85	JBR	Total Acid Analysis	470													
4-6	Transect #4 Boring	11/12/85	JBR	Saturated Paste Analysis	0.36										6.61			
4-6	Transect #4 Boring	11/12/85	JBR	DTPA Extraction Analysis	190													
5-12	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	125													
5-12	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis	0.4										6.67			
5-12	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	25													
5-18	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	75													
5-18	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis	0.25										7.92			
5-18	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	5													
5-24	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	55													
5-24	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis	0.21										7.24			
5-24	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	1													
5-36	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	40													
5-36	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis	0.13										7.17			
5-36	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	1													
5-48	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	45													
5-48	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis	0.21										7.16			
5-48	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	3													
5-6	Transect #5 Boring	11/12/85	JBR	Total Acid Analysis	305													
5-6	Transect #5 Boring	11/12/85	JBR	Saturated Paste Analysis	1.28										6.51			
5-6	Transect #5 Boring	11/12/85	JBR	DTPA Extraction Analysis	90													
6-12	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	60													
6-12	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis	0.12										7.1			
6-12	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	7													
6-18	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	50													
6-18	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis	0.08										7.21			
6-18	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	2													
6-24	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	40													
6-24	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis	0.13										7.22			
6-24	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	1													
6-36	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	40													
6-36	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis	0.1										7.28			
6-36	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	1													
6-48	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	35													
6-48	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis	0.14										6.38			
6-48	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	3													
6-6	Transect #6 Boring	11/12/85	JBR	Total Acid Analysis	200													
6-6	Transect #6 Boring	11/12/85	JBR	Saturated Paste Analysis	0.15										7.14			

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
6-6	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	35		0.2		8			6	55	10				40
TE-2	Transect 2000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	2		0.4		20			130	6	630				3
TE-2	Transect 2000' East of Smelter	11/12/85	JBR	Total Acid Analysis	3.75%		1115		50			1130	2.75%	6310				635
TE-3	Transect 3000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	3		0.3		11			60	13	370				3
TE-3	Transect 3000' East of Smelter	11/12/85	JBR	Total Acid Analysis	4.85%		165		20			255	2.00%	1190				550
TE-4	Transect 4000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	3		0.5		17			140	30	550				7
TE-4	Transect 4000' East of Smelter	11/12/85	JBR	Total Acid Analysis	4.75%		395		35			590	2.20%	2070				450
TE-5	Transect 5000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	6		0.4		11			70	95	350				40
TE-5	Transect 5000' East of Smelter	11/12/85	JBR	Total Acid Analysis	5.35%		225		19			245	2.00%	855				530
TE-6	Transect 6000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	6		0.2		10			40	85	160				60
TE-6	Transect 6000' East of Smelter	11/12/85	JBR	Total Acid Analysis	6.00%		105		16			125	2.10%	530				710
TE-7	Transect 7000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	13		<0.2		12			40	75	120				13
TE-7	Transect 7000' East of Smelter	11/12/85	JBR	Total Acid Analysis	4.60%		225		35			260	1.90%	945				910
TN-4	Transect 4000' North of Smelter	11/12/85	JBR	DTPA Extraction Analysis	3		<0.2		6			30	50	80				35
TN-4	Transect 4000' North of Smelter	11/12/85	JBR	Total Acid Analysis	5.55%		45		9			100	2.40%	235				525
TN-5	Transect 5000' North of Smelter	11/12/85	JBR	DTPA Extraction Analysis	20		<0.2		6			30	80	110				40
TN-5	Transect 5000' North of Smelter	11/12/85	JBR	Total Acid Analysis	4.70%		65		10			120	2.05%	315				625
TN-6	Transect 6000' North of Smelter	11/12/85	JBR	DTPA Extraction Analysis	5		<0.2		3			12	45	55				35
TN-6	Transect 6000' North of Smelter	11/12/85	JBR	Total Acid Analysis	5.50%		25		4			60	2.00%	215				465
TS-4	Transect 4000' South of Smelter	11/12/85	JBR	DTPA Extraction Analysis	17		0.2		8			70	110	210				30
TS-4	Transect 4000' South of Smelter	11/12/85	JBR	Total Acid Analysis	5.15%		170		12			205	2.10%	475				565
TS-5	Transect 5000' South of Smelter	11/12/85	JBR	DTPA Extraction Analysis	16		<0.2		4			40	80	65				30
TS-5	Transect 5000' South of Smelter	11/12/85	JBR	Total Acid Analysis	7.92%		105		7			115	2.50%	195				560
TS-6	Transect 6000' South of Smelter	11/12/85	JBR	DTPA Extraction Analysis	160		0.2		4			60	135	130				35
TS-6	Transect 6000' South of Smelter	11/12/85	JBR	Total Acid Analysis	5.82%		155		6			225	2.20%	420				630
TW-2	Transect 2000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	5		<0.2		25			100	3	730				10
TW-2	Transect 2000' West of Smelter	11/12/85	JBR	Total Acid Analysis	4.60%		315		50			510	2.20%	5310				500
TW-3	Transect 3000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	6		<0.2		11			70	55	890				15
TW-3	Transect 3000' West of Smelter	11/12/85	JBR	Total Acid Analysis	4.50%		160		20			260	2.05%	2005				480
TW-4	Transect 4000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	70		<0.2		15			170	105	360				16
TW-4	Transect 4000' West of Smelter	11/12/85	JBR	Total Acid Analysis	5.00%		320		25			550	2.30%	1820				660
TW-7	Transect 5000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	3		<0.2		<1			3	10	19				16
TW-7	Transect 5000' West of Smelter	11/12/85	JBR	Total Acid Analysis	5.15%		15		1			30	2.15%	125				730
TW-8	Transect 6000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	4		<0.2		<1			2	18	2				17
TW-8	Transect 6000' West of Smelter	11/12/85	JBR	Total Acid Analysis	2.85%		7		<1			12	1.30%	30				290
PCL-1B	Pine Creek Landfill Surface Sample	11/13/85	JBR	EP Toxicity Analysis			0.428	0.04	1.53		0.018			1.78	0.0009	<0.5	<0.5	
PCL-1B	Pine Creek Landfill	11/13/85	JBR	Saturated Paste Analysis			<0.5		8.1			0.12		0.46	0.0079	0.65	<0.01	
PCL-1B	Pine Creek Landfill Surface Sample	11/13/85	JBR	Total Acid Analysis			8250		880			24100		48500	14700	220	180	
PCL-2B	Pine Creek Landfill Surface Sample	11/13/85	JBR	EP Toxicity Analysis			0.1	0.04	3.49		<0.01			1.08	0.0004	<0.5	<0.5	
PCL-2B	Pine Creek Landfill	11/13/85	JBR	Saturated Paste Analysis			0.5		24.5			0.15		1.65	0.0054	1.48	<0.01	
PCL-2B	Pine Creek Landfill Surface Sample	11/13/85	JBR	Total Acid Analysis			3300		3250			8700		64900	830	500	145.5	
PCL-3B	Pine Creek Landfill Surface Sample	11/13/85	JBR	EP Toxicity Analysis			0.1	0.04	1.5		<0.01			2.29	0.0015	<0.5	<0.5	
PCL-3B	Pine Creek Landfill	11/13/85	JBR	Saturated Paste Analysis			<0.5		3.35			0.05		0.3	0.0067	0.5	<0.01	
PCL-3B	Pine Creek Landfill Surface Sample	11/13/85	JBR	Total Acid Analysis			4250		1020			9350		30700	2670	270	124.5	
SIN-1B	Central Smelter	11/26/85	JBR	EP Toxicity Analysis			<0.1	0.11	0.1		<0.01			2.13	<0.0001	<0.5	<0.5	
SIN-1B	Central Smelter	11/26/85	JBR	Total Acid Analysis			2050		70			29500		15600	650	30	501	
AC-SO-01	1281 E. Pine Canyon Road	9/13/95	UDEQ	Total Metals	14300	R	47.1	172	4.8	10	15	74.2	15000	353	0.17	<0.61 J	2.6	695
AC-SO-02	1514 E. Pine Canyon Road	9/13/95	UDEQ	Total Metals	6270	R	17.4	96.2	8.4	4.8	10	84.6	8070	414	0.25	<0.6	1.9	292
AC-SO-03	1662 E. Pine Canyon Road	9/13/95	UDEQ	Total Metals	6740	R	13.8	121	6.4	5.3	8.4	68.6	8020	305	0.19	<0.6	<1.7	331
AC-SO-04	2005 Churchwood	9/13/95	UDEQ	Total Metals	11700	R	45.4	187	11.8	9.4	14.1	341	13400	563	0.53	<0.72	2.5	541
AC-SO-05	2005 Churchwood - Playground	9/13/95	UDEQ	Total Metals	8810	R	55.3	134	11	8.4	11.6	248	13600	674	0.4	<0.6	3	455
AC-SO-06	2388 Churchwood	9/13/95	UDEQ	Total Metals	10200	R	27.9	118	4.4	7.2	11	53.8	11000	194	0.21	<0.61 J	<1.7	456

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Berylllum	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
6-6	Transect #6 Boring	11/12/85	JBR	DTPA Extraction Analysis	70													
TE-2	Transect 2000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	160													
TE-2	Transect 2000' East of Smelter	11/12/85	JBR	Total Acid Analysis	2200													
TE-3	Transect 3000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	70													
TE-3	Transect 3000' East of Smelter	11/12/85	JBR	Total Acid Analysis	580													
TE-4	Transect 4000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	150													
TE-4	Transect 4000' East of Smelter	11/12/85	JBR	Total Acid Analysis	820													
TE-5	Transect 5000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	80													
TE-5	Transect 5000' East of Smelter	11/12/85	JBR	Total Acid Analysis	390													
TE-6	Transect 6000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	90													
TE-6	Transect 6000' East of Smelter	11/12/85	JBR	Total Acid Analysis	300													
TE-7	Transect 7000' East of Smelter	11/12/85	JBR	DTPA Extraction Analysis	110													
TE-7	Transect 7000' East of Smelter	11/12/85	JBR	Total Acid Analysis	580													
TN-4	Transect 4000' North of Smelter	11/12/85	JBR	DTPA Extraction Analysis	50													
TN-4	Transect 4000' North of Smelter	11/12/85	JBR	Total Acid Analysis	275													
TN-5	Transect 5000' North of Smelter	11/12/85	JBR	DTPA Extraction Analysis	60													
TN-5	Transect 5000' North of Smelter	11/12/85	JBR	Total Acid Analysis	265													
TN-6	Transect 6000' North of Smelter	11/12/85	JBR	DTPA Extraction Analysis	30													
TN-6	Transect 6000' North of Smelter	11/12/85	JBR	Total Acid Analysis	165													
TS-4	Transect 4000' South of Smelter	11/12/85	JBR	DTPA Extraction Analysis	45													
TS-4	Transect 4000' South of Smelter	11/12/85	JBR	Total Acid Analysis	205													
TS-5	Transect 5000' South of Smelter	11/12/85	JBR	DTPA Extraction Analysis	25													
TS-5	Transect 5000' South of Smelter	11/12/85	JBR	Total Acid Analysis	120													
TS-6	Transect 6000' South of Smelter	11/12/85	JBR	DTPA Extraction Analysis	30													
TS-6	Transect 6000' South of Smelter	11/12/85	JBR	Total Acid Analysis	150													
TW-2	Transect 2000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	200													
TW-2	Transect 2000' West of Smelter	11/12/85	JBR	Total Acid Analysis	1400													
TW-3	Transect 3000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	90													
TW-3	Transect 3000' West of Smelter	11/12/85	JBR	Total Acid Analysis	690													
TW-4	Transect 4000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	120													
TW-4	Transect 4000' West of Smelter	11/12/85	JBR	Total Acid Analysis	540													
TW-7	Transect 5000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	13													
TW-7	Transect 5000' West of Smelter	11/12/85	JBR	Total Acid Analysis	130													
TW-8	Transect 6000' West of Smelter	11/12/85	JBR	DTPA Extraction Analysis	3													
TW-8	Transect 6000' West of Smelter	11/12/85	JBR	Total Acid Analysis	40													
PCL-1B	Pine Creek Landfill Surface Sample	11/13/85	JBR	EP Toxicity Analysis														
PCL-1B	Pine Creek Landfill	11/13/85	JBR	Saturated Paste Analysis	93.5										6.15			
PCL-1B	Pine Creek Landfill Surface Sample	11/13/85	JBR	Total Acid Analysis	66500													
PCL-2B	Pine Creek Landfill Surface Sample	11/13/85	JBR	EP Toxicity Analysis														
PCL-2B	Pine Creek Landfill	11/13/85	JBR	Saturated Paste Analysis	201										6.14			
PCL-2B	Pine Creek Landfill Surface Sample	11/13/85	JBR	Total Acid Analysis	99800													
PCL-3B	Pine Creek Landfill Surface Sample	11/13/85	JBR	EP Toxicity Analysis														
PCL-3B	Pine Creek Landfill	11/13/85	JBR	Saturated Paste Analysis	12.3										6.53			
PCL-3B	Pine Creek Landfill Surface Sample	11/13/85	JBR	Total Acid Analysis	23100													
SIN-1B	Central Smelter	11/26/85	JBR	EP Toxicity Analysis														
SIN-1B	Central Smelter	11/26/85	JBR	Total Acid Analysis	72100													
AC-SO-01	1281 E. Pine Canyon Road	9/13/95	UDEQ	Total Metals	282	4160	0.96	4460	4740	232	18.9	0.59 J	17.9					
AC-SO-02	1514 E. Pine Canyon Road	9/13/95	UDEQ	Total Metals	378	24300	0.5	2280	3560	112	11.1	0.45 J	9.8					
AC-SO-03	1662 E. Pine Canyon Road	9/13/95	UDEQ	Total Metals	317	8000	0.48	3350	2630	91.6	9	<0.2	8.4					
AC-SO-04	2005 Churchwood	9/13/95	UDEQ	Total Metals	819	8490	0.85	4060	4910	134	19.4	0.67 J	14.1					
AC-SO-05	2005 Churchwood - Playground	9/13/95	UDEQ	Total Metals	593	13500	0.67	3440	4730	119	17.5	0.6 J	11.2					
AC-SO-06	2388 Churchwood	9/13/95	UDEQ	Total Metals	186	16000	0.73	3020	4930	119	12.8	0.36	14.6					

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
AC-SO-07	2231 E. Pine Canyon Road	9/13/95	UDEQ	Total Metals	5960	R	79.5	130	12.9	6.6	6.7	182	14500	1040	1.8	1	3.5	434
AC-SO-08	1519 N. Blue Peak Drive	9/13/95	UDEQ	Total Metals	4560	R	32.7	59.1	3.4	3.9	4.8	41	5970	183	0.12	<0.6 J	<1.7	266
AC-SO-09	1128 N. Erickson Road	9/13/95	UDEQ	Total Metals	10600	R	22.4	140	2.7	8	13.7	33.7	11600	103	<0.1	<0.61	<1.7	452
AC-SO-10	955 N. Erickson Road	9/13/95	UDEQ	Total Metals	5990	R	41.7	111	3.5	5.3	7.7	66.2	8620	268	<0.1	<0.6	1.8	424
AC-SO-16	Pine Canyon - Below Tram Tower	9/13/95	UDEQ	Total Metals	21600	<10.7 J	105	327	12.4	12.7	19.1	134	19000	372	0.41	1.1 J	2.6	957
AC-SO-17	Pine Canyon - North of Trout Pond	9/13/95	UDEQ	Total Metals	13600	<10.5 J	280	145	20.1	11.3	14.4	422	15000	1040	1.3	1.3 J	3.9	568
AC-SO-13	Background - Spring Canyon	9/14/95	UDEQ	Total Metals	9580	R	78.6	1.33	9.9	11.5	10.6	148	11000	427	0.25	<0.6 J	<1.7	766
AC-SO-14	Background - Dino's Pasture	9/14/95	UDEQ	Total Metals	8820	R	28.5	154	13.4	7.5	9.3	122	10200	681	0.41	0.94	2.1	519
AC-SE-02	Pine Canyon Tunnel Outlet	9/15/95	UDEQ	Total Metals	8900	<21.6 J	35.2	69.3	3.2	7	10.8	207	11700	151	<0.21	1.2 J	<3.4	811
AC-SE-03	Kennecott Trout Pond-Head	9/15/95	UDEQ	Total Metals	1690	<14.2 J	13.1	18	1.7	1.5	3.5	22.5	4350	121	<0.14	0.78 J	<2.2	108
AC-SE-04	Pine Creek at Kennecott Property Line	9/15/95	UDEQ	Total Metals	12400	<14.3 J	53.2	101	3.5	9.8	13.5	1610	18800	199	<0.14	0.93 J	3.4	252
AC-SO-15	Pine Canyon - Production Shaft	9/15/95	UDEQ	Total Metals	6540	<10.5 J	74.8	74.5	16.5	5.7	7.3	113	7910	487	0.4	0.73 J	<1.7	474
AC-B3-01	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	2360	<13.4 J	28.4	34.7	1.3	2.8	24.8	62.2	5110	84.3	<0.13	<0.51 J	<2.1	218
AC-B3-08	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	5300	<13.1 J	77.2	32.7	2.6	29.7	29.7	759	73700	36.8	0.12	5.2 J	7.9	694
AC-B3-33	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	5720	<15.3 J	79.1	39.8	2.7	31.8	12.6	488	61800	167	<0.15	3.4 J	6.3	551
AC-B3-37	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	2410	<11.7 J	9.2	26.1	<0.62	2.2	3.4	19.2	4080	27.6	<0.11	<0.45 J	<1.9	77.6
AC-B3-38	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	2370	<11.4 J	10.9	23.9	<0.61	3.7	19.9	26	5750	28.1	<0.11	<0.44 J	<1.8	177
AC-B3-39	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	8900	<21.6 J	35.2	69.3	3.2	7	10.8	207	11700	151	<0.21	1.2 J	<3.4	811
AC-SE-05	Pine Creek Below Slag Pile	9/18/95	UDEQ	Total Metals	10400	<15.8 J	43.5	85.4	5.2	6.8	9.5	166	9320	390	0.57	0.74 J	<2.5	383
AC-SO-11	Background - Pass Canyon	9/18/95	UDEQ	Total Metals	13000	<12.1 J	26.1	147	12.2	8	13.8	142	12400	518	0.23	0.63 J	2.4	423
AC-SO-12	Background - Flood Canyon	9/18/95	UDEQ	Total Metals	7870	<12.1 J	34.7	97.9	7.9	5.5	10.7	122	8870	352	0.31	0.56 J	<1.9	409
AC-B1-07	Waste Pit	9/19/95	UDEQ	Total Metals	6100	<12.2	1780	680	73.9	33.3	24.3	912 J	63400	10100	2.6	28.1	41.6 J	8000 J
AC-B1-CUT	Waste Pit	9/19/95	UDEQ	Total Metals	3200	<12.5	114	44.8	1.6	24.7	10.6	884 J	44800	216	0.17	4.4	2.8 J	600 J
AC-B4-02	IS&R Tailings	9/19/95	UDEQ	Total Metals	222	<11.8	602	393	1.2	10.4	<1.3	248 J	49700	2950	0.42	7.1	44.8 J	106 J
AC-B4-06	IS&R Tailings	9/19/95	UDEQ	Total Metals	922	<11.9	778	323	55.1	41.4	2.6	636 J	94400	3320	0.72	<3.4	31.1 J	10300 J
AC-B4-22	IS&R Tailings	9/19/95	UDEQ	Total Metals	1590	<11.7	8	27.4	<0.62	2.2	4.3	4.4 J	3120	21.3	0.19	<0.67	<0.4	88.9 J
AC-B4-23	IS&R Tailings	9/19/95	UDEQ	Total Metals	1340	<11.4	11.3	18.2	<0.61	3.5	13	9.0 J	4250	5.8	<0.11	<0.65	<0.39	111 J
AC-B4-CUT	IS&R Tailings	9/19/95	UDEQ	Total Metals	3490	<12.4	1200	154	4.7	45.1	2.7	1070 J	93500	1080	0.49	<3.5	10 J	1730 J
AC-SC-01	Tailings East of Dike	9/19/95	UDEQ	Total Metals	2460	<11.0	76.9	75.4	2.6	4.2	3.9	32.6 J	5740	330	0.11	<0.63	1.7 J	481 J
AC-SC-02	Tailings Exposed to Surface Runoff	9/19/95	UDEQ	Total Metals	1580	<12.3	646	502	4.7	15.1	18.9	560 J	61900	5150	0.83	3.9 J	39.6 J	673 J
AC-SC-03	North End of Tailings Berm at Dump	9/19/95	UDEQ	Total Metals	4370	<13.4	56.5	82.1	9	6.6	4.5	239 J	6960	700	0.79	0.81 J	2.2 J	387 J
AC-SC-04	NE Corner of Slag Pile	9/19/95	UDEQ	Total Metals	10000	<10.5	1040	3990	52.8	44.5	26.5	2650 J	147000	14900	4.7	31.1 J	29.6 J	6010 J
AC-SC-08	West of Berm in Drainage	9/19/95	UDEQ	Total Metals	2610	<10.7	368	154	6.3	5.6	5.3	82.2 J	13200	1060	0.15	3	4.8 J	1020 J
AC-B5-03	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	4660	<11.4	178	162	23	9.1	4.5	282 J	19900	2010	0.74	4.5	12 J	1790 J
AC-B5-08	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	2140	<11.7	4.4	66.1	<0.63	2.9	2.9	3.1 J	2940	14.1	<0.11	<0.67	0.68 J	135 J
AC-B5-13	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	769	<11.2	5.4	14.5	<0.6	1.3	2.1	2.0 J	1580	10.7	<0.11	<0.64	<0.39 J	165 J
AC-B5-18.5	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	421	<11.1	5.4	11.3	<0.59	1.4	<1.2	1.7 J	1560	11.8	<0.11	<0.63	<0.38 J	170 J
AC-B5-21	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	275	<11.0	2.8	7.2	<0.59	0.92	1.8	1.2 J	1090	6.3	<0.1	<0.63 J	<0.38 J	88 J
AC-B6-08	Lead Smelter	9/20/95	UDEQ	Total Metals	8050	<12.1 J	37.9	110	289	7	9.9	146 J	10700	113	0.74	3.4	<1.9	229 J
AC-B6-09	Lead Smelter	9/20/95	UDEQ	Total Metals	7970	<15.3 J	9.3	123	197	8.6	10	8.1 J	10500	29.4	<0.15	1.3	<2.4	424 J
AC-B6-15	Lead Smelter	9/20/95	UDEQ	Total Metals	2120	<11.6 J	564	33.7	140	<2.7	3.6	14.8 J	2940	<7.2	0.53	<0.66	<1.8	58.2 J
AC-B6-2.5	Lead Smelter	9/20/95	UDEQ	Total Metals	3910	<13.5 J	211	82.2	29.9	6.7	4.2	177 J	8450	1780	1.5	3.3	4.6 J	206 J
AC-B6-6.5	Lead Smelter	9/20/95	UDEQ	Total Metals	5190	591	11100	29.6	7450	21.4	14.5	1370 J	94100	175000	484	1010	27.4 J	141 J
AC-B8-01	Borrow Pit	9/20/95	UDEQ	Total Metals	2620	<10.9	8.4	47.2	<0.58	3.6	3.7	11.0 J	3810	46.2	<0.1	<0.62	<0.37	242 J
AC-SC-05	NE Smelter Culvert at Kennecott Prop. Line	9/20/95	UDEQ	Total Metals	4670	25.5 J	494	97.2	28.1	10.4	7.6	648 J	11300	3590	3.2	7.3	16.5	500 J
AC-SC-06	Mid Smelter - 150 yds South of Road	9/20/95	UDEQ	Total Metals	6570	<10.8 J	79.2	130	7.3	8.7	9.2	169 J	9940	796	0.79	<0.61	3	399 J
AC-SC-07	South of Smelter area below Archers Canyon	9/20/95	UDEQ	Total Metals	621	<13.3 J	1160	76.5	<0.71	9.8	<1.4	134 J	39500	236	1.2	12.2 J	6.1	32.5 J
AC-SC-09	North Side of Spoil Area	9/20/95	UDEQ	Total Metals	1680	<11.0 J	6.5	34.5	<0.59	<2.4	2.3	6.2 J	2440	41.3	<0.1	<0.63	<1.7	277 J
AC-SC-10	Southern Smelter Area Above Rip-Rap	9/20/95	UDEQ	Total Metals	1620	<11.9 J	98.3	55.7	<0.64	32.7	<1.3	630 J	77300	544	0.71	4.1 J	7.3	57.1 J
AC-SE-06	North Smelter Wetlands	9/20/95	UDEQ	Total Metals	3600	<16.2 J	30.7	64.5	3.7	<6.1	5.4	160 J	5330	265	0.19	1.6	<2.6	336 J
AC-B2-0.5	North Shore Pine Creek	9/21/95	UDEQ	Total Metals	5060	<10.8 J	85.3	103	13.7	5.8	6.5	177 J	7530	795	0.64	0.76	2.9	452 J
AC-B2-10	North Shore Pine Creek	9/21/95	UDEQ	Total Metals	4700	<11.6 J	6.2	53.7	<0.62	5.1	6.6	5 J	5360	13.4	<0.11	<0.66	<1.8	228 J

ANDERSON
ENGINEERING COMPANY INC.

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
AC-SO-07	2231 E. Pine Canyon Road	9/13/95	UDEQ	Total Metals	639	2430	0.49	1910	1870	52.6	11.6	0.68	7.6					
AC-SO-08	1519 N. Blue Peak Drive	9/13/95	UDEQ	Total Metals	118	1230	0.35	1150	1310	70.2	6.4	0.23	7.2					
AC-SO-09	1128 N. Erickson Road	9/13/95	UDEQ	Total Metals	109	16600	0.8	3770	4770	108	14.3	0.45	13.4					
AC-SO-10	955 N. Erickson Road	9/13/95	UDEQ	Total Metals	250	9260	0.49	1940	2550	96.5	9.3	0.53	9					
AC-SO-16	Pine Canyon - Below Tram Tower	9/13/95	UDEQ	Total Metals	233	6330	1.5	4950	6500	212	20.1	2.4	23.5					
AC-SO-17	Pine Canyon - North of Trout Pond	9/13/95	UDEQ	Total Metals	411	1420	1.2	3550	3160	98.7	15.5	3.9	21.5					
AC-SO-13	Background - Spring Canyon	9/14/95	UDEQ	Total Metals	216	3390	0.89	3000	2910	86.4	11.1	0.63 J	17.6					
AC-SO-14	Background - Dino's Pasture	9/14/95	UDEQ	Total Metals	429	7280	0.68	3470	3200	154	9.5	0.91 J	14					
AC-SE-02	Pine Canyon Tunnel Outlet	9/15/95	UDEQ	Total Metals	480	44200	0.64	1950	14300	<103	20.9	<1.8	11					
AC-SE-03	Kennecott Trout Pond-Head	9/15/95	UDEQ	Total Metals	54.6	2920	0.16	400	1510	<68.3	4.8	<1.2	3.6					
AC-SE-04	Pine Creek at Kennecott Property Line	9/15/95	UDEQ	Total Metals	207	19600	0.9	2730	8080	179	17.9	2.9	23.3					
AC-SO-15	Pine Canyon - Production Shaft	9/15/95	UDEQ	Total Metals	260	3060	0.67	2020	2130	<50.6	11	1.3	10.7					
AC-B3-01	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	93.6	19700	0.28	569	4390	<64.2	17.8	<1.1	5.4					
AC-B3-08	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	88.8	91200	1	3200	16800	67.1	36.4	<1.1	<0.82					
AC-B3-33	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	114	87500	0.72	2340	9860	87.4	27	<1.2	4.2					
AC-B3-37	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	37.3	8010	0.2	642	3790	<56.2	5.7	<0.96	5.1					
AC-B3-38	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	36.8	13400	0.2	879	4750	<54.9	7.5	<0.94	4.4					
AC-B3-39	Carr Fork Tailings Pond	9/18/95	UDEQ	Total Metals	480	44200	0.64	1950	14300	<103	20.9	<1.8	11					
AC-SE-05	Pine Creek Below Slag Pile	9/18/95	UDEQ	Total Metals	259	13500	0.71	2380	5610	116	12.7	1.4	14.2					
AC-SO-11	Background - Pass Canyon	9/18/95	UDEQ	Total Metals	367	10600	0.91	3990	4770	151	19.1	1.6	16					
AC-SO-12	Background - Flood Canyon	9/18/95	UDEQ	Total Metals	228	23000	0.7	2260	6760	98	14.2	<0.99	12.4					
AC-B1-07	Waste Pit	9/19/95	UDEQ	Total Metals	8360	73300	0.62	2830	20900	197	31.1	<1.0	2					
AC-B1-CUT	Waste Pit	9/19/95	UDEQ	Total Metals	225	64300	0.67	1910	11300	79.1	18.1	<1.0	1.3					
AC-B4-02	IS&R Tailings	9/19/95	UDEQ	Total Metals	287	43600	0.21	443	103	83.6	11.9	11.4	<0.74					
AC-B4-06	IS&R Tailings	9/19/95	UDEQ	Total Metals	6920	47600	0.68	236	4300	<56.9	47.3	<0.97	<0.75					
AC-B4-22	IS&R Tailings	9/19/95	UDEQ	Total Metals	36.1	571	0.21	373	760	<56.2	4.3	<0.96	4.7					
AC-B4-23	IS&R Tailings	9/19/95	UDEQ	Total Metals	10.5	6450	0.21	372	2870	<54.6	5.4	<0.93	3.9					
AC-B4-CUT	IS&R Tailings	9/19/95	UDEQ	Total Metals	1010	34100	0.76	1370	4650	<59.6	44.2	22.6	<0.78					
AC-SC-01	Tailings East of Dike	9/19/95	UDEQ	Total Metals	247	4510	0.34	788	1840	<52.9	5.2	<0.9	5.9					
AC-SC-02	Tailings Exposed to Surface Runoff	9/19/95	UDEQ	Total Metals	1360	51300	0.62	1810	1890	142	19.3	7.2	<0.77					
AC-SC-03	North End of Tailings Berm at Dump	9/19/95	UDEQ	Total Metals	528	9140	0.54	1330	3800	88.9	9.7	1.5	8.9					
AC-SC-04	NE Corner of Slag Pile	9/19/95	UDEQ	Total Metals	25000	93600	0.9	3220	6590	978	50.5	<.86	1.3					
AC-SC-08	West of Berm in Drainage	9/19/95	UDEQ	Total Metals	857	10900	0.31	750	3660	<51.4	7.3	<0.88	5.6					
AC-B5-03	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	2680	21800	0.5	1360	5530	<54.7	11.6	<0.93	5.9					
AC-B5-08	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	24.6	69200	0.23	532	4310	<56.3	5.3	<0.96	5.9					
AC-B5-13	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	14.6	20100	0.14	218	4930	<54	<2.2	<0.92	3					
AC-B5-18.5	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	22.5	22800	0.09	152	7770	<53.3	<2.2	<0.91	2.6					
AC-B5-21	Northwest Corner Tailings Berm	9/20/95	UDEQ	Total Metals	13.3	17400	<0.08	101	7460	<52.9	<2.1	<0.9	2.4					
AC-B6-08	Lead Smelter	9/20/95	UDEQ	Total Metals	1530	1290	0.87	2770	2500	<58.0 J	26.3	11.8	21					
AC-B6-09	Lead Smelter	9/20/95	UDEQ	Total Metals	1090	1190	0.82	2130	2240	<73.3 J	15.2	3.2	17.5					
AC-B6-15	Lead Smelter	9/20/95	UDEQ	Total Metals	612	452	0.26	629	631	<55.7 J	3.5	5.2	8.4					
AC-B6-2.5	Lead Smelter	9/20/95	UDEQ	Total Metals	639	6380	0.33	690	1250	198	7	2	6.5					
AC-B6-6.5	Lead Smelter	9/20/95	UDEQ	Total Metals	10100	37100	0.4	8100	800	552	41.8	<37.8	0.82					
AC-B8-01	Borrow Pit	9/20/95	UDEQ	Total Metals	37.7	3460	0.28	791	1390	84.4	4.5	<0.89	5.4					
AC-SC-05	NE Smelter Culvert at Kennecott Prop. Line	9/20/95	UDEQ	Total Metals	1320	6770	0.55	1270	3750	<52.9 J	13.4	2.1	11.6					
AC-SC-06	Mid Smelter - 150 yds South of Road	9/20/95	UDEQ	Total Metals	535	2310	0.77	2000	2490	<51.6 J	11.2	1.7	18					
AC-SC-07	South of Smelter area below Archers Canyon	9/20/95	UDEQ	Total Metals	129	69100	0.19	784	408	728 J	10.4	45.9	<0.84					
AC-SC-09	North Side of Spoil Area	9/20/95	UDEQ	Total Metals	44.9	1070	0.22	<334	631	<52.7 J	6.1	<0.9	3.8					
AC-SC-10	Southern Smelter Area Above Rip-Rap	9/20/95	UDEQ	Total Metals	44.4	46200	0.2	628	408	<57.3 J	24.6	66.9	<0.75					
AC-SE-06	North Smelter Wetlands	9/20/95	UDEQ	Total Metals	235	20600	0.44	1030	7990	<77.8 J	11.4	1.3	7.7					
AC-B2-0.5	North Shore Pine Creek	9/21/95	UDEQ	Total Metals	443	2260	0.49	1640	1700	<52 J	9.8	0.87	10					
AC-B2-10	North Shore Pine Creek	9/21/95	UDEQ	Total Metals	30	5850	0.44	1180	2160	<55.5 J	8.4	<0.44	8.6					

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Aluminum	Antimony	Arsenic	Barium	Cadmium	Cobalt	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Manganese
AC-B7-16	Dry Canyon	9/21/95	UDEQ	Total Metals	12300	<12.8 J	5.1	148	<0.68	10.4	10	13.8 J	11200	14.3	<0.12	<0.73	<2.0	599 J
AC-B7-6.5	Dry Canyon	9/21/95	UDEQ	Total Metals	13600	<11.9 J	9.3	181	<0.64	13.5	13.9	12.9 J	14500	16.7	<0.11	<0.68	<1.9	637 J
AC-SC-11	Ravine North of Gun Club	9/21/95	UDEQ	Total Metals	3880	<11 J	157	173	20.9	6.6	6.7	292 J	8380	1310	0.69	0.89	4.7	407 J
AC-SE-07	Pine Creek North of Confluence	9/21/95	UDEQ	Total Metals	7270	<14.7 J	131	132	5.2	12.3	9.4	2040 J	22800	355	0.24	<0.84 J	2.6	454 J
AC-SO-18	Tailings at South West Gate Below Dike	9/21/95	UDEQ	Total Metals	1060	<11.2 J	1100	327	1.5	10.9	3.1	200 J	51300	4300	0.25	3.6 J	23.9	125
AC-SC-12	Tailings Near Concrete Tailings Sluice	10/3/95	UDEQ	Total Metals	2340	161	2510 J	3070	16.5	8	9.6	724	18300	14300	2	8.3 J	58	413
AC-SC-13	Tailings at Cow Pond Dike	10/3/95	UDEQ	Total Metals	5880	553	5420 J	1280	174	31.4	14.8	7590	82500	61300	50.1	98.6 J	228	2970
AC-SO-19	Head of Concrete Tailings Pipe	10/3/95	UDEQ	Total Metals	4660	<6.0	147 J	111	<0.78	8.2	7.1	104	16000	161	0.31	6.3 J	<1.5	422
AC-SE-01	Swenson Canyon Mouth	11/30/95	UDEQ	Total Metals	2160	<9.0 J	8.8	58.5	1.4	2.8	4	11.9	3950	55.4 J	<0.17	<1.5	<2.2	124
AC-B2-20	North Shore Pine Creek	12/11/95	UDEQ	Total Metals	1990	<0.93 J	5.7	21.8	<0.06 J	1.3	5.3	4.1	2980	13.8	<0.11 J	<0.97	<0.32 J	157 J
AC-B2-30	North Shore Pine Creek	12/11/95	UDEQ	Total Metals	4310	<0.95 J	6.7	29.9	<0.06 J	2.5 J	7.3	5.8	5160	12.2	<0.11 J	<0.99 J	<0.32 J	155 J
AC-B2-40	North Shore Pine Creek	12/11/95	UDEQ	Total Metals	1970	<0.92 J	6	25.8	<0.06 J	1.5	4.4	9.7	3140	12.3	<0.1 J	<0.96	<0.31 J	167 J
AC-B8-10	Borrow Pit	12/12/95	UDEQ	Total Metals	2100	<0.92 J	5.9	18.5	<0.06 J	1.5 J	16	6.6	5130	11.8	<0.1 J	<0.96 J	<0.31 J	144 J
AC-B8-15	Borrow Pit	12/12/95	UDEQ	Total Metals	9830	<1.1 J	9.9	78.6	<0.07 J	4.7	9.4	8.3	9630	26.8	<0.12 J	<1.1 J	<0.37 J	373 J
AC-B8-20	Borrow Pit	12/13/95	UDEQ	Total Metals	8010	<0.98 J	7.5	62.4	<0.07 J	3.9 J	9.5	6.8	7790	22.4	<0.11 J	<1.0 J	<0.33 J	314 J
AC-B8-30	Borrow Pit	12/13/95	UDEQ	Total Metals	3510	<0.95 J	6.9	35.7	<0.07 J	2.0 J	6.9	4.8	4360	18.1	<0.11 J	<1.0 J	0.33 J	186 J
AC-B8-40	Borrow Pit	12/13/95	UDEQ	Total Metals	2140	<0.92 J	5.2	17	<0.06 J	1.4	5.9	5.5	4090	13.2	<0.1 J	<0.96	<0.31 J	133 J

Table 1-2
Previous Soil Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTES:
R: Rejected result
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Certified Analysis	Zinc	Calcium	Beryllium	Potassium	Magnesium	Sodium	Nickel	Thallium	Vanadium	Cyanide	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
AC-B7-16	Dry Canyon	9/21/95	UDEQ	Total Metals	37.4	3940	1.1	2920	5440	<61.3 J	18.7	<0.49 J	15.5					
AC-B7-6.5	Dry Canyon	9/21/95	UDEQ	Total Metals	38.1	6540	1.2	2030	4250	<57.3 J	13.8	<0.46	27.8					
AC-SC-11	Ravine North of Gun Club	9/21/95	UDEQ	Total Metals	376	2010	0.41	1050	1610	<52.6 J	10.6	0.95	9.2					
AC-SE-07	Pine Creek North of Confluence	9/21/95	UDEQ	Total Metals	1080	23400	0.88	1540	5630	<70.6 J	21.2	0.87	7.9					
AC-SO-18	Tailings at South West Gate Below Dike	9/21/95	UDEQ	Total Metals	427	34500	0.22	1490	1520	<54 J	13	4.7	<0.71					
AC-SC-12	Tailings Near Concrete Tailings Sluice	10/3/95	UDEQ	Total Metals	967	628	0.38	872	706	117	14.5	3.6	7.9					
AC-SC-13	Tailings at Cow Pond Dike	10/3/95	UDEQ	Total Metals	13900	3030	0.89	1480	2590	173	54.6	18.2 J	0.88					
AC-SO-19	Head of Concrete Tailings Pipe	10/3/95	UDEQ	Total Metals	42.8	257	0.48	1410	1570	<79 J	9.6	<0.45 J	16.9					
AC-SE-01	Swenson Canyon Mouth	11/30/95	UDEQ	Total Metals	51.7	45200 J	<0.33	672	2990	<117 J	5.8	<0.7	6.6					
AC-B2-20	North Shore Pine Creek	12/11/95	UDEQ	Total Metals	27.8	605	0.07	345 J	650	<69.3	5.9	<0.44	4.6					
AC-B2-30	North Shore Pine Creek	12/11/95	UDEQ	Total Metals	23.9	1360	0.17	839 J	1260	<82.4	6.9	<0.45	7.3					
AC-B2-40	North Shore Pine Creek	12/11/95	UDEQ	Total Metals	58.3	20900	0.08	435 J	3060	<70.9	5.9	<0.44	4.8					
AC-B8-10	Borrow Pit	12/12/95	UDEQ	Total Metals	28.7	3330	0.04	474 J	1590	<70.9	12.3	<0.44	4.7					
AC-B8-15	Borrow Pit	12/12/95	UDEQ	Total Metals	64.6	17600	0.35	1910 J	5490	<146	11.1	1	17.5					
AC-B8-20	Borrow Pit	12/13/95	UDEQ	Total Metals	52.5	7840	0.21	1600 J	4350	<137	8.7	1.1	15.1					
AC-B8-30	Borrow Pit	12/13/95	UDEQ	Total Metals	36	16600	0.15	774 J	2280	<95.6	7.1	<0.46	7.3					
AC-B8-40	Borrow Pit	12/13/95	UDEQ	Total Metals	25.5	10600	0.06	535 J	5910	<87.1	5.4	<0.44	5.1					

Table 1-3
Previous Surface Water Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Aluminum		Arsenic		Barium		Boron		Cadmium		Chromium (hex)		Chromium		Molybdenum		Copper		Iron		Lead		Magnesium		Manganese	
Sample Fraction				Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
96	Intermittent Stream Above Slag Pile	5/30/84	DERR	2.2		0.023		0.2				0.025		<0.005		0.03		<0.1		0.055		2.85		0.765		25		0.53	
97	Stream above Hoist Facility	5/30/84	DERR	5.1		0.014		0.15				<0.01		0.012		0.03		<0.1		0.04		4.73		0.375		2		3.355	
99	Tailings material from tailings pond	5/30/84	DERR	0.9		0.029		0.13				<0.01		0.008		<0.02		<0.1		0.035		1.23		0.045		46		0.12	
101	Tailings material from tailings pond	5/30/84	DERR			0.1		<0.05				0.325		<0.005		<0.1								0.32		598			
SW-1	Pine Creek Up	6/21/85	E&E INC.	0.14		0.01		0.027				<0.005				<0.005				0.02		0.191		<0.03		39		0.016	
SW-2	Pine Creek Mid	6/21/85	E&E INC.	0.056		0.012		0.05				<0.005				<0.005				0.009		0.074		<0.03		26.8		<0.005	
SW-3	Pine Creek Down	6/21/85	E&E INC.	0.076		0.012		0.05				<0.005				<0.005				0.007		0.097		<0.03		29.1		<0.005	
SW-01	Big Spring - Above Site	8/22/85	JBR			0.011		0.05		0.038		0.005		<0.005		<0.005		<0.005		<0.005		0.035		<0.01		27		<0.005	
SW-02	Adamson Tunnel - Above Site	8/22/85	JBR			<0.01	<0.01	0.08	0.058	<0.01		0.007	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.008	<0.01	<0.01	26.8		<0.005	<0.005
SW-03	Above Pipeline Leakage	8/22/85	JBR			0.014	0.013	0.088	0.088	<0.01		0.007	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	0.06	0.01	<0.01	<0.01	28.2		<0.005	<0.005
SW-04	Pipe Outlet at Tank Overflow	8/22/85	JBR			0.018	0.018	0.068	0.038	0.13		0.007	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.08	0.018	<0.01	<0.01	28		0.007	0.005
SW-05	Upstream from East Culvert	8/22/85	JBR			0.023		0.063		0.16		0.005		<0.005		<0.005		<0.005		0.013		0.2		<0.01		28		0.012	
SW-06	50' Above Falls at Slag Pile	8/22/85	JBR			0.01	<0.01	0.045	0.03	<0.01		0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.013	0.013	0.288	0.153	<0.01	<0.01	27.6		0.012	0.007
SW-07	Seep at Slag Pile Base	8/22/85	JBR			0.038	0.032	0.02	<0.01	0.13		0.038	0.26	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.035	0.023	0.153	0.043	<0.01	<0.01	59.2		0.017	0.012
SW-08	Old Diversion Dike Below Slag	8/22/85	JBR			0.027	0.025	0.045	0.045	<0.01		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.013	0.013	0.308	0.21	<0.01	<0.01	27.5		0.012	0.012
SW-09	Bridge Above Elton Tunnel	8/22/85	JBR			0.011	<0.01	0.105	0.095	0.038		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	0.008	0.108	0.04	<0.01	<0.01	26.8		0.005	0.005
SW-10	Below Elton Tunnel	8/22/85	JBR			0.01	0.01	0.117	0.072	0.33		0.007	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.01	0.22	0.024	<0.01	<0.01	26.5		0.007	0.007
SW-11	Pine Canyon Tunnel Outlet	9/25/85	JBR			<0.01	<0.01	0.039	0.038	0.022		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	0.129	<0.005	0.186	0.176	41.6		<0.005	<0.005
SW-12	Pine Creek above Slag Pile	10/18/85	JBR			0.011	<0.01	0.08	0.07	0.022		<0.005	<0.005	<0.005		<0.005	<0.005		<0.005	0.012	0.005	0.053	0.04	<0.005	<0.005	28		<0.005	<0.005
SW-13	Pine Canyon Dump Stream	10/18/85	JBR			0.012	<0.01	0.123	0.123	0.049		0.017	0.01	<0.005		<0.005	<0.005		<0.005	0.015	0.015	0.178	0.098	0.132	0.075	45.8		0.055	0.055
SW-14	Below Confluence w/SW-13	10/18/85	JBR			<0.01	<0.01	0.085	0.068	0.025		<0.005	<0.005	<0.005		<0.005	<0.005		<0.005	0.028	0.008	0.495	0.145	<0.005	<0.005	30.5		0.02	0.01
SW-12	Pine Creek above Slag Pile	9/18/86	JBR			0.012	<0.01	0.012	<0.01		0.2	<0.01	<0.01			0.015	<0.01	<0.01	<0.01	0.185	0.032	112	2.5	0.48	0.16		25.3	0.46	0.09
SW-8	Pine Creek @ Diversion Dam	9/18/86	JBR			<0.01	<0.01	0.019	<0.01		0.16	<0.01	<0.01			0.032	<0.01	<0.01	<0.01	2.95	0.015	33	0.46	0.72	0.02		29.2	1.07	0.012
SW-9	Pine Creek above Elton Tunnel	9/18/86	JBR			<0.01	<0.01	0.045	<0.01		0.26	0.038	<0.01			0.06	<0.01	0.11	<0.01	5.08	0.025	105	0.67	3.36	0.022		23.4	1.23	0.018
SW-12	Pine Creek above Slag Pile	1/29/87	JBR				<0.01		0.062		0.03		<0.01		<0.01		<0.01		<0.01		0.016	0.32	0.11		0.08		29.3		0.01
SW-7	Slag Pile Spring	1/29/87	JBR				<0.01		0.048		0.21		<0.01		<0.01		<0.01		<0.01		0.032	0.016	0.032		<0.01		35.2		0.012
SW-8	Pine Creek @ Diversion Dam	1/29/87	JBR				<0.01		0.06		0.02		<0.01		<0.01		<0.01		<0.01		0.018	0.41	0.18		<0.01		29.1		0.012
SW-12	Pine Creek above Slag Pile	5/14/87	JBR	2.3	<0.1	0.013	<0.01	0.145	<0.01	0.13		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.068	<0.01	3.58	0.05	<0.01	<0.01	41		0.25	0.022
SW-7	Slag Pile Spring	5/14/87	JBR	0.1	<0.1	<0.01	<0.01	0.075	0.075	0.35		0.012	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.033	0.033	0.075	0.055	<0.01	<0.01	55.6		0.018	0.016
SW-8	Pine Creek @ Diversion Dam	5/14/87	JBR	4.16	<0.1	0.022	<0.01	0.115	0.079	0.15		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.13	<0.01	5.73	0.05	<0.01	<0.01	37.9		0.44	0.015
SW-9	Pine Creek above Elton Tunnel	5/14/87	JBR	7.55	<0.1	0.04	<0.01	0.085	<0.01	0.14		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.22	<0.01	7.1	0.038	<0.01	<0.01	38.2		0.64	0.02
SW-12	Pine Creek above Slag Pile	8/11/87	JBR		<0.01		<0.01		<0.01		0.22		<0.01		<0.01		<0.01		<0.01		<0.01		0.3		<0.01				<0.01
SW-7	Slag Pile Spring	8/11/87	JBR		<0.01		<0.01		<0.01		0.12		0.015		<0.01		<0.01		<0.01		0.048		0.26		<0.01				0.12
SW-8	Pine Creek @ Diversion Dam	8/11/87	JBR		<0.01		<0.01		<0.01		0.18		<0.01		<0.01		<0.01		<0.01		<0.01		0.3		<0.01				<0.01
SW-9	Pine Creek above Elton Tunnel	8/11/87	JBR		<0.01		<0.01		<0.01		0.15		<0.01		<0.01		<0.01		<0.01		<0.01		0.32		<0.01				<0.01
SW-12	Pine Creek above Slag Pile	10/23/87	JBR				<0.01		0.055		0.028		<0.01		<0.01		<0.01		<0.01		<0.01	0.28	0.081		<0.01		31.8		<0.01
SW-9	Pine Creek above Elton Tunnel	10/23/87	JBR				0.013		0.045		0.041		<0.01		<0.01		<0.01		<0.01		<0.01	0.078	<0.01		<0.01		31.8		<0.01
SW-12	Pine Creek above Slag Pile	7/1/88	JBR				<0.01		0.33		0.024		<0.01		<0.01		<0.01				<0.01	0.505	<0.01		<0.01		32.8		0.02
SW-8	Pine Creek @ Diversion Dam	7/1/88	JBR				<0.01	0.026		0.037			<0.01		<0.01	<0.01					<0.01	0.113	0.018		<0.01		33.6		<0.01
SW-9	Pine Creek above Elton Tunnel	7/1/88	JBR				<0.01		0.18		0.03		<0.01		<0.01		<0.01				<0.01	0.03	<0.01		<0.01		32.9		<0.01
SW-12	Pine Creek above Slag Pile	12/4/88	JBR				<0.01		<0.01				<0.01		<0.01		<0.01				<0.01		<0.01		<0.01		30.8		<0.01
SW-8	Pine Creek @ Diversion Dam	12/4/88	JBR				<0.01		<0.01				<0.01		<0.01		<0.01				<0.01		<0.01		<0.01		37.6		<0.01
SW-9	Pine Creek above Elton Tunnel	12/4/88	JBR				<0.01		<0.01				<0.01		<0.01		<0.01				<0.01		0.02		<0.01		40.1		<0.01
SW-12	Pine Creek above Slag Pile	6/18/89	JBR				<0.01		<0.01		0.2		<0.01		<0.01		<0.01				0.048		0.17		<0.01		39.7		<0.01
SW-8	Pine Creek @ Diversion Dam	6/18/89	JBR				<0.01		0.03	0.18			<0.01		<0.01		<0.01				0.028		0.055		<0.01		18.1		<0.01
SW-9	Pine Creek above Elton Tunnel	6/18/89	JBR				<0.01		0.038		0.22		<0.01		<0.01		<0.01				0.043		0.015		<0.01		25.6		<0.01
SW-12	Pine Creek above Slag Pile	12/14/89	JBR				<0.01		<0.01		0.208		<0.01		<0.01		<0.01				<0.01		<0.01		<0.01		37.2		<0.01
SW-8	Pine Creek @ Diversion Dam	12/14/89	JBR				<0.01		<0.01		0.226		<0.01		<0.01		<0.01				<0.01	0.095	<0.01		<0.01		37.6		<0.01
AC-SW-2	Pine Canyon Tunnel Portal	9/15/95	UDEQ	0.0608		0.0049		0.0218				<0.0028				<0.0057				0.0035		0.031		<0.0027		37.9		0.0073	
AC-SW-3	Kennecott Trout Pond Head	9/15/95	UDEQ	0.0451		<0.0046		0.0482				<0.0028				<0.0057				<0.0032		<0.0236 J		<0.0027		26.7		0.004	
AC-SW-4	Pine Creek at Kennecott Prop. Line	9/15/95	UDEQ	0.0945		<0.0046		0.0586				<0.0028				0.0304				<0.0032		0.187		<0.0027		27		0.0087	
AC-SW-5	Pine Creek Below Slag Pile	9/18/95	UDEQ	0.094		0.0059		0.0618				<0.0028				0.0216				<0.0032		0.124		0.0047		27.7		0.0095	
AC-SW-6	North Smelter Wetlands	9/20/95	UDEQ	0.115		<0.003 J		0.0632				<0.0028				<0.0057				0.0035		0.0519		0.0043 J		27.6		0.0054	
AC-SW-7	Pine Creek North of Confluence	9/21/95	UDEQ	9.35		0.0394 J		0.15				0.0032				0.0078				0.517		9.76		0.197		34.3		0.379	
AC-SW-1	Swenson Mouth Canyon	11/30/95	UDEQ	<0.0205		0.0041		0.0543				<0.0035				<0.0045				<0.0037		0.0142		<0.0029		41.5		0.002	
Drinking Water Maximum Contaminant Levels (ppm)						0.05				2		0.005				0.1				1.3				0.015					
Ambient Water Maximum Contaminant Levels (ppm) - 4 Day Average				0.087		0.19						0.0011		0.011		0.21						1		0.0032					
Ambient Water Maximum Contaminant Levels (ppm) - 1 Hour Average				0.75		0.36						0.0039		0.016		1.7				0.018		1		0.082					

Table 1-3
Previous Surface Water Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Mercury		Nickel		Selenium		Silver		Zinc		Alkalinity	Ammonia	Bicarbonate	Calcium		Carbonate	Chloride	TSS	Conductivity (umhos/cm)	Fluoride	Hardness	Hydroxide
Sample Fraction				Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved				Total	Dissolved							
96	Intermittent Stream Above Slag Pile	5/30/84	DERR	0.0002		<0.1		<0.0005		<0.01		0.175		197		240	51		0	12		505	0.13	232	0
97	Stream above Hoist Facility	5/30/84	DERR	<0.0001		<0.1		<0.0005		<0.01		0.504		84		102	32		0	3		180	0.12	88	0
99	Tailings material from tailings pond	5/30/84	DERR	<0.0001		<0.1		<0.0005		<0.01		0.125		51		62	132		0	44		1100	0.81	520	0
101	Tailings material from tailings pond	5/30/84	DERR	<0.0001				<0.05		0.024				6		7	616		0	24		4040	4.69	4000	0
SW-1	Pine Creek Up	6/21/85	E&E INC.	0.0001		<0.030		<0.005		<0.005		0.089					66.4			4					
SW-2	Pine Creek Mid	6/21/85	E&E INC	0.00017		<0.030		<0.005		<0.005		0.049					54.7			22					
SW-3	Pine Creek Down	6/21/85	E&E INC.	0.00027		<0.030		<0.005		<0.005		0.021					54.4			22					
SW-01	Big Spring - Above Site	8/22/85	JBR	<0.0002		<0.005		<0.002		<0.005		<0.005		139	0.49	170	60.3		0	40.5	<1	560	0.71	246	0
SW-02	Adamson Tunnel - Above Site	8/22/85	JBR	<0.0002	<0.0002	<0.005	<0.005	<0.002	<0.002	<0.005	<0.005	<0.005	<0.005	159	0.4	194	61.8		0	31.8	<1	591	0.43	255	0
SW-03	Above Pipeline Leakage	8/22/85	JBR	<0.0002	<0.0002	<0.005	<0.005	<0.002	<0.002	<0.005	<0.005	<0.005	<0.005	188	0.21	230	64.5		0	19.1	<1	502	0.49	260	0
SW-04	Pipe Outlet at Tank Overflow	8/22/85	JBR	<0.0002	<0.0002	<0.005	<0.005	<0.002	<0.002	<0.005	<0.005	0.01	0.01	143	0.31	175	63.9		0	40	<1	571	0.41	254	0
SW-05	Upstream from East Culvert	8/22/85	JBR	<0.0002		<0.005		<0.002		<0.005		0.015		143	0.39	175	58.8		0	35.4	<1	550	0.44	261	0
SW-06	50' Above Falls at Slag Pile	8/22/85	JBR	<0.0002	<0.0002	0.007	<0.005	<0.002	<0.002	<0.005	<0.005	0.015	0.015	173	0.3	210	58.6		0	36.4	<1	550	0.24	252	0
SW-07	Seep at Slag Pile Base	8/22/85	JBR	<0.0002	<0.0002	0.112	0.102	<0.002	<0.002	<0.005	<0.005	9.48	8.4	172	0.32	210	136		0	75.4	<1	1940	1.76	702	0
SW-08	Old Diversion Dike Below Slag	8/22/85	JBR	<0.0002	<0.0002	<0.005	<0.005	<0.002	<0.002	<0.005	<0.005	<0.002	0.02	131	0.4	160	58.7		0	37.2	<1	540	0.42	246	0
SW-09	Bridge Above Elton Tunnel	8/22/85	JBR	<0.0002	<0.0002	<0.005	<0.005	<0.002	<0.002	<0.005	<0.005	<0.005	<0.005	137	0.19	168	56.5		0.86	35.6	<1	530	0.36	240	0
SW-10	Below Elton Tunnel	8/22/85	JBR	<0.0002	<0.0002	<0.005	<0.005	<0.002	<0.002	<0.005	<0.005	0.055	0.022	127	0.22	155	56.6		1.43	35.6	<1	519	0.53	236	0
SW-11	Pine Canyon Tunnel Outlet	9/25/85	JBR	<0.0002	<0.0002	0.015	0.015	<0.002	<0.002	<0.005	<0.005	0.045	0.025	140	<0.1	170	63.9		0	15.9	<1	584	0.04	329	0
SW-12	Pine Creek above Slag Pile	10/18/85	JBR	<0.0002	<0.0002	0.033	0.005	<0.002	<0.002	0.013	<0.005	0.058	0.02	175		213	39.9		0	26		457	0.11	259	0
SW-13	Pine Canyon Dump Stream	10/18/85	JBR	<0.0002	<0.0002	0.058	0.03	0.003	<0.002	<0.005	<0.005	4.63	4.63	135		164	56.7		0	40		1080	0.34	244	0
SW-14	Below Confluence w/SW-13	10/18/85	JBR	<0.0002	<0.0002	0.018	0.007	<0.002	<0.002	<0.005	<0.005	0.37	0.37	171		208	40.8		0	27		604	0.18	150	0
SW-12	Pine Creek above Slag Pile	9/18/86	JBR	<0.0002	<0.0002	0.05	<0.01	<0.002	<0.002	<0.01	<0.01	0.138	0.065	159	<0.1	189		48.5	3.3	26.1	680	502	0.17	237	0
SW-8	Pine Creek @ Diversion Dam	9/18/86	JBR	<0.0002	<0.0002	0.025	<0.01	<0.002	<0.002	<0.01	<0.01	0.458	0.035	162	<0.1	186		49.8	9.7	27.2	1170	509	0.18	234	0
SW-9	Pine Creek above Elton Tunnel	9/18/86	JBR	<0.0002	<0.0002	0.095	<0.01	0.003	<0.002	<0.01	<0.01	1.99	0.052	137	<0.1	167		52.5	0	23.6	1360	532	0.78	260	0
SW-12	Pine Creek above Slag Pile	1/29/87	JBR		<0.0002		<0.01		0.0028		<0.01		0.05	183	0.18	210		52.2	10.5	23	<1	522	<0.05	249	0
SW-7	Slag Pile Spring	1/29/87	JBR		<0.0002		<0.01		<0.002		<0.01		1.58	168	<0.1	205		73.1	0	30.3	1.2	751	1.07	314	0
SW-8	Pine Creek @ Diversion Dam	1/29/87	JBR		<0.0002		<0.01		<0.002		<0.01		0.085	179	0.19	218		52.4	0	26.4	<1	527	0.08	247	0
SW-12	Pine Creek above Slag Pile	5/14/87	JBR	0.0002	<0.0002	<0.01	<0.01	0.0023	<0.002	<0.01	<0.01	0.13	0.13	248	0.28	303	58.9	50.7	0	38	500	584	0.26	270	0
SW-7	Slag Pile Spring	5/14/87	JBR	<0.0002	<0.0002	0.018	0.018	<0.002	<0.002	<0.01	<0.01	2.72	1.85	188	0.26	229	90.2	89.4	0	41	3.2	1080	1.36	466	0
SW-8	Pine Creek @ Diversion Dam	5/14/87	JBR	0.00023	<0.0002	<0.01	<0.01	0.004	0.0022	<0.01	<0.01	0.36	0.062	213	0.42	250	58.5	56.2	0	40	970	590	0.18	272	0
SW-9	Pine Creek above Elton Tunnel	5/14/87	JBR	<0.0002	<0.0002	<0.01	<0.01	0.0056	<0.002	<0.01	<0.01	0.42	0.038	238	0.26	290	58.4	56.5	0	39	1510	584	0.31	267	0
SW-12	Pine Creek above Slag Pile	8/11/87	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	187	<0.1	213	45.4		7.2	26.4	4.4	542	0.02	252	0
SW-7	Slag Pile Spring	8/11/87	JBR		0.00023		0.06		<0.002		<0.01		8.8	139	0.12	169	103		0	36.5	1.6	971	2.01	393	0
SW-8	Pine Creek @ Diversion Dam	8/11/87	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	180	<0.1	198	44.3		10.7	27.4	2.8	541	<0.1	257	0
SW-9	Pine Creek above Elton Tunnel	8/11/87	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	182	<0.1	202	44.2		10	27.3	2.8	552	0.31	252	0
SW-12	Pine Creek above Slag Pile	10/23/87	JBR		<0.0002		<0.01		0.0022		0.012		0.095	183	<0.1	217		69.2	3.1	24.4		519	<0.1	255	0
SW-9	Pine Creek above Elton Tunnel	10/23/87	JBR		<0.0002		<0.01		<0.002		0.018		0.048	182	0.12	220		66.8	1.2	58.6		514	<0.1	253	0
SW-12	Pine Creek above Slag Pile	7/1/88	JBR		<0.0002		<0.01		<0.002		<0.01		0.03	167	0.26	185		52.3	9.3	80.3		573	0.2	262	0
SW-8	Pine Creek @ Diversion Dam	7/1/88	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	157	<0.1	169		47.2	11	42.8		542	0.23	247	0
SW-9	Pine Creek above Elton Tunnel	7/1/88	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	140	<0.1	155		41.2	7.6	89.5		512	0.17	230	0
SW-12	Pine Creek above Slag Pile	12/4/88	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	165	<0.2	197		44.8	0	51		501	0.36	249	0
SW-8	Pine Creek @ Diversion Dam	12/4/88	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	171	<0.2	208		47	0	63		456	0.3	251	0
SW-9	Pine Creek above Elton Tunnel	12/4/88	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	189	<0.2	230		52.9	0	84		603	0.41	296	0
SW-12	Pine Creek above Slag Pile	6/18/89	JBR		<0.0002		<0.01		<0.002		<0.01		0.023	157	<0.2	189		52.5	1	82.8		545	0.25	249	0
SW-8	Pine Creek @ Diversion Dam	6/18/89	JBR		<0.0002		<0.01		<0.002		<0.01		0.03	103	<0.2	116		41.2	4.6	30		418	0.26	186	0
SW-9	Pine Creek above Elton Tunnel	6/18/89	JBR		<0.0002		<0.01		<0.002		<0.01		0.023	142	<0.2	171		40.8	1.2	29.8		485	0.26	211	0
SW-12	Pine Creek above Slag Pile	12/14/89	JBR		<0.0002		<0.01		<0.002		<0.01		<0.01	162	0.3	198		72.1	0	72		575	0.28	463	0
SW-8	Pine Creek @ Diversion Dam	12/14/89	JBR		<0.0002		<0.01		<0.002		<0.01		0.02	167	0.82	204		88.4	0	96		580	0.32	389	0
AC-SW-2	Pine Canyon Tunnel Portal	9/15/95	UDEQ	<0.0002		<0.0102		<0.002		<0.0083		0.0241					80.6								
AC-SW-3	Kennecott Trout Pond Head	9/15/95	UDEQ	<0.0002		<0.0102		0.0038 J		<0.0083		<0.0098					57								
AC-SW-4	Pine Creek at Kennecott Prop. Line	9/15/95	UDEQ	<0.0002		0.0131		0.0043 J		<0.0083		<0.0102					55.4								
AC-SW-5	Pine Creek Below Slag Pile	9/18/95	UDEQ	<0.0002		0.0169		0.0034 J		<0.0083		<0.0072					55.2								
AC-SW-6	North Smelter Wetlands	9/20/95	UDEQ	<0.0002		<0.0102		0.003 J		<0.0083		0.0039					57.3								
AC-SW-7	Pine Creek North of Confluence	9/21/95	UDEQ	<0.0002		0.0139		0.0091 J		<0.0083		0.502					72.5								
AC-SW-1	Swenson Mouth Canyon	11/30/95	UDEQ	<0.0002		<0.0075		<0.0046		<0.0056		<0.0082					73.9								
Drinking Water Maximum Contaminant Levels (ppm)				0.002				0.05																	
Ambient Water Maximum Contaminant Levels (ppm) - 4 Day Average				0.000012		0.16		0.005				0.11													
Ambient Water Maximum Contaminant Levels (ppm) - 1 Hour Average				0.0024		1.4		0.02		0.0041		0.12													

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Table 1-3
Previous Surface Water Sampling Analytical Results
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

NOTE:
J: Positive result, estimated value

Sample #	Location	Date	Sampled by	Nitrate	Nitrite	Phosphate	Potassium		Silica	Sodium		Sulfate	TDS	Turbidity (NTU)	pH (pH Units)	Cations	Anions	Cyanide	Sulfide	TOC	Oil/Grease
Sample Fraction							Total	Dissolved		Total	Dissolved										
96	Intermittent Stream Above Slag Pile	5/30/84	DERR	0.56	<0.01		1		12	15		61	332	70	8.3	5.32	5.55				
97	Stream above Hoist Facility	5/30/84	DERR	0.26	<0.01		4		11	5		15	234	550	7.8	2.06	2.08				
99	Tailings material from tailings pond	5/30/84	DERR	0.01	<0.01		10		3	31		457	736	205	7.6	12	11.6				
101	Tailings material from tailings pond	5/30/84	DERR	0.54	<0.01		4		30	12		2900	4546	210	6.1	80	61				
SW-1	Pine Creek Up	6/21/85	E&E INC.							14					8.67						
SW-2	Pine Creek Mid	6/21/85	E&E INC.							24					8.67						
SW-3	Pine Creek Down	6/21/85	E&E INC.							24.2					8.63						
SW-01	Big Spring - Above Site	8/22/85	JBR	1.64	0.004	0.018	1.68		9.97	20.8		108	387		7.85			<0.002	0.33	26	<0.4
SW-02	Adamson Tunnel - Above Site	8/22/85	JBR	1.65	0.008	<0.01	1.73		11.46	20.6		113	370		8.19			<0.002	<0.05	38	<0.4
SW-03	Above Pipeline Leakage	8/22/85	JBR	0.77	0.005	<0.01	2.22		8.79	17.6		93	327		8.26			<0.002	<0.05	43	<0.4
SW-04	Pipe Outlet at Tank Overflow	8/22/85	JBR	1.16	0.005	0.015	1.83		9.77	22.1		116	438		8.01			<0.002	0.38	56	<0.4
SW-05	Upstream from East Culvert	8/22/85	JBR	1.18	0.006	0.011	3.38		9.66	22.7		114	382		8.3			<0.002	0.61	40	<0.4
SW-06	50' Above Falls at Slag Pile	8/22/85	JBR	0.94	0.007	0.016	2.56		9.43	22.2		108	382		8.41			<0.002	<0.05	26	<0.4
SW-07	Seep at Slag Pile Base	8/22/85	JBR	0.31	0.008	<0.01	6.76		5.13	32.8		380	1365		7.82			<0.002	<0.05	41	<0.4
SW-08	Old Diversion Dike Below Slag	8/22/85	JBR	0.75	0.004	0.012	1.83		7.18	22.9		120	367		8.48			<0.002	<0.05	22	<0.4
SW-09	Bridge Above Elton Tunnel	8/22/85	JBR	0.74	0.009	<0.01	1.56		7.33	21.5		105	348		8.53			<0.002	<0.05	31	<0.4
SW-10	Below Elton Tunnel	8/22/85	JBR	0.72	0.011	<0.01	2.08		7.08	22.9		118	340		8.61			<0.002	<0.05	27	<0.4
SW-11	Pine Canyon Tunnel Outlet	9/25/85	JBR	0.88	0.005	<0.01	1.15		3.76	28		230	384		7.6			0.002	<0.05	19	<0.4
SW-12	Pine Creek above Slag Pile	10/18/85	JBR				1.47		4.97	36.3		82.5	368		8.07					12	<0.5
SW-13	Pine Canyon Dump Stream	10/18/85	JBR				34		5.28	83.5		346	818		7.82					44	<0.5
SW-14	Below Confluence w/SW-13	10/18/85	JBR				5.56		5.51	41.8		123	416		8.06					18	<0.5
SW-12	Pine Creek above Slag Pile	9/18/86	JBR	1.88	0.011	0.05		2.7			8.16	64	344		8.41			0.008	<0.1	21.2	1.26
SW-8	Pine Creek @ Diversion Dam	9/18/86	JBR	1.67	0.025	0.05		3.4	0		8.22	61	343		8.45			<0.002	<0.1	18.8	<0.5
SW-9	Pine Creek above Elton Tunnel	9/18/86	JBR	2.05	0.037	0.02		6.5			8.18	90	353		8.25			0.004	<0.1	27.8	2.62
SW-12	Pine Creek above Slag Pile	1/29/87	JBR	1.31	0.046	0.023		1	8.2		17.7	56.5	359		8.5						
SW-7	Slag Pile Spring	1/29/87	JBR	1.07	<0.005	0.024	17.5		7.1	30.1		169	510		8.32						
SW-8	Pine Creek @ Diversion Dam	1/29/87	JBR	1.39	0.029	0.033		1.6	9.4		20.2	57.8	343		8.27						
SW-12	Pine Creek above Slag Pile	5/14/87	JBR	1.78	0.026	0.03	2	2	9.66	25.2	25.2	55	396	20	8.92	7.48	7.22				
SW-7	Slag Pile Spring	5/14/87	JBR	1.03	<0.005	0.03	26.2	26	7.7	65.8	65.8	413	800	0.46	7.74	12.63	13.6				
SW-8	Pine Creek @ Diversion Dam	5/14/87	JBR	1.92	0.012	0.015	1.3	1.3	10.4	25.5	25.4	55	287	28	7.99	7.21	6.58				
SW-9	Pine Creek above Elton Tunnel	5/14/87	JBR	1.9	0.026	0.017	1.3	1.3	10.5	25.2	25.1	55	392	45	8.32	7.21	7.04				
SW-12	Pine Creek above Slag Pile	8/11/87	JBR	0.99	<0.005		1.4		8.15	21.1		75	400	2.1	8.47	3.24	6.06				
SW-7	Slag Pile Spring	8/11/87	JBR	1.02	<0.005		25.8		6.61	48.2		352	763	3.4	7.88	8.18	11.25				
SW-8	Pine Creek @ Diversion Dam	8/11/87	JBR	0.86	<0.005		1		7.05	20.5		81	380	1.4	8.55	3.17	6.08				
SW-9	Pine Creek above Elton Tunnel	8/11/87	JBR	0.89	<0.005		0.8		7.11	20.6		61	400	1.3	8.5	3.14	5.72				
SW-12	Pine Creek above Slag Pile	10/23/87	JBR	0.46	<0.005	<0.01		1.7	8		16.5	104	325	0.87	8.33	6.83	6.52				
SW-9	Pine Creek above Elton Tunnel	10/23/87	JBR	0.77	<0.005	<0.01		1.3	7.1		16.7	53	351	0.72	8.37	6.72	6.42				
SW-12	Pine Creek above Slag Pile	7/1/88	JBR	1.27	0.007	<0.01		26.8	7.7		24.8	78	433	0.8	8.58	7.09	7.26				
SW-8	Pine Creek @ Diversion Dam	7/1/88	JBR	2.78	0.008	<0.01		1.4	7.3		19.2	82	355	5.6	8.59	5.99	6.11				
SW-9	Pine Creek above Elton Tunnel	7/1/88	JBR	0.96	0.009	<0.01		1.2	6.3		19.2	84	342	0.7	8.6	5.63	5.68				
SW-12	Pine Creek above Slag Pile	12/4/88	JBR	0.66	<0.005	<0.01		6.9	18.9		22.6	61	303	0.54	8.27	5.93	5.96				
SW-8	Pine Creek @ Diversion Dam	12/4/88	JBR	0.64	<0.005	<0.01		3.2	6		18	57	314	0.14	8.07	6.3	6.4				
SW-9	Pine Creek above Elton Tunnel	12/4/88	JBR	0.36	0.0083	<0.01		5.9	5.6		30.2	64	393	0.62	7.74	7.4	7.49				
SW-12	Pine Creek above Slag Pile	6/18/89	JBR	1.9	<0.005	0.015		2.6	17.3		17.6	125	402	0.42	8.32						
SW-8	Pine Creek @ Diversion Dam	6/18/89	JBR	0.998	0.006	0.012		4.2	7.2		18.9	58	244	0.78	8.66						
SW-9	Pine Creek above Elton Tunnel	6/18/89	JBR	0.452	<0.005	0.016		3.5	10.3		18.5	48	308	0.98	8						
SW-12	Pine Creek above Slag Pile	12/14/89	JBR	1.05	<0.005	<0.01		1.3	22.1		22.4	112	158	6.8	8.24						
SW-8	Pine Creek @ Diversion Dam	12/14/89	JBR	1.02	<0.005	<0.01		1.7	24		18.2	116	195	2.8	8.01						
AC-SW-2	Pine Canyon Tunnel Portal	9/15/95	UDEQ				<1.37			11.4											
AC-SW-3	Kennecott Trout Pond Head	9/15/95	UDEQ				1.66			21.4											
AC-SW-4	Pine Creek at Kennecott Prop. Line	9/15/95	UDEQ				1.95			22.3											
AC-SW-5	Pine Creek Below Slag Pile	9/18/95	UDEQ				1.65			21.3											
AC-SW-6	North Smelter Wetlands	9/20/95	UDEQ				<1.54			22.6											
AC-SW-7	Pine Creek North of Confluence	9/21/95	UDEQ				3.53			22.3											
AC-SW-1	Swenson Mouth Canyon	11/30/95	UDEQ				2.34			37											
Drinking Water Maximum Contaminant Levels (ppm)				10								1000	2000					0.2			
Ambient Water Maximum Contaminant Levels (ppm) - 4 Day Average																		0.022			
Ambient Water Maximum Contaminant Levels (ppm) - 1 Hour Average				10								1000	2000					1			

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1.3.4.1 Summary of Previous Groundwater Investigations

Thomas (1946) described the groundwater in Tooele Valley, discussed the geology of the valley and adjacent mountains, and studied some aspects of the hydrology of the valley in detail.

Gates (1965) prepared a discussion of the groundwater budget, groundwater usage and future potential for the groundwater of the Tooele Valley.

Wahler (1975) presented findings from aquifer testing performed on the Boys Ranch well and information about the aquifer and groundwater regime at the Site. The transmissivity of the aquifer was calculated at 844,000 gallons/day/foot. The average thickness of the aquifer was reported to be 500 feet. The unsaturated zone overlying the aquifer within the tailing pond area averages 600 feet in thickness. Wahler (1978) presented findings of a study performed in preparation for tailing pond management at the Carr Fork Project. Tailings and soils were also tested for geotechnical characteristics.

Ryan et al. (1981) advanced a test boring (Test hole 8) about two miles northeast of Tooele and about two miles west of Pine Canyon. The test hole was cased to 134 feet and was drilled and logged to a depth of 1,511 feet. Based on the neutron log, the sediments did not appear to be saturated until 416 feet below the land surface. The resistivity log indicated water bearing sand and gravel from 416 to 856 feet with only occasional clay zones present. An exceptionally thick gravel zone occurred from 604 to 760 feet. Fresh water was present from 426 to 950 feet, below which depth water quality naturally deteriorated.

The USGS prepared a publication in 1981 (Razem and Steiger, Technical Publication No. 69) which presented the groundwater conditions and discussed the water budget in the Tooele Valley from 1976 through 1978.

Hebdon (1984) working for the Utah Division of Environmental Health, Bureau of Solid and Hazardous Waste (BSHW, now the DERR) presented the findings of the SI performed at the Tooele Smelter and

Anaconda - Carr Fork Operation to the EPA. During the Site investigation on June 30, 1984, BSHW personnel collected two groundwater samples, including a sample of the spring emanating from under the slag pile, and one from the tap water at Boys ranch (source was reported to be spring water). It was reported that the samples were collected under the supervision of the BSHW quality assurance officer; however, details of the sample collection were not included in the SI report. The1997 DERR Report stated (Sadik-McDonald, 1997) that the quality assurance data for the 1984 BSHW inspection and analytical results was "absent or very poor." Samples were submitted to the Utah State Health Laboratory for analysis. Water samples were analyzed for total metals, major cations/anions, and nutrients.

EPA's FIT subcontractor Ecology and Environment, began working at the Site in 1985. They collected a groundwater sample from a Pine Canyon well upgradient of the Site. The groundwater sample was analyzed for total and dissolved metals as well as sulfate and cyanide concentrations. The FIT report stated that water results were given a QA review at the EPA Region VIII laboratory prior to being reported. Constituents tested in the groundwater were reported below the primary and secondary drinking water protection standards.

Atlantic Richfield conducted a groundwater study as part of the 1985 Investigation for reclaiming and stabilizing the Site (JBR, 1986). Between August and December, three sets of samples were collected from the four deeper groundwater wells located north and west of the Site and a spring at the base of the slag pile. The wells sampled included the 16-inch Boys Ranch Well, Sager Well, 6-inch Boys Ranch Well, and Tailing Dam Well.

The DERR completed an expanded SI for the EPA in 1996 (Sadik-Macdonald,1997). The study included sampling four wells: a USGS Well in Lincoln (GW-USGS), Sagers Well (GW-2), well near the Kennecott Property Line (GW-6), and Boys Ranch 6" Well (GW-1). A filtered sample and an unfiltered sample were collected from each of the wells.

The USGS published another report in 1997 (Steiger and Lowe, Water Resources Investigations Report 97-4005) which presented the results of a study of recharge and discharge areas and quality of groundwater in Tooele Valley. The historical analytical results for several wells located near the Site and in and around Erda were presented.

A water rights search was conducted during the RI which included a radius of 8 miles downgradient from the Site. The results of this research are shown and discussed in Section 2.15 (Groundwater Characteristics) of this report.

1.3.4.2 Summary of Previous Soil Sampling

The BSHW performed soil sampling as part of a SI in 1984 (Hebdon, 1984) wherein five waste samples and two soil samples were collected.

The EPA FIT (Tuesday, 1985) collected 10 samples of tailings and subsurface soils.

During the 1985 Investigation by Atlantic Richfield (JBR, 1986) 96 waste samples and 93 soil samples were collected. The results reported soil concentrations of metals along five transects radiating from the center of the former smelter. Samples were obtained every 1,000 feet along these transects for distances totaling between 5,000 and 7,000 feet from the former smelter location. The surficial soil sample obtained in the center of the former smelter location (R1-06), had a reported total lead concentration of 55,500 mg/kg and an arsenic concentration of 1,375 mg/kg. However, these concentrations dropped by more than an order of magnitude within 6 inches of the surface. The concentrations in the surficial soils also dropped significantly with distance from the center point. At distances of 3,000 feet from the center point, and still within the Atlantic Richfield property, the concentration of lead in the surficial soils ranged from 235 mg/kg to 2,070 mg/kg and arsenic ranged from 45 mg/kg to 395 mg/kg (R4-06, TN-4, TS-4, TW-4, TE-4). At the approximate west property line, the surficial soil sample results (TW-8) indicated a lead concentration of 30 mg/kg and arsenic at 7 mg/kg.

In 1997, the DERR performed an Expanded SI (Sadik-McDonald, 1997) that included collection of 13 waste samples and 19 soil samples. Tailing samples ranged in total lead concentration from 36.8 mg/kg to 61,300 mg/kg and arsenic concentrations ranged from 77.2 mg/kg to 5,420 mg/kg (AC-B3-08 and AC-SC-13, respectively). Surficial soil samples obtained on Atlantic Richfield's property ranged in total lead concentration from 41.3 mg/kg to 1,310 mg/kg and arsenic ranged from 6.5 mg/kg to 368 mg/kg (AC-SC-08, -09, and -11). Off-site surficial soil samples obtained from 10 residences in Lincoln ranged in total lead concentration from 103 mg/kg to 1,040 mg/kg and arsenic concentrations ranged from 22.4 mg/kg to 79.5 mg/kg (AC-SO-04 to -10). All the lead concentrations in the Lincoln soil samples collected were below 675 mg/kg except for one sample which had the high of 1,040 mg/kg concentration (AC-SO-07).

1.3.4.3 Summary of Previous Surface Water Investigations

Pine Creek water quality has been analyzed as part of some of the previous studies described while the Carr Fork mine was in operation. In addition, water quality was monitored on a regular basis.

Atlantic Richfield collected surface water samples from Pine Creek and from contributing sources during the 1985 Investigation. A total of 14 locations in the Pine Canyon drainage were sampled, some in August and some in October. All parameters were compared to and found to be within drinking water standards, with the exception of cadmium at a spring at the base of the slag pile (SW-7), lead at both the Pine Canyon Tunnel discharge (SW-11) and a small stream below the Pine Canyon Landfill (SW-13). All parameters were reported to be within drinking water standards at the downstream property line.

In September, 1986, Atlantic Richfield collected three samples from Pine Creek at sample locations SW-12, -9, and -8 which are located in the stream progressively down-gradient of the slag pile. The data from these samples show dissolved metals, except lead, were within drinking water standards (JBR, 1990).

Subsequent to the 1986 reclamation activities, Atlantic Richfield continued to sample four locations on Pine Creek, SW-7, 8, 9, and 12. Samples at these sites were taken quarterly in 1987, and twice yearly in both 1988 and 1989. Further, a spring that contributed flow to the creek after contacting slag material was also sampled the first three quarters of 1987 (SW-7), after which time it dried up and has remained dry.

Atlantic Richfield analyzed the samples for both total and dissolved metals. The results of these analyses indicate one dissolved sample exceeded MCL for lead in sample SW-12 in January1987; however, the concentrations were below drinking water standards after 1987 (post-reclamation).

The DERR took water samples from six locations in Pine Creek during September, 1995 and another sample (AC-SW-01) in November, 1995 from Swenson Canyon, a tributary to Pine Creek (Sadik-McDonald, 1997).

1.3.5 Previous Reclamation Remedial Actions

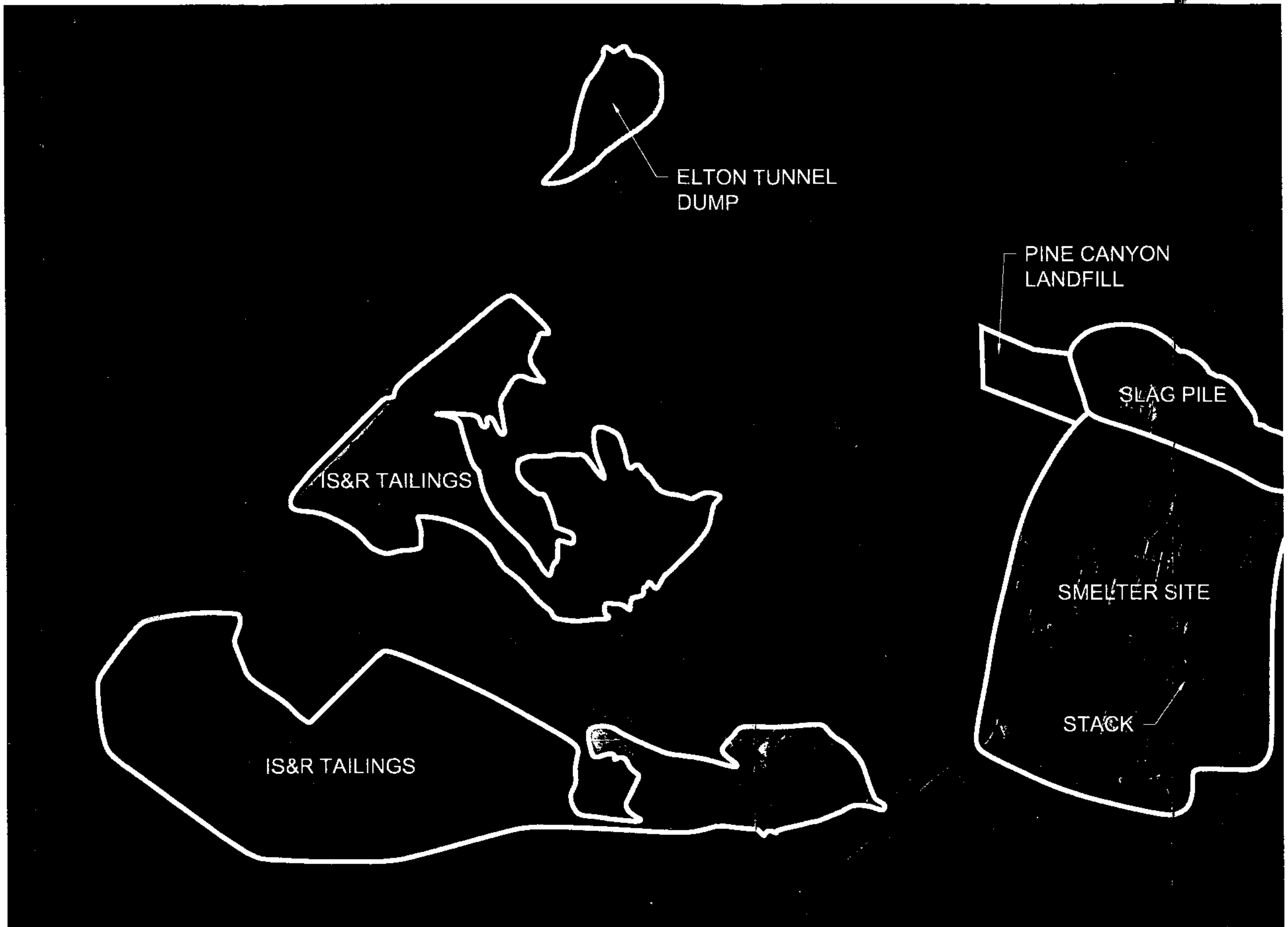
After the above described site investigations by Atlantic Richfield and various agencies, and upon approval to proceed from DOGM, Atlantic Richfield in 1986-1987 performed an extensive voluntary reclamation at the property to control potential risks to health and the environment. The reclamation work included the removal of remaining buildings and structures, consolidation of waste materials, construction of storm water controls and placement of a clean soil cover over the majority of the Site. Figure 1-12 (1952 Surficial Features) shows the Site in 1952 prior to any reclamation work. Figure 1-13 (1987 Surficial Features) subsequently shows the 1987 surficial features immediately following the reclamation efforts and Figure 1-14 (1997 Surficial Features) shows the Site 10 years later, following reclamation. These reclamation actions specifically involved the following tasks:

1.3.5.1 Demolition

In 1972, Anaconda started the process of demolition of the major parts of the IS&R facility. This demolition process removed all the major parts of the facility including the extensive railroad system. Buildings left included the main office, a residential home, a large warehouse, an assay lab (all adjacent to the entry road), two smaller warehouse buildings (one on the south side of Dry Creek and one east of the office building). Remnants of some of the building foundations and other concrete retaining walls were left and formed several terraces on the Site.

