APPENDIX D

UGW#350010

BINGHAM CANYON MINE AND WATER COLLECTION SYSTEM CONCEPTUAL MINE CLOSURE PLAN

VERSION DATE 2003

Kennecott Utah Copper Corporation
12000 West 2100 South
P.O. Box 6001
Magna, Utah 84044-6001
Tel: (801) 569-7120 (Barney's)
Fax: (801) 569-7192 (Barney's)
Tel: (801) 569-7596 (Smelter EMC)
Fax: (801) 569-6408 (Smelter EMC)

Kennecott

Paula H. Doughty
Manager, Environmental Affairs and
Strategic Resources

April 25, 2003

Wayne Hedberg, Permit Supervisor
Minerals Reclamation Program
Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, Utah 84114-5801

Don A. Ostler, Director
Division of Water Quality
Utah Department of Environmental Quality
P.O. Box 144870
Salt Lake City, Utah 84114-4870

Gentlemen:

Subject: Submittal of Bingham Canyon Mine Reclamation and Water Management Plan for DOGM Permit# M/035/002 and for Groundwater Discharge Permit # UGW350010

Attached to this letter is the Kennecott Utah Copper Corporation's (Kennecott's) 2003 Bingham Canyon Mine Reclamation and Water Management Plan. Also attached are responses to the Division of Oil, Gas and Mining (DOGM) comments on the third draft of the plan dated January 31, 2003. Based upon conversations and e-mail communications between Kennecott and Department of Environmental Quality (DEQ) personnel over the past week, Kennecott believes that all of the comments from both Divisions have been addressed in this final update of the plan.

With the submittal of this document Kennecott assumes that the permit requirement for a conceptual closure plan listed in Ground Water Discharge Permit UGW350010 has been fulfilled.

The original Reclamation Plan for the Bingham Canyon Mine was submitted to DOGM in 1976 and was incorporated into the final Mined Land Reclamation Contract signed on September 28, 1978. As requested by the Division, and in accordance with the regulations that were in effect in 1978, Kennecott is pleased to submit this update to the original Reclamation Plan. It should be noted that although the new Reclamation Plan represents a refinement over the 1976 plan, the nature of the reclamation envisioned by both plans does not differ substantially.

It has been a pleasure working with your staff on this project over the past few years. If you have any questions or comments about the final version of the plan, please give me a call at 569-7120.

Sincerely,

Paula Doughty, Manager Environmental
Affairs and Strategic Resources

Attachments

bcc: Vicky Peacey
OPS-RR-MF-Closure Plan ✓

BINGHAM CANYON MINE 2003 RECLAMATION AND

WATER MANAGEMENT PLAN

DOGM PERMIT NUMBER M/035/002

GROUND WATER DISCHARGE PERMIT NUMBER UGW350010

Submitted to

Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, Utah 84114-5801

Utah Division of Water Quality
288 North 1460 West
PO Box 144870
Salt Lake City, Utah 84114-4870

Submitted by

Kennecott Utah Copper Corporation
8315 West 3595 South
PO Box 6001
Magna, Utah 84044-6001

March 2003

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1.0 INTRODUCTION

This report is intended to provide the Utah Division of Oil, Gas and Mining (DOGM) with an update to the Reclamation Plan for mining-related disturbance within the boundaries of Permit Number M/035/002. This report is also designed to fulfill the requirements for a conceptual closure plan required by Ground Water Discharge Permit UGW350010 (Bingham Canyon Mine and Leach Collection System). Kennecott Utah Copper Corporation (KUCC) submitted the original Mining and Reclamation Plan to DOGM in 1976. It was incorporated into the final Mined Land Reclamation Contract signed on September 28, 1978. Reclamation bonding was waived in lieu of a personal guarantee on the part of KUCC.

The original reclamation plan is still valid for KUCC's existing operations and consistent with the reclamation activities described in this report. However, the original plan could not be very specific about future reclamation options because of the long life expectancy of the mining operation. These same planning difficulties exist in 2003 because the surface mine is currently expected to be in operation for at least another 10 years.

This report proposes tentative reclamation actions and attempts to establish a decision-making framework for selecting optimum reclamation actions in the future. To aid in this process, this report also identifies information needed to make reclamation decisions that is not currently available but that will be collected in the future.

1.1 PERMIT NUMBER M/035/002 1976 RECLAMATION PLAN

A copy of the 1976 Mining and Reclamation Plan is attached in Appendix A. Figure 1-1 is a map showing the boundaries of Permit M/035/002 and all subsequent DOGM permits. The original plan divided the permit area into seven operational land use categories and specified maximum areas that could be disturbed within each category: 1) Mine - 3100 acres, 2) Mine Waste Disposal - 8000 acres, 3) Excess Mine Water Disposal - 2700 acres, 4) Ore Transfer - Mine to Process - 400 acres, 5) Ore Processing Facilities - 1800 acres, 6) Tailings Disposal - 6000 acres, and 7) Excess Process Water Disposal - 1000 acres. For each land use category, the plan described the physical setting in 1976 and the land use and vegetation that was present before mining began. It also presented potential post-mining land uses and general reclamation strategies.

1.2 SUBSEQUENT RECLAMATION PLANS

A series of new reclamation plans have been submitted to DOGM since 1976 for new construction projects or land uses that are different from the original 1978 Permit. A new DOGM permit number was issued for each of these projects and bonding was required. These new permits include the Fourth Line/Copperton Concentrator, Pine Canyon, and the North Impoundment Expansion. None of these new permit areas is discussed in detail in this report because they each have their own detailed reclamation plan. Several additional reclamation plans relating to dust control and groundwater quality protection for the existing tailings impoundment have also been submitted to various State agencies.

1.2.1 Copperton Concentrator/Fourth Line Expansion Reclamation Plan

A reclamation plan for the Copperton Concentrator, ore conveyor and tailings pipeline corridor was initially submitted to DOGM in April 1986. Amended plans were subsequently submitted for the addition of the Molybdenum Plant and for a fourth mill line. These plans describe building demolition and reclamation activities and costs for the ore conveyor and Copperton Concentrator. Total bonding for these facilities is currently $19,029,000. The original pipelines within the tailings pipeline corridor were exempted from bonding because of plans to use the pipelines for post-mining water management. However, the second tailings pipeline within the corridor is bonded in order to provide coverage for reclamation costs in the event that it is not used for post-mining water management. These facilities are all managed under DOGM Permit Number M/035/011.

1.2.2 Tailings Pond Reclamation Plans

Several reclamation plans have been submitted for the South Tailings Impoundment and for the North Impoundment expansion. The Tailings Pond Final Reclamation Plan was submitted to the Utah Air Conservation Committee and DOGM in July 1988. The plan focused on revegetation strategies and techniques for dust control on the impoundment. It assumed that the South Impoundment would be in operation for another 30 to 35 years, but this plan became obsolete when the North Impoundment expansion was initiated. The initial notice of intent for the North Impoundment expansion was submitted in 1994 and contained a detailed reclamation plan for the new impoundment. Permit number M/035/015 was issued for the North Impoundment in February 1996 and is currently bonded for $20,628,000. Two more recent reclamation plans have been submitted to State agencies that describe closure and reclamation of the South Impoundment. The Tailings Modernization Fugitive Dust Abatement Program, submitted to the Utah Division of Air Quality in 1994, contains a detailed revegetation plan for the surface of the South Impoundment. The Final Closure Plan for Groundwater Issues, submitted to the Utah Division of Water Quality in 1997, describes how surface and groundwater will be managed on the South Impoundment at closure. These plans are attached in Appendices B and C.

1.2.3 Pine Canyon Reclamation Plan

A reclamation plan for the Pine Canyon Mine and Mill Site was submitted in 1988. The plan was approved and has largely been implemented. Total bonding for Permit M/045/004 is $120,800 for reclamation of the few remaining structures and disturbed acres in the canyon.

1.3 OTHER PERMITS AND LAWS GOVERNING RECLAMATION AND POST-CLOSURE LAND USE

KUCC will have to comply with all applicable permits and laws governing surface water, groundwater, air emissions, hazardous wastes and soil contamination both during and after closure. Many of these laws and permits will influence the extent and character of reclamation that takes place at closure. In particular, as described below, Ground Water Discharge Permit UGW350010 requires the submittal of a closure plan that addresses groundwater quality issues around the mine and waste rock disposal areas.

1.3.1 Groundwater Discharge Permits

Ground Water discharge permits are managed by the Utah Division of Water Quality (DWQ). KUCC's permits require ground water monitoring, reporting and corrective actions if an out of compliance situation exists.

Ground Water Discharge Permit UGW350010 for the Bingham Canyon Mine and Leach Collection System (Part I, K.3) requires the submittal of a conceptual closure plan. The plan is required to "provide detail on all aspects of closure that are related to or have an impact on water quality". This includes preliminary designs and a schedule to modify the waste rock dumps to minimize infiltration, and a description of post-closure monitoring. The permit also requires that a final closure plan be submitted one year before closure. The Bingham Canyon Mine 2003 Reclamation and Water Management Plan (this document) is intended to fulfill the permit's requirements for a conceptual closure plan.

The Groundwater Discharge Permit for the tailings disposal area may also require post-closure maintenance and long-term monitoring. It is likely that the groundwater discharge permit for the North Concentrator area will have fewer post-closure requirements after demolition and reclamation have been completed there.

1.3.2 National Historical Site Registry for Bingham Pit

The Bingham Canyon open pit was designated as a National Historic Landmark in 1966. The designation was based upon the historical significance of the pit as well as its overall physical appearance. The National Historic Preservation Act was passed with the specific intention of identifying and assuring the continued existence of National Historic landmarks. Furthermore, State law requires that each State agency take into account the effect of an undertaking on any district, site, building, structure or specimen that is included in or eligible for inclusion in the National Historic Register of Historic Places or the State Register. Accordingly, reclamation obligations that would alter or amend the Landmark should consider the implications of the activities on the Landmark.

1.3.3 UPDES Permit

The DWQ will also manage the UPDES permit for surface water discharges off the property after closure. The UPDES permit will specify water quality criteria at each permitted outfall point and may specify storm water management practices. KUCC or its designate will continue to manage both surface water and captured groundwater of various qualities from throughout the property after closure.

1.3.4 Air Permits

The Utah Division of Air Quality (DAQ) manages Air Approval Orders, Title V Operating Permits and sections of the State Implementation Plan at the Mine, Concentrators and Tailings Impoundment. Air emissions at the concentrators will end at closure, though certain air quality requirements may apply during demolition and reclamation. The level of dust emissions from the mine, waste rock disposal areas and tailings impoundment will be highly dependent upon the reclamation actions that are selected. It is likely that the DAQ will continue to require oversight of these facilities during and after closure.

1.3.5 CERCLA Sites and NRDC for Acid Plume

Under the terms of various Environmental Protection Agency (EPA) Comprehensive Environmental Response Compensation and Liability Act (CERCLA) administrative orders and a 1995 Memorandum of Understanding (MOU), the EPA and the State Division of Environmental Response and Remediation (DERR) provide oversight and specify minimum cleanup standards during remediation activities at historically contaminated sites. As part of the 1995 MOU, KUCC agreed to "complete environmental assessments of currently identified on-site historic facilities and their associated wastes and conduct cleanups of these wastes if shown necessary by the ecological and human health risk assessments". Figures 1-2 and 1-3 are maps and lists of historical sites within the boundaries of DOGM permit M/035/002. To date, the majority of sites that fall within the permit boundaries have received a "No Further Action" status from the EPA and DERR as identified in two Records of Decision dated December 13, 2000 and September 28, 2001. Most of the remaining sites will be addressed many years before closure, but it is possible that new sites will be identified or that remediation will continue after closure at other sites.

Historical leach water and acid rock drainage (ARD) losses that occurred at the base of the waste rock disposal areas, from the former Bingham Creek Reservoirs and from the South Jordan Evaporation Ponds contaminated portions of the alluvial aquifer in the southwest Jordan Valley. Concentrations of sulfate and metals in some parts of the aquifer are above human health standards for some constituents.

Several corrective measures were taken in the early to mid 1990s to prevent additional releases to the aquifer. These included: 1) taking the South Jordan evaporation ponds out of service, removing and/or consolidating sludges on-site, and capping and reclaiming the area; 2) temporarily taking the Bingham Creek reservoirs out of service and replacing them with

reservoirs that have a triple-layer liner system; and 3) improving the capture of seepage from the Eastside
waste rock disposal areas by upgrading the surface and subsurface collection systems. In addition, active leaching of the waste rock disposal areas was terminated in Fall 2000. These steps are important source control measures for protecting the regional aquifer against further contamination.

Development of a plan to efficiently remediate the existing groundwater contamination involved groundwater management and treatment specialists, state and federal regulators, local community leaders and local water purveyors. Settlement of the Natural Resources Damage Claim made by the State of Utah for the Bingham Creek Groundwater plume requires, among other things, that the acidic portion of the groundwater plume be extracted. Barrier wells installed at the plume's terminus will be pumped in perpetuity to contain the sulfate portions of the plume. These activities will take place before, during and after closure.

1.4 1998 UPDATE OF MINING OPERATIONS

The final draft of the 1998 Update on Mining Operations Conducted Under DOGM Permit Number M/035/002 was submitted to DOGM on September 30, 1998. The 1998 Update describes in detail the mining operations that existed within the permit boundaries in 1998 and provides a brief history of the operations since the original permit was received in 1978.

1.5 REPORT ORGANIZATION

This reclamation report is organized in the same general manner as the 1976 Mining and Reclamation Plan. Section 2.0 describes general reclamation strategies that are common to each land use category described in the original plan. Sections 3.0 through 9.0 present tentative reclamation activities for each land use category. These sections also describe the issues and data requirements that need to be addressed in order to refine and finalize the selected tentative activities. Section 10.0 describes post-closure water management activities and Section 11.0 briefly describes future and on-going research that is being conducted in support of reclamation and closure.

2.0 GENERAL RECLAMATION STRATEGY

The following sections describe the general decision making processes that were used to determine if and when a site should be reclaimed, and to select the most appropriate actions at sites that have been scheduled for reclamation.

2.1 RECLAMATION TIMING

The ultimate fate of facilities that currently exist within the permit boundaries is: 1) to be reclaimed during the life of the mine, 2) to be reclaimed during mine closure, or 3) to not be reclaimed. Any facilities that are to be left in place after closure will need to have a confirmed post-closure use.

It may be logical to close and reclaim some facilities before general mine closure. For example, changes in process or economics may make some facilities obsolete. Facilities that reach the end of their designed operational life, such as the South Tailings Impoundment, may also be reclaimed before general mine closure. Facilities that are inactive and that may pose a risk of contaminant release to the environment will generally be demolished and remediated before general closure.

Under current plans, most facilities will be reclaimed at the time of general mine closure. However, some facilities may be left in place if they have a demonstrated post-mining use and if they do not pose a threat to human health or the environment.

2.2 SELECTION OF RECLAMATION ACTIVITIES

Tentative reclamation actions for each land use category specified in the 1978 Permit are selected according to the following steps:

- closure issues are identified
- possible post-closure land uses are identified
- information that is needed before final closure options can be selected is identified
- tentative reclamation actions are selected.

The following subsections provide a general description of each of these steps. Sections 3.0 through 9.0 are also organized according to the format described here.

2.2.1 Closure Issues

Regulations and permits governing closure, in particular, actions required by the 1976 Mining and Reclamation Plan or Groundwater Discharge Permit UGW350010, are identified for each land use category. Known hazards and environmental liabilities that will exist at closure are also described, and the environmental goals of the reclamation process are listed.

2.2.2 Possible Post-Closure Land Uses

Possible post-closure land uses are identified based upon the limitations imposed by the regulatory, chemical and physical setting that will exist at closure. In the future, land use may also be selected based upon cleanup standards derived from exposure and risk assessments. Sites without long-term maintenance requirements and where all physical and chemical hazards are removed, may have an unrestricted post-closure land use. At the other extreme, sites that will require continuous maintenance after closure, or that will still pose physical or chemical hazards, will have a more limited set of possible post-closure land uses. The identification of these limitations early in the planning process can help define the reclamation strategy.

2.2.3 Data Requirements

This section identifies information that is not currently available but is needed in order to refine the tentative reclamation actions.

2.2.4 Reclamation Activities

Tentative reclamation activities are selected for each land use category based upon the incomplete data set that is currently available. These actions may be refined in the future as necessary data requirements are filled and as new technologies become available.

2.3 RECLAMATION OF BUILDINGS AND STRUCTURES

The original Mining and Reclamation Plan submitted to DOGM in 1976 specified that all surface facilities, utilities, railroads, paved areas and equipment would be razed and/or removed except for those with a post-mining use. This is a common requirement to each of the operational areas specified in the 1978 Permit, and reclamation will generally be conducted in a similar fashion at each site.

Table 2-1 lists the major facilities and structures that currently exist within the permit boundaries, and specifies the closure approach and status currently planned for each facility. Figures 2-1 and 2-2 show the locations of buildings and structures around the mine and the North Concentrator/Magna Tailings area. The closure approach consists of one or more activities for each facility. A brief description of the principle activities is provided below:

- Demolition (Demo) involves the removal of salvageable equipment and destruction of buildings or structures and foundations.

- Remediation (Remed) involves excavation and removal of contaminated soils and debris.

Table 2-1 Facilities and Structures within the Permit Boundaries

FACILITY DESCRIPTION	CLOSURE APPROACH	STATUS
MINE		
Water Tanks	Demo and Reclaim	Final
General Buildings	Demo and Reclaim	Final
Visitors Center and Parking Area	Leave in Place	N/A
Lead Mine Townsite	Demo and Reclaim	Final
Lark Mine Buildings	Demo and Reclaim	Final
Yosemite Road	Demo and Reclaim	Final
Yosemite Truck Shop & Dispatch Tower	Demo	Final
Explosive Storage	Demo and Reclaim	Final
Dry Fork Warehouse & Shops	Demo	Interim
In-Pit Crusher	Demo	Final
6190 Truck Shop	Demo	Final
Code 80 Fuel & Lube Shop	Demo and Reclaim	Final
Miscellaneous Shafts	Demo and Reclaim	Final
44 KV Power Distribution Line	Leave in Place	N/A
Power Lines associated with dewatering	Leave in Place	N/A
Miscellaneous Power Lines	Demo and Reclaim	Final
Miscellaneous Tunnels	Demo and Reclaim	Final
Mine Access Road	Leave in Place	N/A
Asphalt/Concrete Parking Areas	Demo and Reclaim	Final
MINE WASTE DISPOSAL		
Small Bingham Reservoir	Leave in Place	N/A
Large Bingham Reservoir System	Leave in Place	N/A
Precipitation Plant	Demo, Remed and Reclaim	Interim
Water Management System Facilities	Leave in Place	N/A
ARD Collection System Facilities	Leave in Place	N/A
Leach Water Pumping Facilities	Demo and Reclaim	Final
6600 ARD Storage and Evaporation Ponds	Leave in Place	N/A
Pilot-Scale Water Treatment Facilities	Demo and Reclaim	Interim
SX-EW Pilot Plant	Demo and Reclaim or move	Interim
Asphalt/Concrete Parking Areas	Demo and Reclaim	Final
EXCESS MINE WATER DISPOSAL		
Evaporation Ponds and Associated Facilities	Demo, Remed and Reclaim	Completed(1)
ORE TRANSFER-MINE TO PROCESS		

Ore Reload	Demo and Reclaim	Final
Rail Tracks and ties	Demo and Reclaim	Interim
Rail Ballast	Remed and Reclaim	Interim
Copperton Rail Yard	Demo and Reclaim	Final
Railroad Car Repair Shop	Demo and Reclaim	Final
Ore Conveyor (in pit and 5490 Tunnel)	Demo	Final
Asphalt/Concrete Parking Areas	Demo and Reclaim	Final
ORE PROCESSING FACILITIES		
Magna Concentrator Area	Demo, Remed and Reclaim	Interim
Magna Asphalt/Concrete Parking Areas	Demo and Reclaim	Final
Arthur Shops Area	Demo and Reclaim	Final
Arthur Asphalt/Concrete Parking Areas	Demo and Reclaim	Final
Bonneville Area	Demo and Reclaim	Final
Bonneville Asphalt/Concrete Parking Areas	Demo and Reclaim	Final
Pipelines	Demo and Reclaim	Final
TAILINGS DISPOSAL		
Magna Tailings Pond Structures	Demo and Reclaim	Interim
EXCESS PROCESS WATER DISPOSAL		
Excess Process Water Disposal Structures	Leave in Place	N/A
NOTE: Any facilities to be left in place will have a post mining use.		
(1) As described in Section 5, follow-up remediation is currently planned to remove gypsum-bearing sludge from the repository in the Evaporation Pond area.		

- Reclamation (Reclaim) involves regrading and revegetating the affected areas except for structures located in the Bingham Pit, on the waste rock surfaces or on the tailings impoundment. These sites will be reclaimed according to the reclamation activities described in Sections 3, 4 and 8 respectively.

- Leave in Place indicates that the facility will remain for future commercial, water management or other uses. Any facility to be left in place will have a demonstrated post-mining use at closure.

The closure status options listed in Table 2-1 are:

- Interim - indicates that the facility will probably become inactive and be reclaimed before general mine closure.