In 1986 the remaining buildings were demolished prior to reclamation of the smelter property. Specific 1986 demolition activities included the following:

- Removal of asbestos containing material from buildings on-site asbestos containing materials were abated by a professional abatement contractor and disposed of off site at a certified landfill.
- Removal of remaining non-smelter by-product materials such as oils, fertilizer and other similar types of products in small non-reportable quantities. (See ICI Report, Appendix B)



General Notes

N

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

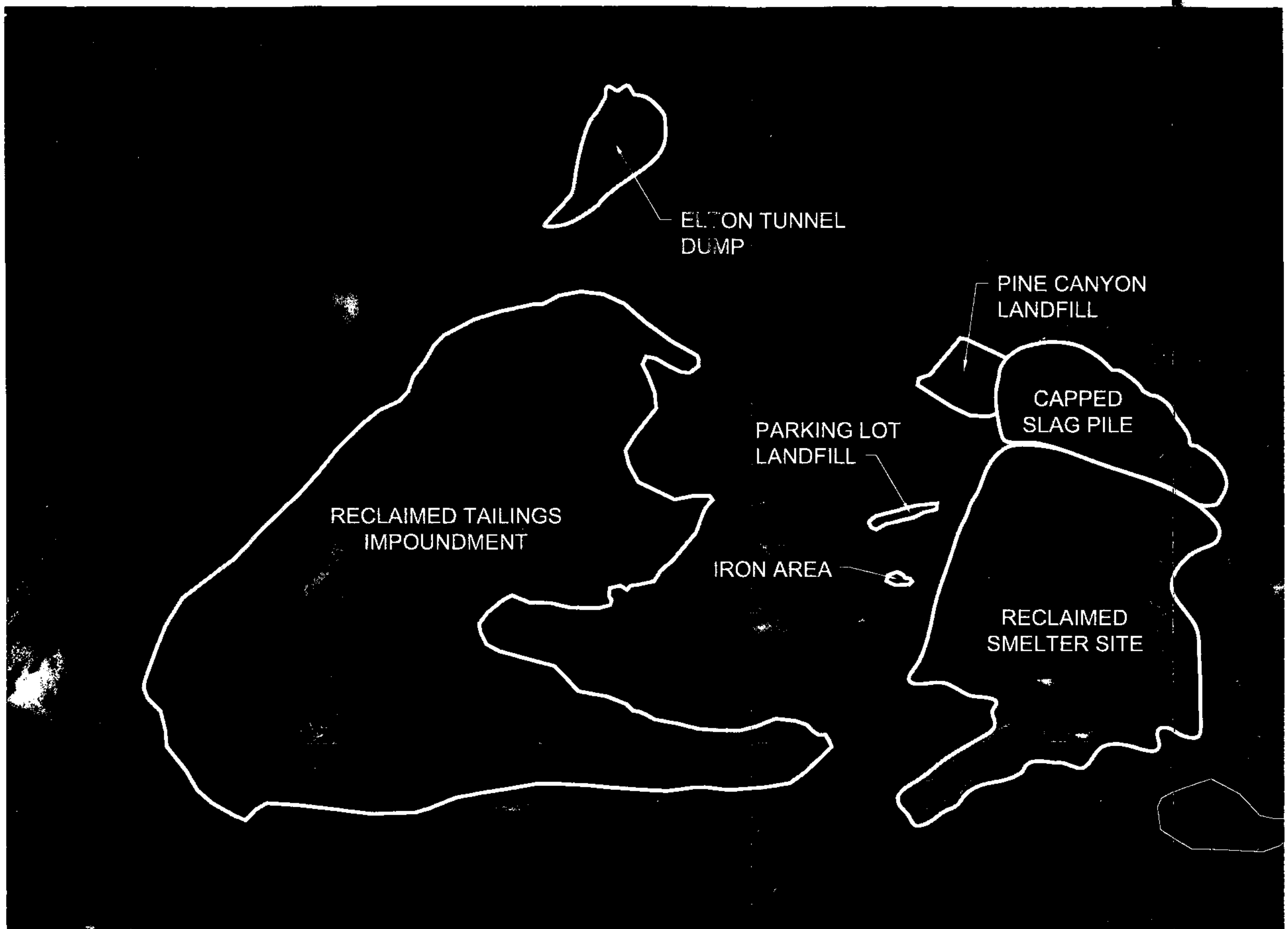
ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SA

1952 SURFICIAL FEATURES
REMEDIAL INVESTIGATION
TOOELE COUNTY, UTAH

Project 97-069
Date APR-03
Scale NO SCALE

FIGURE
1-12



General Notes

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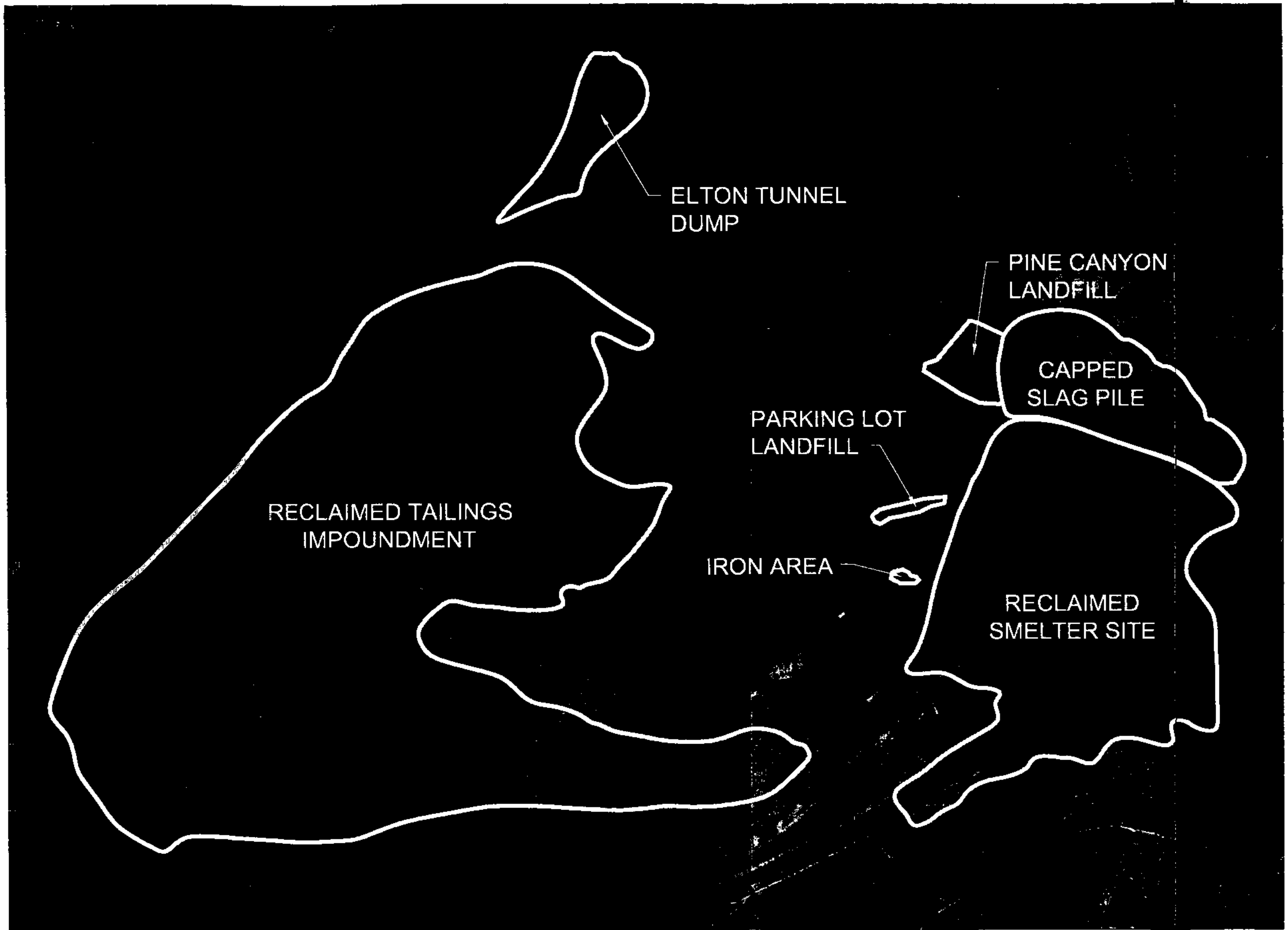
ENGINEER: KC
APPROVED: SA

1987 SURFICIAL FEATURES
REMEDIAL INVESTIGATION
TOODELE COUNTY, UTAH

Project 97-069
Date 03-MARCH-03
Scale NO SCALE

FIGURE
1-13



General Notes

N

No.	Revision/Issue	Date

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ENGINEER:
APPROVED:

1997 SURFICIAL FEATURES
REMEDIAL INVESTIGATION
TOOELE COUNTY, UTAH

Project 97-069
Date 03-MARCH-03
Scale NO SCALE

FIGURE
1-14

- Disposal of remaining surplus equipment, furniture and other debris stockpiled on site and in buildings. There were few major items remaining in the buildings still standing in 1986 except for the warehouse which contained mechanical equipment. Most buildings had previously been cleared of furniture, equipment, etc. Remaining debris was placed in the on-site Carr Fork landfill on the east end of the smelter site.

- Demolition of administration building, assay lab and office, residential home, warehouse and other miscellaneous out buildings. Building debris was placed and compacted into the Carr Fork landfill on the east end of the smelter site.

1.3.5.2 Waste Consolidation

Landfills

During operations there were two on-site landfill areas used for disposal of debris: Pine Canyon Landfill and Parking Lot Landfill. Both landfills are shown on Figure 1-2, Work Area Map. These landfills were used during operations and the 1970s demolition activity but were not closed until the 1986 reclamation efforts.

The Pine Canyon Landfill is located adjacent and west of the slag pile. This landfill covered approximately 2.5 acres. The landfill is located on the steep south slope of Pine Canyon. Debris and wastes ranged in depth from 2'-23'. In 1986, the spatial extent of the landfill was consolidated by dozing waste material up the slope and out of the Pine Canyon drainage. This entire landfill was then covered with clean soil, graded to form a 3:1 slope and revegetated.

The Parking Lot Landfill was a much smaller disposal area than the Pine Canyon Landfill. Encompassing approximately one acre within an ephemeral drainage draw, the landfill contained machinery parts and wire. In 1986 debris was compacted with dozers and then a clean soil cap placed over the surface.

During the mid 1980s the Anaconda Carr Fork facility at the head of Pine Canyon was dismantled. Being a new facility, most of its equipment and metal structures were salvaged and shipped to other mine facilities for future use. Two new disposal areas known as the Carr Fork landfills were developed northeast of the smelter site to receive the remaining debris from the Carr Fork facility. The location for these landfills is shown on Figure 1-2, Work Area Map.

The steel from the 1986 building demolition was salvaged and shipped off site. The remaining debris created during operations and demolition was also placed in the Carr Fork landfill.

Waste Isolation Cell

The 1985 Investigation report identified certain scattered process residues remaining on site which should be consolidated into a newly created waste isolation cell (WIC). Waste materials designated to be moved into the WIC were selected primarily because of their acid generating nature. The volume of waste originally slated in the 1986 Reclamation / Stabilization Plan was 215 cubic yards (JBR, 1986). Following placement and compaction of waste, a 5-ft compacted clean borrow soil cap over the WIC was constructed. The surface was graded to expel water, preventing water infiltration. The location selected for the WIC is in the former Carr Fork tailings. (See Figure 1-2, Work Area Map, WA11)

Because the impoundment surface is the flattest terrain on the property, the WIC location has a minimal potential for mobilization of wastes resulting from surface water erosion. In addition, the mineralogy of the tailing material includes a significant percentage of carbonate, providing a sufficient neutralization potential for any acid leachate produced by the low pH smelter wastes. A summary of the analytical results for the waste material placed in the Waste Isolation Cell is shown on Table 1-4, Analytical Results for Waste Isolation Cell Relocation Material.

The waste piles were removed using a loader; therefore, to be conservative, some underlying and surrounding material was also removed and placed in the WIC. The constructed volume capacity of the WIC was approximately 1050 cubic yards. From these numbers, it is estimated that 80% of material is not acid generating and would not fail the EP-toxicity standard.

Four inches of bentonite clay was blown onto the bottom and side slope surfaces during construction. The clay liner was designed to help prevent migration of COC into underlying soils.

1.3.5.3 Tailing Impoundment

The original tailing impoundment for IS&R operations was constructed prior to the opening of the smelter in July of 1910. Eventually four separate impoundments, covering 278 acres, were constructed to contain tailing materials discharged from the IS&R plant operations. When Anaconda constructed the Carr Fork operations in Pine Canyon, a new large impoundment was constructed as part of that facility. The new Carr Fork impoundment essentially covers the former IS&R ponds. The only remaining evidence of the IS&R impoundment are the dams which are located just west of the Carr Fork dam. The Carr Fork tailing dam is approximately 5,900 feet long, 300 feet wide, and 65 feet high from the toe to crest. The impoundment had a design capacity of 4,705 acre feet. This design was the first stage of what was to be a 200 feet high impoundment.

Table 1-4
Analytical Results for Waste Isolation Cell Relocation Material
ISR Remedial Investigation
(Results given in ppm, unless specified otherwise)

Sample #	Location	Date	Sampled by	Certified Analysis	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver	Zinc	pH	pH (EP Tox.)	pH (Sat. Paste)	Conductivity (umhos/cm)
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	EP Toxicity Analysis	0.181	0.01	<0.1	<0.01		<0.5	<0.0001	0.53	<0.5					
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	pH Testing												6.29	7.46	
RB-ZFA-01	Zinc Furnace Area	8/26/85	JBR	Total Acid Analysis	64700		460		398000	73500	1010	1600	1198	22500				
RB-IST-01	IS&R Tailings	8/28/85	JBR	EP Toxicity Analysis	8.4	0.03	0.23	0.031		1.03	0.0002	<0.5	<0.5					
RB-IST-01	IS&R Tailings	8/28/85	JBR	pH Testing												1.99	1.24	58525
RB-IST-01	IS&R Tailings	8/28/85	JBR	Total Acid Analysis	10430		16		220	13050	370	5	93.7	1925				
RB-OC-01	Ore Concentrates	8/30/85	JBR	EP Toxicity Analysis	<0.1	0.09	1.26	<0.01		2.88	<0.0001	<0.5	<0.5					
RB-OC-01	Ore Concentrates	8/30/85	JBR	pH Testing												5.58	5.78	
RB-OC-01	Ore Concentrates	8/30/85	JBR	Total Acid Analysis	2200		145		595	37600	280	15	83.2	14950				
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	EP Toxicity Analysis	<0.1	0.01	1.93	0.012		1.29	0.0001	<0.5	<0.5					
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	pH Testing												2.23	2.44	
RB-SC-02	Sulfide Concentrator	8/30/85	JBR	Total Acid Analysis	4200		445		1920	17750	280	2	267.5	69400				
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	EP Toxicity Analysis	<0.1	<0.01	4.99	<0.01		44.02	0.0019	<0.5	<0.5					
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	Saturated Paste Analysis	<0.5		38.5		10.5	4.25	0.0014	<0.5	<0.01	182	3.85			
ELB-02	Eastern Lead Blast Area	11/6/85	JBR	Total Acid Analysis	3650		2130		18500	106000	1740	1450	236	68500				

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Other facilities used for holding plant discharges included the Dry Canyon evaporation ponds and Pine Canyon settling ponds. The evaporation ponds received residual waste from the concentrator plant where some settling of solids occurred prior to decanting to the tailing impoundments. The settling ponds in Pine Canyon were used during the Carr Fork operation for a similar purpose. Mine discharge was channeled through the ponds to allow sediment to settle and provide sufficient holding time for lime treatment to neutralize water before releasing to downgradient fields for infiltration. Also in the vicinity of the lower tailing impoundment is the Elton Tunnel dump. The depository contains waste rock excavated during construction of the Elton Tunnel. Reclamation activities completed in 1986 on the tailing impoundment and vicinity included the following:

- Distribute lime over the IS&R tailing surface to provide a neutralization buffer between the tailings and cover.
- Place a 12-inch deep soil cover, using clean borrow material, over the surface of the tailing impoundment and along the plateau east of the impoundment wherever tailings were visible.
- Cut/fill old IS&R tailing dike slopes to 3H:1V and then place a 6 to 12-inch cover of clean soil over dike surface.
- Construct erosion terraces as needed to prevent damage to newly placed cover and re-graded surfaces.
- Grade steep slopes on the Carr Fork effluent pipeline road to 3H:1V.
- Construct terraces along pipeline route as required to control storm runoff and protect newly graded surfaces.
- Construct an engineered breach in the impoundment dike to allow water from Dry Creek to bypass the impoundment preventing storage of water behind the impoundment.
- Seed and fertilize all disturbed areas with native grasses and forbs. Typical to all site seeding operations was placement of 2000 lb/acre of green alfalfa mulch and application of 573 lbs/acre of diammonium-phosphate (18-48-0). The following spring (1987) 109 lbs/acre of urea (46-0-0) was applied to seeded areas. In addition to seeding, 18,345 units of container stock (shrubs) were planted during the spring of 1987 at various locations on the smelter site.
- Construct bulkhead in portal of Elton Tunnel and backfill at 3H:1V against adit. (In 1999, 50 feet of Elton Tunnel was demolished and backfilled.)

- Grade side slopes of the former Elton Tunnel waste rock pile to 3H:1V and place a 12-inch depth of clean topsoil over the entire surface. Construct runoff control terraces as required to protect cover and remediated areas from damage.
- Grade embankment of Pine Canyon settling pond and Dry Creek evaporation pond side slopes to 3H:1V.
- Place a 12-inch depth of clean topsoil over entire Pine Canyon settling and Dry Creek evaporation ponds.

1.3.5.4 Slag Pile

During plant operation, slag was discarded on the south slope of Pine Canyon in an area encompassing approximately 27.5 acres. The slag piles were formed by molten material carried in railroad cars and discharged onto the pile. The outside slopes of the main slag pile are approximately 50 to 190 feet in height. A portion of the east interior part of the main slag pile was mined as part of the zinc recovery process located on the west portion of the slag pile.

Reclamation activities completed in 1986 on the slag pile included the following activities:

- Fill voids in foundations with clean fill.
- Construct runoff terraces at crest of slopes and all roads to protect newly constructed areas.
- Construct a 60-inch tall safety berm from slag material along the edge of the slag pile to deter activity near edge of slag pile.
- Place an 18-inch depth of clean cover soil over the accessible surface areas of the slag pile to promote evapo-transpiration of rainfall and provide a vegetation growth layer.

1.3.5.5 Smelter Site

As described in paragraph 1.3.5.1 all remaining buildings were demolished in 1986. Other reclamation construction on the former smelter site included the following activities:

- Fill remaining basements, tunnels and exposed underground shafts with clean borrow material.
- Construct 3H:1V slope fills, using clean borrow soil, against remaining process buildings, concrete retaining walls and foundations.

- Consolidate waste materials and close landfill. Following placement of debris, the surface of the landfill was covered with 12 inches of clean soil and revegetated.
- Grade smelter yard areas to a uniform contoured slope, eliminating ridges and isolated surface inconsistencies. Place a 12-inch depth of clean soil over most of the smelter site.
- Add additional fill and shape ravines to correlate surface drainage with site drainage plan.

1.3.5.6 Storm Runoff Control

The objective of the Storm Water Control design portion of the 1986 Reclamation Plan was to retain a 10-year, 24-hr storm on site, thus preventing migration of COC by surface water. To accomplish this objective, surfaces were graded to channel runoff into sediment basins strategically placed around the Site. When the sediment basins filled, the design then routed water into the newly re-constructed Dry Creek channel. Ultimately the water would be retained in the lower borrow pit in Work Area No. 9. Only water from storms in excess of the design storm would leave the Atlantic Richfield property. Because the depth to groundwater is nearly 600-ft below the surface, potential infiltration of COC through the vadose zone and into the groundwater aquifer was considered to be an acceptable risk. Storm runoff control activities at the Site consisted of the following:

- Construct 14,250 ft of earthen berms at strategic locations
- Construct storm runoff controls (see Figure 1-15, 1986 Reclamation As-Constructed)
- Reconstruct Dry Creek channel by excavating 5,975 linear feet of channel and installing one concrete control structure. The Dry Creek channel reconstruction included 2,150 ft of rock lined channel and approximately 3,800 ft of geo-fabric lined ditch.
- Excavate a large engineered breach in the Carr Fork Impoundment dike to allow storm drainage to pass through the tailing impoundment dam, rather than collecting and ponding in the tailing impoundment.
- Construct an earthen cutoff channel above the smelter site to direct storm runoff around reclaimed features.

1.3.5.7 Revegetation

Following the reclamation construction, revegetation was performed in the fall of 1986 to assure maximum germination of seeding. Revegetation occurred in areas within WA-2, WA-3, WA-4, WA-6, WA-7, WA-8, and WA-11. Specific range community restoration activities included:

- Prepare newly placed soil by discing and moisture conditioning
- Increase the organic content of soil by adding two tons per acre of chopped alfalfa mulch.
- Adapted grass, forb and shrub species were drill seeded at a planting density of 20 pls/acre.
- Seeded areas were then fertilized with 573 lb/acre of diammonium phosphate (18-48-0).
- The following spring 109 lbs/ac of urea (48-0-0) was spread over planted areas.

1.3.5.8 Post Construction Monitoring and Maintenance

Atlantic Richfield, in cooperation with the UDWR, has continued to conduct maintenance of the reclaimed features at the Site as necessary since completion of the work in 1987. Required repair work has primarily been surficial erosion repair and fence repair. During the Fall of 1999, Atlantic Richfield completed maintenance work which was reported in the Carr Fork-Maintenance Operations Final Report (Anderson, 2000). This construction work included:

- Repaired miscellaneous shallow erosion rills which developed in the protective soil cover placed over the tailing impoundment and smelter area.
- Constructed a spillway at the Elton Tunnel water holding pond.
- Demolished the exposed concrete Elton Tunnel portal and backfilled and graded the area to 3H:1V.
- Filled areas which have settled on the slag to prevent water from accumulating on the surface.
- Constructed diversion berms in smelter area on the edge of Dry Creek Canyon to prevent future erosion damage to Dry Canyon hillsides.

In 2003, additional maintenance work was completed at the Site, which included the following tasks:

- Constructed a diversion berm to prevent erosion of the Carr Fork Landfill cap, and to stop headward erosion of a large gully located on the northwest corner of Work Area 3.

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 2024001

SITE NAME: INTERNATIONAL SMELTING & REFINING

DOCUMENT DATE: 08/01/2004

DOCUMENT NOT SCANNED

Due to one of the following reasons:

- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☑ OVERSIZED
- ☐ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

FIGURE 1-15 1986 RECLAMATION AS-CONSTRUCTED

Contact the Superfund Records Center to view available document.
(303) 312-6473

- Capped two areas containing discolored soil located near the entrance to the Site which is used by visitors, near the sign-in shed. The two areas were covered with 12 inches of clean soil and seeded with a native seed mix.

Information regarding the 2003 maintenance work is contained within a letter from Anderson Engineering Company, Inc. to Joshua Knight (EPA) dated April 26, 2004 (re: Final Report - Work Plan Amendment - Interim O&M Work - IS&R - Tooele, UT).

TABBED PAGE
SECTION 2

2.0 STUDY AREA INVESTIGATION

2.1 Investigation Objectives

Project objectives were established in the Project Work Plan as a result of agency concerns and the Site HRS scoring. These objectives were then used to guide the project activities during the remedial investigation. Objectives included the following:

- Evaluate the conditions of the reclaimed surface and identify areas within the IS&R/Carr Fork Site which require remedial correction.

- Evaluate the human health and environmental risks associated with the smelter site in its current reclaimed condition. A health risk assessment evaluated potential hazards to visitors and workers while participating in uses in accordance with the *Carr Fork Reclamation and Wildlife Management Plan*. The ecological risk assessment evaluated flora, fauna and habitats in harmony with goals outlined in the plan.

- Evaluate smelter impacts to specific, identified areas not previously addressed during the 1986 reclamation and determine the associated health and environmental risks of those areas.

- Locate and evaluate smelter impacts, if any, to the residential yards, cultivated fields and pastures in the Lincoln area and determine potential risks associated with these impacts.

- Investigate existing and historical drainages for evidence of smelter impacts which may have migrated off the Site.

Using the project objectives as a guide, specific objectives were established as outlined below for each of the separate work areas. See Figure 1-2 for locations of referenced Work Areas and refer to Section 1.2.2 for a full description of these Work Areas.

<u>Work Area No.1 - Northern Hills</u>

- Perform site field inspection to determine historical impacts of smelter operation on the area.
- Determine if sediments within drainages or streams in the area have been impacted by smelter operations.

<u>Work Area No. 2 - Slag Pile</u>

- Research historical use of the work area and determine constituent content of slag pile.
- Determine condition and extent of cover soils placed during the 1986 reclamation.

- Determine if other areas which were not previously addressed during the 1986 reclamation, exhibit conditions which create a concern to human health or the environment.
- Determine if COC are being released into Pine Creek from the Slag Pile.

Work Area No. 3 - Smelter Area

- Conduct a historical review of the smelter operations to determine likely waste product constituents.
- Determine geology of underlying soils.
- Locate areas impacted by smelter operations that were not addressed or inadequately addressed during previous reclamation efforts.
- Determine metallic and other COC present on existing surface, within soil materials used for cover, or at the original surface/cover interface.
- Determine potential for identified COC to leach into the local fresh water aquifer.
- Determine potential for off site migration of COC.

Work Area No. 4 - Dry Creek Basin

- Conduct a historical land use review of the Dry Canyon area.
- Perform surface water hydraulic modeling of the Dry Creek drainage basin.
- Determine adequacy of existing storm water flow controls.
- Determine if COC exist within the area and what potential there is for leaching into underground aquifers or for exposure to public or environmental receptors.

Work Area No. 5 - Southern Hills

- Locate areas impacted by smelter operations that were not addressed or inadequately addressed during previous reclamation efforts.

Work Area No. 6 - Lower Smelter Area

- Conduct historical review on use of area.
- Locate areas impacted by smelter operations that were not addressed or inadequately addressed during previous reclamation efforts.
- Determine if sediments in bottom of washes contain COC.
- Determine metallic and other COC present on the existing surface, within soil material used for cover and at the original surface/cover interface.

Work Area No. 7 - Pine Creek Drainage

- Review historical land use of Pine Canyon and canyon outfall riparian zone.
- Determine historical flow patterns of Pine Creek.
- Research water rights associated with Pine Creek surface flows.

- Determine the extent of impacted sediments within stream channel and historical drainages.
- Determine quality of water within the stream and any impacts to water quality as a result of the stream flowing through the former smelter site.
- Perform hydraulic modeling of drainage basin.
- Evaluate smelter impacts to terrestrial and aquatic habitats and flora and fauna species found withing the riparian environment.

Work Area No. 8 - Tailing Impoundment

- Determine planar extent of impounded tailings.
- Calculate an approximate volume of tailings.
- Determine the potential for COC within the tailings to leach into the underground aquifers.
- Determine metallic and other COC present on the existing surface, within soil material used for cover and at the original surface/cover interface.
- Determine if sediment transport from the tailings are having an adverse impact on Dry Creek channel.

Work Area No. 9 - Lower West Area

- Identify and locate current and historical water courses.
- Determine the extent of impacted sediments within stream channel and historical drainages.
- Locate areas impacted by smelter operations that were not addressed or inadequately addressed during previous reclamation efforts.
- Determine metallic and other COC present on the existing surface, within soil material used for cover and at the original surface/cover interface.

Work Area No. 10 - Lincoln Residential Area

- Review records to determine historical land use of the area.
- Determine current and likely future demographics of the community.
- Identify and locate current and historical water courses.
- Determine if sediments within stream channels and historical drainages have been impacted.
- Determine what impacts the smelter may have had on yards and fields.

Work Area No. 11 - Waste Isolation Cell

- Determine through historical research and field studies, the planar extent and volume of wastes placed in the cell in 1986.
- Determine the geologic cross section existing below the cell.
- Determine the potential for cell wastes to leach into underlying soils.
- Identify and determine concentrations of any COC present within the cell.

Work Area No. 12 - Groundwater

- Determine quality of water within area wells.
- Develop a groundwater model to analyze the potential for smelter derived constituents to reach the regional drinking water aquifers.
- Determine water quality up gradient from the Site and the influence the Site has had on water quality.

To aid in the investigative process, a site-specific conceptual model was prepared. A graphical representation of the Site Conceptual Model is shown in Figure 2-1. All known and suspected sources of COC, types of COC and affected media, known and potential routes of migration, and known or potential human and environmental receptors were researched to create the model.

Prior attained sampling data mentioned in section 1.3.4.2, Previous Site Characterization Studies, was used to help establish some of the physical characteristics surrounding the Site. The information assisted in determining the location and types of sampling necessary for the Sampling and Analysis Plan (SAP). A Sample Action Plan (Table 2-1) was created to identify gaps in the current data and whether or not additional information and sampling would be necessary. The Sample Action Plan based on the Site Conceptual Model included identifying the following:

- Primary source of COC
- Primary release mechanisms
- Secondary sources of COC
- Exposure pathways
- Previous reclamation activities
- Current concerns
- Exposure potential
- Data gaps
- New proposed sampling

2.1.1 Potential Site Constituents of Concern

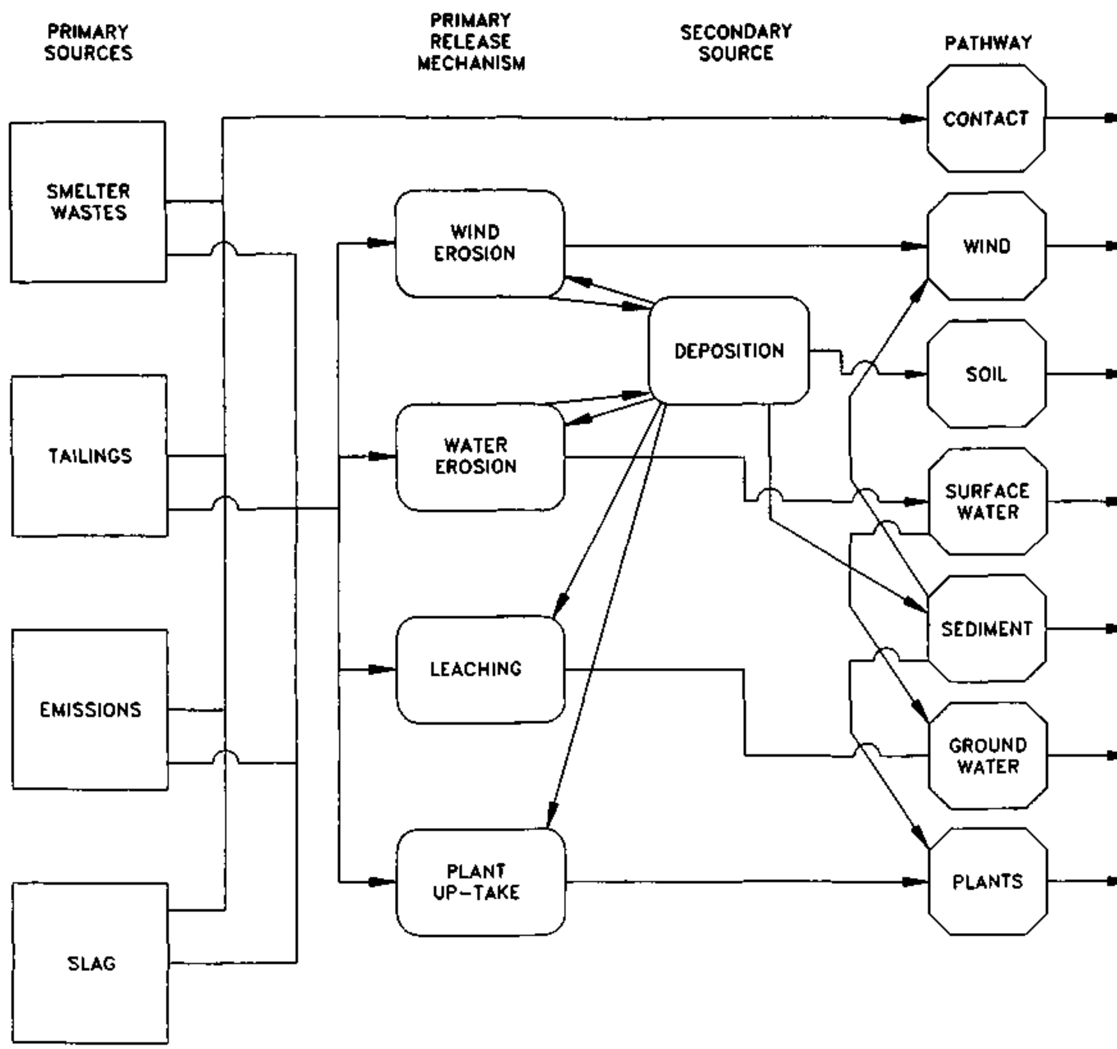
Based on previous studies by Atlantic Richfield, the State of Utah, and EPA, materials at the Site that are known to contain a range of concentrations of arsenic, cadmium, copper, lead, mercury, selenium, silver, sulfate, and zinc. The RI has included estimating the volume and chemical makeup of the potential sources of COC.

2.1.1.1 Primary Contaminant Sources

The primary COC sources at the Site include:

Smelter wastes: Smelter wastes include accumulations of ore, concentrates, smelter intermediate materials, flue dust, debris, and landfill wastes produced from the historic operations on site. The locations and

FIGURE 2-1 SITE CONCEPTUAL MODEL (REVISED APRIL 23, 2002)



		RECEPTOR										
		HUMAN			ECOLOGICAL							
PATHWAY	EXPOSURE ROUTE	AREA RESIDENTS	SITE VISITORS	SITE WORKERS	BENTHIC INVERTEBRATES	MAMMALS	SMALL BIRDS/ WATERFOWL	FISH	RAPTORS	TERRESTRIAL INVERTABRATES	AMPHIBIANS	REPTILES
CONTACT	INGESTION	I	○	○	I	○	○	○	○	○	○	○
	DERMAL	I	○	○	I	○	○	○	○	○	○	○
WIND	INHALATION	○	○	○	I	○	○	○	○	○	○	○
SOIL	INGESTION	●	◐	◐	I	◐	◐	I	◐	●	◐	◐
	DERMAL	●	◐	◐	I	●	○	I	○	●	●	●
SURFACE WATER	INGESTION	○	◐	◐	●	●	●	●	●	◐	●	◐
	DERMAL	○	◐	◐	●	◐	●	●	◐	◐	●	◐
SEDIMENT	INGESTION	○	○	○	◐	◐	◐	◐	◐	●	●	◐
	DERMAL	○	◐	◐	●	◐	◐	●	◐	●	●	●
GROUND WATER	INGESTION	●	I	I	I	I	I	I	I	I	I	I
PLANTS	INGESTION	I	I	I	◐	◐	◐	◐	◐	◐	◐	◐

LEGEND
- I = Incomplete or virtually incomplete
- ○ = Exposure potential relatively low
- ◐ = Exposure potential intermediate (Incidental Ingestion/Contact)
- ● = Exposure potential relatively high (Direct Ingestion/Contact)

General Notes

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: GKL
ENGINEER: KC
APPROVED: SDA

SITE CONCEPTUAL MODEL
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date 25-AUG-2004
Scale NO SCALE

FIGURE 2-1

Table 2-1
Sample Action Plan-Based on the Site Conceptual Model
ISR Remedial Investigation

Primary Source	Primary Release Mechanism	Secondary Source	Exposure Pathway	Previous Sampling Events	Previous Reclamation Activity	Current Concern	Exposure Potential	Data Gaps	Proposed Sampling	SAP Section
Smelter Waste			Original Source	See Table 1-1	Isolated piles of waste material were removed from the smelter site and placed in the Waste Isolation Cell (WIC).	Stability of Waste Isolation Cell	Low	What is the composition and quantity of waste in the Waste Isolation Cell? What is the condition of the Waste Isolation Cell?	**Waste Isolation Cell (WA11)** 1) Field Cap Reconnaissance 2) Geoprobe borings adjacent to Waste Isolation Cell 3) Geoprobe borings within Waste Isolation Cell 4) Directional boring below Waste Isolation Cell	Soil
Smelter Waste			Original Source	See Table A-2	Majority of Smelter Site was capped with 12-inches of topsoil, significantly reducing the risk of contact.	Contact exposure potential for visitors and workers in areas with insufficient cover.	Low	Are there areas where the cap depth is insufficient or missing?	Determine the depth of cover at each soil sample location.	Soil
Smelter Waste	Wind Erosion		Wind		Majority of Smelter Site was capped with 12-inches of topsoil and vegetated, preventing wind scour.	Concern is inhalation by area residents, visitors, workers, mammals and birds. Wind may transport waste materials from areas where cap has eroded or has been removed.	Low	Are there areas where the cap is missing?	Walking canvass of the site to identify exposed areas (site walkovers). Determine the depth of cover at each soil sample location to identify potential exposure and areas of concern.	Soil
Smelter Waste	Wind Erosion	Deposition	Soil	See Table A-2		Concern is that exposed or wind blown soils may cause an ingestion or dermal risk to residents, site visitors, mammals and birds.	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for workers, visitors, invertebrates, mammals, and birds.	Is there soil contamination on residential properties? Are there areas where the cap is missing?	10 pt composite soil sampling on grid for selected Pine Canyon residences. Walkover inspections of the site to identify exposed areas or other areas of concern. Determine depth of cover at each soil sample location in order to identify potential exposure areas of concern. Identify areas of exposed smelter wastes or exposed soil.	Soil
Smelter Waste	Water Erosion	Deposition	Soil/Sediment (general)	See Table A-2	Cap was constructed to allow surface to drain into retention basins and into controlled flow drainage channels.	Are there areas where water erosion has scoured the cap, allowing surface runoff to come in contact with source waste? Are there historical depositions which create a health or environmental risk?	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for workers, visitors, invertebrates, mammals, and birds.	Are there areas where the cap is missing? Are there areas where germination of vegetation has not been successful and if so, why? Are there areas not previously identified?	Walking canvass of site to identify exposed areas and/or under-vegetated areas.	Soil
Smelter Waste	Water Erosion	Deposition	Soil/Sediment (Dry Creek)	See Table A-2	Install drainage structures, i.e. berms and channels to retain a majority of the storm water on site.	Have smelter wastes been transported through erosion of sediments into channels and retention basins?	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for workers, visitors, invertebrates, mammals, and birds.	Is there verification that impacted soils have or have not collected in stream beds or water holding basins constructed during reclamation?	**Smelter Site (WA-3)/ Dry Creek Drainage (WA-4)** 1) Walkover inspection of stream bed to find evidence where reclamation has not addressed waste impacts. 2) Sediment samples behind water holding dikes, from alluvial fans at the base of ravines, and within channels. 3) Transects across stream drainage. 4) Check Depth of cover at points along transects where applicable.	Soil
Smelter Waste	Water Erosion	Deposition	Soil/Sediment	See Table A-2	Move Pine Creek flows away from slag and landfill toe to the extent feasible to prevent erosion through cover into waste.	Determine the impact of slag on Pine creek water quality?	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for workers, visitors, invertebrates, mammals, and birds.	Was reclamation action successful in maintaining Pine Creek water quality?	**Pine Creek Drainage (WA-7)** 1) Sediment Samples from Pine Creek Drainage 2) Transects across stream drainage 3) TCLP test on Slag Pile	Soil

Table 2-1
Sample Action Plan-Based on the Site Conceptual Model
ISR Remedial Investigation

Primary Source	Primary Release Mechanism	Secondary Source	Exposure Pathway	Previous Sampling Events	Previous Reclamation Activity	Current Concern	Exposure Potential	Data Gaps	Proposed Sampling	SAP Section
Smelter Waste	Water Erosion	Deposition	Soil/Sediment	See Table A-2	Areas not previously addressed.	Migration of waste materials off site, creating human and environmental risk?	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for workers, visitors, invertebrates, mammals, and birds.	Have all areas which were not previously addressed identified and delineated?	**Dry Drainages North of Smelter Site (WA-1)** 1) Surficial Soil Samples 2) Sediment Samples from base of gullies **Terrain South of Smelter (WA-5)** 1) Walkover inspection of unit to identify areas of concern **Parking Lot Area (WA-6)** 1) Soil samples in areas not previously capped 2) Sediment samples at base of gullies along NW boundary of WA-6 **South of Tailings (WA-9)** 1) Walkover inspection of unit to identify exposed areas of concern 2) Sediment sample at Terminus of Dry Creek	Soil
Smelter Waste	Leaching		Groundwater	See Table A-1	Surface covered with clean fill and seeded to minimize infiltration of water into subsurface.	Is there evidence of Smelter Waste within local groundwater aquifers?	Ingestion potential is considered high for residents through area drinking wells.	Does groundwater in the area exhibit impacts from smelting/mining operations?	**Smelter Site (WA-3)** Hollow stem sampling in former smelter area at stack location **Waste Isolation Cell (WA-11)** 1) Geoprobe samples within and adjacent to the Waste Isolation Cell 2) Directional boring below Waste Isolation Cell	Ground Water
Smelter Waste	Plant Up-Take		Plants		Following placement of cover, remaining surface was seeded with near surface root zone species to prevent intrusion into waste materials.	Are there ecological risks associated with historical smelter waste?	Roots penetrating through cap into waste material may be of ecological risk to mammals and birds.	Kennecott has completed extensive vegetation studies in the area. Applicable information will be extrapolated to the IS&R project.	Evaluate the soil through sampling. Assess vegetative uptake potential using the Kennecott study.	Ecological
Tailings			Original Source	See Table A-2	Majority of Tailings Areas on site were capped with 12-inches of topsoil, significantly reducing the risk of contact.	Contact exposure to site visitors and workers with areas having insufficient cover.	Low	Are there areas where the cap depth is insufficient or missing?	**Tailings (WA-8)** 1) Walkover inspection of tailings with GPS unit to identify areas of concern. 2) Map/database information. **South of Tailings (WA-9)** 1) Walkover inspection of area looking for exposed tailings or other impacts.	Soil
Tailings	Wind Erosion		Wind		Majority of Tailings Areas were capped with 12-inches of topsoil and seeded, preventing wind scour.	Inhalation concern for area residents, site visitors, workers, mammals, and birds. Wind may transport waste materials in areas where cap has eroded or has been removed.	Low	Are there areas where the cap is missing?	Walkover inspections of the site to identify exposed areas.	Soil
Tailings	Water Erosion	Deposition	Soil	See Table A-2	This pathway was significantly reduced by capping of the primary source.	Concern is that exposed soils may cause an ingestion or dermal risk to residents, site visitors, mammals and small birds.	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for workers, visitors, invertebrates, mammals, and birds.	Are there areas where the cap is missing or areas not addressed which provide a potential source for exposure?	**Lincoln Residences (WA-10)** 1) 10 pt composite samples on grid from 2) 8 Lincoln Residences	Soil
Tailings	Water Erosion	Deposition	Soil/Sediment	See Table A-2	Install drainage structures, i.e.. Berms and channels to retain a majority of the storm water on site.	Are there impacted sediments in channels and retention basins?	Potential is considered intermediate for workers, visitors, invertebrates, mammals, and birds.	Have impacted soils collected in stream beds or water holding basins constructed during reclamation?	**Dry Creek Drainage (WA-9)** 1) Sediment samples within historic Dry Creek channel 2) Sediment sample at the terminus of current Dry Creek channel	Soil

Table 2-1
Sample Action Plan-Based on the Site Conceptual Model
ISR Remedial Investigation

Primary Source	Primary Release Mechanism	Secondary Source	Exposure Pathway	Previous Sampling Events	Previous Reclamation Activity	Current Concern	Exposure Potential	Data Gaps	Proposed Sampling	SAP Section
Tailings	Water Erosion	Deposition	Soil/Sediment	See Table A-2	Construct cap to prevent contact with source waste, and grade the surface to drain surface flows into retention basins and controlled flow drainage channels.	Are there areas where water erosion has scoured the cap allowing surface runoff to come in contact with source waste? Are there areas which were not previously addressed?		Are there areas where the cap is missing? Have areas not previously addressed been sufficiently located and mapped?	**Tailings (WA-8)** 1) Geoprobe soil samples at various locations in Tailings Impoundment 2) Sediment in Dry Creek at opening in Carr Fork Impoundment Dike 3) Determine cap depth at Geoprobe locations 4) Sediment behind water holding dike 5) Sediment within fans at base of alluvial washes 6) Shallow pore water (if soil is saturated) 7) Geoprobe soil samples on dike to characterize dike material 8) Sediment samples from old Dry Creek channel 9) Walkover inspection to identify areas of concern	Soil
Tailings	Water Erosion	Deposition	Soil/Sediment	See Table A-2	Cap was seeded with native grasses to stabilize surface soils, preventing erosion.	Are there areas where water erosion has scoured the cap allowing surface runoff to come in contact with source waste?		Are there areas where germination of vegetation has not been successful and if so why?	Walkover inspection of site to identify unvegetated or exposed areas	Soil
Tailings	Leaching		Groundwater	See Table A-1	Surface was covered with clean fill and seeded to minimize movement of water into subsurface aquifers. Cut off berm was installed to hold majority of runoff water preventing infiltration through the tailings into subsurface aquifers.	Groundwater quality in nearby drinking water wells.	Potential is considered high for ingestion to residents through area drinking wells.	Water quality in drinking water wells.	**Groundwater Wells (WA-12)** Sample monitor wells	Ground Water
Tailings	Plant Up-Take		Plants		Following placement of cover, the remaining surface was seeded with near surface root zone species.	Is there waste impact occurring in site vegetation?	If roots are growing into waste material, there may be ecological risks to mammals, and birds?	Kennecott has completed extensive vegetation studies in the area, this information should also be applicable to the IS&R project.	Evaluate the soil through sampling. Assess vegetative uptake potential using the Kennecott study.	Ecological
Stack Emissions			Original Source	See Table A-2	Some of the stack area waste was relocated to the isolation cell located in the tailings impoundment.	Stability of the Waste Isolation Cell		Composition and quantity of waste in the Waste Isolation Cell, and the condition of the Waste Isolation Cell.	See Waste Isolation Cell sampling	Soil
Stack Emissions			Original Source	See Table A-2	Stack area was capped as part of the overall smelter site area.	Contact exposure to site visitors and workers due to areas with insufficient cover.	Low	Are there areas where the cap depth is insufficient or missing?	See smelter waste sampling	Soil
Stack Emissions	Wind Erosion		Wind	See Table A-2	Majority of tailings areas, smelter site, and slag pile were capped with 12-inches of topsoil and seeded.	Concern is inhalation by area residents, site visitors, workers, mammals, and birds. Wind may transport waste materials in areas where cap has eroded or has been removed.	Low	Surfaces beyond the areas previously remediated have not been addressed.	Walkover inspections of the site to identify unvegetated areas or other areas of concern.	Soil
Stack Emissions	Wind Erosion		Wind	See Table A-2				Areas within the previously addressed area, where desert pavement exists, have not been addressed.	Soil Sampling throughout Site	Soil
Stack Emissions	Wind Erosion	Deposition	Soil	See Table A-2	Majority of tailings areas, smelter site, and slag pile were capped with 12-inches of topsoil and seeded.	Concern is that exposed soils not previously addressed may cause ingestion or dermal risk to residents, site visitors, mammals, and small birds.	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for site workers, visitors, invertebrates, mammals, and birds.	Are there areas where the cap is missing or areas not addressed which provide a potential source for exposure?		Soil

Table 2-1
Sample Action Plan-Based on the Site Conceptual Model
ISR Remedial Investigation

Primary Source	Primary Release Mechanism	Secondary Source	Exposure Pathway	Previous Sampling Events	Previous Reclamation Activity	Current Concern	Exposure Potential	Data Gaps	Proposed Sampling	SAP Section
Stack Emissions	Water Erosion	Deposition	Soil/Sediment	See Table A-2	Install drainage structures, i.e. berms and channels to retain a majority of the storm water on site.	Are there impacted sediments in channels and retention basins from areas on the site which were not previously addressed?	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for site workers, visitors, invertebrates, mammals, and birds.	Have impacted soils collected in stream beds or water holding basins constructed during reclamation?	See discussion on sediment sampling	Soil
Stack Emissions	Water Erosion	Deposition	Soil/Sediment		Areas not previously addressed	Waste transport into streams and clean areas.		Clear identification of areas not previously addressed.	**Area (WA-6)** 1) Sediment samples at the base of each gully 2) Surficial soil samples in un-capped areas **Area (WA-1)** 1) Sediment samples at the base of each gully 2) Surficial soil samples	Soil
Stack Emissions	Water Erosion	Deposition	Surface Water	See Table A-3		Is Pine Creek or Dry Creek flow being impacted by runoff from non-addressed areas on site or beyond the previously addressed areas?	Potential is considered high for ingestion or dermal exposure to area residents. Potential is considered intermediate for dermal exposure to workers and site visitors.	Water quality of Pine and Dry Creek.	**Dry Creek Drainage (WA-4)/ Pine Creek Drainage (WA-7)** 1) Walkover inspection of stream bed to find evidence where reclamation has not addressed waste impacts. 2) Sediment samples behind water holding dikes, from alluvial fans at the base of ravines, and within channels. 3) Transects across stream drainage. 4) Check depth of cover at points along transects where applicable. 5) TCLP test on Slag Pile.	Soil
Stack Emissions	Leaching		Groundwater	See Table A-1	Install drainage structures, i.e. berms and channels to retain a majority of the storm water on site.	Groundwater quality in area drinking water wells.	Potential is considered high for ingestion to residents through area drinking wells.	Current water quality in drinking water wells.	**Groundwater Wells (WA-12)** Sample existing monitor wells.	Ground Water
Stack Emissions	Leaching		Groundwater	See Table A-1	Cut off berm installed to hold the majority of runoff water to the south and end of tailings, preventing infiltration through the tailings into subsurface aquifers.			This bermed holding area collects most of the water from the non-addressed areas on the smelter site.	**Tailings (WA-8)** 1) Sediment samples behind water holding dike 2) Sediment samples within alluvial fans at the base of gullies	Ground Water
Stack Emissions	Plant Up-Take		Plants		Large shrubs in the smelter area were removed as part of the remediation activities. Following the placement of cover, the remaining surface was seeded with near surface root zone species to prevent intrusion into waste materials.	Is there waste up-take occurring in site vegetation?	If roots have penetrated the cap and grown into the waste material, there may be ecological risks to mammals and birds.	Kennecott has completed extensive vegetation studies in the area, this information should also be applicable to the IS&R project.	Evaluate the soil through sampling. Assess vegetative up-take potential using the Kennecott study.	Ecological
Slag Pile			Original Source	See Table A-2	Approximately 2/3 of the slag pile was capped to prevent direct contact with site visitors and workers. The other areas were not safely accessible. Capping also prevents storm water from leaching through the pile, creating springs at the base which eventually drain into the Pine Creek drainage.	1) Contact exposure to site visitors, workers to areas with insufficient cover. 2) Slag or slag dust has an impact on surface water flows in Pine Creek.	Low		Quarterly water samples at the base - SW14 TCLP test on slag sample.	Water

chemical characteristics of these materials are discussed in detail in the Reclamation/Stabilization Plan prepared by JBR following the 1985 investigation.

Tailings: Tailings located on site within the impoundment consist of two major types, the IS&R tailings and the Carr Fork tailings, both of which are located southeast of the Carr Fork tailings dam (see Figure 2-2, Site Map). The tailings are sand to clay-sized solid wastes generated by the two IS&R concentrator mills and the Carr Fork mill in Pine Canyon. IS&R tailings were produced between 1910 and 1971 by the former IS&R copper and lead ore milling operations. They tend to be yellow to orange-brown in color and are dominated by silicate and sulfide mineralogy. The Carr Fork tailings were produced from 1979 to 1981 by the Carr Fork copper concentrator in Pine Canyon. They are generally light gray and greenish-yellow gray dominated by silicate and carbonate minerals with sulfides.

Slag: Slag is a black stony to glassy solid waste produced from the historic smelter operations. It is located immediately north of the former smelter site adjacent to Pine Creek (see Figure 2-2, Site Map). The slag occurs in one main pile and one smaller flat-topped pile located in the mouth of Pine Canyon. The sides of the slag piles are very steep and have the appearance of hard, black lava rock. Pine Creek flows along the base of the slag.

Soils impacted by historic stack emissions: During smelter operations, smoke, gas and fumes were discharged. Smelter gas and smoke that were released into the atmosphere impacted the nearby vegetation. As a result, fine particles of dust and smoke were also deposited on the ground surface around the former smelter resulting in elevated metals concentrations in the upper soil profile. The specific smelter location was chosen based partly on the convection current canyon winds which would carry the stack emissions up Pine Canyon. However, due to the close proximity of Lincoln to the Site, there is a potential for historical wind blown contamination there. Stack emissions from the smelting operations ceased in 1971. Ecological risk assessment studies conducted by KCC in 1994 and 1995 included the Pine Canyon area immediately east of the Site. These studies reported the soil and vegetation concentrations of toxic metals from all sources and evaluated the potential ecological risk for key wildlife species. The metals that were of potential concern for ecological risk were found to include: cadmium, copper, lead, and selenium. (Ecological Planning and Toxicology, 1995)

2.1.1.2 Secondary Sources

Secondary sources at the Site include the following:

- Soil impacted by blowing smelter waste, or tailings. Past investigations have indicated that these impacts tend to be concentrated in the upper 6 to 12 inches of the soil profile (JBR, 1986). The concentrations of metals in the surficial soil also decrease with distance from the former smelter site.

- Surface water may be impacted from contact with waste materials, tailings, slag, or soils.

- Sediments found in the surface water drainages may contain elevated levels of metals either from erosion, and subsequent deposition.

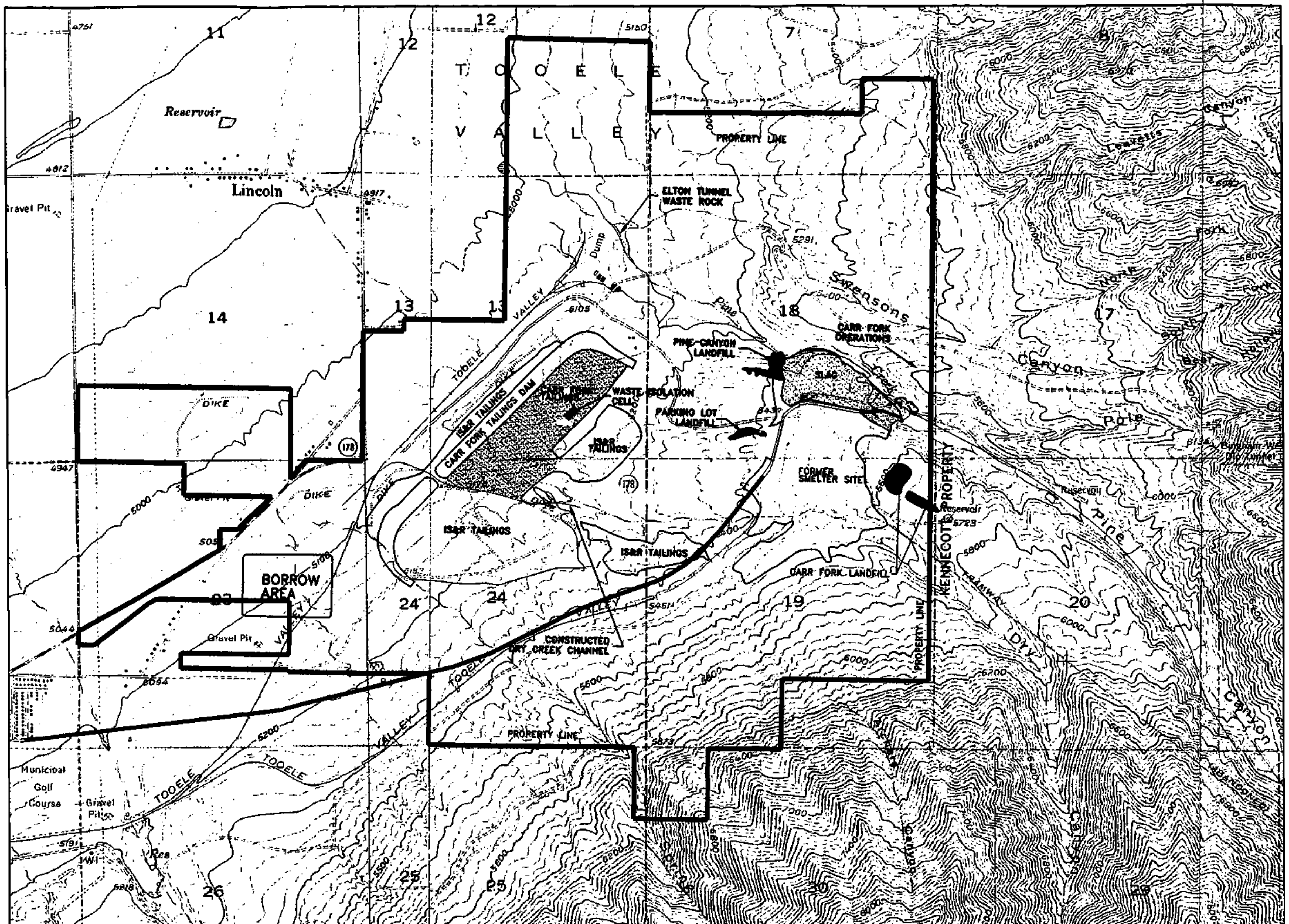
- Groundwater may be impacted by leaching of water through smelter waste, tailings, slag, or contaminated soil.

2.1.1.3 Potential COC Transport Pathways

Sampling locations were selected for the purpose of isolating the spacial extent of smelter impacts along key exposure pathway, as identified in the Site Conceptual Model. Exposure pathways are described below.

Wind Erosion/Deposition: In the past, smelter stack emissions were carried away from the smelter in the air. The stack emissions ceased in 1971 when the smelter operations were terminated. Aerial disposition of emission particulate onto area soils can be re-introduced into the atmosphere by wind erosion. As stated previously, the smelter wastes, tailings and areas of impacted soils at the Site were graded and covered with clean soil during the 1986/87 reclamation activities. Revegetation of this soil surface further stabilized these areas from wind erosion. However, removal of the protective soil cover and/or vegetation stabilization could result in wind erosion of the underlying wastes or impacted soils.

Water Erosion/Deposition: Sources in contact with surface water runoff can be transported in the runoff as sediment. These sediment particles can also be eroded and remobilized by subsequent flow events in the channels with final deposition in channel low spots. Sources exposed to precipitation and surface water runoff can also potentially be dissolved (leached) to various degrees by the water. Dissolved metals in surface water are subject to chemical changes and absorption to particles within the stream flow. Dissolved metals that form chemical precipitates, or became absorbed onto particles in the stream, tend to become entrained in the bottom sediment of the channel. Depending on the pH and organic chemical reactions within the bottom sediments, metals can either be precipitated or remain in a dissolved state within these sediments.



General Notes

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: RDE
ENGINEER: KC
APPROVED: SDA

SITE MAP
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069	FIGURE 2-2
Date APR-03	
Scale NO SCALE	

Reclamation of the Site included the construction of run-off control elements, including berms, swales, riprapped channels, and settling basins. These structures serve to direct run-off and minimize erosion. Nearly all the smelter site drainage as well as the Dry Creek Canyon drainage is routed through the engineering breach in the Tailings Dam within a riprapped channel. This channel is routed to the 1986 created borrow area west of the dam, so no runoff from this drainage leaves the Site. Historic drainages and depositional areas of Pine Creek and Dry Creek Canyon were investigated and sampled as part of this RI.

During the 1986 site reclamation activities, Pine Creek was re-routed away from the base of the covered and closed Pine Canyon Landfill. The stream currently flows through a braided network of small streams and ditches which distributes the water over a wide fan shaped area within the Pine Canyon drainage basin. In 1999, two wildlife watering ponds with a riprap spillway were constructed in conjunction with the UDWR wildlife rangeland improvement plans for the Site, near the former Elton Tunnel opening. Except during heavy runoff the creek is absorbed into the ground prior to leaving the IS&R property. KCC operations, which now pump mine water to the Bingham side of the Oquirrhs, have significantly reduced the amount of flow in Pine Creek.

During the transition from winter to spring, snow melt, and after heavy rains, water accumulates in localized catchment areas on the Site. There is a concern that this ponded water in covered areas of the Site may leach COC out of the ground and pose a threat to ecological receptors, which may ingest the water. The quality of this water was addressed during the RI.

<u>Subsurface Leaching/Groundwater Migration</u>: Metals released in dissolved form to infiltrating precipitation or to surface water runoff that subsequently infiltrates into the ground can potentially be carried downward as unsaturated flow in the alluvium underlying the Site. Infiltrating water reacts with the porous and permeable solid material. If the amount of infiltrating water is less than the natural moisture retention capacity of the porous material, the water would be held in the material as moisture until it is eventually removed by evaporation or plant transpiration or is displaced by additions of more water to the porous material, or remains in place as soil moisture. Water in contact with the solid material also chemically reacts with that material. These reactions can result in both dissolution of the solid material into the water and precipitation of insoluble chemical compounds from the water. Dissolved constituents in the water can also be absorbed to mineral and/or organic materials within the solid material. The regional groundwater aquifer under the Site is over 500 feet below the ground surface with a hydraulic gradient toward the west or northwest. Because of the depth to groundwater, the ability of the dry unsaturated sediments overlying the aquifer to absorb and retain precipitation, and the contaminant

attenuation capacity of these sediments, past investigators at the Site have indicated that contamination of the groundwater from operations at the Site is unlikely (Wahler, 1978 and JBR, 1986).

Shallow groundwater (underflow) along the Pine Creek drainage can discharge in the form of springs at the ground surface. Prior to 1987, there were springs and seeps down-gradient from the slag pile and the Pine Canyon Landfill on the Site that discharged poor quality water (JBR, 1986 and 1990). Water from these springs flowed overland in a small stream and eventually discharged to Pine Creek. Since the completion of the reclamation and stabilization activities in this area, these springs have dried up and no longer affect Pine Creek.

2.1.2 Potential Concerns

The RI has been patterned to address stakeholder potential concerns at this site as defined in pre-meetings and the HRS scoring document. In addition to meeting the stated objectives, the RI investigation tasks have sought to address these specific concerns.

- Although the majority of the smelter site and tailing pond was covered with 6-12 inches of clean soil and revegetated, there is a concern that the cover is missing in some areas, potentially exposing underlying soils and/or tailings.
- Is there potential for site visitors to ingest or be exposed to windblown COC?
- Is there potential for windblown contamination to affect nearby residents?
- There is a concern that the tailings are potentially leaching contaminants into the underlying soils and groundwater.
- Has groundwater on or off the Site been impacted? Specifically, has there been an increase, attributable to the Site, in nitrate concentrations in off-site drinking water wells (Erda).
- There is concern about the integrity/stability of the waste isolation cell, which was built as a repository for waste having acid-generating characteristics or failing the EP Toxicity test. There is also concern about the composition and quantity of the waste in the waste isolation cell.
- Are there impacted sediments in stream channels and sediment retention basins?
- Are there areas where surface water has the potential to scour or erode the cover of the smelter area? Are there any areas in which surface water is coming into contact with smelter waste?

- What is the impact of the slag on Pine Creek water quality?
- What is the impact of the Site on ecological receptors (i.e. flora and fauna)?

2.1.3 Potential Receptors

2.1.3.1 Adjacent Residents

Residents of Lincoln living west of the Atlantic Richfield property line are the nearest residences. The west property line is from 500 to over 2,000 feet away from the nearest potential primary source of contamination (IS&R tailings). During operation of the plant, the majority of down-gradient lands were used for agriculture. A portion of this agriculture area was irrigated from Pine Canyon and Dry Canyon generated runoff. The 500 to 2000 feet strip of property between the tailings impoundment and the west property line is included within the perpetual conservation easement. This strip of land acts as a buffer between residential properties and waste sources. The RI and Risk Assessment evaluated the potential for current and future residents in the area to be exposed to fugitive dust, soil, surface water and groundwater.

2.1.3.2 Site Workers

There are no workers at the Site on a daily basis. Employees of UDWR visit the Site for inspections and seasonal maintenance projects but are not there on a daily basis.

2.1.3.3 Site Visitors

The Site is owned by Atlantic Richfield and current and future land use is designated as a wildlife management area managed by the UDWR. Visitation for the purposes of observing wildlife, hunting, and educational opportunities is allowed by the UDWR. Recreational visitors to the Site may potentially be exposed to primary and secondary sources such as sediments, surface water, soil, erosion exposed wastes, and fugitive dust. Although no records of these visits are kept, the current visitation rate beyond the Site perimeter boundary fence is considered to be relatively infrequent. However, the road from Tooele, which is routed between WA-3 and WA-6, and continues into Pine Canyon, is used frequently by bikers and hikers. Future visitation rates may vary from current rates as population and wildlife increases. The Carr Fork Wildlife Management Area, Site Management Plan, as agreed to by Atlantic Richfield and UDWR in 1994, defines acceptable types and use of the conservation easement.

2.1.3.4 Ecological Resources

The following are considered to be potential ecological receptors.

Terrestrial: The terrestrial food chain is built around a prey base of small rodents, deer, reptiles and passerine birds that feed on insects and vegetation. Prime consumers are raptors and carnivores such as coyotes. The Site provides year-round mule deer habitat. Terrestrial invertebrates, amphibians, and reptiles are also considered receptors at the Site.

Avifauna: Shrub communities at the Site provide optimal habitat for passerine birds and occasional limited use by waterfowl. Ground, low-shrub, and tree-nesting species all use the Site for nesting. Both insect and seed consumers use the habitat.

Aquatic: The riparian habitat along Pine Creek provides food and cover or many wildlife species. The condition of the stream channel has been degraded by past irrigation and livestock grazing practices. However, since reclamation activities in 1986 and subsequent improvement projects by Atlantic Richfield and the State of Utah the Pine Canyon drainage has been enhanced as a watering area for wildlife. Benthic invertebrates are likely inhabitants of the stream but the stream crossing the Atlantic Richfield property does not contain fish. Because of its temporary nature, Dry Creek drainage contains minimal aquatic characteristics.

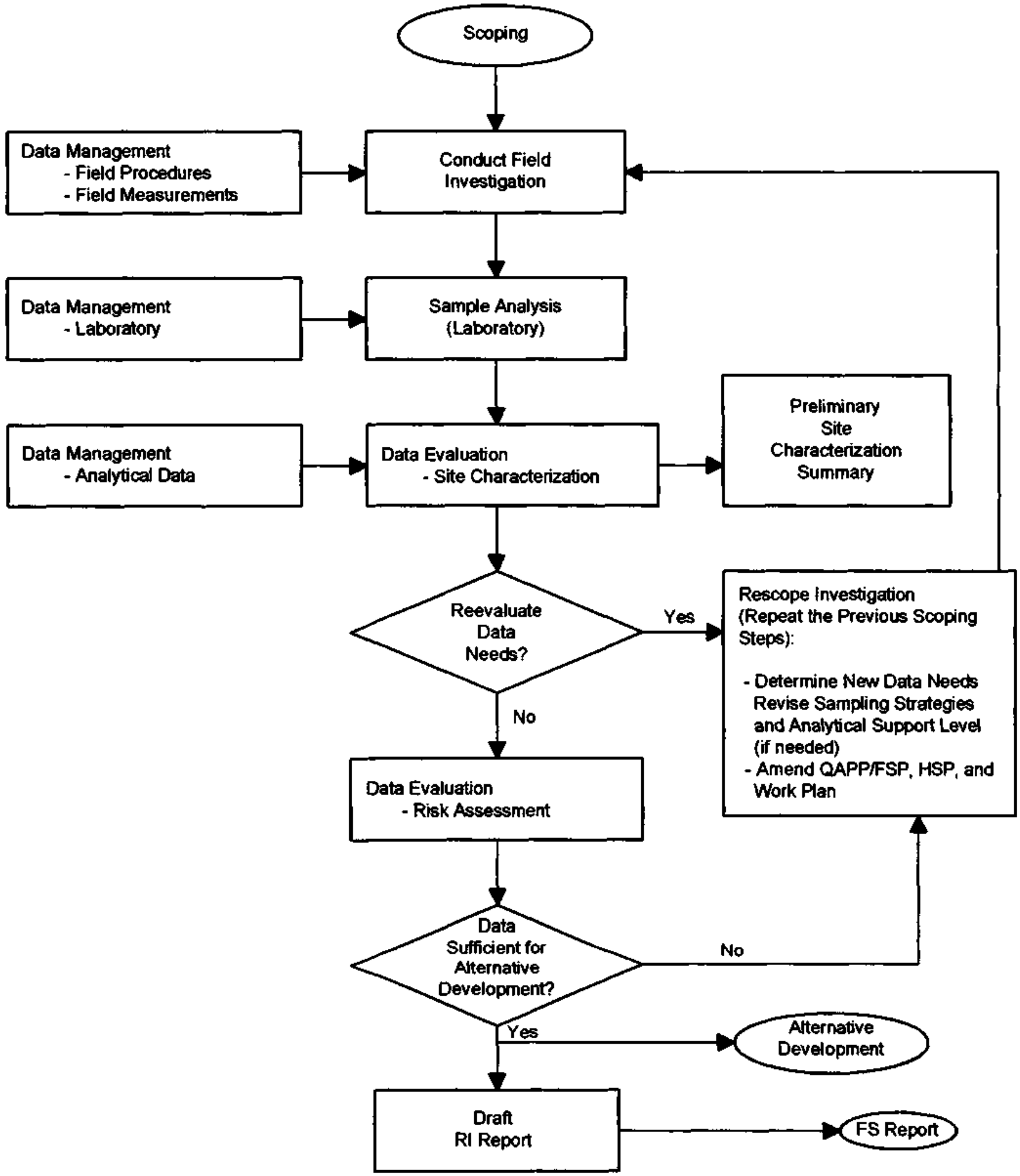
2.2 Investigation Methodology

2.2.1 Sampling Location and Frequency

The Field Sampling Plan was to address specific objectives within each of the before-mentioned WA designations. The general methodology follows the EPA recommended procedure and components for site characterization shown on Figure 2-3, Site Characterization. All sampling performed on property not owned by Atlantic Richfield was coordinated with current property owners who signed access agreements allowing access for sampling purposes. Table 2-2 (Sampling Program) summarizes the sampling conducted in each of the Work Areas. Figure 2-4 shows the sampling locations.

Sample locations included in the Field Sampling Plan were selected based on the Site operational history, consideration of previous reclamation, known areas of potential erosion deposition, areas of suspected surface water and aerial emissions deposition, and historical sampled locations with elevated concentrations.

Field operations were conducted as described in the following sections, and in accordance with the Standard Operating Procedures (SOPs) included as Appendix O. Table 2-3 lists the applicable SOPs for this field work.



ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

IS&R/CARRFORK
REMEDIAL INVESTIGATION
Figure 2-3
Site Characterization

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: RDE

PROJECT: 97-069

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 2024001

SITE NAME: INTERNATIONAL SMELTING & REFINING

DOCUMENT DATE: 08/01/2004

DOCUMENT NOT SCANNED

Due to one of the following reasons:

- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☑ OVERSIZED
- ☐ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

FIGURE 2-4 SAMPLING LOCATIONS

Contact the Superfund Records Center to view available document.
(303) 312-6473

Table 2-2
Sampling Program
ISR Remedial Investigation

Revision Date: Apr-03

Work Area	Sample Type	Sample Description	Analytes Tested	Methodologies	Notes
Work Area No. 1 Northern Hills	Soil	8 sample locations - 1-per 1/4 section	Soil analyte list*	5 point composite at depth: 0-2", 1 aliquot from each sample analyzed.	Area was not disturbed as part of the smelter operation and is up gradient from the smelter site. The likely potential pathway is stack emissions. Surface impacts from stack emissions should be fairly uniform.
	Sediment	4 surficial sediment samples at base of work area drainages		grab sample from single point 0-2" and 2-6"	Drainage sediment samples intended to define if surface impacts are being transported by storm runoff towards agricultural and residential areas below the site.
Work Area No. 2 Slag Pile	Slag	4 slag samples	SPLP analyte list**	grab sample	All slag produced during operations appears to all have the same properties. Four samples were taken to determine leachabilty of the material.
	Soil	3 soil surface samples	Soil analyte list*	5 point composite: 0-2", 2-6". 1of the 0-2" aliqouts from each sample analyzed.	Samples were taken at each of the three distinct slag piles. These samples intended to verify that cover materials placed previously are below action levels for metals and other impacts.
	Subsurface Boring	1 subsurface boring into native soils		Air rotary drill rig, sampled at 10', 25', 50', and below slag.	One hole was drilled into the underlying soils to try and determine if leaching of metals is taking place below the slag pile.
Work Area No. 3 Smelter Area	Soil	10 samples addressing former areas with elevated concentrations	Soil analyte list*	5 point composite: 0-2", 2-6" and below cap. 1 of the 0-2" aliquots from each sample analyzed.	Each sample location randomly selected on grid system to represent approximately 20 acres
		1 sample addressing uncapped former area		5 point composite: 0-2", 2-6". 1 of the 0-2" aliqouts from each sample analyzed.	
	Sediment	12 behind water holding dikes and 1 at base of gully		Grab sample from single point 0-2" and 2-6"	Sediment samples taken behind the control dikes constructed in 1986 intended to investigate whether surface runoff is carrying elevated levels of metals. These samples also intended to determine if water behind these dikes is a source of leachable metals into the groundwater below, or potential risk to wildlife.
	Subsurface Boring	1 subsurface boring		Hollow stem auger, sampled at 10', 25', and 50'	One bore hole will be driven in the former stack area, which is one of the previously sampled areas with the highest metal concentrations. This hole will define to what extent leaching of metals is taking place below the former smelter area.
	Soil Pore Moisture	1 lysimeter	Water analyte list***	1 total and 1 dissolved sample	If the 1995 lysimeters are not found, then 3 additional lysimeters will be installed.
	Surface Water	Surface water collected from 5 water holding ponds		1 total and 1 dissolved sample from each pond	These samples collected in order to determine if water behind these dikes is a source of leachable metals into the groundwater below, or potential risk to wildlife.
Work Area No. 4 Dry Creek	Soil	1 soil sample at pond area near paved road	Soil analyte list*	5 point composite at depths: 0-2", 2-6", and below cap. 1 of the 0-2" aliquots from each sample analyzed.	The SI report identified one location in this area as "blue tailings." The area was reclaimed during 1998 field work. This sample intended to determine if this material still present and of concern.
	Sediment	7 sediment samples		Grab sample from single point 0-2" and 2-6"	Sediment samples collected to potential transport of COCs by storm runoff.
	Sediment	3 transects: #1 having 9 sample locations; #2 having 10 sample locations; #3 having 4		Grab sample from single point 0-2" and 2-6"	Transects to investigate potential smelter impacts within the drainage.
	Subsurface Boring	1 subsurface boring at Railroad Grade pond		Hollow stem auger, sampled at 10', 25', and 50'	Previous sampling has shown that metal concentrations in the Dry Creek Basin were highest in the pond up gradient from the railroad grade. A bore hole intended to determine the potential of leaching from this area.
Work Area No. 5 Southern Hills	Soil	9 soil samples (1 sample per 1/4 section + 3 additional along RR grade)	Soil analyte list*	5 point composite at depths: 0-2", 1 aliquot from each sample analyzed.	Area was not disturbed as part of the smelter operation and is up gradient from the smelter site. Any impact likely from stack emissions. Surface impacts from stack emissions would be fairly uniform therefore one sample was collected per 1/4 section. Three samples along RR grade intended to determine if rail transport vehicles created additional surface impacts.

*Soil Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg, pH, Total Solids
**SPL Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg
***Water Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg, Chloride, Nitrate, Nitrite, Sulfate, TSS, TDS, Alkalinity, Acidity

Table 2-2
Sampling Program
ISR Remedial Investigation

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Work Area	Sample Type	Sample Description	Analytes Tested	Methodologies	Notes
Work Area No. 6 Lower Smelter Area	Soil	6 soil samples	Soil analyte list*	5 point composite at depths: 0-2", 2-6", and below cap (in capped areas). 1 of the 0-2" aliquots from each sample was analyzed.	Soil samples collected to investigate cover materials placed in 1987 are clean. Samples also taken in "desert pavement" areas not previously covered to investigate potential impacts in these areas.
	Soil	2 surficial soil samples		5 point composite at depth of 0-2". 1 aliquot from each sample was analyzed	Soil samples were collected within the gun club to determine the impact of the lead shot on the soils.
	Sediment	4 sediment samples on alluvial fans at base of drainages		Grab sample from single point 0-2" and 2-6"	Drainage sediment samples intended to define if surface impacts are being transported by storm runoff into drainages and sediment holding ponds.
	Subsurface Boring	1 subsurface boring		Hollow stem auger, sampled at 10', 25', and 50'	Borehole intended to determine if any sub-surface COC migration taking place. Borehole was placed down gradient of the parking lot landfill as the potential worst case scenario.
Work Area No. 7 Pine Creek	Surface Water	7 surface water samples	Water analyte list***	Surface water sampling methods	Water samples taken in Pine Canyon prior to entering the site, along the slag pile where the creek is in contact with the slag and downstream at various locations. These samples were used to determine what if any impacts the site has on surface flow. Locations SW9 ad SW10 were dry during the RI.
	Soil	9 soil samples	Soil analyte list*	5 point composite at depths: 0-2" and 2-6". 1 of the 0-2" aliquots from each sample analyzed.	Soil samples were collected at equally spaced locations throughout the drainage basin. Two samples were taken on the Elton Tunnel Dump including one location identified in the Spectral International report. ET dump samples intended to verify the condition of the cap placed in 1986.
	Sediment	13 stream sediment samples		Grab sample from single point 0-2" and 2-6"	Sediment samples intended to identify potential historic smelter impacts to the stream. (Note: the sediment sample at SW-17 at the Pine Canyon Tunnel adit only sampled 0-2 inches)
	Sediment	2 transects: #1 having 8 sample locations and #2 having 20 sample locations		Grab sample from single point 0-2" and 2-6"	Transects were intended to investigate potential smelter impacts within the drainage.
	Subsurface Boring	4 subsurface borings		Hollow stem auger, sampled at 10', 25', and 50'	Subsurface borings were used to determine the potential for the slag pile to be the source of arsenic. The borings were placed within the drainage to also determine if saturated conditions existed in the subsurface alluvium adjacent to Pine Creek. PC2 an PC4 drilled to depth of 50 feet. PC3 drilled to depth of 25 feet. PC1, located adjacent to the toe of the slag pile at location of former spring, drilled to depth of 98 feet.
Work Area No. 8 Tailings Pond	Soil/Tailings	14 geoprobe	Soil analyte list*	All borings sampled 0-2", 2-6", within tailings, and within native material below tailings	Geoprobe samples will be taken at equally spaced locations. Samples will provide both characteristic and quantitative data on the tailings material.
	Carr Fork Dike Crest	3 geoprobe		All borings sampled 0-2", 2-6", within the dike, and within native material below dike	Geoprobe samples will be taken at equally spaced locations. Samples will determine the constitution of the dike materials and what sub-surface conditions are.
	IS&R Dike	4 geoprobe			Geoprobe samples will be taken at equally spaced locations. Samples will determine the constitution of the dike materials and what sub-surface conditions are.
	Sediment	1 sediment samples behind water holding dike		Grab sample from single point 0-2" and 2-6"	Sediment samples taken behind the control dikes are intended to investigate whether surface runoff is carrying elevated levels of metals.
	Dry Creek Channel	1 sediment sample			A sediment sample will be collected in the Dry Creek channel where it crosses through the tailing impoundment, before it flows through the man-made breech. This sample will test in part the integrity of the tailing cap.
	Unnamed Channel	1 sediment sample			A sediment sample was collected to assess the migration of COCs through the unnamed channel which flows through a gully in the bluff to the east.
	Subsurface Boring	1 subsurface boring		Hollow stem auger, sampled at 10', 25', and 50'	Boring intended to examine the potential leaching of COCs from the tailings.

*Soil Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg, pH, Total Solids
**SPL Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg
***Water Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg, Chloride, Nitrate, Nitrite, Sulfate, TSS, TDS, Alkalinity, Acidity

Table 2-2
Sampling Program
ISR Remedial Investigation

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Work Area	Sample Type	Sample Description	Analytes Tested	Methodologies	Notes
Work Area No. 9 Lower West Side	Soil	15 soil samples	Soil analyte list*	5 point composite at depths: 0-2", 1 aliquot from each sample was analyzed	This area was essentially non-disturbed during operations. Sampling intended to evaluate potential impacts from smelter operations. One sample per 1/4 section.
	Sediment	7 sediment samples		Grab sample from single point 0-2" amd 2-6"	Sediment samples were collected in the historical drainages to determine to what extent analytes potentially migrated from the site.
	Subsurface Boring	1 subsurface boring in former borrow area (current terminus for Dry Creek)		Hollow stem auger, sampled at 10', 25', and 50'	Potential flow from Dry Canyon is detained within the former 1986 reclamation borrow area. The boring was drilled in this location to determine the potential for leaching of COCs into the subsurface and to investigate if COCs are being transported from the site in the Dry Creek drainage.
Work Area No. 10 Lincoln Township	Soil	30 soil samples	Soil analyte list*	5 point composite at depth: 0-2", 1 aliquot from each sample was analyzed	Soil samples were collected in a grid pattern, with each sample representing approximately 10 acres. The intent of the sampling was to evaluate what impacts may have resulted from use of Pine Canyon and Dry Canyon water for irrigation purposes.
	Sediment	6 sediment samples within dry former Pine Creek drainage irrigation channels; 1 sediment sample in former pond adjacent to Pine Creek irrigation channel		Grab sample from single point 0-2" and 2-6"	Sediment samples were collected in the historical Pine Creek drainages to determine to what extent analytes migrated through the area.
	Sediment	4 sediment samples within Dry Canyon channel (now irrigation ditch)		Grab sample from single point 0-2" and 2-6"	Sediment samples were collected in the historical Dry Creek drainages to determine to what extent analytes migrated through the area.
	Sediment	2 Sediment samples within unnamed drainage and irrigation ditch		Grab sample from single point 0-2" and 2-6"	Sediment samples were collected to investigate potential historical discharge of COCs from the site through natural drainage and an irrigation ditch that reportedly carried Elton tunnel water at one time.
	Residential Soil	8 residences		10 point composite from 1 to 4 zones per lot; 0-2"	Samples were collected at 5 lots adjacent to the Dry Creek and Pine Creek drainages which are considered most likely to have been impacted. 3 homes which were previously tested were also resampled during this investigation.
	Residential Dust	8 residences	Lead and Arsenic	Dust collected in houses using a HVC3 vacuum	Dust samples were collected and composited from high traffic areas in the homes, including living/family rooms, hallways, and bedrooms. All samples were from carpeted areas -- no wipe samples were collected.
	Subsurface Boring	1 subsurface boring	Soil analyte list*	Hollow stem auger, sampled at 10', 25', and 50'	The purpose of the boring was to determine if any sub-surface lateral movement may be taking place from up-gradient smelter impacts.
Work Area No. 11 Waste Isolation Cell	Waste	2 geoprobe borings in WIC	Soil analyte list*	Borings sampled from 0-2", 2-6", and within the waste material	Samples were collected to determine the constituents in the WIC.
	Soil/Tailing	5 geoprobe borings around perimeter of WIC		All borings were sampled at depths: 0-2", 2-6", and at 12 feet. Two of the borings were also sampled within native material below tailings	Samples were taken to determine if lateral leaching from the WIC was occurring, to verify the depth of the Carr Fork tailings under the WIC, and verify if leaching is taking place through the clay liner placed within the cell. The 12-foot samples were collected at the approximate equivalent elevation of the bottom of the Waste Isolation Cell.
	Subsurface Boring	1 subsurface boring		Hollow stem auger, sampled at 10', 25', and 50'	This hole was drilled through the WIC, with the 25- and 50-foot samples collected in the underlying tailings and soils. The purpose of the boring was to investigate the potential for vertical leaching from the bottom WIC. As with the other borings within the tailing pond, the hole was backfilled with bentonite.

*Soil Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg, pH, Total Solids
**SPL Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg
***Water Analyte List: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn, Hg, Chloride, Nitrate, Nitrite, Sulfate, TSS, TDS, Alkalinity, Acidity

Table 2-3
IS&R/Carr Fork Superfund Site Investigations
Standard Operating Procedures (SOPs)

SUBJECT	PROCEDURE NO.
GENERAL	
-Mobilization, Demobilization, & Field Activities	1-1
-Determining and Recording Station Locations	1-2
-Sample ID and Tracking	1-3
-Field Quality Control Samples	1-4
-Use of Field Logbooks	1-5
-Sample Custody and Documentation	1-6
-Decontamination of Hand Tools & Drilling Equipment	1-7
-Decontamination of Sampling Equipment	1-9
-Site Cleanup Activities	1-10
-Packaging & Shipment of Field Samples	1-11
- Residential Sample Labeling	1-12
HYDROLOGY **GENERAL SAMPLING & MEASUREMENT**	
-Lysimeter Installation and Sampling	2-7
-Preservation and Handling of Aqueous Samples	2-8
-Field Water Quality Measurements	2-9
SURFACE WATER	
-Surface Water & Sediment Sampling	3-1
-Stream Flow Measurements	3-4
-Stream flow Measurement with Portable Meter	3-6
GROUND WATER	
-Groundwater Sampling	4-1
-Low Stress (low flow) Purging & Sampling	4-4
-Monitoring Well & Borehole Abandonment	4-6
-Borehole logging	4-7
-Well Development	4-8
-Well Purging—Pumping Method	4-9
-Monitoring Well Design and Construction	4-10

Table 2-3
IS&R/Carr Fork Superfund Site Investigations
Standard Operating Procedures (SOPs)

SUBJECT	PROCEDURE NO.
SOILS/SOLIDS	
-Compositing Soil Samples	5-1
-Soil Sampling	5-2
-Sample Collection from Soil Borings Excavations and Hand Dug Pits	5-4
-Residential Yard Surface Soil Sampling	5-5
-Hollow Stem Auger Drilling	5-7
-Indoor Dust Sampling	5-8
-Nutrient Growth Characteristic Soil Sampling	5-9
-XRF Sample Analysis	5-10
-Fill and Topsoil Testing	5-11

2.2.2 Walkover Inspections

A detailed inspection was conducted in each of the Work Areas. Areas which received cover during the 1986 reclamation were inspected to verify the integrity of the cover, and to look for areas of erosion or locations where the cover depth is insufficient or missing. Other areas were inspected for evidence of COC or other concerns. A GPS unit was used to mark each location. Walkovers involved traversing each Work Area in a pre-determined pattern with the intent of documenting the following physical characteristics:

1. Estimate of aerial extent of cover placed in previous reclamation activities.
2. Condition of previously placed cover.
3. Condition and estimated percentage of vegetative density and dominant species within the work area.
4. Evidence and locations of smelter impact, including:
    - Chemical staining or exposed smelter wastes
    - Foundations/buildings/utility vaults, etc
    - Roads, pipelines
    - Overhead lines
    - Erosion from wind/water, particularly in areas where a protective cover has been placed
    - Condition of previously constructed fill slopes, embankments, dikes, etc.
    - Debris

5. Verify as-built information from previous remedial actions.

Information gathered during walkovers was recorded in logbooks and entered into the project database for use in categorizing, evaluating and screening future remedial alternatives.