- Final - indicates that the facility will probably become inactive and be reclaimed during general mine closure.

- Not Applicable (N/A) - indicates that the facility may have a post-mining use or that the final closure option has not been selected.

- Completed - indicates that the facility has already been reclaimed.

Before each facility closes, residual feedstock materials and products will be identified, collected and processed, sold or otherwise removed. During demolition, salvageable and recyclable materials will also be sold or recycled. Uncontaminated construction debris that remains after all commercially valuable materials have been removed will either be transported to a Class IV landfill on KUCC property or buried on-site. Wherever possible, construction debris will be used as fill material to minimize the need to excavate and transport fill material from elsewhere. Shaft, adit and tunnel portals that are both within the permit boundaries and on Kennecott property will be assessed to determine if they would pose a risk to the public after closure. Those portals identified as a risk by the hazard assessment will be gated or sealed.

Soils beneath and adjacent to buildings and structures will be sampled during and/or after demolition. Sampling will be performed if it is believed that contamination may be present because of historical activities or field observations. Soils, construction debris or other materials that are determined to be contaminated with metals or organic compounds will be sent to an appropriate disposal or treatment facility. Selected materials may be decontaminated and recycled. Hazardous wastes will be sent to an off-site hazardous waste landfill, or may be disposed of on-site in the Arthur Repository if they meet the requirements of the corrective action management unit. According to their chemical characteristics, other materials will be bioremediated, sent to an industrial landfill, or sent to the waste rock disposal areas. Contaminated materials will be handled in compliance with all existing permits and regulations. However, within this legal framework, material-handling decisions will be based upon cleanup standards derived from exposure and risk assessments. For example, if the post-mining land use is industrial, then the cleanup standards for soils will address industrial worker exposures. If the post-mining land use is wildlife habitat, the clean up standards will be based upon exposures to potentially impacted species.

The footprint of demolished facilities within the Bingham Pit, on the waste rock dumps or on the tailings impoundment will be treated in accordance with the reclamation activities described in Sections 3, 4 and 8 respectively. For facilities that are not underlain by the pit, waste rock or tailings surfaces, fill material will be imported, drainages will be reconstructed, and the land surface will be graded and contoured consistent with the surrounding terrain. If the existing soils or fill materials do not provide a suitable growth media, topsoil will be imported and spread to a minimum depth of six inches. Subsoil will also be imported in addition to topsoil if required to provide a minimum of two feet of rooting media. Wherever possible, topsoil will be taken from nearby existing stockpiles. Reclaimed sites will be planted with native and select non-native species. Species mixes will be adjusted based upon parameters such as elevation and slope orientation. If field assessments indicate it is required, all the surfaces to be revegetated will also receive a light application of chemical fertilizer to provide nitrogen, phosphorus and potassium (not to exceed 50 lbs/acre available nitrogen) or may receive biosolids at application rates not to exceed 10 tons/acre of pure biosolids. If biosolids have been mixed with wood chips or another carbon source, the application rate of the mixture may be as high as 30 dry tons/acre, as long as the biosolids component of the mixture does not exceed 10 dry tons/acre. In general, phosphorus application rates will be higher than nitrogen application rates, which will be higher than potassium application rates.

3.0 MINE AREA

The Bingham Pit is currently about 13,000 feet across at its widest point and covers approximately 2300 acres. The associated support facilities cover about 170 acres and are generally sited on top of old waste rock disposal areas adjacent to the pit. A list of the support facilities is provided in Table 2-1. The open pit extends from approximately 8000 feet above mean sea level (amsl) to about 4500 feet amsl. Overall pit slopes will range between 32 and 52 degrees at closure and will be composed of a series of benches that average about 50 to 100 feet high and 40 to 50 feet wide. The Conveyor Tunnel connects the pit with the Salt Lake Valley. It has a western portal on the northeastern side of the pit at an elevation of about 5490 feet amsl and an eastern portal at an elevation of 5465 feet amsl in lower Bingham Canyon about 2000 feet west (up gradient) of the Bingham cutoff wall and reservoirs (Figure 2-1). According to the current surface mine plan, the pit will be approximately 300 feet deeper and cover several hundred additional acres at closure.

The distribution of sulfide mineralization within the walls of the Bingham pit provides the primary control on contact water chemistry and on the chemistry of soils that form on the pit benches. As the sulfides are oxidized, they produce acid that may be neutralized in situ if sufficient acid neutralizing minerals such as calcium carbonate are present in the rock. The amount of acid that a rock could produce if it is completely oxidized is termed its acid potential (AP) and the amount of acid that a rock can neutralize is termed its neutralization potential (NP). The net neutralization potential (NNP) is calculated by subtracting the AP from the NP and the neutralization potential ratio (NPR) is calculated by dividing NP by AP. A rock with a negative NNP or an NPR of less than one will likely generate acid rock drainage (ARD) as it weathers. In theory, a rock with a positive NNP or NPR greater than one will not generate ARD and may neutralize acidic solutions with which it comes into contact. However, because of the uncertainties created by differential reaction kinetics, leaching rates and mineral distribution in the rock, a commonly used screening criteria assumes that rocks with NNP values above zero and NPR values above one are possibly acid-generating unless the sulfide sulfur content is less than 0.3 % (AP < 10 tons/1000 tons) or the NPR is greater than 2 (Price et al., 1997).

Figure 3-1 is a map of acid potential on the current pit walls and Figure 3-2 is a graph showing the vertical distribution of acid potential. The acid potential is likely overestimated by about ten percent on these figures because it has been calculated from total sulfur analyses and so includes sulfur from non-acid-generating sulfate and sulfide minerals. On average, all of the current pit benches above 6900 feet amsl and most of the benches below 5000 feet amsl contain less than 0.3 percent sulfur (Figure 3-2). The primary acid-generating sulfide minerals in the Bingham Pit are pyrite, chalcopyrite, bornite and molybdenite. Pyrite is generally the most abundant and reactive of these sulfides and its distribution is the most significant control on the AP of the pit walls. Figure 3-3 is a graph showing the vertical distribution of AP derived from pyrite alone on the current pit walls. Below 5100 feet, the average pyrite AP varies between about two and ten tons/1000 tons. Much of the rest of the AP in the bottom of the pit is provided by molybdenite. Although molybdenite may generate acidity under some surface weathering conditions, in practice it is one of the most resistant sulfide minerals to oxidation and so is likely to be a minor contributor to acid production (Plumlee, 1999). The center of the pyrite halo around the ore body, where rock has the strongest potential to generate acid is largely confined to a band between 5500 and 6200 feet amsl.

The NP of the current pit walls is highly variable. Limestone beds tend to have the highest NP values while quartzites and late stage intrusive rocks tend to have the lowest (Table 3-1). Most of this NP is provided by calcium carbonate, but a small amount is also provided by various silicate minerals. For each sedimentary rock type, NP tends to be highest on the uppermost benches of the pit and decreases towards the center of the pit. In general, the sedimentary sequence on the northeast side of the pit has much less NP than in other areas. Within the igneous rocks, NP values tend to be highest in areas adjacent to limestone beds.

The distribution of NNP on the current pit surface is shown on Figures 3-4 and 3-5a. In plan view, the distribution of NNP in the pit can be visualized as donut shaped, with a positive (net-neutralizing) 3500-foot diameter core surrounded by a negative (net acid-generating) 10,000-foot diameter ring. As shown on Figure 3-4, the center of the low-grade core of the ore body has NNP values above 25 tons/1000 tons. The current pit walls are generally net acid-neutralizing below about 5200 feet amsl, are net acid-generating between 5200 and 6600 feet amsl, and are net acid-neutralizing again above about 6600 feet amsl (Figure 3-5a). The rock exposed in the lower 400 feet of the pit has average NPR values of two or higher (Figure 3-5b). As mining continues, more and more of the net neutralizing core will be exposed in the bottom of the pit. Figures 3-6a and 3-6b are vertical profiles of NNP and NPR for an ultimate pit that extends to a depth of 4240 feet amsl. The profiles are based on approximately 250 borehole intercepts with the estimated ultimate pit surface. The exact depth and geometry of the planned ultimate pit changes on a regular basis in response to new analytical data, changing copper prices and technological advances, but the 4240 ft amsl depth represents one of the deeper pit versions currently being considered. Based upon data from the current and 4240 ft ultimate pits, at closure almost all of the rock exposed in the lower 700 feet of the pit will likely be net neutralizing. The lower 200 feet will have average NNP values of greater than 20 tons/1000 tons and NPR values of greater than two. A more detailed description of the acid/base accounting geochemistry of the ore body is presented in the paper "Environmental Geochemistry of the Bingham Canyon Porphyry Copper Deposit, Utah" (Borden, 2003). This paper is attached in Appendix D.

The pit is surrounded by several small waste rock disposal areas (Figure 2-1). Some upper pit benches were mined through these old waste rock deposits as the pit expanded. This waste rock is generally net acid generating.

Surface and ground water inflows into the pit currently average about 1000 gallons per minute (gpm). Dewatering of the pit, combined with pumping from underground workings surrounding the pit, has created a large cone of depression in the groundwater table and caused radial flow towards the pit from all surrounding areas. These waters are currently pumped out of the pit and enter the process water circuit. Without pumping, water levels in the pit would recover to some elevation significantly higher than 5212 feet amsl. This was the maximum surface elevation of the lake that formed in the pit after only three years of filling and with intermittent pumping during the shutdown in the mid 1980s.

The pit is almost entirely surrounded by bedrock ridges and mountains that vary between 6800 and 9200 feet amsl. The lowest point on the pit walls is at the intersection with upper Bingham Canyon, here the bedrock elevation is 5900 ft amsl. As shown on Figure 3-7, the bedrock water table surrounding the open pit tends to mimic the topography. In 2001, the dry bottom of the pit was at approximately 4600 feet amsl and water was being pumped from underground workings on the west and northeast sides of the pit. Despite this peripheral dewatering, the down-gradient water table beneath Bingham Canyon and the 6800 to 7400 ft high ridge to the east of the pit was everywhere above 5449 ft amsl. In 2001, there was thus at least 800 feet of head driving water flow towards the pit from the down-gradient (east) side of the pit. This probably underestimates the actual gradient towards the pit because few of the monitoring points are located beneath the ridge crest, where water levels are likely highest. In 1998, immediately before pumping of the North Ore Shoot began, the bottom of the pit was at 4750 ft amsl and the water level in the North Ore Shoot was at 5647 ft amsl. The North Ore Shoot is located at the upper end of Bingham Canyon, about 5500 feet north-northeast from the bottom of the pit. In 1998, the head difference here was thus 900 feet and the gradient was 160 ft/1000 ft towards the bottom of the pit.

At closure, if other pumping on the perimeter of the pit is discontinued, the estimated annual average inflow could be as much as 2500 gpm. Water quality from different areas on the pit walls is variable depending on the characteristics of the bedrock with which the water has come into contact, and its residence time on the surface or within the surrounding rock mass.

Figure 3-8 is a conceptual model of water movement and water quality in and adjacent to the pit. The primary assumption made to create the conceptual model is that water will be pumped from the pit after closure to limit the elevation of pooled water in the bottom of the pit. If the pit is allowed to partially flood, the lake surface will be maintained at a low enough level to ensure radial groundwater flow into the pit and to minimize contact with the net acid-generating portions of the ore body and pyrite halo. The most significant chemical and physical controls on pit water chemistry are labeled with letters and the most significant flow paths and chemical interactions are labeled with numbers.

Physical and Chemical Controls

A) The low-grade core of the ore body exposed in the bottom of the pit contains few acid generating sulfide minerals and is generally net neutralizing.

B) The main copper-bearing zone of the ore body and the surrounding pyrite halo contain abundant pyrite and chalcopyrite and are generally composed of net acid-generating rock. For convenience in the following discussions this entire rock mass is described as the pyrite halo.

C) Bedrock exposed on the uppermost benches of the pit and surrounding the pyrite halo in the subsurface contains few acid generating sulfide minerals and is generally net neutralizing.

D) Historic waste rock disposal areas fill most of the tributary drainages that discharge into the open pit. This waste rock contains abundant acid-generating sulfide minerals and is typically net

Figure 3-8 Conceptual Model of Water Movement In and Around the Bingham Pit acid generating. The waste rock not only contains abundant pyrite, but it has been rubblized so the release of sulfide oxidation products is much more rapid than for undisturbed bedrock.

E) Numerous underground workings surround the open pit and some intersect the pit surface. These workings provide flow conduits for groundwater and if dewatered allow the access of oxygen into the deep bedrock, accelerating sulfide oxidation reactions. Most of these underground workings were used for mining lead-silver deposits surrounding the copper ore body, and are located outside of the pyrite halo (see Figure 3-7 for a map of underground workings above the regional water table in 2001).

Flow Paths and Chemical Interactions

1) Precipitation falls everywhere within the drainage basin created by the open pit. This includes undisturbed mountain slopes surrounding the pit, waste rock disposal areas surrounding the pit, pit walls above the pyrite halo, pit walls within the pyrite halo and pit walls below the pyrite halo. Precipitation water is removed from the ground surface via evapotranspiration thereby reducing the amount of water that is available to infiltrate or run off. Evapotranspiration is most efficient on well-vegetated surfaces.

2) Water that does not infiltrate or evaporate immediately will flow towards the bottom of the pit as runoff. Runoff is greatest on sloped and compacted or otherwise impermeable surfaces. This water will either flow all the way to the pit bottom as runoff, infiltrate at a location down gradient from where it originally fell or be removed by evapotranspiration at a down gradient location. Runoff from undisturbed mountain slopes surrounding the open pit generally flows onto waste rock surfaces where it infiltrates, contributing to the flow described in 3a. Runoff water that reaches the bottom of the pit by flowing over the pyrite halo will transport some dissolved and suspended contaminants to the pit floor. However, because the contact time is relatively short this water will generally contain fewer dissolved constituents than water that has percolated through waste rock or through unsaturated portions of the pyrite halo.

3) Precipitation that is not removed by evapotranspiration or runoff to the pit floor will infiltrate. There are five general paths by which this water may migrate in the subsurface:

3a) Water that infiltrates into the net acid generating waste rock disposal areas will generally become the poorest quality ARD that drains into the pit. This water will either perch at the bedrock/waste rock contact and discharge onto the upper surface of the pit, or it will pass through the bedrock/waste rock contact and will discharge onto a lower pit surface.

3b) Some of the water that infiltrates into the undisturbed mountainsides surrounding the pit may flow in the shallow subsurface (colluvial and shallow bedrock flow) and discharge into waste rock that covers buried seeps and springs, thereby contributing to the flows described in 3a. This is generally the best quality groundwater surrounding the open pit, but after contacting the waste rock it degrades into the poorest quality ARD reporting to the pit.

3c) Some of the water that infiltrates in the pit drainage basin will pass through the net acid-generating pyrite halo in the vadose zone before it reaches the water table. This water will generally become poor quality ARD because it is in contact with the oxygenated portion of the pyrite halo. Once this water reaches the water table, it will flow laterally and discharge into the bottom of the pit.

3d) Some of the water that infiltrates in the pit drainage basin will pass through net neutralizing bedrock in the vadose zone before it reaches the water table. This water will then flow laterally below the water table and will ultimately discharge into the bottom of the pit. Neutralization reactions may take place below the water table if the water contacts reactive neutralizing minerals, but sulfide oxidation reactions will be inhibited by a lack of oxygen. The quality of this water will remain relatively good because it only contacts the reduced portion of the pyrite halo below the water table.

3e) Water that infiltrates into the bedrock surrounding the pit that is beyond the zone of groundwater capture for the pit will not discharge to the pit floor. The quality of this ground water will be relatively good because it typically will not contact the pyrite halo. The lower the water level that is maintained in the pit, the further from the center of the pit the zone of capture will extend.

4) Water that discharges into the pit will be pumped out. The rate of pumping will be highest for a nearly dry pit and will decrease as the height to which the pit is allowed to flood increases. The lower the water level that is maintained in the pit, the greater the thickness of the pyrite halo that will be exposed above the water table in the bedrock surrounding the pit.

5) Water flows in many of the underground workings surrounding the pit. The majority of underground workings are located outside of the pyrite halo, but some are within the pyrite halo. Water in unflooded workings within the pyrite halo may become poor quality ARD similar to flows described in 3c. Water quality in flooded workings within the pyrite halo may be intermediate in quality between 3c and 3d, and water in workings outside the pyrite halo may be similar to that described in 3e.

5a) Some underground workings drain groundwater into the open pit. If not captured, this water contributes to infiltration and runoff within the pit (flows 2, 3c and 3d). This water may be similar in quality to the flows described in 3c or 3d.

5b) Some underground workings gravity drain groundwater away from the open pit. This water discharges at tunnel portals in Butterfield Canyon and along the east and west side of the Oquirrh Mountains. This water may be similar in quality to flows described in 3d or 3e.

5c) Some underground workings are currently dewatered by pumping and could continue to be dewatered after closure. If not captured, much of this water would contribute to flow 3c or 3d and would need to be removed from the pit (flow 4).

6) If a pit lake is allowed to form in the bottom of the pit, water will be added directly to the lake by precipitation. Water will be removed from the lake by evaporation from the water surface. In this geographical area, evaporation exceeds precipitation on an average annual basis, so this will ultimately reduce the amount of water that must be removed from the pit, but will also increase the concentration of dissolved constituents in the pit lake. The surface area of any lake that is allowed to form in the pit increases with increasing water depth, so the evaporative losses are likely to increase with an increasing depth of flooding.

7) If a pit lake is allowed to form, sulfide oxidation reactions will be inhibited by the lack of oxygen in the surrounding wall rock that is fully and permanently saturated, but neutralization reactions between the lake water and the small percentage of carbonate minerals in the wall rock will continue. Wall rock interactions, water mixing, the potential addition of neutralizing agents and biological activity may cause the precipitation and settling of some metals and other dissolved constituents. These chemical sediments will accumulate on the pit floor along with detrital sediments. Older sediments will become isolated from significant pit water contact by overlying younger sediments, but under certain circumstances, materials may also be redissolved from the upper portion of the sediment column.

The chemistry of water that collects in and is removed from the bottom of the pit will be determined by a complex interaction of each of the flow paths and chemical reactions described above. However, the long-term average water quality in the pit may be roughly similar to water that is currently removed from the pit floor or that collected in the pit during the shutdown of the mid-1980s. A small number of the samples collected from pit dewatering flows in 2000 through 2002 had the following average characteristics: pH – 6.9, alkalinity – 100 mg/L, total dissolved solids (TDS) – 2600 mg/L, sulfate – 1700 mg/L, copper – 2 mg/L, manganese – 0.9 mg/L and zinc – 0.8 mg/L. Iron, aluminum and nickel averaged less than 0.1 mg/L, and arsenic, cadmium, chromium, selenium and silver all averaged less than 0.01 mg/L. A limited amount of data is also available from a lake that formed in the bottom of the pit during the shutdown in the mid 1980s. The pit floor during the shutdown was at an elevation of 5168 feet and so was likely at the base of the net acid-generating portion of the ore body and pyrite halo. The pit lake existed for three years and reached a maximum depth of about 50 feet. The lake was pumped periodically throughout the period and never contained more than about 650 acre-feet of water. Typical values for this pit water were: pH - 6.0, total dissolved solids (TDS) - 2500 mg/L, sulfate - 1500 mg/L, copper - 10 mg/L and cadmium - 30 ug/L. Water that will be removed from the pit may not meet water quality standards acceptable for irrigation, drinking water or discharge to surface water without treatment. At closure, when this water is no longer used in the process water circuit, it may have to undergo some form of treatment for pH, TDS, sulfate, copper and trace metals before it can be released from the property (Section 10.0).

3.1 CLOSURE ISSUES

The original Mining and Reclamation Plan submitted to DOGM in 1976 specified the following activities for the mine area at closure:

- pit sides will be stabilized at a slope of 30 to 50 degrees from horizontal

- it is unlikely that the pit will be revegetated because most of the exposed surface will be solid rock containing natural sulfide mineralization

- surface facilities including buildings, railroad tracks, power lines and poles and equipment will be removed.

The primary closure issues at the pit are driven by the need to ensure long-term groundwater and surface water quality protection. The most significant water management issues are:

- ensuring that contaminated water does not escape from the pit into the surrounding groundwater system

- managing water movements in and around the pit to minimize water quality degradation

- ensuring that any surface water discharges from the pit meet applicable water quality criteria

- minimizing the impacts of pit dewatering on surrounding aquifer recharge and water levels

- minimizing ecological risks posed by water that may accumulate in the pit.

The mine has also been placed on the National Historic Register. This may require that public access be permanently maintained to some point within or adjacent to the pit. However, safety considerations around steep and potentially unstable areas on the pit walls will require the public be excluded from most of the mine area.

3.2 POSSIBLE POST-CLOSURE LAND USE

Based upon the requirement for long-term water management in and around the mine, and the public safety issues associated with steep and potentially unstable areas on the pit walls, post-mining land uses will, by necessity, be limited.

Whatever final closure scenario is ultimately selected, the entire open pit will have to be a water management facility with limited public access. Parts of the pit where vegetation can become established will also become wildlife habitat, and selected areas of the pit may be established as public access points to the National Historic Site.

3.3 DATA REQUIREMENTS

In order to select a final closure scenario the following data requirements will have to be addressed:

- final geometry of the ultimate pit
- acid/base accounting geochemistry of ultimate pit walls
- hydrogeology of the post-closure pit
- geochemistry of water extracted from a largely dry pit or a partially flooded pit, in particular how lake and outflow water chemistry would vary with pit flooding level

Unfortunately, many of these data requirements cannot be addressed until the mine is nearing the end of its life and the geometry and geochemical characteristics of the ultimate pit can be predicted with more certainty.

3.4 RECLAMATION ACTIVITIES

Tentative reclamation activities have been selected based upon the existing incomplete data set and on the assumption that the current mine plan adequately predicts the ultimate geometry of the pit. These tentative plans will be refined as the data gaps identified in Section 3.3 are filled.

All surface facilities including buildings, railroad tracks, most power lines and equipment will be removed from the mine area at closure except for those with a confirmed post-mining use. Demolition of these facilities will be conducted as described in Section 2.3 and reclamation of the underlying footprints will vary depending on the geochemistry of the underlying bedrock (See Sections 3.4.1 through 3.4.4 for details). The only facilities that may be left in place are those related to long-term water management or directly related to public access to the National Historic Site. These facilities may include water pipes, tanks, pump houses, some repair shops, offices, access roads, some power lines and the Visitors Center. Public access to most of the pit will be limited with a combination of engineering and institutional controls. Shaft, adit and tunnel portals within the pit area will be sealed or gated. Roads will be blocked off, and fences and signs will be erected.

Water levels in the pit will be maintained below 4900 feet amsl. Depending upon the final geometry of the ultimate pit floor, water will either be present in 1) a collection pool at the very bottom of the pit, 2) a series of collection pools at various elevations between the bottom of the pit and 4900 feet amsl, or 3) a single lake in the bottom of the pit with a surface elevation of less than 4900 feet amsl. This elevation insures that pooled water is below the pyrite halo on the pit walls. As discussed earlier in this section and as illustrated on Figure 3-7, even at the maximum filling elevation of 4900 feet, there would be more than 500 feet of head driving water flow towards the pit from all sides, insuring that radial flow into the pit is maintained. In reality this value likely underestimates the gradient driving radial flow towards the pit, because water levels will also recover in the down-gradient bedrock if the pit were allowed to partially fill, increasing the calculated head difference. The 4900 ft elevation is also more than 1000 feet below the bedrock and topographic low where Bingham Canyon intersects the pit, about 2000 feet below the bedrock ridge line that separates the pit from Jordan Valley to the east, and about 4000 feet below the bedrock ridge line that separates the pit from Tooele Valley to the west.

If a pit lake is allowed to form, lime or another neutralizing agent will be added if required, in order to maintain a circumneutral pH and minimize metals solubility during flooding. If neutralizing agents are used, they will be added in a manner that assures appropriate mixing. Other options that will also be considered to maximize pit water quality will be the addition of organic matter and the active promotion of biological activity (Castro and Moore, 2000). To maintain water levels below 4900 feet amsl, water will have to be removed from the pit in perpetuity. Water will be pumped from the collection pond(s) or lake surface to the 5490 tunnel and then will be piped to lower Bingham Canyon. If the Elton Tunnel is ever rehabilitated and connected to the open pit, it could also potentially be used to transmit water out of the pit. In order to reduce pit inflows, some water may also be removed in perpetuity from underground workings that surround the pit. This water has a circumneutral pH, but a water treatment facility may be required to treat these outflows to acceptable levels for discharge or sale (Section 10.0).

In order to minimize water quality degradation in and around the pit, and to improve the quality of water that collects in the bottom of the pit, the following activities will also be completed prior to or at closure. These activities are generally designed to minimize water contact with the waste rock disposal areas surrounding the pit and with the pyrite halo in the vadose zone.

3.4.1 Adjacent Waste Rock Disposal Areas

In order to limit infiltration into waste rock surfaces surrounding the open pit (flow 3a on Figure 3-8), most waste rock surfaces will be recontoured to reduce pooling and selected surfaces will also be revegetated to maximize evapotranspiration (Section 4.0). In order to minimize flows from the surrounding unimpacted mountainsides to the waste rock disposal areas (flows 2 and 3b on Figure 3-8), water collection systems will be placed up gradient in drainages that have significant surface or shallow groundwater flow (Section 10.0). These collection systems may include surface impoundments, horizontal drains, collection sumps and shallow groundwater extraction wells. These flows are likely of drinking water quality and will be piped out of the mine area for use or sale.

3.4.2 Pit Benches above the Pyrite Halo

In order to minimize infiltration and runoff (flows 2, 3c and 3d on Figure 3-8), vegetation establishment will be encouraged on pit benches that are above the pyrite halo. These are generally areas that have an NNP that is greater than zero on Figure 3-4 (typically above 6600 feet amsl). Most pit benches are not safely accessible, but benches that are safely accessible with a dozer will be ripped. This will generally limit the ripping to haul and support roads that do not have a post-closure use. Ripped areas will be seeded and seed will also be broadcast onto pit benches that do not have a nearby seed source. Where practicable, surface flows that occur above the pyrite halo from seeps, springs, horizontal drains, tunnel and adit portals and runoff will be captured on the upper benches of the pit and either piped out of the pit or piped to the bottom of the pit so that the water does not contact the pyrite halo (Section 10.0).

3.4.3 Pit Benches within the Pyrite Halo

No revegetation efforts are possible within the pyrite halo because the soils forming on roads and benches will generally be acidic and have high salinity. These are generally areas that have an NNP that is less than zero on Figure 3-4 (typically between 5200 and 6600 feet amsl). In order to minimize infiltration (flow 3c on Figure 3-8) runoff will be encouraged. All roads will be left in a compacted condition. Where practicable, surface flows that occur within the pyrite halo from seeps, springs, horizontal drains, tunnel and adit portals and runoff will be captured and either piped out of the pit or piped to the bottom of the pit so that the water does not infiltrate through the pyrite halo (Section 10.0).

3.4.4 Pit Benches Below the Pyrite Halo

Depending upon the final closure scenario that is selected, much of this area may be flooded. However, in order to minimize infiltration and runoff, vegetation establishment will be encouraged on selected pit benches that are below the pyrite halo. These are generally areas that have an NNP that is greater than zero on Figure 3-4 (typically below 5200 feet amsl). Most pit benches are not safely accessible, so no reclamation work will be completed on the benches. However, seed will be broadcast onto pit benches that do not have a nearby seed source. Road surfaces that are not needed after closure will be also be ripped and broadcast seeded

4.0 MINE WASTE DISPOSAL AREA

The mine waste rock disposal area currently covers about 5100 unreclaimed acres and contains approximately 4 billion tons of material. An additional 410 acres at the foot of the Eastside disposal areas have already been reclaimed. About 250 acres surrounding the disposal areas are being used to manage leach water drain-down and meteoric water flows (ARD) that have contacted the waste rock. A list of the support facilities associated with the disposal areas and water management systems is provided in Table 2-1. The large angle-of-repose (35 to 37 degrees) slopes on the eastern margins of the waste disposal areas are the most prominent visual features from the Salt Lake Valley, but they actually cover less than 15 percent of the total disturbed area. The highest inactive slope is 1200 feet high, but currently no active slopes are higher than 500 feet. Most of the disposal area is composed of flat to slightly irregular waste rock surfaces and angle of repose slopes that are less than 150 feet tall.

Future mine plans call for the placement of nearly one billion additional tons of waste rock before mine closure. The majority of this material will be placed in Bingham Canyon or in lifts on top of existing disposal areas. In some areas waste rock will have to be placed on previously unimpacted ground, so the total area impacted by disposal activities may increase by approximately 200 acres before closure. The additional disturbed acreage will be within the boundaries of DOGM permit number M/035/002 and will not exceed the 8000 acre area allocated for waste rock disposal in the 1978 Mining and Reclamation Plan. The impacted acreage could also increase during reclamation activities when angle of repose slopes are reduced, thereby increasing the waste rock footprint in some areas.

Mine waste is composed of a mixture of intrusive rocks, quartzite, limestone and limestone skarn. Except for copper, average total metals concentrations are relatively low, as illustrated from a 66-sample average for the following elements: arsenic 31 mg/kg, barium 70 mg/kg, cadmium 2.0 mg/kg, chromium 55 mg/kg, copper 809 mg/kg, lead 380 mg/kg, selenium 2.6 mg/kg and zinc 311 mg/kg. The average sulfide concentration, predominantly pyrite, in unweathered waste rock from the pit is about three percent, but sulfides are generally less abundant in waste rock exposed on the surface of the disposal areas. The pyrite begins to oxidize immediately after the waste rock is placed, causing a decline in sulfide abundance and a release of sulfate, iron and acidity. Soils forming on the waste rock surface have paste pH values between 2 and 8; and paste conductivities, a measure of soil salinity, of between 20 and 9000 umhos/cm. Figure 4-1 is a map of the waste rock disposal areas showing the distribution of soil pH and salinity characteristics. The primary controls on soil pH are the percentage of sulfides in the waste rock, the percentage of limestone in the waste rock and the age of the waste rock surface on which the soil is forming. The primary controls on soil conductivity are the percentage of sulfides in the rock and the age of the waste rock surface. In general, the older the waste rock surface, the lower the pH, the lower the conductivity, and the fewer sulfide minerals that are present. On the oldest surfaces with little intact pyrite, flushing of the soil by precipitation will eventually create a soil with a pH above 5 and low salinity. The geochemistry of the waste rock soils is described in detail in the paper “Geochemical evolution of sulphide-bearing waste rock soils at the Bingham Canyon Mine, Utah (Borden 2001). This paper is attached in Appendix E.

Volunteer vegetation is becoming established on almost all dump surfaces that have favorable soil chemistry. Botanical surveys were conducted on the waste rock disposal areas in 1999, 2001 and 2002. One hundred sites with various soil pH and salinity conditions were visited during these surveys and species counts and estimates of total vegetation cover were made at each site. Waste rock surfaces where any historic reclamation activities had occurred were excluded from the survey. The percent gravel (percent not passing a 2 mm sieve) and the compaction (blows with a four pound hammer to drive a one half inch diameter rebar eight inches) at most of the sites were also measured. As shown on Figures 4-2 through 4-5, vegetation has become established on most sites with soil pH above 4.0 and with conductivity below 1000 umhos/cm. Below a pH of 6, nitrogen and phosphorus availability begins to decline in most soils, and below a pH of 5 the toxicity of soluble aluminum and manganese also becomes significant in most soils and will inhibit plant growth (Tucker et al. 1987). Volunteer vegetation density and diversity is highest on surfaces that have a soil pH above 5 and a conductivity of less than 500 umhos/cm. The volunteer vegetation cover for the 31 survey sites with a pH above 5 and conductivity below 500 umhos/cm varied between 0% and 98% and averages 29%. The number of species observed at the sites varies between 0 and 26 and averages 12. Waste rock surfaces that had favorable soil chemistry but which do not support abundant vegetation generally have clear physical barriers to plant establishment. These physical barriers include strongly compacted surfaces, steep slopes with surface creep or lack of fine-grained material on the waste rock surface. Correlation coefficients and the square of the correlation coefficients (R^2 values) were calculated to illustrate the relationship between each of these variables and vegetation cover and species occurrence. A positive correlation coefficient indicates that the two variables are positively related (an increase in one leads to an increase in the other). A negative correlation indicates that the two variables are inversely related. Both the correlation coefficient and the R^2 value vary between 0 and 1. A value of 0 indicates that there is no relationship between the variables and a value of 1 indicates that there is a perfect correlation. The R^2 value can be interpreted as the proportion of the variance in one variable that is attributable to the variance in the other variable. For flat surfaces with favorable chemistry, the correlation coefficient between vegetation cover and the degree of compaction is –0.40 (r^2=0.16) and between diversity and compaction it is –0.41 (r^2=0.17). Generally, end dumped or deeply ripped surfaces do not exhibit any negative impacts due to compaction. For relatively low compaction surfaces with favorable chemistry, the correlation coefficient between cover and slope angle is -0.35 (r^2=0.12), and between diversity and slope angle is -0.43 (r^2=0.18). On average, angle of repose slopes have about 2/3 as much cover as comparable flat surfaces. There is no significant correlation between vegetation cover, diversity and the percent gravel comprising the waste rock surface (r^2=<0.01 and r^2=0.04 respectively) but at gravel concentrations above about 90%, most surfaces support little or no vegetation.

For the nine waste rock survey sites that had no significant physical or chemical barriers (flat, ended dumped or ripped surfaces with gravel <90%, pH > 5 and conductivity < 500 umhos/cm), the percent vegetation cover varied from 20% to 98% and averaged 47% with a 95% confidence interval of 16%. The number of species observed at each site varied between 9 and 22 and averaged 15 with a 95% confidence interval of 3. These surfaces vary between 15 and 40 years old and average 25 years old.

The paste conductivity test used to measure the salinity of the waste rock soils involved mixing the soil with an equal weight of distilled water (1:1 mix) and measuring the conductivity of the decanted liquid. Most agricultural assessments of plant salt tolerance are performed on a saturation extract from the soil. To perform the saturation extract test, distilled water is mixed into the soil sample only until it is saturated, then the water is vacuum extracted from the paste. In order to compare the conductivity results derived by the two tests, sub-samples were collected from 22 homogenized samples and analyzed by both methods. The test results indicate that for the same sample, the saturation extract method yields conductivity values that are approximately 1.9 times higher than the 1:1 extract method. The r^2 value for the two methods was 0.96. If the conductivity values presented in this study are increased by 1.9, it indicates that salinity appears to limit plant growth in the range of 1000 to 1500 umhos/cm. This is consistent with the conductivity tolerance cited by Mass (1990) for salt sensitive crops. According to Mass (1990) salt sensitive species begin to exhibit decreased yield at 1200 umhos/cm.

Table 4-1 lists the most common species observed volunteering on the 31 waste rock surfaces with favorable surface chemistry. For waste rock soils with pH above 5 and conductivity below 500 umhos/cm, almost all of the cover is provided by native, non-weedy species. However, for soils with lower pH and higher salinity, much of the thin vegetation cover that is present is provided by noxious weed species. The waste rock surfaces where soil chemistry is favorable for the establishment of native vegetation cover about 700 acres. There are approximately 200 additional acres where the soil pH is low, but which have very low salinity and very few intact sulfides. These sites are considered marginally favorable for vegetation establishment. This combined 900-acre area is shown in green on Figure 4-1. These surfaces are generally located on the south and southeast sides of the pit, and at higher elevations on the Eastside disposal area. Most of these sites are located above 6800 feet above sea level and are ten to more than fifty years old. Waste rock that was deposited in these areas was generally mined from higher, less mineralized and more weathered benches in the pit.

Groundwater and precipitation that contacts the waste rock generally becomes acidified (becoming ARD). For approximately 50 years, acidic leach water was also continuously recirculated between the Precipitation Plant and the waste rock disposal areas in order to recover copper. However, in 1999 leach water application rates began to be reduced and all leach water applications were terminated in September 2000. Between 1999 and the end of 2002, flows from the base of the disposal areas in Bingham Canyon and on the east side of the Oquirrh Mountains have decreased from more than 25,000 gpm to less than 2000 gpm. Meteoric water that contacts the waste rock and leach water drain-down either reports to the Bingham Pit or is captured by the Eastside Collection System (ECS), a series of State-permitted cutoff walls, sumps, drains, basins and pipes at the foot of the waste rock disposal areas. The ECS captures ARD that discharges from the toe of the Eastside waste rock disposal areas and that flows in the alluvium in Bingham Canyon and other drainages. Most of these flows are perched, and in only a few drainages do the cutoff walls intersect the regional water table. Recent studies have confirmed that the large majority of water that infiltrates into the Eastside waste rock disposal areas perches at the bedrock/waste rock contact and then discharges at the toe of the disposal area slope where it is captured by the ECS (Solomon et. al., 2001). A detailed conceptual model of ARD movement in the vicinity of the Eastside waste rock disposal areas is provided in a report by Borden (2002).

Waste rock contact flows are currently routed to the concentrator process water circuit. During peak runoff periods, excess water is temporarily stored in the Large Bingham Reservoir. Anticipated post-closure flows associated with the waste rock disposal areas are discussed in Section 10.0.

Erosional events and failures have occurred on various waste rock slopes in the past. Since the termination of active dumping on the high slopes facing the Salt Lake Valley in 1984 the frequency and magnitude of slope failures have decreased significantly. However, several shallow surface slumps and debris flows have occurred in the past decade. Precipitation greater than the 25-year, 24-hour storm event (the minimum system requirements specified by the storm water regulations) that falls on the slopes has also exceed the capacity of some down gradient storm water and sediment collection systems in tributary drainages to Butterfield Creek. North of the Butterfield Creek tributary drainages, the Eastside Collection System was designed to handle leach water base flows plus the 10-year, 24-hour storm event. With the termination of leach water applications, base flows in this area have declined from greater than 25,000 gpm to less than 1000 gpm, so the collection system is likely able to handle flows that are greatly in excess of the 25-year, 24 hour storm event. Erosional events may also fill the sedimentation basins of the water collection systems with sediment, increasing the frequency and cost of maintenance. In the past decade these events have most commonly occurred on the waste rock disposal areas above Butterfield Creek on the southeast side of the pit. In only two cases has contaminated sediment or water escaped the property since the ECS was upgraded between 1993 and 1996. Both events occurred in tributary drainages to Butterfield Creek and corrective actions were taken to minimize the risk of future releases in these areas.

4.1 CLOSURE ISSUES

The original Mining and Reclamation Plan submitted to DOGM in 1976 specified the following activities for the mine waste disposal area at closure:

- all dumps will be left in a safe and stable condition
- collection systems will be provided to contain natural seepage in the area
- dikes and ponds will be constructed on the upper levels of the dumps to prevent slope wash and possible mud slides
- no major revegetation is planned because the majority of the waste material contains natural sulfide mineralization
- if and when revegetation practices or methods are developed which would make vegetation economically practicable, such practices and methods will be employed on the dumps

- when no longer needed in mining, mineral extraction or subsequent operations, surface facilities including buildings, above ground utilities, railroads, piping and equipment will be removed.

Current permits and regulations require KUCC to control contact water flows from the waste rock disposal areas in order to protect surface and groundwater quality. The goal of these regulations is to prevent any unpermitted discharge of contaminated water or sediment from the property. Groundwater Discharge Permit number UGW350010 also requires that KUCC take steps to minimize the infiltration of meteoric water into the waste rock. After closure, KUCC will continue to maintain the existing groundwater and surface water collection systems at the foot of the disposal areas to comply with all applicable requirements. In order to ensure compliance after closure in the most cost effective manner, the following goals must be considered during closure planning:

- ensure that catastrophic events cannot compromise the water collection systems and transport contaminated water and sediment off KUCC property

- reduce long-term ARD generation from the disposal areas to minimize the risk of down gradient groundwater contamination and long-term water handling and treatment costs

- minimize the loading of sediment and debris from the disposal areas to reduce long-term maintenance costs for the water collection systems.

4.2 POSSIBLE POST-CLOSURE LAND USE

Based upon the requirement for long-term water management on and around the waste rock disposal areas, the acidic nature of the waste rock, and the public safety issues associated with steep slopes, post-mining land uses in these areas will, by necessity, be limited.

Whatever final closure scenario is ultimately selected, most of the waste rock disposal areas will likely be operated as a water management facility with limited public access. Those parts of the disposal area that are revegetated will also become wildlife habitat.

4.3 DATA REQUIREMENTS

In order to identify the final reclamation options for each portion of the waste rock disposal area, the following data requirements will have to be filled:

- final geometry of the waste rock disposal areas, in particular the location and soil chemistry characteristics of future waste rock piles

- base ARD flows from various parts of the disposal area

- relative effects of each reclamation technique on infiltration and runoff

Many of these data requirements are being addressed by ongoing reclamation programs on the waste rock disposal areas and by the operation of pilot-scale water treatment facilities. The final geometry and geochemistry of the waste rock surface cannot be determined until waste rock disposal and recontouring has been completed.

4.4 RECLAMATION ACTIVITIES

Tentative reclamation activities have been selected based upon the existing incomplete data set and on the assumption that the current mine plan adequately predicts the final geometry of the waste rock disposal area. Figure 4-6 is a map of the waste rock disposal area showing the reclamation activities that are currently planned. The actual acreage and boundaries of the various reclamation treatments may be modified in response to changes in the mine plan or other new information as it becomes available. Long-term water management plans on and adjacent to the waste rock disposal area are described in Section 10.0.

All surface debris, utilities and facilities without a post-closure use will be removed from the entire waste rock disposal area at closure. Reclamation of these facilities will be as described in Section 2.3. Based upon current assumption of post-mining use, the only facilities that may be left in place within the waste rock disposal area will be those related to long-term water management such as the Large and Small Bingham Reservoirs, cutoff walls, sumps, drains, settling ponds, monitoring wells, utilities, selected roads and associated pipes and lined ditches. Public access will be controlled with a combination of engineering and institutional controls. Roads below the waste rock dumps without a post-mining use will be recontoured, ripped and seeded. These roads will also be blocked off if appropriate, and fences and signs will be erected. Additional reclamation activities planned for selected portions of the waste rock dumps are described in the following sections.