The following characteristics and features at each identified location were recorded and entered into the project database.

- GPS coordinate location
- Type of Concern (exposed or stained soils, debris, stressed vegetation or defoliation, etc.)
- Approximate aerial extent of the area
- Photographs were taken on each area

The intent of the first phase of the project walkovers was to clearly define areas of smelter impact which warranted additional review and analysis. Defined areas included both areas where reclamation cover had failed and areas not previously addressed. The second, or sampling, phase was to collect sufficient data so that a statistical comparison could be completed. The data from each phase was then combined to determine the associated risk from each of the AOC. Database information generated from the walkovers was used to categorize the AOC into like sets based on visual characteristics:

- Debris
- Bare soil/stressed vegetation
- Erosion (with no visible staining or tailings)
- Exposed soil (with no visible staining or tailings)
- Bulls eye (particular type of staining pattern)
- Exposed Carr Fork Tailings
- Exposed IS&R staining or tailing
- Exposed waste (such as flue dust)

A representative number of AOC locations were chosen randomly for metals testing in order to make statistical inferences about the total number of AOC. At each of the selected subset locations a 5-point composite sample was taken at a depth of 0-2 inches and analyzed. Composite aliquot locations were adaptively field chosen, but, in general were taken from proportional areas of the selected AOC and at the area's centroid. Collected samples were analyzed for the Soil Analyte List presented in Table 2-4.

Composite samples were gathered, comprised of five individual aliquots, and collected according to the SOP: "Compositing Soil Samples" included in Appendix O. Soil samples were collected from a five point grid which represented discreet sampling areas. The composite samples were intended to mitigate very localized high or low concentration areas present at the sample locations. All samples collected were analyzed for the constituents indicated on Table 2-4.

Sampling of areas not previously addressed by reclamation served to assess the previous deposition of stack emissions on the surrounding land.

2.2.3 Depth and Integrity of Cover Investigation

In work areas which received cover material during the 1986 reclamation work the reclamation cover was excavated at the designated sample locations to determine the depth and integrity of the cover material. Soils underlying the covered areas were also investigated by completing deep hole bore samples in WA2, WA3, WA4, WA6, WA7, WA8, and WA11.

2.2.4 Surface Soil

Composite surficial soil samples were collected from WA1 through WA11. Soil samples were collected from some or all of the following depths:

1. 0-2 inches: these samples provided information for risk assessment. The samples are intended to provide information on any COCs present at the surface, and susceptible to direct contact or by wind or water erosion.
2. 2-6 inches: these samples provided information on the nature and extent of COCs in the cover or subsurface soils.
3. 12-18 inches (underlying the contact point with the cover): these samples were collected in covered areas and provided information on the nature and extent of COCs on the pre-reclaimed surface.

2.2.5 Subsurface Soil

A hollow-stem auger drill rig was used to collect subsurface samples from WA2, WA3, WA4, WA6, WA7, WA8, WA9, WA10, and WA11 (see Figure 2-4). The purpose of these borings and soil samples was to evaluate the subsurface soils for infiltrations of COC and the consequential potential of impacting groundwater. With the exception of the boring in WA2 and two of the borings in WA7, each of the soil borings was advanced to a depth of approximately 50 feet. Soil samples were collected at depths of 10 feet, 25 feet, and 50 feet below ground surface for chemical analysis.

The boring in WA2 was drilled to a depth of 157 feet through the slag pile and into native subsoils (the native soil/slag pile interface was encountered at a depth of 152 feet). In addition to the 10-, 25-, and 50-foot samples, a sample was also collected from a depth of 157 feet. The slag samples from this boring were analyzed using the SPLP extraction procedure.

Two of the borings completed in WA7 were completed to a depth of 50 feet (PC-2 and PC-4). Boring PC-1 was drilled at the toe of the slag pile in the location of the former spring, and was completed to a depth of 98 feet. A PVC piezometer was installed to a depth of 68 feet within the boring. To date no water has been

Table 2-4 (1 of 4)
Analytical Methods and Detection Limits
Solid Samples including Soils, Sediments, Dust and Sludge
IS&R Remedial Investigation

Parameter	Analyte	Preparation Method [5]	Analytical Method [1]	CRQL [3]	Risk Based g-SSL for Residential Soil (mg/kg)	Units	Holding Time [4]
Total Metals	Aluminum	3051	6010B	25	76000	mg/kg	
	Antimony	3051	7041 [7]	10	-	mg/kg	
	Arsenic	3051	7060A [7]	10	0.4	mg/kg	
	Barium	3051	6010B	1	5500	mg/kg	
	Beryllium	3051	6010B	1	160	mg/kg	
	Cadmium	3051	6010B	0.5	70	mg/kg	
	Calcium	3051	6010B	50	-	mg/kg	
	Chromium	3051	6010B	20	230(total)	mg/kg	
	Cobalt	3051	6010B	10	-	mg/kg	
	Copper	3051	6010B	2	2900	mg/kg	
	Iron	3051	6010B	50	23,000	mg/kg	
	Lead	3051	7421 [7]	10	400	mg/kg	6 months
	Magnesium	3051	6010B	50	-	mg/kg	
	Manganese	3051	6010B	2	-	mg/kg	
	Nickel	3051	6010B	2	1600	mg/kg	
	Potassium	3051	6010B	50	-	mg/kg	
	Selenium	3051	7740 [7]	3	390	mg/kg	
	Silver	3051	6010B	1	390	mg/kg	
	Sodium	3051	6010B	10	-	mg/kg	
	Thallium	3051	7841 [7]	6	6	mg/kg	
	Vanadium	3051	6010B	1	550	mg/kg	
	Zinc	3051	6010B	1	23,000	mg/kg	
	Mercury	7471A	7471A	0.1	-	mg/kg	28 days
Physical Properties	Total Solids	NA [6]	160.3 [2]	0.1	-	%	7 days
	pH	9045C	9045C	0.1	-	pH	

Notes:

1. Unless otherwise noted, all methods are SW-846, Third Edition, March 1995
2. Methods for the Chemical Analysis of Water and Wastes, March 1983, EPA-600/4-79-020
3. All results are to be reported on a dry weight basis. Actual detection limits will vary based on the total solids concentration and mass used for each sample.
4. Holding is from the date sampled to the date of analysis. Holding times are taken from Methods for the Chemical Analysis of Water and Wastes, March 1983, EPA-600/4-79-020
5. Preparation method 3050A may be used in place of 3051.
6. NA = Not applicable
7. Method 6010B may be used if available to meet the CRQLs
8. Container for all analytes shall be 4 oz plastic or glass.
9. Maintain samples at 4oC.

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Table 2-4
Analytical Methods and Detection Limits
Aqueous Samples
IS&R Remedial Investigation

Parameter	Analyte	Preparation Method (2)	Analytical Method (1)	CRQL	Units	MCL (mg/l)	UDEQ Surface Water Standards 1 Hr.	Preservative	Holding Time (3)
Total Metals	Aluminum	3005A	6010B	0.2	mg/L	-	0.75	HNO3 to pH<2	6 months
	Antimony	3020A	7041 (4)	0.005	mg/L	0.006	-		
	Arsenic	7060A	7060A (4)	0.01	mg/L	0.05	0.36		
	Barium	3005A	6010B	0.2	mg/L	2	-		
	Beryllium	3005A	6010B	0.002	mg/L	0.004	-		
	Cadmium	3005A	6010B	0.004	mg/L	0.005	0.0039		
	Calcium	3005A	6010B	5	mg/L	-	-		
	Chromium	3005A	6010B	0.01	mg/L	0.1	1.7		
	Cobalt	3005A	6010B	0.05	mg/L	-	-		
	Copper	3005A	6010B	0.025	mg/L	1.3	0.018		
	Iron	3005A	6010B	0.1	mg/L	-	1		
	Lead	3020A	7421 (4)	0.003	mg/L	0.015	0.082		
	Magnesium	3005A	6010B	5	mg/L	-	-		
	Manganese	3005A	6010B	0.015	mg/L	-	-		
	Nickel	3005A	6010B	0.04	mg/L	-	1.4		
	Potassium	3005A	6010B	5	mg/L	-	-		
	Selenium	7740	7740 (4)	0.005	mg/L	0.05	0.02		
	Silver	3005A	6010B	0.01	mg/L	-	0.0041		
	Sodium	3005A	6010B	5	mg/L	-	-		
	Thallium	3020A	7841 (4)	0.001	mg/L	0.002	-		
	Vanadium	3005A	6010B	0.05	mg/L	-	-		
	Zinc	3005A	6010B	0.02	mg/L	-	0.12		
	Mercury	7470A	7470A	0.0002	mg/L	0.002	0.0024		28 days
Anions	Chloride	9056	9056	10	mg/L		-	None	28 days
	Nitrate	9056	9056	5	mg/L	10	4	Cool to 4° C	48 hours
	Nitrite	9056	9056	0.5	mg/L	1	-		48 hours
	Sulfate	9056	9056	10	mg/L	-	-		28 days
Physical Properties	TSS	NA	160.2 (5)	5	mg/L	-	90		7 days
	TDS	NA	160.1 (5)	10	mg/L	-	-		7 days
	Alkalinity	NA	310.1/310.2 (5)	5	mg/L	-	-		14 days
	Acidity	NA	305.1/305.2 (5)	5	mg/L		-		14 days

Notes:

1. Unless otherwise noted, all methods are SW-846, Third Edition, March 1995
2. Preparation method 3015 may be used in place of 3005A and 3020A
3. Holding is from the date sampled to the date of analysis. Holding times are taken from Methods for the Chemical Analysis of Water and Wastes, March 1983, EPA-600/4-79-020
4. Method 6020 and Preparation Method 3005A may be used if available to meet the CRQLs
5. Methods for the Chemical Analysis of Water and Wastes, March 1983, EPA-600/4-79-020
6. NA = Not applicable
7. Filtration performed using a 0.45 µµm glass fiber filter.

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Table 2-4
Analytical Methods and Detection Limits
Aqueous Samples
IS&R Remedial Investigation

Parameter	Analyte	Preparation Method [2]	Analytical Method [1]	CRQL	Units	MCL (mg/l)	UDEQ Surface Water Standards 1 Hr.	Preservative	Holding Time [3]
Dissolved Metals	Aluminum	3005A	6010B	0.2	mg/L	-	0.75	Filter on site[7] HNO_3 to pH ≤ 2	6 Months
	Antimony	3020A	7041 [4]	0.005	mg/L	0.006	-		
	Arsenic	7060A	7060A [4]	0.01	mg/L	0.05	0.36		
	Barium	3005A	6010B	0.2	mg/L	2	-		
	Beryllium	3005A	6010B	0.002	mg/L	0.004	-		
	Cadmium	3005A	6010B	0.004	mg/L	0.005	0.0039		
	Calcium	3005A	6010B	5	mg/L	-	-		
	Chromium	3005A	6010B	0.01	mg/L	0.1	1.7		
	Cobalt	3005A	6010B	0.05	mg/L	-	-		
	Copper	3005A	6010B	0.025	mg/L	1.3	0.018		
	Iron	3005A	6010B	0.1	mg/L	-	1		
	Lead	3020A	7421 [4]	0.003	mg/L	0.015	0.082		
	Magnesium	3005A	6010B	5	mg/L	-	-		
	Manganese	3005A	6010B	0.015	mg/L	-	-		
	Nickel	3005A	6010B	0.04	mg/L	-	1.4		
	Potassium	3005A	6010B	5	mg/L	-	-		
	Selenium	7740	7740 [4]	0.005	mg/L	0.05	0.02		
	Silver	3005A	6010B	0.01	mg/L	-	0.0041		
	Sodium	3005A	6010B	5	mg/L	-	-		
	Thallium	3020A	7841 [4]	0.001	mg/L	0.002	-		
	Vanadium	3005A	6010B	0.05	mg/L	-	-		
	Zinc	3005A	6010B	0.02	mg/L	-	0.12		
	Mercury	7470A	7470A	0.0002	mg/L	0.002	0.0024		28 days

Notes:

1. Unless otherwise noted, all methods are SW-846, Third Edition, March 1995
2. Preparation method 3015 may be used in place of 3005A and 3020A
3. Holding is from the date sampled to the date of analysis. Holding times are taken from Methods for the Chemical Analysis of Water and Wastes, March 1983, EPA-600/4-79-020
4. Method 6020 and Preparation Method 3005A may be used if available to meet the CRQLs
5. Methods for the Chemical Analysis of Water and Wastes, March 1983, EPA-600/4-79-020
6. NA = Not applicable
7. Filtration performed using a 0.45 μm glass fiber filter.

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Table 2-4
Analytical Methods and Detection Limits
Slag Pile Leachability Test
IS&R Remedial Investigation

Characteristic	Parameter	Analyte	Preparation Method (3)	Analytical Method (1)	CRQL	Units	MCL (mg/l)	Container	Preservative	Holding Time
Leachability	SPLP (4)	NA	1312	NA	NA	NA	-	Plastic or Glass, 8 oz	Cool to 4o C	14 days
	Total Metals	Aluminum	3010A	6010B	0.2	mg/L	0.006	Plastic or Glass, 500 ml	HNO_3 to pH ≤ 2	6 Months
		Antimony	3010A	6010B	0.06	mg/L	0.05			
		Arsenic	7060A	7060A (5)	0.01	mg/L	2			
		Barium	3010A	6010B	0.2	mg/L	0.004			
		Beryllium	3010A	6010B	0.005	mg/L	0.005			
		Cadmium	3010A	6010B	0.005	mg/L	-			
		Calcium	3010A	6010B	5	mg/L	0.1			
		Chromium	3010A	6010B	0.01	mg/L	-			
		Cobalt	3010A	6010B	0.05	mg/L	1.3			
		Copper	3010A	6010B	0.025	mg/L	-			
		Iron	3010A	6010B	0.1	mg/L	0.015			
		Lead	3010A	6010B	0.04	mg/L	-			
		Magnesium	3010A	6010B	5	mg/L	-			
		Manganese	3010A	6010B	0.015	mg/L	-			
		Nickel	3010A	6010B	0.04	mg/L	-			
		Potassium	3010A	6010B	5	mg/L	0.05			
		Selenium	7740	7740 (5)	0.005	mg/L	-			
		Silver	3010A	6010B	0.01	mg/L	-			
		Sodium	3010A	6010B	5	mg/L	0.002			
		Thallium	3010A	6010B	0.01	mg/L	-			
		Vanadium	3010A	6010B	0.05	mg/L	-			
		Zinc	3010A	6010B	0.02	mg/L	0.002			
		Mercury	7470A	7470A	0.0002	mg/L				28 days

Notes:

1. Unless otherwise noted, all methods are SW-846, Third Edition, March 1995
2. Chapter 7, SW-846, Third Edition, March 1995
3. Preparation method 3015 may be used in place of 3010A
4. Synthetic Precipitation Leaching Procedure
5. Preparation Method 3010A and Analytical Method 6010B may be used if a serial dilution is performed on each sample and the percent difference is within criteria to assure that there are no significant interferences. If 6010B is used the CRQL my be raised to 0.06 mg/L
6. NA = Not applicable

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encountered within this piezometer. Boring PC-3 was drilled to a depth of 25 feet, where refusal was met.

Samples from the borings were submitted to the laboratory for analysis of the constituents listed in Table 2-4.

2.2.6 Source Samples (Tailing, Waste Isolations Cell and Slag)

A Geoprobe® rig was also used to drill approximately 14 holes into the tailings within the impoundment. Each boring was advanced to a depth approximately 5 feet below the tailings/native soil interface. Samples were collected at depths of 0-2 inches, 2-6 inches, within the tailings, and in the native soil below the tailings. An SOP for this procedure was obtained from Geoprobe®.

Four borings were also completed on the old IS&R tailings dike, west of the Carr Fork impoundment dam. These borings were sampled at the same depth zones as those in the impoundment.

The Geoprobe® rig was used to drill 3 borings through the Carr Fork impoundment dam and into the subsurface material to verify the dam material characteristics and conditions of the underlying soil.

A Geoprobe® rig was also used to sample in and around the WIC. Two holes were advanced into the WIC and samples were collected of the cell contents. Waste material within the cell was not saturated as had been reported in earlier reports. (Sadik-McDonald, 1997). Five holes were advanced into the tailing impoundment materials adjacent to the WIC. These holes were used to assess the potential for migration of COC from the cell. No evidence of leakage was detected in sample analytical results. A hollow stem auger drilling rig was used to collect samples below the WIC. Samples were collected within this hole at the surface, 14 feet, 25 feet and at 50 feet. Following sample collection the drill hole was backfilled with bentonite chips to prevent migration of cell contents into the underlying tailing material.

Four samples of slag were collected from different surface areas of the slag pile and submitted to the laboratory for SPLP analysis of the Target Analyte List metals listed on Table 2-4. In addition to the surface slag samples collected, a deep boring was drilled to sample the interior of the pile as described in Section 2.2.5 to determine depth and concentrations of COC below the slag.

2.2.7 Surface Water

Nine locations along Pine Creek were sampled quarterly, except when sampling location was dry, during the RI. Sampling locations are shown on Figure 2-4 and listed here in order from downstream to upstream.

- SW-10: Located downstream near the western Atlantic Richfield property boundary (not sampled-dry)
- SW-9: Located just east of the Elton Tunnel dump (not sampled - dry)
- SW-14: Located just west of the slag pile
- ACSW-5: Located adjacent to the slag pile
- SW-12: Located adjacent to the slag pile
- SW-5: Located at the upstream culvert just east of the slag pile
- SW-15: Located at the eastern property boundary
- SW-18: Located east of the slag pile, along the drainage from the Bingham West Dip Tunnel, which flows into Pine Creek
- SW-17: Located at the mouth of Pine Canyon Tunnel

Pine Creek was sampled starting downstream and progressing upstream. During each monitoring event, field water quality parameters including temperature, specific conductivity, pH, dissolved oxygen, redox potential and turbidity were measured. Flow rates were also measured (not simply visually estimated) after sample collection at each point using a current meter.

Samples for laboratory analyses were collected in suitable containers and appropriately preserved and handled. The samples were analyzed for the constituents listed on Table 2-4. Both dissolved and total metals were analyzed.

2.2.8 Sediment

Sediment is considered to be the solid medium which has likely been transported through runoff that is found in historic and active water ways. Sediment is found in Pine Creek, as well as in various dry channels, alluvial fans, erosion control dikes, and transects across drainages. The sampling of these sediments was performed in accordance with SOP protocol, as follows (locations are shown graphically on Figure 2-4):

WA1 (Northern Hills): There are three small alluvial fans which have formed near the mouth of Swensons Canyon. Surface samples were collected from each of these. Samples collected were single point grab samples. Samples were collected to gauge the impact of aerial emissions in non-disturbed areas.

WA3 (Smelter Area): Five erosion control dikes have been constructed in the area of the former smelter. During snow melt spring runoff and after rains, standing water and sediment collects in these basins, preventing run-off from the area. Twelve sediment samples were collected from behind these dikes. When standing water was encountered, surface water grab samples were also collected. In addition, a sediment sample was collected from the base of a ravine that has cut into the north slope of WA-3 east of the slag pile. These samples were used to measure the concentrations of COC mobilized by surface runoff. Basins are downgradient from both reclaimed and non-reclaimed areas.

WA4 (Dry Creek Basin): Seven discreet sediment samples were collected from WA-4 in the following locations: one at the eastern property boundary, one at the west culvert in the area of the former evaporation pond, one at the culvert crossing the county road, one within a sedimentation control pond, and three along the length of the channel. Three transects across Dry Canyon were also sampled. Each of the transects involved collecting samples in a line normal to the channel axis, resulting in 46 additional samples.

WA6 (Lower Smelter Area): Four sediment samples were collected from the base of the west-facing slope within eroded ravines. The drainage area contributing water to these ravines include areas not previously covered during the 1986 reclamation. Sediment samples collected here therefore provide a good representation of migration of COC from a much larger area than just the ravine itself.

WA7 (Pine Creek Drainage): Sediment samples were collected in the same locations as the surface water samples. In addition to the nine surface water sampling locations, four other locations had sediment samples collected. These were located at the former settling ponds, the wildlife watering ponds, adjacent to the Elton Dump, and the marshy area downstream from the wildlife watering ponds. In addition to these samples, two transects were sampled across Pine Creek, resulting in 56 samples. Samples collected within the drainages were taken to measure the availability of COC to aquatic receptors and as a source of COC that could migrate downgradient

WA8 (Tailing Impoundment): One sediment sample was collected from the Dry Canyon creek bed at the point where the channel is routed through the engineered breach in the Carr Fork impoundment dam. Another sediment sample was collected behind an erosion control dike located just northeast of the Dry Creek channel. One other sediment sample was collected from the base of a ravine which has formed along the east side of the tailing pond (noted during the Site visit with EPA/UDEQ on August 9, 2001).

WA9 (Lower West Area): One sediment sample was taken at the current terminus of the Dry Canyon creek, within the former borrow area. Two sediment samples were collected in the former Dry Canyon creek channel, just west of the impoundment dam. One sediment sample was collected along the irrigation canal (the old Elton Tunnel ditch) flowing across the western boundary of the Site. Three additional sediment samples were collected along an unnamed channel which flows into a former sediment control dike in the western-most portion of the Site.

WA10 (Lincoln Residential Area): Four sediment samples were collected from the former Dry Canyon creek channel. For many year the channel has been used as an irrigation ditch through the town of Lincoln. The samples were collected at the Atlantic Richfield property boundary, the two culvert crossings within the town, and one downstream from the town. Six other sediment samples were collected in former Pine Creek channels which were identified in historical aerial photographs provided by the EPA. In addition, a sediment sample was collected from a former pond located along the Boys Ranch ditch (near the northwest property corner).

Samples for laboratory analyses were collected in suitable containers and appropriately preserved and handled. The samples were analyzed for the constituents listed on Table 2-4.

2.2.9 Groundwater

Groundwater characteristics and sampling locations are discussed in detail in Section 2.15 of this report.

2.2.10 Shallow Soil Moisture

The UDEQ installed seven lysimeters within shallow exploratory borings drilled at the Site during the 1995 field investigation. Five of the lysimeters were located and sampled. The remaining two lysimeters had been destroyed by burrowing animals.

2.2.11 Lincoln Property Sampling

Originally, eight residential properties were sampled in the Lincoln Township during the RI. Residential properties included the two that were sampled by the DERR in 1985 that had lead concentrations exceeding 400 ppm and six others selected for their proximity to potential pathways, i.e. stream channels, and/or exposed to windblown tailings.

Each selected property was divided into approximately 4 zones based on lot size and other site conditions. A single 10-point composite soil sample was collected from soils at a depth of 0-2 inches from each zone. A total of 32 yard samples were collected from the original eight lots.

Dust samples were collected from the interior of the house on each of the eight properties sampled at the same time the exterior property was sampled. Dust samples were collected in accordance with the SOP: Indoor Dust Sampling.

During 2003 and 2004, the scope of work for Lincoln Township residential sampling was expanded to include an additional 66 lots. These were selected in the following manner. Residences adjacent to each of the original lots which had a weighted average lead concentration exceeding the EPA established screening level of 500 ppm were sampled. This pattern was repeated until three lots adjacent to each other had a weighted average lead concentration below the screening level. The additional residential yards resulted in an additional 349 samples. The total number of samples collected in the Lincoln Township was 381.

2.2.12 Ecological Investigation

The ecological investigation included characterization of the fauna and flora communities and habitats. To complete the characterization biologists surveyed the Site habitats and ecosystem conditions. A complete summary of this work is described in Sections 2.12 and 2.13.

2.2.13 Sample Designation

Sample labeling for the original eight lots and other site samples was done in accordance with SOP 1-3, Sample ID and Tracking. Additional first samples, as discussed in Section 2.2.11, were labeled in accordance with SOP 1-12, Residential Sample Labeling.

The following information provides a summary of SOP 1-3, "Sample ID and Tracking." Each sample collected has a unique sample number. It consists of the Site name (ISR for International Smelting and Refining, the medium, sampling location number, and sampling round (numerical). The blind field duplicate for each medium had a similar designation, except that its location number was unique. The following fields were used to designate the samples.

SITE NAME: All labels began with "ISR" to indicate that the sample is derived from the IS&R/Carr Fork investigation study managed by AECI.

SAMPLE LOCATION NUMBER: Each label included a unique identification number. For soil samples, this number was a 4-digit sequential number starting with "0001" and progressively increasing until the final sample has been collected or tag number "9999" has been reached. Surface water, groundwater, and pore water samples have a number associated with a location or well.

WORK AREA: Each label includes a designation of the work area from which the sample has been collected.

MEDIA: Each label includes a media designation. Media designations are as follows:

DB	Deep Boring (hollow stem auger samples; labeled PC in Pine Canyon drainage)
GW	Groundwater
LYS	Lysimeter (followed by a boring designation, such as B2)
SED	Sediment
SPW	Surface Pond Water
SS	Surface Soil (0" to 2")
SUB	Subsurface Soil
SW	Surface Water
TA	Tailings

SAMPLE ROUND: The sample round designation applies to both surface and groundwater samples. The sample round is a number (1, 2, 3, or 4) indicating the quarter when the sample was taken.

SAMPLE DEPTH: Subsurface soil and waste sample labels indicate the depth (in feet) at which the sample was taken. A surficial sample has the designation "SS".

SAMPLE DATE: All samples contained a sample date consisting of the month and year the sample was taken. If a sample were taken on March 5, 2001, the sample date would read 0301.

ALIQUOT REFERENCE DESIGNATION: The aliquot reference designation is a letter between a and e and represents a portion of a composite sample. When composite samples are taken the sampler begins with the northeast sample first and then proceeds counterclockwise until the last sample is taken in the center.

LOT ZONE DESIGNATION: Lots are generally divided into four separate zones, such as GF (garden/flowerbed), PA (play area), YN, YE, YS, YW (yard sample in cardinal direction from house). Zones are labeled by using a number such as "Z1" followed by the two-letter description.
The following are the designations:
(a) – northeast sample
(b) – northwest sample
(c) – southwest sample
(d) – southeast sample
(e) – center sample.

The following table represents sample designations:

Table 2-5
Sample Designations

Media	Sample Designation
Monitoring Well	ISR[1]-GW1[2] -R1[3]-0302[4]
Surface Water	ISR-SW1-R1-0302
Lysimeter	ISR-LYSB2 - WA#[6] - 0302
Surface Pond Water	ISR-0201[5] - SPW - 0302
Soil	
Surface Soil (0" to 2")	ISR-0001[5]-WA#[6] - SS[7]-0302-a[8]
Subsurface Soil	ISR-0002-WA#[6] - SUB-1.5[9]-0302-a
Sediment	ISR-0003 - WA#[6] - SED-0002[10]- 0302
Tailings	ISR-0004 - WA#[6] - TA-1.5[9] -0302
Waste (Waste Isolation Cell)	ISR-0005 - WA#[6] - WIC-1.5[9] -0302
Boring Sample	ISR-DB[11]WA3 - 10[9] - 0302
Pine Canyon (Lincoln) Property Samples (Original 8 lots)	ISR-####PC[12] – WA# - Z1YN[13] - 0301
Tailing	ISR-0007 - WA8 - TA[14] - 3.5[9] - 0302

1 Site Name
2 Sample designation for locations having multiple sampling rounds (groundwater and surface water) or permanent locations (such as a piezometer or lysimeter)
3 Sampling Round
4 Sample Date
5 Sample Location Number (lot number for Pine Canyon residences)
6 Work Area designation (WA-1 through WA-11)
7 Sample Type Designator (surficial, subsurface, sediment, tailing, or waste isolation cell)
8 Aliquot Reference Designation (use only for composite sample locations)
9 Soil/Tailing Sample Depth (in feet below ground surface; for surface sample this designation was SS)
10 Sediment Sample Depth (in inches below ground surface: 0002 is 0 to 2" sample; 0206 is 2" to 6" sample)
11 Deep Boring
12 Four digit residential address and street designation (for example 1234PC would signify 1234 Pine Canyon)
13 Zone Designation
14 Tailing Material

Duplicate samples for QA/QC were given a separate sample number in the 2000-2999 series so as to be blind to the analytical laboratory. The field data sheets (included in the SOP: Sample ID and Tracking), which are not submitted to the laboratory, link the duplicate sample number with the original sample number.

2.3 Sampling Equipment and Procedures

Detailed discussion of sampling equipment and procedures are attached in Appendix O.

2.3.1 Surface Water Sampling

The surface water field investigations included flow rate measurement, water sample collection for laboratory analysis, and field water quality determinations. The equipment and procedures used for all of these components of the field program were standard and common. Details for each of these components are included in the SOPs (See Appendix O).

2.3.2 Groundwater Sampling

Groundwater was sampled according to the appropriate SOPs. In general, an electric submersible pump was used to purge and sample each well. The pump and stainless steel pipe was decontaminated between wells. An equipment blank collected from each sample round tested the efficiency of the decontamination procedures. The results of the equipment blanks indicated that the decontamination procedures were adequate.

2.3.3 Soil and Sediment Sampling

The soil and sediment field investigation involved collecting soil and sediment samples that were used to determine analyte metals at various locations. The equipment used in the collection process included a hollow-stem auger drill rig, a Geoprobe® rig, hand augers and stainless steel sampling spoons. Detailed sampling procedures are described in the SOPs included in Appendix O.

2.3.4 Sample Handling and Analysis

2.3.4.1 Sample Handling

In order to preserve the quality and integrity of samples from the time of collection to the time of analysis, sample preparation, preservation, storage, and delivery procedures were strictly enforced in accordance with project SOPs and industry standard.

2.4 Smelter Site Surface Features

Surface features existing in early 1900 were an important consideration that made construction of the IS&R smelter at this site a feasible option. The IS&R management ordered a thorough study of the topography of the Great Basin region, resulting in the designation of the Tooele site as a near ideal location for a smelter. Located on a broad bench near the mouth of Pine Canyon in the Oquirrh Mountains, 4-½ miles east of the town of Tooele, Utah, the sloping topography of the Site facilitated gravity flow and movement of materials. Equally important, prevailing winds would carry smoke and gas up the canyon and away from inhabited areas. (Tooele County Historical Society, 1986) Described below are some of the major changes made to the Site area as part of the construction of the smelter complex.

As shown on Figure 2-5 (Surface Features) and Figure 1-12 (1952 Site Aerial Photo) the IS&R smelter complex was constructed along the south rim of Pine Canyon, which was approximately 100 feet above Pine Creek, on a sloping foothill bench having parallel contours running almost perpendicular to Pine Canyon. The area graded for construction of the complex was about 1,300 feet wide and extended south some 3,000 feet to the north rim of Dry Canyon, between elevation contours 5,430 and 5,550. Excavating into a series of benches, pads, footings, foundations and terraces, approximately 200,000 cubic yards of soil was moved. The Site was crossed by several railroad grades and in 1924 two flotation concentrators were constructed southeast of the smelter complex in the area of Dry Creek canyon.

Slag was dumped along the rim of Pine Canyon adjacent to the smelter furnaces and over the years of operation, this dump grew to fill the canyon, pushing Pine Canyon Creek into the north slopes of the canyon. Subsequent stream erosion has created a waterfall of about 40 to 50 feet in height as the stream continues to under cut the soil and move upstream.

Tailings from the ore concentrators were hydraulically transported by pipeline to the IS&R tailings pond area shown on Figure 2-5, Surface Features.

The Carr Fork Mill, including flotation ore concentrators, was constructed in Pine Canyon east of the IS&R complex in 1974. Tailings from the Carr Fork Mill were transported hydraulically by pipeline to the Carr Fork tailings pond, northeast of and over the top of the IS&R tailings as shown on Figure 2-5, Surface Features. During construction of the Carr Fork Mill, a new tailings pond dam was constructed to impound water and tailings. The Carr Fork Mill began operation in 1979 and was shut down in November 1981.

The Elton Tunnel, constructed in the 1930s, accommodated a railroad line with accompanying switch yard and grade roads. Associated with the tunnel were the portal structures and the waste rock and cuttings pile from tunnel excavation, commonly referred to as the Elton Dump. These features were addressed in the 1986 Reclamation Plan as described in that section of this report.

The entire Atlantic Richfield property where the operations took place is now enclosed by fencing, with the exception of a portion of the property that was sold to KCC in 1985. The property sold was in the Pine Canyon area and included the Site of the Carr Fork Milling Operations. The fences provide man/animal gates to allow access to the property to foot traffic and animal movement. Six vehicle gates are provided to allow access to the Site for emergency, maintenance and other official vehicles.

The property surrounding the Site on the west and northwest is privately owned while that on the north is managed by the BLM. Property to the east and south is owned by KCC. The Lincoln Township is immediately adjacent to the Site property to the west shown on Figure 2-2, Site Map.

2.4.1 Investigation Activities

Investigation of surface features included the following activities:

- Search existing literature to determine how and when the original surface features were impacted by the construction and operation of the smelter complex.
- Review history of operational changes that led to impacts upon the surface features of the Site.
- Review previous regulatory involvement that precipitated activity on the Site which had impact to surface features.
- Review previous physical onsite reclamation activities that affected or altered the surface features.

The results of these investigation activities form the basis for most of the non-empirical discussions and findings of this Remedial Investigation Report.

2.5 Operational Impacts

2.5.1 Investigation Activities

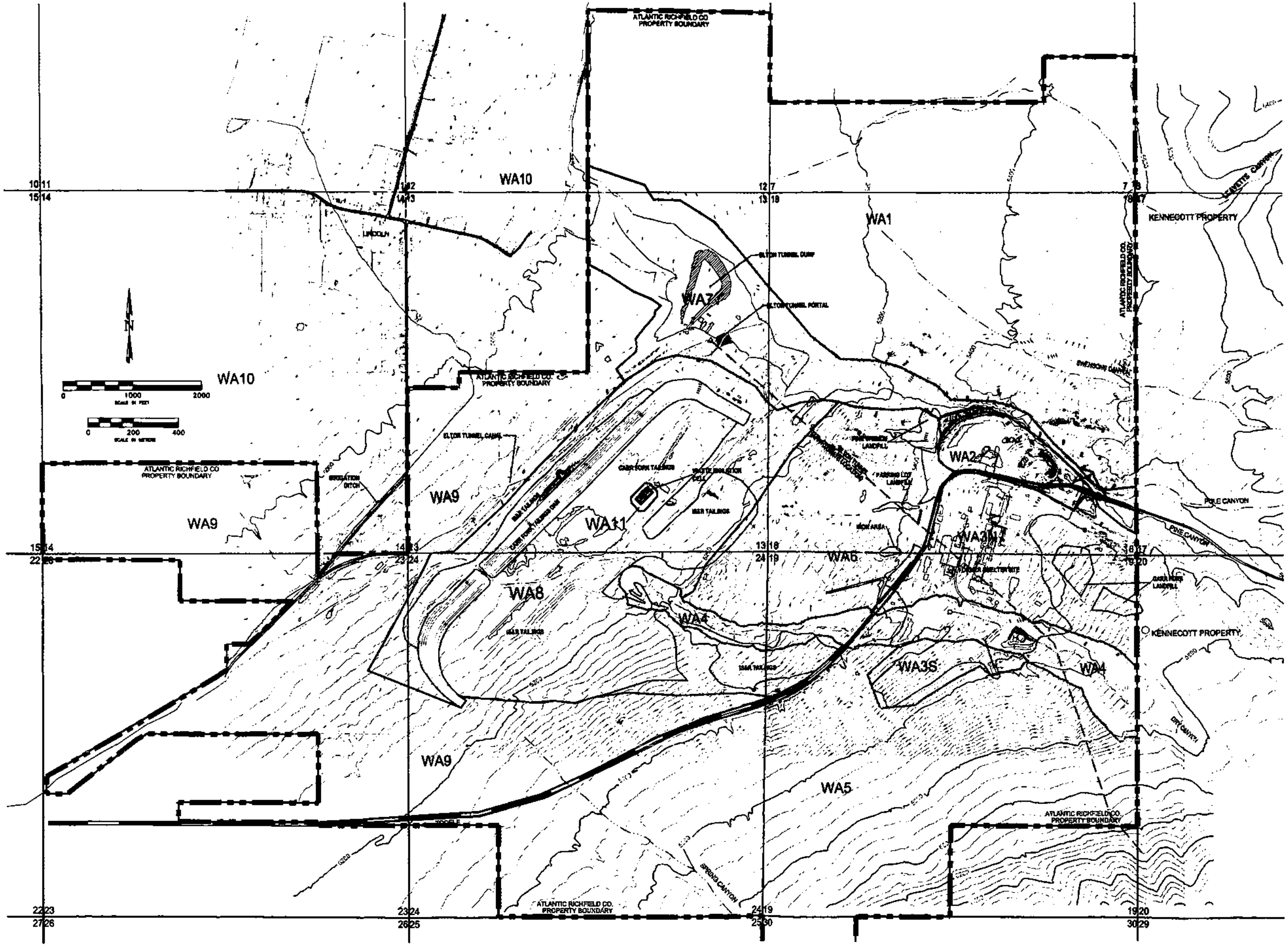
A discussion of operational impacts at the Tooele, Carr Fork site must be preceded by an understanding of how the various processes that comprised the IS&R Smelter developed over the time line of operations from 1908 to its closing in 1972 (see Figure 1-4, Operational Time-line). The construction and short operation period of the Carr Fork concentrating mill in Pine Canyon will also be discussed in Section 2.5.2 as a basis for discussing operational impacts.

Tunnels, buildings, roads, smokestacks, tailings ponds, and railroads were built to assist in the production and operation of the Site. Most of these items were demolished prior to or as part of the reclamation efforts in 1986. Wastes created as a byproduct of the smelting processes included slag, tailings and landfills. This section summarizes to what extent these operations have impacted the Site. In order to determine the nature and extent of the operation waste residues, existing data, articles and previously completed studies were gathered so that field activities could be focused on process residues that resulted from this specific operation. The majority of operational records have either been discarded during past demolitions or were destroyed in 1983 when a mudslide in Pine Canyon destroyed the Anaconda offices. Operational histories have been developed from literature searches at local universities, from periodicals and from records maintained by the company offsite.

2.5.2 Operational Impacts Investigation Results

2.5.2.1 Operational Processes

The mill and smelter were completed in 1910. The original mill and smelter were designed to process only copper ores and included storage bins, a sampling mill, calcining plant, reverberatory furnaces, converters,



General Notes

- Capped Area Boundary
- Year-Round Flow
- Intermittent Flow
- Historical Flow

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: RDE
ENGINEER: KC
APPROVED: SDA

SURFACE FEATURES

REMEDIAL INVESTIGATION
IS&R/CARR FORK
TOOELE, UTAH

Project 97-069
Date APR-03
Scale AS SHWON

FIGURE 2-5

power plant and several small ancillary departments.(TCHS - EMR, 19 Feb 1910, p434) The process required input of crushed ore feed, mechanical energy from electric motors, fuel for heating the plant boilers, various laboratory assay chemicals, and lubricating oils. The product from the process was blister copper, which was sent off-site for refining. The process by-products were ore residuals in the form of gases, fume, ash, dust, spillage, slag, and fuel combustion residuals. Prior to 1924, no chemicals were introduced as a part of the copper smelting process.

The smelter had a maximum capacity of 4000 tons per day, but due to ore quality decline from the Utah Consolidated Mine, by 1911 daily tonnages were running as low as 150 tons and seldom as high as 550 tons.(TCHS - Copper Handbook, p.989) These poor quality copper ores, however, were rich in lead and silver. In an attempt to make the facility profitable, a lead smelter was designed to be constructed on the same site. The lead smelter would utilize the same ore storage, crushing, milling and sampling facilities as the copper smelter, and would include sintering machines, blast furnaces, converters and a drossing plant. The products from the new lead smelter were lead ingots called "pigs", which were shipped off-site to a refinery. The by-products were the ore residuals in the form of gases, fume, ash, dust, spillage, slag and fuel combustion residuals. No chemicals were introduced into the lead smelting process prior to 1924. The lead smelter began operation in March 1912, (TCHS - SLMR, 15,30 November 1912) and operated in parallel with the copper smelter until 1946. The combined smelters treated about 750,000 tons of raw ore annually (TCHS - SLMR, 16 May 1928, pp 9-10). In 1946, copper prices dropped so low that the copper process was shut down. The lead smelter continued operating until 1971, when it was also shut down. Simplified process diagrams for the original copper and lead smelters, as they existed in 1915, were found in the University of Utah Library and are included as Figures 2-6 and 2-7.

In 1924 a sulfide ore concentrator was constructed in the south east portion of the Site, and an oxide ore concentrator was constructed in 1928 (see Figure 1-6, Historical buildings). These ore concentrating facilities mark the first addition of reagents into the smelter process for copper and lead.
The ore concentrators utilized the new principle of flotation as the process for separating and concentrating the copper and lead minerals from the gangue. Because this new technology was very "patent" sensitive, very little information about the Tooele smelter's process or chemicals used could be found in the literature. For this reason, Hong Yong Sohn, Ph.D., Professor of Metallurgical Engineering at the University of Utah, was consulted to research the use of chemicals in the Tooele smelter concentrators. Dr Sohn is an expert in copper/leadsmelting and flotation technology and his statement concerning the Tooele smelter operations is included here in its entirety.

The Tooele operations included both copper and lead production. The descriptions of these operations were obtained from various records and articles as well as the literature covering the typical operating technologies then used elsewhere in the copper and lead production. Based on this information, I have compiled a list of chemical agents likely to have been used during the Tooele operations that could possibly still remain in the soil on that site. This list does not include the metal impurities in the ore that are carried through the metal concentration and smelting processes.

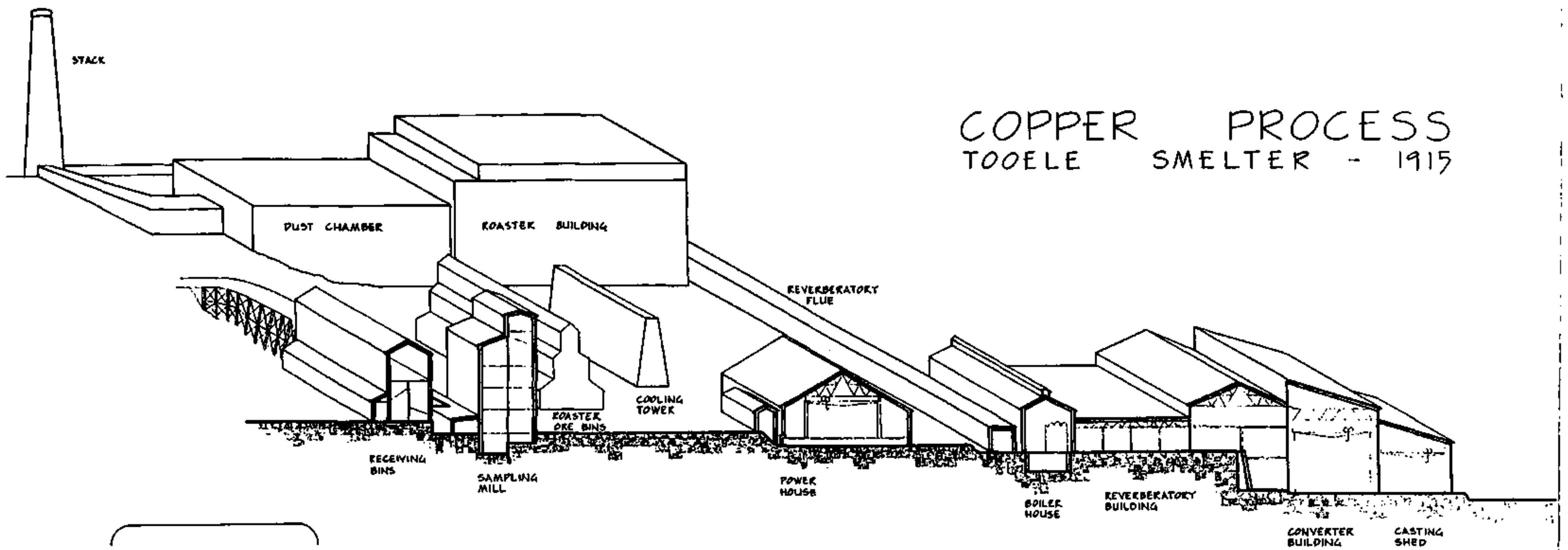
A. Operations Common to Copper and Lead Production

Flotation: The flotation process for concentration of the copper or lead minerals use various chemical agents as collectors (or promoters), frothers, depressants, activators, and modifiers. The role, chemical type, and the typical amount added of each agent are briefly described below:

The collector is used to make specific minerals hydrophobic by selectively adsorbing on the surface of these mineral particles so that they attach themselves to air bubbles and float to the surface of the slurry. The most likely collector used at Tooele is a Xanthate, which is a hydrocarbon molecule containing sulfur atoms and alkali metals (typically sodium or potassium), added to the ore in a typical range of 0.05 – 0.2 pound per ton of ore (Dennis, 1963; Dennis, 1965). Fatty acids, which are chemically similar to common soap, were also used during that time. Xanthates in soil may decompose to produce corresponding alcohols, Na(or $K)_2CS_3$, Na(or $K)_2CO_3$, and CS_2 gas (Pryor, 1965). Over time in the soil, the alcohols are likely to decompose to carbon dioxide and water by micro-organisms, and Na(or $K)_2CS_3$ is likely to be further oxidized to the corresponding carbonate and washed away.

The frother is used to make the bubbles on top of the slurry stable, rather than bursting, until they together with the attached mineral particles are separated from the slurry. The most likely frother used is either pine oil, which is extracted from wood chips that are added in the range of 0.01 – 0.25 pound per ton, (Dennis, 1963; Dennis, 1965; Pryor, 1965) or methyl isobutyl carbinol (MIBC, a hydrocarbon molecule that contains the -OH group, much like phenol) added in the amount of 0.005 – 0.25 pound per ton (Pryor 1965). The organic compounds would over time decompose by oxidation to carbon dioxide and water.

COPPER PROCESS
TOOELE SMELTER - 1915



RECEIVING:
ORE AND CONCENTRATE WERE BROUGHT TO THE SMELTER BY RAILROAD AND THEN DUMPED INTO RECEIVING BINS.

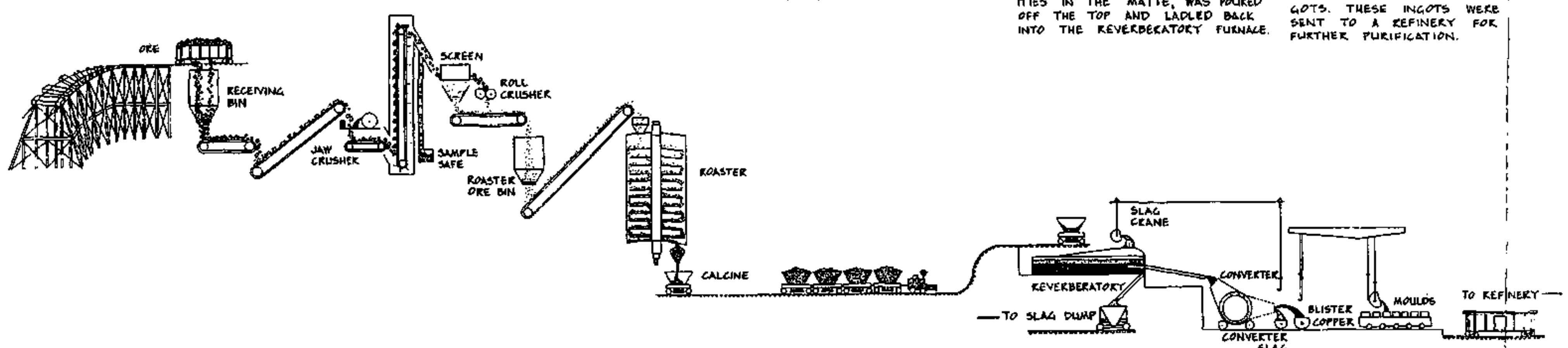
SAMPLING:
ORE WAS CONVEYED TO THE SAMPLE MILL WHERE IT WAS CRUSHED TO 3/8 INCH OR LESS. A BRUNTON SAMPLER WAS USED TO EXTRACT A SMALL REPRESENTATIVE SAMPLE WHICH WAS THEN CHEMICALLY ANALYZED. THE CRUSHED ORE WAS CONVEYED TO STORAGE BINS.

ROASTING:
CONVEYOR BELTS CARRIED CRUSHED ORE AS WELL AS CONCENTRATE TO THE ROASTERS. THE ROASTED MATERIAL, NOW TERMED CALCINE, DROPPED INTO HOPPERS THAT EMPTIED INTO CALCINE CARS. THESE WERE THEN TAKEN TO THE REVERBERATORY FURNACE.

SMELTING:
SMELTING OCCURRED IN THE REVERBERATORY FURNACE WHERE THE CHARGE MELTED TO FORM TWO LAYERS, MATTE AND SLAG. SLAG WAS TAKEN TO THE SLAG DUMP. THE MATTE WAS TAPPED INTO LAUNDERS OR TROUGHS THEN DISCHARGED DIRECTLY INTO THE CONVERTERS.

CONVERTING:
IN THE CONVERTERS THE MATTE WAS BLOWN WITH AIR TO CONVERT THE COPPER SULFIDES AND COPPER OXIDES TO BLISTER COPPER. SLAG FORMED BY IMPURITIES IN THE MATTE, WAS POURED OFF THE TOP AND LADLED BACK INTO THE REVERBERATORY FURNACE.

CASTING:
THE BLISTER COPPER WAS POURED INTO LADLES AND CARRIED BY CRANE TO THE CASTING AREA WHERE IT WAS CAST INTO INGOTS. THESE INGOTS WERE SENT TO A REFINERY FOR FURTHER PURIFICATION.



General Notes

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

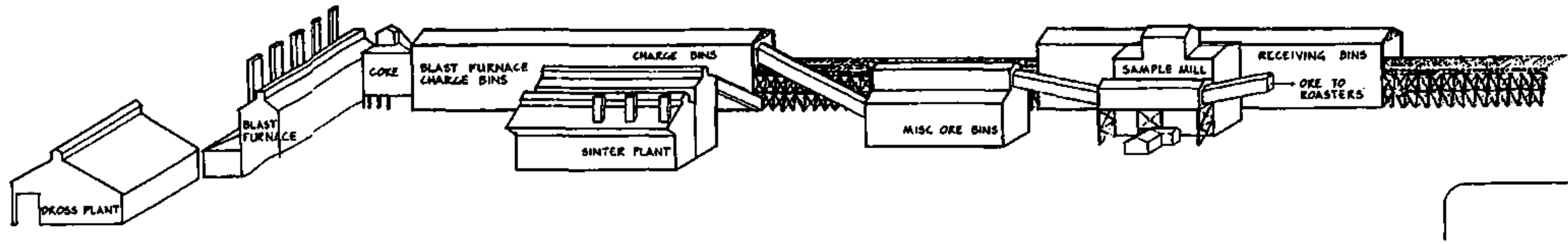
ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY:
ENGINEER: KC
APPROVED: SDA

TOOELE SMELTER COPPER PROCESS

REMEDIAL INVESTIGATION
TOOELE, UTAH

Project	97-069	FIGURE 2-6
Date	APR-03	
Scale	NO SCALE	



DROSSING AND CASTING.
THE MOLTEN LEAD WAS POURED INTO DROSSING KETTLES AND ALLOWED TO COOL UNTIL A LAYER OF IMPURITIES, CALLED DROSS, COULD BE SKIMMED FROM THE SURFACE THE BULLION WAS DISCHARGED FROM THE DROSSING KETTLE THROUGH LAUNDERS OR TROUGHS AND CAST INTO INGOTS. THESE INGOTS WERE THEN LOADED INTO RAIL-ROAD CARS AND TAKEN TO A REFINERY.

SMELTING.
SMELTING OCCURED IN THE BLAST FURNACE HERE THE CHARGE MELTED FORMING THREE LAYERS: SLAG, MATTE, AND LEAD BULION THE SLAG AND MATTE WEE TAPPED INTO A SETTLIG KETTLE AND SEPARATEE MATTE, OR SPEISS, GOING ? THE COPPER SMELTER AND 'AG TO THE SLAG DUMP. TE MOLTEN LEAD BULLION WAS TAPPED INTO LADLES ND TAKEN TO THE DROSSIG PLANT.

CHARGING.
THE CARS CONTAINING SINTER WERE PULLED BACK TO THE CHARGE BINS WHERE THE SINTER WAS MIXED WITH COKE AND FLUXING MATERIAL AS IT WAS DUMPED INTO CHARGE CARS. THESE WERE THEN PULLED TO THE TOP OF THE BLAST FURNACE.

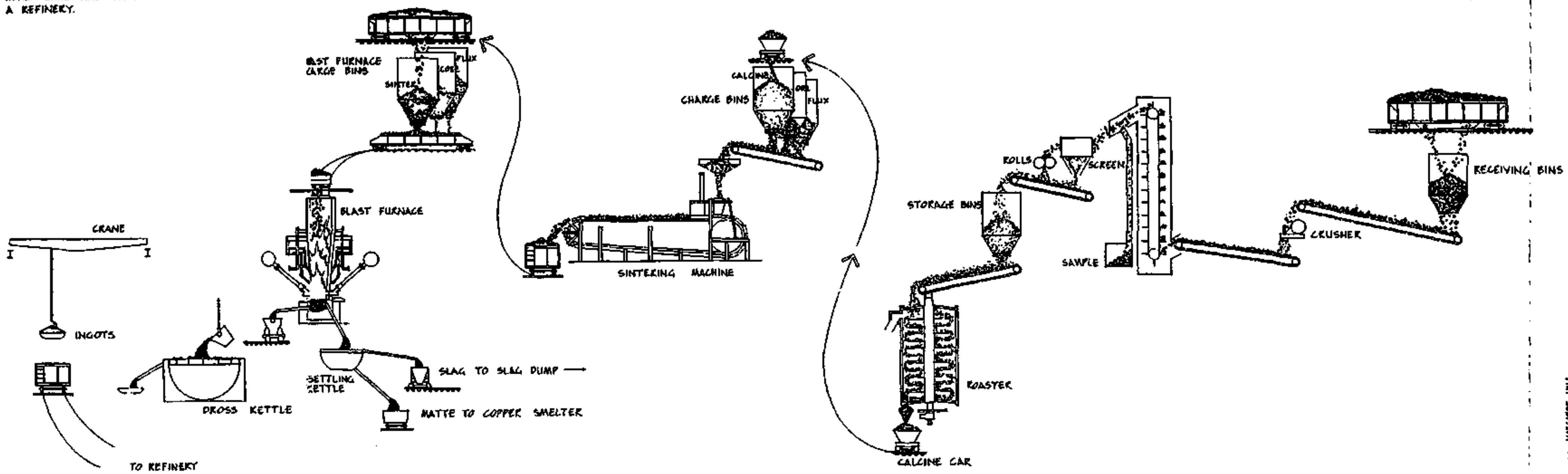
SINTERING:
CALCINE, ORE , AND FLUX WERE MIXED AND FED ONTO SINTERING MACHINES, WHERE THE MIXTURE WAS IGNITED THIS BURNING FUSED THE MATERIAL INTO A LOW-SULFER, POROUS PRODUCT CALLED SINTER. THE SINTER FELL FROM THE MACHINES INTO HOPPERS THAT FED IT INTO RAILROAD CARS BELOW.

ROASTING:
CONVEYOR BELTS CARRIED CRUSHED ORE AS WELL AS CONCENTRATE TO THE ROAST-ERS THE ROASTED MATERIAL, NOW TERMED CALCINE, DROPPED INTO HOPPERS THAT EMPTIED INTO CALCINE CARS THE CARS WERE THEN TAKEN TO CHARGE BINS AND UNLOADED.

SAMPLING
ORE WAS CONVEYED TO THE SAMPLE MILL WHERE IT WAS CRUSHED TO 3/8 INCH OR LESS A BRUNTON SAMPLER WAS USED TO EXTRACT A SMALL REPRE-SENTATIVE SAMPLE WHICH WAS THEN CHEMICALLY ANALYZED. THE CRUSHED ORE WAS CON-VEYED TO STORAGE BINS.

RECEIVING:
ORE AND CONCENTRATE WERE BROUGHT TO THE SMELTER BY RAILROAD AND THEN DUMPED FROM THE CARS INTO RECEIV-ING BINS

LEAD PROCESS
TOOELE SMELTER - 1915



General Notes

No.	Revision/Issue	Date

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DRAWN BY:
ENGINEER:
APPROVED:

TOOELE SMELTER LEAD PROCESS

REMEDIAL INVESTIGATION
TOOELE, UTAH

Project	97-069
Date	APR-03
Scale	NO SCALE

FIGURE 2-7

The depressant is used to discourage the collector from adsorbing on the surface of certain minerals so that flotation may be selective. A number of depressants have been used in flotation technology, including sodium cyanide (NaCN) to depress zinc sulfide, lime (CaO) to depress iron sulfide, dichromate ($Na_2Cr_2O_7$ or $K_2Cr_2O_7$) to depress lead sulfide, and sodium sulfite (Na_2SO_3) to depress zinc sulfide. These depressants were typically added in the range of 0.02 – 1 pound per ton (Dennis, 1963; Dennis, 1965; Pryor, 1965). Sodium cyanide over time is oxidized to sodium cyanate (NaOCN), which is much less toxic than the cyanide. The chromium in the dichromates would remain in an oxidized form in the soil.

The activator acts in an opposite manner to the depressant, especially after a mineral has been depressed by a depressant. In other words, the activator allows a collector to adsorb on the mineral surface by forming on the surface a layer that is friendly to the collector. The most notable example is copper sulfate ($CuSO_4$), widely used to activate zinc sulfide that has been depressed by cyanide. The quantity added typically ranges from 0.1 to 1 pound per ton (Dennis, 1963; Dennis, 1965; Pryor, 1965). The only other activator commonly used is sodium sulfide (Na_2S), added in the amount of 0.5 – 20 pounds per ton of mineral, which activates oxidized lead minerals. Sodium sulfide in nature is likely to produce hydrogen sulfide gas and be transformed to sodium salts or sodium carbonate.

The modifier adjusts the condition (mainly the pH) of the slurry, which affects the charge of the mineral particle surface. Most commonly used modifiers are lime (CaO), soda ash (Na_2CO_3), and sulfuric acid (less common, mainly for oxide minerals). The amounts used depend on the desired pH level, which is not too far from neutral, in the range of 3 – 13 (Pryor, 1965). Sometimes sodium silicate (Na_2SiO_3) is used to disperse slimes away from the mineral surface. Sodium silicate would precipitate silica (SiO_2) in an acidic environment and form insoluble calcium silicates ($CaSiO_3$, Ca_2SiO_4, etc.) in contact with lime or limestone.

<u>Thickening</u>: Thickening is a gravity settling process to separate fine solid particles suspended in water in various stages of mineral processing operations. The process is carried out in large thickeners equipped with rotating rakes. When the slurry contains very fine particles, their settling speed can be very slow or they can even remain in virtually indefinite suspension rather than settling. In this case, settling has to be induced by flocculation --- particles being encouraged to coalesce into small flocs (floccules, agglomerates) of sufficient size to allow ready settlement.

Flocculation is commonly effected by neutralizing the electrical charge on the solid particles, thereby reducing the Brownian motion resulting from the repellant force of the same charge. Typical flocculants include lime, (Dennis, 1965; Pryor, 1965; Taggart, 1945) starch or animal glue, (Pryor, 1965) and Nalcolytes (long-chain hydrocarbon-based polyelectrolytes (Pryor, 1965). The typical amount added is less than 0.02 – 0.05 % of the slurry (SME Mineral Processing Handbook, 1985).

B. Copper Production

Roasting: Roasting involves oxidizing part of sulfur in a sulfide mineral in solid state. The gaseous oxidation product is sulfur dioxide and some sulfur may be oxidized to sulfate and remain in the solid. No chemicals are added in this process.

Mattemaking: Mattemaking involves further oxidation, in molten state, of the roasted mineral to oxidize more sulfur to sulfur dioxide gas and most of the undesired metal constituents such as iron to metal oxides that are absorbed into the slag. The copper sulfide and remaining iron sulfide form molten matte, which is separated from the slag. No chemicals are added in this step, other than silica and sometimes a small amount of limestone added as fluxes that form the slag.

Converting: Converting is a process in which matte is further reacted with oxygen containing gas (air in the years of the Tooele smelter, but recently oxygen-enriched air is used in many smelters) to completely oxidize the remaining sulfur and iron to produce molten copper (crude or blister copper). No chemicals other than silica are added in converting operation.

Fire Refining and Electrorefining: These are steps to remove very small quantities of impurities still remaining in the blister copper produced from converting. Electrolytic refining requires the use of sulfuric acid and some electrode modifiers like glue. The records show, however, the Tooele smelter did not have the refining step, the blister ingots being sent to New Jersey or Montana for refining (Dunlavy, 1986).

C. Lead Production

Sintering: Lead concentrate sintering is equivalent to roasting of copper sulfide concentrate, except here the object is to produce sufficiently strong and porous blocks of sinter. Sintering is aided by adding limestone and silica to the lead concentrate. Sulfur is oxidized by air to either sulfur dioxide gas or sulfate.

<u>Blast Furnace</u>: The lead sinter is charged into a blast furnace together with coke, limestone, and iron scrap. A blast of air oxidizes coke to produce carbon monoxide that reduces the lead oxide (which is also partly reduced directly by carbon when molten) to produce crude molten lead. The iron absorbs sulfur from any unoxidized lead sulfide, arsenic, and other impurities like copper and bismuth to form a speiss. Lime, produced when the limestone is thermally decomposed, combines with the silica in the sinter and iron oxide forms a slag, which absorbs impurities and a small amount of lead oxide. No other chemicals are added in this step.

<u>Refining</u>: The crude lead produced in the blast furnace contains small amounts of various impurities such as silver, copper, tin, arsenic, antimony, iron and bismuth totaling about 4% of the total mass. Crude lead is refined by recovering silver and removing other impurities through a large number of treatments (Dennis, 1965; Hayes, 1993) in which it is contacted with sulfur (drossing), caustic soda + sodium nitrate ($NaNO_3$) + oxygen (softening), zinc (desilverization), and chlorine gas (dezincing) at various stages.

The record on the Tooele smelter, however, indicates that the treatment of crude lead there did not include all of these steps. Comp states that their treatment consisted of bubbling air through the molten crude lead and skimming off the resulting slag, the lead being cast into pigs and shipped to the IS&R refinery in East Chicago. (It is this writer's opinion that they might also have done the cooling and sulfur treatment, because these steps usually precede the oxidation step and remove iron, zinc, copper and parts of arsenic and antimony (Dennis, 1965; Hayes, 1993).

<u>Slag Treatment</u>: The blast furnace slag contains considerable levels of zinc and lead. After thirty years of the smelter operation, large slag dumps had accumulated and it became economic to extract the zinc content (Dunlavy, 1986) (and at the same time recover the lead content as well). The slag treatment involves heating the cold slag together with fresh hot slag, flue dust, and oxide zinc ore, and introducing air and pulverized coal into the furnace tuyeres. The reducing condition of the gas drives off the fume, containing zinc and lead, through a flue system to be cooled and collected in a baghouse. No other chemicals are added in this process.

A summary of process operations employed at the Tooele Smelters in the production of copper matte and "pig" lead, along with major ingredients added during the process, and process products/by-products is shown on Table 2-6, Tooele Smelter Processes, Additives, Products, and By-products. A list of chemicals used in the process and their general toxicity listing is shown in Table 2-7, Tooele Smelter Process Chemicals.

Table 2-6
Tooele Smelter Processes, Additives, Products, and By-Products

Process	Process Additives	Products	By-Products
Ore Preparation			
1. Crushing 2. Grinding, Milling 3. Screening 4. Auto Sampling	Raw Cu/Pb ores Electrical, mechanical energy	Ore fines and samples	Dust, Spillage
Ore Concentration			
1. Flotation	Collector, activator and depressor chemicals	Copper and lead ore concentrates	Process water, and chemicals Tailings and gangue
2. Mineral Thickening	Flocculants	Copper and lead ore concentrates	Process water, and chemicals Tailings and gangue
3. Tails Thickening	Flocculants	Copper and lead ore concentrates	Process water, and chemicals Tailings and gangue
Copper Smelting			
1. Roasting (common to Cu/Pb)	Mineral concentrates Heating fuels O^2 from air	Calcine	Sulfurdioxide gas Fume, ash, dust, and spillage
2. Matte Making (Reverb. Furnace)	Calsine O^2 from air Heating fuels	Matte copper	Sulfurdioxide gas Fume, ash, dust Slag, spillage
3. Converting	Matte copper O^2 from air Heating fuels	Blister copper	Sulfurdioxide gas Fume, spillage Slag
Lead Smelting			
1. Sintering	Calsine, lime, silica Mineral concentrates O^2 from air, heat-fuel	Copper and lead sinter	Sulfurdioxide gas Fume, ash, dust, and spillage
2. Blast Furnace	Copper, lead, sinter, coke, iron, scrap, limestone	Matte copper Lead (Molten)	Sulfurdioxide gas Fume, ash, dust, and spillage
3. Drossing	Molten lead O^2 from air Heating fuels	"Pig" lead ingots	Sulfurdioxide gas Fume, spillage

Table 2-7
Tooele Smelter Process Chemicals

Chemical Name	lbs/Ton of Ore	I.D. #	Guide #	Potential Hazard	Decomposes to :	I.D. #	Guide #	Potential Hazard
				Collectors:				
Xanthate (Sodium Isopropyl) (Potassium Amyl)	0.05-0.2 0.05-0.2	NL* NL	NL NL	skin irritation, burns, with prolonged exp. can be explosive can be combustible degradable if wet	Alcohols: Na_2CS_3 K_2CS_3 Na_2CO_3, K_2CO_3, CS↑	NL NL NL NL NL	NL NL NL NL NL	Non-toxic Non-toxic Non-toxic Non-toxic Non-toxic
				Activators:				
Copper Sulfate ($CuSO_4$)	0.1-1.0	NL	NL	Non-toxic	Stable comp.	NL	NL	Non-toxic
Sodium Sulfate (Na_2S-hydrated)	0.5-2.0	1849	153	Toxic - inhalation, ingestion, skin on contact. May cause injury, burns, death Explosive if heated	Sodium Salts	NL	NL	Non-toxic
					or carbonates	NL	NL	Non-Toxic
					H_2S↑ gas	1053	117	Non-Toxic at concentration released
				Depressants:				
Sodium Cyanide (NaCN)	UN**	1689	157	Toxic - inhalation, ingestion, skin on contact. May cause injury, burns, death	Sodium Cyanate (NaOCN)	NL	NL	Only slightly toxic
Dichromates ($Na_2Cr_2O_7$) ($K_2Cr_2O_7$)	UN	NL	NL	Non-toxic	NaCrO4	NL	NL	Non-toxic
		NL	NL	Non-toxic	KCrO4	NL	NL	Non-toxic
				Modifiers:				
Lime, CaO	Adj. To: pH 3-13	NL	NL	Non-toxic		NL	NL	Non-toxic
Soda Ash ,Na_2CO_3	pH 3-13	NL	NL	Non-toxic				
SulfuricAcid,H_2SO_3	pH 3-13	1831	137	Toxic, inhalation, ingestion, skin on contact. May cause injury or death	H_2O SO_4 ion			
Sodium Silicate Na_2SiO_3	pH 3-13	NL	NL	Non-toxic	SiO_2 $CaSiO_3$			

Table 2-7
Tooele Smelter Process Chemicals

Flocculants:								
lime, CaO	.02-.05%	NL	NL	Non-toxic	NA	NA	NA	NA
Starch, Glue	.02-.05%	NL	NL	Non-toxic				
Nalcolytes	.02-.05%	NL	NL	Non-toxic				
Frother:								
Pine Oil	0.01-.25	NL	NL	Non-toxic	NA	NA	NA	NA
MIBC (methyl isobutyl carbonol)	.005-.25	NL	NL	Non-toxic				

2.5.2.2 Waste Volumes

Methods used to characterize various wastes associated with the Site, included gathering information about the Site, determining volumes utilizing digital terrain management software. Field efforts included boring to find the depths of certain materials and a walking reconnaissance of the Site to identify AOC, boundaries of features, and general condition of the Site to determine status of reclaimed features. Maps showing locations of waste, an estimate of their quantity, and a general depiction of how volumes were calculated and what assumptions were made are included for each of the major features. Sampling completed to evaluate the Nature and Extent of each identified waste is discussed in detail in Section 3.0.

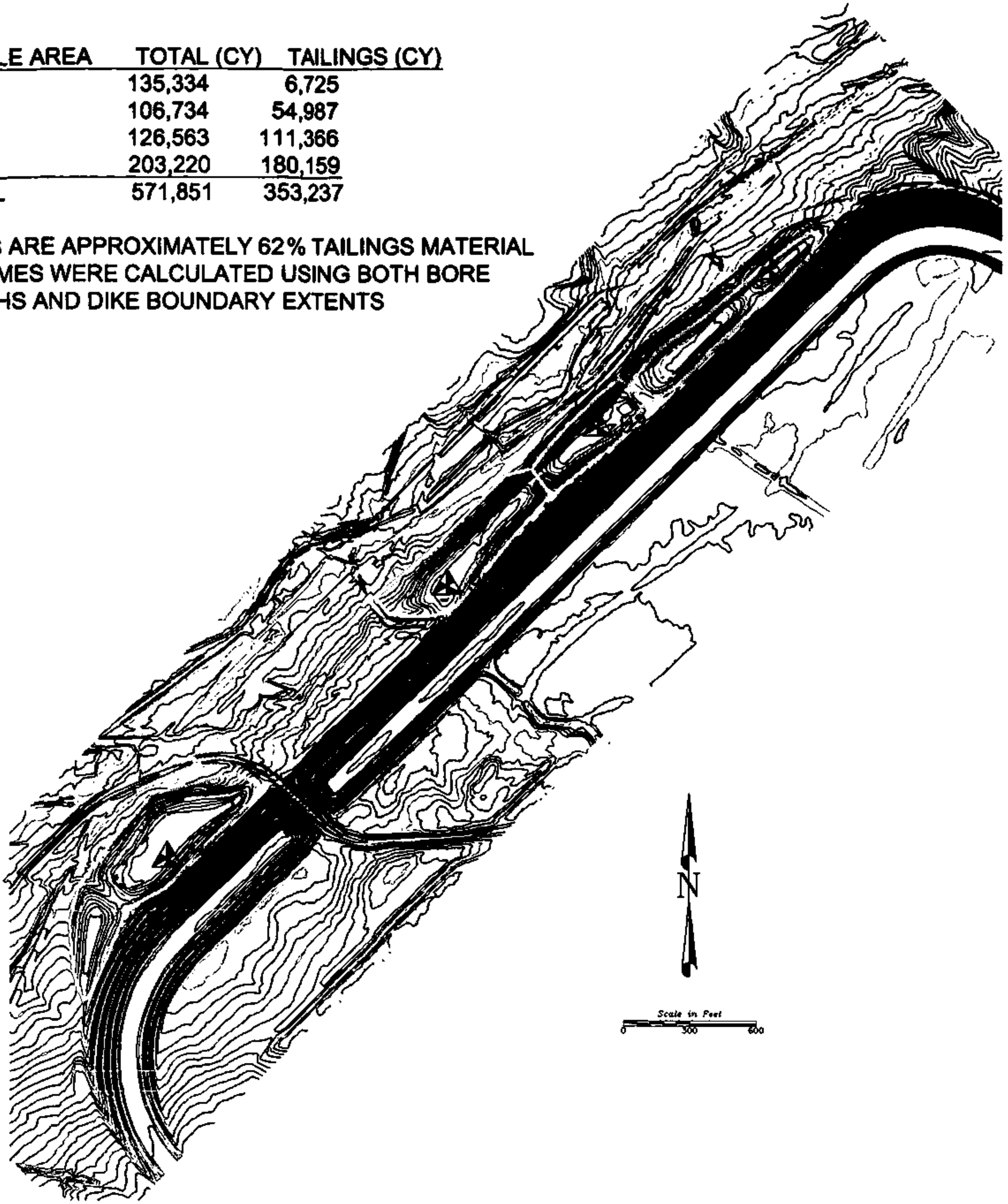
<u>Tailings</u>: The primary production source of IS&R mill tailings were the concentrators that were part of the smelter flotation-complex located along the margins of Dry Creek Canyon. These tailings (distinguishable by their orange/yellowish color) were transported directly by slurry to the pond by gravity pipeline. The IS&R tailings were impounded in one of two separate ponds as shown on Figure 1-12, Tailings Impoundment. This concentrator operation continued from 1924 to the closure of the lead smelter in 1972. The tailings covered approximately 278 acres. Slurry water also collected and evaporated out of ponds behind constructed earthen dikes.

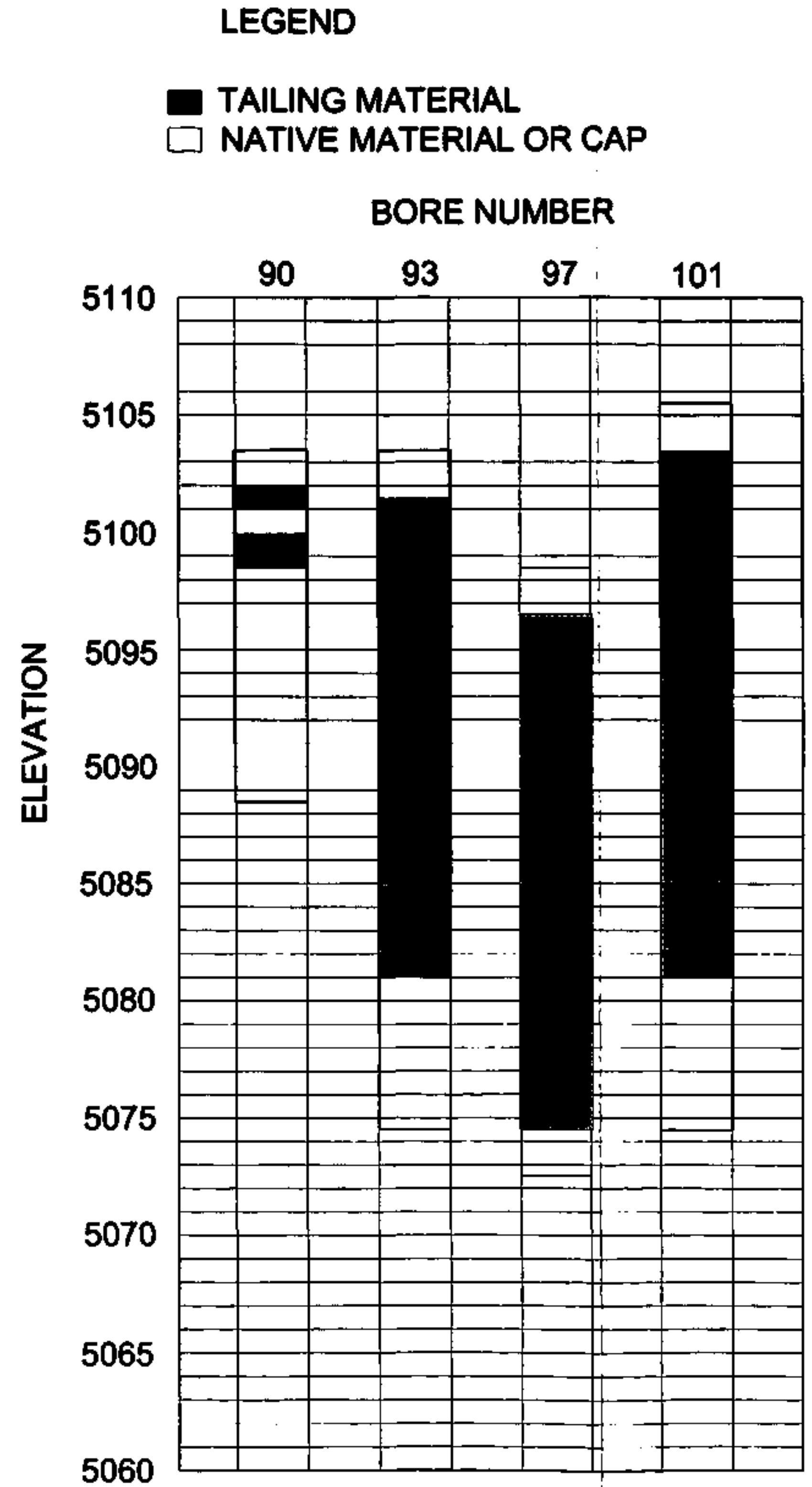
The tailing dike area was divided into four individual areas for calculating volumes of tailings within the dike. These locations coincide with the four bore locations as shown on Figure 2-8. These borings were considered representative of the dike depth in each individual area. The volume of material in each area was calculated by taking the depth of the dike indicated by the boring log and assuming construction materials were

IS&R TAILINGS DIKE VOLUME

SAMPLE AREA	TOTAL (CY)	TAILINGS (CY)
90	135,334	6,725
93	106,734	54,987
97	126,563	111,366
101	203,220	180,159
TOTAL	571,851	353,237

DIKES ARE APPROXIMATELY 62% TAILINGS MATERIAL
VOLUMES WERE CALCULATED USING BOTH BORE DEPTHS AND DIKE BOUNDARY EXTENTS





General Notes

DIKE VOLUME BOUNDARY

TAILINGS VOLUME BOUNDARY

BORE LOCATION

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

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ENGINEER:
APPROVED:

IS&R TAILINGS DIKE VOLUME
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date APR-03
Scale 1"=600'

FIGURE
2-8

placed in even layers. This method of calculation approximated a total volume of 640,000 cubic yards of material within the IS&R tailings dike of which approximately 62% is considered to contain tailing material. Figure 2-8, IS&R Tailings Dike Volume depicts the tailings area and depths.

In 1974 the Anaconda Company constructed and began operations of the Carr Fork mill in Pine Canyon, transporting the mill tailings to a newly constructed tailing impoundment. A large earthen dam (Carr Fork Dam) approximately 60 feet high, was constructed to contain slurried tailings from the Carr Fork mill as well as 100 year runoff flows from Dry Creek Canyon IS&R smelter area. The Carr Fork dam was constructed using soils from borrow areas within the proposed pond area. One borrow area was directly below the main IS&R dike just south of Dry Creek drainage. A second borrow area was below a secondary IS&R dike along the same elevation contour to the north of the Dry Creek drainage. Even though the Carr Fork dam was constructed from soil from these borrow areas within the tailings impoundment, the soil was apparently cleared of most tailings prior to excavation. No evidence of tailing material was found in bore holes drilled in the Carr Fork dam. Tailings material from the Carr Fork process filled the borrow area creating tailing depths as thick as 40 feet. The depth and carbonate nature of the tailings are cited in the 1986 Reclamation Plan (JBR, 1986) as the antecedent for placing the WIC (WA11) at its current location.

The Carr Fork Dam has as approximate volume of 1,447,650 cubic yards. This volume was calculated by taking the difference between the existing adjacent topographic contours and the constructed dam. Figure 2-9, Carr Fork Dam Volume shows the boundaries for the Carr Fork Dam.

Runoff flows onto adjacent areas and eventually into the lined and stabilized Dry Creek channel. Figure 2-10, Tailings Impoundment, shows the boundary area for both the IS&R and Carr Fork impoundment tailings. The Carr Fork tailings volume calculations using boring data show approximately 2.5 million cubic yards.

The volume of tailings for the IS&R impoundment was calculated using the bore data to determine the extent and depth of the tailings-related soils. The IS&R tailings volume is approximately 1,146,950 cubic yards.

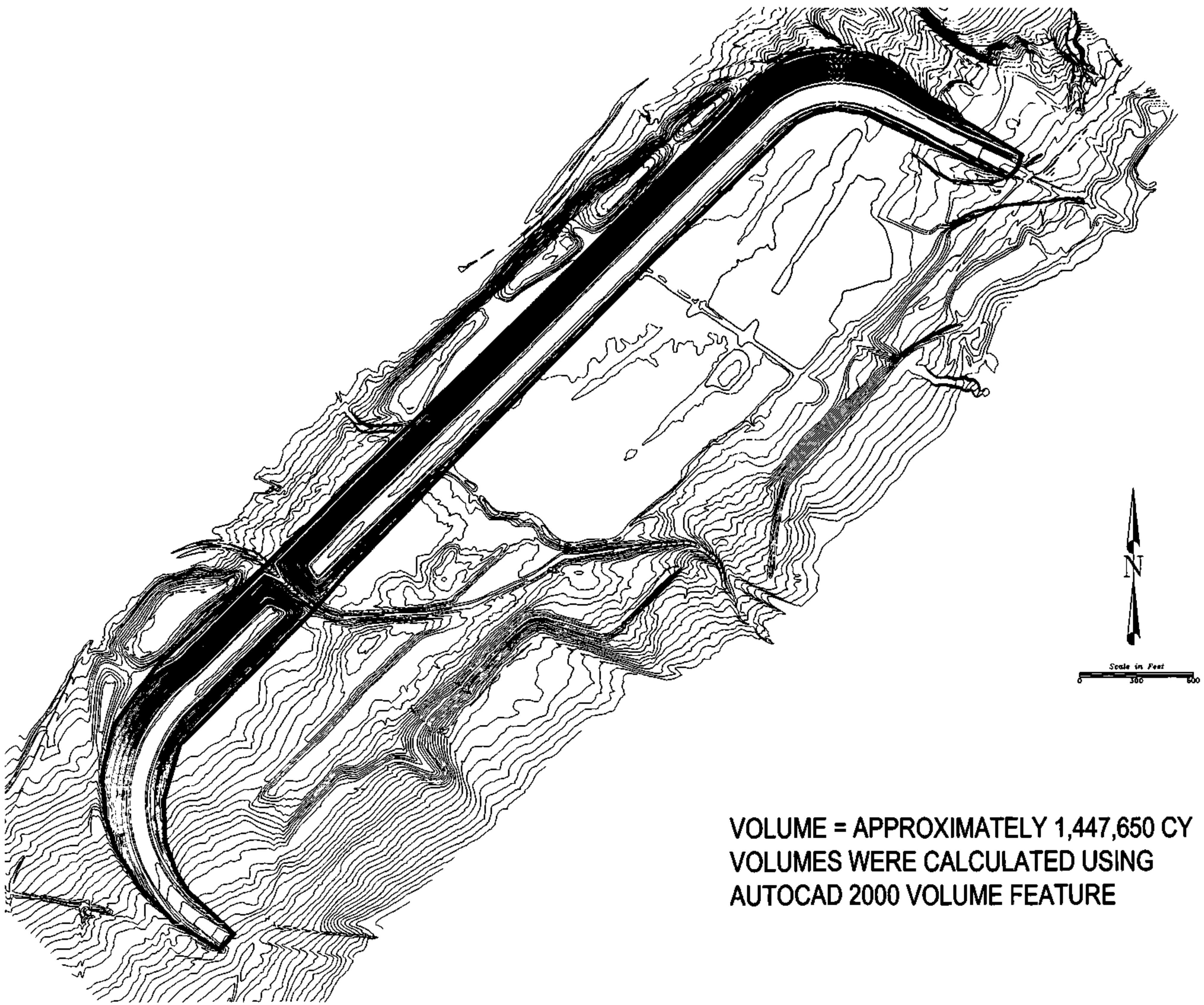
In the 1986 site investigation certain scattered waste materials remaining on site were identified for relocation to a newly constructed WIC. The WIC was located in an area in which a Carr Fork Tailings dam borrow area had subsequently been filled with Carr Fork tailings. After tailings were deposited back into the borrow area it provided a 40-ft depth of tailings between the WIC and underlying clean soils. The location chosen for the waste cell was in the Carr Fork tailings because the tailings, having a mineralogy with significant amounts of carbonate material, provided assurance that neutralization of any acid leachate produced by the low pH smelter wastes in the cell would take place before the leachate could reach native soils. In addition, the tailings in WIC location were the flattest terrain on the property, and therefore, had the least potential for mobilization of wastes by surface water erosion.

JBR indicated wastes selected for relocation to the isolation cell were those which failed the EP-toxicity standards or were found to be acid-generating. The original volume of wastes slated for relocation was 215 cubic yards (JBR, 1986). During actual construction waste piles were conservatively removed using a front end loader, taking underlying and surrounding material as well as specified waste and placed in the WIC. The final constructed volume capacity of the WIC was approximately 1050 cubic yards. It is suspected that 2/3 to 3/4 of the contents of the cell is composed of material which is not acid generating and would not fail the EP-toxicity standard. Sample results of waste removed from the cell bear this out.

A 5-ft compacted clean borrow soil cover was constructed over the WIC. Surface grading was done to expel precipitation water which falls on the cell in order to minimize water migration into the waste materials. Grading provides flow in all directions away from a high point in the center of the cell surface. Runoff flows onto adjacent areas and eventually into the lined and stabilized Dry Creek channel. This water is ultimately captured in the former borrow area at the southwest corner of the Site. However, due to the small size of the WIC (approximately 150 feet by 50 feet), the water drainage from the cell cover surface is minimal.

Slag: During the smelter operation, waste gangue, in the form of slag, was deposited in the Pine Canyon drainage. The slag pile located directly north and adjacent to the historical smelter facility was considered to be range land prior to the design and construction of the smelter. As slag was deposited into the drainage the original streambed was blocked and the creek water forced northward toward the alluvial hillside. During the later years of operation, as the plant became more efficient at metal extraction, the slag pile was mined in an effort to retrieve residual metals. During this period, to prevent stream water from inundating the excavation area, an earthen channel was constructed to carry the creek water. The combination of these two activities has resulted in the stream running along the northern edge of the slag pile. Along the eastern two-thirds of the slag pile, where the earthen channel has been constructed, the stream is stable and a significant plant community has established itself in the area. Along the less protected area on the western third of the pile, the stream has eroded the lose alluvial material creating a canyon between the slag pile and the natural hillside. In this area, the streambed drops approximately 45 feet over a vertical waterfall before continuing down the Pine Canyon drainage.

CARR FORK DAM VOLUME



VOLUME = APPROXIMATELY 1,447,650 CY
VOLUMES WERE CALCULATED USING
AUTOCAD 2000 VOLUME FEATURE

General Notes

VOLUME BOUNDARY

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON
ENGINEERING COMPANY, INC.

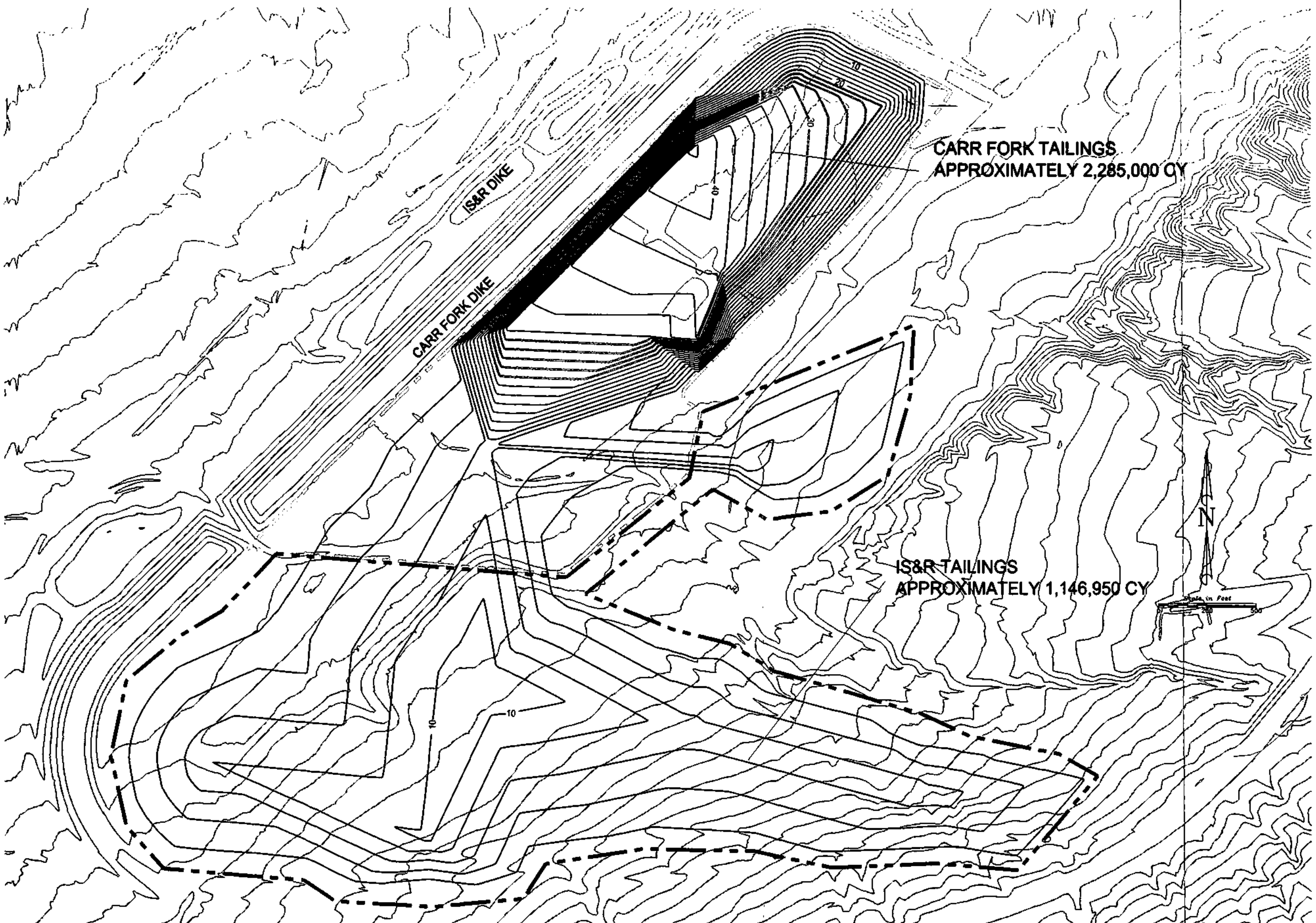
DRAWN BY: GKL
ENGINEER:
APPROVED:

CARR FORK DAM VOLUME
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date APR-03
Scale 1"=600'

FIGURE 2-9

IS&R/CARR FORK TAILINGS IMPOUNDMENT



General Notes

CARR FORK TAILINGS BOUNDARY

IS&R TAILINGS BOUNDARY

DEPTHS OF TAILINGS

40 FEET

30 FEET

20 FEET

10 FEET

NOTE: VOLUMES CALCULATED USING BORE INFORMATION

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: GKL

ENGINEER:

APPROVED:

IS&R/CARR FORK TAILINGS IMPOUNDMENT

REMEDIAL INVESTIGATION

TOOELE, UTAH

Project 97-069

Date APR-03

Scale 1"=500'

FIGURE 2-10

The slag pile volume was calculated using a pre-IS&R/Carr Fork development surface constructed by taking existing topographical features and recreating the contours to parallel what the creek channel would have looked like before the development began. The surface was then compared with existing topographical surfaces to calculate the volume differences between the two. Contours were compared to soil bore log depths and checked accordingly. Figure 2-11 "Slag Waste Volume" depicts the two surfaces and the calculated 3.86 million cubic yard volume.

<u>Elton Tunnel Dump</u>: The historical land use of the Pine Canyon drainage (WA7) prior to construction of the IS&R smelter was range grazing land for ranch cattle, sheep and horses, and irrigation ditches to carry water to local farm land. However, after the construction and operation of the smelter began, this area was included in the purchase of surrounding properties to create a buffer and support zone for the smelter operations. In 1937-38 excavation and construction of the Elton Tunnel began and continued until completion in 1941. Spoils from the tunnel excavation were piled and graded onto the Elton Tunnel Dump.

The Elton Tunnel Dump waste rock volume was calculated by creating a pre-development surface based upon current adjacent topographical features and comparing it with existing topographical surfaces to calculate the volume differences between the two. The Elton Tunnel Dump material was simply excavated rock from the tunnel. There is no indication that there are any tailings-impacted materials within the dump site. Figure 2-12, Elton Tunnel Dump Volume illustrates the two surfaces. The approximate volume of the rock is 193,760 cubic yards. Table 2-8 summarizes the estimated volumes of waste deposits on site.

Table 2-8
Waste Volume Estimates

AREA	VOLUME (CY)
IS&R Dike	
Elton Tunnel Dump	193,760
IS&R Impoundment	1,146,950
Carr Fork Impoundment	2,522,350
Waste Isolation Cell	1,050
Slag Pile	3,855,400
TOTAL	9,807,160

Landfills: There are three known landfills in WA6. The largest is the Pine Canyon Landfill. This landfill is on the southern canyon slope just west of the slag pile as shown on Figure 1-2, Work Area Map. During operations, worn machinery parts, process wastes and other debris associated with the smelter were placed in this landfill. The debris which extended into the canyon bottom was removed from the landfill in 1986. The second largest landfill was called the Parking Lot Landfill. This landfill, prior to reclamation, consisted of debris dumped into a drainage wash at the base of the smelter facility. Finally, a third small debris area consisting mostly of rusted iron smelter parts and iron rich tailings was located during the Site investigation in 1985. This area is also shown on Figure 1-2, Work Area Map.

There were two known landfills in the eastern portion of WA3N. These landfills were created during operation of the Carr Fork mill in Pine Canyon. During operation of the mill, non-process waste materials generated by daily plant activities were placed in the landfills. These are both labeled as Carr Fork landfill on the drawings.

2.6 Meteorology

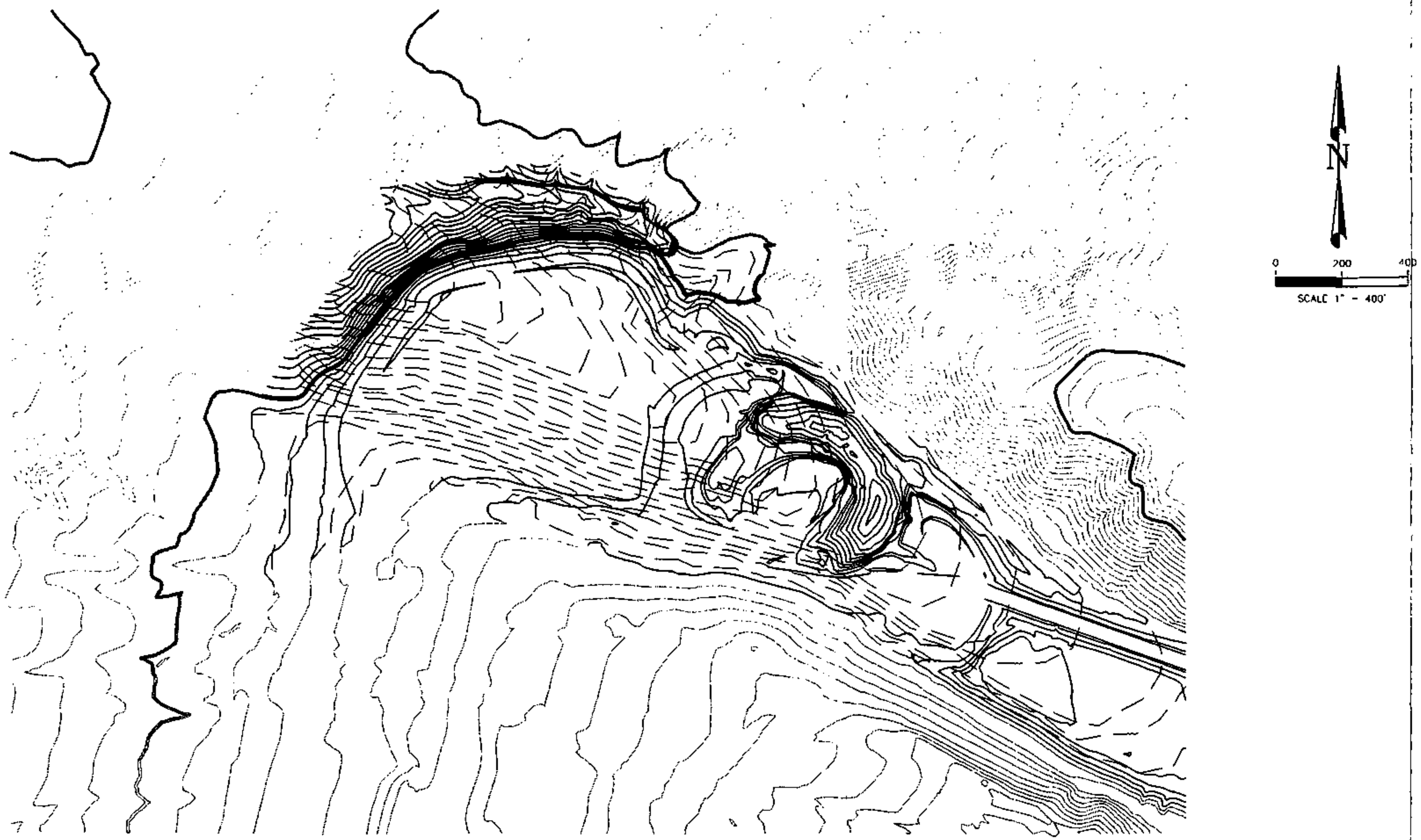
2.6.1 Investigation Activities

Meteorological data was collected to help accurately identify and characterize COC pathways. Local climate parameters were gathered, including precipitation, temperature, wind speed and direction. Information gathered was used to determine recharge, erosion, evaporation potential, effect of weather patterns on remedial actions, and area of deposition of particulates. Weather extremes such as storms, floods, and winds were also researched to help determine the selection and timing of remedial actions. Data was obtained from a variety of sources including the Western Regional Climate Center (WRCC), the National Climatic Data Center, and the Department of Agriculture's Snotel Data Network.

2.6.2 Meteorology Investigation Results

Climatic conditions which affect the environmental conditions at the Site include precipitation, temperature, wind speed and direction, and annual snow cover. The following tables illustrate these important variables.

SLAG WASTE VOLUME



APPROXIMATE SLAG VOLUME = 3,855,400 CY

NOTE: VOLUMES WERE CALCULATED BY CREATING A PRE-SLAG SURFACE AND A POST-SLAG SURFACE AND CALCULATING THE DIFFERENCE BETWEEN THE TWO SURFACES. PRE-SLAG SURFACE WAS INTERPOLATED USING UPSTREAM/DOWNSTREAM EXISTING CONTOURS AND SLAG PILE BORE HOLE INFORMATION

General Notes

—— POST SLAG
— — PRE SLAG ESTIMATE

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON
ENGINEERING COMPANY, INC.

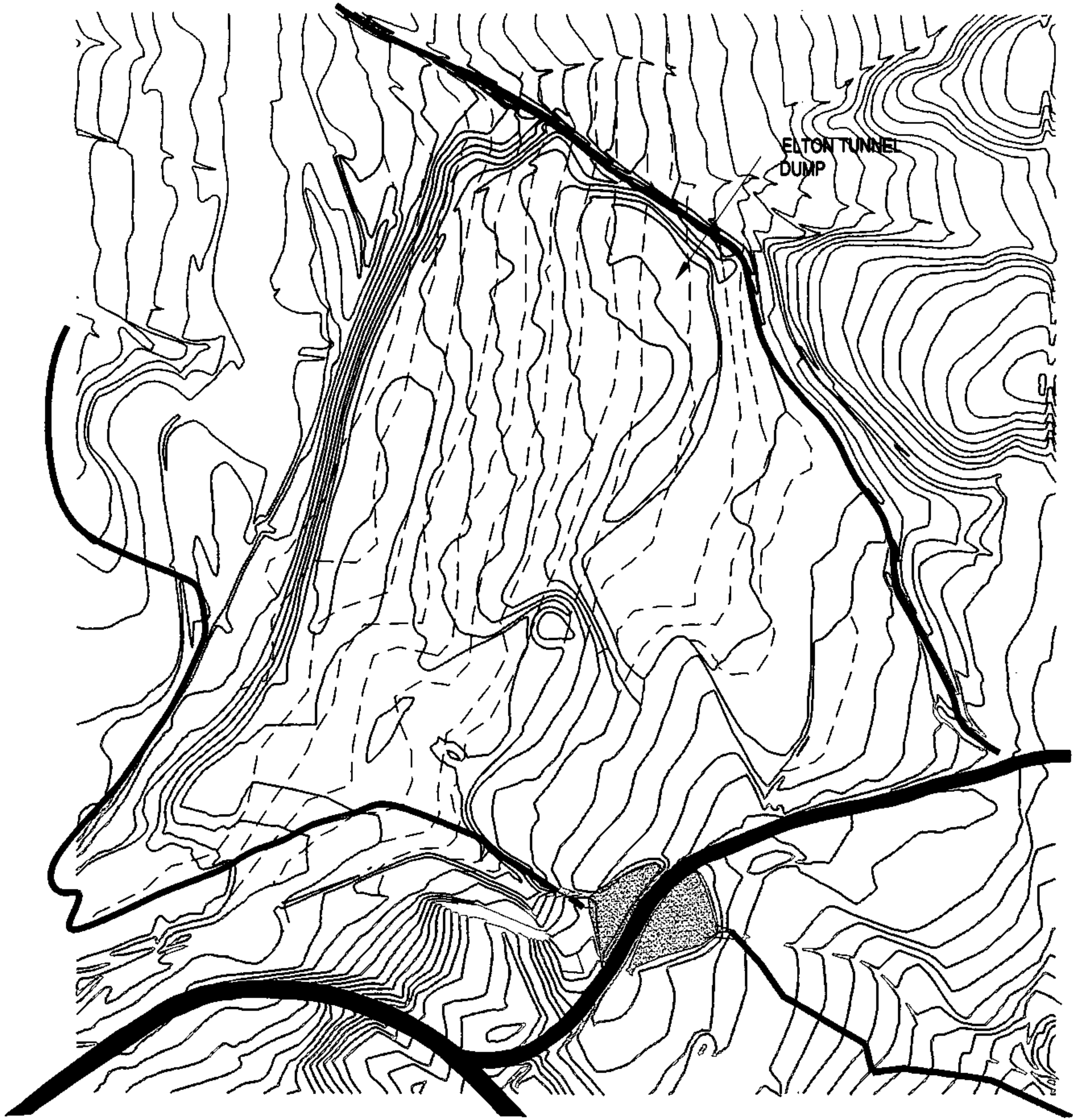
DRAWN BY: CKL
ENGINEER:
APPROVED:

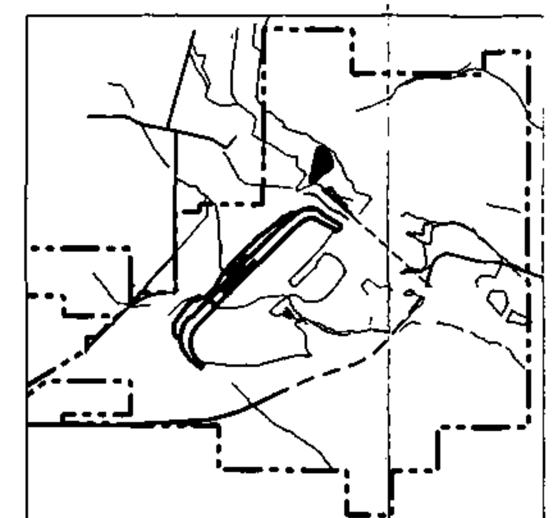
SLAG WASTE VOLUME
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date APR-03
Scale 1" = 400'

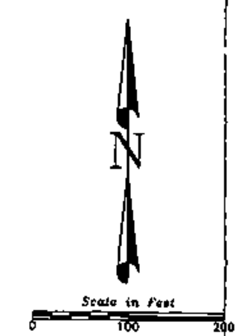
FIGURE 2-11

ELTON TUNNEL DUMP VOLUME





LOCATION MAP



APPROXIMATE VOLUME = 196,000 CY

General Notes

— — PRE-WASTE SURFACE

—— POST-WASTE SURFACE

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: GKL
ENGINEER:
APPROVED:

ELTON TUNNEL DUMP VOLUME
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-068
Date APR-03
Scale 1"=200'

FIGURE 2-12

TABLE 2-9
CLIMATIC CONDITIONS

Average Maximum Temperature (°F)[a] (Tooele)												
JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	YR
38.3	42.8	51.0	60.2	69.2	79.5	88.0	86.5	76.5	63.3	49.1	39.0	61.9
Average Temperature (°F)[a]												
JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	YR
29.1	33.2	40.5	48.8	57.3	66.8	75.0	73.5	63.9	51.5	39.1	30.1	50.7
Average Minimum Temperature (°F)[a] (Tooele)												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
19.9	23.6	30.0	37.4	45.4	54.1	62.0	60.5	51.2	39.7	29.2	21.2	39.5
Dry Fork Precipitation Averages: (in)[b] (Tooele)												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
2.66	3.01	3.93	3.91	3.10	1.46	1.46	1.88	2.74	3.58	3.8	3.45	35.0
Tooele City Precipitation Averages: (in)[a]												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
1.38	1.47	2.13	2.15	2.06	1.01	.78	.88	1.17	1.54	1.62	1.35	17.6
Dry Fork Snow Water Equivalent (SWE) Averages (in) Measured on the 1ST and the 15TH of each month.[b]												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
8.6	10.5	15.3	16.6	9.3	0.0	0.0	0.0	0.0	0.0	1.6	5.1	67.0
9.4	12.0	16.0	14.0	2.7	0.0	0.0	0.0	0.0	0.8	3.1	6.8	64.8
Tooele Average Total Snowfall (in)[a]												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
12.3	11.5	11.0	5.2	1.3	0.0	0.0	0.0	0.1	2.3	8.2	12.8	64.7
Tooele Average Total Snow Depth (in)[a]												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
3.0	3.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.0	1.0
Salt Lake City Int'l Airport Average Wind Speed (mph)[a]												
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
7.2	7.7	8.8	9.3	9.1	9.5	9.5	10.0	8.9	8.1	7.9	7.5	8.6

[a]Western Regional Climate Center
[b]Snotel

The average temperature of Tooele and the Site fluctuates from 29°F in January to 75°F in July with the average minimum being 19.9°F in January and the average maximum being 88°F in July.

Snow melt during the spring has historically resulted in the greatest sustained flows, and is consequently the instigator of erosion throughout the Site. There are two locations near the IS&R site which monitor precipitation and snow quantities. One is a Snotel site and the other is the city of Tooele. The Snotel location is approximately 2.75 miles to the northeast of the IS&R Site in the "Dry Fork" drainage area on the east side of the mountain divide at an elevation of 7160 feet. Data from this location is similar but not an accurate depiction of the Site because it is at a much higher elevation and on the other side of the divide. The second location is in Tooele City which is immediately next to the Site. The Tooele City data will be highly comparable to that of the lower site areas with values changing at higher elevations across the Site. Tooele averages 17.6

inches of precipitation a year with Dry Fork averaging around 35 inches. It is estimated the Site would average around 18-19 inches a year.

The original builders of the IS&R facility selected the location because of what was referred to as the prevailing winds moving up the canyon and away from the population center and farmland near Tooele. A wind rose from one year (1973) of actual site weather station data (only meteorology records available) indicates the dominant wind directions are north and south with westerly winds next most prevalent. See Figure 2-13, Wind Rose. This information, though limited, is consistent with other wind data gathered for the area (See SAIC Wind Rose, Appendix N) In addition to normal prevailing winds, the foothills where the smelter sat benefit from evening canyon winds created by convection currents creating air movement up the canyon each day. Areas affected by the SO_2 emissions from the smelter stacks are now slowly recovering. Wind velocities in the area as recorded at the Salt Lake City Airport average 8-10 mph.

Weather extremes in the form of floods, tornados, and storms rarely occur in the Tooele Area. The National Climatic Data Center has 90 events reported in Tooele County, Utah between 1950 and 2002 which classify as "Storm Events". The majority of storm events recorded for Tooele County were thunderstorms, high winds, hail, lightening, and dry micro bursts.

Attached in Appendix F are additional historical weather data including:

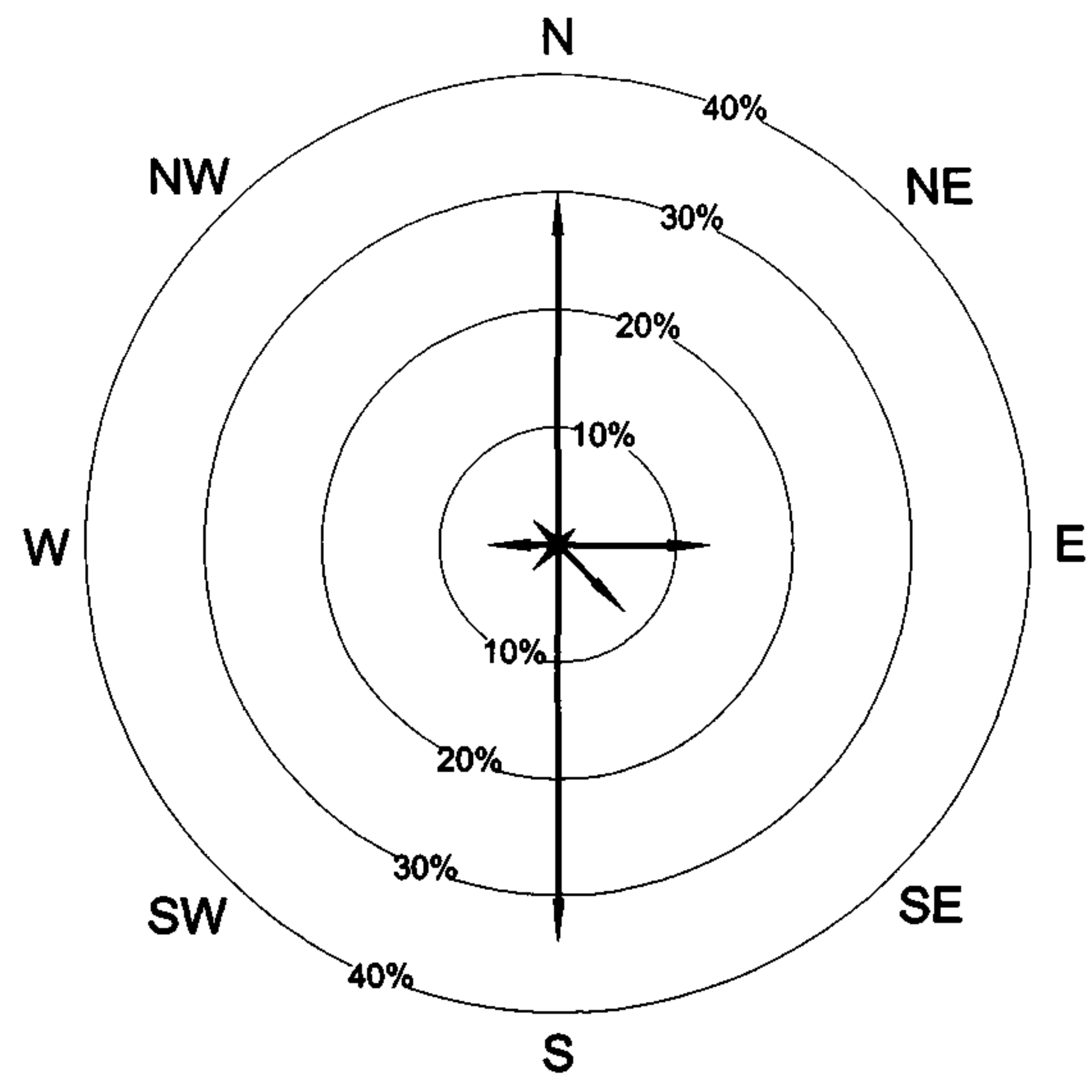
Mean monthly and annual dew point temperature (F)
Mean monthly and annual Wet bulb temperatures
Mean monthly and annual percent relative humidity (afternoon)
Mean monthly and annual percent relative humidity (morning)
Mean monthly and annual percent of possible sunshine
Mean monthly and annual number of thunderstorms
Mean monthly and annual number of cloudy days
Mean monthly and annual number of days heavy fog
Mean monthly and annual number of clear days
Spring "freeze" probabilities (Jan 1 - July 31)
Fall "freeze" probabilities (Aug 1 - Dec 31)
"Freeze free" Season Probabilities
Daily snowdepth average and extreme
Heating Degree Days
Cooling Degree Days
Growing Degree Days

2.7 Topography

2.7.1 Investigation Activities

Topographic contouring as shown on figures and drawings in this report are from aerial photography and mapping completed by Olympus Aerial in December, 2000. Surface features shown are post reclamation.

WIND DIRECTION



IS&R/CARR FORK
SMELTER SITE WEATHER STATION

JANUARY - DECEMBER 1973

RINGS REPRESENT PERCENT OF TIME (100% TOTAL)

Addendum No.1 December 21, 2001

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

IS&R SITE WIND ROSE DIAGRAM

REMEDIAL INVESTIGATION
TOOELE, UT

Project 97-089	FIGURE 2-13
Date APR-03	
Scale NO SCALE	

2.8 Geology

2.8.1 Geological Investigation Activities

The majority of geological information for the Site has been derived from literature research of documents published by USGS and others. Various researchers have investigated the geology of the area, both locally and regionally, over the years. Regional information from literature was locally verified and expanded upon during the RI field work.

During the remedial investigation, several exploratory borings were drilled to depths ranging from 25 to 750 feet. As part of the shallow subsurface investigation at the Site, a series of exploratory borings were completed within the majority of the Site Work Areas. In general, most of the borings were completed to a depth of 50 feet, with the exception of boring PC-1, completed to a depth of 98 feet within Pine Canyon (WA7). As part of the groundwater investigation, the following wells were drilled to depth ranging from 650 to 750 feet.

- GW-3A Northwest property corner 650' deep
- GW-7 West of Boys Ranch well (WA10) 655' deep
- GW-8 West of Boys Ranch well (WA10) 665' deep
- GW-1BR Replaced 16" Boys Ranch Well 750' deep

In addition to the subsurface investigation, surface topography was analyzed in order to interpret the local geology.

2.8.2 Geology and Soils Physical Investigation Results

The IS&R/Carr Fork site is located within the Basin and Range Physiographic Province. It is situated on the western flank of the Oquirrh Mountains, along the eastern edge of Tooele Valley, a graben formed by Cenozoic era normal faulting.

Valley fill consists of interfingered sands, silts, gravels, and clays originating from lake bottom, lakeshore, stream, and alluvial fan deposits. The lower portion of the Site (the western portion) is situated on Lake Bonneville shoreline deposits, consisting primarily of sandy beach deposits. The upper portion of the Site, from WA6 eastward, including the smelter area, consists of Harkers Alluvium, containing sand, silt, clay, and gravel deposited in pre-Lake Bonneville alluvial fans.

The thickness of the alluvial valley fill ranges from over 7,000 feet in parts of the northern portion of Tooele Valley, to 0 feet where the fill feathers out at the margins of the valley. The deep boring information obtained at the Site from the monitoring well logs indicate that the alluvium underlying the majority of the Site is at least 730 feet deep (based on the well log information from site monitoring well GW-4). Information from the USGS indicates that the alluvium in the vicinity of Lincoln is at least 900 feet deep (Razem and Steiger, 1981).

The bedrock exposed above the Site is primarily composed of the following formations, in order from oldest to youngest (Davis, 1983):

- Bingham Mine Formation (Upper Pennsylvanian): consisting of gray to tan quartzite interbedded with gray sandstone, limestone and siltstone
- Curry Peak Formation (Lower Permian): consisting of gray to light tan sandstone, siltstone, and quartzite, with thin interbedded limestone
- Freeman Peak Formation (Lower Permian): consisting of gray and tan calcareous quartzite, with thin shale and sandstone
- Kirkman and Diamond Creek Formations (Lower Permian): consisting of light gray, tan, or white sandstone overlying bluish gray brecciated limestone

These formations have contributed to the alluvium underlying the Site which, as indicated previously, consists of a mixture of sand, silt, clay, and gravel (sandstone, limestone, and quartzite gravel). Typical of valley margins in the Basin and Range physiographic province, alluvial fans form at the mouth of each of the canyons, their size dependent upon the size of the drainage basin and the transportabilty of the material within the basin. Over time, multiple alluvial fans tend to coalesce into a bajada. Much of WA1 is located on a large bajada formed from Swensons, Leavitts, and Pass Canyons. The well logs from drilling GW-3A (located in the northwest corner of WA1), GW-1BR (located on the west side of WA7), GW-7 and GW-8 (located on the east side of WA10, across the property line from the Boys Ranch Wells), indicates that the subsurface material descriptions are consistent with the general characteristics of the valley margin environment. The logs showed a 750 foot mixture of sand, silt, clay, and boulders, typical of an alluvial fan depositional environment.

The quartz monzonite intrusion of the Bingham Stock crops out approximately 4.5 miles to the east of the Site (see Figure 2-14, Site Geology). The intrusion caused the emplacement of the copper ore which has been mined by the Bingham pit, various former mines and tunnels of the IS&R era, and the former Carr Fork Mine. The mountains to the east of the Site, surrounding the stock, are highly mineralized. The ore bodies surrounding the intrusion are replacement deposits of copper, zinc, and silver-lead, zonally arranged outward from the intrusion. The chief copper ores present are chalcopyrite ($CuFeS_2$), bornite (Cu_5FeS_4), chalcocite (Cu_2S), and enargite (Cu_3AsS_4). Also present in these deposits are large quantities of pyrite (FeS_2)and arsenopyrite (FeAsS). Arsenic is a natural occurrence as a result of the enargite and arsenopyrite.

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 2024001

SITE NAME: INTERNATIONAL SMELTING & REFINING

DOCUMENT DATE: 08/01/2004

DOCUMENT NOT SCANNED

Due to one of the following reasons:

- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☑ OVERSIZED
- ☐ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

FIGURE 2-14 SITE GEOLOGY

Contact the Superfund Records Center to view available document.
(303) 312-6473

The Occidental Fault, a normal fault with the downthrown side on the west, traverses the northeast corner of the property through WA1. Based on the inferred trace of the fault, it apparently caused the formation of Pine Canyon. The inferred fault trace follows the northwest trend of the canyon into the valley. It is possible for mineralized groundwater solutions to migrate along the pathway of the faultline, and then through the canyon alluvium. In particular, arsenical water may preferentially migrate along the fault and corresponding Pine Canyon alluvium at depth. This is a potential contributing factor in the arsenic contamination of the Boys Ranch well.

The Figure 2-14 also shows an antithetic fault parallel to the Occidental Fault in the area of Erda. The trace of this fault is close to several of the wells which were sampled in Erda. This may also be a potential pathway for migration of some of the groundwater constituents into wells in the Erda area.

2.9 Demography and Land Use

2.9.1 Investigation Activities

Investigative activities for demography and land use included conducting personal interviews with town residents and members of the various governmental agencies and researching various municipal documents obtained from both city and county sources. The Community Advisory Group (CAG) provided a source for several interviews with local leaders and community members. Local resident Ken Shields (CAG Chairman) was instrumental in providing information about growth, current water systems and the number of households in Lincoln. The Tooele County Engineer provided information about the growth patterns for the city of Tooele. Also Nicole Cline from the Tooele County Planning Department provided the necessary documents to outline the future uses and zoning for Lincoln.

2.9.2 Demography & Land Use Investigation Results

The Atlantic Richfield property is designated as a wildlife conservation area in accordance with an easement agreement between Atlantic Richfield and the Utah State Department of Natural Resources. This agreement precludes the property from being used for purposes other than the maintaining and enhancement of wildlife indigenous to the Oquirrh range foothills. The 1986 reclamation objective was to return the Site area to natural wildlife rangeland and extensive efforts were made then and have been made since to protect this area for wildlife purposes. The Management Plan prepared by UDWR and endorsed by Atlantic Richfield defines uses and periods of use allowable on the property (UDWR, 1994).

In general, current use of the area includes light recreational uses such as walking, wildlife observation and hunting. Motorized vehicles are not permitted on site. The property is fenced to prevent unauthorized use of the area.

Lincoln: The nearest community, Pine Canyon (Lincoln)Township, is a rural residential and farming area. The Lincoln Township was established in 1996 to avoid annexation or incorporation from neighboring Tooele City. The township operates as a separate planning district within the county and has its own planning commission which reviews local planning and land use issues, defines future land use and development, and makes recommendations for approval or denial to the county commission. Figure 2-15, Site Topographical Map shows physical features of the Lincoln Township. Current use include residences, recreational sites and open agricultural land. Early settlers began building homesteads in Lincoln in the mid 1850's. Residents negotiated with Tooele City citizens for 1/3 of the water discharging from Middle Canyon. This water coupled with Pine Canyon discharges provided an attractive location for farming and grazing cattle. Over the years the community has grown to a population of approximately 500 people.

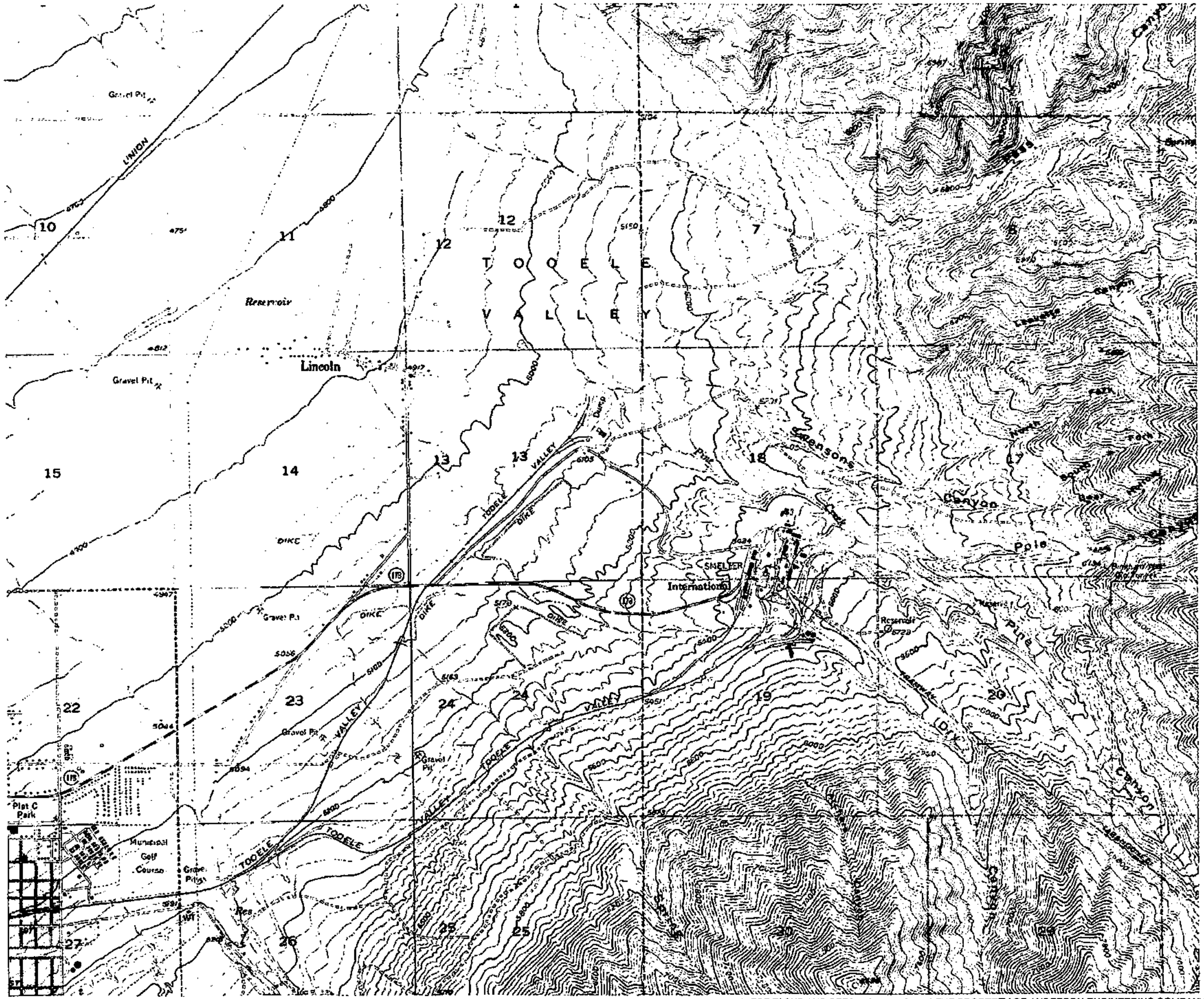
Water: Drinking water is the controlling factor for growth in the Lincoln area. The Township has a private user owned water company, Lincoln Culinary. Sources for this water are springs and wells located in non-smelter-impacted Murray and Middle Canyons. Currently all Lincoln Culinary water is allocated to existing land owners with little to no capacity for future development (Shields, 2002). Likewise the State Engineer's office is not approving new applications for water in the Tooele Valley because of the already existing over-allocation of underground resources in the valley.

Lincoln does have an emergency connection to the Tooele City water system. However, because of the valley's limited water supply, Tooele is not accepting new users to their system outside of the existing city limits. Any new growth in the Lincoln area will require a comprehensive valley wide solution to the limited water resources available.

Middle Canyon Irrigation Company provides the water now being used for irrigation purposes in Lincoln. This ditch flows adjacent to Ericson Road, onto WA9 on the IS&R site and into the old Dry Creek channel where it flows northwest through town. Various users extract water from the ditch as it passes through town. The irrigation ditch and the Dry Creek streambed also serve as the primary drainages for surface water generated on community streets during storm water events.

There are no perennial streams that flow through the central core area of the Township. Historically, irrigation water from Pine Canyon Creek, supplemented by flows from Elton Tunnel and the Carr Fork mine, was diverted for use on fields in and around Lincoln. Since Kennecott has been diverting water from mine dewatering to the Salt Lake Valley side of the Oquirrh range, Pine Canyon flows are so low that irrigation use is unfeasible.

Sewer: There is not a centralized sewer system in Lincoln. The size and location of the Township make either creating or connecting into an existing centralized system very costly and economically unfeasible. (Tooele County Master Planning



General Notes

N

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: GKL

ENGINEER: KC

APPROVED: SDA

SITE TOPOGRAPHICAL MAP

REMEDIAL INVESTIGATION

TOOELE, UTAH

Project 97-069	FIGURE 2-15
Date APR-03	
Scale NO SCALE	

document, Chapter 15) Currently all residences are connected to individual septic tanks and drain fields.

Over the past two years a Community Advisory Group (CAG) has participated with EPA in informing local residences of the remedial investigation progress and interim results. Residents who are members of the committee have expressed the desire to maintain the slow growth policies currently in place and wish to preserve the rural residential nature of the township.

Land Use: There are three types of use within the Lincoln Township: 1) residential, 2) agricultural and 3) recreational. Residential use is concentrated along Ericson Road, Blue Peak Road, Pine Canyon Road and Churchwood Drive. Behind the houses along the roads are large open fields used for farming and pasture. Northwest of the Pine Canyon/Blue Peak Road intersection is a large tract of land used as a weekend camp for scout groups. This parcel is the original Boys Ranch established in the mid 1800's.

The Tooele Valley and in particular Tooele City has grown rapidly during the last decade. Because of the perceived availability of open space in Lincoln, growth is edging toward Lincoln. Land use planning and infrastructure limitation will, however, deter significant growth. To maintain the rural agricultural flavor of the area, the master plan restricts the amount and type of growth in Lincoln. Though the actual township boundaries are large in area, the bulk of the population is located along Ericson Road and near the intersection of Blue Peak Drive and Pine Canyon Road. The intersection is considered the population center and is zoned RR-1 (see Figure 2-16, Lincoln Township Zoning). The area surrounding the population center is currently Zoned RR-5 also shown on Figure 2-16, Lincoln Township Zoning. The master plan allows for an annual review of the RR-5 zone and the need for changing the zoning to RR-1.

Development growth of the community to the north and to the east will not occur as a result of the conservation easement on the Atlantic Richfield property and the no development policies on the BLM property. The southwest quarter of Section 12, T3S, R4W, is owned by Boy Scouts of America. This area is also unlikely to be developed into residential use in the foreseeable future. Land to the southwest of the central core is currently zoned A-20. (see Figure2-16, Lincoln Township Zoning) As described in the Tooele County Master Plan (Cline, 2002) the area could be zoned for higher density after the core district is developed. Other areas to the south and east of the Atlantic Richfield parcels are zoned MU - 40 as shown on Figure 2-16, Lincoln Township Zoning. Residential use in these areas is a permitted use; however, such use is unlikely because the intent of this designation is to preserve natural foothills and valleys from human habitation.

The master planning document states "When the central village zone is developed at 90% of its total density with lots at the minimum size, then the planning commission needs to consider expansion of the higher density area to accommodate future development." Tooele County is a master plan compliance county which requires that all development must comply with the master plan. Master plan changes can only be made with extensive study and public input.

Current Estimated Population:	530 (Tooele County Planning Department, verbal conversation Steve Anderson/Nicole Cline 16 July 2002)
Current Estimated Households:	136 (Lincoln Culinary, verbal conversation Kevin Cosper/Ken Shields, 17July 2002)
Estimated Population - 2010:	652 (Tooele County Planning Department verbal conversation Steven Anderson/Nicole Cline 16, July 2002)

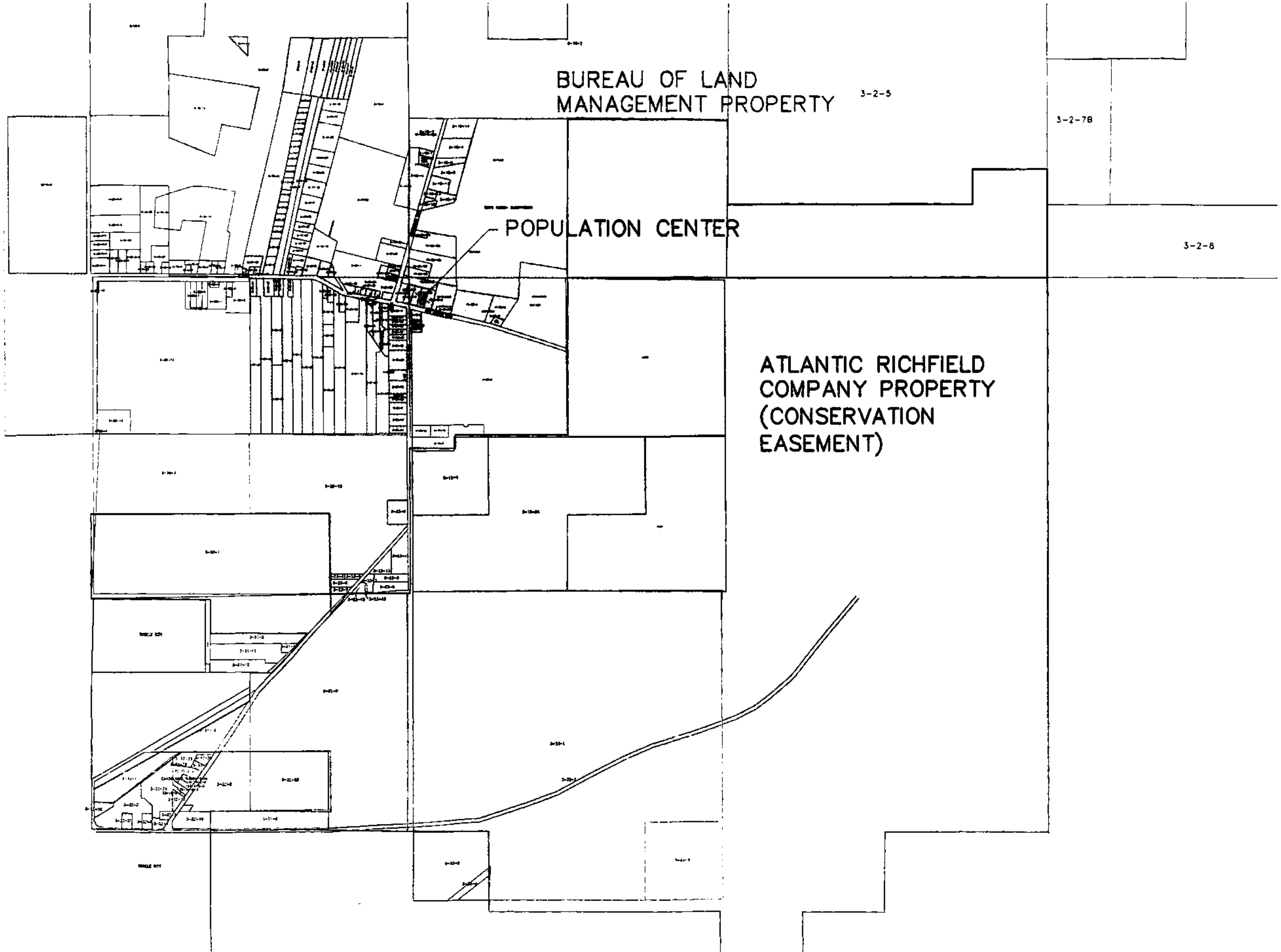
As of October 24, 2002 there were no future plans for utilities or additional development in the Lincoln Township area. The township planning commission has also stated a desire to minimize new growth to the extent allowable in zoning regulations and due to restrictions caused by the limited resources available in the area. In conclusion, because of the growth management emphasis by the township planning commission and the limited infrastructure available to support new development, the population in Lincoln is not likely to change dramatically during the foreseeable future. The current land use of light residential, recreational and agriculture will remain the situation in the future.

2.10 Surface Water and Sediments

The IS&R/Carr Fork Smelter Site is located along the foothill bench of the Oquirrh Mountain Range, at an elevation gradient ranging from about 5,600 feet at the eastern boundary to approximately 5,050 feet at the western boundary. It is about 3,600 feet below Clipper Peak, elevation 9,207 feet, which defines the upper limits of the Pine Creek surface drainage area. Pine Creek channel extends above the Site for a distance of about 3-1/2 miles to the head of the drainage area at Clipper Peak. Two lesser surface storm runoff areas that flow through the Site are the Dry Canyon channel which extends about 2-1/2 miles above the Site, and the Spring Canyon channel, extending about 2-1/4 miles to the upper limit at Clipper Ridge. Between these three major surface storm runoff channels are several minor drainages that fan out along the foothill bench in small rivulets. This over surface flow has been diverted into one of the three major channels before reaching the area impacted by the smelters and mills. This section will discuss existing topography and previous reclamation features that affect surface water conditions and drainage patterns over the Site.

2.10.1 Investigation Activities

Existing site features that affect surface water flow were studied using topographical maps, aerial photos, site inspections, and information from the Soil Conservation Service. The focus of these activities was to develop a database of information that will allow a determination as to whether overland flows can result in significant offsite or onsite flows. These flows were then analyzed to determine if they are significant enough to develop flow patterns that could form constituent pathways or cause damage to reclaimed features.



General Notes

MU-40
Multiple Use 40 Acre Minimum. To establish areas in mountain, hillside, canyon, mountain valley, desert, and other open and generally undeveloped lands where human habitation would be limited in order to protect land and open space resources

A-20
Agriculture Use, 20 Acre Minimum. To promote and preserve in appropriate areas conditions favorable to agricultural uses and to maintain greenbelt open spaces.

RR-5
Rural Residential, 5 Acre Minumum. To promote and preserve in appropriate areas conditions favorable to large-lot family life, the keeping of limited numbers of animals and fowl and reduce requirements for public services.

RR-1
Rural Residential, 1 Acre Minimum. To promote and preserve in appropriate areas conditions favorable to large-lot family life, the keeping of limited numbers of animals and fowl and reduce requirements for public services.

TOOELE CITY
Those areas incorporated and zoned in the city of Tooele

CONSERVATION EASEMENT

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: GKL
ENGINEER: KC
APPROVED: SDA

LINCOLN TOWNSHIP ZONING
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-089
Date APR-03
Scale NO SCALE

FIGURE
2-16

Surface water hydrology and hydraulic calculations were made for each watershed associated with impacted areas of the Site. The hydrology calculations consisted of both the 25-year and the 100-year, 24-hour storm events. The present surface water impoundments found on the reclaimed smelter site were designed to meet a 10-year, 24-hour event. Calculations were made to verify the capacity of these structures. Hydraulic calculations were performed on natural channels at critical locations as well as previously modified channels that exist on both the smelter site and main tailings impoundment. These computations were also completed for diversion channels and applicable culverts in the area. A map showing the features listed above and the defined watershed boundaries is presented as Figure 2-17 (IS&R/Carr Fork Site Surface Water Hydrology Map). With the exception of Pine Creek, most of the streams that flow across the Site are ephemeral. These include flows from Spring, Archers, Dry, Pole, Swensons, Leavetts, and Pass Canyons. Some of these flow across the Site through diversions, culverts, energy control structures, and both modified and natural channels. The most significant of these ephemeral streams is Dry Creek because it flows through the former smelter area as well as the main tailings impoundment. Each of these major contributing watersheds and their relationship to the Site are listed below.

Surface water runoff volumes were determined using the TR-55 Graphical Peak Discharge Method based in AutoCAD 2000i Land Development Software. This program uses as inputs: storm depth, duration, rainfall distribution, frequency, watershed area, curve number, pond and swamp areas, and time of concentration.

Rainfall depth was determined using information from the National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Volume VI. The 25-year, 24-hr storm values ranged, depending on elevation, from 2.5 to 2.8 inches. For the 100-year, 24-hour storm the values ranged from 3.0 to 3.4 inches. The 10-year, 24-hour storm was 2.4 inches. A type II rainfall distribution was considered most representative of high-intensity rainfall conditions experienced in the region.

Curve numbers were assigned based on soil type as well as vegetative type and percent cover. These parameters were evaluated using information from both field surveys and aerial photographs. The numbers were selected using Curve Number tables provided by the U. S. Soil Conservation Service and using professional judgment where required.

Watershed area boundaries were defined specifically to calculate flows at determined locations and can be viewed on Figure 2-17. Individual watersheds have acronym designations representing an association of watersheds. For example, all of the watersheds that drain into Dry Creek have a designation of DC, where as, all watersheds associated with Pine Creek are designated with PC.

Hydraulic channel calculations were performed using the Channel Calculator based in AutoCAD 2000i Land Development Software. This program allows for several different channels. There are options for rectangular, trapezoidal, and advanced channel cross-sections. This program uses as inputs: flowrate, slope, Manning's roughness coefficient, depth of flow, and channel shape parameters. Typically, the user solves for one of the first four inputs listed above. In site related channel calculations the input solved for was either flowrate or depth of flow.

Culvert computations were implemented using the culvert calculator within AutoCAD 2000i Land Development Software. This program uses a number of inputs including: shape, number of barrels, flowrate, Manning's roughness, diameter, length, entrance loss coefficient, outflow works, and elevations of the embankment, inlet, and outlet. The computed results are the headwater elevation, slope, and velocity. These results are then analyzed with respect to in-place structures onsite.

2.10.2 Surface Water Physical Investigation Results

The following drainages were examined during the course of the remedial investigation. All calculations associated with the discussed results can be viewed in Appendix G.

2.10.2.1 Pine and Pole Canyon Watersheds

Pine Creek is the only perennial stream that flows onto the Site. Its headwaters are a combination of minor springs, located approximately one-half mile up gradient of the Site in Pine Canyon, and mine discharge from the Adamson, Bingham West Dip, and the Pine Canyon Tunnels. Flow from the Adamson and Bingham West Dip Tunnels is piped into Pine Canyon from surrounding canyons.

The Pine Canyon watershed is represented by PC-2 on Figure 2-17 and is approximately 2,659 acres in size. This is the second largest watershed that flows through the Site.

Pole canyon is a smaller watershed at approximately 492 acres and its flow is ephemeral. This watershed is represented by PC-8 on Figure 2-17. Any potential flow from Pole Canyon enters Pine Creek just east of the slag pile and to the west of the eastern property boundary.

Flow in the Pine Creek channel enters the boundary of the Site just east of the slag pile. It then meanders to the north of the slag pile where it flows over a 45-ft waterfall and then continues down toward the Elton Tunnel Dump. There it flows into a designated wetland area where at higher flows, the stream is divided into two channels. It ultimately enters into the diversion channel near Lincoln which runs north just east of the

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 2024001

SITE NAME: INTERNATIONAL SMELTING & REFINING

DOCUMENT DATE: 08/01/2004

DOCUMENT NOT SCANNED

Due to one of the following reasons:

- ☐ PHOTOGRAPHS
- ☐ 3-DIMENSIONAL
- ☑ OVERSIZED
- ☐ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
- ☐ POOR LEGIBILITY
- ☐ OTHER
- ☐ NOT AVAILABLE
- ☐ TYPES OF DOCUMENTS NOT TO BE SCANNED (Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

FIGURE 2-17 IS&R/CARR FORK SURFACE WATER HYDROLOGY MAP

Contact the Superfund Records Center to view available document.
(303) 312-6473

Boy's Ranch property. The stream flowing through the Site is small and typically diminishes before the northwestern boundary of the Site.

As part of the RI, flow measurements were taken at specific locations within Pine Creek on a quarterly basis. Surface water sample locations along Pine Creek can be viewed on Figure 2-4 (Sampling Location Map). Sample locations were selected for two reasons: 1) to coincide with historical locations and data, and 2) to determine the magnitude of contributing sources. SW-17 measures the direct input of the Pine Canyon Tunnel. SW-15 indicates flow from both the up gradient springs and the Adamson Tunnel discharge. SW-18 measures discharge from both the Pine Canyon and Bingham West Dip Tunnels.

Flows at all sample locations, with the exception of SW-5, were measured using a portable flow meter. Sample location SW-5 was measured using a previously installed V-notched weir. Table 2-10 (Surface Water Flows in Pine Creek) shows the resulting flows from the quarterly sampling efforts. Figure 2-18 (Surface Water Flow Trends in Pine Creek) illustrates surface water flow trends as the sampling progressed during the investigation.

Table 2-10
Surface Water Flows in Pine Creek
(cfs)

Date	SW-17	SW-15	SW-18	SW-5	SW-12	ACSW-5	SW-14	SW-9	SW-10
Dec-01	0.058	0.052	0.12	0.095	0.065	0.075	0.049	0	0
Apr-02	0.078	0.63	0.07	0.4	0.27	0.25	0.24	0	0
Jul-02	0.083	1.25	0.08	0.79	0.9	0.84	0.88	0	0
Sep-02	0.028	0.023	0.14	0.063	0.083	0.079	0.42	0	0

During the investigation, there was no flow in the downstream portion of Pine Creek represented by sample locations SW-9 and SW-10. In past sampling events flows at these locations were minimal and closely resembled flows at sample location SW-17 which represents flow at the Pine Canyon Tunnel adit. The highest flows were found at sample location SW-15 indicating that the majority of water in Pine Creek comes from both the upstream springs and Adamson Tunnel.

Potential flows were calculated for this drainage and are illustrated in Tables 2-11 (25-yr and, 24-hr Storm Event for Pine Creek) and 2-12 (100-yr, 24-hr Storm Event for Pine Creek).

Table 2-11
25-yr, 24-hr Storm Event for Pine Creek

Area Description	Area (ac)	Peak Discharge (cfs)*	Cumulative Peak Discharge (cfs)**	Cumulative Runoff Volume (acft)***
PC-1	23.20	10.15	10.15	1.10
PC-2	2167.00	104.24	124.65	33.58
PC-3	17.90	6.19	6.19	0.04
PC-4	5.03	1.89	10.26	0.18
PC-5	4.23	2.18	2.18	0.20
PC-6	6.59	24.63	0.00	0.00
PC-7	18.58	3.17	0.00	0.00
PC-8	492.00	15.94	140.59	38.50
PC-9	145.00	4.99	145.58	39.82
PC-10	75.00	11.61	157.19	41.75

* Represents flow contribution from specific watershed area not including storm water detention.
** Represents total flow after detention from both the specific area and upstream watersheds.
*** Represents total runoff volume after detention from both the specific area and upstream watersheds.

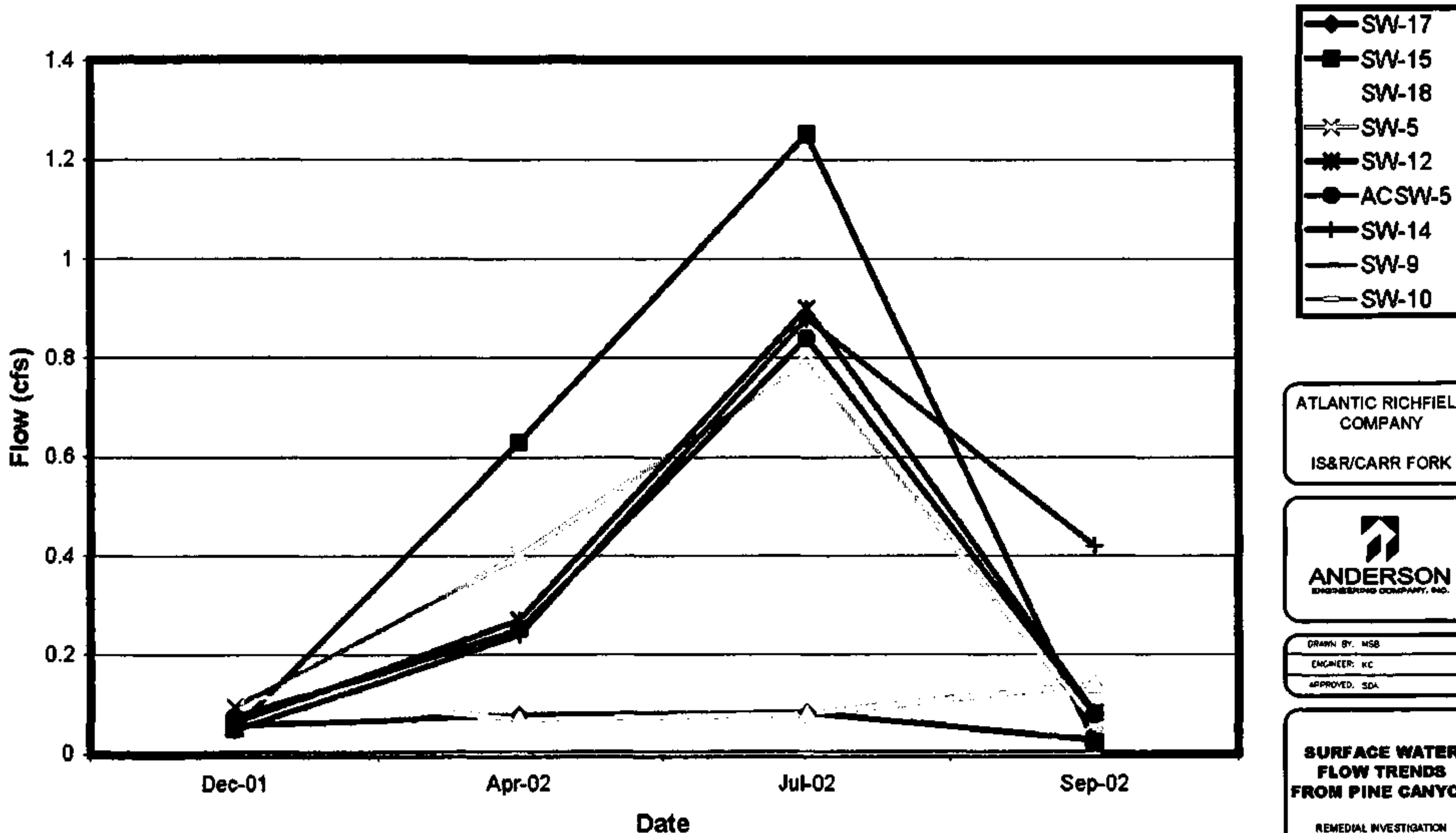
Table 2-12
100-yr, 24-hr Storm Event for Pine Creek

Area Description	Area (ac)	Peak Discharge (cfs)*	Cumulative Peak Discharge (cfs)**	Cumulative Runoff Volume (ac/ft)***
PC-1	23.20	17.30	17.30	1.72
PC-2	2167.00	258.31	293.02	77.02
PC-3	17.90	10.51	10.51	0.52
PC-4	5.03	3.20	17.41	0.90
PC-5	4.23	3.70	3.70	0.31
PC-6	6.59	30.83	0.00	0.00
PC-7	18.58	5.95	0.00	0.00
PC-8	492.00	67.28	360.30	92.60
PC-9	145.00	10.66	370.96	95.49
PC-10	75.00	21.06	392.02	98.98

* Represents flow contribution from specific watershed area not including storm water detention.
** Represents total flow after detention from both the specific area and upstream watersheds.
*** Represents total runoff volume after detention from both the specific area and upstream watersheds.

Below are the points of interest associated with flow from Pine and Pole Canyon watersheds.

Slag Pile Waterfall: The waterfall immediately north of the slag pile is a result of the slag pile relocating the stream to the north side of the canyon. Over time the stream has eroded the unconsolidated alluvial slopes and formed a steep gully downstream. Along with the alluvial sediment, the stream has also transported portions of slag immediately



ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

SURFACE WATER FLOW TRENDS FROM PINE CANYON

REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date APR-2003
Scale NO SCALE

FIGURE 2-18

downstream, though not nearly the magnitude of the alluvial sediment. Potential flows through this area as indicated in Tables 2-11 and 2-12 are 141 cfs for the 25-year storm and 360 cfs for the 100-year storm. This represents a combined flow from both Pine and Pole Canyons. These flows are significant and could result in further back-cutting of the channel in this area.

Pine Creek Channel at Slag Pile: Channel hydraulic computations were performed on the Pine Creek channel near the slag pile. The flowrate in this area is expected to be 360 cfs for the 100-year event. The flow depth was computed to be 2.52 feet with velocities at 6.8 fps. This flow is subcritical. These results indicate that the channel would be able to handle flow from the 100-year, 24-hour storm without spilling into the slag pile's depression area.

Lower Pine Creek Channel: The diverted channel west of the slag pile would not be able to handle a flow of this magnitude. In this region, west of the Elton Tunnel Dump, the stream would over-run its diversion channel and flow back into its natural channel. Ultimately both the diverted channel and the natural channel flow into the diversion channel to the east of the Boy's Ranch property.

Conclusions: Hydraulic calculations indicate that the upper Pine Creek channel is sufficient to handle potential flows of the 100-year event. It was found that at locations downstream, surface water flow departs from small diversion channels and enters its natural channel. This does not appear to present a problem because the previous channel has the capacity to adequately handle the magnitude of a 100-year event. Further, the portion that spills into the natural channel is redirected back into the original diversion channel before the flow leaves the Site.

The lingering concern found along Pine Creek is the continued back-cutting of the waterfall adjacent to the slag pile. This has created a large gully with very steep slopes. Currently, the waterfall is developed on a thin cover of slag which retards the upstream head cutting of the falls. This thin layer of slag, if subjected to high flows from a larger storm event, could sluff off resulting in additional back-cutting of both the slag pile and the alluvium to the north. This back-cutting may result in a collapse of the south bank of Pine Creek which would divert the stream into the slag depression area.

2.10.2.2 Dry Canyon Watershed

The Dry Canyon watershed extends to the southeast of the Site and is approximately 1,000 acres in size. On Figure 2-17 the main portion is represented by watersheds DC-1 and DC-2. This watershed is a significant drainage because it flows through both the former smelter site as well as the main tailings impoundment.

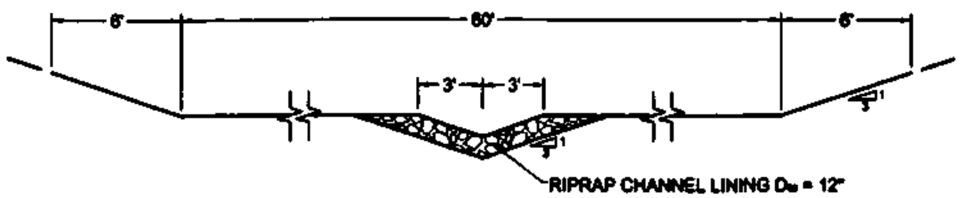
Dry Creek enters the eastern boundary of the Site in a natural channel approximately one-half mile to the south of Pine Creek. From there, it quickly enters the former smelter site area. The channel was modified during the 1986 reclamation activities in order to mitigate potential soil erosion on the reclaimed area. Figure 2-19 (Upper Dry Creek Channel) shows an overall summary of the upper Dry Creek channel modifications. The first of these modifications is a 5-ft wide by 4-ft tall concrete box culvert. As flow exits this box culvert the velocities are decreased by energy-dissipating concrete structures. The channel then fans out to a bottom width of 60 feet where it progresses for approximately 450 feet. The flow is then constricted into a riprap lined channel and then exits into a small detention basin. The flow exits this small basin to the southwest, down an embankment, and into a larger detention basin. Once enough water fills that basin it begins to flow over a spillway, down a riprap channel and off of the former smelter location.

After the smelter site, Dry Creek flows through a 48-inch corrugated metal pipe culvert into a natural braided channel which extends approximately 3/4 of a mile to the west. It then flows through a engineered riprap lined reach until it enters a modified channel that extends through the tailings impoundment. After the tailings impoundment it flows through a breach in the Carr Fork Tailings Dam and into another modified channel which carries the flow to a former borrow pit located near the southwest edge of the tailings dam. A portion of the potential flow from Dry Creek is captured in this borrow pit and the remainder enters a spillway to the west of the pit. This water goes through a culvert and on into fields to the west.

The Dry Canyon drainage was divided into several watersheds for two investigative purposes. The first purpose was to analyze several surface water impoundments located on the former smelter site and to determine whether these still function according to their respective designs. The second purpose was to find out how much potential flow could be introduced into the existing culverts as well as the modified channel reaches. As discussed above.

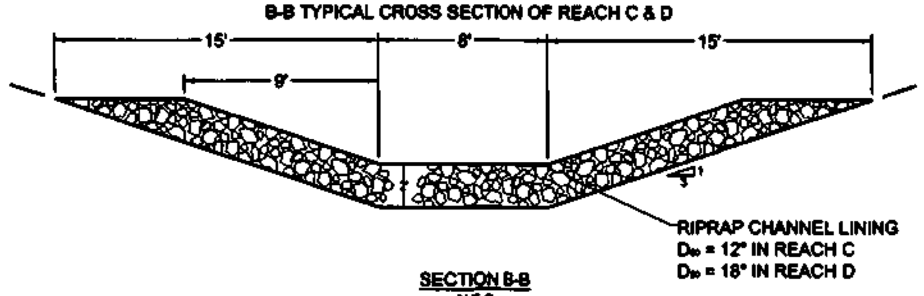
Table 2-13 (25-yr, 24-hr Storm Event for Dry Creek) and Table 2-14 (100-yr, 24-hr Storm Event for Dry Creek) show the resulting peak discharge and runoff volumes that the Dry Creek watersheds would experience during a 25-year and 100-year storm event.

A-A TYPICAL CROSS SECTION OF REACH A & B

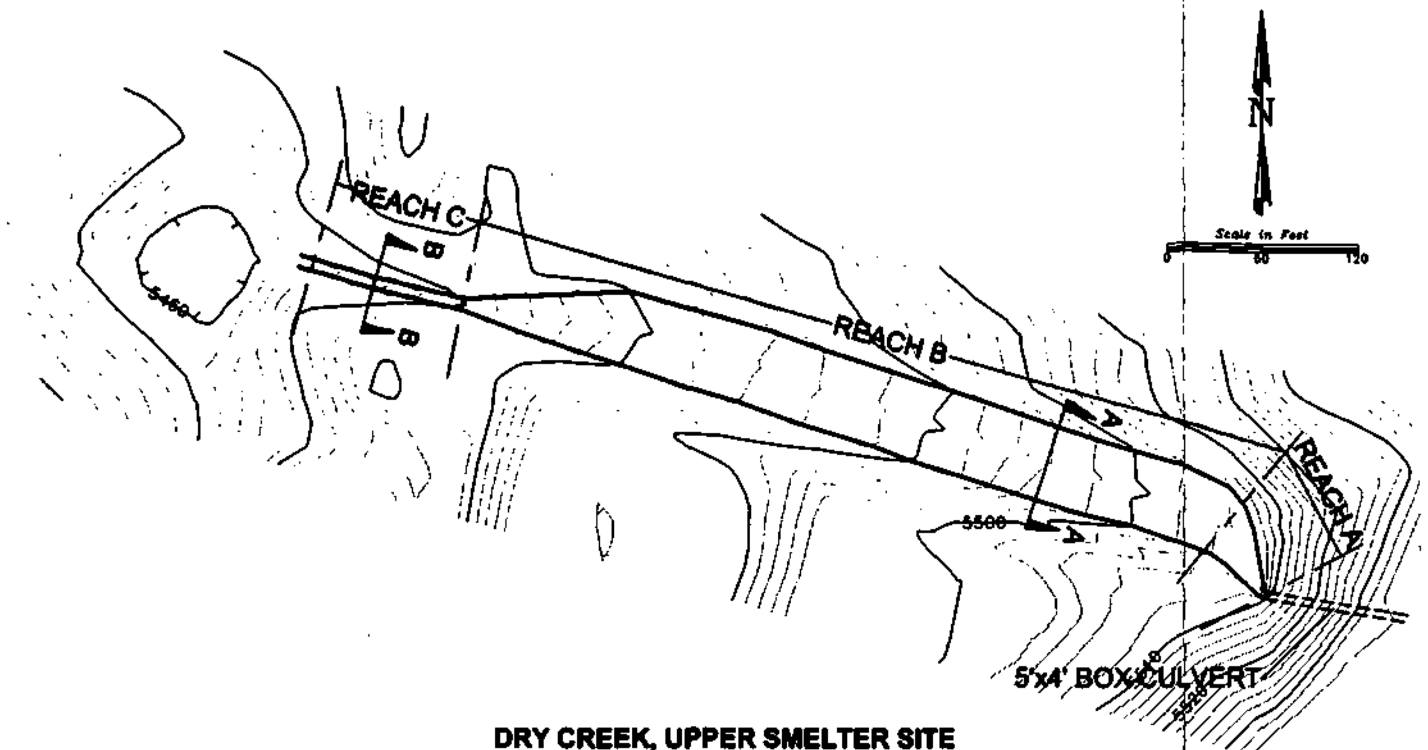


SECTION A-A
N.T.S.

B-B TYPICAL CROSS SECTION OF REACH C & D

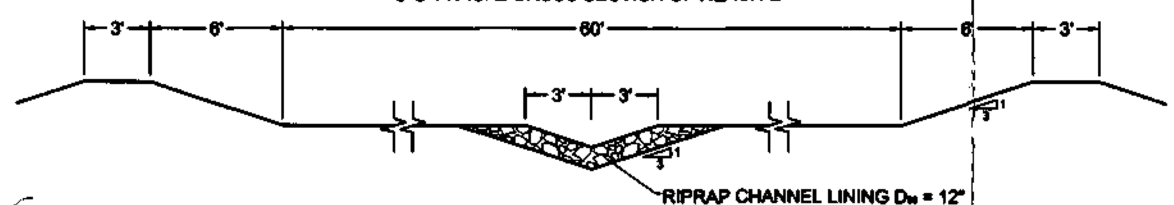


SECTION B-B
N.T.S.



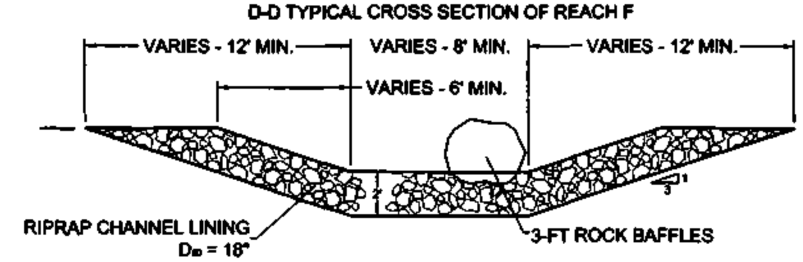
DRY CREEK, UPPER SMELTER SITE

C-C TYPICAL CROSS SECTION OF REACH E



SECTION C-C
N.T.S.

D-D TYPICAL CROSS SECTION OF REACH F



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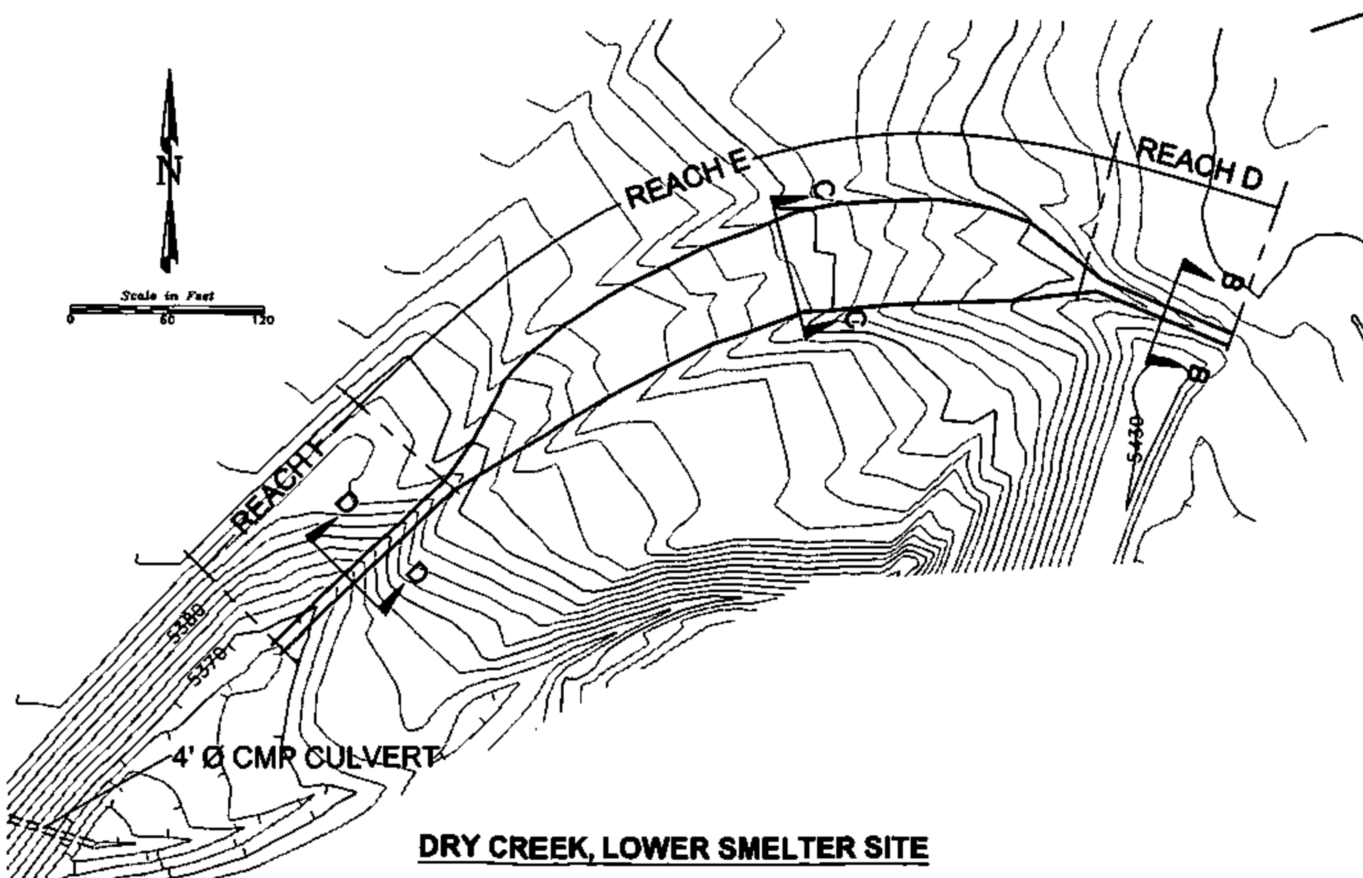


DRY CREEK, LOWER SMELTER SITE

General Notes

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

UPPER DRY CREEK CHANNEL
REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date 31-MAR-03
Scale AS SHOWN

FIGURE
2-19

Table 2-13
25-year, 24-hour Storm Event for Dry Creek

Area Description	Area (ac)	Peak Discharge (cfs)*	Cumulative Peak Discharge (cfs)**	Cumulative Runoff Volume (ac/ft)***
DC-1	15.70	0.92	0.92	0.25
DC-2	985.00	43.69	44.61	15.85
DC-3	7.72	2.33	46.94	16.22
DC-4	30.00	4.54	51.48	15.66
DC-5	23.20	2.66	60.31	17.13
DC-6	28.30	8.60	0.00	0.00
DC-7	5.13	2.07	2.07	0.24
DC-8	2.52	0.88	0.88	0.12
DC-9	6.71	2.52	0.00	0.00
DC-10	9.16	3.38	0.00	0.00
DC-11	19.30	6.17	6.17	0.92
DC-12	9.90	3.36	3.36	0.47
DC-13	113.00	14.74	18.10	1.52
DC-14	34.70	3.04	3.04	0.69
DC-15	8.40	2.18	0.00	0.00
DC-16	46.50	5.10	26.24	0.49
DC-17	44.70	4.87	0.00	0.00
DC-18	13.70	2.65	0.00	0.00
DC-19	13.20	1.25	1.25	0.21
DC-20	96.00	6.88	6.88	1.52
DC-21	7.21	0.87	7.75	1.63
DC-22	9.11	0.90	0.90	0.14
DC-23	103.00	14.40	0.00	0.00
DC-24	84.00	17.08	17.08	0.06
DC-25	110.00	6.44	85.08	19.62
DC-26	76.70	13.34	98.42	18.04

* Represents flow contribution from specific watershed area not including storm water detention.

** Represents total flow after detention from both the specific area and upstream watersheds.

*** Represents total runoff volume after detention from both the specific area and upstream watersheds.

Table 2-14
100-yr, 24-hr Storm Event for Dry Creek

Area Description	Area (ac)	Peak Discharge (cfs)	Cumulative Peak Discharge (cfs)	Cumulative Runoff Volume (ac/ft)
DC-1	15.70	2.39	2.39	0.50
DC-2	985.00	109.94	112.33	31.69
DC-3	7.72	3.98	116.31	32.26
DC-4	30.00	9.68	125.99	32.35
DC-5	23.20	5.68	142.21	34.96
DC-6	28.30	14.67	14.67	0.41
DC-7	5.13	3.49	18.16	0.79
DC-8	2.52	1.50	1.50	0.19
DC-9	6.71	4.27	0.00	0.00
DC-10	9.16	5.73	0.00	0.00
DC-11	19.30	10.54	10.54	1.43
DC-12	9.90	5.71	5.71	0.73
DC-13	113.00	31.08	36.79	3.75
DC-14	34.70	7.21	7.21	1.24
DC-15	8.40	3.89	3.89	0.07
DC-16	46.50	9.21	57.10	4.31
DC-17	44.70	8.81	0.00	0.00
DC-18	13.70	4.80	0.00	0.00
DC-19	13.20	3.37	3.37	0.42
DC-20	96.00	18.13	18.13	3.04
DC-21	7.21	2.39	20.52	3.27
DC-22	9.11	2.43	2.43	0.29
DC-23	103.00	27.80	0.00	0.00
DC-24	84.00	30.93	30.93	1.81
DC-25	110.00	14.90	191.41	41.17
DC-26	76.70	24.20	215.61	41.19

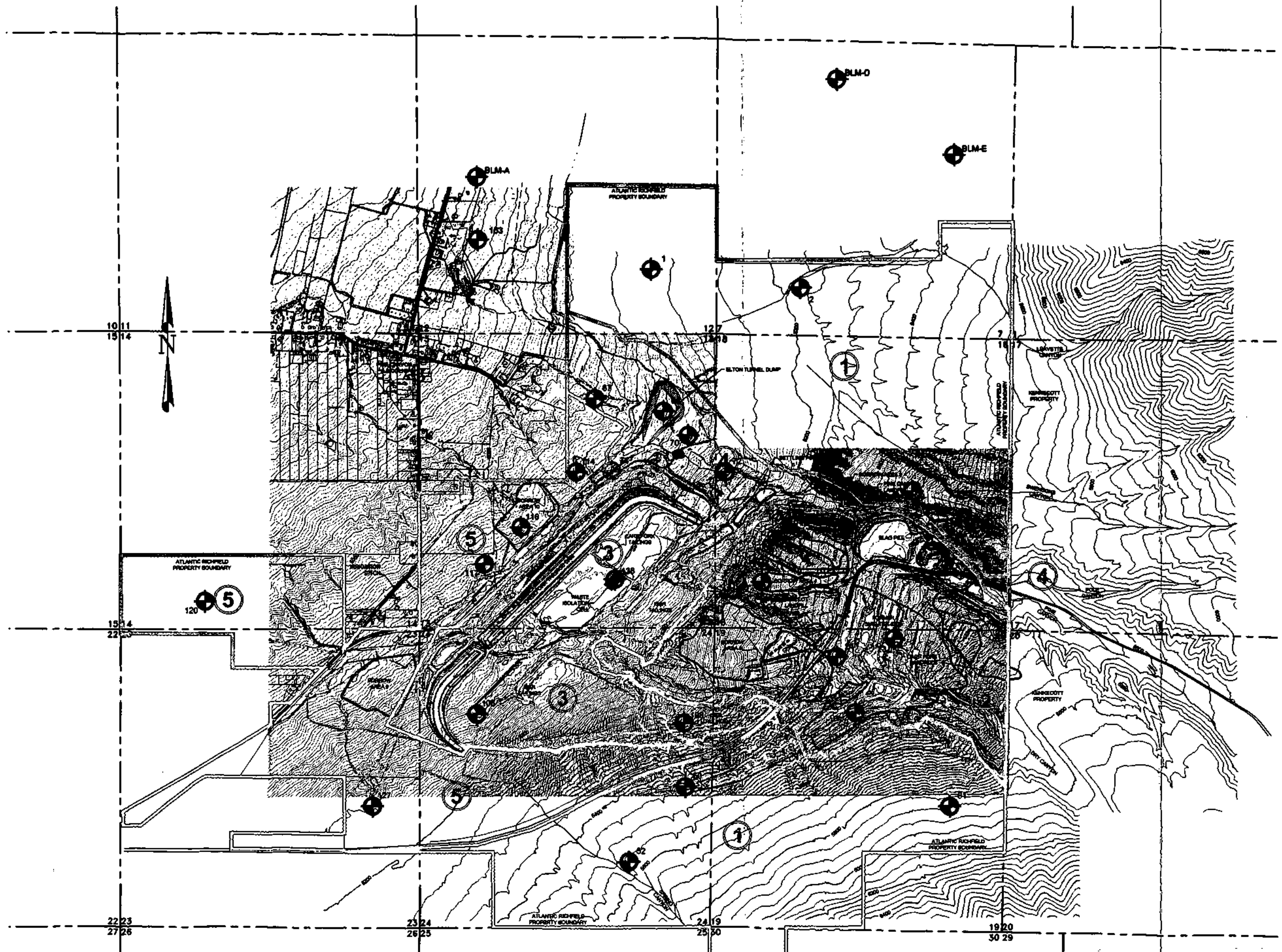
* Represents flow contribution from specific watershed area not including storm water detention.

** Represents total flow after detention from both the specific area and upstream watersheds.

*** Represents total runoff volume after detention from both the specific area and upstream watersheds.

There are several points of interest along Dry Creek. Below are the results associated with these points of interest.

<u>4-foot by 5-foot Box Culvert</u>: This culvert would experience a flow of 112 cfs during a 100-year event. The water velocities reached within the



General Notes

LEGEND

① VEGETATION ZONE NUMBER
VEGETATIVE ZONE BOUNDARY
SMELTER RIDGE CLASSIFICATION BOUNDARY
VALLEY SLOPE CLASSIFICATION BOUNDARY
SALT TOLERANT CLASSIFICATION BOUNDARY
VEGETATION SAMPLE LOCATION

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

VEGETATION ZONES

REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date APR-03
Scale NO SCALE

FIGURE 2-20

structure at this flow is 20.4 feet per second (fps). This velocity is highly erosive and is controlled by an energy dissipating outflow system. The headwater for this type of flow would not submerge the inlet. The maximum depth experienced at this location would be 3.92 feet.

Reaches A, B, and C: Reaches A, B, and C are shown with their respective cross-sections on Figure 2-19. They could experience a potential flow of 116 cfs during a 100-year event. The depth of flow in reaches A and B would be 1.32 feet from the bottom of the V-channel. Velocities would range from 4.8 fps in the shallow depths to 6.3 fps in the riprap lined V-channel portion.

The depth of flow within reach C is expected to be 1.05 feet with velocities reaching 9.5 fps. This trapezoidal channel reach is lined with riprap to prevent these high velocities from eroding the surrounding soils. A small detention basin is at the base of this portion of channel and this is where the energy is dissipated.

Reaches D, E, and F: Reaches D, E, and F are shown with their respective cross-sections on Figure 2-19. They could experience a potential flow of 126 cfs with the 100-year event. The depth of flow within reach D is expected to be 1.22 feet with velocities reaching 8.9 fps. This portion is a trapezoidal channel and is lined with riprap to counter the high erosive forces.

Reach E is similar to reaches A and B above. This portion of channel may be subjected to a flow of 126 cfs which would result in a flow depth of 1.25 feet above the V-channel portion of the cross-section. Velocities of 7.1 fps are expected within this reach. After moving through reaches D, E, and F, the flow enters a depression containing a 4-foot pipe culvert described below.