4.4.1 Completed Reclamation Activities

Reclamation work has already been completed on about 410 acres of the waste rock disposal area. The sites that have been reclaimed are located on the northeast portion of the disposal area and in drainages along the eastern edge of the disposal area (Figure 4-6). It should be noted that this acreage estimate only includes areas that were directly impacted by Bingham Canyon Mine waste rock disposal. It does not include several hundred additional acres that have also been reclaimed within the DOGM permit boundaries, but that were impacted by historic leach water contact or by other historic mining operations unrelated to open pit mining at Bingham Canyon. Most of these areas are in drainages located between the foot of the Eastside waste rock disposal area and Highway 111.

Waste rock has been removed from about 80 acres within drainages below the Eastside disposal area (Figure 4-6). Some of this waste rock was transported into the drainages by erosion caused by the historic leaching operations and some was intentionally placed in the drainages to create dams and settling ponds for the historic leach collection system. All of this waste rock was moved back to the foot of the waste rock disposal areas and the drainage surfaces were recontoured, had topsoil applied if needed and were seeded.

About 330 acres on the northeast margin of the Eastside disposal area were recontoured, capped and revegetated. The angle of repose slopes were reduced to slopes of 2.5:1 or less and between 18 and 48 inches of growth media were placed on top of the waste rock before the surfaces were revegetated.

4.4.2 Areas to be Recontoured and Revegetated

Approximately 900 acres of the waste rock surface are currently planned to be recontoured and revegetated. Most of the areas that are intended to be revegetated are located above 6800 feet on the southwest, south and east sides of the pit (Figure 4-6). Almost all of these sites are underlain by waste rock soils that will support vegetation after relatively minor soil modification. The waste rock soils in these areas contain very few intact sulfide minerals, generally have conductivity values that are less than 500 umhos/cm and have pH values between 2.5 and 8.

The anticipated benefits of the recontouring and revegetation activities will be:

- To reduce infiltration into these waste rock surfaces by enhancing evapotranspiration. This will reduce the amount of waste rock contact water that must be collected and treated at the toe of the disposal area and that may reach the regional water table (Section 10.0).

- To provide wildlife habitat.

- To provide a native seed source for surrounding waste rock surfaces that currently cannot support vegetation but that may be able to after additional weathering.

- To enhance slope stability and limit erosion.

- To create a surface that resembles the surrounding natural landforms.

Most angle of repose slopes will be reduced to 2.5:1 or less and will be cross-ripped. On flat or gently sloping surfaces, depressions will be filled, end dump piles will be smoothed out and most areas will be deeply ripped. This ripping will loosen compacted surfaces, will limit erosion potential on slopes, will bring fine material to the surface and will create microhabitats to encourage plant establishment. Studies at other mines have indicated that truck-induced compaction declines dramatically within the first two feet below the waste rock surface, so ripping will extend to a depth of at least two feet (Uhrie and Koons, 2001). Surfaces will be recontoured to minimize the transport of runoff from large relatively flat surfaces to adjacent slopes. Wherever possible, native mature volunteer vegetation on the dump surface will be left undisturbed during these recontouring and ripping activities. This will enhance surface stability and will supply a native seed source to the surrounding recontoured waste rock surface. The recontouring will also be designed to limit the amount of previously unimpacted land that is disturbed. Many of these waste rock disposal surfaces surround small islands of native hillside that can also provide a valuable seed and mycorrhizae source to the surrounding waste rock surface. In some locations angle of repose slopes will be left in place if they already support native vegetation or if the recontouring will cover important unimpacted areas below them. It is anticipated that the recontouring and ripping will remove most physical barriers to vegetation establishment except for the relatively small percentage of the surfaces that are underlain by very coarse gravel (sites where >90% of the soil is composed of gravel).

The pH of acidic surfaces will be raised above 6 by the addition of crushed limestone or another neutralizing agent that does not inhibit plant growth. Because there are few intact acid-generating sulfides in the waste rock, these surfaces will not reacidify once the pH has been raised. This technique has been successfully used for direct planting of weathered acidic waste rock and soil surfaces at many other mine and smelter sites (Winterhalder 1988; Nawrot et. al. 1988). Depending on the initial soil chemistry at each site, anywhere from 0 to 10 tons/acre of crushed limestone or equivalent will be applied to the surface. In general, no limestone will be added to surfaces that already have a pH above 6.5. Surfaces with a pH of less than 4 will receive a minimum of 5 to 10 tons/acre of limestone, surfaces with pH values of 4 to 5 will receive a minimum of 3 to 5 tons/acre of limestone, and surfaces with a pH of 5 to 6.5 will receive a minimum of 0.5 to 3 tons/acre of limestone. The actual application rate will be dependent upon the average pH, the soil salinity and the amount of intact sulfides that are present. Generally, within each pH range, if the paste conductivity is above 500 umhos/cm the higher application rate will be used and if the conductivity is below 100 umhos/cm the lower rate will be used. If field assessments indicate it is required, all the surfaces will also receive a light application of chemical fertilizer to provide nitrogen, phosphorus and potassium (not to exceed 50 lbs/acre available nitrogen) or may receive biosolids at application rates not to exceed 10 tons/acre of pure biosolids. If biosolids have been mixed with wood chips or another carbon source, the application rate of the mixture may be as high as 30 dry tons/acre, as long as the biosolids component of the mixture does not exceed 10 dry tons/acre. In general, phosphorus application rates will be higher than nitrogen application rates, which will be higher than potassium application rates. Studies at Bingham Canyon and elsewhere indicate that over-fertilization with nitrogen in biosolids or chemical fertilizers promotes the establishment of weedy species and inhibits species succession (Black and Borden 2002; McLendon and Redente 1992). The study that was conducted at Bingham Canyon is summarized in the attached paper (Appendix F).

A seed mix that is predominantly composed of native grasses, forbs, shrubs and trees will be broadcast or drill seeded onto the surface. The seed mixes that are used will largely be composed of native species that are already volunteering onto the waste rock surface or closely related species (Table 4-1). However, the exact composition of the seed mixes will vary depending on elevation and slope aspect of the surface to be seeded, and on species availability and assessments of earlier revegetation efforts. For sites with elevations below about 6500 feet, the seed mix may be altered significantly from the species listed in Table 4-1. For instance, Douglas fir, Bigtooth maple and Aspen may not be appropriate for most low elevation sites. Conversely, other species that are not listed on Table such as Western wheatgrass, Slender wheatgrass and

Fourwing saltbush have been very successful on reclaimed sites at lower elevations on the waste rock disposal areas (Black and Borden, 2002).

Most of these reclamation activities will occur between the present and mine closure.

4.4.3 Areas to be Recontoured

Approximately 3200 acres of the waste rock surface are currently planned to be recontoured without revegetation. This area includes flat and irregular surfaces as well as angle of repose slopes that are less than 150 feet high (Figure 4-6). These areas will not be revegetated because they currently contain abundant unweathered sulfides, have elevated soil salinity and generally have low pH. If limestone were applied to neutralize the acidity in these areas, continued sulfide oxidation would cause most surfaces to reacidify (Doolittle and Hossner 1997). Even if the surface pH could be maintained at near neutral, the salinity of these soils would prevent native vegetation establishment because they will continue to contain abundant gypsum precipitated during the in situ neutralization of acid generated from the oxidizing sulfides (Borden 2001). Water in contact with gypsum will maintain a conductivity of approximately 2000 umhos/cm, well above the salinity tolerance of most native species growing on the waste rock surfaces and in the surrounding mountains (Figures 4-4 and 4-5) (Richards 1954; Wali 1999).

The anticipated benefits of the recontouring activities will be:

- To reduce infiltration into these waste rock surfaces by reducing pooling on the surface. This will reduce the amount of waste rock contact water that must be collected and treated at the toe of the disposal area and that may reach the regional water table (Section 10.0).

- To create a surface that resembles the surrounding natural landforms.

- To remove physical barriers to vegetation establishment such as steep slopes with surface creep and compacted surfaces. Continued weathering and sulfide oxidation on these surfaces will eventually create soils that are geochemically favorable to native vegetation establishment.

- To enhance slope stability.

Most angle of repose slopes that are less than 150 feet tall will be reduced to 2.5:1 or less, depressions in the surface will be filled and end dump piles will be smoothed out. Surfaces will be recontoured to minimize the transport of runoff from large relatively flat surfaces to adjacent slopes. Neutralizing agents such as cement kiln dust, waste lime or waste limestone may be applied to selected surfaces if they become available in the future and if they can be placed economically. Some relatively short angle of repose slopes may be left in place if the slope reduction would cover important facilities or previously unimpacted land. Slopes will be cross-ripped to minimize surface flow and potential erosion. These areas will generally be recontoured between the termination of waste rock production and one to two years after mine closure.

It is anticipated that in the future, continued weathering on these waste rock surfaces will create additional waste rock soils that may be revegetated by direct planting (Borden 2001). After closure and after all recountering has been completed, a follow-up soil chemistry survey will be performed on this portion of the waste rock surface. Large, contiguous areas that contain few intact sulfides and that have soil paste conductivity values below 500 umhos/cm will be revegetated in the same manner as described in Section 4.4.3. This will include ripping or re-ripping most surfaces followed by limestone, fertilizer and seed application.

4.4.4 Areas to Undergo Slope Stabilization Study

A slope stabilization study is being performed on approximately 200 acres located on the southeast margin of the waste rock disposal areas (Figure 4-6). This area covers the angle of repose slopes that are located at the upper end of six dry tributary drainages to Butterfield Creek, a perennial stream. The individual drainages are listed along with selected physical characteristics on Table 4-2. The maximum height of the angle of repose slopes in these drainages ranges from approximately 700 to 900 feet and they are all less than a mile from Butterfield Creek. A preliminary assessment of these areas indicates that they have the greatest potential of any slopes to release contaminated sediment and contact water from the property. All six of the drainages are well-defined, narrow channels with generally thin alluvial deposits and relatively steep gradients. The gradients vary between 650 feet/mile and 990 feet/mile from the toe of the waste rock angle of repose slope to the drainage intersection with Butterfield Creek. Since the Eastside Collection System at the foot of the Eastside disposal area was upgraded between 1993 and 1996, there have only been two incidents in which contaminated sediment or water have escaped the property. These incidents occurred in the Olsen and Castro drainages at the southern end of the 200-acre area. Sediments deposited down gradient during these incidents were cleaned up and returned to the waste rock disposal area.

The slope stabilization study will involve a detailed assessment of the risk of contaminated water and sediment release in each drainage. An assessment of long-term maintenance costs in each drainage with and without slope stabilization will also be made. The study also will involve an engineering assessment of the cost and efficacy of various slope stabilization methods in each drainage. The study is planned for completion in the next two years and slope stabilization plans for each drainage will be created. It is possible that the angle of repose slopes in the Olsen, Butterfield, Castro, South Saints Rest and Saints Rest drainages will need to be reduced, capped with a growth media and revegetated unless another suitable stabilization alternative can be identified. Waste rock with favorable physical and chemical characteristics may be used as a growth media if available in sufficient quantities (pH > 6.5, conductivity < 500 umhos/cm, % gravel < 85%). The requirements for the slopes within the Yosemite drainage cannot be identified until the assessment is completed. This drainage generally poses a lesser risk of contaminant release because it has a lower gradient and has a longer travel distance to reach Butterfield Creek than the other drainages (Table 4-2).

4.4.5 Areas to be Recontoured, Capped and Revegetated

The extension of waste rock disposal operations into lower Bingham Canyon will allow a stair-stepped outer dump face to be created that will be reclaimed (Figure 4-6). The reclaimed face will be about 850 feet high and will cover approximately 140 acres. It will tie into native ridges on either side of the canyon and will be recontoured to a maximum slope of 2.75:1. The slope will have 15-foot wide benches every 150 vertical feet. These benches will slope approximately two degrees towards the north or south edge of the dump face. The soils forming on the waste rock surface will likely be acidic and/or saline, so the outer face will be capped with an average of two feet of growth media. The thickness of the growth media will be varied so that approximately 30 % of the face will be capped with up to three feet of material and about 70% will be capped with 18 inches of material. The outer dump face will be cross-ripped or otherwise roughened before placement of the growth media. At least a portion of the cap material will likely come from the growth media stockpile on the 5900 ft level of the waste rock dumps about 3000 feet south of Bingham Canyon (approximate mine coordinates N3500, E13800 and N1500, E13500). The areas with a thick cap will be able to support some trees and woody shrubs, but grasses and forbs will likely dominate the areas with a thinner cap. This will create a natural mosaic of plant communities on the outer face. The face will again be cross-ripped or pitted after the placement of the cap and before it is seeded. Cross ripping will be shallow enough to avoid mixing waste rock into the cap material. The 140-acre outer dump face will be seeded with the seed mix listed in Table 4-3. In addition to seed application, Gambel oak and Curl leaf mountain mahogany seedlings will be planted at a rate of 40 plants/acre each (80 seedlings/acre total) on the three-foot thick portions of the cap. The three-foot cap areas will also receive 0.05 lbs/acre of Curl leaf mountain mahogany seed. If field assessments indicate it is required, the capped surface will receive a light application of chemical fertilizer to provide nitrogen, phosphorus and potassium (not to exceed 50 lbs/acre available nitrogen) or may receive biosolids at application rates not to exceed 10 tons/acre pure biosolids. If biosolids have been mixed with wood chips or another carbon source, the application rate of the mixture may be as high as 30 dry tons/acre, as long as the biosolids component of the mixture does not exceed 10 dry tons/acre. In general phosphorus application rates will be higher than nitrogen rates, which will be higher than potassium application rates.

Reclamation will be completed within two years of the termination of waste rock placement on the outer dump face.

4.4.6 Areas Where No Further Action is Currently Planned

No further action is currently planned for approximately 800 acres within the waste rock disposal area. These acres are entirely comprised of angle of repose slopes that are greater than 150 feet tall. The majority of these slopes are located on the eastern margin of the waste rock dumps, north of the Butterfield Canyon tributary drainages, but this area also includes the angle of repose slopes in upper Dry Fork Canyon and Freeman Gulch, and miscellaneous slopes on top of the waste rock disposal area (Figure 4-6). As described earlier in this section, surface debris, utilities and facilities without a post-mining use will be removed from these slopes. The upper crest of the angle of repose slopes will also be bermed, and the overlying waste rock surfaces will be contoured, to prevent runoff from flowing onto the slopes.

None of these slopes pose a significant risk of contaminant transport off the property and the costs of slope stabilization would not be offset by the reductions in long-term maintenance costs for the sediment and water collection systems located down gradient from the slopes. All of these slopes are either located above relatively flat waste rock surfaces or are above relatively low gradient, poorly defined drainages. All of these slopes are also relatively distant from any down gradient public access points or water bodies (Table 4-2). These slopes are tall, so the cost per acre for slope reduction would be prohibitively high. All of these slopes are also composed of waste rock with abundant pyrite, high salinity and low pH, so revegetation would not be practicable. However, if additional stability assessments identify slopes that pose a significant risk of offsite waste rock and contaminant transport, or if new reclamation techniques are developed that would make the recontouring of these slopes practicable in the future, some of these slopes may be partially or fully reclaimed at closure.

About half of the east-facing angle of repose slopes where no further action is planned are located immediately above large, flat waste rock surfaces. Shallow failures or erosional events on these slopes will merely deposit material onto the lower waste rock surface. The remaining east-facing angle of repose slopes are located above broad, poorly defined, alluvium-floored and relatively low-gradient dry drainages (Copper and Keystone drainages on Table 4-2). The Eastside Collection System at the base of the east-facing slopes north of the Butterfield tributary drainages was designed to handle leach water base flows plus the 10-year, 24-hour storm event. With the termination of leach water applications, base flows in this area have declined from greater than 25,000 gpm to less than 1000 gpm, so the collection system is likely able to handle flows that are greatly in excess of the 25-year, 24 hour storm event. The closest water body of any kind is the Provo Reservoir Canal more than five miles down gradient and the closest public access point is Highway 111 more than one mile down gradient. The Jordan River is located more than nine miles down gradient.

The tall angle of repose slopes in upper Dry Fork Canyon and Freeman gulch are facing up-canyon, so the risk of significant up gradient transport of sediment and water from these slopes is minimal. If these slopes were reduced it would also cover previously unimpacted, forested areas within these drainages.

5.0 EXCESS MINE WATER DISPOSAL AREA

At present there are no areas devoted to this activity as it was defined in the 1978 Permit. Mine water generated by pit dewatering operations, surface runoff and groundwater capture other than from leaching areas is currently piped to the Copperton Concentrator and used in the process water circuit. Between 1936 and 1986 this water was sent to the South Jordan Evaporation Ponds area. The ponds were located seven miles east of the Bingham Mine, one mile south of Bingham Creek and five miles west of the Jordan River. At closure in 1986, the site contained approximately four million tons of neutralized sludges in 25 individual ponds covering 530 acres. Total metals analysis of the material showed it to contain elevated concentrations of arsenic, cadmium, copper, lead and zinc. However, batch leach testing indicated that the metal-bearing material was not leachable and therefore did not pose a significant risk of migration. Leachable sulfate, which is not regulated, was the most significant contaminant of concern at the site because of its concentration and solubility.

Groundwater beneath the site contains elevated sulfate and total dissolved solids concentrations, but does not contain elevated metals concentrations. Much of this water is above the Utah Groundwater Quality Protection standard of 500 mg/L for sulfate but below the health limit of 1500 mg/L.

The original Mining and Reclamation Plan submitted to DOGM in 1976 specified the following activities for the excess mine water disposal area at closure:

- stabilization will be accomplished consistent with subsequent land use and may include removal or covering of accumulated salts, treatment with neutralizer, grading and revegetation work

- the area will be left in a safe, stable condition suitable for future use and without hazard of erosion or surface water accumulation

- any revegetation work would likely be accomplished to suit farming requirements.

5.1 COMPLETED RECLAMATION PROGRAM

In 1994 and 1995, KUCC reclaimed the evaporation ponds with oversight by EPA and DERR. The remediation and reclamation activities were completed in accordance with the Administrative Order on Consent for the South Jordan Evaporation Ponds (USEPA Docket Number CERCLA-VIII-18) and the Record of Decision, Kennecott South Zone Site (USEPA, Region 8, 2001). A completion certificate for this removal has been issued by the EPA. Some of the material in the ponds was returned to the waste rock disposal areas at Keystone Notch or was placed in the Bluewater I Repository. The remaining materials, composed of gypsum and gypsum-contaminated soils, were consolidated into a 210-acre low mound within the northern footprint of the ponds. The entire area was regraded, and the mound was capped with three to five feet of clean topsoil and seeded. During the reclamation an estimated seven million cubic yards of contaminated soils were moved and four million cubic yards of clean soil were emplaced.

The removal of materials with elevated metals concentrations, and the consolidation and capping of the remaining sediments, has minimized this site as a source of groundwater contamination. Infiltration of precipitation and irrigation canal water in the area is diluting and dispersing the remains of the historic sulfate groundwater plume.

5.2 FUTURE RECLAMATION PLANS

The 210-acre repository was designed to hold the gypsum and gypsum-bearing soils in perpetuity. However, current plans are to remove this material and place it in a repository with a much smaller footprint that is located up-gradient of the Eastside Collection System at the mine. The likely repository location is in Copper Notch at the foot of the Eastside waste rock dumps.

5.3 POST-CLOSURE LAND USE

The majority of the excess mine water disposal area can now be used for non-mining purposes without restriction. Most of the reclaimed site is currently open space, but in the future it may also be used for agricultural, residential, recreational, commercial, industrial or other purposes. After the remaining gypsum-bearing sludge has been removed, the 210-acre repository area may also be used without restriction.

6.0 ORE TRANSFER AREA - MINE TO PROCESS

Ore was transferred 15 miles by standard gauge rail from the Mine to the North Concentrator until the concentrator was permanently closed in 2001. The track and railroad maintenance facilities associated with ore transfer cover about 330 acres. The railway network and operations are largely the same as described in the 1978 Permit. The entire ore haulage track is owned by KUCC and is within the permit boundaries. A conveyor transfers ore from the in-pit crusher to the Copperton Concentrator. Demolition and reclamation of the conveyor below the open pit and the 5490 tunnel is covered by DOGM permit M/045/004

6.1 CLOSURE ISSUES

The original Mining and Reclamation Plan submitted to DOGM in 1976 specified the following activities for the ore transfer area at closure:

- at such time as the railroad is no longer needed in the mining or processing operations or for subsequent use, trackage and surface facilities will be removed and the area left in a condition suitable for conversion to other use

- revegetation will be accomplished if appropriate for the subsequent use.

Some areas adjacent to the tracks may contain historic ore spillage or other materials associated with rail haulage. If left in place these materials could inhibit the reestablishment of vegetation.

6.2 POSSIBLE POST-CLOSURE LAND USE

After the removal of all process materials, demolition and reclamation have been completed, there will be no restrictions on post-closure land use. Much of the land will probably be returned to farming, wildlife habitat or to some other use. Some sections of track may be left in place to service sites of post-mining industrial or commercial development.

6.3 DATA REQUIREMENTS

The only information still needed to select final reclamation activities is the determination of post-closure land use. In particular, segments of track that should be left in place and areas that will be returned to farming after closure will need to be identified.

6.4 RECLAMATION ACTIVITIES

Tentative reclamation activities have been selected based upon the existing incomplete data set.

Before closure, the entire ore transfer area will be surveyed for ore and other process materials. Identified materials will be removed and either processed, placed on the waste rock disposal areas or properly handled in another manner. Any other contaminated areas will be cleaned up as described in Section 2.3. The ore conveyor in the open pit and in the 5490 tunnel will be removed. Those sections of track with a post-mining use will be left in place, and all other track and buildings will be demolished. All steel and as many ties as possible will be salvaged. Any materials that are not salvageable will be properly disposed. Based upon its volume and chemical characteristics, ballast and fill material from some areas may be excavated and removed for proper disposal.

All sites except those located on waste rock disposal areas will be regraded to conform to the surrounding land surface and natural surface drainage will be reestablished. All areas will be reseeded, except for those that will be used for farming within one growing season or where post-mining construction activities are planned immediately after closure.

7.0 ORE PROCESSING FACILITIES AREA

The North Concentrator consists of the Bonneville Crushing and Grinding Plant, the Magna Flotation Plant, a few remaining structures from the Arthur Concentrator and the Arthur maintenance shops and warehouse (Table 2-1 and Figure 2-2). The entire complex covers approximately 220 acres. In 1997 the complex processed 9,700,000 tons of ore and produced 229,866 tons of concentrate. The North Concentrator was permanently closed in 2001.

The North Concentrator Complex is located immediately west of the town of Magna, and has good access to the interstate highway and railroad systems. The area also has a well-developed infrastructure including water supply systems, electrical transmission lines, sewage treatment facilities and arterial roadways and rail lines. The western limits of Magna, adjacent to the North Concentrator Complex, is zoned for heavy industrial use.

In the past, soils in and around the North Concentrator complex were contaminated with metal-bearing process materials, hydrocarbons and reagents in the course of normal operations. Soils with elevated lead and arsenic concentrations have already been identified and cleaned up at the old Arthur Concentrator, the Magna Concentrator and the Bonneville Crushing and Grinding Plant. Clean-up levels were established to allow industrial use of the site in the future. It is possible that other contaminated soils are present beneath existing structures.

7.1 CLOSURE ISSUES

The original Mining and Reclamation Plan submitted to DOGM in 1976 specified the following activities for the ore processing facilities area at closure:

- surface facilities including buildings, utilities, railroads and equipment that are no longer needed for ore processing or related purposes and are not convertible to some other use, will be razed and/or removed

- all hazardous conditions will be eliminated and ground surfaces stabilized and planted.

In addition to these DOGM requirements several other issues should be considered during closure planning:

- at closure the land should be left in a condition which maximizes its value and minimizes restrictions that will be placed on post-closure land use

- materials or conditions that may have a significant negative impact on surface or groundwater quality will need to be removed or corrected before closure

7.2 POSSIBLE POST-CLOSURE LAND USE

The primary limits on post-closure land use are the concentration and extent of soil and groundwater contamination that remains on the site at closure. To comply with the requirements of the 1976 Mining and Reclamation Plan and to maximize the post-closure value of the land, remediation and reclamation will be designed at a minimum to allow industrial/commercial land use at closure. Within much of the disturbed area it is assumed that there will be unrestricted land use at closure that could include industrial/commercial, residential and wildlife habitat.

7.3 DATA REQUIREMENTS

In order to select final and detailed reclamation actions, the following data requirements will have to be filled:

- the character and extent of soil or groundwater contamination that may remain on site

- the regional economic and demographic conditions at the time of closure and the viability of selling or leasing specific buildings to another party for industrial development.

7.4 RECLAMATION ACTIVITIES

Tentative reclamation activities have been selected based upon the existing incomplete database. Before closure all process materials will be processed, sold or otherwise remediated. Currently it is assumed that all facilities will be demolished unless a valid post-mining use can be identified in the future. Contaminated soils and debris that are identified before or during demolition activities will be removed, treated or buried in place to allow at least industrial/commercial land use after closure. After demolition and remediation have been completed all sites will be reclaimed as described in Section 2.3.

8.0 TAILINGS DISPOSAL AREA

The South Tailings Impoundment currently contains about two billion tons of material and until recently received about 55 million additional tons annually. The original footprint of the impoundment was about 5800 acres, of which less than 2000 acres are currently not reclaimed. The current flat, interior portion of the impoundment covers about 3500 acres and the embankment covers about 2300 acres. Since 1999, the area of active tailings deposition has been reduced on top of the impoundment and new tailings deposition is currently only occurring intermittently on the eastern quarter of the impoundment. Interim and permanent reclamation activities are currently being performed on the inactive interior areas. Approximately 1100 acres of the embankment have been permanently reclaimed with trees and shrubs, and most of the remaining embankment area has undergone reclamation with a mix of fast growing grasses and forbs for dust control. The top of the impoundment is almost 250 feet high and the overall embankment slope is maintained at approximately 11 degrees.

The South Tailings Impoundment has almost reached its operational capacity and construction of the new North Impoundment expansion began in 1996. The transition to the North Impoundment is scheduled to extend from 1998 to 2004.

The tailings contain fewer sulfides and a lower acid potential (AP) than the ore produced in the mine because almost all of the chalcopyrite, bornite and molybdenite, and some of the pyrite, is removed during the beneficiation process and sent to the Smelter as concentrate. Samples of tailings from the Magna and Copperton Concentrators collected between 1996 and 2002 contain about 0.6 percent sulfide sulfur on average. If all of these sulfides were oxidized, the weighted average AP would be about 18 tons of calcium carbonate per 1000 tons of tailings. The sampling program also indicates that the tailings contain the equivalent long-term weighted average neutralization potential (NP) of about 29 tons of calcium carbonate per 1000 tons of tailings. The seven year weighted average net neutralization potential (NNP) of the tailings is thus 11 tons/1000 tons with a 95% confidence interval of 5 tons/1000 tons. The neutralization potential ratio (NPR) of the Magna and Copperton tailings has a weighted average of 1.6. However, coarse tailings material, which generally accumulates on the margins of the impoundment near the discharge points, has a higher concentration of sulfide minerals and tends to be more acid-generating than the impoundment tailings as a whole. More than 250 samples were collected from the surface and subsurface of the embankment between 1994 and 1996 (Shepard Miller, Inc. and Schafer and Associates, 1995; Shepard Miller, Inc., 1997). These samples represent a historical record of tailings deposition spanning several decades. The average AP of the data set was 22 tons/1000 tons and the average NP was 28 tons/1000. The average NNP was 6 tons/1000 tons with a 95% confidence interval of 6 tons/1000 tons. The average NPR of the tailings embankment samples was 1.3.

These NNP and NPR values are not clearly diagnostic of ARD potential under field conditions, so kinetic tests are also being performed on tailings samples in compliance with Utah Ground Water Discharge Permit UGW350011. Kinetic net acid generation (NAG) tests have recently been completed on 21 tailings samples with a range of NNP and NPR values. During NAG tests, tailings are mixed with a hydrogen peroxide solution for 24 hours and the pH and temperature of the mixture are continuously monitored. Hydrogen peroxide is a strong oxidizing agent, so the sulfides in the sample are oxidized at a rapid rate, mimicking years or decades of surface weathering during the short-term test. As shown on Figures 8-1a and 8-1b, the NNP and NPR are very good predictors of the final pH of the oxidized tailings. Samples with an NNP of less than –2 tons/1000 tons (NPR=0.8) all acidified, whereas samples with an NNP of greater than 3 tons/1000 tons (NPR=1.2) maintained a neutral pH throughout the test. Sulfide oxidation reactions are strongly exothermic, and samples with an excess of AP all exhibited very elevated temperatures during the tests (Figure 8-2a and 8-2b). Samples with an excess of NP all remained near room temperature throughout the test.

These results indicate that, although portions of the South Impoundment will acidify, the overall risk of ARD from the impoundment as a whole is low. On a mass basis, it is estimated that less than ten percent of the South Impoundment material has the potential to become acidic because of its NNP characteristics or because it will remain saturated in perpetuity. (Shepard Miller Inc. and Schafer and Associates, 1995). Most of the tailings will remain saturated in perpetuity. The sulfides in tailings that are below the water table are unlikely to ever be oxidized, but the NP of these saturated tailings will be able to neutralize any acidic solutions that they may contact.

Portions of the embankment surface will likely acidify because 1) sulfides are preferentially partitioned to the margins of the impoundment, and 2) oxygen is more readily available in the well-drained and coarse-grained embankment than in the fine-grained interior. Based upon the data collected between 1994 and 1996 and the new NAG test results, approximately 50 % of the tailings exposed on the embankment surface have the potential to acidify in the long term (assuming that all tailings with an NNP of less than 0 could ultimately acidify). Recent tailings deposited on some portions of the existing interior surface of the South Impoundment have also been more acid-generating than the long-term average. Acid-base accounting and kinetic NAG testing of new tailings deposited in the impoundment will continue in the future.

Some tailings may also have elevated salinity, predominantly associated with NaCl, because they are deposited by saline process water. The process water tends to be saline because some of it is derived from water with a relatively high total dissolved solids content and because it is continuously recirculated and undergoes evaporative concentration. In some locations, the salinity may be high enough to inhibit vegetation establishment.

Except for copper, the tailings have relatively low average total metals concentrations, as illustrated by a 61-sample average for the following elements: arsenic 25.1 mg/kg, barium 199 mg/kg, cadmium 0.3 mg/kg, chromium 47.3 mg/kg, copper 785 mg/kg, lead 23.0 mg/kg and selenium 1.2 mg/kg. Synthetic Precipitation Leaching Procedure analyses (EPA Method 1312) conducted on 30 un-weathered tailings samples yielded average leachate concentrations of less than detection for all of these elements.

8.1 CLOSURE ISSUES

The original mining and Reclamation Plan submitted to DOGM in 1976 specified the following activities for the South Tailings Impoundment at closure:

- when no longer needed for tailings deposition, mineral recovery or material source, grading and revegetation of dike slopes not already done will be completed

- the surface of the tailings pond will be stabilized using the most practicable technology available upon the termination of the deposition of the tailings.

In addition to the DOGM requirements, the primary closure issues at the South Tailings Impoundment include:

- dust must be controlled from the impoundment in perpetuity

- surface water runoff and surface seepage of tailings water from the impoundment must be captured and conveyed to a designated outfall point where it must meet applicable water quality criteria to be discharged

- groundwater quality must not be degraded

- long-term slope stability must be maintained.

8.2 SUMMARY OF EXISTING CLOSURE PLANS

The existing closure plans described in Section 1.2.2 and attached in Appendices B and C detail the reclamation activities that will occur when the South Impoundment closes. The ultimate goal for the surface of the South Impoundment is to establish a permanent, self-sustaining vegetative cover to minimize dust generation, water infiltration and erosion, while improving wildlife habitat, slope stability and aesthetics. In some areas of the South Impoundment interior, where vegetation establishment may be difficult because of salinity issues, the primary goal will be to create a stable surface that will inhibit dust generation.

Areas of the South Impoundment have been taken out of service sequentially, from west to east, to allow continued use of the decant pond until final closure of the existing impoundment. This has been done by constructing access dikes to subdivide the existing active surface. The peripheral discharge system has been reestablished on each new dike to keep the remaining active surface properly wetted. As each new area is isolated and begins to dry, it has been initially stabilized by one or more of the following methods: planting of rapid-growing grass seed, hydromulching, or temporary dust control using water or suppressants. Permanent revegetation of the surface is being conducted after the surface has dried sufficiently or in the next appropriate season. For tailings that have acidified or that may acidify in the future, limestone or another neutralizing agent will be added to maintain a near-neutral pH in the long-term. For some tailings with elevated salinity, final reclamation may need to be delayed several years to allow the salts to be removed by precipitation, infiltration and runoff. Recent sampling and historical studies indicate that this natural leaching process likely occurs within several years on the embankment surface and on portions of the interior, but it may involve decades on portions of the flat interior surface underlain by very saline, very fine-grained tailings (Utah State University, 1974). It may not be possible to establish vegetation on some very saline interior surfaces. In these areas other methods of permanent surface stabilization may be employed such as capping with a growth media, capping with coarse material, capping with a growth media underlain by a capillary break or promoting the formation of salt crusts.

At final closure, the flat, upper tailings surface will be constructed so that all precipitation will be retained on the surface. Captured precipitation will either infiltrate or will be removed by evapotranspiration. Water falling on the embankment and seepage that discharges from the base of the embankment, will report to the toe collection ditch. Ultimately, this water will be discharged through a UPDES outfall (Section 10.0). Groundwater monitoring will continue for some time after closure to ensure that there are no adverse impacts to groundwater quality.

More detailed descriptions of the closure activities are provided in the attached plans.

9.0 EXCESS WATER MANAGEMENT AREA

Facilities that are currently used for excess water management cover about 100 acres. As defined in the 1978 Permit under the land use category of excess process water disposal, this includes all the facilities that handle water from the tailings impoundment for disposal or recycling. Excess water from the South Impoundment is transferred from the decant pond to the clarification canal. From the canal, water flows around the southeast side of the impoundment to a pump station that returns it to the concentrator. Excess water not subject to recycle requirements is discharged to the Great Salt Lake from a series of permitted outfall points.

All of the other areas included under the excess process water land use category in the 1978 Permit are either closed or are only used by the Smelter or Refinery and so are not covered by DOGM permits. This includes the former wastewater treatment plant (WWTP) and its associated sludge lagoons that were demolished and reclaimed in 2001. Metals-bearing gypsum sludge generated during the neutralization process at the WWTP was discharged to five lagoons. Approximately 1.1 million cubic yards of sludge were moved from the lagoons to the Arthur Step Back Repository on the southwest side of the existing tailings impoundment. This repository was constructed under EPA oversight to meet the conditions of a RCRA Subtitle C facility. A portion of the repository underwent permanent capping and closure in 2001. The remainder has been temporarily capped and is authorized by EPA for future hazardous material disposal that meets the conditions of the corrective action management unit. It will be filled, closed and capped at closure.

9.1 CLOSURE ISSUES

The original Mining and Reclamation Plan submitted to DOGM in 1976 specified the following activities for the excess process water disposal area at closure:

- surface facilities that are no longer needed, and that are not convertible to some other use will be razed and/or removed
- sludge ponds and evaporation ponds will be left in a condition suitable for conversion to other uses, this may involve filling or covering, or other stabilization and revegetation work
- canals will most likely be left indefinitely for conveyance of natural surface flows and drainage to the Great Salt Lake.

After closure some of the facilities associated with excess water management will have to be used in perpetuity to handle surface water flows and seepage from the South Impoundment and the North Impoundment. It is also probable that some waters from the mine area and the mine waste disposal area will need to be routed through the existing process water disposal systems and into the Great Salt Lake. After closure all discharges will continue to be regulated under UPDES permit UT0000051 or a subsequent UPDES permit.

9.2 POSSIBLE POST-CLOSURE LAND USE

Based upon the long-term need to handle water from the tailings impoundments and possibly other areas, much of the area will be used for water management in perpetuity after closure. Some of the area may also be preserved as wetlands wildlife habitat. Selected areas, particularly those associated with process water recycling, may have an unrestricted land use after closure, demolition and reclamation.

9.3 DATA REQUIREMENTS

Some of the data requirements that will need to be filled before final post-mining closure options are selected include:

- the ultimate character of the post-mining water management system in the Oquirrh Mountains

- the final geometry of the tailings impoundments and their required water management systems.

9.4 RECLAMATION ACTIVITIES

Tentative reclamation activities have been selected based upon the existing incomplete data set. An outfall point or multiple points will be maintained in perpetuity to discharge water from the tailings impoundments and from other sources in the Oquirrh Mountains into the Great Salt Lake. Selected waters from the mine and the mine waste disposal areas will likely be transported north in existing pipelines within the tailings pipeline corridor. Most existing canals and ditches will be left in place to use for water management and to provide wildlife habitat. Structures currently associated with process water recycling, such as pump houses and pipes, will be removed unless they are determined to have a post-mining use. All buildings and structures that do not have a post-mining use will be demolished and reclaimed as described in Section 2.3.

10.0 POST-CLOSURE WATER MANAGEMENT

After closure the surface and shallow groundwater flows listed on Table 10-1 will need to be captured and managed in perpetuity. The table generally lists flows that have been impacted by contact with waste rock, tailings, underground workings or the open pit. Figure 10-1 is a map of the Bingham Canyon mine area showing watersheds that contribute to these flows and the existing surface water collection systems. Generally, watersheds that contain waste rock surfaces where leach water was historically applied have the lowest water quality. Watersheds that contain waste rock that was never leached have intermediate water quality and up gradient watersheds that are undisturbed contain potable quality water. Currently the surface and shallow groundwater flow in all of the up gradient drainages except for Dry Fork infiltrates into the down gradient waste rock dumps and is ultimately captured as ARD below the dumps. These up gradient watersheds also tend to receive significantly more precipitation than the areas below, so they will contribute relatively more water to the collection systems than is implied by their surface areas. Some watersheds near the range crest of the Oquirrh Mountains receive more than 30 inches/year average precipitation compared to an average of around 16 inches/year near the base of the waste rock disposal areas. Potable quality water discharging from springs, seeps or adits has been identified in several drainages. Listed in decreasing order of annual surface flow these include: Dry Fork, Freeman, Zelnora, Log Fork, Cottonwood and Sap gulches (Figure 10-1). Although Markham Gulch does not currently have any surface flow, historical records indicate that in the past it has produced as much water as Freeman Gulch.

Also listed on Table 10-1 is the water that will be produced as part of the Southwest Jordan Valley Plume remediation. Not included in the table are natural surface flows elsewhere within the permit boundaries in the Oquirrh Mountains or surrounding the Tailings Impoundment. Water extracted from the acid plume remediation contains the largest amount of acidity that will need to be treated, but the great majority of the acid plume will be removed before closure. It is anticipated that the water discharging from the toe of the north Eastside waste rock disposal areas and water flowing in the Bingham Canyon alluvium will contain the great majority of the acidity that must be managed in perpetuity. Both of these areas have been impacted by acid-generating waste rock disposal and historic leach water applications.

Most of the water quality data used to construct Table 10-1 was collected between 2000 and 2002. It is likely that before closure, flushing by precipitation and relatively clean groundwater flow will cause an improvement in water quality in some areas; particularly those that were impacted by historic leach water applications. Proper management of up gradient water, as well as reduced infiltration because of vegetation establishment may also improve some water quality. Conversely, it also is possible that continued sulfide oxidation in the pyrite halo of Bingham pit, the Magna Tailings Impoundment or in the newer waste rock disposal areas in Bingham Canyon may cause water quality in some of these areas to worsen with time.

10.1 CLOSURE ISSUES

The primary closure issues associated with water management are defined by the need to comply with all surface and groundwater regulations and permits in the most cost effective manner. The primary water management issues that will need to be addressed after closure are to:

- comply with the requirements of the UPDES and groundwater discharge permits
- minimize contact of precipitation, surface and groundwater with waste rock, tailings and sulfide-bearing bedrock
- capture contaminated water that has contacted waste rock, tailings and sulfide-bearing bedrock
- segregate different quality water flows to avoid contaminating relatively good quality water with poor quality water
- minimize contaminant loading into down gradient surface and groundwater
- remediate down gradient waters that have been impacted by historical contaminant loading
- treat water to a quality that is consistent with its ultimate end use
- transport water to the appropriate end users or discharge point
- perform groundwater and surface water quality monitoring to ensure down gradient areas are not being adversely impacted

10.2 POST-CLOSURE WATER MANAGEMENT ACTIVITIES

Post-closure water management will involve the collection, treatment and transport of relatively good quality up gradient waters, contaminated contact waters and contaminated waters extracted during remediation activities. Table 10-2 lists the facilities that may be left in place after closure to complete these tasks and lists their locations where available. The final location and configuration of many facilities cannot be determined yet. The final facility designs will be dependent upon water quality and flow data collected between now and closure. Most of the water management facilities are already in existence or will be constructed before closure. After closure on-going management of these facilities will include periodic inspections, routine maintenance and repairs.

10.2.1 Up Gradient Water Collection Systems

As described in Sections 3.0 and 4.0, collection facilities will be constructed up gradient from the waste rock disposal areas and the pyrite halo in the open pit to capture relatively clean water before it contacts sulfide-bearing waste rock and bedrock. These facilities will generally be located in drainages that have significant surface or shallow groundwater flow which discharges to the waste rock disposal areas. Selected surface water flows from the upper, net neutralizing benches in the open pit will also be captured and removed before they contact the pyrite halo. Collection sites will be located in upper Dry Fork Canyon, upper Freeman Gulch, selected drainages surrounding the open pit (most likely in Zelnora, Log Fork, Cottonwood, Sap and Markham Gulches) and on selected upper pit benches (Figure 10-1). In most cases the collection sites will be designed to capture water flowing on the surface or in alluvium, colluvium or shallow bedrock. Collection structures may include ponds, sumps, ditches, cutoff walls, horizontal drains or extraction wells. Once captured the water will be piped out of the area so that it does not contact any sulfide-bearing material. Pipes will likely transport the water to the mouth of Bingham Canyon, where it can be distributed to end-users. Small recharge areas, poor water quality, lack of surface flow and low bedrock porosity on undisturbed land within Muddy Gulch and Galena Gulch (South Side Natural on Figure 10-1) will generally prevent any significant water capture in these areas.