4-foot Diameter Pipe Culvert: The 4-foot diameter culvert is a corrugated metal pipe. During a 100-year event, this culvert would see a flow of 142 cfs. This would result in a pressurized flow with velocities of 11.3 fps. The headwater depth would be 7.62 feet above the pipe invert at the inlet. The road embankment extends approximately 24 feet above the invert of the culvert in this area giving the backwater effects extensive storage capacity. After exiting the pipe culvert, the flow enters a natural braided stream channel.

Modified Channel Through Tailings Impoundment: This portion of the channel could receive up to 191 cfs from a 100-year event. The resulting flow depth would be 2.09 feet with velocities of 6.4 fps. The flow condition in this reach is subcritical which indicates a low potential for erosive forces. This is important because the channel surface is protected by geofabric and plant growth through the tailings impoundment.

Channel Through Breach in Tailings Dam: With a 100-year event, this portion of stream could also experience a flow of 191 cfs. This would result in velocities of 12.5 fps with a flow depth of 1.29 feet. This channel is lined with larger diameter riprap to counter the erosive forces.

Spillway From Borrow Pit: After storing approximately 4.2 acre-feet of water in the former borrow area, the flow then exits through a spillway. The spillway may receive potential flows of 216 cfs during a 100-yr event. This would result in a channel flow depth of 1.55 feet and velocities of 11 fps. This spillway is also riprap lined and designed to guard against potential scouring.

Stream Diversions 1, 2, 5, 6, and 7: These stream diversions are addressed in Section 2.10.2.5.

Conclusions: Hydraulic calculations indicate that all components of the Dry Creek channel are sufficient to handle potential flows of the 100-year event. It was found that in many locations surface water flow was considered super-critical. In each of these locations the channel reach had been reinforced with riprap to counter erosive forces. It appears that the 1986 reclamation efforts to stabilize Dry Creek are adequate for the 100-year, 24-hour storm event.

2.10.2.3 Archers and Spring Canyon Watersheds

Archers and Spring Canyon watersheds make-up the channel network that enters the southern boundary of the Site. Archers Canyon watershed is represented by watersheds SC-1 and SC-2 on Figure 2-17 (IS&R Site Surface Water Hydrology Map) and encompasses approximately 585 acres. The Spring Canyon watershed is represented by SC-3 on the same figure and is approximately 569 acres.

Historically, flow from Archers Canyon entered into Dry Creek. This flow was redirected using a series of diversion channels noted as numbers three and four on Figure 2-17. They were created to minimize erosion of former railroad grades that traverse the hillside in this area. The diversion channels reroute this flow into Spring Canyon which then bypasses the main tailings impoundment to the south. Ultimately, this combined flow joins the flow from Dry Creek after Dry Creek leaves the aforementioned borrow pit.

Table 2-15 (25-yr, 24-hr Storm Event for Archers and Spring Canyon Watersheds) and Table 2-16 (100-yr, 24-hr Storm Event for Archers and Spring Canyon Watersheds) show the resulting runoff volumes that these watershed would experience during a 25-year and 100-year storm event.

Table 2-15
25-yr, 24-hr Storm Event for Archers and Spring Canyon Watersheds

Area Description	Area (ac)	Peak Discharge (cfs)*	Cumulative Peak Discharge (cfs)**	Cumulative Runoff Volume (ac/ft)***
SC-1	301.00	18.65	18.65	4.27
SC-2	284.00	17.71	36.36	8.27
SC-3	569.00	32.68	69.04	16.78
SC-4	10.80	0.92	69.96	16.95
SC-5	260.00	28.49	98.45	26.05

* Represents flow contribution from specific watershed area not including storm water detention.
** Represents total flow after detention from both the specific area and upstream watersheds.
*** Represents total runoff volume after detention from both the specific area and upstream watersheds.

Table 2-16
100-yr, 24-hr Storm Event for Archers and Spring Canyon Watersheds

Area Description	Area (ac)	Peak Discharge (cfs)	Cumulative Peak Discharge (cfs)	Cumulative Runoff Volume (ac/ft)
SC-1	301.00	48.61	48.61	9.03
SC-2	284.00	46.20	94.81	17.52
SC-3	569.00	84.41	179.22	35.04
SC-4	10.80	2.53	181.75	35.38
SC-5	260.00	51.17	232.92	49.88

* Represents flow contribution from specific watershed area not including storm water detention.
** Represents total flow after detention from both the specific area and upstream watersheds.
*** Represents total runoff volume after detention from both the specific area and upstream watersheds.

Below are the points of interest associated with flow from Archers and Spring Canyon watersheds.

Stream Diversions 2 and 3: These stream diversions are addressed in Section 2.10.2.5.

4-foot Diameter Pipe Culvert: The 4-foot diameter culvert is a corrugated metal pipe and is plugged at the outlet. Assuming the culvert was functional during a 100-year event, this culvert would see a flow of 182 cfs. This would result in a pressurized flow with velocities of 14.5 fps. The headwater depth would be 4.36 feet above the pipe invert at the inlet.

Conclusions: Significant flows come from these two watersheds. This flow is diverted, and therefore, eliminates the potential for erosion along the former railroad grades. With the exception of the plugged culvert, the in-place structures will adequately handle flows from the 100-year event.

2.10.2.4 Swensons, Leavetts, and Pass Canyon Watersheds

Pass Canyon is the Largest of all the watersheds that enter the Site at 2,966 acres. Swensons and Leavetts are much smaller in size at 791 and 681 acres respectively. All three of these watersheds make up the ephemeral stream network in the northern segment of the Site. Flow from these canyons ultimately end up in the diversion channel located to the east of the aforementioned Boys Ranch property. This diversion channel runs north and empties into fields on the BLM property.

Surface water from Swensons, Leavetts, and Pass Canyons does not flow through impacted areas of the Site and therefore was not a focus in the remedial investigation efforts.

2.10.2.5 Stream Diversions

Table 2-17 shows the constructed onsite stream diversion capacities in relation to the 25-year and 100-year storm events. The depth of flow and the flow capacity results represent each diversion flowing with one foot of freeboard. All of the diversions can hold the 25-yr event. All but the lower reach of Diversion 3 and Diversion 4 can handle the 100-year event with one foot of freeboard.

Table 2-17
Stream Diversion Capacities with 1 foot of Freeboard

Diversion Number	Depth of Flow (ft)	Flow Capacity (cfs)	25-yr Event (cfs)	100-yr Event (cfs)
1	2	45.6	3.36	5.71
2	1	19.6	0.92	2.39
3 upper	2	133.4	14	37
3 lower	2	43.0	18.7	48.6
4	2	132.3	69	179
5	2	88.2	1.25	3.37
6	2	162.4	7.75	20.5
7	2	103.7	0.9	2.43

The lower reach of diversion three would be able to handle the 100-year event with 0.91 feet of freeboard. Diversion number four would be able to handle this same event with 0.76 feet of freeboard.

2.10.2.6 Surface Water Impoundments

Surface water impoundments were created on the former smelter site to stop runoff from progressing off impacted areas. These impoundments can be viewed on Figure 2-17 (IS&R/Carr Fork Site Surface Water Hydrology Map) and are shown with a blue hatch. The dimensions of the impoundments can also be located on this same figure within the surface water impoundment table.

In the 1986 reclamation, these impoundments were designed and constructed to handle the 10-year storm event as well as a 10-year sediment loading. Table 2-18 (Surface Water Impoundments) illustrates the relationship between the runoff from the 10-year storm event and the impoundment capacity.

Table 2-18
Surface Water Impoundments

Impoundment Map Designation	Associated Watershed	10-year Runoff Volume* (ac-ft)	Impoundment Capacity** (ac-ft)
1	PC-2	0.78	4.50
2	PC-3	0.57	0.42
3	PC-4	0.44	0.13
4	DC-6	0.90	0.50
5	DC-7	0.56	0.16
6	DC-9	0.69	3.70
7	DC-10	0.29	3.10
8	DC-4	NA	0.86
9	DC-13	2.10	2.97

* Total runoff volume before entering impoundments.
** Represents capacity with one foot of freeboard.

Impoundments 2, 3, 4, and 5 do not have the capacity to handle runoff from the 10-year storm event and still have one foot of freeboard. Of these impoundments, numbers 3 and 5 would overflow with volumes equaling approximately 0.15 and 0.35 acre-feet respectively. In each case, the excess flow would be captured by a down-gradient impoundment. From these computations it was determined that surface water is still being contained within the impacted areas.

2.11 Air

2.11.1 Investigation Activities

With the exception of isolated bare areas exposed to wind erosion, the Site is not a current source of COC migration through the aerial pathway. Previous researchers have attempted to quantify the aerial emissions historically discharged by the smelter during its 60 year history of operations. Estimates are based on an extremely limited data set and actually do not provide usable information for creating remedial objectives. Elevated concentrations of COC in soils and sediments, the effect of sulfur dioxide on the plant community and the appurtenant effects on the top soil are in part the result of the historic discharge. Site soil sampling was designed to evaluate the spacial extent of aerial deposition by testing for the metals, pH and other discharged analytes in area surface soils.

2.11.2 Air Physical Investigation Results

Because there is not a current source air monitoring was not conducted during the RI. Historically, 3 stacks at the Site emitted varying amounts of sulfur dioxide and other plant residuals not caught by the inline baghouses. The most obvious impact from the stack emissions is the stressed vegetation in Pine Canyon and other outlying areas. Metals analysis and nutrient growth samples were also collected at numerous areas in and around the Site to determine the impact to surface soils. Analytical results from soil and sediment sampling are detailed in Section 3.0 of this report.

2.12 Ecological Setting – Flora

(Prepared in part by Val Anderson, PhD, Brigham Young University and Frank Vertucci, PhD, ENSR International)

2.12.1 Regional Characteristics

The Tooele Valley area is in the Great Basin section of the Basin and Range physiographic province. This province has a horst-graben landscape, which is characterized by uplifted mountain ranges and down-dropped basin valleys. The basin valleys are filled with thick wedges of sediment derived from long-term erosion of the uplifted mountain ranges. The Oquirrh Mountains, which are located in Central Utah on the eastern edge of the Great Basin Desert, rise about 3600 feet above the Great Salt Lake with peaks over 8400 feet in elevation. The soils, elevation of the area, and related climatic conditions have resulted in several plant communities in the region.

The two primary sources of parent soil material are derived from the weathering of sandstone and quartzite from area slopes. Local lake terrace deposits of gravelly alluvium are derived from the sedimentary and igneous rocks of the Oquirrh Mountains. The west-facing slopes and foothills of the Oquirrh Mountains in the Tooele area are represented by three general soil units: 1) Fan terraces and lake terraces containing very deep, well-drained soils with moderate to steep slopes, 2) Mountainsides and hillsides containing shallow, well-drained soils with steep and very steep slopes and 3) Rock outcrops.

Vegetation of the region contains combinations of grasses, forbs, shrubs and trees. The lower elevation playas and salt flats of the lake valley can be barren of vegetation or contain some stands of salt tolerant plants on saline soils. Terrace locations contain native vegetation that are mainly big sagebrush (*Artemisia tridentata*), bluebunch wheatgrass (*Agropyron spicatum*), rabbitbrush (*Chrysothamnus nauseosus var. wyomingensis*), Utah juniper (*Juniperus osteosperma*), black sagebrush (*Artemisia nova*) and cliffrose (*Cowania mexicana*). The upper elevations, above 6000 feet, are dominated by fir trees, other conifers, aspen (*Populus tremuloides*), Gambels oak (*Quercus gambelii*), mountain brome (*Bromus marinatus*), mountain sagebrush (*Artemisia tridentata var. vassiana*) and bluebunch wheatgrass.

2.12.2 Site Soils and Characteristic Vegetation

The United States Department of Agriculture, Natural Resource Conservation Service (NRCS) conducted a site survey in 2000 to report soil conditions. Three general soil map units exist for the project area and are characteristic of the various elevations. These NRCS general soil map units represent fan terraces and lake terraces, hillsides and mountainsides, and steep to very steep mountainsides and rock outcrops in the overall area of the Site. The detailed soil map units on the Site include six soil groups as described below. The vegetation commonly associated with the soils on site is also described.

2.12.2.1 Birdow Loam

Birdow loam is generally found on slopes of 1 to 4 percent. This soil is very deep, well drained and is on the flood plain, stream terraces and the alluvial fan of Pine Canyon. It formed in alluvium derived mainly from limestone and quartzite. This soil is typically comprised of a surface layer of loam and in some areas sandy loam. Subsoils may contain gravelly loam. The plant community is generally perennial grasses, forbs and shrubs. Important plant species are basin wild rye (*Elymus cinereus*), western wheatgrass (*Agropyron smithii*) and basin big sagebrush (*Artemisia tridentata var. tridentata*).

2.12.2.2 Kapod Gravelly Loam

Kapod gravelly loam occurs on slopes of 2 to 10 percent. This is very deep, well-drained soil and is on fan remnants. It formed in alluvium derived primarily from sandstone and limestone. The surface is generally a stony loam and the subsoil is very cobbly sandy loam. The vegetation is mainly mountain big sagebrush, bluebunch wheatgrass, mules ear (*Wyethia amplexicalis)* and Gambels oak.

2.12.2.3 Lakewin Gravelly Loam

Lakewin gravelly loam is located on 1 to 5 percent slopes. The soil is very deep and well drained. This soil is found on lake terraces and formed in alluvium and lacustrine sediments from mainly quartzite and limestone. Slopes are medium in length and convex. Typically the surface layer is a gravelly loam and the subsoil is gravelly sandy clay loam or very gravelly sandy loam. The lower soils are very gravelly sand. This soil is often cultivated in local flat areas. Natural vegetation is characterized by bluebunch wheatgrass, mountain big sagebrush and rabbitbrush.

2.12.2.4 Kapod Cobbly Loam

Kapod Cobbly Loam is prominent on 5 to 30 percent slopes. This very deep, well-drained soil is located on fan remnants. It was formed in alluvium derived mainly from sandstone and limestone. Slopes are medium in length and are linear to convex. The surface layer is very cobbly loam. The subsoil is cobbly sandy clay loam and the lower soils are very cobbly sandy loam to very cobbly loam. The dominant species are Utah juniper, mountain big sagebrush, bitterbrush and bluebunch wheatgrass.

2.12.2.5 Yeates Hollow Cobbly Loam

Yeates Hollow Cobbly Loam is found on slopes between 6 and 20 percent. The soil is very deep, well drained and located on fan remnants formed in alluvium, which are derived mainly from quartzite and sandstone. Slopes are a medium length and convex. The upper soil is both a cobbly loam and a gravelly loam. The subsoil is very cobbly clay loam, and the substratum is extremely cobbly sandy clay loam. The predominant vegetative species occurring on this soil are bluebunch wheatgrass, basin wild rye, rabbitbrush, mules ear and mountain big sagebrush.

2.12.2.6 Reclamation Soil Cover of Mine and Mill Areas

The former smelter site, landfills, slag pile, sediment ponds and tailings materials (slickens) were located in one area of the Site and have been covered with local soil. Slickens, as termed in this soil unit by the NRCS, are the accumulation of fine textured materials separated by ore milling operations. The flat and lower disturbed areas (principally Work Areas 7, 8 and 9) have been covered with borrow material from a combination of surface, subsurface and substratum from the Birdow loam and the Lakewin gravelly loam soil units. Higher elevation and slightly steeper disturbed areas (principally Work Areas 2, 3 and 4) were covered with Kapod gravelly loam. The removal of the borrow soils allowed for a blending of soil particle sizes achieving a more uniform texture for cover application. Cover soils were originally placed to a depth of about 12 inches and have consolidated over time to approximately 8 inches in depth. The covered areas were prepared as seedbeds. Three seed mixtures were used on the various covered locations. The selection of revegetation species was based on soil/vegetation associations, test plots, erosion-control properties and wildlife habitat value.

2.12.3 Site Climate Characteristics

The climate is characterized by cold, snowy winters and warm, dry summers. The average annual precipitation is 12 to 18 inches, however, it has been as high as 20 inches on south and west exposures. June is typically the driest month. Annual distribution varies from 20 to 45 percent during the plant-growth period, which is from May to October. Rain storms come as intermittent intense cloudbursts during July and August. The effective moisture for plant growth is the 55 to 80 percent that falls during the plant-dormant period in the winter, which allows for deeper absorption into plant root zones. Absorbed sunlight warms the exposed site slopes causing heating of the overlying air mass resulting in diurnal up slope and down slope convection winds that routinely move up and down the mountainside and through canyon valleys.

2.12.4 Site Vegetation Characteristics

The Site vegetation information has been assembled by onsite ocular surveys and quantitative vegetation inventories completed on Atlantic Richfield property and adjacent BLM range land. The taxa identified in this section represent best flora estimations based on site vegetative analysis surveys. Vegetation was inventoried for diversity, cover and biomass. Vegetation surveys included work areas with a history of physical site disturbance and areas without such a disturbance history. The current condition of the reclaimed plant communities can then be compared to the vegetation of adjacent rangelands without surface impacts due to historic mining activities.

The plant inventories were completed on the Site by ocular collection of plant canopy cover estimates by species. The Site was subdivided into five zones that contained similar vegetation and conditions. The zones are defined as follows:

- Zone 1 - Mountain shrub - sagebrush terrace with no physical mining disturbance. The range site is primarily an upland gravelly loam with a Gambel oak and sagebrush vegetation group. There has been no ground disturbance related to operations in the zone; it contains Work Areas 1 and 5.

- Zone 2 - Mountain shrub - sagebrush area with mining and milling operations disturbances. The general range site is an upland gravelly loam with a Gambels oak and sagebrush vegetation group. This area is the Site of former operation where most areas have been covered and revegetated. Zone 2 contains Work Areas 2, 3, 4 and 6.

- Zone 3 - Sagebrush-grass steppe with revegetated tailings facilities. The general range site is classified as an upland gravelly loam, Mountain Big Sagebrush vegetation group. This area contains the tailings impoundment and has been covered and revegetated. Zone 3 is made up of Work Areas 8 and 11.

- Zone 4 - Canyon Creek Area (Pine Canyon) riparian vegetation area with some physical mining disturbances. The general range site includes a mountain gravelly loam at the upper reach and loamy alluvial bottom at the lower reach of the area. It is a Basin Wild rye vegetation group. This area contains Work Area 7.

- Zone 5 - Sagebrush-grass steppe area with no physical mining or milling operation disturbance and no revegetation. The range site is classified as an upland gravelly loam with Mountain Big Sagebrush vegetation. The alluvial fan areas are loamy-bottomed with Basin Wild rye vegetation. Zone 5 contains Work Areas 9 and 10.

- Adjacent Rangelands – Sagebrush-grass steppe area with no physical mining or milling disturbance. The range site is classified as an upland gravelly loam with Mountain Big Sagebrush vegetation. The area lies immediately north of the IS&R Site and is BLM land.

Each vegetation zone was sampled to determine the current plant community existing on the Site. The sampling locations are shown on Figure 2-20 (Vegetation Zones). Sampling was completed in two sampling events. The first was completed in December 2002 and the second in July 2003.

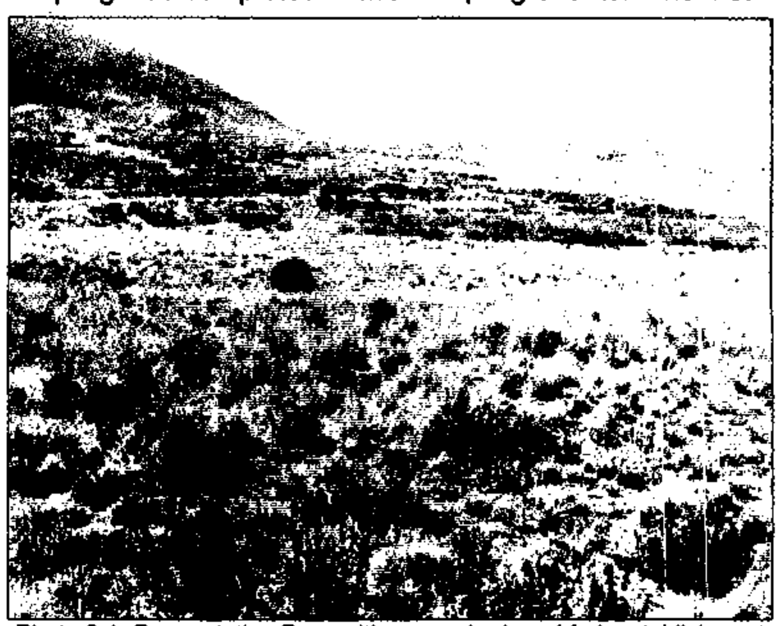


Photo 2-1: Revegetation Zone with grass shrub and forb establishment

In December 2002, 23 site locations were randomly chosen and inventoried for plant diversity and canopy cover. At each location, five 1 m^2 quadrats, one at the center point and one at five meters in each of the cardinal directions, were sampled for diversity and cover. The canopy cover for each species was estimated and the contribution of each species was summed to reach the total for each quadrat. Results from the five quadrats were

Color Photo(s)

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averaged to represent the location. The total number of locations from each zone was averaged to represent the mean plant composition for each vegetation zone. In addition to the Site locations, three locations were chosen on the adjacent rangelands area. The same procedure was followed for these locations. The results of plant inventories and cover estimates for the December 2002 sampling event are shown in Table 2-19 (Plant Inventory and Cover Determination: December 2002).

In July 2003, 12 site locations from among the original 23 were sampled again. Also, the three adjacent rangeland locations were resampled. The same procedure as mentioned above was followed to inventory plant diversity and measure canopy cover. Biomass sampling was also conducted in the July 2003 sampling event to better understand the productive capacity of the plant community. A similar procedure was followed to measure the biomass production. Five quadrants were placed as described above. Biomass was estimated at all five quadrants. One quadrat was randomly selected for biomass harvesting. All vegetation was clipped at the ground level and later weighed after drying. The biomass from each species was estimated/harvested individually and summed to reach the total biomass per quadrat. As stated above, the five quadrats were averaged to represent the location and all locations within a vegetation zone were averaged to represent the productive capacity of that zone. The results of plant inventories and cover estimates for the July 2003 sampling event are shown in Table 2-20 (Plant Inventory and Cover Determination: July 2003). Biomass results are shown in Table 2-21 (Biomass Results). Dominant species and plant groups included several species of perennial wheatgrass (*Agropyron spp.*), blue grasses (*Poa spp.*), sagebrush (*Artemisia spp.*), bitterbrush (*Purshia tridentata*) and other weedy forbs. Discussion of sampling events is located in Section 2.12.11.

Photo 2-2: Riparian Zone anchored by willows, rushes and sedges.

Extensive grazing use was made of these foothill ranges throughout the region for spring and fall grazing. The use between the mid 1800s and early 1930s was uncontrolled and resulted in the decimation of the preferred forage species. Sagebrush composition increased as palatable grasses, forbs and shrubs declined. Invasion of exotic annual grasses and forbs has changed the ecology of this system by creating continuous fine fuels between shrubs and eventually, through fire, these ranges were converted largely to a weedy fire tolerant plant composition. Most of the area of the IS&R/Carr Fork facility shared this use history until it was excluded from grazing nearly 40 years ago. From 1910 through 1970 the Site smelter was a local source of potentially phytotoxic SO_2 emissions that further impacted local vegetation.

The cumulative long-term historical damage to the plant communities by regional over grazing and local smelter emissions and the resulting soil quality degradation through the loss of surface soil organic matter has likely impaired the rate and potential end state of vegetation recovery. Natural recovery may be impaired by a variety of factors including climatic constraints, soil condition following erosion post-grazing and smelter emissions, limited seed source and perhaps phytotoxicity in some areas of concern.

2.12.5 Site Plant Nutrients

Plant establishment and growth is also a function of nutrients in the soil. Before soils used for covering were selected, soil samples were collected from several locations to assess the nutrient and potential phytotoxic characteristics of the Site surface soils. During early study of the Site in the mid 1980s soils of the main two soil map units were analyzed for fertility (JBR, 1986). The general finding at that time was that the soils on site were acceptable as plant growth media. These soils were used for covering and plant growth media at the Site.

A recent evaluation of random soil samples taken throughout the facility found that nutrient levels and indicators are generally adequate for plant growth and development in the surface soil layers. Nitrogen and organic matter levels are low in the soils. This is characteristic of most rangeland soils in these soil map units but adequate for plant growth. Most other nutrients and pH are within normal ranges (analytical analysis of area samples can be reviewed in Appendix C). Two samples may have levels that are of concern for plant vigor. One location had a relatively low pH value. The plant cover is 9.8% in this area. This soil condition exists in what appear to be limited areas within WA9. Table 2-22 presents a summary of the nutrient sample results. The nutrient soil samples were taken at the same locations as the plant inventory and cover determination samples. Table 2-22 (Plant Nutrients from Site Soils) also shows the average plant cover percentage for the various areas sampled. Areas of concern that contain very little or no vegetation are discussed in Section 3.14 of this report. In areas where soil additions and seeding occurred, plant community development is occurring at an accelerated rate. Relative to soils generally throughout the facility, plant communities can be expected to move through the natural process of secondary succession as constrained by local topographic and climatic

Table 2-19
Plant Inventory and Cover Determination: December 2002
ISR Remedial Investigation

Location	Work Area	Zone	Common Name	Quadrat 1		Quadrat N		Quadrat E		Quadrat S		Quadrat W		MEAN	
				Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp
BLM-A	BLM		Red Threeawn	14.00%	45.16%	10.00%	17.24%	15.00%	42.86%	7.00%	28.57%	6.00%	21.43%	10.40%	31.05%
			Broom Snakeweed	5.00%	16.13%	20.00%	34.48%	4.00%	11.43%	4.00%	16.33%	7.00%	25.00%	8.00%	20.67%
			Bulbous bluegrass	1.00%	3.23%	25.00%	43.10%	11.00%	31.43%	10.00%	40.82%	13.00%	46.43%	12.00%	33.00%
			Cheat grass	1.00%	3.23%	0.00%	0.00%	0.00%	0.00%	1.00%	4.08%	0.00%	0.00%	0.40%	1.46%
			Red-stem Filaree	10.00%	32.26%	3.00%	5.17%	5.00%	14.29%	2.00%	8.16%	2.00%	7.14%	4.40%	13.40%
			Perennial Annual Forb	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.50%	2.04%	0.00%	0.00%	0.10%	0.41%
			SUM	31.00%		58.00%		35.00%		24.50%		28.00%		35.30%	
BLM-D	BLM		Red Threeawn	25.00%	62.50%	7.00%	32.56%	14.00%	53.85%	24.00%	68.57%	12.00%	36.36%	16.40%	50.77%
			Dalmation Toadflax*	9.00%	22.50%	7.00%	32.56%	3.00%	11.54%	3.00%	8.57%	5.00%	15.15%	5.40%	18.06%
			Curlycup Gumweed	1.00%	2.50%	0.00%	0.00%	0.50%	1.92%	0.00%	0.00%	0.00%	0.00%	0.30%	0.88%
*Either toadflax or			Bulbous bluegrass	5.00%	12.50%	7.00%	32.56%	8.00%	30.77%	8.00%	22.86%	11.00%	33.33%	7.80%	26.40%
similar weedy species.			Red-stem Filaree	0.00%	0.00%	0.50%	2.33%	0.50%	1.92%	0.00%	0.00%	5.00%	15.15%	1.20%	3.88%
			SUM	40.00%		21.50%		26.00%		35.00%		33.00%		31.10%	
BLM-E	BLM		Red Threeawn	6.00%	35.29%	10.00%	55.56%	17.00%	70.83%	2.00%	10.81%	10.00%	38.46%	9.00%	42.19%
			Ragweed	1.00%	5.88%	0.50%	2.78%	1.00%	4.17%	3.00%	16.22%	1.00%	3.85%	1.30%	6.58%
			Bulbous bluegrass	3.00%	17.65%	0.50%	2.78%	1.00%	4.17%	9.00%	48.65%	12.00%	46.15%	5.10%	23.88%
			Broom Snakeweed	4.00%	23.53%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.80%	4.71%
			Red-stem Filaree	1.00%	5.88%	1.00%	5.56%	1.00%	4.17%	1.00%	5.41%	2.00%	7.69%	1.20%	5.74%
			Dalmation Toadflax	2.00%	11.76%	6.00%	33.33%	4.00%	16.67%	1.00%	5.41%	1.00%	3.85%	2.80%	14.20%
			Curlycup Gumweed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	5.41%	0.00%	0.00%	0.20%	1.08%
			Cheat grass	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	5.41%	0.00%	0.00%	0.20%	1.08%
			Sunflower	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.50%	2.70%	0.00%	0.00%	0.10%	0.54%
			SUM	17.00%		18.00%		24.00%		18.50%		26.00%		20.70%	

BLM MEAN 29.0%

7e	WA 1	1	Dogbane	7.0%	100.0%	0.0%	0.0%	0.0%	0.0%	2.0%	100.0%	4.0%	100.0%	2.6%	60.0%
			SUM	7.0%		0.0%		0.0%		2.0%		4.0%		2.6%	
1e	WA1	1	Bulbous bluegrass	30.0%	89.6%	20.0%	62.5%	13.0%	38.2%	19.0%	76.0%	14.0%	50.9%	19.2%	63.4%
			Ragweed	1.0%	3.0%	0.0%	0.0%	1.0%	2.9%	2.0%	8.0%	0.5%	1.8%	0.9%	3.1%
			Dalmation Toadflax	0.5%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%
			Red-stem Filaree	2.0%	6.0%	1.0%	3.1%	1.0%	2.9%	2.0%	8.0%	2.0%	7.3%	1.6%	5.5%
			Big Sagebrush	0.0%	0.0%	8.0%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.6%	5.0%
			Broom Snakeweed	0.0%	0.0%	2.0%	6.3%	0.0%	0.0%	0.0%	0.0%	5.0%	18.2%	1.4%	4.9%
			Red Threeawn	0.0%	0.0%	0.0%	0.0%	19.0%	55.9%	0.0%	0.0%	6.0%	21.8%	5.0%	15.5%
			Cheat grass	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	4.0%	0.0%	0.0%	0.2%	0.8%
			Curlycup Gumweed	0.0%	0.0%	1.0%	3.1%	0.0%	0.0%	1.0%	4.0%	0.0%	0.0%	0.4%	1.4%
			SUM	33.5%		32.0%		34.0%		25.0%		27.5%		30.4%	

ANDERSON

Table 2-19
Plant Inventory and Cover Determination: December 2002
ISR Remedial Investigation

Location	Work Area	Zone	Common Name	Quadrat 1		Quadrat N		Quadrat E		Quadrat S		Quadrat W		MEAN	
				Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp
2e	WA1	1	Red-stem Filaree	13.0%	65.0%	6.0%	48.0%	4.0%	20.0%	1.0%	3.3%	1.0%	8.7%	5.0%	29.0%
			Cheatgrass	2.0%	10.0%	2.0%	16.0%	1.0%	5.0%	1.0%	3.3%	2.0%	17.4%	1.6%	10.3%
			Ragweed	0.5%	2.5%	0.5%	4.0%	0.0%	0.0%	0.5%	1.6%	1.0%	8.7%	0.5%	3.4%
			Curlycup Gumweed	0.5%	2.5%	1.0%	8.0%	1.0%	5.0%	1.0%	3.3%	1.0%	8.7%	0.9%	5.5%
			Bulbous bluegrass	4.0%	20.0%	3.0%	24.0%	10.0%	50.0%	11.0%	36.1%	6.0%	52.2%	6.8%	36.4%
			Red Threeawn	0.0%	0.0%	0.0%	0.0%	4.0%	20.0%	16.0%	52.5%	0.0%	0.0%	4.0%	14.5%
			Babysbreath	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	4.3%	0.1%	0.9%
			SUM	20.0%		12.5%		20.0%		30.5%		11.5%		18.9%	
50e	WA5	1	Mule's Ear	6.0%	20.0%	16.0%	51.6%	5.0%	16.9%	5.0%	24.4%	4.0%	25.0%	7.2%	27.6%
			Bulbous bluegrass	23.0%	76.7%	12.0%	38.7%	24.0%	81.4%	15.0%	73.2%	11.0%	68.8%	17.0%	67.7%
			Perennial grass	1.0%	3.3%	3.0%	9.7%	0.5%	1.7%	0.5%	2.4%	0.5%	3.1%	1.1%	4.1%
			Babysbreath	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	3.1%	0.1%	0.6%
			SUM	30.0%		31.0%		29.5%		20.5%		16.0%		25.4%	
51e	WA5	1	Bulbous bluegrass	10.0%	87.0%	9.0%	56.3%	19.0%	86.4%	10.0%	76.9%	10.0%	74.1%	11.6%	76.1%
			Curlycup Gumweed	1.0%	8.7%	0.5%	3.1%	1.0%	4.5%	1.0%	7.7%	0.0%	0.0%	0.7%	4.8%
			Red-stem Filaree	0.5%	4.3%	4.0%	25.0%	1.0%	4.5%	0.5%	3.8%	2.0%	14.8%	1.6%	10.5%
			Sunflower	0.0%	0.0%	0.5%	3.1%	1.0%	4.5%	1.0%	7.7%	1.0%	7.4%	0.7%	4.6%
			Mule's Ear	0.0%	0.0%	2.0%	12.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	2.5%
			Perennial grass	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	3.8%	0.5%	3.7%	0.2%	1.5%
			SUM	11.5%		16.0%		22.0%		13.0%		13.5%		15.2%	
52e	WA5	1	Mule's Ear	4.0%	17.8%	3.0%	22.2%	4.0%	40.0%	9.0%	37.5%	4.0%	34.8%	4.8%	30.5%
			Bulbous bluegrass	16.0%	71.1%	10.0%	74.1%	5.0%	50.0%	12.0%	50.0%	7.0%	60.9%	10.0%	61.2%
			Curlycup Gumweed	0.5%	2.2%	0.5%	3.7%	0.5%	5.0%	1.0%	4.2%	0.5%	4.3%	0.6%	3.9%
			Perennial Grasses	1.0%	4.4%	0.0%	0.0%	0.0%	0.0%	0.5%	2.1%	0.0%	0.0%	0.3%	1.3%
			Ragweed	0.5%	2.2%	0.0%	0.0%	0.5%	5.0%	1.0%	4.2%	0.0%	0.0%	0.4%	2.3%
			Dalmation Toad Flax	0.5%	2.2%	0.0%	0.0%	0.0%	0.0%	0.5%	2.1%	0.0%	0.0%	0.2%	0.9%
			SUM	22.5%		13.5%		10.0%		24.0%		11.5%		16.3%	

ZONE 1 MEAN 18.1%

23e	WA3	2	Wheatgrass, Agropyron spp.	16.0%	100.0%	1.0%	16.7%	9.0%	100.0%	9.0%	81.8%	18.0%	90.0%	10.6%	77.7%
			Bulbous bluegrass	0.0%	0.0%	4.0%	66.7%	0.0%	0.0%	1.0%	9.1%	0.5%	2.5%	1.1%	15.7%
			Ragweed	0.0%	0.0%	0.5%	8.3%	0.0%	0.0%	0.0%	0.0%	1.0%	5.0%	0.3%	2.7%
			Curlycup Gumweed	0.0%	0.0%	0.5%	8.3%	0.0%	0.0%	1.0%	9.1%	0.0%	0.0%	0.3%	3.5%
			Dalmation Toadflax	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	2.5%	0.1%	0.5%
			SUM	16.0%		6.0%		9.0%		11.0%		20.0%		12.4%	

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ENGINEERING COMPANY INC.

Table 2-19
Plant Inventory and Cover Determination: December 2002
ISR Remedial Investigation

Location	Work Area	Zone	Common Name	Quadrat 1		Quadrat N		Quadrat E		Quadrat S		Quadrat W		MEAN	
				Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp
24e	WA3	2	Wheatgrass, Agropyron spp.	10.0%	71.4%	11.0%	66.7%	11.0%	73.3%	11.0%	64.7%	11.0%	73.3%	10.8%	69.9%
			Bulbous bluegrass	4.0%	28.6%	3.0%	18.2%	3.0%	20.0%	3.0%	17.6%	3.0%	20.0%	3.2%	20.9%
			Perennial grass	0.0%	0.0%	2.0%	12.1%	1.0%	6.7%	0.0%	0.0%	1.0%	6.7%	0.8%	5.1%
			Ragweed	0.0%	0.0%	0.5%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.6%
			Curlycup Gumweed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	2.9%	0.0%	0.0%	0.1%	0.6%
			Gray Rabbitbrush	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	11.8%	0.0%	0.0%	0.4%	2.4%
			Cheat grass	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	2.9%	0.0%	0.0%	0.1%	0.6%
			SUM	14.0%		16.5%		15.0%		17.0%		15.0%		15.5%	
27e	WA3	2	Wheatgrass, Agropyron spp.	5.0%	43.5%	12.0%	88.9%	5.0%	71.4%	7.0%	40.0%	10.0%	83.3%	7.8%	65.4%
			Bulbous bluegrass	5.0%	43.5%	0.0%	0.0%	0.5%	7.1%	9.0%	51.4%	2.0%	16.7%	3.3%	23.7%
			Curlycup Gumweed	1.0%	8.7%	1.0%	7.4%	0.5%	7.1%	0.0%	0.0%	0.0%	0.0%	0.5%	4.6%
			Babysbreath	0.5%	4.3%	0.5%	3.7%	0.5%	7.1%	0.5%	2.9%	0.0%	0.0%	0.4%	3.6%
			Dalmation Toadflax	0.0%	0.0%	0.0%	0.0%	0.5%	7.1%	0.5%	2.9%	0.0%	0.0%	0.2%	2.0%
			Cheat grass	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	2.9%	0.0%	0.0%	0.1%	0.6%
			SUM	11.5%		13.5%		7.0%		17.5%		12.0%		12.3%	
56e	WA6	2	Wheatgrass, Agropyron spp.	10.0%	87.0%	5.0%	71.4%	7.0%	100.0%	6.0%	80.0%	9.0%	90.0%	7.4%	85.7%
			Dalmation Toadflax	1.0%	8.7%	0.0%	0.0%	0.0%	0.0%	0.5%	6.7%	0.0%	0.0%	0.3%	3.1%
			Cheat grass	0.5%	4.3%	0.5%	7.1%	0.0%	0.0%	0.5%	6.7%	0.5%	5.0%	0.4%	4.6%
			Annual Forb	0.0%	0.0%	1.0%	14.3%	0.0%	0.0%	0.0%	0.0%	0.5%	5.0%	0.3%	3.9%
			Curlycup Gumweed	0.0%	0.0%	0.5%	7.1%	0.0%	0.0%	0.5%	6.7%	0.0%	0.0%	0.2%	2.8%
			SUM	11.5%		7.0%		7.0%		7.5%		10.0%		8.6%	

ZONE 2 MEAN 12.2%

Location	Work Area	Zone	Common Name	Quadrat 1 Cover	Quadrat 1 % Comp	Quadrat N Cover	Quadrat N % Comp	Quadrat E Cover	Quadrat E % Comp	Quadrat S Cover	Quadrat S % Comp	Quadrat W Cover	Quadrat W % Comp	MEAN Cover	MEAN % Comp
106e	WA8	3	Bulbous bluegrass	12.0%	82.8%	5.0%	58.8%	9.0%	81.8%	10.0%	87.0%	9.0%	85.7%	9.0%	79.2%
			Perennial Grass	2.0%	13.8%	3.0%	35.3%	2.0%	18.2%	1.0%	8.7%	1.0%	9.5%	1.8%	17.1%
			Ragweed	0.0%	0.0%	0.5%	5.9%	0.0%	0.0%	0.5%	4.3%	0.0%	0.0%	0.2%	2.0%
			Curlycup Gumweed	0.5%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	4.8%	0.2%	1.6%
			SUM	14.5%		8.5%		11.0%		11.5%		10.5%		11.2%	
108e	WA8	3	Bulbous bluegrass	5.0%	41.7%	11.0%	55.0%	19.0%	95.0%	18.0%	85.7%	4.0%	66.7%	11.4%	68.8%
			Yellow Sweetclover	3.0%	25.0%	2.0%	10.0%	0.0%	0.0%	0.5%	2.4%	1.0%	16.7%	1.3%	10.8%
			Perennial grass	1.0%	8.3%	3.0%	15.0%	1.0%	5.0%	0.5%	2.4%	1.0%	16.7%	1.3%	9.5%
			Red-stem Filaree	3.0%	25.0%	4.0%	20.0%	0.0%	0.0%	2.0%	9.5%	0.0%	0.0%	1.8%	10.9%
			SUM	12.0%		20.0%		20.0%		21.0%		6.0%		15.8%	
138	WA8	3	Ragweed	1.0%	5.3%	0.5%	2.9%	0.5%	7.1%	1.0%	6.1%	0.0%	0.0%	0.6%	4.3%
			Bulbous bluegrass	10.0%	52.6%	5.0%	28.6%	3.0%	42.9%	6.0%	36.4%	6.0%	44.4%	6.0%	41.0%
			Curlycup Gumweed	0.5%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%
			Yellow Sweetclover	3.0%	15.8%	0.0%	0.0%	0.0%	0.0%	5.0%	30.3%	4.0%	29.6%	2.4%	15.1%
			Crested Wheatgrass	4.0%	21.1%	11.0%	62.9%	3.0%	42.9%	4.0%	24.2%	3.0%	22.2%	5.0%	34.6%
			Cheat grass	0.5%	2.6%	0.5%	2.9%	0.5%	7.1%	0.5%	3.0%	0.5%	3.7%	0.5%	3.9%
			Red-stem Filaree	0.0%	0.0%	0.5%	2.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.6%
			SUM	19.0%		17.5%		7.0%		16.5%		13.5%		14.7%	

ZONE 3 MEAN 13.9%

ANDERSON

Table 2-19
Plant Inventory and Cover Determination: December 2002
ISR Remedial Investigation

Location	Work Area	Zone	Common Name	Quadrat 1		Quadrat N		Quadrat E		Quadrat S		Quadrat W		MEAN	
				Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp
67e	WA7	4	Common Rye	25.0%	90.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	18.2%
			Ragweed	1.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.7%
			Dogbane	1.0%	3.6%	0.0%	0.0%	1.0%	9.1%	1.0%	11.1%	2.0%	23.5%	1.0%	9.5%
			Cheat grass	0.5%	1.8%	1.0%	5.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	1.4%
			Sunflower	0.0%	0.0%	0.5%	2.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%
			Perennial grass	0.0%	0.0%	16.0%	86.5%	6.0%	54.5%	5.0%	55.6%	5.0%	58.8%	6.4%	51.1%
			Red-stem filaree	0.0%	0.0%	1.0%	5.4%	2.0%	18.2%	1.0%	11.1%	0.5%	5.9%	0.9%	8.1%
			Bulbous bluegrass	0.0%	0.0%	0.0%	0.0%	2.0%	18.2%	0.0%	0.0%	0.0%	0.0%	0.4%	3.6%
			Dalmation Toadflax	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	11.1%	1.0%	11.8%	0.4%	4.6%
			Curlycup Gumweed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	11.1%	0.0%	0.0%	0.2%	2.2%
			SUM	27.5%		18.5%		11.0%		9.0%		8.5%		14.9%	
68e (There is scattered Gray Rabbitbrush in the area.)	WA7	4	Bulbous bluegrass	11.0%	88.0%	12.0%	92.3%	5.0%	25.6%	0.0%	0.0%	12.0%	58.5%	8.0%	52.9%
			Cheat grass	1.0%	8.0%	0.0%	0.0%	0.0%	0.0%	1.0%	20.0%	1.0%	4.9%	0.6%	6.6%
			Curlycup Gumweed	0.5%	4.0%	1.0%	7.7%	6.0%	30.8%	0.0%	0.0%	6.0%	29.3%	2.7%	14.3%
			Dalmation Toadflax	0.0%	0.0%	0.0%	0.0%	0.5%	2.6%	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%
			Crested Wheatgrass	0.0%	0.0%	0.0%	0.0%	2.0%	10.3%	0.0%	0.0%	0.0%	0.0%	0.4%	2.1%
			Gray Rabbitbrush	0.0%	0.0%	0.0%	0.0%	6.0%	30.8%	0.0%	0.0%	0.0%	0.0%	1.2%	6.2%
			Perennial grass	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	20.0%	1.0%	4.9%	0.4%	5.0%
			Red-stem Filaree	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	60.0%	0.5%	2.4%	0.7%	12.5%
			SUM	12.5%		13.0%		19.5%		5.0%		20.5%		14.1%	
70e	WA7	4	Cheat grass	1.0%	25.0%	1.0%	14.3%	1.0%	14.3%	2.0%	22.2%	0.0%	0.0%	1.0%	15.2%
			Dalmation Toadflax	1.0%	25.0%	0.0%	0.0%	2.0%	28.6%	2.0%	22.2%	5.0%	62.5%	2.0%	27.7%
			Dogbane	2.0%	50.0%	1.0%	14.3%	0.0%	0.0%	0.0%	0.0%	2.0%	25.0%	1.0%	17.9%
			Perennial grass	0.0%	0.0%	1.0%	14.3%	0.0%	0.0%	0.0%	0.0%	1.0%	12.5%	0.4%	5.4%
			Annual Forb	0.0%	0.0%	4.0%	57.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	11.4%
			Curlycup gumweed	0.0%	0.0%	0.0%	0.0%	1.0%	14.3%	0.0%	0.0%	0.0%	0.0%	0.2%	2.9%
			Hoary Cress	0.0%	0.0%	0.0%	0.0%	3.0%	42.9%	0.0%	0.0%	0.0%	0.0%	0.6%	8.6%
			Willow	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	55.6%	0.0%	0.0%	1.0%	11.1%
			SUM	4.0%		7.0%		7.0%		9.0%		8.0%		7.0%	
71e (This area is on the old railroad grade.)	WA7	4	Ragweed	1.0%	7.7%	1.0%	11.1%	0.0%	0.0%	1.0%	10.0%	0.0%	0.0%	0.6%	5.8%
			Cheat grass	1.0%	7.7%	1.0%	11.1%	0.0%	0.0%	1.0%	10.0%	1.0%	5.3%	0.8%	6.8%
			Rye grass	11.0%	84.6%	7.0%	77.8%	10.0%	83.3%	6.0%	60.0%	0.0%	0.0%	6.8%	61.1%
			Hoary Cress	0.0%	0.0%	0.0%	0.0%	1.0%	8.3%	1.0%	10.0%	0.0%	0.0%	0.4%	3.7%
			Willow	0.0%	0.0%	0.0%	0.0%	1.0%	8.3%	1.0%	10.0%	0.0%	0.0%	0.4%	3.7%
			Red Threeawn	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	16.0%	84.2%	3.2%	16.8%
			Bulbous bluegrass	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	10.5%	0.4%	2.1%
			SUM	13.0%		9.0%		12.0%		10.0%		19.0%		12.6%	

Table 2-19
Plant Inventory and Cover Determination: December 2002
ISR Remedial Investigation

Location	Work Area	Zone	Common Name	Quadrat 1		Quadrat N		Quadrat E		Quadrat S		Quadrat W		MEAN	
				Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp	Cover	% Comp
72e	WA7	4	Red three awn	5.0%	22.7%	0.0%	0.0%	0.0%	0.0%	12.0%	80.0%	0.0%	0.0%	3.4%	20.5%
			Dalmation Toadflax	1.0%	4.5%	0.0%	0.0%	0.0%	0.0%	1.0%	6.7%	0.0%	0.0%	0.4%	2.2%
			Perennail grass	11.0%	50.0%	0.0%	0.0%	0.0%	0.0%	1.0%	6.7%	0.0%	0.0%	2.4%	11.3%
			Bulbous bluegrass	3.0%	13.6%	0.0%	0.0%	0.0%	0.0%	1.0%	6.7%	0.0%	0.0%	0.8%	4.1%
			Ragweed	0.5%	2.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%
			Curlycup Gumweed	0.5%	2.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%
			Cheat grass	1.0%	4.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.9%
			SUM	22.0%		0.0%		0.0%		15.0%		0.0%		7.4%	

ZONE 4 MEAN 11.2%

Location	Work Area	Zone	Common Name	Quadrat 1 Cover	Quadrat 1 % Comp	Quadrat N Cover	Quadrat N % Comp	Quadrat E Cover	Quadrat E % Comp	Quadrat S Cover	Quadrat S % Comp	Quadrat W Cover	Quadrat W % Comp	MEAN Cover	MEAN % Comp
114e	WA9	5	Bulbous bluegrass	11.0%	78.6%	11.0%	91.7%	0.0%	0.0%	2.0%	33.3%	4.0%	80.0%	5.6%	56.7%
			Crested Wheatgrass	2.0%	14.3%	0.0%	0.0%	3.0%	85.7%	3.0%	50.0%	0.0%	0.0%	1.6%	30.0%
			Cheat grass	0.5%	3.6%	1.0%	8.3%	0.5%	14.3%	0.5%	8.3%	0.5%	10.0%	0.6%	8.9%
			Ragweed	0.5%	3.6%	0.0%	0.0%	0.0%	0.0%	0.5%	8.3%	0.5%	10.0%	0.3%	4.4%
			SUM	14.0%		12.0%		3.5%		6.0%		5.0%		8.1%	
116e (Big Sage, Bitterbrush, and Yellow Sweetclover are scattered in the area.)	WA9	5	Bulbous bluegrass	12.0%	53.3%	12.0%	47.1%	20.0%	70.2%	5.0%	41.7%	15.0%	57.7%	12.8%	54.0%
			Crested Wheatgrass	5.0%	22.2%	3.0%	11.8%	0.0%	0.0%	3.0%	25.0%	6.0%	23.1%	3.4%	16.4%
			Yellow Sweetclover	4.0%	17.8%	10.0%	39.2%	8.0%	28.1%	0.0%	0.0%	4.0%	15.4%	5.2%	20.1%
			Cheat grass	0.5%	2.2%	0.5%	2.0%	0.5%	1.8%	1.0%	8.3%	1.0%	3.8%	0.7%	3.6%
			Red-stem Filaree	1.0%	4.4%	0.0%	0.0%	0.0%	0.0%	3.0%	25.0%	0.0%	0.0%	0.8%	5.9%
			SUM	22.5%		25.5%		28.5%		12.0%		26.0%		22.9%	
117e	WA9	5	Common Rye	18.0%	100.0%	10.0%	100.0%	9.0%	100.0%	0.0%	0.0%	8.0%	100.0%	9.0%	80.0%
			Perennial grass	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%	100.0%	0.0%	0.0%	0.8%	20.0%
			SUM	18.0%		10.0%		9.0%		4.0%		8.0%		9.8%	
120e	WA9	5	Bulbous bluegrass	9.0%	62.1%	5.0%	45.5%	5.0%	41.7%	10.0%	54.1%	3.0%	28.6%	6.4%	46.4%
			Crested Wheatgrass	4.0%	27.6%	5.0%	45.5%	5.0%	41.7%	3.0%	16.2%	3.0%	28.6%	4.0%	31.9%
			Ragweed	1.0%	6.9%	1.0%	9.1%	1.0%	8.3%	0.5%	2.7%	1.0%	9.5%	0.9%	7.3%
			Red threeawn	0.5%	3.4%	0.0%	0.0%	0.0%	0.0%	4.0%	21.6%	1.0%	9.5%	1.1%	6.9%
			Cheat grass	0.0%	0.0%	0.0%	0.0%	0.5%	4.2%	0.5%	2.7%	0.0%	0.0%	0.2%	1.4%
			Babysbreath	0.0%	0.0%	0.0%	0.0%	0.5%	4.2%	0.5%	2.7%	0.5%	4.8%	0.3%	2.3%
			Curlycup Gumweed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	9.5%	0.2%	1.9%
			Red-stem Filaree	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	9.5%	0.2%	1.9%
			SUM	14.5%		11.0%		12.0%		18.5%		10.5%		13.3%	
127e	WA9	5	Bulbous bluegrass	23.0%	50.5%	22.0%	81.5%	37.0%	90.2%	16.0%	78.0%	22.0%	62.9%	24.0%	72.6%
			Red threeawn	21.0%	46.2%	2.0%	7.4%	2.0%	4.9%	0.0%	0.0%	10.0%	28.6%	7.0%	17.4%
			Ragweed	0.5%	1.1%	0.0%	0.0%	1.0%	2.4%	1.0%	4.9%	1.0%	2.9%	0.7%	2.3%
			Red-stem Filaree	0.5%	1.1%	2.0%	7.4%	0.5%	1.2%	1.0%	4.9%	0.5%	1.4%	0.9%	3.2%
			Curlycup Gumweed	0.5%	1.1%	0.5%	1.9%	0.0%	0.0%	0.5%	2.4%	0.5%	1.4%	0.4%	1.4%
			Dalmation Toadflax	0.0%	0.0%	0.5%	1.9%	0.5%	1.2%	0.0%	0.0%	0.0%	0.0%	0.2%	0.6%
			Plant (cotton-balls)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	9.8%	1.0%	2.9%	0.6%	2.5%
			SUM	45.5%		27.0%		41.0%		20.5%		35.0%		33.8%	

ZONE 5 MEAN 17.6%

ANDERSON

Ta[illegible]2-20
Plant Inventory and Cover Determination: July 2003
ISR Remedial Investigation

Location	Work Area	Zone	Common Name	Quadrat 1		Quadrat N		Quadrat E		Quadrat S		Quadrat W		Mean Value	
				cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp
BLM-A	BLM		Red threeawn	4.00%	15.38%	10.00%	47.62%	7.00%	33.33%	0.00%	0.00%	8.00%	66.67%	5.80%	32.60%
			Perennial Grass	1.00%	3.85%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	8.33%	0.40%	2.44%
			Bulbous bluegrass	1.00%	3.85%	1.00%	4.76%	1.00%	4.76%	1.00%	25.00%	1.00%	8.33%	1.00%	9.34%
			Cheat grass	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.00%	50.00%	0.00%	0.00%	0.40%	10.00%
			Broom Snakeweed	20.00%	76.92%	10.00%	47.62%	13.00%	61.90%	1.00%	25.00%	2.00%	16.67%	9.20%	45.62%
			SUM	26.00%		21.00%		21.00%		4.00%		12.00%		16.80%	
BLM-D	BLM		Red threeawn	20.00%	32.52%	8.00%	32.00%	5.00%	15.87%	30.00%	80.00%	17.00%	35.05%	16.00%	39.09%
			Bulbous bluegrass	0.50%	0.81%	1.00%	4.00%	1.00%	3.17%	1.00%	2.67%	0.50%	1.03%	0.80%	2.34%
			Species I	40.00%	65.04%	16.00%	64.00%	25.00%	79.37%	6.00%	16.00%	30.00%	61.86%	23.40%	57.25%
			Curlycup Gumweed	1.00%	1.63%	0.00%	0.00%	0.50%	1.59%	0.50%	1.33%	0.00%	0.00%	0.40%	0.91%
			Ragweed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	2.06%	0.20%	0.41%
			SUM	61.50%		25.00%		31.50%		37.50%		48.50%		40.80%	
BLM-E	BLM		Red threeawn	5.00%	29.41%	5.00%	23.81%	7.00%	70.00%	6.00%	54.55%	6.00%	60.00%	5.80%	47.55%
			Bulbous bluegrass	0.50%	2.94%	0.00%	0.00%	0.00%	0.00%	1.00%	9.09%	0.00%	0.00%	0.30%	2.41%
			Perennial Grass	0.50%	2.94%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	0.59%
			Ragweed	1.00%	5.88%	2.00%	9.52%	1.00%	10.00%	2.00%	18.18%	3.00%	30.00%	1.80%	14.72%
			Species I	10.00%	58.82%	14.00%	66.67%	2.00%	20.00%	2.00%	18.18%	1.00%	10.00%	5.80%	34.73%
			SUM	17.00%		21.00%		10.00%		11.00%		10.00%		13.80%	

BLM MEAN 23.80%

2e	WA1	1	Bulbous bluegrass	3.00%	16.22%	0.50%	4.76%	4.00%	34.78%	1.00%	5.26%	3.00%	15.79%	2.30%	15.36%
			Cheatgrass	3.00%	16.22%	3.00%	28.57%	0.50%	4.35%	2.00%	10.53%	1.00%	5.26%	1.90%	12.98%
			Ragweed	11.00%	59.46%	2.00%	19.05%	4.00%	34.78%	4.00%	21.05%	5.00%	26.32%	5.20%	32.13%
			Curlycup Gumweed	1.00%	5.41%	1.00%	9.52%	0.00%	0.00%	0.00%	0.00%	1.00%	5.26%	0.60%	4.04%
			Dalmation Toadflax	0.50%	2.70%	4.00%	38.10%	0.00%	0.00%	0.00%	0.00%	6.00%	31.58%	2.10%	14.48%
			Species I	0.00%	0.00%	0.00%	0.00%	2.00%	17.39%	5.00%	26.32%	3.00%	15.79%	2.00%	11.90%
			Bindweed	0.00%	0.00%	0.00%	0.00%	1.00%	8.70%	7.00%	36.84%	0.00%	0.00%	1.60%	9.11%
			SUM	18.50%		10.50%		11.50%		19.00%		19.00%		15.70%	
50e	WA5	1	Bulbous bluegrass	1.00%	2.35%	0.50%	0.66%	2.00%	4.71%	1.00%	2.78%	2.00%	7.27%	1.30%	3.55%
			Bluebunch Wheatgrass	0.50%	1.18%	0.00%	0.00%	0.50%	1.18%	0.00%	0.00%	0.00%	0.00%	0.20%	0.47%
			Wheatgrass, Agropyron spp.	0.00%	0.00%	0.50%	0.66%	0.00%	0.00%	0.00%	0.00%	0.50%	1.82%	0.20%	0.50%
			Mule's Ear	40.00%	94.12%	75.00%	98.68%	40.00%	94.12%	35.00%	97.22%	25.00%	90.91%	43.00%	95.01%
			Species D	1.00%	2.35%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	0.47%
			SUM	42.50%		76.00%		42.50%		36.00%		27.50%		44.90%	

ZONE 1 MEAN 30.3%

ANDERSON
ENGINEERING COMPANY INC.

Ta[illegible]2-20
Plant Inventory and Cover Determination: July 2003
ISR Remedial Investigation

Location	Work Area	Zone	Common Name	Quadrat 1		Quadrat N		Quadrat E		Quadrat S		Quadrat W		Mean Value	
				cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp
23e	WA3	2	Wheatgrass, Agropyron spp.	4.00%	36.36%	11.00%	64.71%	14.00%	87.50%	8.00%	72.73%	12.00%	66.67%	9.80%	65.59%
			Bulbous bluegrass	1.00%	9.09%	0.00%	0.00%	0.00%	0.00%	1.00%	9.09%	1.00%	5.56%	0.60%	4.75%
			Cheat Grass	1.00%	9.09%	1.00%	5.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.40%	2.99%
			Crested Wheatgrass	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	5.56%	0.20%	1.11%
			Ragweed	4.00%	36.36%	0.00%	0.00%	1.00%	6.25%	0.00%	0.00%	0.00%	0.00%	1.00%	8.52%
			Curlycup Gumweed	1.00%	9.09%	2.00%	11.76%	1.00%	6.25%	1.00%	9.09%	0.00%	0.00%	1.00%	7.24%
			Dalmation Toadflax	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	5.56%	0.20%	1.11%
			Red-stem Filaree	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	9.09%	0.00%	0.00%	0.20%	1.82%
			Clover	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.00%	16.67%	0.60%	3.33%
			Species B	0.00%	0.00%	2.00%	11.76%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.40%	2.35%
			Species C	0.00%	0.00%	1.00%	5.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	1.18%
			SUM	11.00%		17.00%		16.00%		11.00%		18.00%		14.60%	
24e	WA3	2	Wheatgrass, Agropyron spp.	7.00%	58.33%	6.00%	46.15%	10.00%	66.67%	12.00%	80.00%	4.00%	44.44%	7.80%	59.12%
			Bulbous bluegrass	2.00%	16.67%	1.00%	7.69%	1.00%	6.67%	1.00%	6.67%	1.00%	11.11%	1.20%	9.76%
			Bluebunch Wheatgrass	0.00%	0.00%	0.00%	0.00%	1.00%	6.67%	0.00%	0.00%	3.00%	33.33%	0.80%	8.00%
			Cheat grass	0.00%	0.00%	2.00%	15.38%	0.00%	0.00%	2.00%	13.33%	0.00%	0.00%	0.80%	5.74%
			Ragweed	0.00%	0.00%	0.00%	0.00%	1.00%	6.67%	0.00%	0.00%	0.00%	0.00%	0.20%	1.33%
			Curlycup Gumweed	0.00%	0.00%	1.00%	7.69%	2.00%	13.33%	0.00%	0.00%	1.00%	11.11%	0.80%	6.43%
			Species D	3.00%	25.00%	3.00%	23.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.20%	9.62%
			SUM	12.00%		13.00%		15.00%		15.00%		9.00%		12.80%	
27e	WA3	2	Wheatgrass, Agropyron spp.	9.00%	90.00%	11.00%	88.00%	10.00%	90.91%	0.00%	0.00%	0.00%	0.00%	6.00%	53.78%
			Bulbous bluegrass	1.00%	10.00%	1.00%	8.00%	1.00%	9.09%	0.00%	0.00%	0.50%	3.23%	0.70%	6.06%
			Milkvetch	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	85.00%	100.00%	0.00%	0.00%	17.00%	20.00%
			Dalmation Toadflax	0.00%	0.00%	0.50%	4.00%	0.00%	0.00%	0.00%	0.00%	1.00%	6.45%	0.30%	2.09%
			Dogbane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	6.45%	0.20%	1.29%
			Gambel Oak	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	13.00%	83.87%	2.60%	16.77%
			SUM	10.00%		12.50%		11.00%		85.00%		15.50%		26.80%	
56e	WA6	2	Wheatgrass, Agropyron spp.	11.00%	100.00%	5.00%	83.33%	13.00%	96.30%	5.00%	83.33%	6.00%	75.00%	8.00%	87.59%
			Cheat grass	0.00%	0.00%	0.50%	8.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	1.67%
			Dalmation Toadflax	0.00%	0.00%	0.50%	8.33%	0.50%	3.70%	1.00%	16.67%	0.00%	0.00%	0.40%	5.74%
			Forb	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.00%	25.00%	0.40%	5.00%
			SUM	11.00%		6.00%		13.50%		6.00%		8.00%		8.90%	

ZONE 2 MEAN 15.8%

106e	WA8	3	Bulbous bluegrass	1.00%	15.38%	1.00%	16.67%	1.00%	28.57%	1.00%	33.33%	1.00%	50.00%	1.00%	28.79%
			Wheatgrass, Agropyron spp.	3.00%	46.15%	5.00%	83.33%	2.00%	57.14%	2.00%	66.67%	1.00%	50.00%	2.60%	60.66%
			Crested Wheatgrass	2.00%	30.77%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.40%	6.15%
			Ragweed	0.00%	0.00%	0.00%	0.00%	0.50%	14.29%	0.00%	0.00%	0.00%	0.00%	0.10%	2.86%
			Curlycup Gumweed	0.50%	7.69%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	1.54%
			SUM	6.50%		6.00%		3.50%		3.00%		2.00%		4.20%	

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Ta[illegible]2-20
Plant Inventory and Cover Determination: July 2003
ISR Remedial Investigation

Location	Work Area	Zone	Common Name	Quadrat 1		Quadrat N		Quadrat E		Quadrat S		Quadrat W		Mean Value	
				cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp
108e	WA8	3	Bulbous bluegrass	0.50%	11.11%	1.00%	25.00%	1.00%	14.29%	0.50%	11.11%	1.00%	14.29%	0.80%	15.16%
			Wheatgrass, Agropyron spp.	1.00%	22.22%	1.00%	25.00%	1.00%	14.29%	2.00%	44.44%	1.00%	14.29%	1.20%	24.05%
			Red-stem Filaree	1.00%	22.22%	0.00%	0.00%	1.00%	14.29%	0.00%	0.00%	0.00%	0.00%	0.40%	7.30%
			Milkvetch	1.00%	22.22%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.00%	42.86%	0.80%	13.02%
			Species F	1.00%	22.22%	0.00%	0.00%	4.00%	57.14%	2.00%	44.44%	0.00%	0.00%	1.40%	24.76%
			Species G	0.00%	0.00%	2.00%	50.00%	0.00%	0.00%	0.00%	0.00%	2.00%	28.57%	0.80%	15.71%
			SUM	4.50%		4.00%		7.00%		4.50%		7.00%		5.40%	
138	WA8	3	Bulbous bluegrass	5.00%	38.46%	1.00%	8.70%	1.00%	33.33%	1.00%	12.50%	4.00%	44.44%	2.40%	27.49%
			Crested Wheatgrass	3.00%	23.08%	4.00%	34.78%	2.00%	66.67%	3.00%	37.50%	1.00%	11.11%	2.60%	34.63%
			Cheat grass	0.00%	0.00%	0.50%	4.35%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	0.87%
			Ragweed	5.00%	38.46%	6.00%	52.17%	0.00%	0.00%	4.00%	50.00%	4.00%	44.44%	3.80%	37.02%
			SUM	13.00%		11.50%		3.00%		8.00%		9.00%		8.90%	

ZONE 3 MEAN **6.2%**

Location	Work Area	Zone	Common Name	cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp
70e	WA7	4	Cheat grass	0.00%	0.00%	6.00%	15.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.20%	3.08%
			Bulbous Bluegrass	3.00%	9.09%	0.00%	0.00%	1.00%	8.33%	0.00%	0.00%	0.00%	0.00%	0.80%	3.48%
			Dalmation Toadflax	30.00%	90.91%	3.00%	7.69%	11.00%	91.67%	20.00%	90.91%	2.00%	8.00%	13.20%	57.84%
			Dogbane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	20.00%	1.00%	4.00%
			Hoary Cress	0.00%	0.00%	30.00%	76.92%	0.00%	0.00%	0.00%	0.00%	5.00%	20.00%	7.00%	19.38%
			Willow	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.00%	9.09%	3.00%	12.00%	1.00%	4.22%
			Shrub	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	40.00%	2.00%	8.00%
			SUM	33.00%		39.00%		12.00%		22.00%		25.00%		26.20%	

ZONE 4 MEAN **26.2%**

Location	Work Area	Zone	Common Name	cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp	cover	%comp
117e	WA9	5	Common Rye	75.00%	100.00%	60.00%	92.31%	80.00%	100.00%	30.00%	100.00%	50.00%	100.00%	59.00%	98.46%
			Dalmation Toadflax	0.00%	0.00%	5.00%	7.69%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	1.54%
			SUM	75.00%		65.00%		80.00%		30.00%		50.00%		60.00%	
120e	WA9	5	Bulbous bluegrass	1.00%	28.57%	1.00%	33.33%	1.00%	16.67%	1.00%	25.00%	1.00%	25.00%	1.00%	25.71%
			Crested Wheatgrass	0.50%	14.29%	1.00%	33.33%	4.00%	66.67%	2.00%	50.00%	1.00%	25.00%	1.70%	37.86%
			Ragweed	1.00%	28.57%	0.00%	0.00%	1.00%	16.67%	1.00%	25.00%	2.00%	50.00%	1.00%	24.05%
			Species J	1.00%	28.57%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	5.71%
			Thistle	0.00%	0.00%	1.00%	33.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	6.67%
			SUM	3.50%		3.00%		6.00%		4.00%		4.00%		4.10%	

ZONE 5 MEAN **32.1%**

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Table 2-21
Biomass Results: July 2003
ISR Remedial Investigation
(Results given in grams/square meter, bold represents measured values)

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
BLM-A	BLM		Bulbous Bluegrass	7	7	7	**13**	7	
			Cheat Grass				**32**		
			Red Three-Awn	16	29	29		29	
			Perennial Grass	5				29	
			Broom Snakeweed	79	58	42	**3**	12	
			Litter	58	30	30	**55**	113	
			Living Biomass	106	94	79	48	78	81
			Total Biomass	164	124	109	103	191	138
BLM-D	BLM		Bulbous Bluegrass	5	7	5	7	**4**	
			Red three-awn	84	16	29	111	**94**	
			Species I	27	88	27	27	**102**	
			Curlycup Gumweed				0		
			Litter	30	36	30	169	**156**	
			Living Biomass	116	111	61	145	200	127
			Total Biomass	146	146	91	314	356	211
BLM-E	BLM		Bulbous Bluegrass	**8**	5		16		
			Red Three-awn	**16**	29	57	70	43	
			Cheat grass	**16**		22		22	
			Perennial grass	**1**					
			Species I	**39**	58	12	3	3	
			Ragweed	**5**	3	0	3	12	
			Litter	**174**	391	113	175	58	
			Living Biomass	85	94	91	91	80	88
			Total Biomass	259	486	204	266	138	270

BLM Living Mean **99**
BLM Total Mean **206**

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
2	WA1	1	Bulbous Bluegrass	43	5	43	**12**	7	
			Cheat grass	63	63	10	**21**	10	
			Species I	58	58	27	**35**	27	
			Ragweed	42	3	3	**9**	12	

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Table 2-21
Biomass Results: July 2003
ISR Remedial Investigation
(Results given in grams/square meter, bold represents measured values)

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
			Bindweed			3	**20**		
			Curlycup Gumweed	12	3			3	
			Dalmation Toadflax	3	58			27	
			Litter	113	58	58	**72**	113	
			Living Biomass	221	189	86	97	86	136
			Total Biomass	334	246	143	169	200	218
50	WA5	1	Bulbous Bluegrass	16		29	7	**29**	
			Bluebunch Wheatgrass	7		7			
			Tall Wheatgrass		11				
			Mule's Ear	149	240	118	88	**84**	
			Annual Forb (D)	3					
			Litter	58	169	58	30	**40**	
			Living Biomass	174	251	155	95	113	158
			Total Biomass	232	420	213	125	153	229

Zone 1 Living Mean **147**
Zone 1 Total Mean **224**

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
23	WA3	2	Tall Wheatgrass	**28**	**72**	**43**	**33**	**45**	
			Bulbous bluegrass	**4**					
			Crested Wheatgrass					**5**	
			Cheat grass	**4**	**3**				
			Bluebunch Wheatgrass				**1**		
			Ragweed	**4**		**1**			
			Curlycup Gumweed	**5**	**4**	**1**	**1**		
			Clover					**8**	
			Red-stem Filaree	**1**				**2**	
			Species C (Forb)		**1**				
			Litter	**30**	**50**	**35**	**37**	**41**	
			Living Biomass	46	80	45	35	60	53
			Total Biomass	76	130	80	72	101	92

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Tabl[illegible]-21
Biomass Results: July 2003
ISR Remedial Investigation
(Results given in grams/square meter, bold represents measured values)

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
24	WA3	2	Tall Wheatgrass	**45**	**38**	**63**	**68**	**32**	
			Bulbous Bluegrass	**14**	**4**	**4**	**5**	**5**	
			Bluebunch Wheatgrass					**20**	
			Crested Wheatgrass	**1**					
			Cheat grass				**12**		
			Ragweed			**2**			
			Curlycup Gumweed		**2**	**7**		**1**	
			Red-stem Filaree	**11**	**8**				
			Litter	**38**	**66**	**78**	**88**	**119**	
			Living Biomass	71	52	76	85	58	68
			Total Biomass	109	118	154	173	177	146
27	WA3	2	Tall Wheatgrass	**32**	70	47			
			Bulbous Bluegrass	**5**	13	13		7	
			Bluebunch Wheatgrass			5			
			Milkvetch				514		
			Curlycup Gumweed		0				
			Dogbane					9	
			Gambel Oak					210	
			Dalmation Toadflax					3	
			Litter	**43**	113	169	447	113	
			Living Biomass	37	83	65	514	229	185
			Total Biomass	80	196	234	961	342	363
56	WA6	2	Tall Wheatgrass	70	138	138	**33**	252	
			Bluebunch Wheatgrass				**11**		
			Dalmation Toadflax		0	3	**6**		
			Annual Forb (E)				**3**	3	
			Dogbane		27				
			Litter	30	13	225	**80**	169	
			Living Biomass	70	165	141	53	255	137
			Total Biomass	100	179	366	133	424	240

Zone 2 Living Mean **111**
Zone 2 Total Mean **210**

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Tabl[illegible]-21
Biomass Results: July 2003
ISR Remedial Investigation
(Results given in grams/square meter, bold represents measured values)

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
106	WA8	3	Tall Wheatgrass	**57**	25	25	25	25	
			Bulbous Wheatgrass	**4**	7	7	16	16	
			Crested Wheatgrass	**19**					
			Ragweed			0			
			Litter	**108**	58	58	225	113	
			Living Biomass	80	32	32	40	40	45
			Total Biomass	188	90	89	265	154	157
108	WA8	3	Tall Wheatgrass	11	25	**26**	11	20	
			Bulbous Bluegrass	7	13	**7**	7	7	
			Red-stem Filaree	0		**2**		0	
			Annual Forb (F)	0		**16**	0	0	
			Annual Forb (G)		3			42	
			Dalmation Toadflax		0				
			Milkvetch					3	
			Litter	58	86	**62**	58	86	
			Living Biomass	18	40	51	18	72	40
			Total Biomass	76	126	113	76	158	109
138	WA8	3	Bulbous Bluegrass	43	**14**	13	7	43	
			Crested Wheatgrass	24	**20**	9	9	6	
			Cheat grass		**5**				
			Ragweed	15	**10**		15	15	
			Litter	58	**52**	58	225	58	
			Living Biomass	82	49	22	31	63	49
			Total Biomass	139	101	80	256	121	139

Zone 3 Living Mean 45
Zone 3 Total Mean 135

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
70	WA7	4	Bulbous Bluegrass	57		29			
			Cheat grass		**17**		63		
			Dalmation Toadflax	362	**25**	58	118	27	
			Willow				27	179	
			Dogbane					58	

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Table 2-21
Biomass Results: July 2003
ISR Remedial Investigation
(Results given in grams/square meter, bold represents measured values)

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
			Perennial Shrub (H)					179	
			Hoary Cress		**188**	15	15	27	
			Litter	447	**409**	336	336	892	
			Living Biomass	418	230	102	224	470	289
			Total Biomass	809	639	408	560	1362	756

Zone 4 Living Mean **289**
Zone 4Total Mean **756**

Location	Work Area	Zone	Common Name	Quadrat 1	Quadrat N	Quadrat E	Quadrat S	Quadrat W	MEAN
117	WA9	5	Common Rye	330	330	**329**	193	220	
			Dalmation Toadflax		0				
			Litter	225	225	**168**	225	225	
			Living Biomass	330	329	329	193	220	280
			Total Biomass	554	554	497	418	445	494
120	WA9	5	Crested Wheatgrass	6	**18**	20	20	6	
			Bulbous Bluegrass	16	**23**	7	7	7	
			Thistle		**4**				
			Ragweed	0		0	0	3	
			Annual Forb (J)	0					
			Litter	30	**40**	58	30	13	
			Living Biomass	21	45	27	27	16	27
			Total Biomass	50	85	85	57	29	61

Notes: All units are grams/square meter. Bold values represent measure data.

Zone 5 Living Mean **154**
Zone 5 Total Mean **277**

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conditions. Succession and recovery from physical disturbance is very slow in semi-arid environments without intensive intervention.

Table 2-22
Plant Nutrients from Site Soils
2002 Carr fork Analysis

No.	Work Area	Zone	Texture	pH	Salinity - Ece (dS/m)	Phosphorous (mg/kg)	Potassium (mg/kg)	Nitrate-Nitrogen (mg/kg)	Zinc (mg/kg)	Iron (mg/kg)	Copper (mg/kg)	Manganese (mg/kg)	Sulfate-Sulfur (mg/kg)	Organic Matter (percent of total)	Average Cover
2	1	1	Loam	6.8	0.6	29	276	3.9	47.7	23.6	16.6	20.9	6.1	4.00%	18.9%
23	3	2	Loam	6.6	0.5	21	175	3.3	26.2	18.8	26.9	10.8	5.7	2.20%	12.4%
24	3	2	Loam	6.7	0.7	27	184	3.9	49.7	19.8	41.1	10.1	7.4	3.10%	15.5%
27	3	2	Loam	6.4	1	30	144	3	24.9	20.8	28.4	10	55	2.20%	12.3%
50	5	1	Clay Loam	6.1	0.4	24	350	3.3	65.6	37.8	26.7	22.7	6.1	3.80%	25.4%
56	6	2	Clay Loam	6.6	1	30	274	3.5	67.5	30.3	44.5	14.8	5.5	2.60%	8.6%
70	7	4	Loam	6.9	0.8	30	287	3.8	198	4.8	231	4.2	20.6	4.50%	7.0%
106	8	3	Sandy Loam	7.7	0.7	14.5	105	3.2	40.8	10.8	5	7.4	24	1.80%	11.2%
108	8	3	Clay Loam	6.9	3	28	268	3.4	3.9	21.3	5.7	12.3	129	2.40%	15.8%
117	9	5	Sandy Loam	5.2	0.2	19.2	138	3.6	39.7	113	21.4	17.6	20.8	2.20%	9.8%
120	9	5	Sandy Loam	6	0.2	18.1	136	2.9	4.1	22.3	6.8	12.0	4.4	2.10%	13.3%
138	8	3	Sandy Loam	7.8	0.5	10.6	109	3.4	223	22.3	19.9	7.3	21.2	2.30%	14.7%
153	10	6	Loam	7.2	0.7	22	307	4.8	42	14.4	47.2	20.5	8.8	3.80%	ND

Note: 5-pt composite samples taken from 0-12". Plant available amounts. Utah State Analytical Lab Results

2.12.6 Sensitive Species

The IS&R/Carr Fork facility is located within the geographical boundaries of the Salt Lake Field Office (SLFO) of the BLM. The agency indicates that there are no officially listed threatened and endangered plant species on public lands within the SLFO. The BLM lists 12 plant species that are Special-Status-Plants that do receive management considerations for protection within the SLFO (BLM, 2001). However, none of these are located within 6 miles of the IS&R/Carr Fork Facility and all have substrate specific requirements that are nonexistent at this facility.

2.12.7 Site Vegetation Associations

The IS&R/Carr Fork Facility contains three primary vegetation associations. The higher elevation areas, located along the southeast and east boundaries of the property, are a mountain shrub association dominated by Gambel oak with a variety of understory shrubs, forbs and grasses.

The majority of the property is a sagebrush-grass steppe association dominated by sagebrush, rabbitbrush, bitterbrush and a variety of forbs and grasses. The plant composition for this association is highly variable dependent on the revegetation history. Areas where physical mining surface disturbance occurred have been soil-covered and reseeded. The reclaimed areas support populations of perennial shrubs and grasses that possess good ground-cover values and herbage production. Areas on site not directly impacted by surface disturbance and not revegetated resemble surrounding public lands and support low seral species and invasive weeds.

The third vegetation association is a small riparian zone that bisects the sagebrush-grass steppe association and supports willows, sedges and mesic grasses. This is a smaller area vegetation association but is important relative to wildlife in the area.

Photo 2-3: Lower Riparian Zone with willows and revegetated zone slope with shrub establishment

2.12.8 Sensitive Vegetation Associations

The vicinity of the former IS&R/Carr Fork Operations, including the reclaimed areas, does not contain sensitive vegetation associations or groups (Anderson, 2002).

2.12.9 Site Abiotic Conditions and Land Use

Several limiting resources and stressors have major influences on the vegetation found within the Site. Some of these are naturally occurring factors of the Great Basin desert environment while others have their origin with the encroachment of human development and related activities.

2.12.9.1 Precipitation and Temperature

The Site is located within a desert area with its accompanying low amounts of precipitation and high summer temperatures. Cold winter temperatures differentiate this area from the hotter deserts of the southwestern United States. Precipitation occurs as spring rain showers and winter snows. Oftentimes precipitation comes in intense cloudbursts, with most of the year having long periods with little or none. Rapid sporadic and seasonal rains can cause surface erosion and land damage. Temperature and moisture commonly operate as paired limiting factors.

As temperature and/or moisture seasonally raise or lower, vegetation will respond either by reduced vegetative production, limiting seed production, dormancy, or in extreme cases, loss of the plant.

2.12.9.2 Soil

It is commonly known that the substratum imposes limitations on the productivity and diversity of a biotic community (Oosting, 1956). Due to the internal drainage patterns of the Great Basin, area soils contain varying degrees of salts resulting in an alkaline state. Alkali soils have a narrowing effect on the diversity of plants. Soil structure and its ability to retain moisture can have a significant influence on the distribution of plant communities, in some cases even more than precipitation and temperature. Although Great Basin soils are expected to be alkaline, soil sampling shows that most site soils are nearly neutral or slightly acidic.

2.12.9.3 Mine and Mill Areas

The materials that remained on the surface that were associated with the physical disturbance from mining and milling operations were not well suited for plant growth. The existence of metal accumulation in the surface disturbed soils had resulted in a lack of adequate vegetation ground cover (JBR, 1986). These areas have since been covered for reclamation purposes with local or adjacent soils as described in Section 2.12.2.6. The soil-covered areas were seeded with mixes adapted for reclamation of the Site. It has been observed there are various small areas within the former mining and milling areas that display poor plant establishment. These isolated areas likely consist of poor soil conditions that may cause localized inadequate plant emergence. These areas of concern appear to have thin or non-existent cover soils and the surface material may contain minerals or metals that have a negative influence and impede plant growth and diversity of plants. The potential for current and future vegetation effects from historic smelter metals deposition and any associated soil acidification have been addressed in the base line ecological risk assessment. Section 3.14 discusses areas of concern.

2.12.9.4 Fire

Fire can be both a major naturally occurring ecological factor and a detrimental artificial limiting factor. When properly used, fire can be a great ecological land management tool. When accidentally or wantonly discharged, fire can destroy years of the best-laid land management plans (National Research Council, 1986).

One of the addressed management goals contained in the conservation easement addresses the use of fire on the property. Main objectives are to prevent and suppress wild fires on or in the vicinity of the property, to prohibit all dumping and burning, and to prohibit campfires within the unit.

Fire could seriously set back the delicate habitat conditions that are now beginning to fully be re-established on the property. Gambel oak, a dominant shrubland species in the area, will regenerate quickly after a fire, maintaining its dominance by eliminating the opportunity of invading species to become established (Coleman, 1953).

To minimize damage from human-caused range fires, a three-mile long firebreak has been established along the west property line and mowing along County roads has been implemented as part of the Site O&M procedures. Extensive planned burning would not be beneficial at the current time to any of the available habitats within the property. Fire would be a dominant detrimental factor in both the submontane shrub and riparian habitats.

2.12.9.5 Livestock Grazing

The general area of the Site and adjacent BLM land in the past were leased for livestock grazing. This practice has been discontinued with the establishment of the Site conservation easement. Livestock grazing influences the rate and pattern of successional changes within the Site by effectively removing preferred rangeland grazing plants and substituting non-native noxious weeds in their place. Unauthorized grazing is closely controlled and monitored by UDWR. Restoration of the Atlantic Richfield property has been, in a large part, successful. This part of the range has responded well and possesses a large number of desirable rangeland plants.

2.12.9.6 Other Disturbances

Unrestricted motor vehicle use, including off-road vehicles (ORVs) would certainly destroy watershed soils and plant cover and influence associated wildlife populations. Motor vehicle traffic is restricted to designated roads. Public access is managed with access points, designated vehicle parking areas, property boundary fences, gates, signs, and trail designations.

Additionally, restrictions on farming expansion (except where specified), soil or plant removal (except in approved habitat improvement projects), dumping of refuse, and unnecessary use of ponded water will help to preserve Site habitats.

2.12.10 Management Plan and Status

The Utah Division of Wildlife Resources (UDWR) began implementing a wildlife habitat management program following the creation of the Carr Fork area conservation easement effective in 1994 (UDWR, 1994). A key element to the wildlife management program is to provide high quality winter and spring range vegetation capable of supporting optimum mule deer and elk populations during this season. The vegetation component of the area habitat will also involve improvement of cover, feed and nesting areas for resident bird populations.

The overall management goal of the conservation easement is to preserve, enhance, and protect the conservation value of the property consistent with Atlantic Richfield's environmental commitments. Other supporting goals are to: 1) Increase wildlife species diversity. 2) Increase upland game carrying capacity, 3) Increase big game carrying capacity, 4) Develop effective property management programs, and 5) Monitor effectiveness of the management plan.

Specific vegetation improvements and planned actions contained in the Carr Fork Reclamation and Wildlife Management Area, Management Plan to be implemented by UDWR include the following:

- Restore sagebrush - grass community on bench-land
- Enlarge riparian zone associated with Pine Creek
- Plant approximately 10,000 containerized seedlings annually
- Plant containerized trees and shrubs along the Pine Creek corridor
- Control livestock grazing pressure via fencing
- Winter cover plantings in sized patches of 1-2 acres each
- Mix species throughout to create multi-layered structure to the plant community
- Include species that produce fruit
- Plant a mixture of grasses, forbs and shrubs on big game winter range rehabilitation areas
- Control motorized vehicle entrance
- Plant 10 ea. one acre shelterbelt: 800 plants per acre
- Plant 10 acres in wheat and annual sunflower and replant every two years
- Plant Triticale in select test plots

Much of the mining physically impacted area has been revegetated by seedbed preparation and seeding. Each year beginning in 1995 and continuing to 2003, between 50 and 185 acres have been re-seeded. Between 25-30,000 seedling plants have been manually planted by UDWR personnel, volunteers, and others. Fourteen thousand bitterbrush plants were planted along the bench lands in areas where snow cover is greatest in the winter months, thus providing additional moisture for these developing seedlings.

Cover and plant inventories confirm abundant herbage production for both grazing and browsing wildlife. The wildlife carrying capacity is expected to increase as improvement goals and objectives are implemented.

2.12.11 Reference Site Comparisons

A common practice in range management and for disturbed area revegetation success is to assess the health of plant communities by comparison to similar undisturbed sites (CSU, 1977 and CSU, 1983) or natural pre-disturbance climax plant communities (Holecheck, 2001). Three procedures for comparing reclaimed areas to reference areas were used at the IS&R site. The first approach uses vegetation cover, the second biomass and the third uses the range condition method.

2.12.11.1 Vegetation Cover

Information for vegetation cover on mining disturbed areas is needed in order to evaluate restoration of surface disturbed areas in post mining reclamation (CSU, 1977). In many cases, old mining and smelter operations had no pre-disturbance vegetation data collected to aid in revegetation success evaluation. Establishment of reference areas assists in vegetation benchmarking for plant establishment on reclaimed areas. The use of reference areas is an acceptable procedure for evaluation of revegetation for many operations regulated under the Surface Mining Control and Reclamation Act (CSU, 1988). At the IS&R site, the current plant community on site has been compared to a reference area that is similar in vegetation and soil type, topography, and climate.

The adjacent rangeland was selected as the reference area. This area is described in Section 2.12.4. The adjacent BLM land was physically undisturbed by mining operations. Because of the comparable vegetation communities the BLM land was deemed suitable for use as a reference area. The vegetative cover and diversity from the reference area and site areas are compared on Table 2-23 (Vegetation Comparison Summary).