Gravity flow from some underground workings such as the Bingham, Mascotte, Utah Metals and Butterfield tunnels will continue to dewater some bedrock on the pit margins after closure (Figure 3-7). Selected up gradient underground workings may also continue to be dewatered by pumping after closure. Water is currently being removed from the North Ore Shoot shaft in upper Bingham Canyon and the Carr Fork workings in Pine Canyon. A shaft within the Utah Metals tunnel may also provide a viable up gradient dewatering point. Extraction from these workings would keep the north and west sides of the pit dewatered. After closure, the continued removal of water from selected underground workings surrounding the open pit will prevent groundwater quality from degrading as it flows through the pyrite halo towards the bottom of the pit. In most cases, the captured up gradient water will be of good quality and could be used or discharged without any restrictions.

10.2.2 Contact Water Collection Systems

As described in Sections 3.0, 4.0 and 8.0, contact water collection systems will be maintained after closure to capture water that has been degraded by contact with sulfide-bearing waste rock, tailings and bedrock. The anticipated flows that will need to be captured and treated in perpetuity are listed in Table 10-1. However, the capture of up gradient flows, and the increase in evapotranspiration on recontoured and revegetated surfaces may ultimately reduce the amount of contact water that must be collected.

The Eastside Collection System will continue to operate after closure. This system collects water that has contacted the Eastside, Bingham Canyon and Dry Fork waste rock disposal areas. The collection system captures water that discharges from the toe of the Eastside waste rock disposal areas and that flows in the alluvium of Bingham Creek and several other drainages. The Eastside Collection System is composed of a series of collection sumps and ponds, settling ponds, cutoff walls, pipes, canals and pump stations. Water will also continue to be extracted in upper Bingham Canyon and lower Dry Fork Canyon after closure. Collection systems will include pumping from the West Mountain Shaft or its replacement and pumping from an extraction well located at the intersection of Dry Fork and Bingham Canyons. This collection system is designed to minimize the migration of contaminated water from the Dry Fork/Bingham Canyon area into lower Bingham Canyon. Water extraction at these sites in upper Bingham Canyon will likely decrease the quantity and improve the quality of water that must be captured at the cutoff wall.

Surface water collection systems will also be established on the lower, net acid-generating walls of the open pit to capture water from runoff, springs, and underground workings before it can infiltrate into the pyrite halo. The water will be captured in collection sumps and will either be piped to the bottom of the pit, or it will be piped directly out of the pit. Water that discharges into the bottom of the pit will ultimately be pumped out via the 5490 tunnel.

Collection systems on the margins of the South Tailings Impoundment will also need to be maintained after closure. Contact water from seeps and springs on the lower embankment slopes will be captured in ponds, sumps or ditches. This water will then be managed in conjunction with contact waters from other parts of the operation.

In most cases, contact water that is captured will have to be treated before it will meet standards acceptable for irrigation, drinking water or discharge to surface water.

10.2.3 Bingham Creek Groundwater Remediation

The historic groundwater contamination in the southwest Jordan Valley has been subdivided into two zones, Zone A and Zone B, for management purposes. Zone B, includes an area east and southeast of the former KUCC evaporation ponds in South Jordan, and is characterized by sulfate concentrations averaging approximately 700 mg/L. Zone B treatment will be addressed through a Reverse Osmosis (RO) treatment plant which will be constructed by the Jordan Valley Water Conservancy District (JVWCD) located at approximately 1300 West and 8200 South.

The most significant portion of Zone A, is located immediately down gradient from the Large Bingham Reservoir. Water in the core of Zone A is characterized by low pH (<4.5), elevated heavy metals, and high sulfate (>20,000 mg/L). The settlement of a Natural Resource Damage (NRD) claim made by the State of Utah against KUCC for contamination of groundwater in the southwestern Jordan Valley required among other things that the acidic portion of the plume be pumped at an annual rate of 250 gpm based on a rolling five year average. The principal objective of the NRD claim is to "restore, replace or acquire the equivalent" of the damaged groundwater resource. There are portions of the settlement that overlap the scope of CERCLA remedial actions that are also required. These include among others, preventing the migration of contaminated groundwater into previously uncontaminated portions of the aquifer. The U.S. Environmental Protection Agency's Record of Decision (ROD) for the CERCLA action also provides that KUCC:

- Monitor the plume to follow the progress of natural attenuation for the portions of the Zone A plume which contain sulfate in excess of the state primary drinking water standard for sulfate (500 ppm sulfate).

- Disposal of treatment concentrates via the existing pipeline used to slurry tailings to the tailings impoundment prior to mine closure.

- Develop a post-mine closure plan to handle treatment residuals for use when the mine and mill are no longer operating.

Recent groundwater modeling suggests a much higher pumping rate than 250 gpm is required to contain the plume. The Remedial Investigation and Feasibility Study (RI/FS) for the contaminated groundwater demonstrated that the plume will continue to flow towards the Jordan River unless hydraulically contained and that the extracted acidic water must be treated before discharge. The RI/FS calls for the installation of additional groundwater extraction wells in the acidic portion of the plume that will be pumped at a rate of approximately 2000 to 2500 gpm. The pumping rate will remove most of the acidic plume before closure and will satisfy the NRD settlement and CERCLA corrective action requirements. Additionally, as proposed in the RI/FS, a barrier well system to extract elevated sulfate in groundwater and hydraulically contain the plume will be installed at the plume terminus.

The acidic water removed from the core of Zone A will be neutralized with lime and tailings and will be discharged to the tailings line during the active life of the mine. It is anticipated that before closure, one or more lime treatment plants will be built somewhere near the mouth of Bingham Canyon. The lime treatment capacity will be sized to handle the anticipated post-closure flows. A plant for treating Zone A sulfate water from the margins of the plume will be constructed by KUCC near the barrier wells. The treatment system will use RO treatment technology to produce approximately 3500 acre-feet/year of drinking quality water. As required by the EPA ROD, the clean RO permeate water will be sent to municipal supply for delivery through the Jordan Valley Water Conservancy District (JVWCD) distribution pipelines to affected users. The RO concentrate will be discharged to the tailings line during the active life of the mine. Studies have been conducted as part of the Remedial Design Workplan to ensure that the deposition of treatment sludges and precipitates in the North Tailings Impoundment (DOGM permit number M/035/015) will not adversely impact the geochemical stability of the tailings. Geochemical monitoring will also continue for the life of the project.

The current assumptions for the post-closure management of RO concentrate and lime-neutralized water is for it to be discharged to the Great Salt Lake through a future permitted discharge outfall. Further studies, to confirm the feasibility of this option and address post-closure management of lime treatment sludges will be conducted over the next few years as part of the Remedial Design Workplan. Options to be evaluated include stabilization of the sludge and placement on the waste rock disposal areas or construction of a repository.

10.2.4 Mine Water Treatment and Discharge

Acidic post-closure flows from the mine area may total about 1500 gpm (Table 10-1). Depending on the final closure scenario selected for the pit, up to about 2500 gpm may also need to be treated at closure (pit with a small collection pond or ponds) or treatment may be delayed for up to 30 years after closure (partial flooding scenario). It is anticipated that all of these post-closure flows will be treated by lime neutralization, sedimentation and clarification. It is also possible that a small pretreatment plant may also remain in place after closure to recover copper from selected copper-bearing flows that discharge from the waste rock disposal areas. This plant would likely be located above the cutoff wall in lower Bingham Canyon and will feed water to the lime plant.

As indicated in section 10.2.3, KUCC intends to remove most of the acidic groundwater plume before closure. At closure, the reduction in treatment needs for the acid plume, will allow for lime treatment plant capacity to be available for the mine flows. The treated effluent may be pumped to the tailings pipeline and ultimately discharged into the Great Salt Lake. Some of the water may also be provided for municipal use if it is treated sufficiently. The sludges generated during the treatment of mine waters will be handled in a similar manner to the sludges generated by the acid plume remediation. During active operations these sludges will be discharged to the tailings impoundment, but after closure they will be handled as determined in the Remedial Design Workplan.

10.2.5 Long-Term Monitoring

Long-term monitoring of surface water and groundwater quality will be required after closure to ensure that remediation objectives have been attained and to ensure that down gradient areas are not negatively impacted by waste rock, tailings and sulfide-bearing bedrock. Monitoring will generally be accomplished by the periodic sampling of wells and surface flows. Figures 10-2 and 10-3 are maps showing the existing wells owned by Kennecott within the permit boundaries. The wells are designated as permit monitoring wells, production wells and other monitoring wells. After closure it is likely that many of the monitoring wells required by groundwater discharge permits and most of the production wells will be left in place. Continued access to some of the non-permit monitoring wells will also be needed after closure. Those wells that do not have a post-mining use will be abandoned in accordance with all applicable regulations including with the State Engineers specifications.

It is anticipated that after closure at least 25 years of monitoring will be required for Groundwater Discharge Permits UGW350010 and UGW350011. These permits are associated with the waste rock disposal areas and the tailings impoundment respectively. Post-closure monitoring requirements for the groundwater discharge permit associated with the North Concentrator may be of a shorter duration. After all process materials and facilities have been removed from the North Concentrator site and the land has been reclaimed, there will be no potential contaminant sources remaining. Other than general assumptions about the duration of monitoring, it would be premature to try to designate post closure sampling points and frequencies at this time. A detailed post closure monitoring plan for the ground discharge permits will be prepared a short time before closure based upon the surface and groundwater conditions at that time.

11.0 FUTURE AND ON-GOING RESEARCH IN SUPPORT OF CLOSURE

KUCC has been conducting research in support of reclamation and closure since 1978. Much of this work has focused on long-term management of water resources and on the development and testing of reclamation techniques.

In particular, since 1992 KUCC has developed and tested several revegetation methods for the waste rock and tailings disposal areas. This work has been focused on several technologies including slope reduction techniques, the use of biosolids and other soil amendments, the placement of various types and thicknesses of cap materials, the use of acid-neutralizing agents and the planting of mycorrhizae-inoculated and un-inoculated seeds and seedlings. These efforts began with test plots and culminated in the slope reduction, capping and revegetation of 330 acres of low pH waste rock surfaces and additional acres on the existing tailings impoundment. Investigations have recently focused on direct planting onto older waste rock surfaces that have favorable soil chemistry. To date approximately 200 acres of waste rock surfaces with favorable soil chemistry have been recontoured into natural landforms, amended with liming agents and have been directly planted. This research will continue in the future, testing new technologies as they become available and existing techniques in new physical and geochemical environments.

Preliminary studies of waste rock soil geochemical evolution, volunteer vegetation establishment on waste rock surfaces, reclamation and infiltration modeling, direct planting on waste rock surfaces, long-term implications of biosolids application and pit wall acid/base accounting geochemistry have also been completed recently. There are many other ongoing or planned research projects that are designed to fill some of the data requirements identified in Sections 3.0 through 10.0. These studies include:

Study Description	**Status**
Acidification Potential of the Tailing Impoundments	On-going
Acid Base Accounting Study of Current and Ultimate Pit Walls	On-going
Waste Rock Revegetation Test Plots with Various Soil Amendments	On-going
Botanical Surveys of Past Reclamation Sites	On-going
Pit-Slope Stability Analysis	On-going
Waste Rock Stability Analysis	On-going
Waste Rock Disposal Area Water Balance	On-going
Treatability Study of the Bingham Groundwater Plume	On-going
Treatability Studies of Leach Water and ARD	On-going
Ecological/Human Health Risk Assessment	On-going
Regional Numeric Groundwater Modeling	On-going
Land Use Master Plan	On-going
Waste Rock Disposal Area Design Studies	On-going
Geochemical Evolution of Tailings Impoundment Soils	On-going
Slope Stabilization Study of South Eastside Waste Rock Disposal Areas	On-going
Survey of Surface and Shallow Groundwater Flow Around the Open Pit	On-going
Precipitation Plant Closure Plan	Planned

Hydrogeology of the Post-closure Pit	Planned
Water Chemistry of the Post-Closure Pit	Planned
Long-Term Sustainability Plan	Planned
Closure Waste Rock Soil Geochemistry Survey	Planned

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APPENDIX A - 1976 MINING AND RECLAMATION PLAN

SCOTT M. MATHESON
Governor

GORDON E. HARMSTON
Executive Director,
NATURAL RESOURCES

CLEON B. FEIGHT
Director

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS, AND MINING
1588 West North Temple
Salt Lake City, Utah 84116
(801) 533-5771

OIL, GAS, AND MINING BOARD

I. DANIEL STEWART
Chairman

CHARLES R. HENDERSON
JOHN L. BELL
THADIS W. BOX
C. RAY JUVELIN

October 2, 1978

ACT/035/002

Mr. Chuck Stillman
Kennecott Copper Corporation
P.O. Box 11299
Salt Lake City, Utah 84147

Re: Final Approval for
Kennecott Copper Corporation's
Mining and Reclamation Plan
Bingham Canyon Mine

Dear Mr. Stillman:

The Board of Oil, Gas, and Mining, at its September 28, 1978 executive meeting, approved your previously submitted surety contract for reclamation of the Bingham Canyon Mine.

Enclosed herewith is Kennecott's copy of the fully executed Mined Land Reclamation Contract. Therefore I hereby issue final approval to the Kennecott Copper Corporation's Bingham Canyon Mine to operate under the Utah Mined Land Reclamation Act.

Sincerely,

Cleon B. Feight

CLEON B. FEIGHT
DIRECTOR

CBF/sp
enc: Reclamation Contract

Do not
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RECEIVED
SEP 8 1978
DIVISION OF
OIL, GAS, & MINING

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
BOARD OF OIL, GAS, AND MINING
1588 WEST NORTH TEMPLE
SALT LAKE CITY, UTAH 84116

* MINED LAND RECLAMATION CONTRACT *

THIS CONTRACT, made and entered into this 28TH day of SEPTEMBER, 1978, between Kennecott Copper Corporation a corporation duly authorized and existing under and by virtue of the laws of State of Utah as party of the first part, and hereinafter called the Operator, and the BOARD OF OIL, GAS, AND MINING, duly authorized and existing by virtue of the laws of the State of Utah, as party of the second part hereinafter called the Board.

WITNESSETH:

WHEREAS, the Operator is the owner and in possession of certain mining claims and/or leases hereinafter more particularly mentioned and described in Exhibit "A" attached hereto.

WHEREAS, the Operator did on the Ninth day of August 1976, file with the Division of Oil, Gas, and Mining, a "Notice of Intention to Commence Mining Operations" and a "Mining and Reclamation Plan" to secure authorization to engage, or continue to engage, in mining operations in the State of Utah, under the terms and provisions of the Mined Land Reclamation Act, Section 40-8, U.C.A., 1953.

WHEREAS, the Operator is able and willing to reclaim the above mentioned "lands affected" in accordance with the approved Mining and Reclamation Plan, the Mined Land Reclamation Act of 1975 and the rules and regulations adopted in accordance therewith.

WHEREAS, the Board has considered the factual information and recommendations provided by the Staff of the Division of Oil, Gas, and Mining as to the magnitude, type and costs of the approved reclamation activities planned for the land affected.

WHEREAS, the Board is cognizant of the nature, extent, duration of operations, the financial status of the Operator and his capability of carrying out the planned work.

NOW THEREFORE, for and in consideration of the mutual covenants of the parties by each to the other made and herein contained, the parties hereto agree as follows:

1. The Operator promises to reclaim the land affected in accordance with its Mining and Reclamation Plan which was approved by the Board on February 22, 1978, the Mined Land Reclamation Act, and the rules and regulations adopted in accordance therewith.

2. The Board, in lieu of accepting the posting of a bond or other surety, accepts the personal guarantee of the Operator to reclaim the land affected in accordance with its approved reclamation plan.

3. The Board and Operator both agree that the Operator will be obligated to expend a minimum average, excluding salaries, but not operating wages, of $50,000 - 1978 dollars per year for each three (3) year period, in maintaining a program of experimentation and in the application of the best available technology toward rehabilitation of land associated with or affected by mining or processing operations.

4. The Board and Operator further agree that the annual expenditure as set forth in paragraph three (3) above, unless waived by the Board, will continue until mining as described in the notice of intention is permanently terminated, and that said annual expenditure will not constitute the fulfillment of the obligations of the Operator as to mined land reclamation. The Operator further agrees to waive the requirements for the fixed sum as surety as required in Section 40-8-14 (8), U.C.A., 1953.

5. The Operator agrees to provide to the Board and Division annually, a detailed report of reclamation work performed during the preceeding year, including a cost accounting for said reclamation work in 1978 dollars.

6. The Operator further agrees to work jointly with the Division in establishing annual reclamation plans for each forthcoming year. Said plan will be subject to the review of the Board. Consideration will be given to the annual report of the previous year in establishing such plans.

7. The Operator agrees to designate a responsible individual who is involved in the Operator's on-going reclamation efforts, who will serve as liaison to the Division.

8. This contract shall be binding on all successors and assigns, to the Operator.

IN WITNESS THEREOF, the parties of the first and second parts, hereto have respectively set their hands and seals this 28 day of Sept.

1978

KENNECOTT COPPER CORPORATION

By: [signature]

Its President ~~Metal Mining Division~~

ATTEST:

[signature]

Asst. Secretary

APPROVED

[signature]

BOARD OF OIL, GAS, AND MINING

By [signature]

Chairman

Note: If the Operator is a corporation, the agreement should be executed by its duly authorized officer with the seal of the corporation affixed.

EXHIBIT A
MINING APPLICATION
NO. ACT-035-002

Date August 9, 1976

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING
1588 West North Temple
Salt Lake City, Utah 84116

NOTICE OF INTENTION TO COMMENCE MINING OPERATIONS
(See Rule M of General Rules and Regulations)

1. Name of Applicant or Company Kennecott Copper Corporation, Utah Copper Division
Corporation (X) Partnership ( ) Individual ( )

2. Address P. O. Box 11299, Salt Lake City, Utah 84147
Permanent

3. Name and title of person representing company B. B. Smith, General Manager

4. Address P. O. Box 11299, Salt Lake City, Utah 84147 Office Phone 322-1533

5. Location of Operations Salt Lake and Tooele within the following sections:
County

Sec 7, 8, 9, 10, 11, 17, 18, 19, 20, 21, 30, 31 & 32, T1S, R2W, SLB&M;
Sec 9, 10, 11, 12, 13, 14, 15, 16, 22, 23, 24, 25, 26 & 36, T1S, R3W, SLB&M;
Sec 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 22, 23, 27, 28 & 33, T2S, R2W, SLB&M;
Sec 7, 17, 18 & 19, T3S, R1W, SLB&M;
Sec 4, 8, 9, 13, 14, 15, 16, 17, 18, 19, 20, 21, 24, 25, 28, 29, 30, 31 & 32, T3S, R2W, SLB&M;
Sec 11, 12, 13, 14, 15, 21, 22, 23, 24, 25, 26, 27, 33, 34, 35 & 36, T3S, R3W, SLB&M;
Sec 6 & 7, T4S, R2W, SLB&M;
Sec 1, 2, 3, 11 & 12, T4S, R3W, SLB&M.

6. Name of Mine Bingham Canyon Mine

7. Mineral to be mined:

( ) Coal
(X) Copper
( ) Manganese
( ) Iron Ore
( ) Phosphate
( ) Potash
( ) Fluorspar
( ) Flagstone
( ) Gravel
( ) Shale
( ) Uranium
( ) Gilsonite
( ) Bituminous Sandstone
( ) Tungsten
(X) Other (specify) Minerals associated with copper.

Mining methods:
Open pit, waste leaching, insitu leaching, underground.

8. Have you or any person, partnership or corporation associated with you received an approved Notice of Intention to Commence Mining Operations by the State of Utah for operations other than described herein?
( ) Yes (X) No *

If yes, list all approval numbers now under surety:

* Kennecott's Tintic Mines Division may have requested approval.

9. Owner/Owners of record o_ the surface area within the la(o be affected:

Kennecott Copper Corporation	Address	161 East 42nd Street, New York, NY 10017
U. V. Industries	Address	(Local Office) University Club Bldg, Salt Lake City, UT
The Anaconda Company	Address	(Local Office) 1849 West North Temple, Salt Lake City, UT

10. Owner/Owners of record of minerals to be mined:

Kennecott Copper Corporation	Address	161 East 42nd Street, New York, NY 10017
U. V. Industries	Address	(Local Office) University Club Bldg, Salt Lake City, UT

11. Owner/Owners of record of all other minerals within any part of the land affected:

The Anaconda Company	Address	(Local Office) 1849 West North Temple, Salt Lake City, UT

11a. Have the above owners been notified in writing?

(X) Yes ( ) No

12. Source of Operator's legal right to enter and conduct operations on land to be covered by the Notice:

Legal documents, including deeds, easements, mining claims, agreements, licenses, etc.

13. Approximate acreage to be disturbed:

Mine	3,100 acres
Mine waste disposal	8,000 acres
Excess mine water disposal	2,700 acres
Ore transfer - mine to process	400 acres
Ore processing facilities	1,800 acres
Tailing disposal	6,000 acres
Excess process water disposal	1,000 acres
Total	23,000 acres

14. Give the names and post office addresses of every principal Executive, Officer, Partner, (or person performing a similar function) of Applicant:

	Name:	Title:	Address:
a.	B. B. Smith	General Manager Utah Copper Division	P. O. Box 11299 Salt Lake City, UT 84147
b.	H. H. Kremer	President Metal Mining Division	161 East 42nd Street New York, NY 10017
c.	F. B. Milliken	President	161 East 42nd Street New York, NY 10017

15. Has Applicant, any subsidiary or affiliate of any person, partnership, association, trust, or corporation controlled by or under common control with Applicant, or any person required to be identified by Item 14, ever had an approval of a Notice of Intention withdrawn or has surety relating thereto ever been forfeited?

( ) Yes (X) No

If yes, explain:

STATE OF UTAH)
: ss
COUNTY OF SALT LAKE)

I, B. B. Smith, having been duly sworn depose and attest that all of the representations contained in the foregoing application are true to the best of my knowledge; that I am authorized to complete and file this application on behalf of the Applicant and this application has been executed as required by law.

KENNECOTT COPPER CORPORATION
Utah Copper Division

By [signature]
Its General Manager

Taken, subscribed and sworn to before me the undersigned authority in my said county, this 9th day of August, 1976.

Keith L. Hansen
Notary Public

My Commission Expires:
November 1, 1979

MINING APPLICATION

NO. ACT-035-002

DATE: August 9, 1976

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING
1588 WEST NORTH TEMPLE
SALT LAKE CITY, UTAH 84116

MINING AND RECLAMATION PLAN

PREAMBLE

Planning for rehabilitation of an operation mine is always difficult. This difficulty is magnified many times when the expected life of the mine may be decades or even a century. Such is the case of the Bingham Mine. It is not even possible to determine the approximate land uses at the end of the mining operation. For that reason, this rehabilitation plan cannot be as specific as that of other, more short-lived, operations.

However, regardless of the end use of the land, it is the intention of Kennecott to leave the land in a stable and productive condition consistent with location, possible uses, and topography, recognizing that since the mine is open pit in nature that the land itself cannot be restored as it was prior to commencement of mining.

To accomplish these objectives, Kennecott will maintain a program of experimentation and will apply the best available technology toward rehabilitating each piece of land as it moves from mining to other uses. A detailed annual report of reclamation work performed during the preceding year will be developed for review by the Board of Oil, Gas and Mining. These annual reports will be utilized by Kennecott and the Division in jointly establishing reclamation plans for the forthcoming year with the intent of accomplishing the overall objectives.

The following plan represents an attempt to outline some of the possible land uses and describe the steps the company will take to reach the general objectives.

MINING AND RECLAMATION PLAN

A. Applicant - Kennecott Copper Corporation, Utah Copper Division.

B. Type of Operation - Mining and processing for mineral extraction. Mining method and processing facilities are continually modified and updated to meet natural and physical requirements and conditions of market, technology, governmental regulation, economics and other factors. Large scale mining operation has been underway since about 1904. Remaining life of the mining operation will depend upon many things including the likelihood that eventual mineral shortages and improved technology will justify mineral extraction from materials now considered waste. It is, therefore, impossible to predict a terminal point for the mining and processing operations. However, it is not expected that this terminal point will occur within the next 50 years.

The Utah Copper Division operations extend from in and around the Bingham Mine to just beyond the north end of the Oquirrh Mountains near Magna (see CONFIDENTIAL map, Exhibit A). The operation is divided into the following areas which are identified on Exhibit A, shown in schematic arrangement on process diagram Exhibit B, and covered separately herein:

1. Mine
2. Mine Waste Disposal
3. Excess Mine Water Disposal
4. Ore Transfer-Mine to process
5. Ore Processing Facilities
6. Tailing Disposal
7. Excess Process Water Disposal

1. Mine Area

The mine area from which overburden and ore is removed comprises approximately 3100 acres.

Prior to open pit mining which began in 1904, this mountainous area had been a source of timber and was being used for underground mining operations with associated surface facilities, residences, businesses, etc. As open pit mining has expanded, these other used have been discontinued.

Determination of a definite use for the area after mining operations cease is difficult due to many uncertainties involved, but will be determined in light of potential use of the land and the condition of the land after reclamation by means that are technologically and economically practicable. Possibilities include:

Scenic attraction.

Historical landmark.

Other public or private use.

Very little vegetation remains in the mining area because of the considerable volume of material having been displaced. The remaining vegetation consists of grasses, forbs, shrubs, and trees such as aspen, mountain mahogany, Utah juniper and fir. The pH of undisturbed soils ranges from 4.5 to 7.5 as determined by mixing 100 gm of soil with 100 ml of distilled water. Most materials removed from or exposed in the mine are acidic. Surface elevation ranges from approximately 5240 feet to over 7800 feet above sea level.

Underground workings and natural bedrock aquifers have been, and will continue, to be, encountered during mining operations. The drainage from these abandoned mines and fault-related aquifers is discharged through a railroad tunnel to supply make up water for leaching operations. At times the water is bypassed by pipeline and canal to a disposal area (see Area 3). Typical analysis of this water is listed below:

pH	4.7	Fe	100 ppm
TDS	2,400 ppm	Cl	70 ppm
SO_4	1,400 ppm	Ca	500 ppm
Al	5 ppm	Cu	4 ppm
Mg	50 ppm		

Experiments are being conducted to determine if this water can be used for irrigation.

Since open pit mining began, over 1,350,000,000 tons of ore and 2,400,000,000 tons of waste have been removed. This is one of the largest mining operations ever undertaken, having produced more copper than any other mine in history. The present excavation is approximately 2-1/4 miles wide and 1/2 mile deep (see photograph Exhibit C). There are now 56 levels or benches in the mine which typify open-pit mining, a feasible and economical system for handling the low grade ore and overburden in vast quantities. Height of the benches ranges between 40 and 50 feet. Material is now being removed from 20 lower benches and from upper benches by truck.

SCOTT M. MATHESON
Governor

GORDON E. HARMSTON
Executive Director,
NATURAL RESOURCES

CLEON B. FEIGHT
Director

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS, AND MINING
1588 West North Temple
Salt Lake City, Utah 84116
(801) 533-5771

OIL, GAS, AND MINING BOARD

I. DANIEL STEWART
Chairman

CHARLES R. HENDERSON
JOHN L. BELL
THADIS W. BOX
C. RAY JUVELIN

October 2, 1978

ACT/035/002

Mr. Chuck Stillman
Kennecott Copper Corporation
P.O. Box 11299
Salt Lake City, Utah 84147

Re: Final Approval for
Kennecott Copper Corporation's
Mining and Reclamation Plan
Bingham Canyon Mine

Dear Mr. Stillman:

The Board of Oil, Gas, and Mining, at its September 28, 1978 executive meeting, approved your previously submitted surety contract for reclamation of the Bingham Canyon Mine.

Enclosed herewith is Kennecott's copy of the fully executed Mined Land Reclamation Contract. Therefore I hereby issue final approval to the Kennecott Copper Corporation's Bingham Canyon Mine to operate under the Utah Mined Land Reclamation Act.

Sincerely,

Cleon B. Feight

CLEON B. FEIGHT
DIRECTOR

CBF/sp
enc: Reclamation Contract

Do not retype copy + insert

RECEIVED SEP 8 1978 DIVISION OF OIL, GAS, & MINING

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
BOARD OF OIL, GAS, AND MINING
1588 WEST NORTH TEMPLE
SALT LAKE CITY, UTAH 84116

* MINED LAND RECLAMATION CONTRACT *

THIS CONTRACT, made and entered into this 28TH day of SEPTEMBER, 1978, between Kennecott Copper Corporation a corporation duly authorized and existing under and by virtue of the laws of State of Utah as party of the first part, and hereinafter called the Operator, and the BOARD OF OIL, GAS, AND MINING, duly authorized and existing by virtue of the laws of the State of Utah, as party of the second part hereinafter called the Board.

WITNESSETH:

WHEREAS, the Operator is the owner and in possession of certain mining claims and/or leases hereinafter more particularly mentioned and described in Exhibit "A" attached hereto.

WHEREAS, the Operator did on the Ninth day of August 1976, file with the Division of Oil, Gas, and Mining, a "Notice of Intention to Commence Mining Operations" and a "Mining and Reclamation Plan" to secure authorization to engage, or continue to engage, in mining operations in the State of Utah, under the terms and provisions of the Mined Land Reclamation Act, Section 40-8, U.C.A., 1953.

WHEREAS, the Operator is able and willing to reclaim the above mentioned "lands affected" in accordance with the approved Mining and Reclamation Plan, the Mined Land Reclamation Act of 1975 and the rules and regulations adopted in accordance therewith.

WHEREAS, the Board has considered the factual information and recommendations provided by the Staff of the Division of Oil, Gas, and Mining as to the magnitude, type and costs of the approved reclamation activities planned for the land affected.

WHEREAS, the Board is cognizant of the nature, extent, duration of operations, the financial status of the Operator and his capability of carrying out the planned work.

NOW THEREFORE, for and in consideration of the mutual covenants of the parties by each to the other made and herein contained, the parties hereto agree as follows:

1. The Operator promises to reclaim the land affected in accordance with its Mining and Reclamation Plan which was approved by the Board on February 22, 1978, the Mined Land Reclamation Act, and the rules and regulations adopted in accordance therewith.

2. The Board, in lieu of accepting the posting of a bond or other surety, accepts the personal guarantee of the Operator to reclaim the land affected in accordance with its approved reclamation plan.

3. The Board and Operator both agree that the Operator will be obligated to expend a minimum average, excluding salaries, but not operating wages, of $50,000 - 1978 dollars per year for each three (3) year period, in maintaining a program of experimentation and in the application of the best available technology toward rehabilitation of land associated with or affected by mining or processing operations.

4. The Board and Operator further agree that the annual expenditure as set forth in paragraph three (3) above, unless waived by the Board, will continue until mining as described in the notice of intention is permanently terminated, and that said annual expenditure will not constitute the fulfillment of the obligations of the Operator as to mined land reclamation. The Operator further agrees to waive the requirements for the fixed sum as surety as required in Section 40-8-14 (8), U.C.A., 1953.

5. The Operator agrees to provide to the Board and Division annually, a detailed report of reclamation work performed during the preceeding year, including a cost accounting for said reclamation work in 1978 dollars.

6. The Operator further agrees to work jointly with the Division in establishing annual reclamation plans for each forthcoming year. Said plan will be subject to the review of the Board. Consideration will be given to the annual report of the previous year in establishing such plans.

7. The Operator agrees to designate a responsible individual who is involved in the Operator's on-going reclamation efforts, who will serve as liaison to the Division.

8. This contract shall be binding on all successors and assigns, to the Operator.

IN WITNESS THEREOF, the parties of the first and second parts, hereto have respectively set their hands and seals this 28 day of Septemb. 19 78

KENNECOTT COPPER CORPORATION

By: [signature]
Its President ~~Metal Mining Division~~

ATTEST:

[signature]
Asst Secretary

APPROVED
[signature]

BOARD OF OIL, GAS, AND MINING

By [signature]
Chairman

Note: If the Operator is a corporation, the agreement should be executed by its duly authorized officer with the seal of the corporation affixed.

EXHIBIT A
MINING APPLICATION
NO. ACT-035-002

Date August 9, 1976

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING
1588 West North Temple
Salt Lake City, Utah 84116

NOTICE OF INTENTION TO COMMENCE MINING OPERATIONS
(See Rule M of General Rules and Regulations)

1. Name of Applicant or Company Kennecott Copper Corporation, Utah Copper Division
Corporation (X) Partnership ( ) Individual ( )

2. Address P. O. Box 11299, Salt Lake City, Utah 84147
Permanent

3. Name and title of person representing company B. B. Smith, General Manager

4. Address P. O. Box 11299, Salt Lake City, Utah 84147 Office Phone 322-1533

5. Location of Operations Salt Lake and Tooele (County) within the following sections:

Sec 7, 8, 9, 10, 11, 17, 18, 19, 20, 21, 30, 31 & 32, T1S, R2W, SLB&M;
Sec 9, 10, 11, 12, 13, 14, 15, 16, 22, 23, 24, 25, 26 & 36, T1S, R3W, SLB&M;
Sec 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 22, 23, 27, 28 & 33, T2S, R2W, SLB&M;
Sec 7, 17, 18 & 19, T3S, R1W, SLB&M;
Sec 4, 8, 9, 13, 14, 15, 16, 17, 18, 19, 20, 21, 24, 25, 28, 29, 30, 31 & 32, T3S, R2W, SLB&M;
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Sec 1, 2, 3, 11 & 12, T4S, R3W, SLB&M.

6. Name of Mine Bingham Canyon Mine

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( ) Coal
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(X) Other (specify) Minerals associated with copper.

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8. Have you or any person, partnership or corporation associated with you received an approved Notice of Intention to Commence Mining Operations by the State of Utah for operations other than described herein?
( ) Yes (X) No *

If yes, list all approval numbers now under surety:

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9. Owner/Owners of record o_ the surface area within the la(o be affected:

Kennecott Copper Corporation	Address	161 East 42nd Street, New York, NY 10017
U. V. Industries	Address	(Local Office) University Club Bldg, Salt Lake City, UT
The Anaconda Company	Address	(Local Office) 1849 West North Temple, Salt Lake City, UT

10. Owner/Owners of record of minerals to be mined:

Kennecott Copper Corporation	Address	161 East 42nd Street, New York, NY 10017
U. V. Industries	Address	(Local Office) University Club Bldg, Salt Lake City, UT

11. Owner/Owners of record of all other minerals within any part of the land affected:

The Anaconda Company	Address	(Local Office) 1849 West North Temple, Salt Lake City, UT

11a. Have the above owners been notified in writing?
(X) Yes ( ) No

12. Source of Operator's legal right to enter and conduct operations on land to be covered by the Notice:

Legal documents, including deeds, easements, mining claims, agreements, licenses, etc.

13. Approximate acreage to be disturbed:

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Excess process water disposal	1,000 acres
Total	23,000 acres

14. Give the names and post office addresses of every principal Executive, Officer, Partner, (or person performing a similar function) of Applicant:

	Name:	Title:	Address:
a.	B. B. Smith	General Manager Utah Copper Division	P. O. Box 11299 Salt Lake City, UT 84147
b.	H. H. Kremer	President Metal Mining Division	161 East 42nd Street New York, NY 10017
c.	F. B. Milliken	President	161 East 42nd Street New York, NY 10017

15. Has Applicant, any subsidiary or affiliate of any person, partnership, association, trust, or corporation controlled by or under common control with Applicant, or any person required to be identified by Item 14, ever had an approval of a Notice of Intention withdrawn or has surety relating thereto ever been forfeited?

( ) Yes (X) No

If yes, explain:

STATE OF UTAH)
: ss
COUNTY OF SALT LAKE)

I, B. B. Smith, having been duly sworn depose and attest that all of the representations contained in the foregoing application are true to the best of my knowledge; that I am authorized to complete and file this application on behalf of the Applicant and this application has been executed as required by law.

KENNECOTT COPPER CORPORATION
Utah Copper Division

By B. B. Smith
Its General Manager

Taken, subscribed and sworn to before me the undersigned authority in my said county, this 9th day of August, 1976.

Keith L. Hansen
Notary Public

My Commission Expires:
November 1, 1979

MINING APPLICATION

NO. ACT-035-002

DATE: August 9, 1976

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING
1588 WEST NORTH TEMPLE
SALT LAKE CITY, UTAH 84116

MINING AND RECLAMATION PLAN

PREAMBLE

Planning for rehabilitation of an operation mine is always difficult. This difficulty is magnified many times when the expected life of the mine may be decades or even a century. Such is the case of the Bingham Mine. It is not even possible to determine the approximate land uses at the end of the mining operation. For that reason, this rehabilitation plan cannot be as specific as that of other, more short-lived, operations.

However, regardless of the end use of the land, it is the intention of Kennecott to leave the land in a stable and productive condition consistent with location, possible uses, and topography, recognizing that since the mine is open pit in nature that the land itself cannot be restored as it was prior to commencement of mining.

To accomplish these objectives, Kennecott will maintain a program of experimentation and will apply the best available technology toward rehabilitating each piece of land as it moves from mining to other uses. A detailed annual report of reclamation work performed during the preceding year will be developed for review by the Board of Oil, Gas and Mining. These annual reports will be utilized by Kennecott and the Division in jointly establishing reclamation plans for the forthcoming year with the intent of accomplishing the overall objectives.

The following plan represents an attempt to outline some of the possible land uses and describe the steps the company will take to reach the general objectives.

MINING AND RECLAMATION PLAN

A. Applicant - Kennecott Copper Corporation, Utah Copper Division.

B. Type of Operation - Mining and processing for mineral extraction. Mining method and processing facilities are continually modified and updated to meet natural and physical requirements and conditions of market, technology, governmental regulation, economics and other factors. Large scale mining operation has been underway since about 1904. Remaining life of the mining operation will depend upon many things including the likelihood that eventual mineral shortages and improved technology will justify mineral extraction from materials now considered waste. It is, therefore, impossible to predict a terminal point for the mining and processing operations. However, it is not expected that this terminal point will occur within the next 50 years.

The Utah Copper Division operations extend from in and around the Bingham Mine to just beyond the north end of the Oquirrh Mountains near Magna (see CONFIDENTIAL map, Exhibit A). The operation is divided into the following areas which are identified on Exhibit A, shown in schematic arrangement on process diagram Exhibit B, and covered separately herein:

1. Mine
2. Mine Waste Disposal
3. Excess Mine Water Disposal
4. Ore Transfer-Mine to process
5. Ore Processing Facilities
6. Tailing Disposal
7. Excess Process Water Disposal

1. Mine Area

The mine area from which overburden and ore is removed comprises approximately 3100 acres.

Prior to open pit mining which began in 1904, this mountainous area had been a source of timber and was being used for underground mining operations with associated surface facilities, residences, businesses, etc. As open pit mining has expanded, these other used have been discontinued.

Determination of a definite use for the area after mining operations cease is difficult due to many uncertainties involved, but will be determined in light of potential

After crushing, the ore will be conveyed out of the pit to a new grinding facility located approximately one mile north of Copperton. Waste will be hauled by truck to the existing waste dumps.

The ore body is in the shape of a plug, or an inverted cone. As the mine progressively develops in depth, all benches must be pushed farther and farther back to gain necessary operating space and assure safety by maintaining a stable slope ranging from 25 1/4 to 29 1/4 from horizontal. Modernization and other technological advances, such as innovative dewatering techniques, will allow maintenance of stable pit slopes as a function of specific rock type and moisture conditions in the various sections of the mine. At the conclusion of mining, pit sides will be stabilized at a slope of 30° to 50° from horizontal as a function of location in the mine.

The mining sequence includes drilling, blasting, loading by shovel and haulage by trucks, waste cars and ore cars. At the present time, approximately 108,000 tons of ore and 380,000 tons of waste are removed during each operating day. Ore is transported by rail to process plants, and waste is deposited in outlying areas of the mine (see Area 2). Equipment size continues to increase through improved materials and technology. Haulage trucks now in use at the mine range in capacity from 65 tons to 150 tons. Shovels range from 6-yard to 25-yard capacity.

It is expected that in the future other mining methods such as underground mining and in-situ extraction may become economically feasible and practiced for recovery of lower lying minerals in the Bingham mine area.

At present, it is not possible to perform any revegetation on active dumps or in the pit as open pit mining progresses because the total area is continually being disturbed. At the conclusion of open pit mining, sides will be stabilized at a slope in the range of 32 1/4 to 37 1/4 from horizontal. It is very unlikely that the pit could be revegetated at that time because most of the exposed surface will be solid rock containing natural sulfide mineralization. Meteoric water and atmosphere will generate acidic conditions from these minerals. The bottom of the pit may eventually fill with water; however, the level can be limited by discharge through one of the available railroad tunnels. Such discharge water would either be processed for mineral extraction and neutralization, impounded, used for other acceptable purposes or otherwise safely disposed of as may be determined in the future by the appropriate regulatory agency.

Surface facilities including buildings, railroad tracks, power lines and poles and equipment will be removed from the mine area when no longer needed in the mining or subsequent operations.

2. Mine Waste Disposal Area

Waste material or overburden removed from the mine is deposited in outlying areas in Bingham Canyon, on the west front of the Oquirrhs and in Butterfield Canyon. Total area comprises approximately 8000 acres. Leaching and precipitation operations are conducted for recovery of minerals from this waste material.

Prior to use for waste disposal, the area ranged in elevation from 5200 feet to 7900 feet above sea level and had been a source of timber, was used for dry farming, grazing, and underground mining with associated facilities, residences, business, etc. These uses have been discontinued as waste material has covered the area. However, some grazing and dry farming continues on low lying perimeter areas.