Table 2-23
Vegetation Comparison Summary

Reference Zone	Cover Data		Diversity	
	December 2002	July 2003	December 2002	July 2003
BLM	29%	24%	6.7	5
Site Zones				
Zone 1	18%	30%	5.5	6
Zone 2	12%	16%	5.8	7
Zone 3	14%	6%	5	5
Zone 4	11%	26%	8	7
Zone 5	18%	32%	5.2	3.5

Cover and diversity data are averages of all locations within each zone.

Site-wide the cover compares favorably with the adjacent BLM land. During the July 2003 sampling event Zones 1, 4 and 5 exceeded the cover found on BLM land. Zones 2 and 3 showed lower cover values. This is due in part to the lack of invasive broadleaf weeds found on the adjacent rangelands. The diversity on site zones compares favorably with the BLM land. Zone 4 contained the highest diversity in both sampling events. Cover data shows the Site compares favorably with adjacent rangeland and is expected to continue to improve as shrubs further establish themselves.

2.12.11.2 Biomass

As explained above, reference areas are used for comparison of reclaimed areas. The same reference and site zones were used for comparison of biomass results. The biomass results from the July 2003 sampling event are shown below in Table 2-24 (Biomass Results Summary).

Table 2-24
Biomass Results Summary

Reference Zones	Biomass (g/m^2)
BLM	99
Site Zones	
Zone 1	147
Zone 2	111
Zone 3	45
Zone 4	289
Zone 5	154

Biomass measures the productivity of an ecosystem. Larger biomass values at the vegetative level leads to higher carrying capacity of larger heterotrophic organisms. Biomass was measured at site lands to compare the vegetative production to analogous rangelands. Biomass values in all zones, except zone 3, exceed the BLM value. The grasses in Zone 3 do not grow as densely as in other areas; therefore, the biomass production is less. In general, biomass production on the Site is better than BLM production and site production should improve as the shrub population increases.

2.12.11.3 Range Condition Analysis

The pre-settlement native plant community approach has been commonly termed "range condition analysis" (Holecheck, 2001). Plant communities that have below 26% of the native composition are in poor range condition. Plant communities having 26% to 50% of the native composition are in fair range condition. Plant communities with 51% to 75% of the native composition are in good range condition. Plant communities having over 75% of the native composition are in excellent range condition. Soil and plant community descriptions are provided by the USDA (NRCS, 2000) for the vegetation zones and range sites in each state. The NRCS range site type for the IS&R site is the Mountain Big Sagebrush and is shown in Appendix P. The plant species and composition values in this table are for an upland gravelly loam, Mountain Big Sagebrush range site at pre-settlement condition (NCRS, 1993). Species composition is calculated by measurements of plant dominance, which include biomass and cover measurements. Composition in the NRCS site guides is calculated on the basis of biomass, which for herbaceous species is often linearly correlated with cover. Plant community composition for the IS&R site was calculated for cover and biomass. The results were obtained from field sampling and are located in Section 2.12.4. The IS&R site values are compared to the species composition presented by the NRCS. During the 1986 reclamation, perennial wheatgrasses such as tall and crested wheatgrass were planted. Because these species share a common ecological niche with bluebluch wheatgrass the pre-settlement conditions were adjusted to allow tall or crested wheatgrass to count as a surrogate for bluebunch wheatgrass. The range condition results for each zone are shown in Table 2-25 (Range Condition Analysis Summary). The calculations for each data set are available in Appendix P.

Table 2-25
Rangeland Condition Analysis Summary

Reference Zone	Percent of Natural Community			Range Condition		
	12/02 cover	07/03 cover	07/03 biomass	12/02 cover	07/03 cover	07/03 biomass
BLM	23%	20%	20%	poor	poor	poor
Site Zones						
Zone 1	20%	17%	21%	poor	poor	poor
Zone 2	56%	59%	58%	good	good	good
Zone 3	33%	51%	53%	fair	good	good
Zone 4	23%	27%	36%	poor	fair	fair
Zone 5	33%	35%	33%	fair	fair	fair

Zones 2 and 3 were physically impacted by the mining operations. Most of these areas were covered with imported soil and reseeded with perennial grasses, forbs and shrubs. Range condition results show this reclamation effort was successful. All site zones compare favorably with the BLM reference zone. Range conditions are better on site zones 2 and 3 because they are more highly populated with desirable perennial wheatgrasses. Scores are lower on the reference zone because much of the plant composition consists of less desirable invasive forbs. Although many zones contain populations of bitterbursh (*Purshia spp.*) and sagebrush (*Artemisia spp.*), these shrubs were absent from most of the sampling quadrats. As the shrub population density increases, percent scores can be expected to increase up to 30%.

The IS&R site vegetation compares favorably with adjacent rangelands. Cover and diversity data are similar between the reference and site zones. Biomass results show the Site is a productive ecosystem with respect to the BLM land. Range condition analysis shows there is a higher population of desirable species on reclaimed site zones than in the analogous off-site zone. Reclamation efforts at the IS&R site have been successful and the flora community is expected to continue to improve as the shrub population increases.

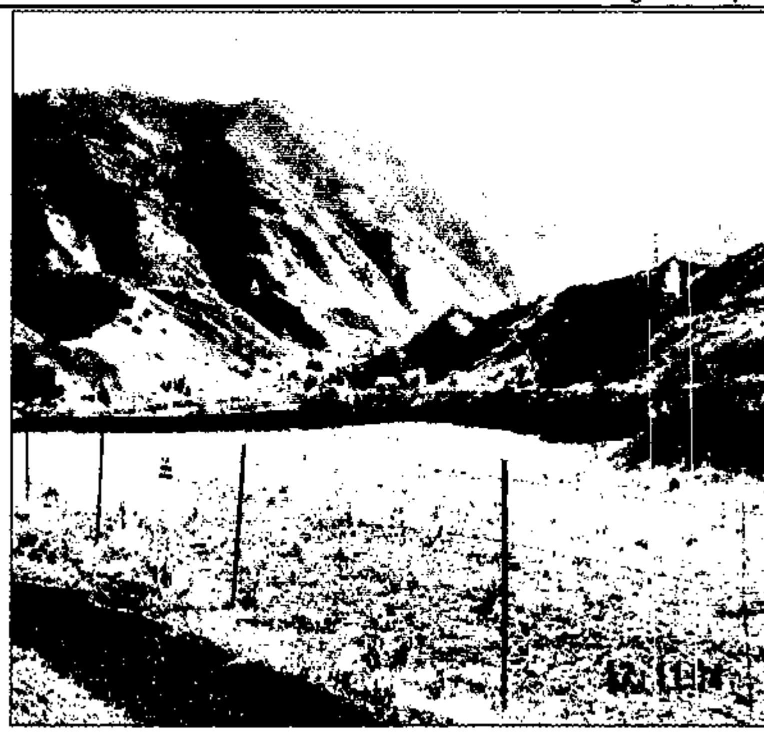
2.13 Ecological Setting - Fauna

2.13.1 Regional Characteristics

The Tooele Valley area is in the Great Basin section of the Basin and Range physiographic province. This province is characterized by uplifted block faulted mountain ranges and down-dropped faulted basin valleys. The basin valleys are filled with thick wedges of sediment derived from long term erosion of the uplifted mountain ranges. The Oquirrh Mountains are located on the eastern edge of the Great Basin Desert. The mountains rise about 3600 feet above the Great Salt Lake with peaks over 8400 feet in elevation. This elevation and related climatic conditions have resulted in several plant communities and wildlife habitats. These include salt desert shrub areas at the lowest relief, cool desert shrub and sub-mountain shrub areas at slightly higher elevations. Juniper woodlands exist at low to mid elevation and aspen and coniferous forest at the high elevations. Mesic shrubs and vegetation are found in some of the draws, and springs with associated riparian species exist in select canyons. This region also includes grasslands or rangeland, woodlands and interspersed agricultural areas. (see paragraph 2.12 for a more through discussion of regional flora taxonomy)

Wildlife varies over the region and is subject to relief, water availability, vegetation and human interaction. The various relief settings and vegetative associations have many representations of species for each level of a general food web. The food web is inclusive of herbivores, granivores, insectivores and first and second order carnivores. Reptiles exist in all zones and amphibians inhabit riparian areas. Migratory birds and waterfowl utilize the Oquirrh Mountains and the shoreline of wetlands and lakes during migration. They also use these areas during summer breeding. Livestock is pastured on the rangeland and lower elevations of the mountains.

Photo 2-4: View looking east over the project site showing a section of the reclaimed grassland on top of the tailings depicted in the foreground, upland desert shrub areas are on each side, a riparian area surrounding Pine Canyon Creek is in the central middle ground, and the Oquirrh Mountains are visible in the back ground.



2.13.2 Site Wildlife Characteristics

Information contained in this report is primarily a product of ocular surveys completed on the Site, literature research and State produced species lists for the subject and surrounding areas. Specific taxa identified in this report represent best fauna estimations based on the field visits and literature search. Field trapping, or detailed inventories or other types of quantitative analysis were not part of this investigation. Although the Project Area is relatively small in size, the wildlife component is nevertheless influenced by the associated plant communities. Each trophic level is represented, including herbivores, carnivores, and omnivores, both as generalists and specialists.

Photo 2-5

Site surface water is restricted to one small intermittent stream, Pine Canyon Creek. With a width of about one foot and summer depth of less than three inches, vertebrate wildlife species totally dependent upon an aquatic environment for habitat or as a source of food, are either not found or would be expected to be present in low numbers. Pine Canyon Creek habitat does not sustain fish and does not leave the Site with any surface flow. Amphibians potentially are represented by at most three species of toads. No frogs are expected to be present on the property.

Occasionally, the control dikes in WA3 accumulate local surface runoff into small ponds which exist for a time until evaporation and percolation can disperse the water. The location of these ponds is south and east of Smelter Road and immediately south of the slag pile on the south side of Smelter Road. The purpose of these constructed ponds was to retain, infiltrate, and evaporate any local surface runoff created on the previous smelter site location. During this time of retention, the pond water is available to the local fauna for various uses including drinking, washing, hunting, etc. The standing water is generally seasonal and occurs primarily during the Spring months. Five pond water samples were taken from standing water in these pools and are documented in Section 3, WA3, of the Remedial Investigation Report

A brief field survey of the stream invertebrates at one location on Pine Canyon Creek conducted on 10/17/02 using a D-frame net found representatives of the following taxa: Oligochaeta (worms) (1), Plecoptera (stone flies) (1), Trichoptera (caddis flies) (2), Coleoptera (beatles) (4), Diptera, Chironomidae (midge flies) (1), Gastropoda (snails) (1), Odonata, Anisoptera (damselflies) (1), Colembola (spring tails) (1), and Hydracarina (water mite) (1). The stream sample was taken in WA7 as shown in Photo 2-5

Reptiles are represented by 14 species potentially found in all available regional habitats. The Utah milk snake, *Lampropeltis triangulum taylori*, is the only completely protected reptilian species possibly occurring, though not observed, on the property.

Approximately 126 species of birds would be expected to use the Project Area during the year. Most would be considered residents or summer breeders. Representative permanent residents would include western meadowlark, *Sturnella neglecta*, horned lark, *Eremophila alpestris*, house finch, *Carpodacus mexicanus*, spotted towhee, *Pipilo maculatus*, western scrub jay, *Amphelocoma coerulescens*, and common raven, *Corvus corax*. Diurnal birds of prey would be red-tailed hawk, *Buteo jamaicensis*, Cooper's hawk, *Accipiter cooperii*, and American kestral, *Falco sparverius*. Included in the nocturnal birds of prey would be great-horned owl, *Bubo virginianus*, and western screech owl, *Otus kennicottii*. Breeding summer residents would include: mourning dove, *Zenaida macroura*, common nighthawk, *Chordeiles minor*, broad-tailed hummingbird, *Selasphorus platycercus*, dusky flycatcher, *Epidonax oberholseri*, western kingbird, *Tyrannus verticalis*, warbling vireo, *Vireo givus*, yellow warbler, *Dendroica petechia*, green-tailed towhee, *Pipilo chlorurus*, Brewer's sparrow, *Spizella breweri*, black-headed grosbeak, *Pheucticus melanocephalus*, and Bullock's oriole, *icterus bullockii.*

Winter avian visitors are not plentiful in the Project Area but may include bald eagle, *Haliaeetus leucocephalus*, merlin, *Falco columbarius*, rough-legged hawk, *Buteo lagopus*, northern shrike, *Lanius excubitor*, American crow, *Coruus brachyrhynchos*, and American tree sparrow, *Spizella arborea*. As a result of the minimal aquatic habitat, migratory shorebirds and waterfowl would not be expected to regularly use the property. However, a number of passerines including warblers, vireos, and sparrows would pass by and sporadically use the property.

The mammalian component is represented by both terrestrial (shrews) and avian (bats) insectivores, twenty-seven rodents, three lagomorphs, eleven carnivores, and two ungulates. The mule deer, *Odocoileus hemionus*, is a major influent in the biotic community with elk, *Cervis elephus*, mountain lion, *Felix concolor*, coyote, *Canis latrans*, and other large mammals playing a minor role. Mule deer are found on the property year round, especially during the winter when the property provides critical winter range and during the spring green-up. Elk use the property infrequently during the winter months. A goal of the Utah Division of Wildlife Resources (UDWR) Carr Fork Wildlife Management Plan is to provide high quality winter range to support 250 mule deer during winter and spring periods.

Upland game animals used by hunters for recreational purposes include cottontail rabbit, *Syulvilagus sp.*, mourning dove, *Zenaida macroura*, ring-necked pheasant, *Phasianus colchicus*, chukar, *Alectons chukar*, wild turkey, *Meleagris gallopavo*, and California quail, *Callipepla californica*. The latter two species have been recently introduced on the property.

A complete list of all wildlife species observed or expected to occur on the Site is found in Table 2-26.

Table 2-26
Animals of the IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Seasonal Status	Habitat
Vertebrate Taxa			
Fish			
None			
Amphibians			
Anurans (Toads & Frogs)			
Great Basin Spadefoot	*Scaphiopus intermontanus*	R	1 2 3
Western Toad	*bufo boreas*	R	1 2 3
Woodhouse Toad	*Bufo woodhousei*	R	1 2 3
Reptiles			
Saurians (Lizards)		R	1 2 3
Collared Lizard	*Crotaphytus collaris*	R	1 3
Leopard Lizard	*Crotaphytus wislizeni*	R	1 3

Table 2-26
Animals of the IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Seasonal Status	Habitat
Desert horned Lizard	*Phynosoma platyrhinos*	R	1 2 3
Short-horned Lizard	*Phynosome douglassii*	R	1 2 3
Side-blothched Lizard	*Uta stansburiana*	R	1 2 3
Sagebrush Lizard	*Sceloporus graciosus*	R	1 2 3
Western fence Lizard	*Sceloporus occidentalis*	R	1 2 3
Western Skink	*Eumeces skilltonianus*	R	3
Western Whiptail	*Cnimidophorus tigris*	R	1 2 3
Serpentines (Snakes)			
Western Yellow-bellied Racer	*Coluber constrictor*	R	1 2 3
Striped Whipsnake	*asticophis taeniatus*	R	1 2 3
Long-nosed Snake	*Rhinocheilus lecontei*	R	1 2 3
Milk Snake	*Lampropeltis triangulum*	R	3
Ringneck Snake	*Diadolphis puntatus*	R	1 2 3
Gopher Snake	*Pituophis melanoleucus*	R	1 2 3
Night Snake	*Hypsiglena torquata*	R	1 2 3
Common Garter Snake	*Thamnophis sirtalis*	R	3
Western Terrestrial Garter Snake	*Thamnophis elegans*	R	1 2 3
Western Rattlesnake	*Crotalis viridis*	R	1 2 3
Birds			
Falconiformes (Birds of Prey)			
Turkey Vulture	*Cathartes aura*	S	1 2
Bald Eagle	*Haliaeetus leucocephalus*	W	1 2
Northern Harrier	*Circus cyaneus*	R	1 2 3
Sharp-shinned Hawk	*Accipiter stiatus*	R	1 3
Cooper's Hawk	*Accipiter cooperii*	R	1 2 3
Swainson's Hawk	*Buteo swainsoni*	S	1 2 3
Red-tailed Hawk	*Buteo jamaicensis*	R	1 2 3
Ferruginous Hawk	*Buteo regalis*	R	1 2
Rough-legged Hawk	*Buteo lagopus*	W	1 2
Golden Eagle	*Aquila chrysaetos*	R	1 2
American Kestral	*Falco sparverius*	R	1 2 3
Merlin	*Falco columbarius*	W	1 2
Peregrin Falcon	*Falco peregrinus*	R	1 2
Prairie Falcon	*Ifalco mexicanus*	R	1 2
Galliformes (Pheasants & Grouse)			
Chukar	*Alectoris chukar*	R	1 2
Ring-necked Pheasant	*Phasianus colchicus*	R	1 2 3
Wild Turkey	*Meleagris gallopavo*	R	1 2 3
California Quail	*Callipepla californica*	R	3
Charadriiformes (Gulls and Shorebirds)			
Long-billed Curlew	*Numenius americanus*	M	1 2
California Gull	*Larus californicus*	R	1 2
Ring-billed Gull	*Larus delawarensis*	W	1 2

Table 2-26
Animals of the IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Seasonal Status	Habitat
Columbiformes (Pigeons & Doves)			
Rock Dove	*Columba livie*	R	1 2 3
Mourning Dove	*Zenaida macroura*	S	1 2 3
Strigiformes (Owls)			
Western Screech Owl	*Otus kennicottii*	R	1 2 3
Great Horned Owl	*Bubo virginianus*	R	1 2 3
Long-eared Owl	*Asio otus*	R	1 2 3
Short-eared Owl	*Asio flammeus*	R	1 2 3
Caprimulgiformes (Goatsuckers)			
Common Nighthawk	*Chordeiles minor*	S	1 2 3
Common Poorwill	*Phalaenoptilus nuttallii*	S	1 2 3
Apodiformes (Hummingbirds)			
Black-chinned hummingbird	*Archilochus alexandri*	S	3
Broad-tailed Hummingbird	*Selasphorus platycercus*	S	1 2 3
Rufous Hummingbird	*Selasphorus rufus*	M	1 2 3
Picaformes (Woodpeckers)			
Downy Woodpecker	*Picoides pubescens*	R	3
Northern Flicker	*Colaptes auratus*	R	1 2 3
Passeriformes (Perching Birds)			
Western Wood-Pewee	*Contopus sordidulus*	S	1 3
Willow Flycatcher	*Empidonax traillii*	S	3
Hammond's Flycatcher	*Empidonax Hammondii*	M	1 3
Dusky Flycatcher	*Empidonax oberholseri*	S	1 2 3
Gray Flycatcher	*Empidonax wrightii*	S	1 2
Cordilleran Flycatcher	*Empidonax occidentalis*	S	1 3
Say's Phoebe	*Sayomis saya*	S	1 2
Ash-throated Flycatcher	*Myiarchus cinerascens*	S	1 2
Western Kingbird	*Tyrannus verticalis*	S	1 2
Northern Shrike	*Lanius excubitor*	W	1 2 3
Loggerhead Shrike	*Lanius Ludovicianus*	R	1 2
Cassin's Vireo	*Vireo cassinii*	M	1 3
Plumbeous Vireo	*Vireo plumbeous*	S	1 3
Warbling Vireo	*Vireo givus*	S	1 3
Western Scrub-Jay	*Amphelocoma coerulescens*	R	1
Pinyon Jay	*Gymnorhinus cyanocephalus*	R	1
Black-billed Magpie	*Pica pica*	R	1 2 3
American Crow	*Corvus brachyrhynchos*	R	1 2
Common Raven	*Corvus corax*	R	1 2
Horned Lark	*Eremophila alpestris*	R	2
Tree Swllow	*Tchycinata bicolor*	S	1 2 3
Violet-green Swallow	*Tachycinata thalassina*	S	2 3
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	S	1 2 3
Bank Swallow	*Riparia riparia*	S	1 2 3

Table 2-26
Animals of the IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Seasonal Status	Habitat
Cliff Swallow	*Hirundo pyrrhonota*	S	1 2 3
Barn Swallow	*Hirundo rustica*	S	1 2 3
Black-capped Chickadee	*Parus atricapillus*	R	1 2 3
Mountain Chickadee	*Parus gambeli*	W	1 3
Juniper Titmouse	*Baeolophus griseus*	R	1
Bushtit	*Psaltriparus minimus*	R	1 2
Red-breasted Nuthatch	*Sitta canadensis*	M	3
Brown Creeper	*Certhia americana*	W	3
Rock Wren	*Salpinctes obsoletus*	S	1 2
Bewick's Wren	*Thryomanes bewickii*	S	1 3
House Wren	*Troglodytes sedon*	S	1 3
Marsh Wren	*Cistothorus platensis*	R	3
Ruby-crowned Kinglet	*Regulus calendula*	R	1 3
Blue-gray Gnatcher	*Polioptila caerulea*	S	1 2
Mountian Bluebird	*Sialia currucoides*	S	1 2
Townsen's Solitaire	*Myadestes townsendi*	R	1 2
Swainson's Thrush	*Catharus ustulata*	S	3
Hermit Thrush	*Catharus guttatus*	S	3
American Robin	*Turdus migratorius*	R	1 2 3
Cray Catbird	*Cumetella carolinensis*	S	3
Northern Mockingbird	*Mimus polyglottos*	S	1 2 3
Sage Thrasher	*Oreoscoptes montanus*	S	1 2
European Starling	*Sturnus vulgaris*	R	1 2 3
American Pipit	*Anthus rubecens*	M	2
Bohemian Waxwing	*Bombycilla garrulus*	W	3
Cedar Waxwing	*Bombycilla cedrorum*	R	3
Tennessee Warbler	*Vermivora peregrina*	M	1 3
Orange-crowned Warbler	*Vermivora celata*	S	1 3
Nashville Warbler	*Vermivora ruficapilla*	M	1 3
Virginia's Warbler	*Vermivora virginiae*	S	1 3
Yellow Warbler	*Dendroica petechia*	S	3
Yellow-rumped Warbler	*Dendroica coronata*	R	1 3
Black-throated Gray Warbler	*Dendroica nigrescens*	S	1
Townsend's Warbler	*Dendroica townsendi*	M	1 3
MacGillivray's Warbler	*Oporonis tolmiei*	S	3
Common Yellowthroat	*Geothylpis trichas*	S	3
Wilson's Warbler	*Wilsonia pusilla*	M	3
Yellow-breasted Chat	*Icteria virens*	S	3
Western Tanager	*Piranga ludoviciana*	M	1 3
Green-tailed Towhee	*Pipilo chlorurus*	S	1 2 3
Spotted Towhee	*Pipilo maculatus*	R	1 3
American Tree sparrow	*Spizella arborea*	W	1 2 3
Chipping sparrow	*Spizella passerina*	S	1 2 3
Brewer's Sparrow	*spizella breweri*	S	1 2

Table 2-26
Animals of the IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Seasonal Status	Habitat
Vesper Sparrow	*Pocecetes gramineus*	S	2
Lark Sparrow	*Chondestes grammacus*	S	1 2
Black-throated Sparrow	*Amphispiza brlineata*	S	1 2
Sage Sparrow	*Amphispiza belli*	R	1 2
Savannah Sparrow	*Passerculus sandwichensis*	S	1 2
Song Sparrow	*Melospiza melodia*	R	3
Lincoln's Sparrow	*Melospiza linclonii*	S	3
White-throated Sparrow	*Zonotrichia Albicollis*	W	1 3
Harris's Sparrow	*Sonotrichia querula*	W	3
White-crowned Sparrow	*Zonotrichia leucophrys*	R	1 3
Dark-eyed Junco	*Junco hyemalis*	W	1 2 3
Black-headed Grosbeak	*Pheucticus melanocephalus*	S	1 2 3
Lazuli Bunting	*Passeriana amoena*	S	1 2 3
Red-winged Blackbird	*Agelaius phoeniceus*	R	3
Western Meadowlark	*Sturnella neglecta*	R	2
Brewer's Blackbird	*Euphagus cyanocephalus*	R	1 2 3
Brown-headed Cowbird	*Molothrus ater*	S	1 2 3
Bullock's Oriole	*Icterus bullockii*	S	3
Cassin's Finch	*Carpodacus cassinii*	M	1
House Finch	*Carpodacus mexicanus*	R	1 2 3
Pine Siskin	*Carduelis pinus*	M	1 3
American Goldfinch	*Carduelis trists*	R	1 3
Evening Grosbeak	*Coccothraustes vespertinus*	W	3
House Sparrow	*Passer domesticus*	R	2
Mammals			
Insectivores (Shrews)			
Masked shrew	*Sorex cinereus*	R	1 2 3
Merriam Shrew	*Sorex merriami*	R	1 2
Vagrant Shrew	*Sorex vagrans*	R	3
Chiroptera (Bats)			
Little Brown Myotis	*Myotis lucifugus*	M	1 2 3
Cave Myotis	*Myotis velifer*	M	1 2 3
Fringed Myotis	*Myotis thysanodes*	M	1 2 3
Long-eared Myotis	*Myotis evotis*	M	1 2 3
Long-legged Myotis	*Myotis volans*	M	1 2 3
California Myotis	*Myotis californicus*	M	1 2 3
Small-footed Myotis	*Myotis leibii*	M	1 2 3
Yuma Myotis	*Myotis yumanensis*	M	1 2 3
Silver-haired Bat	*Lasionycteris noctivagans*	M	1 2 3
Western Pipistrel	*Pipistrellus hesperus*	M	1 2 3
Big Brown Bat	*Eptesicus fuscus*	M	1 2 3
Hoary Bat	*Lasiutus cinereus*	M	3
Western Big-eared Bat	*Plecotus townsendii*	M	1 2 3
Spotted Bat	*Eudema maculatum*	M	1 2

Table 2-26
Animals of the IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Seasonal Status	Habitat
Pallid Bat	*Antrozous pallidus*	M	1 2 3
Mexican Freetail Bat	*Tadarida brasiliensis*	M	1 2 3
Carnivores			
Racoon	*procyon lotor*	R	1 2 3
Shorttail Weasel	*Mustela erminea*	R	1 2 3
Longtail Weasel	*Mustela frenata*	R	1 2 3
Badger	*Taxidea taxus*	R	1 2 3
Spotted Skunk	*Spilogale putorius*	R	1 2 3
Stripped Skunk	*Mephitis mephitis*	R	1 2 3
Coyote	*Canis latrans*	R	1 2 3
Red Fox	*Vulpes vulpes*	R	1 2 3
Kit Fox	*Vulpes macrotis*	R	1 2 3
Mountain Lion	*Felix concolor*	R	1 2 3
Bobcat	*Lynx rufus*	R	1 2 3
Rodents			
Yellow-belly Marmot	*Marmota flaviventris*	R	1 2 3
Rock Squirrel	*spermophilus varegatus*	R	1 2
Townsend Ground Squirrel	*Spermophilus townsendi*	R	1 2
Golden-mantled Squirrel	*Spermophilus lateralis*	R	1 2 3
Whitetail Antelope Squirrel	*Ammospermophilus leucurus*	R	1 2
Least Chipmunk	*Eutamias minimus*	R	1 2 3
Cliff chipmunk	*Eutamias dorsalis*	R	1 2
Botta's Pocket Gopher	*Thomomys bottae*	R	1 2
Northern Pocket Gopher	*Thomomys talpoides*	R	1 2
Great Basin Pocket Mouse	*Perognathus parvus*	R	1 2
Longtail Pocket Mouse	*Perognathus formosus*	R	1 2
Dark Kangaroo Mouse	*Microdipodops megacephalus*	R	1 2
Ord Kangaroo Rat	*Dipodomys ordii*	R	1 2
Great Basin Kangaroo Rat	*Dipodomys microps*	R	1 2
Western Harvest Mouse	*Reithrodontomys megilotis*	R	1 2 3
Canyon Mouse	*Peromyscus crintus*	R	1
Deer Mouse	*Peromyscus maniculatus*	R	1 2 3
Brush Mouse	*Peromyscus boylii*	R	1
Pinyon Mouse	*Peromyscus truei*	R	1
Northern Grasshopper Mouse	*Onychomys leucogaster*	R	1 2 3
Desert Woodrat	*Neotoma lepida*	R	1 2
Bushytail Woodrat	*Neotoma cinerea*	R	3
Longtail Vole	*microtus longicaudus*	R	1 2 3
Richardson Vole	*Microtus richardsoni*	R	1 2 3
House Mouse	*Mus musculus*	R	1 2 3
Western Jumping Mouse	*Zapus princeps*	R	3
Porcupine	*Erethizon flaviventris*	R	1 2 3
Blacktail Jackrabbit	*lepus californicus*	R	1 2
Desert Cottontail	*Sylvilagus auduboni*	R	1 2 3

Table 2-26
Animals of the IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Seasonal Status	Habitat
Mountain Cottontail	*Sylvilagus nuttali*	R	1 3
Elk	*Cervis elephus*	W	1 2 3
Mule Deer	*Odocoileus heminus*	R	1 2 3

Code Keys

Seasonal Status
R = Resident
S = Summer
W = Winter
M = Migrant

Habitat
1 = Submontane Shrub/Brushland
2 = Reclaimed/Revegetated Areas
3 = Riparian Zone

2.13.3 Sensitive Species

2.13.3.1 Fish

Utah lists 21 fish species as either endangered, threatened, or of special concern due to declining populations. None of these are found in the project area. The least chub, *Iotichthys phlegethontis*, is the only sensitive fish species which may have historically inhabited the small drainages along the west side of the Oquirrh Mountains. It is currently known to occur in small desert springs of western Tooele and neighboring Juab and Millard counties. An introduced, experimental population was established in the late 1970s not far from the Project Area at a spring located off the northwest end of the Oquirrhs near the shoreline of the Great Salt Lake. It was inundated and the population lost due to flooding of salt water in the mid 1980's.

2.13.3.2 Amphibians

Of the five amphibian species of special concern listed by Utah, none were likely to ever have occurred in the Project Area. The spotted frog, *Rana pretiosa*, occurred along the Wasatch Front in Salt Lake County and currently is found in isolated desert marshlands of western Tooele County, but minimal sustainable habitat would have ever existed in the Project Area. The boreal toad, *Bufo boreas*, has been recorded in the Oquirrh Mountains but again, not likely in the Project Area.

2.13.3.3 Reptiles

The Utah milk snake, *Lampropeltis trianguleaum taylori*, is the only completely protected reptile which may be found in the Project Area (Rawley, 1979). It is a species of special concern in Utah due to declining populations and popularity by collectors in the pet trade industry. It is found in the canyons and benchlands of the Oquirrh Mountains and although not observed it may infrequently occur on the project lands.

2.13.3.4 Mammals

Utah lists 33 mammals on their sensitive species list. Only three listed bat species may occur in the Project Area. Each species listed is of concern due to limited distribution and or declining populations. The spotted bat, *Euderma maculatum*, is the only bat found on federal sensitive species lists. The spotted bat is rare across its entire range, which is primarily the southwest, but does extend into western Utah (Hasenyager, 1980). The spotted bat has not been recorded near the Project Area. The other two bats, Mexican free-tailed bat, *Tadarida brasiliensis,* and Townsend's big-eared bat, *Plecotus townsendii,* have wide distributions and although not observed it may be found at times within the Project Area. Both are species of concern due to declining populations across their range.

2.13.3.5 Birds

Twenty-six bird species are listed as either endangered, threatened, or species of concern by the Utah Division of Wildlife Resources. Eight of these, though not seen on site walkovers, may occur seasonally in the Project Area. Table 2-27 contains a listing and explanation of the avian species that could potentially be on the Site.

Table 2- 27
Bird Species that may Occur on the
IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Status	Occupancy
American Peregrine Falcon	Falco peregrinus	Utah - Endangered Fed. - Removed from the Endangered Species List (1999)	Does not nest in project area. May hunt over project area.
Bald Eagle	Haliaeetus leucocephalus	Utah - Federal - Threatened	No known nests or roosting in project area, primarily wintering species in Utah. Often concentrate in western Utah desert valley and around large water bodies. May hunt over project area.
Ferruginous Hawk	Buteo regalis	Utah - Threatened Federal -	No known nests on the project area. Nests in open desert valleys. May hunt over project area
Swainson's Hawk	Buteo swainsoni	Utah - Species of Concern Federal -	No known nests on the project area. Nests in open desert valleys. May hunt over project area.

Table 2- 27
Bird Species that may Occur on the IS&R/Carr Fork Wildlife Management Area

Common Name	Scientific Name	Status	Occupancy
Short-eared Owl	Asio flammeus	Utah - Noted Decline	No known nesting on project area, but can be found in bench land and open areas such as those of the project area. May hunt over project area.
Long Billed Curlew	Numnenius americanus	Utah - Species of Concern Federal -	No known nests on project area. This species does forage open grassland bench areas of the type on the Site during migration.
Common Yellowthroat	Geothlypis trichas	Utah - Species of Concern Federal -	No known nests on project area. May have adequate marsh habitat on the lower Pine Creek riparian corridor for nesting.

2.13.4 Site Habitat Characteristics

Climatological data and vegetation characteristics are cursorily described in the following paragraphs as they relate to wildlife habitats. A more thorough treatise on these topics can be found in Section 2.6 and Section 2.12 respectively.

2.13.4.1 Climatological

The Project Area is within the Great Basin Cold Desert portion of west central Utah, and thus its climatological characteristics include hot, dry, summers (mean temperatures 70° to 79° F) and cold winters (mean temperatures -28° degrees to 40° F). Annual precipitation averages about 10 inches with heaviest rainfall usually in April and May. Snow cover is common in winter months. (See paragraph section 2.6 for a more thorough discussion on site Meteorology).

2.13.4.2 Submontane Shrub Vegetative Association

Starting with the higher elevation benchland, the submontane shrub is represented. The area is also known as the Rocky Mountain Brushland. It is an ecotone or mixture between the lower desert shrub and grassland areas and the higher elevation submontane woodland where quaking aspen, *Populus tremuloides*, and conifer would occur. In the Project Area these areas are dominated by Gambel oak, curl-leaf mountain mahogany, bitterbrush, and cliffrose, *Cowania mexicana*. This habitat is represented along the slopes of both the north and south boundaries. The habitat on the slope of the north boundary is pictured in Photo 2-6.

Photo 2-6

The major influent wildlife species of this brushland community are either seasonal, transitory, or are no more confined to this area than they are to any of several others (Shelford, 1963). Mule deer, primarily, and elk, occasionally, use this area as critical wintering range. Large predators would include mountain lion, coyote, bobcat, and red fox. Small mammals would include yellow-belly marmot, *Marmota flaviventris,* rock squirrel, *Spermophilus variegatus,* least chipmunk, *Eutamias minimus,* and brush mouse, *Peromyscus boylii.*

Approximately one hundred species of birds have been recognized as using this area. Representative permanent residents would include western scrub jay, chukar, black-capped chickadee, *Parus atricapillus,* northern flicker, *Colaptes auratus,* common bushtit, *Psatriparus minimus,* and spotted towhee. Summer breeding birds would include black-headed grosbeak, *Pheucticus melanocephalus,* lazuli bunting, *Passeriana amoena,* rock wren, *Salpinctes obsoletus,* broad-tailed hummingbird, *Selasphorus platycercus,* and dusky flycatcher, *Empidonax oberholseri.*

The western fence lizard, *Scleroporus occidentalis,* side-blotched lizard, *Uta Stansburiana,* gopher snake, *Pituophis melanoleucus,* and western rattlesnake, *Crotalus viridus,* may be found in this vegetation zone.

2.13.4.3 Reclaimed Areas Vegetation Association

The second vegetatively distinct area would include those areas impacted by mining and smelter operations and their associated tailings. This area includes the previously disturbed Project Area and contains the slag, former tailing impoundments, tailing dams, and other former operational areas. Revegetation of the disturbed areas has taken place with mixtures of grasses, forbs, and woody vegetation. (see Photo 2-4; Photo 2-7; and Photo 2-8) Representative grasses and forbs include: cheatgrass, *Bromus tectorum,* yellow sweet clover, *Melilotus officinalis,* tall wheatgrass, *Elymus elongatus,* and western ragweed, *Ambrosia psilostrachya.* Woody vegetation includes rubber rabbitbrush, *Chrysothamnus nauseosus,* bitterbrush, and sandbar willow.

Vegetation of this area has been designed to increase carrying capacity of big and upland game habitat, as outlined in the Carr Fork Wildlife Management Plan. Previously disturbed areas seeded during the 1986 reclamation or during O&M activities since, are re-establishing well as seen in Photo 2-7. Addressed areas have a good mixture of food plants for wildlife, in many areas provide good cover, and have increased availability of forage for wintering big game. There is evidence of sustained use by deer during each season of the year. Photos 2-9 and 2-10 show a reclaimed area with significant evidence of forage use by deer.

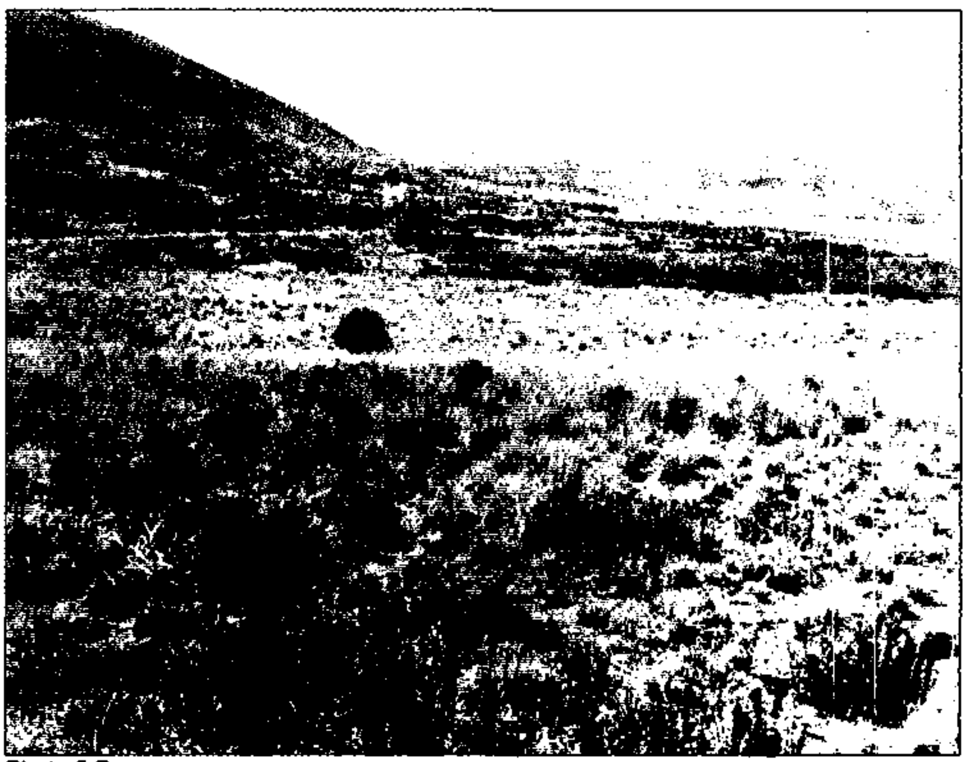


Photo 2-7

Photo 2-8

Photo 2-9

Photo 2-10

T

The Project Area range, in general, looks to be in much better shape than many of the surrounding rangelands. Many of the wildlife species found in the more open benchlands will be found in this area also. Western meadowlark, *Sturnella neglecta*, horned lark, *Eremophila alpestris*, vesper sparrow, *Pooecetes gramineus*,
and lark sparrow, *Chondestes grammacus*, would nest in this area. Small microtine rodents and associated predators would use this area.

2.13.4.4 Riparian Vegetation Association

The third distinct vegetative habitat is the riparian area of the Pine Creek drainage. Representative vegetation includes russian olive, sandbar willow, box elder maple, and narrowleaf cottonwood. The ribbon of riparian habitat following Pine Creek can be seen starting in the bottom right hand corner of Photo 2-11 just below the tailings with a broadening of the

Photo 2-11

riparian area downstream. A small marshy area has been established through excavation at the lower end of the property as seen in Photo 2-12 looking upstream in the Pine Creek drainage. Although small in acreage, this riparian area represents perhaps the best wildlife habitat in the Project Area in terms of diversity. Of the 212 wildlife species expected to occur on the property, either as permanent, seasonal residents or migratory visitors, not less than 165 of these species are associated directly with the riparian area. Reptiles that would be tied closely to this habitat would include the western skink, *Eumeces skiltonianus,* common garter snake, *Thamnophis sirtalis,* and milk snake.

Many summer season passerine birds would be confined along this habitat, including yellow warbler, warbling vireo, Bullock's oriole, yellow-breasted chat, and willow flycatcher, *Empidonax traillii.* Permanent residents, which would primarily use this area, would include the introduced California quail and wild turkey. Many migrant songbirds would use this area during spring and fall movements.


Photo 2-12

Many of the insectivorous shrews and bats would also be dependent on this area. Raccoon, *Procyon lotor,* weasels, *Mustela sp.*, and both resident skunks, striped skunk, *Spilogale putorius,* and spotted skunk, *Mephitis mephitis*, use riparian areas extensively.

2.13.5 Sensitive Habitats

During field investigations, two areas are identified which, in terms of maintaining a healthy diversity of fauna habitat, need protection and preservation to avoid deterioration of the current state. These are the riparian area existing along the Pine Creek corridor and the benchland areas in WA1 and WA5.

The riparian area in the Pine Creek drainage has made significant recovery from its previous altered state, with its intermittent areas of dense thickets of stream and channel vegetation. This area will continue to improve as long as no major disturbance occurs. The existing habitat could be enhanced with a constant year round water flow in Pine Creek and supplemental planting of key shrubs and trees to help fill in the gaps. The existing areas with saturated soils, with associated emergent cattail, *Tyhpha sp.*, and bulrush, *Scirpus sp.*, could be enlarged to provide additional marshland. This can be accomplished through the Site UDWR management plan.

The higher benchland areas dominated by Gambel oak and other shrubs are an other important area for wildlife, especially for big game.

2.13.6 Site Abiotic Conditions and Land Use

Several limiting resources and natural abiotic stressors have major influences on the biota found within the Project Area. Some of these naturally occurring stressors common to the Great Basin desert environment have been exacerbated by the encroachment of human development and related land use activities, especially grazing.

2.13.6.1 Precipitation and Temperature

As was noted earlier, the Project Area is located within a desert area with its accompanying low amounts of precipitation and high summer temperatures. Cold winter temperatures differentiate this area from the hotter deserts of the southwestern United States. Precipitation occurs as spring rain showers and winter snows. Oftentimes precipitation comes in intense "cloud bursts", with most of the year having long periods with little or none. Rapid sporadic and seasonal rains can cause surface erosion and land damage. Temperature and moisture commonly operate as paired limiting factors. As temperature and/or moisture seasonally raise or lower, wildlife will respond either by hibernation, aestivation, migration, or adaptation of daily habits (Odum, 1967).

2.13.6.2 Soil

It is commonly known that the substratum imposes limitations on the productivity and diversity of a biotic community (Oosting, 1956). The Project Area soils show deficiency of certain growth elements required for optimum plant production. Due to the internal drainage patterns of the Great Basin, area soils contain varying degrees of salts resulting in an alkaline state. Alkali soils have narrowing effect on the diversity of plants and thus influence fauna distribution and abundance accordingly. Soil structure and its ability to retain moisture can have a significant influence on the distribution of plant communities, in some cases even more than precipitation and temperature.

2.13.6.3 Fire

Fire can be both a major naturally occurring ecological factor and a detrimental artificial limiting factor. When properly used, fire can be a great ecological land management tool. When accidentally or wantonly discharged, fire can destroy years of the best laid land management plans (National Research Council, 1986).

One of the addressed management goals contained in the conservation easement addresses the use of fire on the property. Main objectives are to prevent and suppress wild fires on or in the vicinity of the property, to prohibit all dumping and burning, and to prohibit campfires within the unit. Fire could seriously set back the delicate habitat conditions which are now beginning to be fully re-established on the property. Gambel oak, a dominant shrubland species in the area, will regenerate quickly after a fire, maintaining its dominance by eliminating the opportunity of invading species to become established. (Coleman, 1953)

To minimize damage from human-caused range fires, a three-mile long fire break has been established along the west property line and weed/grass mowing along County roads has been implemented as part of the Site O&M procedures. Extensive planned burning would not be beneficial at the current time to any of the available habitats within the property. Fire would be a dominant detrimental factor in both the submontane shrub and riparian habitats.

2.13.6.4 Livestock Grazing

Historically, portions of the Atlantic Richfield property and adjacent BLM land were leased for livestock grazing. This practice has been discontinued with the establishment of the Site conservation easement. Livestock grazing influences the rate and pattern of successional changes by removing preferred rangeland grazing plants and substituting non-native noxious weeds in their place. Unauthorized grazing is closely controlled and UDWR monitored. Restoration of the Atlantic Richfield property has been, in a large part, successful. This part of the range has responded well and now exceeds the diversity, abundance, and carrying capacity of desirable rangeland plants found on adjoining lands.

2.13.6.5 Other Disturbances

The Carr Fork Wildlife Management Plan addresses several other activities which would have significant adverse effects on the habitat if restrictions were not put in place. Unrestricted motor vehicle use, including off-road vehicles (ORVs) would certainly destroy watershed soils and plant cover and influence associated wildlife populations. Motor vehicle traffic is restricted to designated roads. Public access is managed with access points, designated vehicle parking areas, property boundary fences, gates, and signs. No public access is allowed from December 1 to April 15 to minimize disturbance to wintering big game. Restrictions on dog exercising/training in upland game nesting areas, is similar to other statewide regulations, whereby dogs can not be used in nesting areas from April 15 to August 15.

Additionally, restrictions on farming expansion (except where specified), soil or plant removal (except in approved habitat improvement projects), well drilling, dumping of refuse, and unnecessary use of ponded water will help to preserve Project Area habitats.

2.13.7 Management Plan and Status

The UDWR began implementing a wildlife habitat management program soon after the conservation easement agreement was signed in 1994. Initial funds were directed toward restoration of rangeland through discing, aerial seeding, and tree and shrub planting. An addendum was signed in 1995 which permitted additional transfer of monies to the Division to cover fencing and signing. A five year development and maintenance budget was designed (D. Sakaguchi, personal communication). All funds were placed in a non-lapsing dedicated account of the Division for the sole purpose of implementing the development plan.

The overall management goal of the conservation easement is to preserve, enhance, and protect the conservation value of the property consistent with Atlantic Richfield's environmental commitments. Other supporting goals are to: 1) Increase wildlife species diversity, 2) Increase upland game carrying capacity, 3) Increase big game carrying capacity, 4) Develop effective property management programs, and 5) Monitor effectiveness of the management plan.

To increase species diversity, objectives were identified concerning riparian and benchland areas, upland and big game habitats, and introduction of new species. To date, little or no work to enlarge and vegetatively enhance the riparian area has been completed. However, current conditions indicate there is a rich riparian habitat along Pine Creek (Photos 2-11, 2-12). Maintaining surface water is critical to the wildlife vitality in this important area.

Much of the reclaimed impacted area has been revegetated by discing and seeding. Each year, beginning in 1995 and continuing to 1998, between 50 and 185 acres have been re-seeded. Between 25 - 30,000, seedling plants have been manually planted by DWR personnel, volunteers, and a crew of inmates from the Utah State Prison. Fourteen thousand bitterbrush plants were planted along the benchlands in areas where snow cover is greatest in the winter months, thus providing additional moisture for these developing seedlings.

Rio Grande variety of wild turkeys that were captured in Kansas were released into the area in 1999 by UDWR. Wild turkey can be seen in the rich riparian habitat of Pine Creek in Photo 2-13. During the last four years California quail have been released depending on availability.

Photo 2-13

Overall, the diversity, abundance, and carrying capacity of wildlife species on the Project Area would have been expected to increase as beneficial activities have been carried out. In several areas this has taken place. Carrying capacity for big and upland game has increased on the property since reclamation. Deer are residents of the area, with fawns born and raised on the property. Spring and winter deer classification counts show a healthy resident herd (T. Becker, personal communication). The management goal of providing habitat capable of sustaining 250 deer during critical times of the year is close to becoming a reality. Snow depth dictates use by deer in the area during winter months. During mild winters deer numbers approach management goals. Heavy use during spring green-up occurs annually.

Elk, on the other hand, do not regularly use the area. Only a small number of elk have been observed sporadically on the property. Elk are naturally slower to colonize a new area, even when better habitat is available. Most Oquirrh Mountains elk winter on Kennecott Utah Copper (KCC) land on the north and east area of the mountains. There appears also to be a break in available adequate habitat north of the Atlantic Richfield property. This fragmented habitat on the north, along with encroachment of human development on the south and west have shown natural movement of elk into the Carr Fork Management Area unlikely in the future.

Upland game use is increasing as shown by hunter use and bag censuses. Mourning dove hunting is the highest hunter use, with ring-necked pheasant, quail and chukar hunters increasingly using the property. Wild turkey are hunted in the area by drawing permit only. Upland game brood counts are conducted each year and results show an increase in upland game availability.

2.13.8 Site Comparison with Kennecott Utah Copper Site and Adjacent BLM Lands

The Atlantic Richfield Project Area property is bordered on the north by BLM land, on the east by KCC property, on the south by BLM with some private lands, and on the west by private lands.

Though smaller in size, the Project Area is not unlike the similar KCC properties located directly over the east side of the Oquirrh Mountains. This region has experienced active mining operation since the 1860's. The history of the KCC property parallels the IS&R/Carr Fork property with various mining, smelting, and other processing operations having taken place over the same period. An ecological Risk Assessment for KCC was completed in the Northern Oquirrh Mountains in 1996 (Ecological Planning and Toxicology, 1996).

As was summarized in KCC Ecological Risk Assessment in 1996, the greatest determinant of animal presence and abundance on the studied area was the quality of the habitat. The author theorized that reduced grazing pressure in all KCC areas would result in increases in the amount and quality of the wildlife habitat for many species (Ecological Planning and Toxicology, 1996).

A comparison of wildlife species diversity between KCC and the IS&R/Carr Fork Project Area shows close similarities based on the habitat available. The KCC property contains much more extensive areas of each available habitat than the Project Area; however, a species comparison would show basically identical species for the reclaimed lands, submontane brushland belt and small riparian areas. Some KCC lands differ markedly from IS&R/Carr Fork in that they contain areas of open water, including portions of the Great Salt Lake and ponds. Kennecott land also has several large areas of emergent marshlands. These habitats attract waterfowl, shorebirds and associated wetland birds in large numbers and diversity, especially during migration. With little or no standing water on the Atlantic Richfield property, these species would not normally be found. Likewise, the higher elevation of KCC would contain certain fauna, such as coniferous forest nesting birds, which would rarely be found on the Atlantic Richfield property.

A list of animals on the Oquirrh mountains and southeastern Great Salt Lake wetlands compiled for the KCC Ecological Risk Assessment includes 272 wildlife species. One hundred ninety one of these would be expected to occur on the Atlantic Richfield Project Lands, with 81 not occurring, and eight confined more to the west side of the Oquirrhs. Representative animals in the higher elevations occurring on KCC but not on Atlantic Richfield property would be: ruffed grouse, *Bonasa umbellus*, blue grouse, *Dendragapus obscurus,* northern goshawk, *Accipiter gentilis*, Clark's nutcracker, *Nucifraga columbiana*, snowshoe hare, *Lepus americana*, red squirrel, *Tamiasciurus hudsonicus*, and several species of upper montane voles, *Microtus sp.*

Species that might be expected to occur on the Atlantic Richfield property, but not likely on KCC property would include: ringneck snake, *Diadolphis puntatus,* long-nosed snake, *Rhinocheilus lecontei,* kit fox, *Vulpes macrotis,* Great Basin kangaroo rat, *Dipodomys microps,* and longtail pocket mouse, *Perognathus formosus.*

To the extent the Kennecott site is similar in habitat and species composition to the project site appropriate aspects of the prior ecological risk assessment can be used to support development of the Site ecological risk assessment.

2.14 Cover Stability

The cover soil placed over the former smelter site and tailings at the IS&R/Carr Fork site were obtained locally. The soil characteristics and potential for use as plant growth media was evaluated during the early stages of reclamation and are discussed in Section 2.13. The overall stability of the cover placed on these reclaimed area surfaces is dependent on the soil texture, surface roughness, length of slope grade and cover that protects the surface to erosional forces.

An estimation of soil loss from water and wind erosion has been made to understand the stability of the reclaimed features soil cover. To predict the soil loss from these areas the USDA, National Resources Conservation Service models were utilized. The Revised Universal Soil Loss Equation (RUSLG) was used to predict water erosion and the Wind Erosion Equation (WEO) was used to predict loss as a result of wind. Characteristics of the soils units used for cover were obtained from the Soil Survey of the Tooele area, Utah (NRCS, 2000). Cover data was field collected and range condition assigned. The biomass production values for the subject soils was estimated from the range analysis data Table 2-28, Summary of Water and Wind Erosion Soil Loss Predictions, shows the soil loss for the main reclaimed area. A weighted average was totaled for water erosion and added to the wind erosion losses. The total soil loss for the reclaimed areas ranges from 5.8 to 9.2 tons per acre per year. This translates to cover losses of 0.0025 ft to 0.0040 ft per year with present cover conditions. As the plant community continues to mature to higher levels of succession and ground cover litter increases the losses are expected to reduce in future years. Assuming present conditions without plant improvement, predictions of soil erosion indicate that an average loss of the cover will be 0.32 ft in 100 years. With plant community improvement and site management for wildlife enhancement this would predictably be even less. In addition, wind soil deposition from upgradient areas and sediment deposition will be adding soils in which have not been accounted for in the model.

Table 2-28
Summary of Water and Wind Erosion Soil Loss Predictions

Area	Average Water Erosion Tons/Acre/Yr	Method	Average Wind Erosion Tons/Acre/Yr	Method	Total Erosion Tons/Acre/Yr	Ft Loss per Year	Cover Loss in Ft For 100 Years
WA3	2.38	NRCS-RUSLE	5.0	NRCS-WEQ	7.4	0.0032	0.32
WA6	3.92	NRCS-RUSLE	5.3	NRCS-WEQ	9.2	0.0040	0.40
WA8	0.325	NRCS-RUSLE	5.5	NRCS-WEQ	5.8	0.0025	0.25

2.15 Groundwater Characteristics

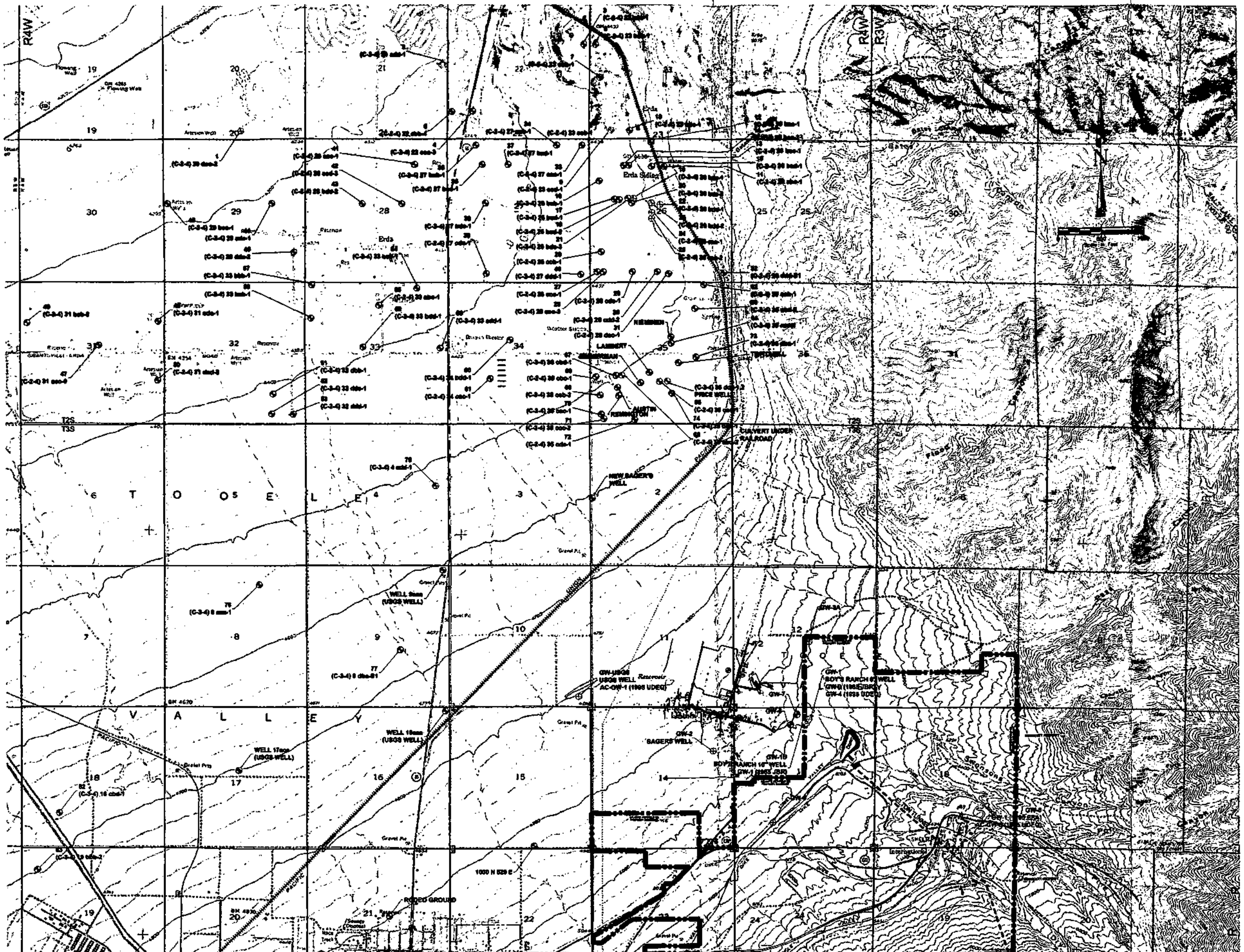
Forty nine groundwater samples were collected from 24 wells on and near the Site as shown on Figure 2-21. Groundwater was found to be within drinking water standards at all locations with the exception of elevated concentrations of arsenic at GW-1, GW-1B (wells at the base of Pine Canyon) and elevated nitrate and arsenic at two wells in the Erda area. The investigation determined that the arsenic and nitrates in the Erda wells was not related to the IS&R site. Though a direct link to the Site was not found for the elevated arsenic at the base of Pine Canyon, the areal extent of the plume was estimated and it as determined that the plume appears to be stable in its present configuration.

2.15.1 Objectives of Groundwater Investigation

The primary objective of the groundwater investigation was to determine what impacts, if any, to area aquifers are a result of IS&R/Carr Fork operations. To meet the study objective, historical monitoring records, current and past water use, geologic characteristics, hydraulic properties, and hydraulic flow direction were investigated. In addition, soil and groundwater samples were collected from the Site, and computer modeling was performed. To begin the groundwater portion of the remedial investigation, records from previous studies were collected and reviewed to determine which wells or COC should be the focus of more thorough study. Following this initial research a separate Groundwater Site Conceptual Model (GSCM) was prepared which outlined potential receptors and pathways (Figure 2-22). The Groundwater Site Conceptual Model was submitted to EPA for approval on April 17, 2002 (Anderson, 2002).

The GCSM defines three groups of potential sources associated with the IS&R facility that may result in impacts to area aquifers. These potential sources include the following.

- Historic Operations
- Smelter Site Sources
- Off Site/Other Sources



General Notes

LEGEND

- GROUNDWATER WELL LOCATION
- GROUNDWATER WELLS SAMPLED QUARTERLY FOR REMEDIAL INVESTIGATION
- GROUNDWATER WELLS INSTALLED POST-RI 2004
- GROUNDWATER WELLS SAMPLED AS PART OF ERDA STUDY

No.	Revision/Issue	Date

Atlantic Richfield Company

IS&R
Tooele, UT

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

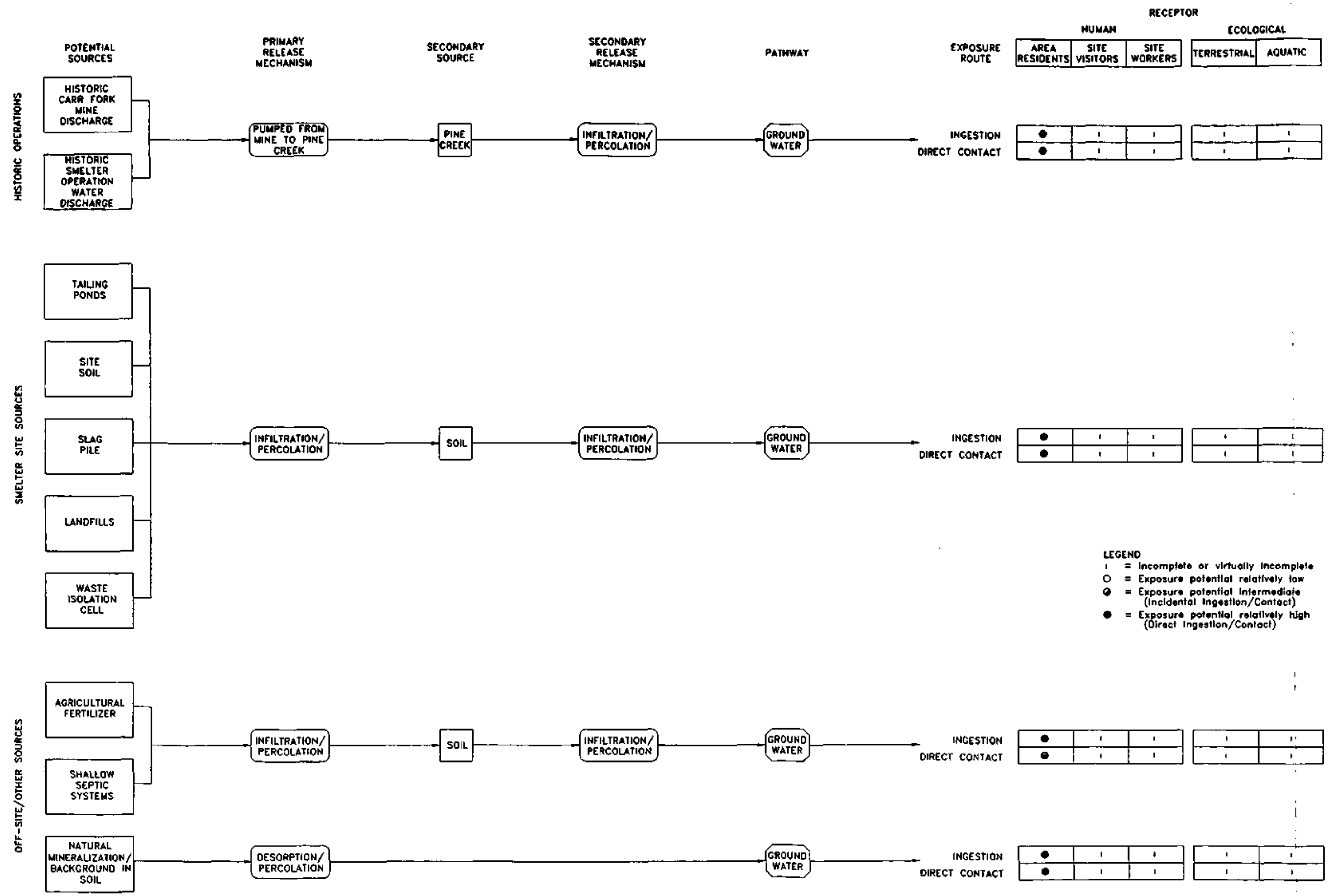
IS&R GROUNDWATER INVESTIGATION MONITORING WELL LOCATIONS

IS&R SITE

Project: 97-069	FIGURE
Date: 18-AUG-2004	2-21
Scale: AS SHOWN	

FIGURE 2-21 GROUNDWATER SOURCE/MECHANISM DIAGRAM

NOTE: THIS DIAGRAM ILLUSTRATES THE RANGE OF POSSIBLE SOURCES, PATHWAYS, AND EXPOSURE MECHANISMS TO POTENTIAL GROUNDWATER CONCERNS.



General Notes

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: gkl
ENGINEER: KC
APPROVED: SDA

GROUNDWATER CONCEPTUAL SITE DIAGRAM

REMEDIAL INVESTIGATION
TOOELE, UTAH

Project 97-069
Date 18-AUG-04
Scale N/A
FIGURE 2-22

2.15.1.1 Historic Operations

This potential source includes mine and smelter discharge released during operations, which historically could have infiltrated into the ground in quantities sufficient to create an adverse impact to the aquifer. The primary release mechanism for the mine discharge source is infiltration within the Pine Canyon drainage and the downstream irrigation channels. During the IS&R smelter operation and later during development and working the Carr Fork mine, water was pumped from the Apex and associated shafts into the Elton Tunnel or Pine Canyon Tunnel. A time line of dewatering activities is shown on Figure 1-4. Both of the tunnel outlets eventually discharged into the Pine Canyon drainage and then through down gradient irrigation ditches. Because of this, the quality and points of water discharge have been a major focus during the investigation. An extensive history of the mine dewatering activities is found in Section 2.15.2.5. To evaluate historic operations as a potential source the following tasks were completed:

- Historical plant records were researched to isolate points of discharge. Soils at these points and down gradient areas were then sampled to determine if water discharge contained elevated concentrations of COC which would adsorb to soil particles as the water infiltrated into the ground.

- Historical analytical results were researched to evaluate the water quality of released discharges. Section 2.15.2.5 provides a summary of this research.

- Discharge records were researched to determine the period of discharge and the volume of water released. Section 2.15.2.5 provides a summary of this research.

- A new well (GW-3A) was drilled and installed in July 2002 adjacent to the main irrigation ditch (Boys Ranch ditch) which is also in the center of the infiltration area used for mine water discharge. The well was sampled and analyzed for COC impacts.

- Down gradient wells below the smelter site were sampled from December 2001 through July 2004 to investigate the concentration of COC in the groundwater under and in the vicinity of the Site. In addition, wells in the Erda area were sampled in August 2002 to determine if site COC were found in elevated concentrations. Section 3.13 provides the results of current RI sampling.

- Particle Tracking Models were run in December 2002, then expanded in April 2003 to determine down gradient flow directions. The model was recalibrated with new data in July 2004. Section 2.15.3 provides a summary of this research.

- Comparative analysis of major anions and cations was completed from August 2003 through April 2003 to confirm results of hydraulic modeling analysis. Section 2.15.4 provides a summary of this research.

- NETPATH modeling was completed from August 2003 through April 2003 to determine if water types found in the potential sources could evolve into water types found in down gradient wells. Section 2.15.4.5 provides a summary of this research.

- Isotopic analysis was completed from August 2003 through April 2003 to compare geochemical properties of potential source water with water found in down gradient wells. Section 2.15.4.6 provides a summary of this research.

- The upper and lower sections of the 6" Boys Ranch Well was sampled in April 2003 to investigate the vertical distribution in April 2003.

- It was then acid-cleaned and sampled again in June 2004.

- The 16" Boys Ranch Well was abandoned in May 2004 and replaced by a new deeper (750 feet deep) 4" diameter well to test a lower aquifer zone.

- Two new wells, GW-7 and GW-8, were drilled and installed in June 2004 downgradient from the Boys Ranch Well along the analytical model flow line and the hydraulic model flow line, respectively

2.15.1.2 Smelter Site Sources

This potential source as a group comprises waste materials remaining on the Site that were created during operations. Tailing Ponds, Slag Pile, Landfills and the Waste Isolation Cell contain the bulk of these materials. To a lesser degree site soils impacted by aerial emissions also constitute a potential source of COC to the area aquifers. The primary potential pathway from Smelter Site sources into area aquifers would be meteoric water mobilizing COC into subsurface soils and underlying aquifers. To evaluate this potential source, the following investigation tasks were completed. Details of this sampling (media other than groundwater) are included in Section 3.0.

- 19 Geoprobe borings were drilled within the tailing pond and the tailings and underlying subsurface native soil were sampled.

- Four deep holes were drilled down gradient of the slag pile to determine vadoze zone moisture conditions and soil samples were collected at various depths. Samples were analyzed for evidence of COC leaching into subsurface soils.

- Soil samples were collected from within and below the Waste Isolation Cell and analyzed for migration of COC.

- Exploratory borings were drilled to a depth of 50-ft. deep in each Work Area known to be impacted by smelter operations. Soil samples were collected at various depths and analyzed for COC migration.

- Pore water was collected and analyzed from lysimeters installed during the 1997 DERR study.

2.15.1.3 Off-Site/Other Sources

Because historical monitoring indicated elevated concentrations of arsenic and nitrate in the Price area wells and elevated arsenic in the wells at the base of Pine Canyon, other possible sources for these elements were researched to determine if there were other plausible sources for this COC in area aquifers. Off-site sources investigated include agricultural fertilizers and waste, septic systems and naturally occurring mineralization of mountain front aquifer recharge. Nitrate in groundwater is ordinarily associated with agricultural fertilizers and human or animal waste handling practices. Therefore waste handling methods in the Erda area were researched for correlation with water analysis results from samples collected there.

USGS and others have found that elevated concentrations of arsenic can be found in isolated pockets, commonly associated with Lake Bonneville sediments or mineralized bedrock (Mayo, 2003; Susong, 2003). Natural arsenic minerals are commonly associated with sulfide copper ores such as those in the mineralized zone of the Oquirrh mountains east of the Site (Jensen and Bateman, 1981). Arsenic has been encountered in spring water from Leavetts Canyon and in runoff from Pass Canyon. In 1971 a sample from Pass Canyon runoff had an arsenic concentration of 146 ppb. It was reported that Lincoln Township had investigated the potential for developing a spring in Leavetts Canyon to supplement their water culinary system; however, a sample of the spring had elevated arsenic, and so precluded its use for culinary purposes (Ken Shields, 2003). The

Occidental fault trace is mapped along the axis of Pine Canyon, which may be a potential mechanism for transporting arsenic laden waters from the bedrock into the Pine Canyon alluvium.

One current anthropogenic source of arsenic includes land spreading of poultry and hog manure containing arsenic from feed additives. Roxarsone, an organic arsenic compound, has been used extensively in the poultry industry as a feed additive at the rate of 22.7 to 45.5 g per ton, for the purpose of improving weight gain, feed efficiency, and to control infections and parasites (Christen, 2001). Previous studies have demonstrated that these organoarsenic compounds do not accumulate in poultry tissue or feathers, but are rapidly excreted, resulting in elevated concentrations of arsenic (20 to 40 mg/kg) in poultry litter (Garbarino, 2000). Because poultry manure is high in nutrients, it is commonly sold and used as a fertilizer. Studies have shown that organic arsenic may be transformed by bioprocesses into inorganic arsenic, specifically into arsenate As (V), which can then be reduced to the more mobile arsenite As (III) (Christen, 2001). Current studies indicate the strong potential for mobilization of arsenic into surface and/or groundwater from agricultural fields which have been amended with poultry litter (Miller, 2000).

2.15.2 Historical Sampling and Groundwater Use

2.15.2.1 Historical Groundwater Monitoring

During the initial phase of the investigation it was determined that Lincoln area residents were the only potential receptor with a relatively high potential for exposure from groundwater, primarily from ingestion. Currently there are no residents who extract water from local wells, nor do they have access to wells containing elevated metallic elements in the Lincoln area. Culinary water is supplied by the Lincoln municipality, with a source within a nearby canyon (Middle Canyon).

Sampling of groundwater from area wells has been on-going for several years. Samples have been collected by Anaconda, Atlantic Richfield, agencies, and consultants researching possible effects of the IS&R/Carr Fork operation on area aquifers. Table 2-29 provides a summary of historic sample analytical results from GW-1 (Boys Ranch Well), GW-2 (Sagers Well), and GW-4 (Tailings Dam Well). The review of the historical analytical results indicated that no site COC have consistently exceeded MCL standards, except arsenic at the Boys Ranch wells. In general, these analytical results were collected from tables or other similar databases that typically do not include methodology, or quality control procedures. Though lacking in detail, the results provided a basis for what elements may be of concern and provided a background for developing the sampling and field investigation program carried out during the RI. A majority of the analytical

Table 2-29
Historical Groundwater Results
ISR Remedial Investigation
(Results given in ppm)

Boys Ranch Well Concentrations: May 1972 - Sept. 1972 (Discharge Water was Discharged into Pine Canyon during Pump Test)

Well Name	Date	Arsenic		Calcium		Copper		Iron		Lead		Magnesium		Manganese		Sodium		pH (pH Units)
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	
16" Well - Boys Ranch	5/18/1972	0.419		148		0.012		3.7	<0.02	0.029		66		0.065		30		7.45
16" Well - Boys Ranch	5/25/1972			81.8		0.01		0.39	0.2			53		0.09		35.1		7.85
16" Well - Boys Ranch	7/2/1973	0.21		110		0.039		0.03		0.045		44		0.05		47		7.4
16" Well - Boys Ranch	7/6/1972	0.353		145		<0.05		4.8	0.25	<0.1		65		<0.05		100		7.63
16" Well - Boys Ranch	8/14/1972			110		0.01		0.6	0.25			55		0.12		46		7.65
16" Well - Boys Ranch	8/15/1972			118		0.01		2.95	0.5	0.05		51.3		0.08		88		7.55
16" Well - Boys Ranch	8/18/1972			137								60						8.03
16" Well - Boys Ranch	8/31/1972	0.587		128		0.031		<0.02		0.05		61		0.31		50		8.05
16" Well - Boys Ranch	9/20/1972			116		0.01			0.51	0.1		58		0.23		42		7.7

Boys Ranch Well Concentrations: Oct. 1972 - 1975 (Time Period between the Pump Test and Carr Fork Dewatering)

Well Name	Date	Arsenic		Calcium		Copper		Iron		Lead		Magnesium		Manganese		Sodium		pH (pH Units)
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	
16" Well - Boys Ranch	10/9/1972			107		0.04		7.5	0.16	0.13		60		0.25		48		7.7
16" Well - Boys Ranch	11/8/1972			110					0.15	0.05		50		0.22		50.3		7.5
16" Well - Boys Ranch	12/4/1972			107.2					0.13	0.02		44.4		0.16		57.3		7.5
16" Well - Boys Ranch	1/22/1973			107.2					0.12	0.01		44.8		0.1		66.9		7.5
16" Well - Boys Ranch	2/12/1973	0.25	0.18	110		0.009		0.02		0.018		43		0.031		44		7.8
16" Well - Boys Ranch	3/2/1973	0.12		107		0.013		0.02		0.015		44		0.022		45		7.8
16" Well - Boys Ranch	3/6/1973	0.2																
16" Well - Boys Ranch	4/6/1973	0.289		100		0.011		0.2		0.015		42		0.065		45		8.13
16" Well - Boys Ranch	5/11/1973	0.18		108		0.011		0.02		0.11		44		0.017		50		7.93
16" Well - Boys Ranch	6/1/1973	0.17		107		0.012		<0.02		0.02		46		0.01		46		8.25
16" Well - Boys Ranch	7/2/1973	0.21																
16" Well - Boys Ranch	8/1/1973	0.35		120		0.016		0.05		0.033		45		0.015		47		7.9
16" Well - Boys Ranch	2/1/1974		0.082		120		0.016		0.02		0.014		43		0.195		45	7.8
16" Well - Boys Ranch - 11:35 AM	8/21/1974	0.46		108		0.01		0.05		0.014		40		0.014		44.8		8
16" Well - Boys Ranch - 10:00 PM	8/21/1974	0.49		104		0.033		0.03		0.014		40		0.014		46.2		8.3
16" Well - Boys Ranch - 8:00 AM	8/22/1974	0.43		110		0.017		0.01		0.025		40		0.014		47.6		8
16" Well - Boys Ranch	1/8/1975						0.02											8

Boys Ranch Well Concentrations: 1976 - 1984 (Carr Fork Dewatering)

Well Name	Date	Arsenic		Calcium		Copper		Iron		Lead		Magnesium		Manganese		Sodium		pH (pH Units)
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	
6" Well - Boys Ranch	10/31/1977		0.038		102		0.021		0.15		0.028		46		0.063		46	7.6
6" Well - Boys Ranch - 1st Bail	8/23/1979	0.007		133		0.013		0.09		0.006		66		0.648		43		7.9
6" Well - Boys Ranch - After Bail	8/23/1979	0.005		132		0.025		0.1		0.006		70		0.638		46.1		7.9
6" Well - Boys Ranch - 1st Bail	2/11/1981	0.004		91		0.02		0.08		<0.001		39		0.01		41.5		7.4
6" Well - Boys Ranch - After Bail	2/11/1981	0.001		93		0.02		0.12		<0.001		40		0.3		44.8		7.4
6" Well - Boys Ranch	6/24/1982	0.12		109		0.01		54.7	21.45	0.032		44.9		0.56		44		7.3
6" Well - Boys Ranch - After 4 Hours	6/24/1982	0.165		131		0.03		54.1	24.65	0.217		53.5		1.83		47.5		7.4
6" Well - Boys Ranch	12/10/1984	<0.001		89.6		0.17		10.2	4.5	0.005		33.12		0.1		59		7.45
6" Well - Boys Ranch	9/25/1995	0.147	0.135	86.7	89.2	0.0053	0.004	0.652	<0.0236	0.0039	0.0013	40.1	41.2	0.0136		38.3	39.9	

Table 2-29
Historical Groundwater Results
ISR Remedial Investigation
(Results given in ppm)

Boys Ranch Well Concentrations: May 1972 - Sept. 1972

Well Name	Date	Alkalinity	Chloride	Nitrate	Nitrite	Sulfate	TDS	TSS	Bicarbonate	Flouride	Hardness as $CaCO_3$
16" Well - Boys Ranch	5/18/1972	260	55	2.27		404					
16" Well - Boys Ranch	5/25/1972	240	66	0.85		114.8	675				
16" Well - Boys Ranch	7/2/1973	209	40			240			260	0.5	450
16" Well - Boys Ranch	7/6/1972	277	52	2.94		382	680				
16" Well - Boys Ranch	8/14/1972	242	62	0.88		239	808				
16" Well - Boys Ranch	8/15/1972	120	50	0.96		460	917				
16" Well - Boys Ranch	8/18/1972	299	51	3.62		366	870				
16" Well - Boys Ranch	8/31/1972	240	54	3.28		351					
16" Well - Boys Ranch	9/20/1972	238	58	1.15		305	869				

Boys Ranch Well Concentrations: Oct. 1972 - 1975 (Time

Well Name	Date	Alkalinity	Chloride	Nitrate	Nitrite	Sulfate	TDS	TSS	Bicarbonate	Flouride	Hardness as $CaCO_3$
16" Well - Boys Ranch	10/9/1972	222	56	1.05		300	846				
16" Well - Boys Ranch	11/8/1972	210	52	1.06		280	803				
16" Well - Boys Ranch	12/4/1972	220	48	1.1		257	784.8				
16" Well - Boys Ranch	1/22/1973	242	48	1.05		252.5	810				
16" Well - Boys Ranch	2/12/1973	230	56	3.87		247					
16" Well - Boys Ranch	3/2/1973	228	39	3.73		253					
16" Well - Boys Ranch	3/6/1973										
16" Well - Boys Ranch	4/6/1973	218	36	3.89		230					
16" Well - Boys Ranch	5/11/1973	225	40	4.52		258					
16" Well - Boys Ranch	6/1/1973	230	40	3.80		246					
16" Well - Boys Ranch	7/2/1973										
16" Well - Boys Ranch	8/1/1973	221	41	3.93		250			270	0.5	480
16" Well - Boys Ranch	2/1/1974	153	38			240			190	0.47	470
16" Well - Boys Ranch - 11:35 AM	8/21/1974	214	36.8	3.96			630				
16" Well - Boys Ranch - 10:00 PM	8/21/1974	218	37.4	4.29			690				
16" Well - Boys Ranch - 8:00 AM	8/22/1974	218	38.7	4.50			660				
16" Well - Boys Ranch	1/8/1975	218	39			260			270	0.6	440

Boys Ranch Well Concentrations: 1976 - 1984 (Carr Fork

Well Name	Date	Alkalinity	Chloride	Nitrate	Nitrite	Sulfate	TDS	TSS	Bicarbonate	Flouride	Hardness as $CaCO_3$
6" Well - Boys Ranch	10/31/1977	177	30		8.9	260			220	0.56	450
6" Well - Boys Ranch - 1st Bail	8/23/1979	205	57.1	1.94		210	680				
6" Well - Boys Ranch - After Bail	8/23/1979	214	54.6	1.86		234	704				
6" Well - Boys Ranch - 1st Bail	2/11/1981	220	40.65	2.10		216	616	542			
6" Well - Boys Ranch - After Bail	2/11/1981	216	41.98	2.42		228	672	2786			
6" Well - Boys Ranch	6/24/1982	231.1	43.7	3.41	0.25	284	699				
6" Well - Boys Ranch - After 4 Hours	6/24/1982	235.2	40.1	3.74	0.31	383	830				
6" Well - Boys Ranch	12/10/1984	267	41	2.55	<0.01	164	550				
6" Well - Boys Ranch	9/25/1995			3.1	<0.1	180					

Table 2-29
Historical Groundwater Results
ISR Remedial Investigation
(Results given in ppm)

Sagers Well Concentrations: 1958 - April 1972 (Discharge Water was Discharged to the Bingham Side of the Oquirrh Mountains)

Well Name	Date	Arsenic		Calcium		Copper		Iron		Lead		Magnesium		Manganese		Sodium		pH (pH Units)
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	
Sagers Well - Lincoln	10/7/1971	<0.001		29		<0.05				<0.1		49		0.45		24		7.42

Sagers Well Concentrations: May 1972 - Sept. 1972 (Discharge Water was Discharged into Pine Canyon during Pump Test)

Well Name	Date	Arsenic		Calcium		Copper		Iron		Lead		Magnesium		Manganese		Sodium		pH (pH Units)
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	
Sagers Well - Lincoln	5/17/1972	0.025		122		0.025		36	<0.02	0.048		59		0.46		25		7.72
Sagers Well - Lincoln	6/26/1972			122.5				3.25	1.8			51.4		0.35		26.2		7.5
Sagers Well - Lincoln	7/3/1972			136		<0.05		0.7		<0.1		66		<0.05		66		7.78
Sagers Well - Lincoln	7/6/1972			120				3.1	1.2			56.4		0.31		25		7.5
Sagers Well - Lincoln	8/18/1972			130								35						7.67
Sagers Well - Lincoln	8/30/1972	0.04		112		0.01			0.15			66				20		7.6

Sagers Well Concentrations: Oct. 1972 - 1975 (Time Period between the Pump Test and Carr Fork Dewatering)

Well Name	Date	Arsenic		Calcium		Copper		Iron		Lead		Magnesium		Manganese		Sodium		pH (pH Units)
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	
Sagers Well - Lincoln	7/11/1974		0.001		130		0.033		0.04		0.015		54		0.147		38	7.7

Sagers Well Concentrations: 1976 - 1984 (Carr Fork Dewatering)

Well Name	Date	Arsenic		Calcium		Copper		Iron		Lead		Magnesium		Manganese		Sodium		pH (pH Units)
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	
Sagers Well - Lincoln	10/31/1977		0.001		120		0.016		0.31		0.03		52		0.129		40	7.6
Sagers Well - Lincoln	6/8/1978				120								58				39	
Sagers Well - Lincoln - 1st Bail	8/22/1979	0.002		36		0.071		0.187				10		0.01		5.1		8.1
Sagers Well - Lincoln - After Bail	8/22/1979	0.002		150		0.071		0.006				76		0.337		39.9		7.4
Sagers Well - Lincoln - 1st Bail	2/13/1981	0.002		116		0.02		0.09		<0.001		47		1.28		41.8		7.1
Sagers Well - Lincoln - After Bail	2/13/1981	0.004		115		0.02		0.09		<0.001		45		1.22		41.5		7.1
Sagers Well - Lincoln	12/18/1984		<0.001		83		0.68				0.015		36		0.66		41	7.5

Tailings Dam Well Concentrations: 1976 - 1984 (Carr Fork Dewatering)

Well Name	Date	Arsenic		Calcium		Copper		Iron		Lead		Magnesium		Manganese		Sodium		pH (pH Units)
		Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	
Tailings Dam Well	2/10/1981	0.001		116		0.03		0.17		0.001		48		0.68		40.5		7.8
Tailings Dam Well	6/24/1982	<0.001		96.5		0.02		2.73	1.45	0.104		49.6		0.16		38.5		7.6
Tailings Dam Well - After 8 Hours	6/24/1982	0.001		119		0.02		0.42	0.31	0.012		46		0.025		39		7.1
Tailings Dam Well	12/20/1984	0.001		14.4		0.02		1.29	1.08	0.035		32.4		0.04		76		8.45

Table 2-29
Historical Groundwater Results
ISR Remedial Investigation
(Results given in ppm)

Sagers Well Concentrations: 1958 - April 1972 (Discharge Wate

Well Name	Date	Alkalinity	Chloride	Nitrate	Nitrite	Sulfate	TDS	TSS	Bicarbonate	Flouride	Hardness as $CaCO_3$
Sagers Well - Lincoln	10/7/1971	185	33	0.3		256	424				

Sagers Well Concentrations: May 1972 - Sept. 1972 (Discharge

Well Name	Date	Alkalinity	Chloride	Nitrate	Nitrite	Sulfate	TDS	TSS	Bicarbonate	Flouride	Hardness as $CaCO_3$
Sagers Well - Lincoln	5/17/1972	275	35	1.54		387					
Sagers Well - Lincoln	6/26/1972	220	42	0.48		257.7	769				
Sagers Well - Lincoln	7/3/1972	296	36	1.13		337					
Sagers Well - Lincoln	7/6/1972	220	45	0.49		260	774				
Sagers Well - Lincoln	8/18/1972		38.6	1.08		360	810				
Sagers Well - Lincoln	8/30/1972	224	38	1.4		310	819				

Sagers Well Concentrations: Oct. 1972 - 1975 (Time Period betv

Well Name	Date	Alkalinity	Chloride	Nitrate	Nitrite	Sulfate	TDS	TSS	Bicarbonate	Flouride	Hardness as $CaCO_3$
Sagers Well - Lincoln	7/11/1974	200	38			320			240	0.36	540

Sagers Well Concentrations: 1976 - 1984 (Carr Fork Dewatering

Well Name	Date	Alkalinity	Chloride	Nitrate	Nitrite	Sulfate	TDS	TSS	Bicarbonate	Flouride	Hardness as $CaCO_3$
Sagers Well - Lincoln	10/31/1977	200	31			320			240	0.49	510
Sagers Well - Lincoln	6/8/1978	250	39			300			300	0.1	540
Sagers Well - Lincoln - 1st Bail	8/22/1979	99	7.4	0.99		12	148				
Sagers Well - Lincoln - After Bail	8/22/1979	185	43.1	2.24		288	728				
Sagers Well - Lincoln - 1st Bail	2/13/1981	226	41.98	2.60		305	816	0.84			
Sagers Well - Lincoln - After Bail	2/13/1981	221	41.32	2.53		316	708	768			
Sagers Well - Lincoln	12/18/1984	217	43			220			260	0.3	360

Tailings Dam Well Concentrations: 1976 - 1984 (Carr Fork Dewa

Well Name	Date	Alkalinity	Chloride	Nitrate	Nitrite	Sulfate	TDS	TSS	Bicarbonate	Flouride	Hardness as $CaCO_3$
Tailings Dam Well	2/10/1981	240	34.65	1.23		328	656	338			
Tailings Dam Well	6/24/1982	210.4	30.2	0.26	<0.01	265	610				
Tailings Dam Well - After 8 Hours	6/24/1982	268	38.8	0.45	0.19	237	646				
Tailings Dam Well	12/20/1984	117	35	0.11	0.02	168	398				

reports from the early 1970s (sampled by Anaconda) indicated that the samples were unfiltered (total metals analyses). In these cases the concentrations of metals in the water would likely have been heavily influenced by the amount of suspended solids in the sample. Anaconda data from the late 1970s and early 1980s do not indicate whether the samples were dissolved or total.

Elevated levels of arsenic have been encountered in GW-1 and GW-1B (the 6-inch and 16-inch Boys Ranch wells) since testing began in the 1970s. Even though the majority of these samples were unfiltered, there were a few apparently filtered samples, which exceeded MCL standards. RI sampling has indicated that current dissolved arsenic concentrations within GW-1 and GW-1B exceed MCLs. The same tests have confirmed that lead is no longer problematic in any of the wells.

The 1995 DERR study indicated that in addition to metallic elements, the IS&R/Carr Fork site may also be a source for elevated nitrates in shallow Erda wells (Sadik-McDonald, 1997). EPA also stated that the IS&R/Carr Fork site may be responsible for elevated arsenic in wells located in the town of Erda, within Section 35, T2S, R4W (Knight, 2003). In 2000, the USGS installed a triple completion well in this northeastern portion of Erda. The well, referred to as the Price Well, has screened completion zones at 210 ft below surface, 251 ft below surface and 352 ft below surface. Water in the shallow and middle zones of this well have had concentrations of arsenic and nitrate above MCL standards. This well was also sampled during the RI, (see Section 3.13). In order to respond to the EPA and DEQ concerns, the remedial investigation has focused extensively on the historical sources, nature, extent, fate and transport of the elevated arsenic at the Boys Ranch Wells and arsenic and nitrate at the Erda Price Well.

2.15.2.2 Regional Subsurface Hydrology

Logs compiled during installation of area wells generally indicate that the valley-margin deposits are comprised of sand and gravel with varying amounts of silt and clay, while the deposits toward the center of the valley are predominantly silt and clay with sand interbeds. Smaller stream channel and colluvial deposits locally interfinger with the alluvial and lacustrine deposits. The stream channel deposits are typically well sorted and very permeable, whereas the colluvial deposits are poorly sorted and have low permeability. (Wahler, 1975)

Along the bench areas, where the IS&R Smelter site is located, groundwater occurs under water table conditions in the valley margin deposits which consist mostly of alluvial fan and beach material. These deposits thicken rapidly and are very permeable, with transmissivity of up to 60,000 gpd/ft not uncommon. (Wahhler, 1975).

Recharge to area aquifers is primarily by rain and snow falling on the Oquirrh range and subsequently percolating downward through the consolidated rock and alluvial beds into the Tooele Valley. Zones of heavy infiltration are also found at the mouths of the canyons (at the valley margins). In addition, but in a much smaller amount, surface infiltration in the valley itself may provide some recharge to area aquifers. The USGS, in a 1981 study, estimated recharge from direct precipitation along the valley margins to be 3 percent of the annual precipitation falling at these elevations (Razem and Steiger, 1981). Wahler (1975), a hydrologist retained by Anaconda during the development of the Carr Fork facilities, presented data from others that indicated a different conclusion for surface water recharge of the aquifer in the interfluvial portions of the Site. In this report Wahler concluded that direct recharge via infiltration of precipitation was unlikely. Wahler based this conclusion on data from soil samples obtained on the property that had an average moisture content of approximately 8 percent at a depth of 5 feet and field capacities of approximately 17 percent. This moisture deficiency was created as a result of the net negative precipitation regime where evapotranspiration exceeds precipitation by 23 inches annually. Wahler also calculated that the unsaturated zone underlying the property had the retention capacity on average of 60 acre-feet per acre.

Groundwater movement in the valley is primarily horizontal. This is evident from the following information:

- The groundwater elevations collected at area wells indicate that the gradient is fairly steep coming out of the mountains, then becomes flat under the valley floor.
- Groundwater elevations are very similar in wells that are near the Site but are separated by a quarter mile or more.
- The Price Well in Erda has three separate completions at different depths, but the static water surface elevations of the three completions are nearly identical.
- Groundwater collected from various depths within the aquifer have very different water chemistries.

2.15.2.3 Site Subsurface Hydrology

The smelter site is located in the east Tooele Valley groundwater district. The two major historical operational facilities, the IS&R Smelter Site and the IS&R/Carr Fork tailing impoundment, were located on alluvial-fan and lacustrine deposits. In the Carr Fork design documents, Bechtel (1977) described the bulk of the unconsolidated material underlying the tailings area as alluvial fan detritus which consists of crudely stratified, poorly to partly sorted clay, silt, sand and gravel layers. The alluvial material was estimated by Bechtel to be more than 600 feet thick in the vicinity of the tailings. Wahler (1975) presented gravity data which indicated that the thickness of unconsolidated material under the Elton Tunnel portal was approximately 1,800 feet. Wahler also estimated the thickness of alluvium under the smelter site to be approximately 1,400 feet. This is due, in part, to the location of the property on the down dropped sides of two major fault systems which intersect southeast of the smelter (Figure 2-14, Site Geology). The surficial deposits, in the area of the tailings, are comprised of lacustrine fine grained sand with interbeds of silt and gravel. The edge of the beach deposit is located at the base of the bluffs about 2,000 feet to the northwest of the smelter. At this location, the lacustrine deposits have a thin edge and thicken to a depth of about 50 feet under the tailing dam. The alluvial and lacustrine deposits are traversed by the stream deposits of Dry and Pine Creeks.

2.15.2.4 Groundwater Use and Existing Water Rights

Groundwater in the area generally flows from recharge areas along the mountain front towards the west-northwest. Below the former smelter site the water table drops very rapidly as witnessed by the fact that water is 100 ft below the surface at GW-6 and over 600 ft. below the surface at GW-1. Piezometric contours (See Figure 2-23) show the Lincoln area to be downgradient of the Site. The piezometric surface trends toward the surface as the water moves west into the valley. With the exception of a few springs near Erda and range front canyons, extraction of water from pumped wells is the primary water source in the Tooele Valley. In order to evaluate potential receptors, all existing groundwater use within a 3-mile radius of the smelter centroid was investigated. In the downgradient flow direction (west-northwesterly) the radius was extended to four miles. The centroid of the study area is the common corner of Sections 24, 13, 18, and 19 on the range line for Range 3W and 4W in Township 3S (See Figure 2-24).

<u>Regional Water Use</u>

A groundwater data base search at the Utah State Engineer's Office was conducted to identify all registered claims for subsurface water usage within the subject area. This search identified water applications, both approved and unapproved, descriptions, allocations, maximum permitted use, current status and ownership. The subsurface allocations include groundwater diversions from tunnels, springs and wells. The status of each water right was obtained from the data to determine the allocated volumes being diverted, and the potential future quantities. The results of this search are summarized and tabulated in Appendix J. Not all of the approved water rights have been perfected (wells developed), as noted in the status column.

The downgradient specific area of study includes all or portions of 15 sections. Approved allocations within these sections are shown in Table 2-30. A total of 25 cfs, and/or 1,993 ac-ft/yr have been allocated in the sector. In addition to private concerns, this allocation includes water rights to public entities and corporations in the amount of 19 cfs and/or 688 ac-ft/yr. These entities include the following:

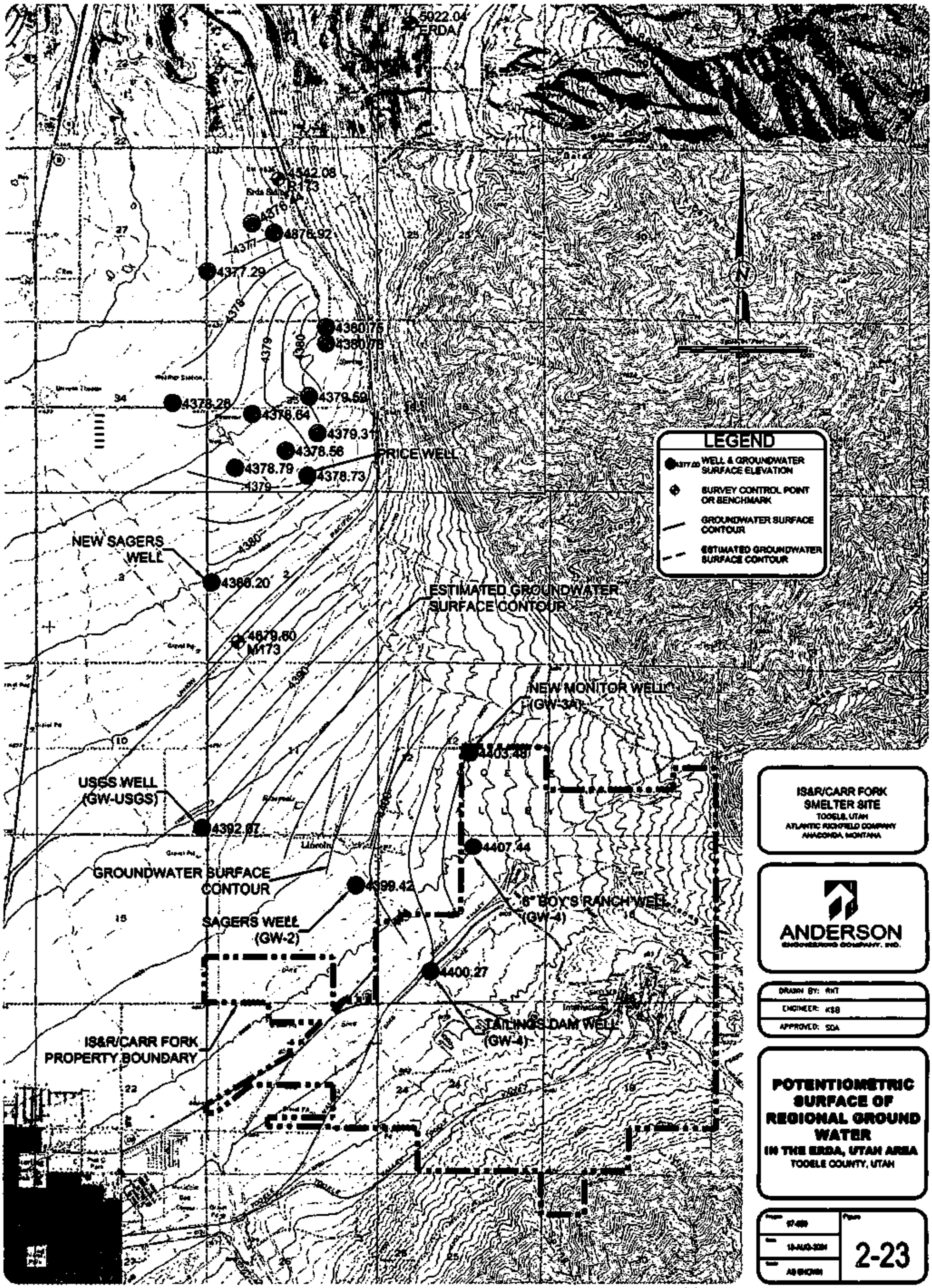
- Tooele City Municipal Corporation
- Stansbury Park Improvement District
- Terracor Inc.
- Eimko Corp.
- Kennecott Utah Copper Corp.

Table 2-30
Specific Area of Study Water Right Allocation Data

Location	**Allocation**		**Water Use**					
Section	**Cfs**	**acre-ft**	**Domestic**	**Stockwater**	**Irrigation**	**Municipal**	**Mining**	**Other**
(C2-4) 34	3.165	630.3	X	X	X			
(C2-4) 35	7.9307	1339.91	X	X	X			
(C3-4) 2	0.015	0.0	X	X	X			
(C3-4) 12	0.0	1.0	X	X	X			
(C3-4) 13 *(Elton Tunnel)***	*12.93*	0.0	X	X	X			
(C3-4) 14	0.0	0.45	X					
(C3-4) 16	1.0	5.0	X		X			X
Total	25.0407	1992.66						

Lincoln Area Water Use

Available water for domestic purposes is the controlling factor for growth in the Lincoln area. The township's residents receive domestic water through the quasi-public Lincoln Culinary Water Company that is owned by the connected water users. Sources for this water are springs and wells located in Murray and Middle Canyons, both upgradient from smelter activity. Currently all available water is allocated to existing land owners with little to no capacity for future development. Also as a result of limited resources the State Engineer's office is no longer approving new



IS&R/CARR FORK SMELTER SITE
TOOELE, UTAH
ATLANTIC RICHFIELD COMPANY
ANACONDA, MONTANA

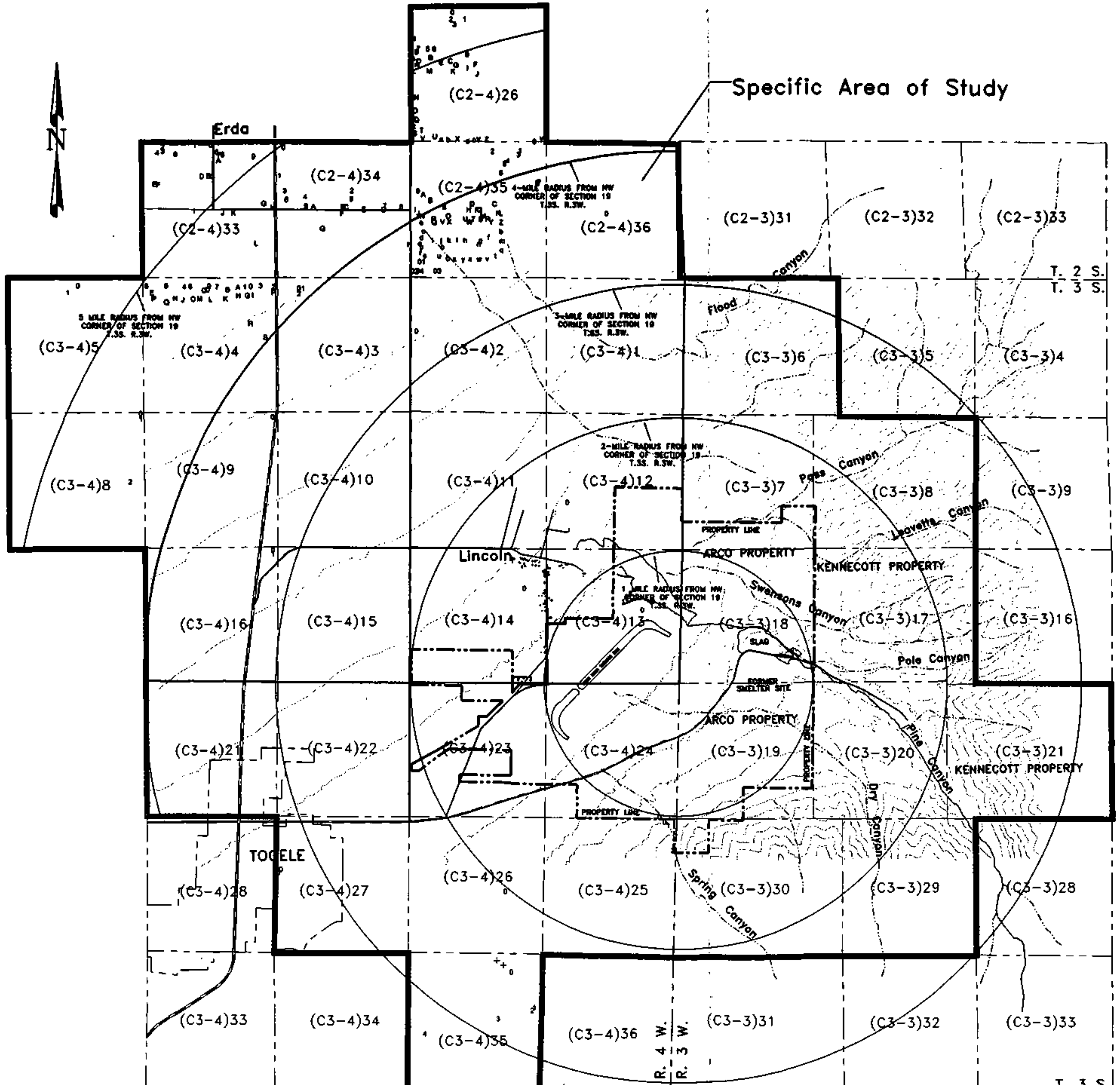
ANDERSON ENGINEERING COMPANY, INC.

DRAWN BY: RHT
ENGINEER: KSB
APPROVED: SDA

POTENTIOMETRIC SURFACE OF REGIONAL GROUND WATER IN THE ERDA, UTAH AREA
TOOELE COUNTY, UTAH

Figure 2-23

AS SHOWN



General Notes

LEGEND

- SECTION LINE
- SECONDARY DRAINAGE
- PRIMARY DRAINAGE
- BOUNDARY LINE
- MEDIUM-DUTY ROAD
- LIGHT-DUTY ROAD
- B GROUND WATER RIGHT POINT OF DIVERSION LOCATION MARKER
- INCLUDED IN WATER RIGHT SEARCH

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

IS&R/CARR FORK

ANDERSON ENGINEERING COMPANY, INC.
977 West 2100 South
Salt Lake City, Utah 84119
(801) 972-6222

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

GROUNDWATER USE INVESTIGATION AREA MAP

REMEDIAL INVESTIGATION

TOOELE, UTAH

Project 97-069
Date 19-AUG-2004
Scale NO SCALE
Figure 2-24

applications for water in the Tooele Valley water basin because of the existing over-allocation of underground resources in the valley (Mann, 2003, also see http://www.waterrights.utah.gov/wrinfo/policy/wrareas/are15.html). There is a possibility for a land owner in Lincoln to obtain approval from the State Engineer to transfer the point of diversion from another existing right within the same water basin. While this option is possible, the probability is limited due to the cost of installing and operating a 500 - 600-ft. deep well. The existing water rights within the Lincoln area are listed in Table 2-31.

Table 2-31
Lincoln Area Water Rights

Water Right	Allocation		Water Use			
No.	cfs	acre-ft	Domestic	Stockwater	Irrigation	Other
a22780 (Ronald Dale) (not installed, not perfected)	0.0	1.0	X	X	X	
15-3719 (GW-2) (Sager's Well) (not perfected; lapsed)	0.0	0.45	X			

2.15.2.5 Smelter Site/Mine Groundwater Discharge

Figure 1-4 provides a time line of dewatering operations conducted by Anaconda at the mines (Apex, Yampa, Rood and Carr Fork).

<u>1909-1938 - Pre-Elton Tunnel</u>

Apparently, little to no water developed within the Pine Canyon drainage passed the smelter during the early years. Howard Clegg, a prominent local resident and rancher who was under contract with Anaconda to manage rangeland and mine de-watering water for several years, indicates that prior to the Pine Canyon Tunnel excavation and subsequent mine dewatering, the IS&R smelter used *"every drop of water"* coming down Pine Canyon. In addition to using Pine Canyon water, IS&R also drilled additional wells above the smelter to meet plant requirements. Early operators also installed a pipeline from Pass Canyon to the smelter to collect and deliver Pass and Leavitt's Canyon water to the smelter. (Clegg, 2002) This information is consistent with existing physical features in the canyon where a small reservoir (sometimes referred to as the Fish Pond) collects spring water. Water which collected in the reservoir was pumped to the smelter for plant operation. Also still visible is the route of the pipeline from Pass Canyon along the hillside.

There is no record of water between 1909 and 1937 being released for irrigation or other uses downstream from the smelter. The point and quantity of plant discharge, other than the tailings ponds if any, from the plant is not known.

1937-1950 - Mine De-watering through Elton Tunnel

Ore that supplied IS&R came from a variety of mining operations scattered throughout the region. Shortly after operations began IS&R began acquiring mining reserves in the area that could supply a consistent grade of ore to the smelter. Five companies in which Anaconda had a partial interest were consolidated and became known as the National Tunnels and Mines Company. This company started construction of the 27,000-foot long Elton Tunnel in 1937 and continued construction on the tunnel until 1941 when the underground mine workings accessed from the Apex shaft were intercepted. (Dunlavy, 1986, Ch. 18) Prior to the Elton Tunnel encountering the workings in 1941, an outlet from the Apex to the Tooele side of the mountain did not exist. Earlier, ore was transported from the Apex and other local shafts on a cable tramway over the top of the mountain. The Elton tunnel provided a conduit for transporting ore, equipment, personnel and a means of dewatering the mine workings. The tunnel was utilized for several years until it became unusable due to unstable and collapsing conditions during the 1950s. Water discharge from the tunnel had principally two sources, mountain rock that most of the tunnel was driven through, and mine dewatering flow entering the tunnel at its upper end.

"Water flow from the tunnel increased from 217-gpm in January 1938 to 5,329-gpm on December 8, 1939. On June 15, 1941, the flow was 5,803-gpm due to tapping the Apex mine 2,500' level with diamond drill holes from the Elton Tunnel which is about 30 feet above the 2,500' level at this point. Caving of the tunnel began in 1950. By December 1, 1954, the flow was 70-gpm after numerous caving problems in the tunnel." (Letter from J.F. Dugan to F. A. Wardlaw, Anaconda, 12-14-52)

Table 2-32 contains flow measurements at the Elton Tunnel portal. The author of the 1938 -1945 information is not known; however, the records appear to be generally consistent with other references to flows discharging from the tunnel.

Table 2-32
Elton Tunnel Discharge Flow Quantities
Handwritten note entitled Water Flow out of Portal Elton Tunnel (gpm)
(no date)

Year	January 1	July 1
1938	217	856
1939	472	801
1940	5257	4312
1941	4041	4306
1942	3021	2959
1943	2595	2143
1944	8104	3145
In a letter from J. F. Dugan to F.A. Wardlaw, Jr. entitled "Discharge over Outside Weir from January 1, 1945 to August 1, 1947, and also August 1, 1947 to December 1, 1954" additional Elton discharge information is provided.		
Year	**January**	**July**
1945	2252	2543
1946	2145	2535
1947	2298	2536
1948	2298	2298
1949	2298	2298
1950	2298	1958
1951	2298	2065
1952	1950	1398
1953	720	605
1954	500	435
Note: Values are averages of the selected monthly readings		

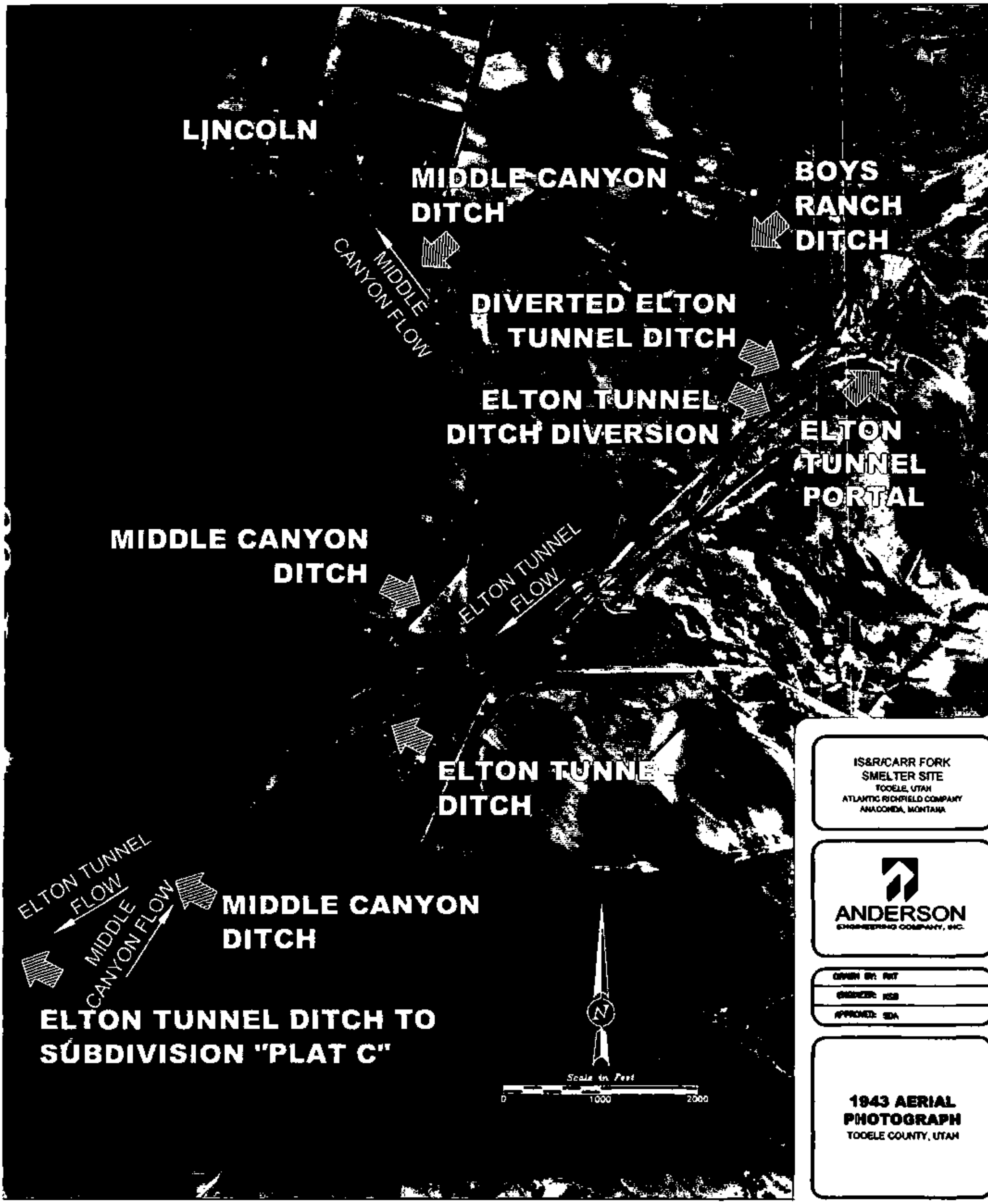
Downstream uses - Elton Tunnel Discharge: In the 1943 aerial photograph (see Figure 2-25) Elton Tunnel water flowing towards Tooele is evident. Howard Clegg recalls that after the initial high flows from the flooded Apex mine, all of the water coming from the Elton Tunnel was directed south through a new ditch to the "Plat C" Subdivision. This subdivision was constructed in Tooele by IS&R for workers and their families. Tunnel water was used to irrigate yards and gardens. When flows were greater than what could be used in the subdivision (flow >2000 gpm) and during winter months, the water was diverted back to the Lincoln area through the Elton Tunnel ditch diversion (indicated on Figure 2-25).

At times "poor water" (see Water Quality discussion below) was "diverted from the irrigation systems that normally used the water." (McArthur and Botz, 1971). The report does not further define where the water was diverted to, however, in the 1943 and the 1950 aerial photograph (see Figure 2-26) show that the aforementioned Elton Tunnel ditch diversion was likely used for this purpose. The photo also shows a dike constructed across the Pine Canyon drainage along the west property line. This dike likely was used to retain water allowing settlement and seepage into the ground, minimizing sediments and water released to the north. Another pond east of the Elton Tunnel waste rock pile can also be seen in the photo which may have also been used for the same purpose.

Howard Clegg recalls (and the photograph supports his recollection) that the excess water and at times winter flow was discharged onto the Boys Ranch property and fields north in Section 12. Clegg recalls water quickly infiltrated into the ground and does not recall ever observing water ponding north of the Union Pacific Railroad tracks in Section 2.

The Certificate of Appropriation issued for 12.93 cfs in 1933 by the Utah State Engineers office allowed irrigation with water discharging from Elton Tunnel ditch on Sections 11, 12, 13, 14, 22, 23 T3S R4W. 995 irrigated acres are included in the appropriation. (Certificate of Appropriation of Water, State of Utah Cert. No. 4883 for 12.93 CFS.) Figure 2-27 (1971 aerial photograph) shows the appropriated irrigated areas. The approximate centroid of this irrigated land is the east 1/4 corner in Section 11, Section 35, T2S R4W. The appropriated area is considerably larger than the area actually irrigated based on aerial photographs taken during the release of water. The hatched area on Figure 2-27 illustrates the probable irrigated areas.

<u>Elton Tunnel - Water Quality</u>: The Elton Tunnel was constructed as a service and dewatering tunnel for the Apex, Yampa and other underground shafts. As stated above, water discharged from the tunnel was used for irrigation in the Lincoln and Tooele area or infiltrated into the ground. Detailed water quality records from the tunnel discharge are limited as a result of the mudslide, which destroyed the Carr Fork office in 1984. Research indicates the tunnel produced water from both the front range and from the mine workings. Flow records as shown above denote water discharging from the adit before tunnel excavation intercepted the Apex mine workings in June 1941 (see Table 2-32). This infiltration of clean water into the tunnel would have tended to dilute and help neutralize any poorer quality mine water that entered the tunnel. In a memo from J.D. Moore to Clark Wilson of Anaconda, Moore states, "*the pH (of the water from the Elton Tunnel) varied widely from about 4.6 to 7.9 with many readings in the 5 to 7 range.*" This is similar to the Apex shaft water quality information that was generated during dewatering the same shaft in the 1971 to1972 time frame. The Elton Tunnel water was essentially from the same mine area as water later pumped from the Carr Fork mine by Anaconda and would therefore have a similar chemistry and water quality. In both cases, initially there



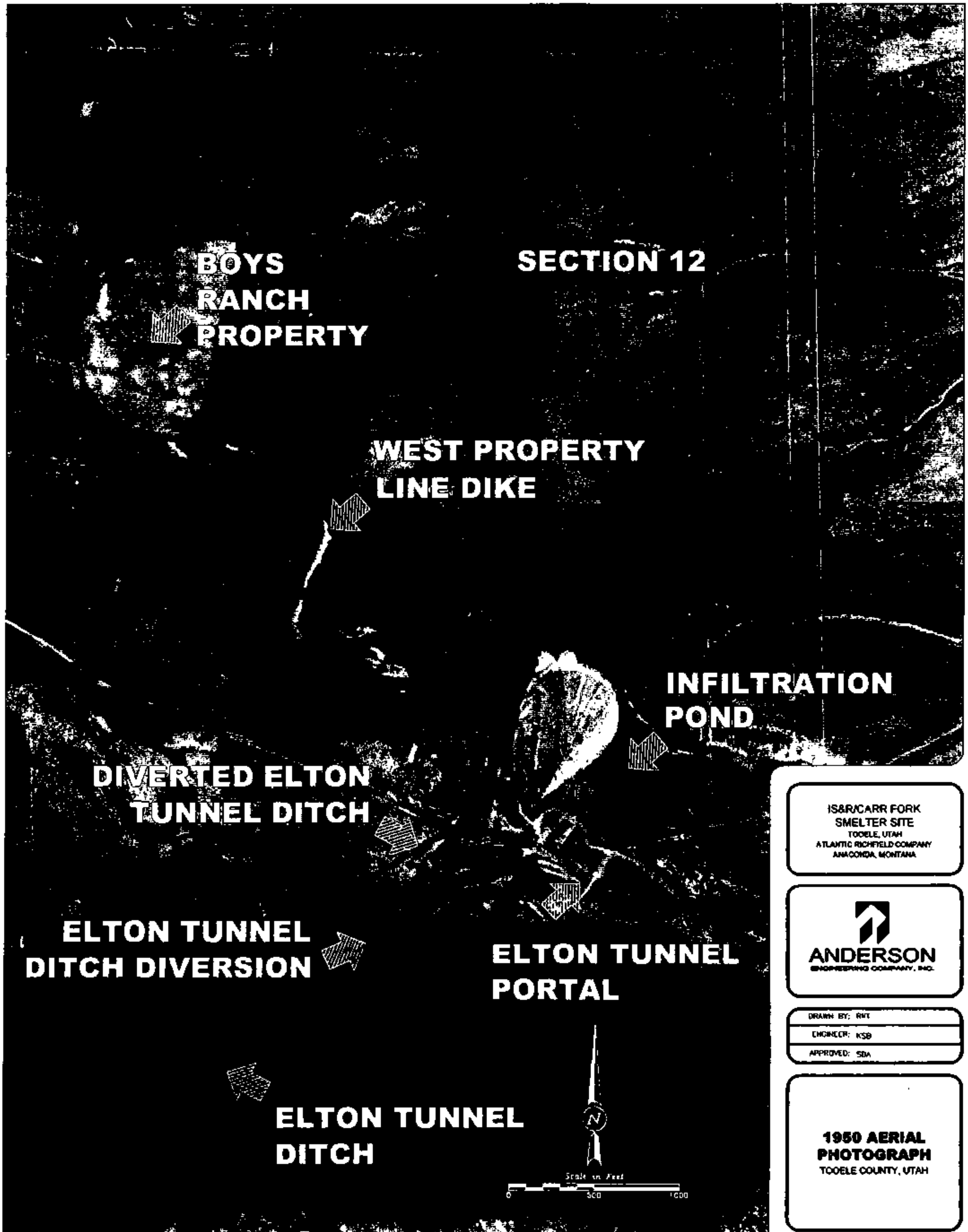
IS&R/CARR FORK SMELTER SITE
TOOELE, UTAH
ATLANTIC RICHFIELD COMPANY
ANACONDA, MONTANA

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY:	RKT
ENGINEER:	KSB
APPROVED:	SDA

1943 AERIAL PHOTOGRAPH
TOOELE COUNTY, UTAH

Project 97-069	Figure
Date 18-AUG-2004	2-25
Scale AS SHOWN	



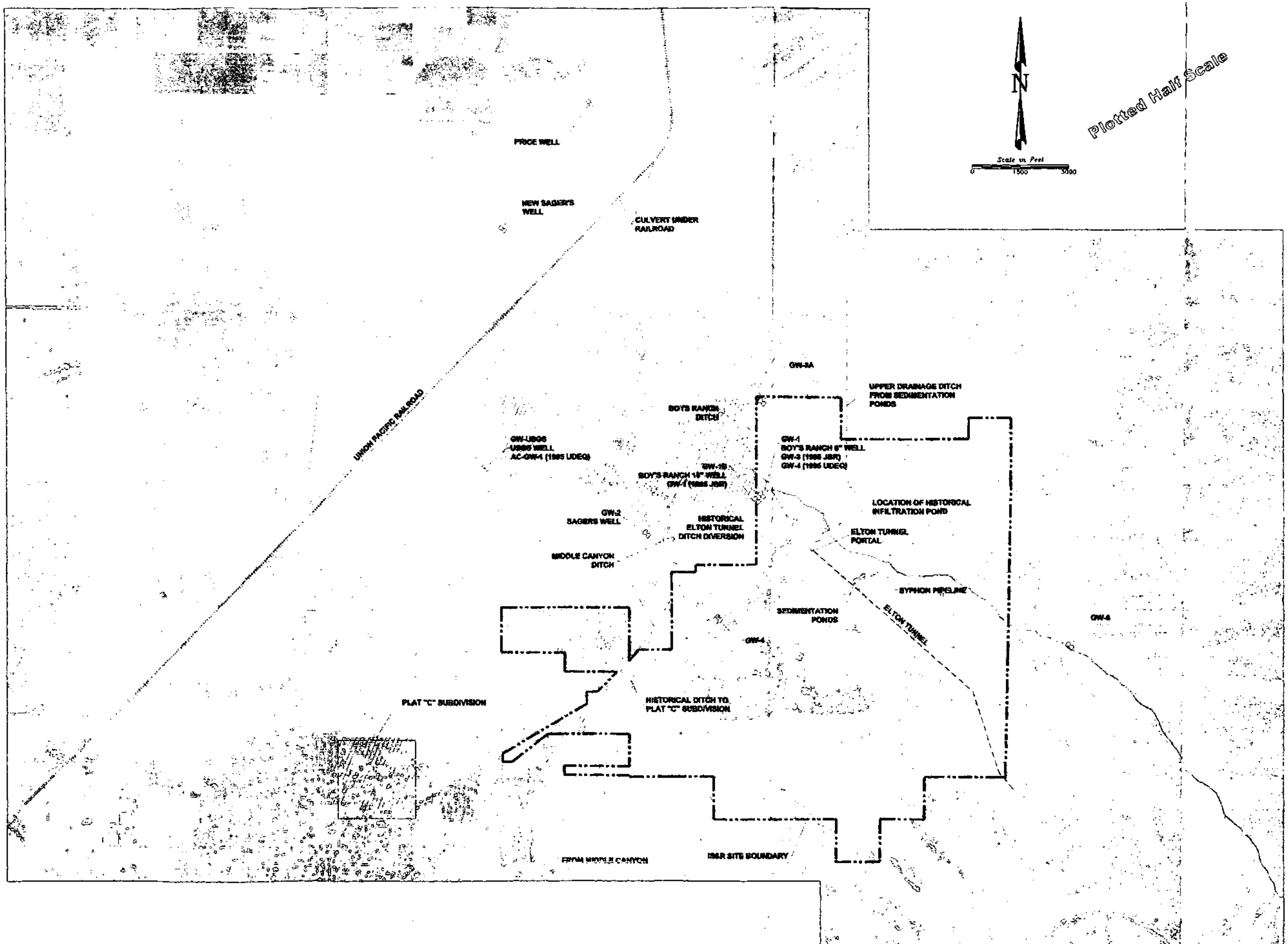
IS&R/CARR FORK
SMELTER SITE
TOOELE, UTAH
ATLANTIC RICHFIELD COMPANY
ANACONDA, MONTANA

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: RMT
ENGINEER: KSB
APPROVED: SDA

1950 AERIAL PHOTOGRAPH
TOOELE COUNTY, UTAH

Project 97-069	Figure
Date 16-AUG-2004	2-26
Scale AS SHOWN	



General Notes

LEGEND

- GROUNDWATER WELL LOCATION
- AREAS APPROPRIATED FOR IRRIGATION WITH ELTON TUNNEL WATER
- AREAS IRRIGATED WITH MINE DISCHARGE ACCORDING TO TEMPORARY CHANGE APPLICATION 60.47 (3/31/80)

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

TOOELE, UT

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

1971 AERIAL PHOTO

REMEDIAL INVESTIGATION
IS&R/CARR FORK SITE
TOOELE, UT

Project: 97-069
Date: 18-AUG-2004
Scale: AS SHOWN
Figure: 2-27

was a high volume discharged as water stored in the mine was drained, followed by a discharge of lesser volumes. The initial flows of stored water discharged from the Elton Tunnel, originating in the Apex and Rood shafts, likely contained lower pH and higher COC than at later times. This hypothesis is supported by the March 1975 Whaler and Associates report on the Carr Fork Mine Water Management Plan wherein it predicted the Carr Fork mine water quality based on records of Elton Tunnel water quality analytical results. The author of this report states that after the initial pumping, the Carr Fork mine water quality would become similar to that last monitored at the Elton Tunnel. The report goes on to reference results shown on Table 2-33.

Table 2-33
Chemistry of Elton Tunnel Discharge - 1952

Parameter	Concentration (mg/l)
pH	7.0
TDS	800.
Sulfate	300
Copper	<0.2
Iron	<0.2
Arsenic	<0.03
Calcium	110
Magnesium	40
Lead	<0.1
Zinc	<0.2
Manganese	1
Cadmium	<0.02
Silver	<0.05
Chloride	25
Fluoride	<4
Nitrate	<1.5
Phosphate	<0.8

During the Carr Fork mine dewatering, it was observed that the arsenic in the discharge coprecipitated with iron oxide a result of the oxygenation which occurred as the water flowed down the open channel. Since both dewatering systems, Carr Fork and Elton Tunnel discharge, drained water from the same mine and orebody, arsenic and other metals in the Elton Tunnel discharge also would have precipitated as the water flowed down the open air tunnel.

<u>1958-1971 - Water Pumped to Bingham Canyon</u>

After the collapse of the Elton Tunnel in the late 1950s all excess mine water was pumped through the Parvenu level to the Bingham side of the Oquirrh Mountains. At some point during this period the mine was allowed to flood until a pumping program began again in May 1971. Pumped water generated during this period was discharged to the Bingham side of the mountain through the Parvenu adit. Pumping of the workings was discontinued on September 1, 1971 presumably allowing the mine to flood once again.

"*Pumping from Apex shaft through the Parvenu tunnel was discontinued September 1, 1971. Reason – the Kennecott reservoir which held 528,000 gallons had reached 350,000 gallon September 1 and Kennecott wanted to retain capacity for runoff water.*" (Memo from E.R. Dunford 10-14-71)

<u>1972 - Carr Fork Pump Test Pine Canyon Tunnel Discharge</u>

In May of 1972, upon completion of the Pine Canyon Tunnel, Anaconda conducted another pump test. Water from this test was channeled down Pine Canyon into holding basins and seepage ponds.

"An existing tunnel leading due west from the Parvenu Tunnel – Apex 1000 level station crosscut will be extended approximately 4,000 feet through quartzite to Pine Canyon. This tunnel will serve several purposes including access to the Apex and Yampa shafts on the Parvenu Tunnel level. It will also supplement ventilation requirements for development of the Apex Shaft. Its primary purpose however, will be to provide a means for disposal of Apex water to the Tooele Valley side." (Memo from JD Moore, 9-20-71)

T.H. Dudley explains in a memo how the discharge water was handled. *"Pumping to discharge through the Pine Canyon Tunnel started May 27, 1972. Prior to that date, facilities had been completed or were under construction at that time to handle the water on the Tooele side of the tunnel. These consisted of four settling ponds with inlet and outlet canals below the Tooele smelter and a series of settling ponds extending up Pine Canyon from a point above the smelter reservoir.*

The system below the smelter consists of four ponds with a total area of just under four acres. These ponds can be individually fed from a canal connecting with the Pine Canyon drainage and the effluent is collected in a second canal which drains north.

The settling ponds in Pine Canyon are formed by dikes extending across the canyon with the upper dike receiving the tunnel discharge. A system of inlets and outlets allows the effluent from the upper pond to flow downstream through the ponds in series. There are 23 of these ponds in the system. At the present time, the tunnel discharge is all being handled in the upper part of the system. Five of them are full and in normal operation. Two more *have nominal amounts of water which they receive by seepage from the pond above."* (Memo from Dudley, 8-1-72)

This memo indicates that little if any mine water from the 1972 pump test (May 27, 1972 to September 19, 1972) was discharged to the irrigation system, although some water was apparently discharged from the settling ponds at monitoring Point "I" (combined effluent from settling ponds in lower Pine Canyon). This sample point is referred to as the Boys Ranch ditch in some of the laboratory reports and the "Seepage Pond Outlet" in others. Arsenic concentrations for this monitoring location in the period of 1972 through 1973 ranged from 0.00 to 0.281 mg/l and averaged 0.075 mg/l. There is no description in the files of how much water this effluent represented and where it was disposed of. According to Howard Clegg, the majority of the water released from the settling ponds during the 1972 pump test was discharged into an infiltration ditch which ran diagonally across Section 18. Water released into the Boys Ranch ditch would have been infiltrated over the Boys Ranch which was apparently controlled by Anaconda at the time for the purpose of water disposal. The Boys Ranch Ditch samples were most likely taken at the outlet of the Settling Ponds. The highest arsenic concentrations (0.240 - 0.281 ppm) occurred during the winter months in 1973, well after the pump test was completed so the amount of water being handled was likely small, and probably seeped into the ground before leaving the property. The ditch which took effluent from the lower seepage ponds to the north across Section 18 can be seen in the 1971 aerial photo (see Figure 2-27). This ditch was constructed in the early 1970s exclusively for the purpose of water disposal.

Carr Fork Pumping Test - Water Quality: Water quality testing samples collected early in the Carr Fork (Apex shaft) dewatering (1971) showed the water to have elevated concentrations of dissolved iron, arsenic, copper, lead, zinc, manganese, sulfate and other constituents. Lab and field experience indicated the mine water increased in pH after being brought to the surface through the apparent off-gassing of CO_2, throwing off an iron precipitate that co-precipitated the arsenic. Simple aeration and clarification of the mine water was shown in pilot tests to reduce arsenic concentrations from 1.12 mg/l to 0.028 mg/l, a 97.5 percent reduction, while iron concentrations were reduced by over 99 percent. Concentrations of the other metals were also decreased. This testing also showed that more aeration of the water resulted in further reductions in dissolved arsenic concentrations until these levels reached analytical detection limits. Test data and operational reports in the files indicate that all Carr Fork mine water discharged to Pine Canyon was aerated by its flow down the water handling works in the canyon and clarified in settling ponds before being discharged for use in irrigation. Intentional aeration of mine discharge was specifically meant to improve the water quality and is mentioned in various documents leading up to the operation of the Carr Fork mine facilities. Also, during this period, before being discharged from the tunnel opening, the mine water was treated with lime in a series of underground sumps to make sure that low pH water was not discharged from the Pine Canyon Tunnel (Eurick, 2002).

1972 - 1976 No Pumping

No pumping activities are known to have occurred during this period. During this period the Carr Fork mill was constructed and other planning completed for a project start-up in early 1976.

1976 - 1985 - Carr Fork Mine Drainage and Use

The Carr Fork mine workings had been allowed to flood after the 1972 pump test. Approval to dewater the Carr Fork mine and dispose of the water on irrigated fields was received from the Utah Bureau of Water Quality in February 1975. Dewatering was to commence in April 1975, however, actual pumping and dewatering of the Carr Fork mine began in May 1976 and continued until the pumps were shut off in February 1985. Under normal operating conditions during this period, water flowed down the Pine Canyon drainage, into the settling ponds and then was released to downstream irrigation users.

During this period, farmers in the area requested and were allowed to use excess water from the settling pond discharge. Water from the settling ponds in the SW/4 of Section 18 would drain northwest to the "diversion point" near the mid-point of Section 13 where the stream would be split. One reach (Northern Reach) would continue diagonally northwest to the mid-point of the section line between Sections 12 and 13. From this point the water ran north along the mid-line (north-south) in Section 12 (Boys Ranch ditch), terminating ¼ mile from the north boundary of Section 12.

From the "diversion point" the other reach (Western Reach) would run southwesterly across Section 13 and generally follow the section line between Sections 14 and 23 in a westerly direction terminating at the western boundary of Section 14 (southwest corner of Section 14).

The planned irrigation areas were described as follows (See Figure 2-27):

Section 11 T3S R4W: Total 510 acres
NE ¼ 160 acres
NW ¼ 160 acres
SW ¼ N/2 80 acres
SW/4 40 acres
N/2 SE/4 20 acres
SE ¼ irregular distribution 50 acres

Section 12 T3S R4W: Total 240 acres
SW ¼ 160 acres
NW ¼ S/2 80 acres

Section 13 T3S R4W: Total 70 acres
NW ¼ NW/4 40 acres
SW ¼ NW/4
SW/4 30 acres

Section 14 T3S R4W: Total 530 acres
NW ¼ 150 acres
SW ¼ 160 acres
SE ¼ N/2 SW/4 120 acres
NE ¼ NW/4 and SW/4 and SE/4 100 acres

In 1980, a change application for water rights showed Carr Fork mine water being used to irrigate 1,599 acres of land in T3S R4W as follows:

Section 1 T3S R4W: Total 240 acres
SW ¼ and S/2 of the SE ¼

Section 11 T3S R4W: Total 639 acres
Entire section except fraction northwest of UPRR tracks

Section 12 T3S R4W: Total 640 acres
Entire section

Section 10 T3S R4W: Total 80 acres
E/2 of the SE ¼

The one major exception was from June 1984 until the pumps were shut off, when mine drainage, to prevent downstream flooding, resulting from heavy rainfall combined with mine discharge, was directed into the tailing ponds and not released for irrigation. (Garmoe, 1985).

In the Mine Water Management Plan written by Wahler and Associates in 1975, it was assumed that consumptive use of the irrigation water for growing alfalfa would be 29.4 inches per year.

By applying water evenly over 1,000 acres, 2,454 acre-feet of irrigation water could be consumed each year. The planned mine dewatering rate for the first two years was 4,647 acre-feet in the first year and 3,005 acre-feet in the second. The excess water in the first year would then be 2,193 acre-feet and 551 acre-feet in the second year. This excess water would be allowed to infiltrate at the same fields and be stored in the vadose zone.

During the rest of the 23-year mine life, another 21,250 acre-feet of water was planned to be removed from the mine. Of this amount, 60 percent was assumed to be consumed in future irrigation leaving 8,500 acre-feet of excess water to dispose of during the mine life.

The report indicated that the vadose zone in the vicinity of Lincoln averages 500 feet thick. Samples of this material were obtained and tested to show that the field capacity ranged from 16.9 to 42.9 percent by volume(v) and existing field moisture ranged from 3.7 to 12.7 percent (v). The difference between these values was termed their "moisture deficiency" and ranged from 9.1 to 39.2 percent (v). The authors of the report assumed a very conservative average moisture deficiency of 4.5 percent (v) for the study.

Based on the assumption that the excess mine water not consumed by irrigation would be evenly spread over 1,000 acres and underlain by a 500-foot thick vadose zone having an average moisture deficiency of 4.5 percent, the report indicated this unsaturated zone could store 22,500 acre-feet of water without percolation to the water table.

The Wahler report indicated that the 22,500 acre-feet storage capacity in the vadose zone could hold all the excess water that would be produced during the initial two years of mine dewatering (3,500 acre-feet) and all the remaining excess water that would be produced during the 23-year life of the mine (8,500 acre-feet) leaving 10,000 acre-feet of excess storage capacity in the vadose zone.

Four monitor wells, 175 to 210 feet deep, were drilled in or around the year 1972 downgradient from the settling ponds. The wells were drilled for the purpose of gauging the moisture in the unsaturated vadose zone. None of the wells encountered water during drilling nor did later monitoring indicate saturated conditions. The wells were labeled Q, R, S, and T (See Figure 2-28). The current monitor well GW-3A was drilled within 15 feet of well T.

While it is possible and probably even likely that a portion of this water did find preferential routes to the aquifer, a large percentage would have been stored within the unsaturated vadose zone. The

ATLANTIC RICHFIELD COMPANY IS&R/CARR FORK	**IS&R/CARRFORK REMEDIAL INVESTIGATION** **1978 AERIAL PHOTOGRAPH** **FIGURE 2-28**	ANDERSON ENGINEERING COMPANY, INC.	DRAWN BY: CNF PROJECT: 97-069

limited water that did infiltrate would still be at least 1-3 miles from the Price Well and based on modeling completed during the RI (Section 2.15.3.2) would not flow through the Price Well, as further confirmed by geochemical evolution calculations (Section 2.15.4.5).

The Carr Fork environmental manager, Glenn Eurick, sketched a map in 1980 indicating the potential flow path of mine discharge water (Figure 2-29). From this map it appears that most of the Carr Fork Mine water was consumed by irrigation in Sections 12 and 11 during the growing season. It can therefore be assumed that during at least 6 months of the year, that mine water was spread on irrigated fields in and south of Sections 11 and 12. This area is more than 1-1/2 miles south of the Price Well. During the winter, it was Anaconda's intent to dispose of mine irrigation water by spreading the water on the same irrigated fields. The 1981 map shows that Carr Fork Mine water during the extreme wet years of the early 1980s flowed from Section 12 into Section 2 up gradient of the railroad grade, but only small quantities flowed past the railroad grade (less than 5 gallons per minute). According to Eurick the 1981 map was sketched specifically to trace the extent of flow from a large storm event (Eurick, 2002). The drawing shows that even under extreme flood events only a very small quantity of mine water made it to the railroad grade culvert.

Carr Fork Mine Dewatering - Water Quality: Water quality monitoring was conducted at the Pine Canyon tunnel adit, and at the inlet and outlet points of the settling ponds at the base of the canyon. Arsenic results of this monitoring are shown in the following table:

Table 2-34
Average Arsenic Concentrations in Carr Fork Mine Water Handling System (mg/l)

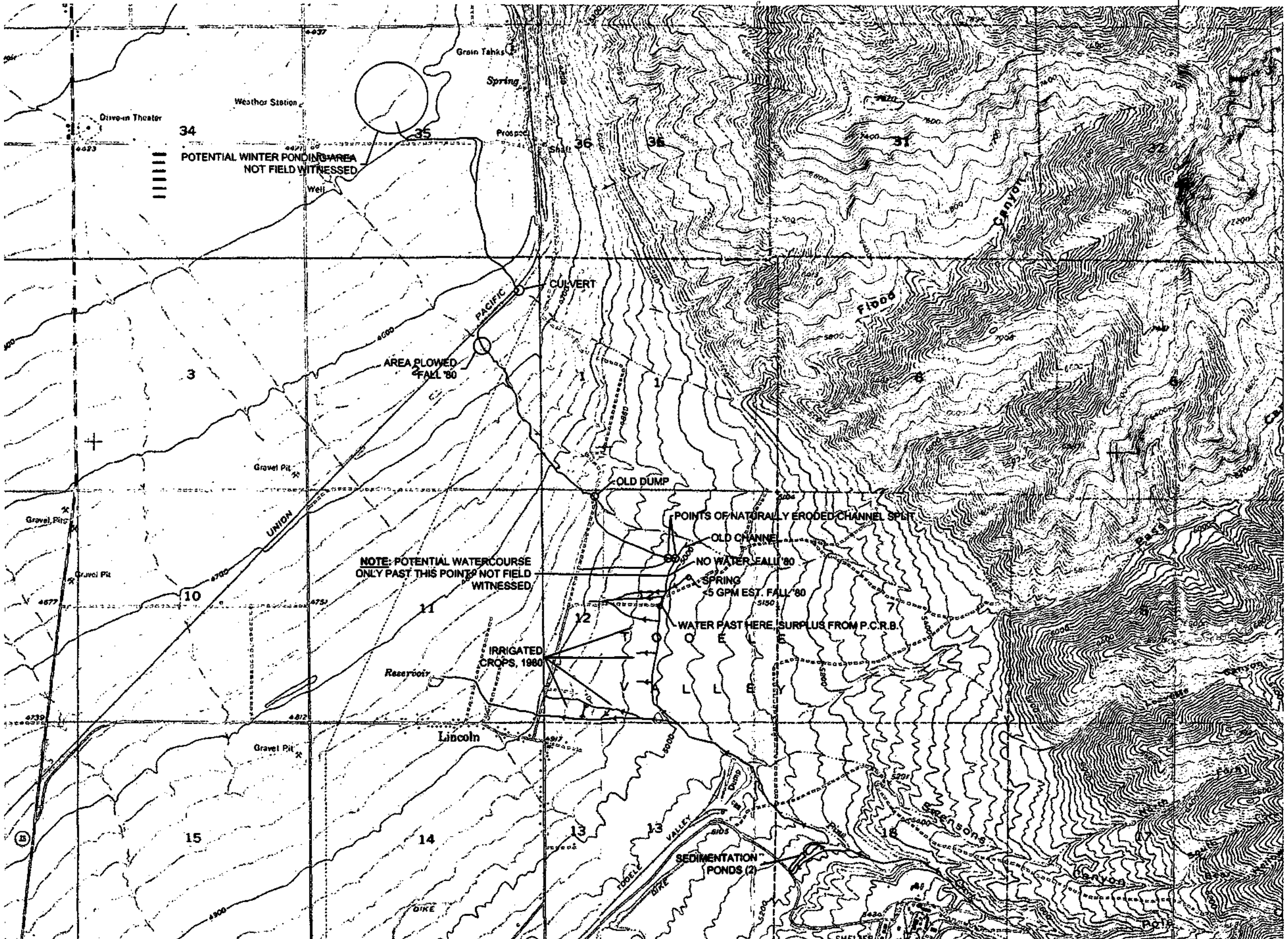
Year	Pine Canyon Tunnel	Pond Influent	Pond Effluent	Pond Effluent Standard Deviation	Number of Samples
1976	0.197	0.005	0.003	0.00179	187
1977	0.08	0.003	0.003	0.00215	363
1978	0.035	0.004	0.003	0.00335	91
1979	No data	0.005	0.006	0.00534	69
1980	No data	0.004	0.003	0.00283	20
1981	No data	0.004	0.003	0.00128	9
1982	No data	0.062	0.006	0.00171	4
1983	0.097	0.062	0.025	NA	1
1984	0.16	0.03	0.001	NA	1

This data illustrates the significant effect the arsenic co-precipitation had as the water traveled between the top and bottom of Pine Canyon. Clarification of the mine water in the settling ponds further reduced the arsenic concentrations in the pond influent water. Over the entire 1976 to 1984 period the average arsenic concentration of the settling pond influent was 0.007 mg/l and 0.003 mg/l in the pond effluent. The table also illustrates the standard deviation and the number of Pond Effluent samples.

The historic monitoring information confirms that annual average arsenic concentration in the water samples obtained from the outlet of the settling ponds was low, ranging from 0.001 mg/l to 0.025 mg/l. The 1983 0.025 mg/l measurement is unusually high and is only one grab sample so is not likely representative of average 1983 water discharge from the settling ponds. Whereas, the 1976 – 1984 average arsenic concentration at the settling pond outlet was 0.003 mg/l. This mean is based on a total of 745 samples which is a significant data set. The short term fluctuations in these concentrations are likely due to differences in aeration and settling efficiencies of the water handling works.

Nitrate concentrations in the effluent were likewise very minimal having an average concentration of 3.35 ppm during dewatering operation at the Carr Fork mine (see Table 2-35).

In conclusion, there is historical documentation that mine water was discharged for infiltration into the fields northwest of the Site (Sections 11 and 12) during several periods of time. These time periods include the Elton Tunnel dewatering during the 1940s and the Apex shaft dewatering during the late 1970s. Minimal water quality data is available for the Elton Tunnel water; however, since the tunnel dewatered the same mine workings as the later Apex shaft dewatering, the water quality is considered to be similar. Extensive monitoring of the settling pond effluent indicates that the water had low average arsenic and nitrate concentrations (As = 0.003 ppm and NO_3 = 3.35 ppm).



General Notes

BACKGROUND MAP: USGS BINGHAM CANYON AND TOOELE QUADRANGLE MAPS.
CONTOUR INTERVAL SHOWN: 40'
MAP CURRENT AS OF 1975

No.	Revision/Issue	Date

ATLANTIC RICHFIELD COMPANY

ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: CNF
ENGINEER: KC
APPROVED: SDA

APPROXIMATE SUMMER MINE WATER FLOW ROUTING DURING IRRIGATION SEASON
(1980)

Project: 97-069
Date: 08-AUGUST-2002
Scale: NO SCALE
Sheet: FIGURE 2-29

Table 2-35
Average Nitrate Concentrations in Mine Discharge Water (mg/l)

Year	Pond Effluent	Pond Effluent Standard Deviation	Pond Effluent Max	Pond Effluent Min	Number of Samples (Pond Effluent)
1972-Pump Test	2.57	1.85	4.70	1.50	3
1972-After Pump Test	No Data	No Data	No Data	No Data	No Data
1973	2.28	0.61	3.89	1.70	11
1974	9.8	N/A	9.80	9.80	1
1975	No Data	No Data	No Data	No Data	No Data
1976	2.45	1.32	5.65	1.20	17
1977	2.61	0.76	5.00	1.43	26
1978	3.50	1.48	5.64	1.70	11
1979	4.82	2.43	9.58	0.64	41
1980	2.99	1.29	4.92	0.86	8
1981	3.71	0.81	4.80	2.15	9
1982	1.55	1.05	2.89	0.59	8
1983	0.21	N/A	0.21	0.21	1
1984	0.99	N/A	0.99	0.99	1

2.15.3 Groundwater Modeling

2.15.3.1 Base Model

Based on potentiometric contours, water beneath the IS&R site generally flows in a west-northwesterly direction towards the Great Salt Lake. Recharge flow originating in the Oquirrhs in this northeast part of the valley is bounded by the bedrock Oquirrh mountain interface on the east and on the south by a groundwater mound formed by the much greater annual recharge at the mouths of Settlement and Middle Canyons.

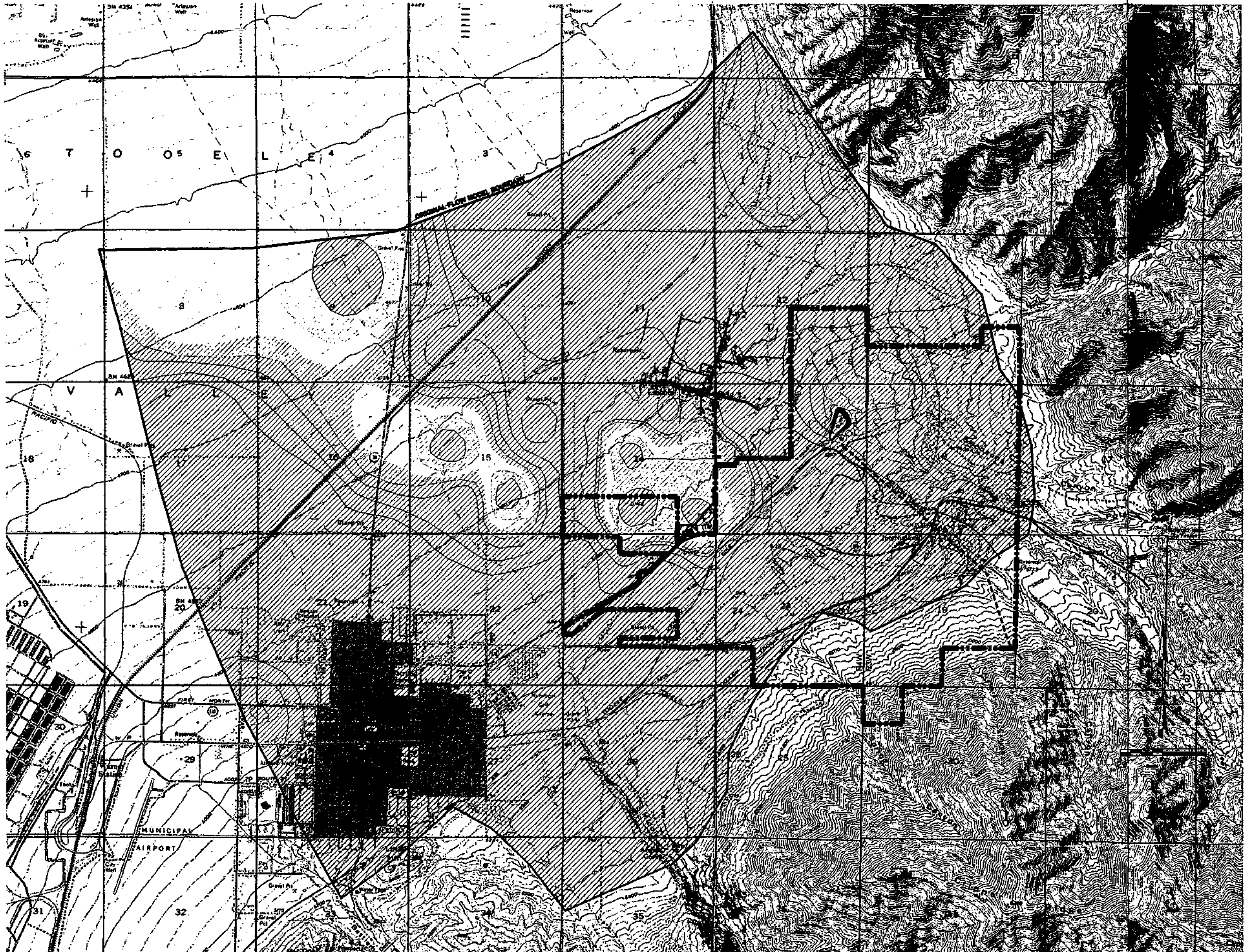
In November 2002 an updated potentiometric contour map was created from field surveys completed on eight area wells including six smelter site wells and two additional wells down gradient of the Site. Figure 2-23 illustrates the results of this most recent update. Using the piezometric head data, groundwater modeling was conducted to help better understand groundwater movement down gradient from GW-1 (Boys Ranch Well). Model development was conducted in close coordination with representatives of the USGS who had completed a previous numerical model in Tooele Valley (Lambert and Stolp, 1999). The USGS numerical model code MODFLOW was used to construct a 1-layer, steady-state flow model of the unconfined aquifer in the Tooele-Lincoln area. Head values within the model were based on the measured water levels at wells within the model domain.

The aquifer parameters were similar to the second layer of the previous USGS model for Tooele Valley. A specified flux boundary similar to that used by the USGS was used at the south and east sides of the model to approximate recharge from the Oquirrh Mountains (3,200 acre-ft/yr from Pine Creek; 5,000 acre-ft/yr from Middle Canyon; and 6,000 acre-ft/yr from Settlement Canyon). A grid size of approximately 250 feet square was used to better discretize the model area, compared to the 1,000 foot cells used in the previous USGS model. A parallel flow boundary was used along the west side of the model and a specified head boundary was used along the north side of the model (4376 ft). The model was calibrated by adjusting the horizontal hydraulic conductivity until the root mean square of the residual (difference between the measured head and the modeled head) was less than 0.5 feet and a specific horizontal hydraulic conductivity field was established for the model domain. Table 2-36 shows the comparison of the measured heads versus the modeled heads. Figure 2-30 shows the calculated hydraulic conductivity zones and values.

Table 2-36
Measured vs. Modeled Heads (ft)
Original Model

Well Identification	Measured Head	Computed Head	Residual
New Sagers Well	4380.7	4380.79	0.093
1000 N 520 E	4393.0	4393.39	0.381
Rodeo Ground	4461.4	4460.72	-0.680
West of Lincoln GW-USGS	4393.6	4393.87	0.309
Tailing Dam Well GW-4	4401.5	4401.77	0.223
NW property corner GW-3A	4403.3	4402.72	-0.599
Sagers Well GW-2	4400.9	4400.81	-0.112
Boys Ranch Well GW-1	4409.4	4408.5	-0.903
Mean Error		0.1597	
Mean Absolute Error		0.4138	
Root Mean Squared Error		0.4942	

In order to determine the pathway groundwater would travel in the vicinity of GW-1, particle tracking was simulated using the hydraulic model. There is no known point source for the arsenic in groundwater in the vicinity of GW-1, but it is known that arsenic was a byproduct from the smelting of sulfide copper ore. Three potential sources upgradient from GW-1 were investigated during



General Notes

HORIZONTAL HYDRAULIC CONDUCTIVITY in ft/day

320.0
280.0
240.0
200.0
160.0
120.0
80.0
40.0
0.0

No.	Revision/Issue	Date

Atlantic Richfield Company

IS&R
Tooele, UT

ANDERSON
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DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

BASE MODEL HORIZONTAL HYDRAULIC CONDUCTIVITY IN FT/DAY

SOUTHEASTERN TOOELE VALLEY
TOOELE COUNTY, UTAH

Project 97-069	Figure 2-30
Date 08-AUG-2004	
Scale AS SHOWN	

the remedial investigation. These included the slag pile, the Pine Canyon landfill, and a presumed infiltration pond located adjacent to the Elton Tunnel waste rock dump evident in historical aerial photographs. During the RI, a series of borings in Pine Canyon were used to rule out the potential for the slag pile and the Pine Canyon landfill as a source of arsenic (see discussion in Section 4.3.3). The remaining potential source, the infiltration pond next to the Elton Tunnel dump, was used for the particle track modeling.

The model added theoretical groundwater particles along the western side of the infiltration pond. The model then allowed these particles to migrate downgradient from this location for up to 140 simulated years. The tracks of these particles, taken together, describe a broad band within which is the most likely location of any groundwater particles originating from the former pond (Figure 2-31). Hydraulic model results show the following wells would be expected to be downgradient of the water disposal pond: GW-1 (Boys Ranch Well), GW-2 (Sagers Well), and GW-USGS (USGS Well).

A number of other model runs were used to test the effects of increased recharge rates in the Pine Canyon alluvial fan area (result: moves particle tracks further west) and changes to the porosity value (result: no changes in particle track locations).

The conclusions reached in this base model calculation were:

- The most likely migration direction of potential groundwater constituents emanating from the water disposal pond intercepts the locations of GW-1, GW-2, and GW-USGS
- Increased recharge conditions deflect the most likely migration direction to the west; however, particle migration still intercepts GW-1 and GW-2.

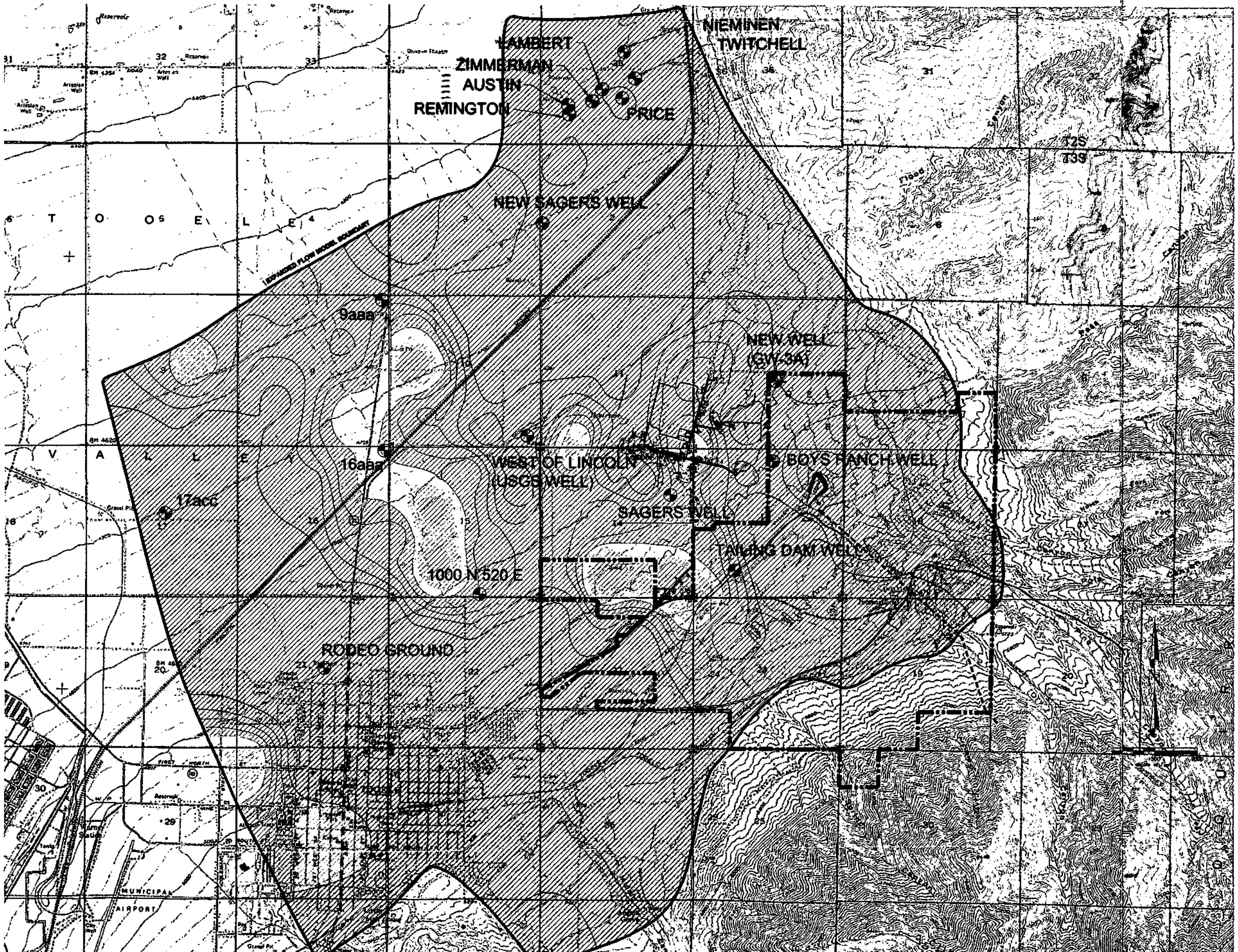
2.15.3.2 Extended Hydraulic Model - Erda Area

To better understand the hydraulic relationship between the IS&R site and wells in the Erda area, the base model described in the previous section was extended to include the hydraulic conditions at the Price Well and other wells in the Erda area.

Northeast of the Price Well, Rose Spring flows from the base of the mountains into the valley. According to discussions with the USGS, they have mapped a groundwater mound in this area, which they attributed to localized recharge of the valley fill aquifer by the water flow which creates the spring. This is important to the investigation of the Price Well, because the mound, which is situated north of the well, locally tends to push groundwater flow direction south through the vicinity of the Price Well toward the IS&R property. The spring was included as a specified flux boundary in the revised model. The incoming flow at the spring was set at 100-gpm, the base flow rate given by the USGS. The north model boundary between the spring and the specified head boundary is a parallel flow boundary following the contours of the USGS groundwater mound. The head at the specified head boundary was set at 4368 ft. The other recharge values used in the USGS steady state model were also used in this model.

During the calibration process the horizontal hydraulic conductivity was adjusted to calibrate the model. Figure 2-32 shows the conductivity field for the calibrated model. The final conductivity field is very similar to the conductivity field of the previous groundwater model with zone of higher permeability extending west-northwest from the mouth of Pine Canyon, and a low permeability for the rest of the model domain. The maximum K value was 300 ft/day.

The calculated piezometric surface for the expanded model was similar to that of the base model, having steeper gradients in the Middle Canyon and Pine Canyon recharge areas and flatter gradients with a generally northwest-trending slope in the rest of the model domain. The maximum residual head at any well was less than one foot. The following table shows the calibration statistics for the expanded model.



General Notes

HORIZONTAL HYDRAULIC CONDUCTIVITY in ft./day

- 320.0
- 280.0
- 240.0
- 200.0
- 160.0
- 120.0
- 80.0
- 40.0
- 0.0

No.	Revision/Issue	Date

Atlantic Richfield Company

IS&R
Tooele, UT

ANDERSON
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DRAWN BY: MSB

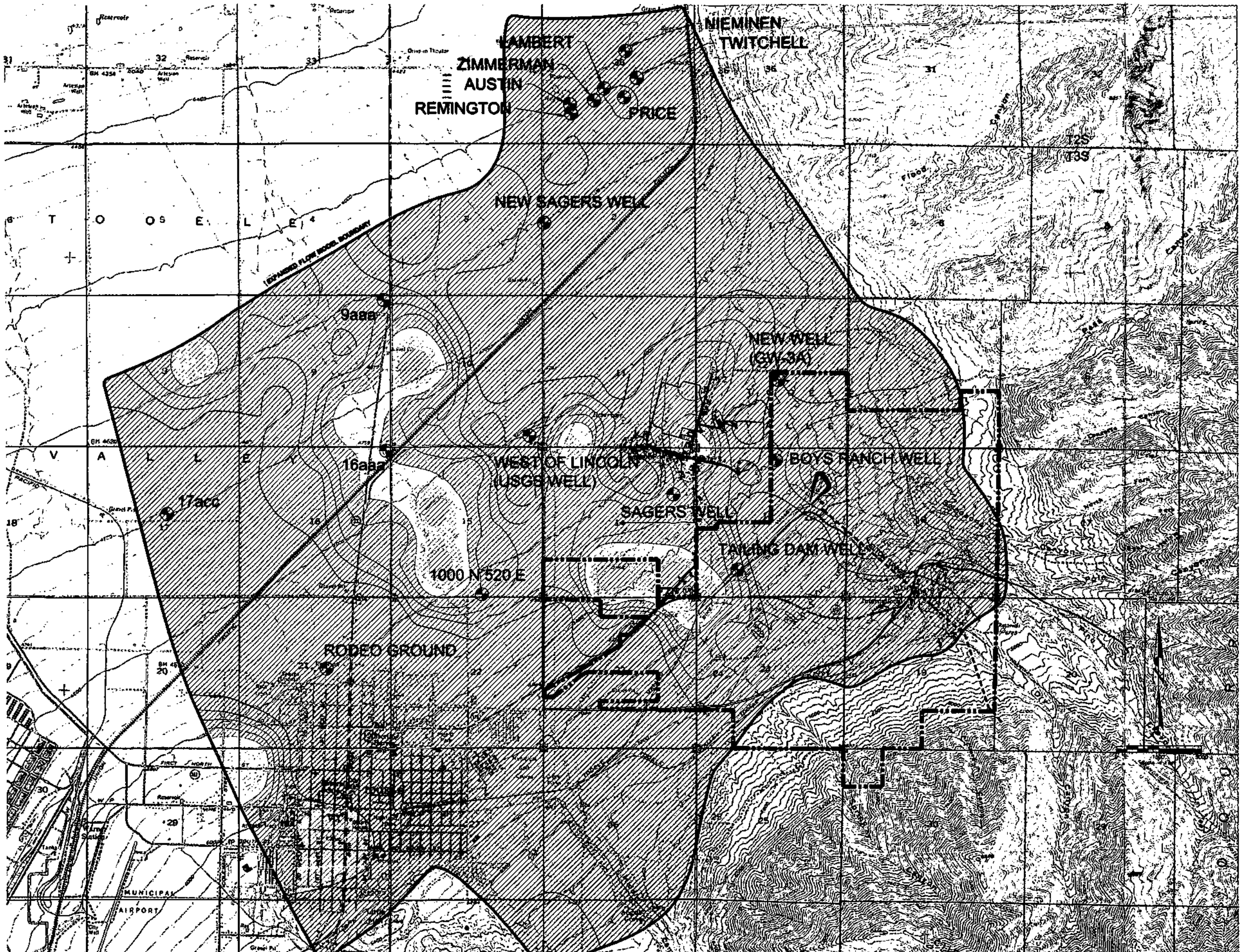
ENGINEER: KC

APPROVED: SDA

EXPANDED MODEL HORIZONTAL HYDRAULIC CONDUCTIVITY IN FT/DAY

SOUTHEASTERN TOOELE VALLEY
TOOELE COUNTY, UTAH

Project 97-069	FIGURE
Date 16-AUG-2004	2-31
Scale AS SHOWN	



General Notes

HORIZONTAL HYDRAULIC CONDUCTIVITY in ft/day

320.0
280.0
240.0
200.0
160.0
120.0
80.0
40.0
0.0

No.	Revision/Issue	Date

Atlantic Richfield Company

IS&R
Tooele, UT

ANDERSON
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DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

EXPANDED MODEL HORIZONTAL HYDRAULIC CONDUCTIVITY IN FT/DAY

SOUTHEASTERN TOOELE VALLEY
TOOELE COUNTY, UTAH

Project	97-059	FIGURE
Date	18-AUG-2004	2-32
Scale	AS SHOWN	

Table 2-37
Measured vs. Modeled Heads (ft)
Expanded Model

Well Identification	Measured Head	Computed Head	Residual
Nieminen	4379.7	4379.3	-0.40
Lambert	4378.6	4378.6	-0.04
Price	4378.7	4379.0	0.32
Zimmerman	4378.4	4378.2	-0.16
Twitchell	4379.1	4379.5	0.36
Austin	4376.8	4376.0	-0.77
Remington	4375.1	4375.9	0.75
9aaa	4376.0	4375.9	-0.12
16aaa	4385.0	4385.1	0.06
17acc	4382.0	4382.0	0.02
New Sagers Well	4380.7	4380.8	0.05
1000 N 520 E	4393.0	4393.1	0.11
Rodeo Ground	4461.4	4461.4	0.04
West of Lincoln	4393.6	4393.6	0.02
Tailing Dam Well	4401.5	4402.3	0.75
New Well (NW prop)	4403.3	4403.4	0.0
Sagers Well	4400.9	4400.4	-0.55
Boys Ranch Well	4409.4	4409.3	-0.14
Mean Residual (Head)		-0.019	
Mean Absolute Residual (Head)		0.261	
Root Mean Squared Residual (Head)		0.373	

Particle Tracking Analysis

Using the extended model, particle tracking was again performed. Theoretical particles were added at three points of interest, including at GW-3A (located at the end of the Boys Ranch ditch at the north boundary of the former Boys Ranch property). Section 2.15.2.5 discusses the historical use of the Boys Ranch ditch for mine water disposal. GW-3A is situated approximately at the middle of the east side of the major mine water disposal area, used during the Carr Fork Project. The particles added to GW-3A were forward tracked toward the northwest (Figure 2-33).

The forward particle track from GW-3A shows that water from this location moves toward the northwest in the general vicinity of

Erda, but does not flow through the Price Well. Figure 2-33 illustrates that the particle track from the north end of Section 12 and from the UP Railroad culvert trends northwest toward the Erda area and the Price Well but the particle track veers westward, prior to encountering the Price Well. This is due to the effect of the groundwater mound in the Erda area. The arrows along the particle tracks also indicate the travel time for the particles. Each arrow indicates 10 years of travel time. The spacing of these arrows indicate it would take approximately 150 year for water recharged to the aquifer in the GW-3A location to flow to the nearest (½ mile away) point to the Price Well. The arrow spacing also indicates that mine water infiltration from Section 12 and in the southeast half of Section 2, T3S R4W, would take over 200 years to travel to the Erda area and from the UP Railroad culvert over 80 years. These time frames in and of themselves practically exclude the smelter/mine drainage as a possible source for elevated COC at the Price Well.

The original USGS model at its coarse level of accuracy indicated that groundwater particles potentially could travel through the Price Well when released from the irrigation ditches. The particle tracking predicted by the new finer level of accuracy extended model indicates that groundwater particles infiltrated do not travel through the Price Well. The different conclusions in the two models may be explained as follows:

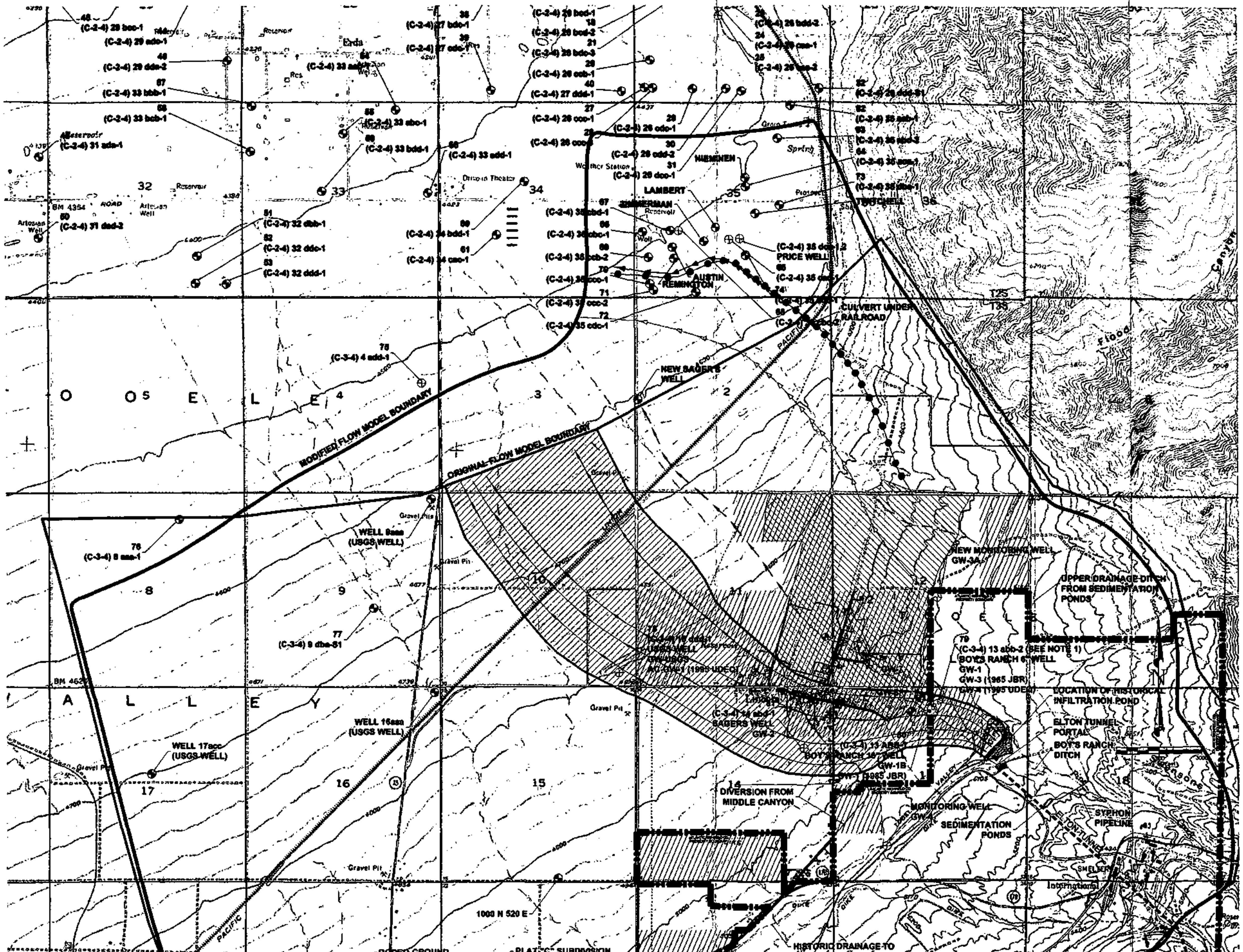
- More head data was available in the area of interest for the new model. Several of the wells used to calibrate the new model were not drilled when the USGS completed the original model.

- The new model is better calibrated in the area of interest. Specific information was included for the groundwater mound at the Rose Spring.

- The mountain front recharge in the USGS model was distributed all along the mountain front. In the new model, this recharge is more concentrated at the canyon mouths.

- The new model is more discretized than the USGS model. The USGS model used cell sizes of 100 ft^2. The smaller cell size allows for better calibration of the model in the area of interest and with a smaller cell size the particle tracking is better defined.

The results of the tracking analyses are also shown in Figure 2-33. The travel times estimated by this model are similar to the 130 to 200 years indicated by the USGS for water to travel between the Smelter Site area to the Erda area (Lambert and Stolp, 1999).



General Notes

1. WELL PREVIOUSLY MISLABELED BY USGS AS (C-3-4) 12 dca-1, REFERRING TO AN ABANDONED WELL APPROXIMATELY 150-FT TO THE NORTH.
2. NUMBERS BY WELLS (1-81) WERE ORIGINALLY ASSIGNED BY ABCI IN THE IS&R REMEDIAL INVESTIGATION WORK PLAN (SEPT. 2003).
3. PREVIOUS DESIGNATIONS FOR REMEDIAL INVESTIGATION MONITORING WELLS ARE SHOWN IN GRAY. REFERENCE OF PREVIOUS INVESTIGATION DATE AND INVESTIGATOR ARE SHOWN IN PARENTHESIS.

LEGEND

- GROUNDWATER PARTICLE TRACKING FLOW PATH BASED ON GROUNDWATER ADVECTION (USING MODFLOW HYDRAULIC MODEL)
- GROUNDWATER PARTICLE TRACKING FLOW PATH BASED ON LINEAR HEAD INTERPOLATION (ANALYTICAL MODEL)
- GROUNDWATER WELL LOCATION
- GROUNDWATER WELLS SAMPLED QUARTERLY FOR REMEDIAL INVESTIGATION
- GROUNDWATER WELLS SAMPLED AS PART OF ERDA STUDY
- AREAS APPROPRIATED FOR IRRIGATION WITH ELTON TUNNEL WATER
- ACTUAL AREAS IRRIGATED WITH MINE DISCHARGE ACCORDING TO AERIAL PHOTOGRAPHIC DOCUMENTATION
- APPROPRIATED AREA FOR MINE WATER DISCHARGE ACCORDING TO TEMPORARY CHANGE APPLICATION
- FORWARD PARTICLE TRACKING FROM "NEW WELL" (GW-3A)
- FORWARD PARTICLE TRACK FROM THE NORTH LINE OF SECTION 12
- FORWARD PARTICLE TRACK FROM CULVERT UNDER RAILROAD TRACKS

CIRCLES ALONG THE PARTICLE TRACK ARE SPACED AT 10-YEAR INTERVALS INDICATING THE ADVECTION RATE ALONG THE FLOW PATH.

No.	Revision/Issue	Date

Atlantic Richfield Company

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ENGINEER: KC
APPROVED: SDA

EXPANDED HYDRAULIC MODEL PARTICLE TRACK ANALYSIS

IS&R SITE

Project	Figure
97-069	2-33
Date 18-AUG-2004	
Scale AS SHOWN	

This extended model was designed with a porosity value of 0.2, similar to that used previously by the USGS. The fine grained sediments in the subject area between the Smelter Site and Erda could, in fact, have a porosity that is higher, which would tend to decrease the advection rate and increase the travel times for particle transport. This was demonstrated in the previous base model where various advection rates of particles for porosities of 0.15, 0.2 and 0.25. Particles moved faster with a porosity of 0.15 compared to 0.2. They moved slower with a porosity of 0.25 compared to 0.2.

Influence of Rose Spring

The MODPATH model was used to determine the effect of increasing and decreasing the recharge flux at the Rose Spring to evaluate its effect on hydraulic flow paths from the smelter. In consultation with USGS, flow at the spring was estimated at 100 gpm as a base flow for Rose Spring. The spring has flowed at a higher rate; however, it has not been known to flow much less than the current approximately 100 gpm rate. The flux was increased three fold to 300 gpm to represent wetter years. The model predicted the higher spring flow would result in a more pronounced groundwater mound in the Erda area. Higher spring flows would tend to contribute a greater percentage of the recharge from the spring area to the north to the Price Well location.

The model was also run with the flux at the spring cut by a third to 33.33 gpm. The results of decreased spring flow are reflected in better model calibration than the 300 gpm case but poorer than the 100 gpm base case. The groundwater mound is less pronounced in the 33.33 gpm case than the 100 gpm and the spring flow and the Erda groundwater mound have less control on the recharge to the Price Well.

As expected, the larger the spring flow, the greater its effect on the hydraulic conditions at the Price Well and its influence on the particle tracking migrating from the south. As spring flow is increased the particle track flow line turns west sooner, with an opposite result when spring flow is reduced.

Conclusions that can be drawn from the extended model are:

- Assuming that some of the released irrigation water penetrated unsaturated vadose zone and entered the aquifer, particles would flow towards the northwest. However, the particle track analysis indicates that the particles, as released from various points of interest corresponding to known infiltration areas, do not pass through the Price Well.

- Advection travel time to the Price Well from the particle origin points is much longer than the time since water was removed from the Elton Tunnel or Carr Fork Mine.
- The Rose Spring above Erda has an effect on the flow from the south. Under all conditions modeled, particles from the direction of the smelter did not flow through the Price Well.

2.15.3.3 Re-Calibration of Model June 2004

In June 2004 the 16-inch Boy's Ranch Well was deepened and completed with a 4-inch casing to 750 feet deep. The reconstructed well was renamed GW-1BR. Two other monitoring wells were installed during June downgradient of GW-1BR, and were named GW-7 and GW-8. GW-7 was installed to a depth of 655 feet approximately 470 feet northwest of GW-1BR. This is along the "analytical" (downgradient based only on the observed piezometric surface) particle track discussed in Section 2.15.3.1. Well GW-8 was installed to a depth of 665 feet approximately 550 feet west from GW-1BR. This is along the "modeled" (downgradient under the influence of the piezometric head and the hydraulic conductivity field in the model) particle track discussed in Section 2.15.3.1.

Data on depth to water and arsenic concentrations for the three new wells were used for the following tasks:

- Compare new monitoring well head data to the original model
- Recalibrate the model with the new monitoring well head data
- Rerun the particle tracking analysis with the new calibrated model

Comparison of the New Head Data with the Original Model

In June of 2004 head measurements were taken at the 6-inch Boy's Ranch Well (GW-1), GW-1BR, GW-7 and GW-8. Table 2-38 lists the June 2004 head measurements (elevations).

Table 2-38
June 2004 Head Measurements

Well	Head (ft)
GW-1	4398.7
GW-1BR	4389.5
GW-7	4398.1
GW-8	4398.3

The previous groundwater model used head measurements from 2002. In the original model the 6-inch Boy's Ranch Well had a head measurement of 4409.4 ft, 10.7 higher than the June 2004 head. This is not unexpected with the drought that has existed in Utah for the last 6 years. The observed head values for GW-7 and GW-8 were therefore increased by 10.7 ft to compare them with the original model. The differences between the adjusted, observed and modeled heads for the GW-7 and GW-8 locations are shown in Table 2-39.

Table 2-39
Measured and Computed Heads for New Observation Wells

Well	Measured Head (ft)	Modeled Head (ft)	Residual Head (ft)
GW-7	4408.8	4407.6	1.2
GW-8	4409.0	4406.6	2.4

The adjusted-observed heads are relatively close to the modeled heads, indicating that the previous model still calibrates acceptably to the new monitoring well data. This data indicates that the previous model is still valid.

The original model was calibrated by adjusting the horizontal hydraulic conductivity. The same process was followed when recalibrating the model, the horizontal hydraulic conductivity was adjusted. The automated calibration code PEST was used to calibrate the model. Figure 2-34 shows the horizontal hydraulic conductivity field for the recalibrated model.

Table 2-40 lists the observation wells and the difference between the measured and model computed heads in the new model, as well as the overall model error.

Table 2-40
Recalibrated Model Measured and Computed Heads

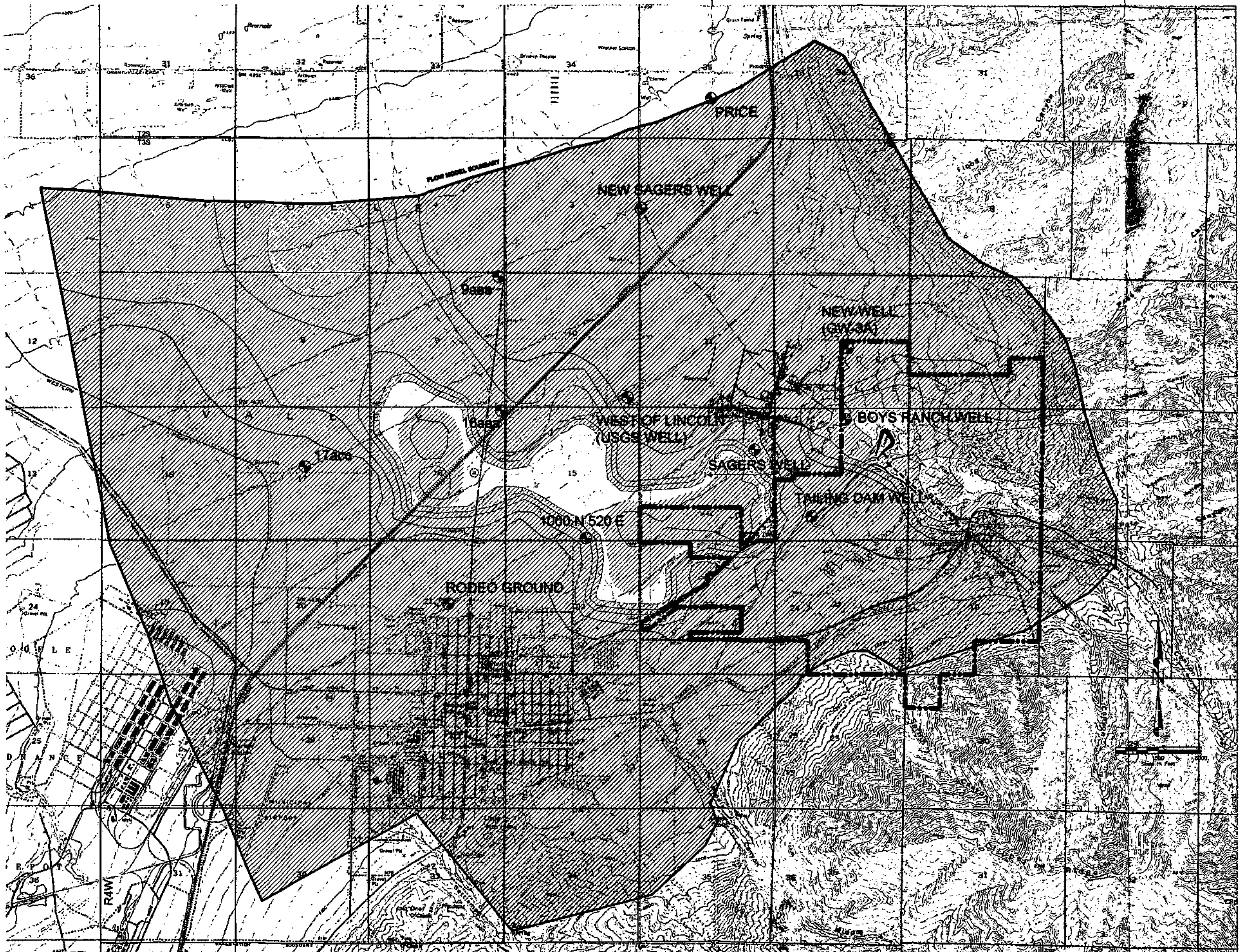
Well	Measured Head (ft)	Modeled Head (ft)	Residual Head (ft)
Boys Ranch Well	4409.4	4409.4	0.05
Sagers Well	4400.9	4400.9	0.02
NW prop	4403.3	4403.6	0.28
Tailing Dam Well	4401.5	4401.8	0.25
West of Lincoln	4393.6	4393.8	0.21
Rodeo Ground	4461.4	4462.3	0.87
1000 N 520 E	4393.0	4393.3	0.26
New Sagers Well	4380.7	4380.8	0.11
GW-7	4408.8	4408.7	-0.09
GW-8	4409.0	4408.5	-0.54
Mean Error			-0.14
Mean Absolute Error			0.27
Root Mean Squared Error			0.36

Overall the new model is still well calibrated with an RMS error of .36 and the heads have not changed significantly from the original model. Figures 2-35 and 2-36 show the difference in the computed heads and the horizontal hydraulic conductivity fields between the two models.

Overall, all the heads change only slightly throughout most of the model. The head is most different near the model boundaries where we do not have head measurements.
There is change in the hydraulic conductivity when considering the value at each cell; however, the general pattern of the hydraulic conductivity shown in the previous figures is quite similar. We would expect the hydraulic conductivity to change when recalibrating the model because this is the only parameter that was adjusted to calibrate the model.

Particle tracking was run with the recalibrated model and a porosity of 0.3. The results from forward tracking from the pond and Boys Ranch Well in the recalibrated model are shown in Figure 2-37.

The particle tracking results indicate that the particle tracks in the new model follow very similar paths to those of the old model.



General Notes

HORIZONTAL HYDRAULIC CONDUCTIVITY In ft./day

320.0
280.0
240.0
200.0
160.0
120.0
80.0
40.0
0.0

No.	Revision/Issue	Date

Atlantic Richfield Company

IS&R
Tooele, UT

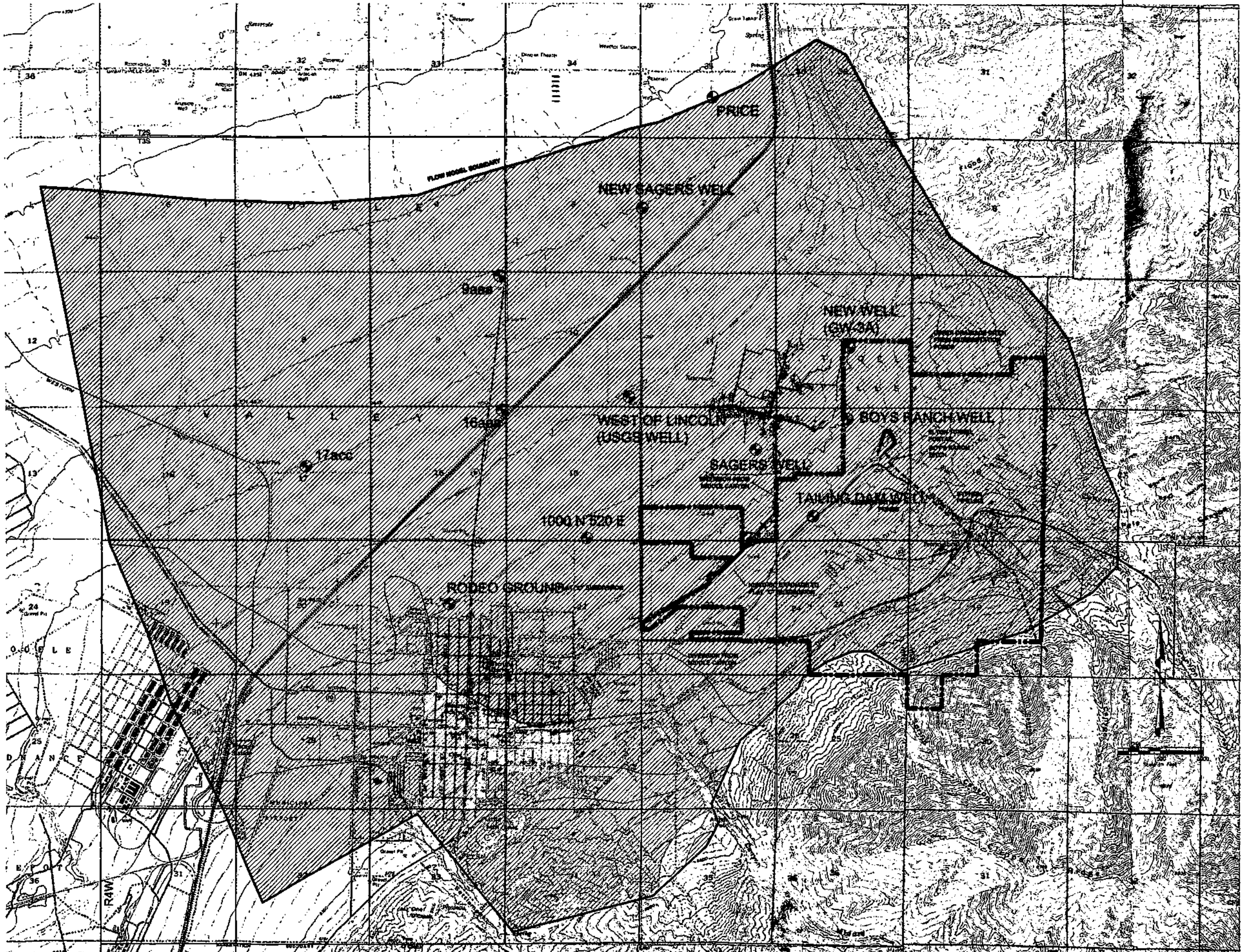
ANDERSON
ENGINEERING COMPANY, INC.

DRAWN BY: MSB
ENGINEER: KC
APPROVED: SDA

RECALIBRATED MODEL HORIZONTAL HYDRAULIC CONDUCTIVITY IN FT/DAY

SOUTHEASTERN TOOELE VALLEY
TOOELE COUNTY, UTAH

Project 97-069
Date 08-AUG-2004
Scale AS SHOWN
Sheet 2-34



General Notes

HEAD DIFFERENCE

180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0

No.	Revision/Issue	Date

Atlantic Richfield Company

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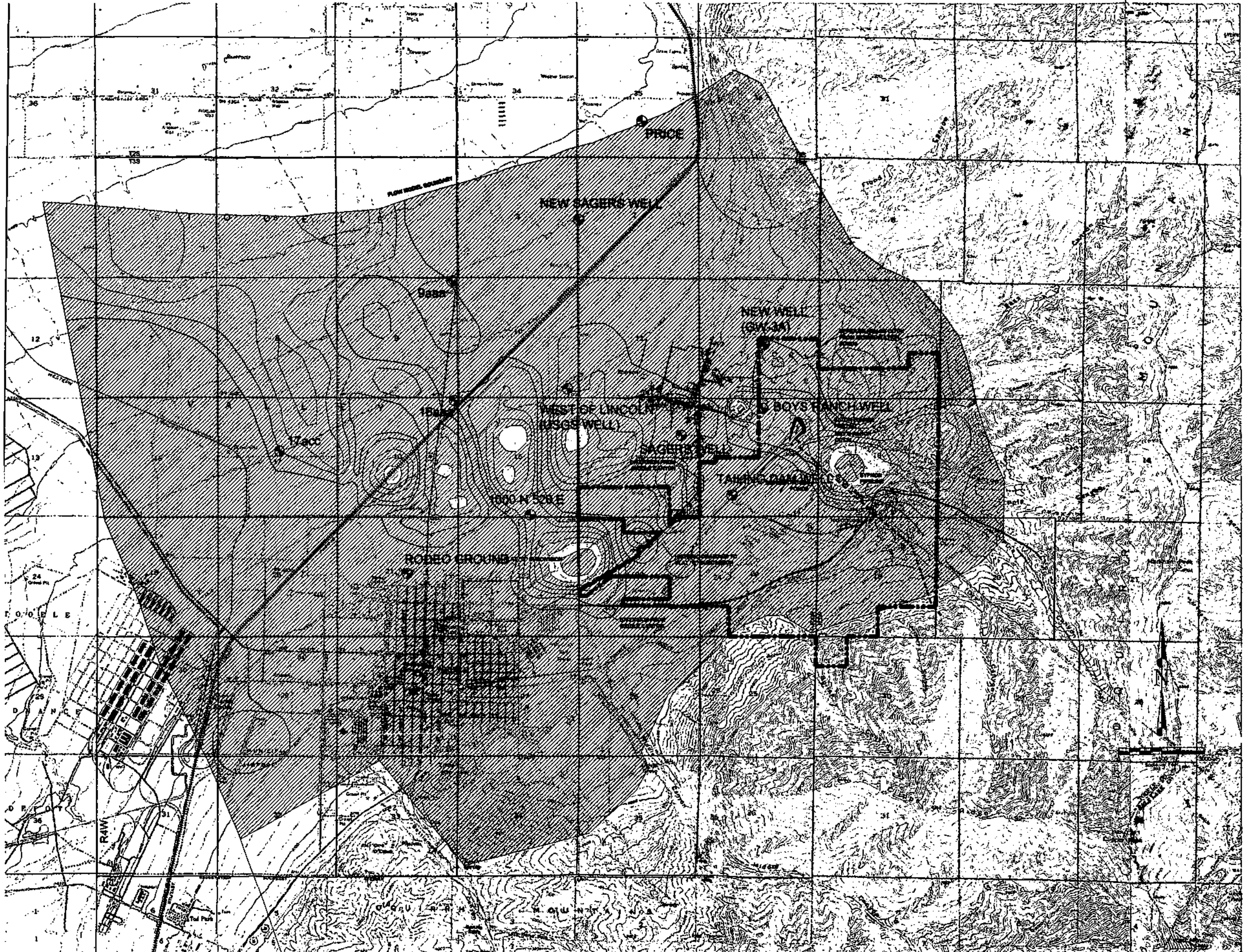
ENGINEER: KC
APPROVED: SDA

DIFFERENCE IN HEADS FROM ORIGINAL MODEL AND RECALIBRATED MODEL (FT)

SOUTHEASTERN TOOELE VALLEY
TOOELE COUNTY, UTAH

Project 97-060	Sheet 2-35
Date 18-AUG-2004	
Scale AS SHOWN	



General Notes

HEAD DIFFERENCE

240.0
210.0
180.0
150.0
120.0
90.0
60.0
30.0
0.0

No.	Revision/Issue	Date

Atlantic Richfield Company

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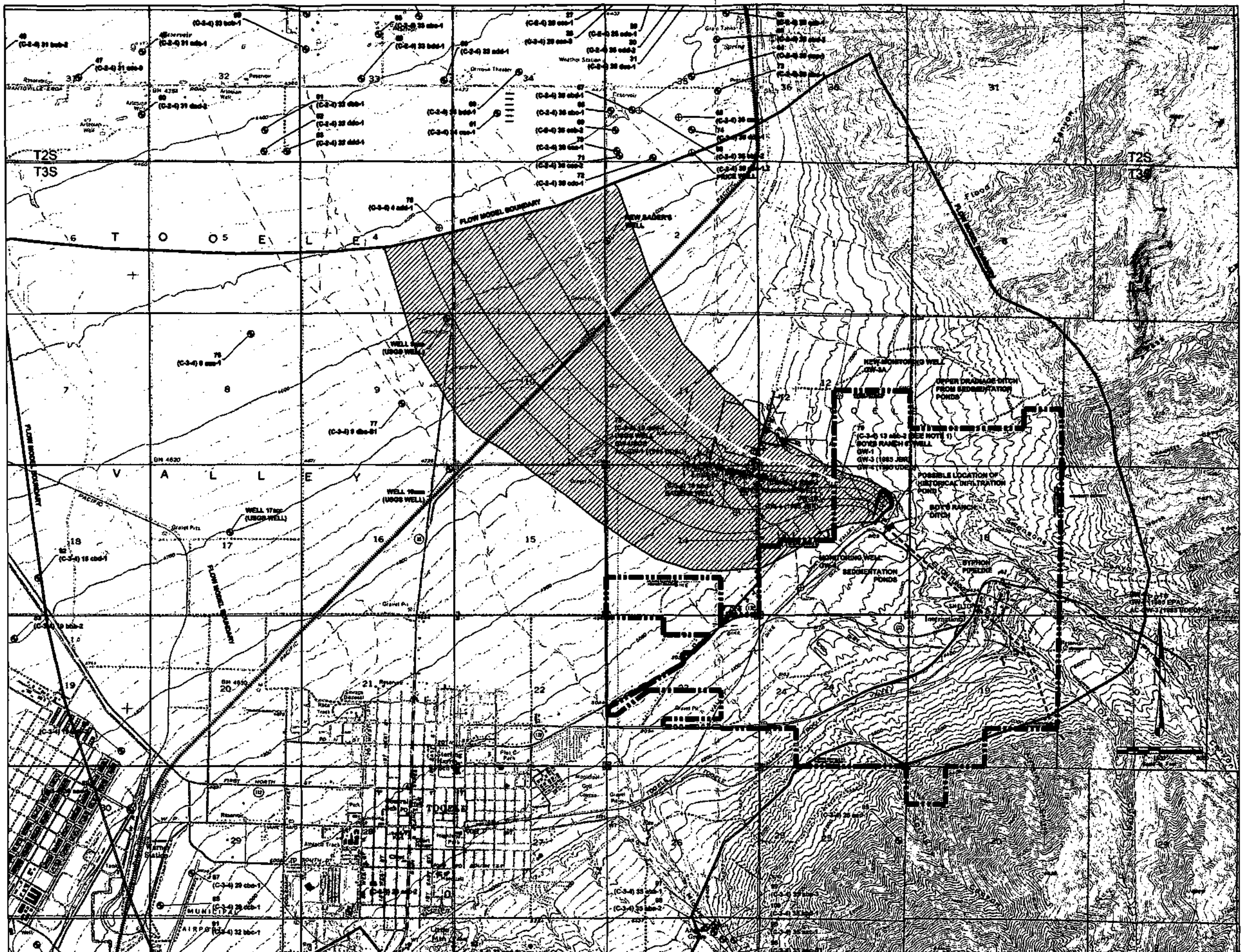
ENGINEER: KC
APPROVED: SDA

HYDRAULIC CONDUCTIVITY DIFFERENCE BETWEEN ORIGINAL AND RECALIBRATED MODEL (FT/DAY)

SOUTHEASTERN TOOELE VALLEY
TOOELE COUNTY, UTAH

Project 97-059
Date 18-AUG-2004
Scale AS SHOWN

Sheet 2-36



General Notes

1. WELL PREVIOUSLY MISLABELED BY USGS AS (C-3-4) 12 dcc-1, REFERING TO AN ABANDONED WELL APPROXIMATELY 160-FT TO THE NORTH.
2. NUMBERS BY WELLS (1-81) WERE ORIGINALLY ASSIGNED BY AECI IN THE IS&R REMEDIAL INVESTIGATION WORK PLAN (SEPT. 2000).
3. PREVIOUS DESIGNATIONS FOR REMEDIAL INVESTIGATION MONITORING WELLS ARE SHOWN IN GRAY. REFERENCE OF PREVIOUS INVESTIGATION DATE AND INVESTIGATOR ARE SHOWN IN PARENTHESIS.

LEGEND

- RECALIBRATED GROUNDWATER PARTICLE TRACKING FLOW PATH BASED ON GROUNDWATER ADVECTION (USING MODFLOW HYDRAULIC MODEL)
- GROUNDWATER WELL LOCATION
- GROUNDWATER WELLS SAMPLED QUARTERLY FOR REMEDIAL INVESTIGATION
- GROUNDWATER WELLS SAMPLED AS PART OF ERDA STUDY
- RECALIBRATED MODEL PARTICLE TRACK FROM BOY'S RANCH WELL

No.	Revision/Issue	Date

Atlantic Richfield Company
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Tooele, UT

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DRAWN BY: GMN
ENGINEER: KC
APPROVED: SDA

RECALIBRATED GROUNDWATER PARTICLE TRACKING FLOW PATHS

IS&R SITE

Project 97-059	FIGURE 2-37
Date 11-FEB-2003	
Scale AS SHOWN	

The particle tracks in the new model have a more northerly component than the old model but the general shape of the tracks is unchanged. The general direction of flow in the new model is still toward the west close to the sources and then curving toward the northwest. The significant finding of the particle tracking in the recalibrated model is that Sagers Well is still shown to be downgradient of the former pond source. Also of note is that even with a porosity of 0.3 in the new model, the advective flow travel time between the pond and Sagers Well (GW-2) is about 30 years, indicating that there has been ample time for groundwater from the vicinity of the pond to flow to the Sagers Well since the pond was in operation.

2.15.4 Regional Water Chemistry

Based on information provided by the USGS (Razem and Steiger, 1981), and confirmed by the Stiff diagrams produced from RI-generated data (see Figure 2-38), it is apparent that the groundwater in the basin fill aquifer in the Tooele Valley generally ranges between calcium magnesium bicarbonate type and sodium chloride type. In addition, some areas contain water which represents a mixture of the two types with sulfate being one of the major ions. In general, water in the southwestern part of the valley is of the calcium bicarbonate type, and water in the northern and middle parts of the valley is of the sodium chloride type. Usually the bicarbonate type water is representative of recharge areas, which may be indicative of the predominately carbonate bedrock in the area. The water quality in the recharge zone is generally good with TDS values of 1,000 ppm or less. As water moves through the valley fill, it tends to pick up additional dissolved solids and become more sodium chloride rich. In Tooele Valley the chloride concentrations naturally increase towards the Great Salt Lake, northwest of the Site. Water produced in the middle of the valley is of lower quality with TDS values of 1,000 to 3,000 ppm, whereas the TDS concentrations are below 600 ppm in all of the smelter wells.

2.15.4.1 Smelter Site Water Chemistry

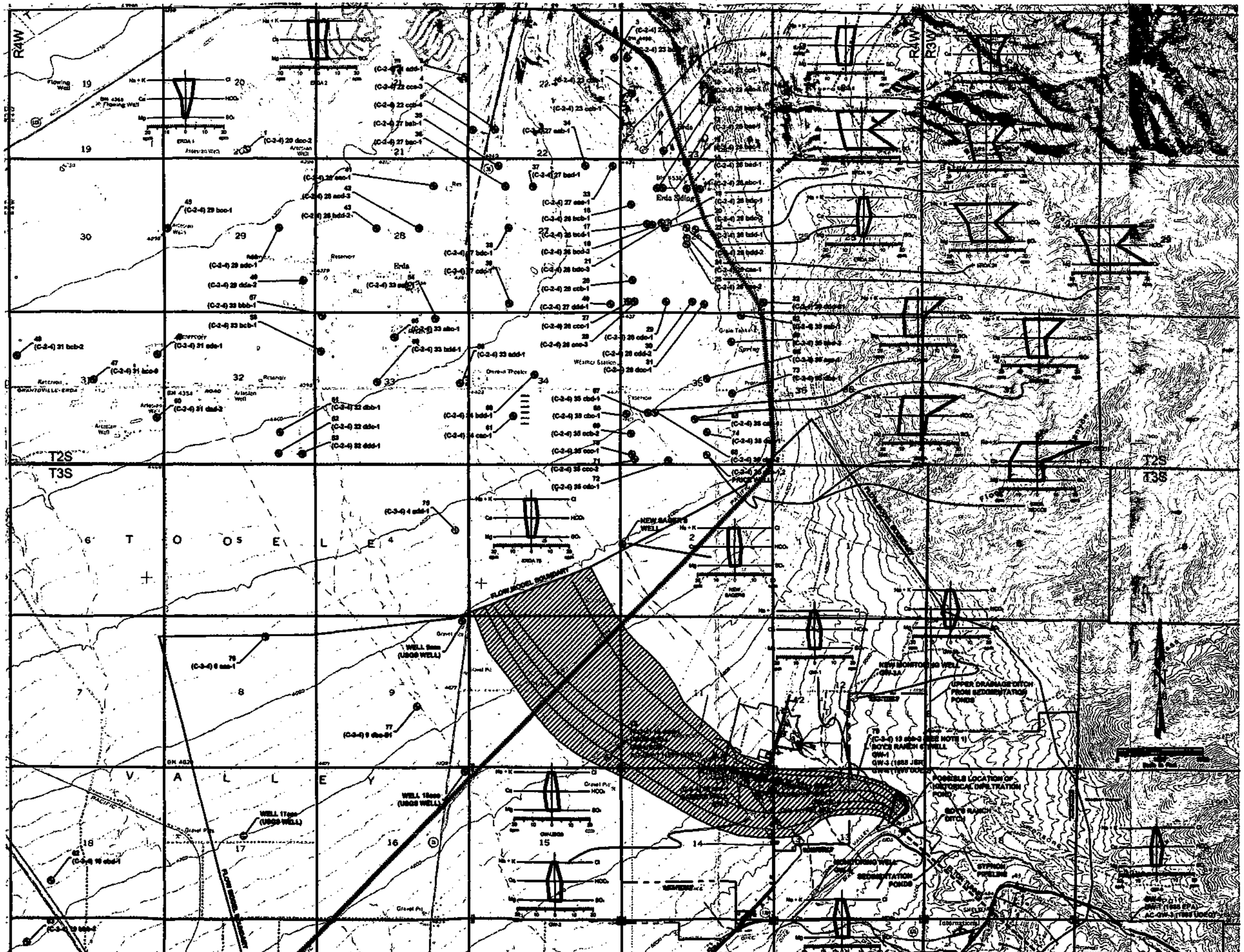
Smelter site water is defined as water collected from the smelter site wells which are on or immediately up or down gradient of the IS&R plant site. They include wells GW-1, 2, 3A, 4, 6, 7, 8, GW-USGS Well. Well GW-1BR is in the same vicinity; however, it actually samples a deeper portion of the aquifer. The physical parameters of the water collected from the smelter site monitoring wells indicate that all are drawing similar type water.

Stiff diagrams representing water collected from the wells in the Carr Fork – Erda area are displayed on Figure 2-38. Stiff diagrams graphically show the concentrations of major cations and anions plotted on one scale. The Stiff diagrams plotted for the GW-1, 2, 3A, 4, 6, GW-USGS, and New Sagers wells all show similar water chemistries with relatively low concentrations of all plotted ions. This is indicative of these wells being developed in a common groundwater source. This also suggests all of these wells are located in a generally common flow path of mountain front recharge water, flowing out into the deeper valley fill sediments. This finding supports the flow directions as calculated in the hydraulic model. The smelter site monitoring wells collect water from within the top 100 feet of the aquifer, except for the New Sagers Well which is a bottom fed casing that extends approximately 150 feet below the top of the saturated zone (See Figure 2-39). Even though the New Sagers Well draws from a zone 50 feet deeper, the water drawn is chemically similar to that found in the other smelter wells. Physical parameters of water extracted from the smelter site wells are shown on Table 2-41.

Table 2-41
Physical Parameters of Smelter Site Monitoring Wells Water

Well Designation	TSS	TDS	Alkalinity	Acidity	pH (field)
GW-1 (6" Boys Ranch Well)	<4.34	470 - 490	210 -220	<3.51	7.13 - 7.79
GW-1B (16" Boys Ranch Well)	<4.34	480	210 - 220	<3.51	6.94 - 7.28
GW-2 (Sagers Well)	<4.34	470	210 - 230	<3.51	6.88 - 7.49
GW-3A (Northwest Corner)	<4.34	470 - 480	270 - 280	<3.51	6.96 - 7.45
GW-4 (Tailings Dam Well)	<4.34	530 - 570	220	<3.51	7.31 - 7.56
GW-5 (Designation not used)		n/a	n/a	n/a	n/a
GW-6 (KCC Well)	<4.34	350 - 360	210 - 220	<3.51	7.32 - 7.44
GW-USGS	<4.34	560 - 600	200 - 220	<3.51	7.11 - 7.47
New Sagers	11	570	220	<3.51	-
GW-7	<8	490	230	<3.18	7.23
GW-8	<8	430	230	<3.18	7.44

Groundwater analytical results from water collected in the smelter site wells have exhibited relatively elevated levels of sulfate (150mg/l to 380 mg/l) in the past. Sulfate in groundwater is derived principally from gypsum and anhydrite and to a lesser degree oxidation of iron sulfide. Sulfate concentrations have trended down in the smelter site water, collected during the RI, to a range from 68 mg/l to 190 mg/l, a value very similar to the background range found throughout the Tooele Valley.



General Notes

1. WELL PREVIOUSLY MISLABELED BY USGS AS (C-3-4) 12 dcc-1, REFERING TO AN ABANDONED WELL APPROXIMATELY 180-FT TO THE NORTH.
2. NUMBERS BY WELLS (1-61) WERE ORIGINALLY ASSIGNED BY AECI IN THE IS&R REMEDIAL INVESTIGATION WORK PLAN (SEPT. 2000).
3. PREVIOUS DESIGNATIONS FOR REMEDIAL INVESTIGATION MONITORING WELLS ARE SHOWN IN GRAY. REFERENCE OF PREVIOUS INVESTIGATION DATE AND INVESTIGATOR ARE SHOWN IN PARENTHESIS.

LEGEND

- GROUNDWATER PARTICLE TRACKING FLOW PATH BASED ON GROUNDWATER ADVECTION (USING MODFLOW)
- GROUNDWATER PARTICLE TRACKING FLOW PATH BASED ON LINEAR HEAD INTERPOLATION
- GROUNDWATER WELL LOCATION
- GROUNDWATER WELLS SAMPLED QUARTERLY FOR REMEDIAL INVESTIGATION
- GROUNDWATER WELLS SAMPLED AS PART OF ERDA STUDY

No.	Revision/Issue	Date

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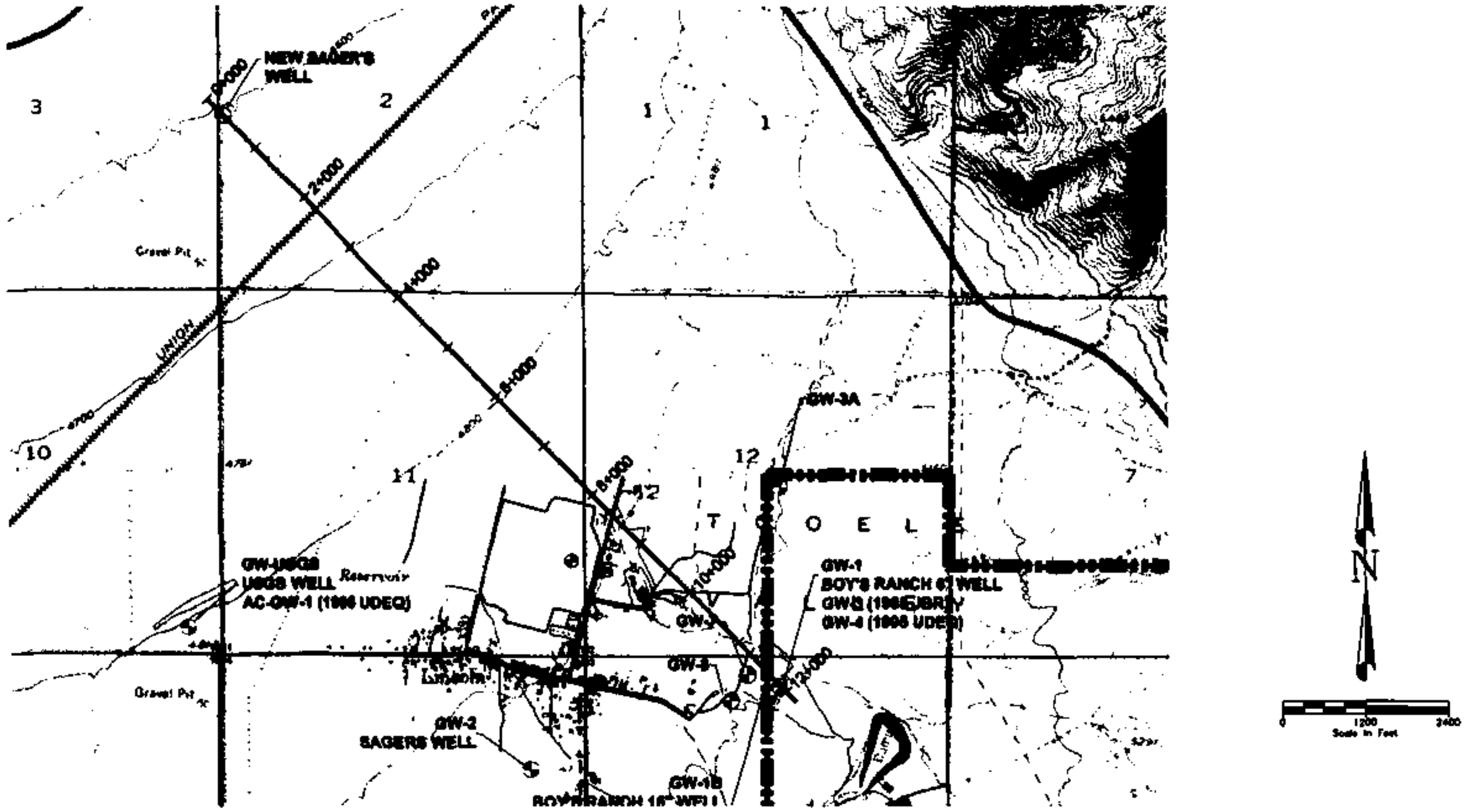
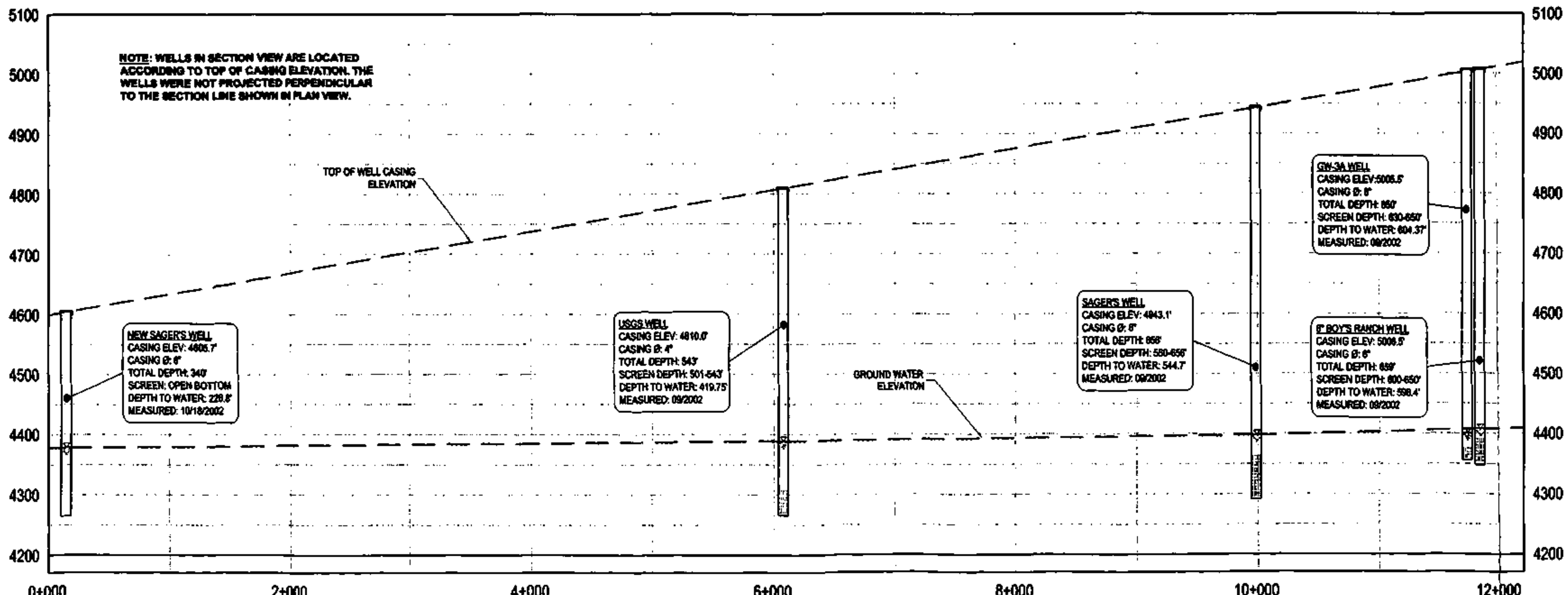
ENGINEER: KC
APPROVED: SDA

GROUNDWATER GEOCHEMISTRY - STIFF DIAGRAMS

IS&R SITE

Project 97-009
Date 19-AUG-2004
Scale AS SHOWN
Sheet 2-38





GROUNDWATER WELL SECTION

SCALE: HOR. 1" = 500' / VER. 1" = 100'

General Notes

No.	Revision/Issue	Date

Atlantic Richfield Company

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GROUNDWATER WELL CROSS SECTION MAP

IS&R SITE

Project: 07-069
Date: 10-AUG-2004
Scale: AS SHOWN
Figure: 2-39

Chloride concentrations in the smelter wells range from 12 mg/l to 56 mg/l, again a range that is similar to or less than that found in other areas within the valley. Chloride concentrations in the Great Basin region are typically higher than many other regions due to the Lake Bonneville sediments underlying the area.

Chloride in groundwater is predominantly derived from three sources, weathering of crystalline and sedimentary rocks, lake bed sediments and human and agricultural waste. Human and agricultural sewage waste is also generally high in chloride, and once deposited on the ground, chloride often moves into the groundwater system. GW-6, the well highest above the valley floor has the lowest chloride concentration. Smelter wells lower in the valley have higher concentrations, but do not appear to be abnormal relative to other valley wells.

Nitrogen, unlike other elements, is not derived from weathering of rocks in the groundwater system. Instead it enters the groundwater through external sources. Certain flora, such as, alfalfa, fix atmospheric nitrogen and transfer it to the soil for use by the plant community. Excess nitrogen not used eventually percolates downward through the unsaturated zone and enters the groundwater system. More commonly, nitrate in groundwater is associated with animal and human waste, decomposing plant debris and agriculture fertilization. Nitrate in groundwater can also be associated with mining. However, the nitrate concentrations in samples collected from smelter site wells historically and during the RI, ranging from 0.75 mg/l to 2.5 mg/l, are not abnormal for the area.

2.15.4.2 Erda Area Water Chemistry

The Erda area water is defined as water drawn from wells in Sections 26 and 35, T2S, R4W. Erda has at least two distinct water signatures based on water sampled during the RI. The shallow zone which extends to an elevation of approximate 4320 appears to have been highly influenced by agricultural practices, sewage disposal methods and possibly by lake bed sediments suggesting little evidence of smelter/mine impacts. Geochemistry also shows the water is from a different source than water collected from smelter wells. As shown on the plotted stiff diagrams (Figure 2-38), concentrations of chloride and sodium are significantly higher in the shallow water zone which results in a predictably higher TDS. Physical parameters of the Erda wells sampled are shown in Table 2-42 below. Erda22 and Erda23 are next to each other with Erda 23 approximately 130-ft deeper than Erda22. This set of wells, as well as the Price Well shallow/deep comparison, illustrate the two water types between the shallow and deeper zones.

Water from the Price Well, Erda35 ((C-2-4)35dcc-1, 2) and two other wells near the Price Well, drawing from the shallow Erda area aquifer, Erda69 ((C-2-4)35ccb-2) and Erda74 ((C-2-4)35dcb-1), also had detectable arsenic and/or nitrate concentrations in 1995. Erda69 and Erda74 are both in the general area of the Price Well. The 1995 arsenic concentrations of Erda69 and Erda74 were 17 ppb and 13 ppm, respectively. Based on the most recent sampling completed during the RI, arsenic concentrations in the Price Well are steadily declining (206 ppb in 2000, 102 ppb in 2001, and 84 ppb in 2002). Relatively higher concentrations of chloride in the shallow water in the Erda area are likely a result of both biological waste and lake bed sediments.

Table 2-42
Physical Parameters of Erda Area Monitoring Wells Water

Well Designation	TDS	Alkalinity	Chloride	pH (field)
ERDA22	1500	230	410	7.5
ERDA23	420	240	66	7.7
ERDA35 Zone 1	1500	200	700	7.2
ERDA35 Zone 2	2000	160	1000	7.3
ERDA35 Zone 3	677	209	186	7.3
ERDA65	1200	170	500	7.6
ERDA68	1300	180	470	7.5

2.15.4.3 Solute Compositions

To address EPA's assessment that the Carr Fork/IS&R site could have been responsible for the elevated arsenic (and nitrate) in the Price Well (Knight, 2003), Erda groundwater was investigated using geochemical and isotopic methods. The study evaluated potential influences of Carr Fork/IS&R facility wastewater (i.e. Elton Tunnel drainage, mine water settling ponds and irrigation water conveyed through the Boys Ranch ditch). The study also evaluated the hydraulic connection between the Site and the New Sagers Well. As detailed in Section 2.15.2.5, mine discharge was released into irrigation canals from the former Carr Fork mine (Pine Canyon Tunnel) and Elton Tunnel. Mine water chemistry data is readily available for the Carr Fork water while very little data is available for the Elton Tunnel water. However, data from the mine dewatering operations indicate that because the Elton Tunnel and the Carr Fork mine drained the same mining deposits, the water chemistry of both dewatering flows would have been similar. Carr Fork water chemistry is available for the outlet from the Pine Canyon Tunnel, the inlet to the sediment settling pond system used to clarify the water, and from the Boys Ranch ditch used to convey the clarified water to the Boys Ranch fields. Based on the data, it is apparent that the discharge water had minor amounts of nitrate, and typical arsenic concentrations in the settling pond discharge were well below the drinking water standards.

A large share of the water used for irrigation was likely consumed in evapotranspiration with most of the remaining stored in the subsurface vadoze zone. A small amount of an unknown quantity could have percolated into the subsurface aquifer.

Between 1971 and 2002, plant operators, the USGS, and various consultants analyzed solute compositions of water samples collected from more than 100 locations including wells, springs, ponds, mine discharges, and surface waters in the IS&R/Carr Fork - Lincoln - Erda area. Many sites have been sampled several times. As part of the RI, water samples from 14 wells in the Erda area, 6 wells on and near the Carr Fork site, and the Pine Canyon Tunnel discharges were collected and analyzed in 2002 for metals and other physical parameters, including arsenic and nitrate (Table 2-43). Stable isotopic compositions (^{2}H and ^{18}O) were examined in samples obtained from 14 Erda area wells, 6 site wells, and the Carr Fork Service Shaft Discharge (Table 2-44).

Stiff diagrams of selected wells and surface waters plotted on Figure 2-38 show that water in the Price and other Erda area wells has different major ion chemistry from water in the Pine Canyon recharge area. Further analysis was also completed on the underlying major ion solute data used to produce these diagrams.

Mine water potentially discharged through the sediment settling pond outlet and then through the Boys Ranch ditch, has been identified as a potential elevated arsenic recharge source for the shallow Price Well.

Analytical results during the dewatering operation in the late 1970s and early 1980s have shown that the mine water discharged from the settling pond outlet typically had very low arsenic concentrations, averaging 0.003 mg/l arsenic. This alone would indicate that percolating mine water is not likely a source for the elevated (greater than 0.01 mg/l) arsenic concentrations in the Price Well. However, an evaluation of the major ion chemistries of the different waters of interest was undertaken to help understand if it was possible for the percolating mine water to be responsible for the current groundwater chemistry at the Price Well.

Potential receiving groundwater for settling pond and Boys Ranch ditch water include groundwater drawn from smelter site wells and groundwater intercepted by the shallow Price Well and New Sagers Well. Groundwater in the smelter wells are generally low (i.e. <600 mg/l) TDS - Ca^{2+}- Mg^{2+}- HCO_3^- - SO_4^{2-} type (Table 2-45). The shallow Price Well is high TDS (i.e. >1500 mg/l), low SO_4^{2-} and high Cl^- water. The New Sagers well is low TDS (i.e. 600 mg/l) and low SO_4^{2-} and Cl^- water.

The mean compositions of Erda waters are also included in Table 2-45. All of the waters have elevated TDS (1,500 to 2,000 mg/l). Some of the waters have elevated SO_4^{2-} whereas others do not.

Discharge water from the settling pond is high TDS water with very elevated concentrations of the conservative anion SO_4^{2-} (Table 2-46). Sulfate is considered to be conservative because SO_4^{2-} must reach very high concentrations before being precipitated and these conditions are not found in typical groundwater flow situations. The Boys Ranch ditch also had elevated SO_4^{2-} concentrations.

Table 2-46
Average Sulfate Concentrations in Mine Discharge Water (mg/l)

Year	Pond Effluent	Pond Effluent Standard Deviation	Pond Effluent Max	Pond Effluent Min	Number of Samples (Pond Effluent)
1976	1422	416	2271	580	24
1977	685	134	1154	169	296
1978	544	41	634	405	88
1979	399	235	1253	315	43
1980	673	118	952	485	18
1981	677	56	770	616	8
1982	677	72	750	538	7
1983	680	N/A	N/A	N/A	1
1984	300	N/A	N/A	N/A	1

2.15.4.4 Factors Affecting Water Chemistry

There are several factors that can account for changes in groundwater chemistry between various observation points, these include:

- Vertical variability in water chemistry within an aquifer
- Distance from the point of recharge
- Proximity to faults
- Variability in aquifer matrix, e.g. low permeability rocks tend to contain poorer quality water than high permeability rocks

All of the above factors are primarily controlled by the reaction of the groundwater with the aquifer matrix materials. Aquifers can be divided stratigraphically into high and low permeability zones. In valley fill aquifers, the low permeability zones are caused by a greater abundance of fine silts and clay which reduce the ability of

Table 2-43
Solute compostions of groundwater in the vicinity of the IS&R Facility, Utah

Field Sample ID	Well ID	Well Depth (ft)	Date Collected	pH	oC	mg/L TDS	Ca	Mg	Na	K	HCO3	SO4	Cl	Arsenic	Nitrate
IS&R Facility Area															
ISR GW1	16" Boys Ranch Well	660	9/18/02	7.3		490	71.4	34.4	36.3	1.73	210	140	32	0.141	1.9
ISR GW2	Old Sagers Well	656	9/19/02	7.5		470	78.6	34.5	30.8	1.97	210	150	27	<0.00209	1.9
ISR GW3A	New AECI Well	650	9/20/02	7.4		470	77.4	32.0	45.5	1.91	280	73	53	<0.00209	0.72
ISR GW4	Tailings Dam Well	730	9/18/02	7.4		530	86.5	35.9	41.9	1.45	220	170	35	<0.00209	1.8
ISR GW6	Pine Cyn. Well	200	9/16/02	7.3		360	53.5	29.6	24.8	1.30	210	77	12	0.00310	0.76
ISR GWUSGS	USGS Well - Lincoln	542	9/17/02	7.4		600	93.3	30.8	51.3	1.49	200	190	53	0.00211	2.5
Erda Area															
ERDA1	2-4 20dcc-2	?	8/19/02	7.8	10.3	560	41.4	15.1	144.0	1.87	200	33	160	<0.00279	1.6
ERDA2	2-4 21ddd-1	90	8/19/02	7.6	14.3	870	102.0	44.4	129.0	5.1	220	220	180	<0.00279	2.3
ERDA8	2-4 23ccb-1	164	8/26/02	7.4		760	103.0	47.7	84.6	3.56	220	140	180	<0.00279	3.9
ERDA9	2-4 23ccd-1	141	8/20/02	7.6	16.8	1100	129.0	61.4	163.0	4.83	220	260	300	<0.00279	7.1
ERDA19	2-4 26bdc-1	167	8/20/02	7.7	15.0	2100	221.0	100.0	289.0	8.08	240	870	340	<0.00279	4.8
ERDA22	2-4 26bdd-1	180	8/20/02	7.5	17.0	1500	162.0	74.8	241.0	5.22	230	400	410	<0.00279	11
ERDA23	2-4 26bdd-2	224	8/19/02	7.7	16.1	420	64.5	29.9	43.4	2.68	240	43	66	<0.00279	1.1
ERDA24	2-4 26caa-1	161	8/20/02	7.8	15.2	2200	205.0	97.0	391.0	7.00	250	640	570	<0.00279	15
ERDA25	2-4 26caa-2	141	8/19/02	7.5	15.6	2600	247.0	117.0	402.0	10.0	230	1000	490	<0.00279	11
ERDA35DCC1	Shallow Price	210	8/26/02	7.19		1500	219.0	143.0	210.0	16.9	200	100	700	0.0841	18
ERDA35DCC2	Intermediate Price	251	8/26/02	7.27		2000	285.0	177.0	194.0	5.83	160	180	1000	<0.00279	25
ERDA65	2-4 35cad-1	280	8/20/02	7.6		1200	152.0	82.9	135.0	4.21	170	110	500	<0.00279	11
ERDA68	2-4 35cbd-2	204	8/20/02	7.5	14.8	1300	142.0	68.5	189.0	3.93	180	210	470	<0.00279	7.8
ERDA75	3-4 4add-1	261	8/26/02	7.61		500	62.2	21.1	84.0	1.71	210	83	83	<0.00279	2.1

Field Sample ID	Well ID	meq/L Ca	Mg	Na	K	HCO3	SO4	Cl
IS&R Facility Area								
ISR GW1	16" Boys Ranch Well	3.56	2.83	1.58	0.04	3.44	2.91	0.90
ISR GW2	Old Sagers Well	3.92	2 84	1.34	0.05	3.44	3.12	0.76
ISR GW3A	New AECI Well	3.86	2.63	1.98	0.05	4.59	1.52	1.50
ISR GW4	Tailings Dam Well	4.32	2.95	1.82	0.04	3.61	3.54	0.99
ISR GW6	Pine Cyn. Well	2.67	2.44	1.08	0.03	3.44	1.60	0.34
ISR GWUSGS	USGS Well - Lincoln	4.66	2.53	2.23	0.04	3.28	3.96	1.50
Erda Area								
ERDA1	2-4 20dcc-2	2.07	1.24	6.26	0.05	3.28	0.69	4.51
ERDA2	2-4 21ddd-1	5.09	3.65	5.61	0.13	3.61	4.58	5.08
ERDA8	2-4 23ccb-1	5.14	3.93	3.68	0.09	3.61	2.91	5.08
ERDA9	2-4 23ccd-1	6.44	5.05	7.09	0.12	3.61	5.41	8.46
ERDA19	2-4 26bdc-1	11.03	8.23	12.57	0.21	3.93	18.11	9.59
ERDA22	2-4 26bdd-1	8.08	6.16	10.48	0.13	3.77	8.33	11.57
ERDA23	2-4 26bdd-2	3.22	2.46	1.89	0.07	3.93	0.90	1.86
ERDA24	2-4 26caa-1	10.23	7.98	17.01	0.18	4.10	13.32	16.08
ERDA25	2-4 26caa-2	12.33	9.63	17.49	0.26	3.77	20.82	13.82
ERDA35DCC1	Shallow Price	10.93	11.77	9.14	0.43	3.28	2.08	19.75
ERDA35DCC2	Intermediate Price	14.22	14.57	8.44	0.15	2.62	3.75	28.21
ERDA65	2-4 35cad-1	7.58	6.82	5.87	0.11	2.79	2.29	14.11
ERDA68	2-4 35cbd-2	7.09	5.64	8.22	0.10	2.95	4.37	13.26
ERDA75	3-4 4add-1	3.10	1.74	3.65	0.04	3.44	1.73	2.34

Table 2-44
Stable isotopic compostions of groundwater in the vicinity of the IS&R facility, Utah

Field Sample ID		$d^{18}O$ (o/oo)	d^2H (o/oo)
IS&R Facility Area	**Well ID**		
ISR GW1	16" Boys Ranch Well		
ISR GW2	Old Sagers Well	-15.8	-119.7
ISR GW3A	New AECI Well	-16.2	-123.4
ISR GW4	Tailings Dam Well	-15.3	-118.9
ISR GW6	Pine Cyanyon Well	-16.1	-120.9
ISR GWUSGS	USGS Well - Lincoln	-15.4	-118.7
CFSS	Carr Fork Service Shaft	-16.6	-124.3
Erda Area			
ERDA1	2-4 20dcc-2	-16.1	-120.6
ERDA2	2-4 21ddd-1	-15.7	-120.1
ERDA8	2-4 23ccb-1	-15.8	-121.1
ERDA9	2-4 23ccd-1	-15.3	-118.8
ERDA19	2-4 26bdc-1	-15.9	-121.2
ERDA22	2-4 26bdd-1	-15.4	-119.0
ERDA23	2-4 26bdd-2	-16.1	-122.2
ERDA24	2-4 26caa-1	-14.6	-115.2
ERDA25	2-4 26caa-2	-15.6	-119.5
ERDA35DCC1	Shallow Price	-14.0	-113.0
ERDA35DCC2	Intermediate Price	-14.3	-113.5
ERDA65	2-4 35cad-1	-14.5	-115.0
ERDA68	2-4 35cbd-2	-14.4	-114.8
ERDA75	3-4 4add-1	-15.6	-119.9

Table 2-45
Summary of mean solute compositions used in geochemical modeling and discussion

Source	Sample date	n	pH	oC	mg/L TDS	Ca	Mg	Na	K	HCO3	SO4	Cl	TDS sum ions
sediment pond outlet	1980 - 1984	33	8.1	15.0		177	78	21	5	170	664	25	1140
boys ranch ditch	1972-1974	19	7.1	15.0	490	100	54	28	8	205	325	15	735
IS&R Wells (GW1-4)	2002	4	7.4	15.0	490	78	34	39	2	230	133	37	553
GW-6 (Pine Canyon well)	2002	1	7.3	15.0	360	54	30	25	1	210	77	12	408
shallow Price well	2002	1	7.2	19.3	1500	219	143	210	17	200	100	700	1589
new Sagers well	2002	1	7.5	13.2		69	33	74	2	220	130	73	601
Erda high TDS wells (all)		9	7.5	15.8	1722	196	102	246	7	209	419	531	1710
Erda high TDS wells (low SO4)		5	7.4	15.5	1420	185	107	178	7	186	172	594	1429
Erda high TDS (lhigh wells SO4)		4	7.6	16.0	2100	209	97	331	8	238	728	453	2062

Source	Sample date	n	pH	oC	meq/L TDS	Ca	Mg	Na	K	HCO3	SO4	Cl
sediment pond outlet	1980 - 1984	33	8.1	15.0	33.58	8.83	6.42	0.89	0.12	2.79	13.83	0.70
boys ranch ditch	1972-1974	19	7.1	15.0	21.41	5.00	4.45	1.21	0.19	3.36	6.76	0.43
IS&R Wells (GW1-4)	2002	4	7.4	15.0	16.03	3.92	2.81	1.68	0.05	3.77	2.77	1.03
GW-6 (Pine Canyon well)	2002	1	7.3	15.0	11.60	2.67	2.44	1.08	0.03	3.44	1.60	0.34
shallow Price well	2002	1	7.2	19.3	57.29	10.93	11.77	9.14	0.43	3.28	2.08	19.67
new Sagers well	2002	1	7.5	13.2	17.80	3.44	2.72	3.22	0.05	3.61	2.71	2.05
Erda high TDS wells (all)		9	7.5	15.8	56.15	9.77	8.43	10.70	0.19	3.42	8.72	14.92
Erda high TDS wells (low SO4)		5	7.4	15.5	49.28	9.25	8.77	7.75	0.18	3.05	3.58	16.69
Erda high TDS (lhigh wells SO4)		4	7.6	16.0	64.75	10.42	8.00	14.39	0.19	3.89	15.15	12.72

water to flow through these materials, but also provide an abundance of particle surfaces and cation exchange capacity that tends to increase concentrations of dissolved solutes in the water.

In valley fill aquifers in northern Utah, groundwater quality is typically best near the point of recharge at mountain fronts and decreases with flow distance from the point of recharge. The groundwater quality in the near surface aquifers also tends to be lower quality than deeper aquifers, particularly in areas with extensive irrigation and urban development where man-made recharge can carry pollutants of various types downward to the shallow groundwater. The difference in water quality between the Erda area wells and the wells at the smelter site can largely be explained by a combination of these two factors.

Stratigraphic variances in aquifer properties can control the vertical variability in groundwater quality by separating different waters in the aquifer with low permeability beds. The stratigraphic variability in the valley fill aquifer of the Tooele Valley has been described by previous workers. Samples of groundwater taken from different depths within a specific area can have different water chemistries. This has been demonstrated by the different groundwater chemistries at the USGS Price Wells. The shallow Price Well (210 feet deep) has elevated arsenic concentrations, which are not found in the intermediate (251 feet deep) or deep (352 feet deep) wells. In addition, as discussed in Section 3.13.1.10, the 16" Boys Ranch Well was re-drilled in 2004 to monitor a deeper portion of the aquifer (750 ft versus 650 ft). The arsenic concentration in the deeper zone was below detection, whereas the arsenic concentration in the 600 to 650 ft zone was 0.220 mg/L.

Naturally occurring arsenic concentrations have been observed in monitoring wells located at waste disposal facilities in western Tooele County (Mayo, 2003). Elevated, natural arsenic concentrations have also been observed in aquifers in the Delta, Utah areas (ibid). These elevated arsenic concentrations are not widespread and appear to be localized to certain wells. This variability in groundwater chemistry has been attributed to aquifer matrix geochemistry differences within the Lake Bonneville sediments.

Samples have also been collected in the past from nearby Leavett and Pass canyons. A sample collected in 1971 labeled "Pass Canyon Runoff" had an arsenic concentration of 146 ppb. Lincoln Township pursued the option of supplementing their water supply from Pass Canyon; however, a sample of the springs within the canyon had an arsenic concentration which exceeded the drinking water standard (Shields, 2002) The axes are both canyons intersect the axis of Pine Canyon at the location of GW-1. Subsurface flow from these canyons into valley alluvium may be partially responsible for groundwater chemistry encountered in GW-1.

The area at the mouth of Pine Canyon is a point of significant recharge for the valley fill aquifer in Tooele Valley. The sediments in this location are high permeability materials with relatively good groundwater quality (i.e., low sulfate, TDS, and chloride; arsenic at GW-1 excepted). The groundwater table elevation at GW-1 is approximately 4410 feet, which is slightly higher than the water table elevation at shallow Price Well (4379 feet). This elevation difference based on piezometric surface elevations suggests groundwater from the smelter site could potentially flow to the Erda area, even though the particle tracking did not show a pathway from GW-1 to the shallow Price, and showed a very long time frame to even travel to the Erda vicinity. In order to confirm previous findings, and assess the potential for smelter groundwater to evolve into Erda groundwater, geochemical evolution modeling was performed. Along this flow path, the groundwater would likely be separated stratigraphically by the increasing prevalence of finer lakebed sediments. The groundwater quality would also be expected to be affected by reaction with the aquifer matrix materials in the flow path.

2.15.4.5 Geochemical Evolution

Chemical reaction pathways were modeled, using the code NETPATH, to determine the plausibility of several potential groundwater flow paths (Table 2-47) and ratify the hydraulic model results. Minerals and substances modeled include those likely encountered along the flow path (i.e. calcite, dolomite, carbonic acid, gypsum, and halite). These minerals represent the major ion chemistry found in the surface and groundwater.

The model results indicate whether the concentration of each specific substance of interest is increased (positive number) or decreased (negative number) between the initial and final water chemistries. Increases in mineral substance concentrations in the water would occur through dissolution of these minerals from the aquifer substrate whereas decreases in the concentrations of minerals would have to occur through precipitation and ion exchange reactions. Decreases in mineral concentrations can only occur when these concentrations are high enough for these reactions to proceed to completion. The model will not return a result if the conditions for the chemical equilibrium reactions are not present ("nm" in Table 2-47). In certain cases, the model reported plausible results for certain substances and not for others; in these cases, the reaction conditions that were not plausible were ignored and the other results were reported ("ci" in Table 2-47). In all the "ci" cases, the reaction results were not plausible because either dolomite or gypsum needed to be

Table 2-47
NETPATH modeling results
Geochemical Evolution from Various Surface and Groundwater to other Groundwater
Carr Fork - Linclon - Erda area
(Positive results indicated mineral dissolution or gas consumption)
(Negative values indicate mineral precipitation or gas production. Results are in mmole/L)

No Mixing

Initial Water	Pine Canyon Well (GW-6)	Pine Canyon Well (GW-6)	Pine Canyon Well (GW-6)	IS&R Wells (1-4)	IS&R Wells (1-4)
Final Water	IS&R Wells (1-4)	Price Shallow Well	New Sagers Well	Price Shallow Well	New Sagers Well
CALCITE	-0.15	-0.77	-0.3	-0.62	-0.15
CO2	0.09	-8.70	0.08	-8.8	0.00
DOLOMITE	0.164	4.66	0.12	4.49	ci(0.04)
GYPSUM	0.58	0.24	0.55	ci (-0.34)	ci(-0.03)
HALITE	0.71	19.45	1.72	18.73	1.01

Initial Water	Sed Pond Outlet	Sed Pond Outlet	Sed Pond Outlet	Boys Ranch Ditch	Boys Ranch Ditch	Boys Ranch Ditch
Final Water	IS&R Wells (1-4)	Price Shallow Well	New Sagers Well	IS&R Wells (1-4)	Price Shallow Well	New Sagers Well
CALCITE	4.87	4.25	4.72	2.27	1.65	2.12
CO2	0.08	-8.72	0.80	-0.43	-9.23	-0.43
DOLOMITE	ci	2.67	ci	ci	3.67	ci
GYPSUM	ci	ci	ci	ci	ci	ci
HALITE	0.34	19.06	1.35	0.62	19.35	1.64

Mixing

Initial Water 1	Sed Pond Outlet	Sed Pond Outlet	Sed Pond Outlet	Sed Pond Outlet	Sed Pond Outlet	Boys Ranch Ditch	Boys Ranch Ditch
Initial Water 2	Boys Ranch Ditch	Boys Ranch Ditch	Boys Ranch Ditch	IS&R Wells (1-4)	IS&R Wells (1-4)	IS&R Wells (1-4)	IS&R Wells (1-4)
Final Water	IS&R Wells (1-4)	Price Shallow Well	New Sagers Well	Price Shallow Well	New Sagers Well	Price Shallow Well	New Sagers Well
% Initial Water 1	84.4	nm	85.2	12.8	3.1	27.4	6.7
% Initial Water 2	15.6	nm	14.8	87.2	96.9	72.6	93.3
CALCITE	4.47	nm	4.33				
CO2		nm		-8.79	0.00	-8.92	-0.3
DOLOMITE	ci	nm	ci	4.26	ci	4.27	ci
GYPSUM	ci	nm	ci	ci	ci	ci	ci
HALITE	0.38	nm	1.40	18.78	1.03	18.90	1.06

ci = models returned only by ignoring one or more constraints; reaction not plausible
nm = no models returned; reaction not plausible
empty cell = no model run

precipitated and their concentrations in the water were not high enough for this to occur.

Modeling results indicate that groundwater encountered in the KCC Well (GW-6), which is located at the mouth of Pine Canyon, may readily evolve to the groundwater encountered in the IS&R smelter monitoring wells as well as the shallow Price and New Sagers Well. In each of these cases, groundwater evolution between GW-6 and the subject location includes loss of calcite by precipitation and increases in dissolved dolomite, gypsum, and halite. Such concentration increases in groundwater from the point of mountain-front recharge to locations in valley fill sediments some distance from the point of recharge are common throughout the western United States.

Modeling results show that groundwater in the smelter area (GW1-4) may evolve to that encountered in the Price Well only if slight amounts of gypsum and gypsum+dolomite respectively are precipitated. These reactions are not theoretically plausible because the concentrations of these solutes in the groundwater are not high enough to precipitate. However, the required changes in concentrations are so slight that they are considered within the accuracy limitations of the data and modeling method. Plausible reaction models that involve either settling pond or Boys Ranch ditch water as the sole source of groundwater encountered in the smelter area or shallow Price Well were not possible. In all cases, the appreciable concentration of gypsum and/or dolomite in the mine water had to be decreased through precipitation to evolve the subject groundwaters, and the concentrations of these minerals in the mine water were not high enough to support the precipitation reactions.

To further evaluate the geochemical evolution of the various groundwaters, certain source waters were modeled to allow mixing in an iterative fashion so the model could identify plausible blended conditions and chemical reactions. The results show that no combination of settling pond and Boys Ranch ditch water would evolve the groundwaters in the smelter area or the Price Well. The same is true when varying amounts of settling pond or Boys Ranch ditch water were mixed with smelter area groundwater to try to evolve the groundwater in the Price Well. In all cases, the appreciable concentration of gypsum and/or dolomite in the mine water had to be decreased through precipitation to evolve the subject ground waters, and the concentrations of these minerals in the mine water were not high enough to support the precipitation reactions.

Results of mixture modeling show that mixed settling pond/or Boys Ranch ditch water with smelter area groundwater is an unlikely source of groundwater chemistry encountered in the shallow Price Well because major precipitation of dolomite and/or gypsum would be required, and the concentrations of these minerals in the water are not high enough to support these precipitation reactions. The modeling also indicates that groundwater encountered in the shallow Price Well would not evolve from the water in wells GW-1 through GW-4, because of the required unlikely minor precipitation of dolomite and/or gypsum.

Table 2-48 summarizes the conclusions reached by the geochemical modeling.

Table 2-48
Summary of Geochemical Evolution Feasibility

Initial Water	Final Water	Potential Geochemical Evolution
GW-6 (Pine Canyon alluvial water)	Smelter wells GW-1, GW-2, GW-3 and GW-4	Evolution likely
GW-6 (Pine Canyon alluvial water)	Shallow Price Well	Evolution likely
Smelter wells GW-1, GW-2, GW-3 and GW-4	Shallow Price Well	Evolution not likely – minor precipitation of dolomite and/or gypsum required
Mine Dewatering Sedimentation Pond Outlet	Smelter wells GW-1, GW-2, GW-3 and GW-4	Evolution not likely – major precipitation of dolomite and/or gypsum required
Mine Dewatering Sedimentation Pond Outlet	Shallow Price Well	Evolution not likely – major precipitation of dolomite and/or gypsum required
Boys Ranch Ditch	Smelter wells GW-1, GW-2, GW-3 and GW-4	Evolution not likely – major precipitation of dolomite and/or gypsum required
Boys Ranch Ditch	Shallow Price Well	Evolution not likely – major precipitation of dolomite and/or gypsum required
Mine Dewatering Sedimentation Pond Outlet + Boys Ranch Ditch	Smelter wells GW-1, GW-2, GW-3 and GW-4	Evolution not likely – major precipitation of dolomite and/or gypsum required
Mine Dewatering Sedimentation Pond Outlet + Boys Ranch Ditch	Shallow Price Well	Evolution not geochemically plausible
Mine Dewatering Sedimentation Pond Outlet + Smelter Wells GW-1 through GW-4	Shallow Price Well	Evolution not likely – major precipitation of dolomite and/or gypsum required
Boys Ranch Ditch + Smelter Wells GW-1 through GW-4	Shallow Price Well	Evolution not likely – major precipitation of dolomite and/or gypsum required

2.15.4.6 Isotopic Compositions

The stable isotopic composition of a sample is reported as the per mil (‰) difference of the sample relative to the isotopic composition of a standard using the delta ( ) notation defined as:

$$\delta = \frac{(R_{sample} - R_{standard})}{(R_{standard})} x1000 \quad (‰)$$

Where R = $^{18}O/^{16}O$ and $^{2}H/^{1}H$. The notation is reported in terms of the heavy isotope in the ratio R (i.e., ^{2}H for $^{2}H/^{1}H$).

The stable isotopic compositions of waters are usually interpreted relative to the world-wide Meteoric Water Line (MWL). The MWL is empirically derived from the worldwide plotting locations of coastal zone precipitation and is defined by the equation $^{2}H = 8\ ^{18}O+10$. A key utility of stable isotopes is the recognition that precipitation that forms under cooler conditions will plot lower on the MWL than will precipitation that forms under warmer conditions. The natural isotope partitioning during precipitation can be used as a tool to discriminate between different groundwaters regardless of the differences in their solute concentrations.

Except for unusual conditions, such as heating above about 100°C and excessive evaporation, the ^{2}H and ^{18}O composition of a groundwater is set at the time of recharge and is not affected by subsurface conditions such as residence time and mineral dissolution and precipitation reactions. In other words, the recharge and flow history of groundwater can be evaluated independently of the solute content of the water using stable isotopic compositions.

The stable isotopic compositions of groundwater in the Carr Fork – Lincoln – Erda area plot in two general locations relative to the MWL (Figure 2-40). The different plotting locations indicate that water encountered in the Price Well as well as other groundwater located on the southern slope of the Rose Spring groundwater mound, are not the same as other groundwater in the area, including groundwater beneath the IS&R facility and mine dewatering water(CFSS).

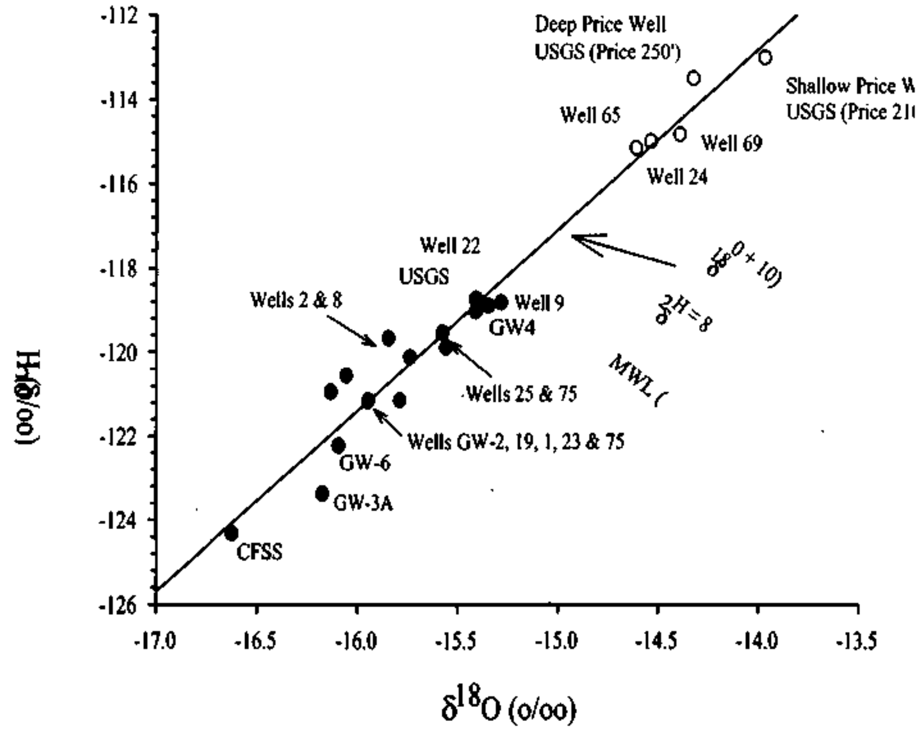

Figure 2-40. Stable Isotopic Compositions of Groundwater in the Carr Fork - Lincoln - Erda Area, Utah

In conclusion, the stable isotopic data provides further evidence that water encountered in the shallow Price Well is chemically and isotopically distinct from the groundwater under the IS&R site or that pumped from the Carr Fork underground mine (CFSS). Historical discharge data, along with current groundwater and geochemical modeling, as well as the isotopic sampling, indicate that the Site is not the source for the impacts to the Erda wells.

2.15.5 Remedial Investigation Sampling

Using historical data as a guide, a groundwater field investigation program was developed for monitoring current aquifer conditions. The field phase of the study employed various tasks as needed to determine current aquifer water quality both regionally and locally, vadose zone saturation, vadose zone pore water quality and evidence of COC movement through the unsaturated zone above the water table.

2.15.5.1 Groundwater RI Sampling

Using a series of downgradient existing wells, a monitoring net was used to assess existing and potential smelter associated groundwater impacts. Wells upgradient of the Site and wells in the Erda area were also field sampled and analyzed. Past pump tests, well logs and well phreatic surfaces were used to determine hydraulic aspects.

During the RI, samples were collected from each of the designated smelter site wells a minimum of four times, once per quarter, with the exception of two new wells, GW7 and GW8, which were installed in June, 2004, and have been sampled only once. Monitoring wells used in the investigation are listed on Table 2-49 and shown on Figure 2-21.

Wells were sampled (and in some cases, installed) in accordance with the following Standard Operating Procedures (SOP):

- SOP 1-3: Sample ID and Tracking
- SOP 1-4: Field QC
- SOP 1-5: Use of Field Log Books
- SOP 1-6: Sample Custody and Documentation
- SOP 1-7: Decontamination of Hand Tools and Drilling Equipment
- SOP 1-11: Packaging and Shipment of Field Samples
- SOP 2-8: Preservation and Handling of Aqueous Samples
- SOP 2-9: Field Water Quality Measurements
- SOP 4-1: Groundwater Sampling
- SOP 4-4: Low Flow Purging and Sampling Procedure
- SOP 4-6: Monitoring Well and Borehole Abandonment
- SOP 4-7: Borehole Logging
- SOP 4-8: Well Development
- SOP 4-9: Well Purging
- SOP 4-10: Monitoring Well Design and Construction

Following purging and sampling of each of the wells, aqueous samples were analyzed for parameters and analytes as shown on Table 2-4.

Physical properties of the smelter site wells are shown on Table 2-49 below. Water quality analytical results from the smelter site well sampling are included in Section 3.13. Descriptions, justification and the reason for sampling each of the wells is provided in the paragraphs below.

Table 2-49
Monitor Wells Sampled In IS&R Remedial Investigation

Well Designation	Casing Diameter (inches)	Screened Interval (feet)	Depth of Well (feet)	Depth to Water (feet)	Surface Casing Elevation (feet)	Water Elevation (feet)	Year Installed
GW-1 (6" Boys Ranch Well)	6	600 - 650	660	601 (12/02) 608 (6/04)	5006	4405	1975
GW-1B (16" Boys Ranch Well)	16	600 - 650	642	599 (12/02)	5001	4402	1970s
GW-2 (Sagers Well)	8	580 - 656	652	545 (9/02)	4943	4398	1970s
GW-3A (Northwest Corner)	6	630 - 650	650	606 (12/02)	5005	4399	200
GW-4 (Tailings Dam Well)	6	610 - 739	739	674 (12/02)	5071	4397	unknown
GW-5 (Designation not used)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GW-6 (KCC Well)	8 - 10	80 - 195	195	106 (9/02)	5564	5458	1936
GW-USGS	4	501 - 543	543	420 (9/02)	4810	4390	1995
New Sagers	8	open casing	340	227 (10/02)	4606 (ground surface)	4379	2002
GW-1BR	4	736 - 746	746	614 (6/04)	5003	4389	2004
GW-7	4	605-655	655	590 (6/02)	4988	4398	2004
GW-8	4	615-665	665	594 (6/02)	4992	4398	2004

<u>GW-1- 6" Boys Ranch Well:</u> GW-1 sits in a strategic location at the base of the Pine Canyon drainage and is at the center of the downgradient water quality monitoring net. The original purpose of this well is not known for certain, however, it was used at least once in 1975 as part of a pump test conducted to determine hydraulic properties of the aquifer. This well in particular is ideally located to monitor the Pine Canyon drainage and its tributaries.

Historically, arsenic concentrations have exceeded MCL standards (see Table 2-29). Physical properties of this well, as shown above, were determined by video taping the well in the spring of 2002. In June 2004, the screened interval of this well was cleaned with mechanical scraping and an acid wash, and a new video was filmed at this time.

GW-1B - 16" Boys Ranch Well: GW-1B was installed in 1970 by Anaconda. Historically, arsenic concentrations have exceeded MCL standards in this Boys Ranch well also (see Table 2-29). This well was sampled during the first RI sampling event in December 2001 and found to have similar water chemistry and quality as GW-1. Therefore, due to the close proximity of the two wells, only GW-1 was sampled during the remainder of the RI. Physical properties of this well, as shown above, were also determined by video taping the well in the spring of 2002. In June 2004, GW-1B was abandoned and replaced by a deeper well (GW-1BR) drilled to 750 feet.

GW-1BR New Boys Ranch Well: In June 2004, the perforated zone of the 16' Boys Ranch well was grouted up. Then a new 4" diameter well was drilled through the grout, then into native soil to a depth of 750 feet. The new screened interval is 736 to 746 feet. Information from a nearby exploratory boring completed in the 1970s indicated the presence of several thin clay beds around 730 ft depth. The new perforated zone was designed to be directly below these clay beds, thought to separate two separate zones of the aquifer. GW-1BR represents a deeper groundwater zone, which is apparently not hydraulically connected to the upper zone, based on water levels measured in June 2004. The groundwater elevation in GW-1, GW-7, and GW-8 were all within 0.63 ft of each other, whereas the groundwater elevation in GW-1BR is 9 feet lower. Analytical results discussed in 2.13.1.10 support the conclusion, as the arsenic value was undetected in GW-1BR, but was 0.220 mg/L in GW-1B.

GW-2 - Sagers Well: The well referenced to as the GW-2 (Sagers Well) was installed in 1963 by Robert Sagers, as a source of irrigation water. The State Engineers office does not have a record of a water right being applied for by the original owner. However, a subsequent landowner, Rodney Mecham, applied for and received approval for a water right to extract water from this well for domestic purposes. The application, submitted on November 30, 1994 and approved April 5, 1996, is for 0.45-ac ft for one household. The proof for this application was due on October 31, 2003. The Utah Division of Water Rights now lists this water right as "lapsed." GW-2 well is located approximately ½ mile downgradient from the GW-1. GW-2 represents groundwater in the Lincoln area and is the only current source of groundwater that could be used for domestic consumption. This well was included in the sampling program to confirm that COC migration had not occurred in the Lincoln area. Only once in the historical record this well contained lead concentrations which exceeded MCL standards (May 1972). This sample represented a total concentration.

GW-3A: GW-3A was drilled as part of the RI in 2002. The well was drilled at the northwest corner of the Atlantic Richfield property to: 1) monitor groundwater flow at the northern most edge of the property, 2) gauge the effects of the infiltration of mine water discharged over the field directly up gradient, and 3) monitor infiltration impacts of surface water flowing in the adjacent Boys Ranch ditch. Anaconda, during the 1970s drilled a 200 foot deep well at this location to monitor the unsaturated zone moisture, as part of their water infiltration disposal program. That hole (named well "T") is currently dry and from available records, always has been. The well is located down gradient of the SE1/4 of Section 12, an area known to be used heavily for infiltration of mine de-watering flows. The well also sits at the terminus of the irrigation portion of Boys Ranch ditch. Formally at this location a head gate stopped the water during the irrigation season so that it could overflow into downstream fields and irrigation ditches. Also adjacent to the well are remnants of a pond (no longer used) that stored excess irrigation water for use at the Boys Ranch field.

GW-4 -Tailing Impoundment Well: GW-4 has been used for many years by both the agencies and Anaconda to check for migration of COC into the groundwater from the tailing impoundment or other operations up gradient. The well was sampled during the RI for this same purpose. Except for two isolated samples with elevated lead in the early 1980s, water quality in the well has always contained acceptable levels of COC concentrations.

GW-6: KCC Well: GW-6 is in the Pine Canyon drainage above the smelter site. The purpose for including this well in the monitoring program was to better understand aquifer conditions and water properties in the recharge zone and determine if elevated levels of COC exist up gradient of the smelter site. At the beginning of the RI, this well was the only existing well in Pine Canyon above the Site. In the fall of 2002, the USGS drilled a deeper well, at a higher elevation in the canyon.

GW-USGS Well: The USGS Well is the next existing downstream well from GW-2. The USGS well was included in the RI sampling program to confirm that COC migration has not occurred. Water from this well has always met MCL standards.

New Sagers - William Sagers Well: In the fall of 2002, William Sagers drilled a new well for irrigation. The well is not within the hydraulic flow path of particles from the Smelter, however as the next available sampling point down gradient, relative to the analytical model, the well was sampled to confirm COC levels are below MCL standards.

GW-7: Well GW-7 was installed in June 2004 downgradient of the Boys Ranch wells. The purpose of the well was to investigate the potential migration of contaminants along the modeling analytical flow path.

GW-8: Well GW-8 was installed in June 2004 downgradient of the Boys Ranch wells. The purpose of the well was to investigate the potential migration of contaminants along the modeling hydraulic flow path.

As discussed in Section 3.13.2, limited sampling was conducted on 14 of the wells in the vicinity of Erda (listed in Table 3-16). Since these wells were domestic, and there was no access to the wells, samples were collected from outside faucets. The exception was the Price Wells. These are not used for domestic purposes, and a submersible pump was used to purge and sample these wells in accordance with applicable SOPs. The Erda wells were only analyzed for the following cations and anions: calcium, magnesium, sodium, potassium, arsenic, lead, bicarbonate, chloride, sulfate, nitrate, and nitrite. In addition, they were analyzed for TDS and pH.

2.15.5.2 Non-Groundwater RI Sampling

Media other than groundwater, which were sampled during the investigation of WA 12. These media included:

- Subsurface soil samples in potentially impacted Work Areas
- Subsurface soil down gradient from the slag pile
- Tailings and underlying native soil
- Soil samples from within the Waste Isolation Cell
- Pore water samples from lysimeters

Results of this sampling are included in Section 3.0.