It is expected that leaching and precipitation operations and possibly other processing methods will be used for mineral extraction from the dumps long after final deposition of mine waste is completed. Some possible ultimate uses of the area may include:

A source of borrow and granular material
Residential, commercial or industrial development
Recreational
Scenic
Other

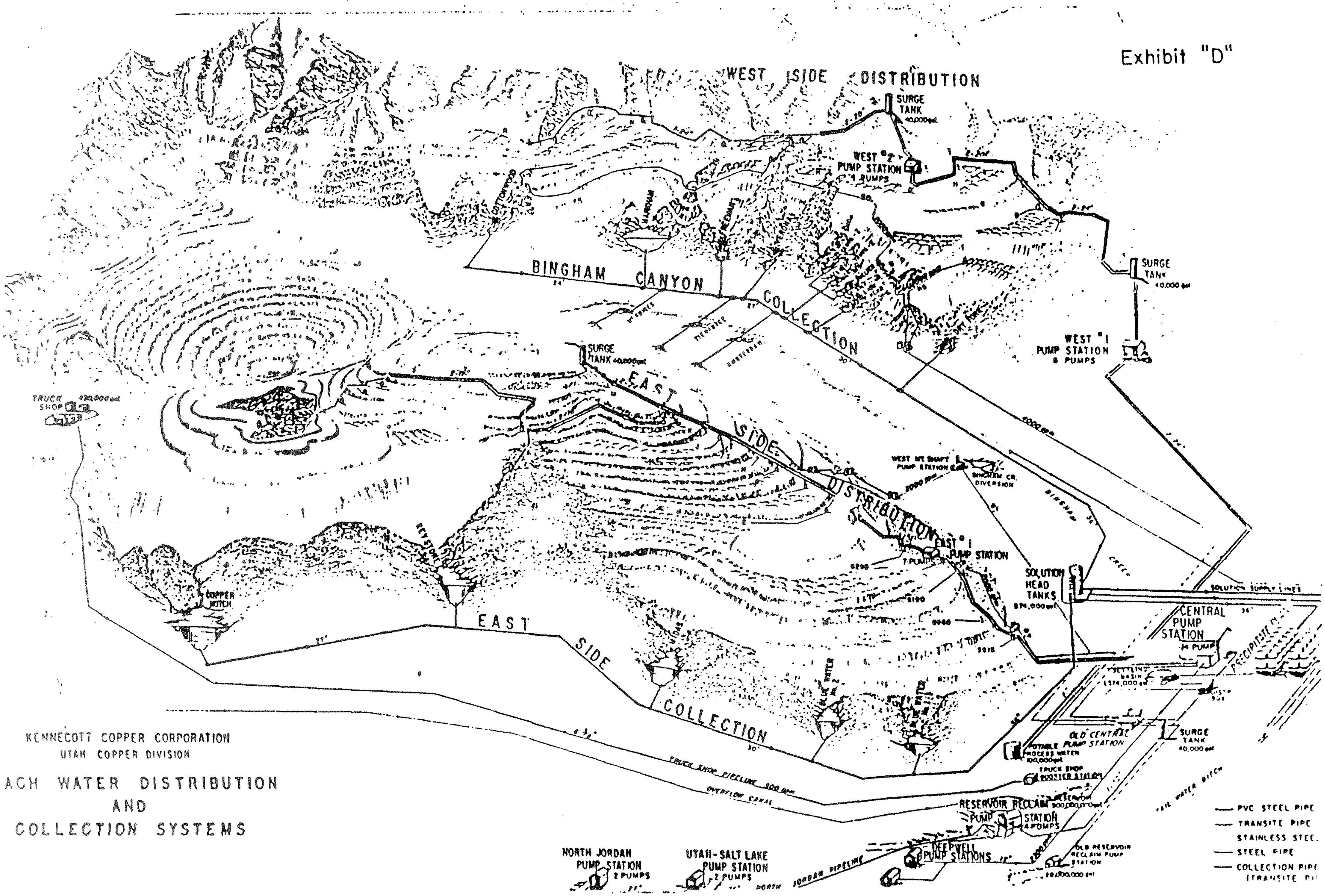
Little or no vegetation exists on areas covered by waste dumps. Vegetation on area that will eventually be covered consists of grasses, forbs, shrubs and trees such as juniper, mountain mahogany and maple. The pH of undisturbed soils ranges from 4.5 to 7.5 as determined by mixing 100 gm of soil and 100 ml of distilled water. Waste dumps tend to become acidic from meteoric water and atmosphere and from the leach solutions (pH 3 - 3.5) that are distributed over the dumps.

The leaching and collection system, including the protection against escape of leach water from waste dumps into lower lying areas, is shown in schematic arrangement on Exhibit D. It consists of reservoirs, pumps and piping to distribute solution on the dumps, pipelines from dams to the precipitation plant and an overflow canal to collect and convey any escaping solution to the reservoir. Leach solution is processed at the precipitation plant for mineral recovery. During extremely wet or high runoff period, excess leach solution may accumulate in the reservoirs and require discharge to the Excess Mine Water Disposal Area (Area 3).

As noted under Area 1, waste dumps presently comprise approximately 2,400,000,000 tons of material and are increasing at the rate of 380,000 tons per day. Waste is transported from the mine by trucks and is dumped over the banks to a natural angle of repose. Rail dumps are terraced at approximately 100 foot levels which progress out generally in a uniform manner. Truck dumps are higher and are extended out at the same level without terracing. Problems in dumps stability have been encountered on some large truck dumps which are generally associated with inadequate foundation material underlying the dumps. Slides have occurred from failure of this underlying or foundation material. However, because these dumps are active, no attempt is needed to stabilize these areas other than monitoring and precautionary systems for safety. Movement detection switches and movement noise detectors have been installed to detect any dump movement prior to failure. These systems will continue to be maintained and improved as mining progresses. In addition, computer models have been developed to simulate conditions in dumps to estimate the position of the dump crest when stability becomes critical. In the future, control points or a survey net may be established to check dump movement and settlement. After dumps become inactive for dumping, other steps will be implemented so that all dumps are left in a safe and stable condition. Techniques to accomplish this may include terracing and hydraulic methods consistent with subsequent use determined at that time. Necessary collection systems will be provided to contain natural seepage in the area. Dikes and ponds will be constructed on the upper levels of dumps to prevent slope wash and possible mud slides.

No major revegetation is planned because the majority of the waste material contains natural sulfide mineralization which becomes acidic when exposed to meteoric waters and the atmosphere. However, in some small areas of the dumps where there is little or no sulfide mineralization, tests are being conducted to determine possible methods and types of vegetation suitable for these areas. These tests include aerial

Exhibit "D"


KENNECOTT COPPER CORPORATION
UTAH COPPER DIVISION
ACH WATER DISTRIBUTION
AND
COLLECTION SYSTEMS
WEST SIDE DISTRIBUTION
SURGE TANK 40,000 gal
WEST #2 PUMP STATION 4 PUMPS
SURGE TANK 40,000 gal
WEST #1 PUMP STATION 6 PUMPS
BINGHAM CANYON COLLECTION
SURGE TANK 40,000 gal
EAST SIDE DISTRIBUTION
WEST MT. SHAFT PUMP STATION
BINGHAM CR. DIVERSION
EAST #1 PUMP STATION
SOLUTION HEAD TANKS 874,000 gal
CENTRAL PUMP STATION
SOLUTION SUPPLY LINES
TRUCK SHOP 450,000 gal
COPPER NOTCH
KEYSTONE
EAST SIDE COLLECTION
OLD CENTRAL PUMP STATION
SURGE TANK 40,000 gal
POTABLE PUMP STATION
PROCESS WATER 100,000 gal
TRUCK SHOP BOOSTER STATION
TRUCK SHOP PIPELINE 300 gpm
OVERFLOW CANAL
RESERVOIR RECLAIM PUMP STATION 4 PUMPS
DEEPWELL PUMP STATIONS
OLD RESERVOIR RECLAIM PUMP STATION
20,000,000 gal
NORTH JORDAN PUMP STATION 2 PUMPS
UTAH-SALT LAKE PUMP STATION 2 PUMPS
JORDAN PIPELINE
TAIL WATER DITCH
PVC STEEL PIPE
TRANSITE PIPE
STAINLESS STEE
STEEL PIPE
COLLECTION PIPE
(TRANSITE PI

seeding of approximately 20 acres with grasses, forbs and shrubs, and hand planting of a two-acre control area for more detailed study which is being conducted jointly with the U. S. Forest Service. If and when revegetation practices or methods are developed which would make vegetation economically practicable, such practices and methods will be employed on the dumps. When no longer needed in the mining, mineral extraction or subsequent operations, all surface facilities, including buildings, above ground utilities, railroads, piping and equipment will be removed. Much of this type effort has been accomplished in the past, including demolition of buildings in the city of Bingham Canyon, removal of trackage from old rail dumps and removal of bridges in Carr Fork and other demolition and clean up work. Appropriate revegetation of these areas will take place.

3. Excess Mine Water Disposal Area

This involves an approximate 2700-acre area upon which excess mine water is transported and contained in ponds for evaporation. Facilities may be installed at a later date for treatment of water prior to disposal.

Prior to use for excess mine water disposal, which commenced in 1935, the land was used for grazing and dry farms. After construction of the Bingham Creek reservoir at the mouth of Bingham Canyon in 1965, discharge to the evaporation pond area was considerably reduced and now required only during extremely wet or high runoff periods. Currently, much of the land is used for dry farming and sand and gravel operations.

Possible future uses of the land when no longer needed in the mining operation may include one or more of the following:

Sand and gravel operations
Farming
Water storage and evaporation
Recreational
Sludge or water disposal by others
Residential, commercial or industrial development
Other

In addition to dry-farm wheat, the area contains natural grasses, forbs and shrubs. The pH of the natural soils ranges from 6.5 to 7.5 as determined by mixing 100 gm of soil and 100 ml of distilled water. Surface elevation ranges from approximately 4675 feet to 5200 feet above sea level.

Residues of evaporation are acidic and contain soluble ions of iron, aluminum, magnesium and sulfate. Depending upon specific source of excess water from mine operation, water analysis will range between the following values:

pH	4.7 - 3.2	Fe	100 - 2,400 ppm
TDS	2,400 - 6,700 ppm	Cl	70 - 180 ppm
SO_4	1,400 - 52,000 ppm	Ca	400 - 500 ppm
Al	5 - 4,600 ppm	Cu	4 - 100 ppm
Mg	50 - 6,300 ppm		

Evaporation ponds are contained and separated by dikes constructed of earth from the area. Dikes are approximately four feet high and twelve feet wide on top. Side slopes are approximately two horizontal to one vertical. Dikes are monitored and maintained to prevent spill of solution.

At such time as area is no longer needed for excess water disposal or other purposes associated with mining operation, stabilization will be accomplished consistent with subsequent use determined at that time. Stabilization will take into account all pertinent factors including surrounding land usage, potential use, and may include removal or covering accumulated salts, treatment with neutralizer, grading and revegetation work. In any event, area will be left in a safe, table condition suitable for future use and without hazard of erosion or surface water accumulation.

Because the area appears better suited for future uses in farming than other vegetative purposes, any revegetation work would most likely be accomplished to suit farming requirements. In the event of farming, or soil stabilization, this would involve testing by standard agricultural analysis (e.g. Utah State Soils Laboratory), application of fertilizer and cultivation. Such crops as wheat, barley, alfalfa, wheatgrass and clover could be raised. irrigation could be considered if sufficient water becomes available.

There will be no changes in the excess mine water disposal area as a result of modernization. Kennecott is conducting an extensive surface water study. The results of this study may change water usage practice. Kennecott is also conducting a detailed five-year study relevant to this area in cooperation with the State of Utah and Salt Lake County. Any recommendations for amendment of this area will be forthcoming after the study is completed.

4. Ore Transfer - Mine to Process Area

From the mine area at Bingham, ore was transported to the processing plants near Magna by railroad cars. Instead, the ore will be conveyed to a grinding plant located one mile north of Copperton. Approximately 37 acres of right-of-way between the mine and grinding plant will be disturbed by the construction of the conveyor. After construction is completed, the right-of-way will be replanted with a mixture of grass seeds. When the conveyor is no longer needed for mining or other activities, the surface structures will be removed. The area will then be returned to the farming and pasture usage currently ongoing on the property.

The existing railroad between the mine and the facilities near Magna will be maintained and will be used for the transport of precipitate copper and general freight.

Land along the railroad is used primarily for dry farming. It may have been previously used for grazing.

When no longer needed in the mining operation, the railroad may be used to serve future industrial or commercial needs. Otherwise, the railroad right-of-way will have potential use for:

Residential, commercial or industrial development
Utility right-of-way
Roadway
Other

In addition to dry farm wheat, the area contains natural grasses, forbs and shrubs. The pH of the soils ranges from 6.5 to 7.5 as determined by mixing 100 gm of soil and 100 ml of distilled water. Surface elevation ranges from approximately 5400 feet to 4500 feet above sea level.

At such time as the railroad is no longer needed in the mining or processing operations or for subsequent use, trackage and surface facilities will be removed and area left in condition suitable for conversion to other use determined at that time. Revegetation will be accomplished if appropriate for the subsequent use when the trackage and surface facilities are removed and the right-of-way has no future use as such.

5. Ore Processing Facilities Area

Over the years ore processing facilities have been added, changed, enlarged and improved to suit needs and conditions. Many more such modifications are expected in the future. Facilities at one time consisted of the Arthur, Magna, and Bonneville concentrators, power plant, railroad car and engine shops, lime plant, foundry and other supporting and related surface structures and utilities. Total land area comprises approximately 1600 acres. Other separated facilities include water supply and distribution systems and maintenance shops. This represents a total additional area of approximately 200 acres.

As modernization takes place, ore will be received via conveyor at a coarse ore stockpile located at a new ore grinding plant north of Copperton. Ore will be reclaimed from beneath the pile and will be ground in semi-autogenous (SAG) mills and ball mills. The ground ore will be gravity slurried, via pipeline, to the existing concentrators for additional processing through the existing facilities.

The grinding plant will be located on a 100-acre site currently under cultivation for wheat. Following construction, the disturbed but undeveloped areas will be replanted. When the grinding plant is no longer needed for mining or other activities, the surface structures will be removed. The area will then be returned to agriculture or will be available for other types of development.

The pipeline corridor will pass through areas used for wheat cultivation, pasturage, railroad right-of-way, manufacturing, and mining. Approximately 210 acres of the corridor will be on land previously undeveloped for mining or manufacturing purposes. After construction is completed, the disturbed areas within the pipeline right-of-way will be replanted with a mixture of grass seeds. When the slurry pipeline is no longer needed for mining or other activities, the surface structures will be removed. The area will be returned to agriculture or will be available for other types of development.

Possible future uses of the area when no longer needed for ore processing may include one or more of the following:

Other industrial or commercial operations
Residential
Other public or private use

Prior to construction of initial process facilities in about 1906, vegetation consisted of natural grasses, forbs and shrubs such as sagebrush, oak, service, mahogany and juniper. Most of this vegetation remains in undisturbed portions of the area. Other vegetation has been added for stabilization and appearance. This includes trees such as Russian Olive and Chinese Elm, and plants such as alfalfa, clover and various grasses. The pH of natural soils ranges from 6.5 to 7.5 as determined by mixing 100 gm of soil and 100 ml of distilled water. Surface elevation ranges from approximately 4200 feet to 5400 feet above sea level.

At such time as the surface facilities, including buildings, utilities, railroads, equipment, etc., are no longer needed for ore processing or related purposes and if not convertible to some other use, they will be razed and/or removed. All hazardous conditions will be eliminated and ground surfaces stabilized and planted using vegetation types natural or subsequently determined to be best suited to the area.

6. Tailings Disposal Area

Tailing produced from the ore concentrators is discharged as a slurry into a 6000-acre tailing pond adjacent to north of the concentrators. The original ground surface which ranged in elevation from 4210 feet to 4340 feet above sea level is believed to have been a sparsely vegetated, highly alkaline soil such as present perimeter areas. Prior to use for trailing disposal, which began about 1916, some limited livestock grazing may have been attempted.

In its terminal condition for deposition, the tailing pond may be considered as a resource. It will contain unrecovered minerals that eventually may justify reprocessing for recovery. Tailing material also has value as fill for land reclamation and construction such as currently used for highway embankment work. Studies have demonstrated that mixing tailing material with alkali soils enhances capability of sustaining a wide range of vegetation. Considerable areas of Western Utah and Nevada may be reclaimed for agricultural and other purposes by this material.

When no longer needed for foregoing purposes, the tailing disposal area will have potential use for one or more of the following:

Farming
Residential, commercial or industrial development
Recreational
Scenic Attraction
Other

Natural vegetation in the area includes salt grass, wire swamp grass, cattails and salt bush. The pH of the natural soils ranges from 8.5 to 9.0 as determined by mixing 100 gm of soil and 100 ml of distilled water. High clay content of the soil, close proximity to Great Salt Lake, and poor drainage would have contributed to the highly alkaline condition.

The tailing pond is a continually rising area (currently rising at about 3-1/2 feet per year) and is contained by a dike which extends completely around its perimeter. This dike must also be continually raised and be maintained in a stable condition. Initially, dike fill was rock waste from the mine; later fill hauled from areas adjacent to the concentrator plants was used; and more recently, dike build up is being accomplished by relocation of previously placed dike fill material by drag line. This is followed by sealing of the pond side of the dike with a berm of coarse tailing distributed by a perimeter pumping system. To obtain adequate dike stability, the outside of the dike is maintained at 5 to 1 slope as recommended by consultants on slope stability. Periodic inspections are conducted by consultants to assure long-range stability of the system. Present elevation of the pond surface averages approximately 4345 feet above sea level. Dewatering of the tailing pond is by means of two buoy-supported siphon lines which remove clear water, most of which is reclaimed as concentrator process water.

The area near the top of the dike which is subject to being disturbed in the subsequent dike build up, and roads on the dike, are stabilized and will be stabilized to prevent wind erosion. Farther down the outside slope where the surface is permanent, revegetation is practiced. Current plantings include several plant and tree species along the dike slopes. Success has been achieved with Japanese millet, rye, yellow sweet clover, wheatgrass, brome, range alfalfa and vetch plants, and Russian olive, larch and elm trees. Because of the continually rising tailing deposition, permanent stabilization or revegetation of the pond surface is not possible as long as operation continues. However, wind erosion control is and will be practiced. About 90% of the pond surface is kept moist at all times by the natural meandering of the tailing stream discharged into the pond. The remaining areas are treated by several different methods to stabilize the surface. Where possible, the surface is wetted by tailing distribution lines installed for this purpose. If this is not feasible, and the dry areas are accessible to land vehicles, the surface is treated with stabilizing agents.

If not accessible by land vehicles, dry areas are treated by application of a polymer product with aircraft. Use of fast growing grasses is also being investigated for wind erosion control.

Based upon current operating rates and practices, by the year 2025, the tailing pond surface will be reduced to approximately 3,000 acres and the average elevation will be approximately 4560 feet above sea level.

When no longer needed for tailing deposition, mineral recovery or material source, grading and revegetation of dike slopes not already done will be completed. Drainage will not be a problem. As noted previously, the outer surface of the dike will have an average 5 to 1 slope. The pond surface will have, or will be graded to, a natural slope which will be more than adequate for drainage needs, considering that this is a region of low precipitation and the surface can adequately absorb normal precipitation.

Revegetation is also receiving consideration by Kennecott and other mining companies for stabilization and subsequent reclamation of inactive tailing pond surfaces. To this end, test work is being conducted to ascertain which species of vegetation are suitable, and procedures required to obtain adequate vegetation growth. Planting Japanese millet at the rate of 10 to 15 pounds per acre with fertilizer may be a means of vegetating the tailing pond surface after deposition is completed and to a limited extent during the deposition process. The surface of the tailing pond will be stabilized using the most practicable technology available upon the termination of the deposition of the tailing.

7. Excess Process Water Disposal Area

This comprises a treatment plant, sludge disposal area, canals and diversion facilities now existing, as well as possible additional treatment facilities, water storage and evaporation ponds and other facilities that may be required in the future. It involves perimeter areas around the tailing disposal area (Area 6) comprising a total of approximately 1000 acres. Any excess water is discharged under the provisions of NPDES Permit UT-0000051. The discharge criteria may be modified in the future as a result of the surface water study cited in Section 3.

Most of the area remains in a natural state and may have been used for very limited grazing prior to the early 1900's.

Possible future uses of the area when no longer needed for water treatment and disposal may include one or more of the following:

Other industrial or commercial operations
Residential development
Other public or private use

Natural vegetation in the areas includes salt grass, wire swamp grass, cattails and salt bush. The pH of the natural soils ranges from 8.5 to 9.0 as determined by mixing 100 gm of soil and 100 ml of distilled water. The area is comparable to the original ground surface of the tailing disposal area. Surface elevation ranges from 4210 feet to 4300 feet above sea level.

Canals have been constructed around the tailing pond area to convey natural flows and drainage and excess water from tailing pond and treatment plant to the Great Salt Lake. Sludge from the treatment plant is deposited in a low diked area.

At such time as the surface facilities including treatment plant, piping and utilities are no longer needed, and if not convertible to some other use, they will be razed and/or removed. Sludge ponds, evaporation ponds and possible other areas will likewise be left in condition suitable for conversion to other use determined at that time. This may involve filling or covering with tailing and other stabilization and revegetation work comparable to that designated for the tailing disposal area. Canals will most likely be left indefinitely for conveyance of natural surface flows and drainage to Great Salt Lake.

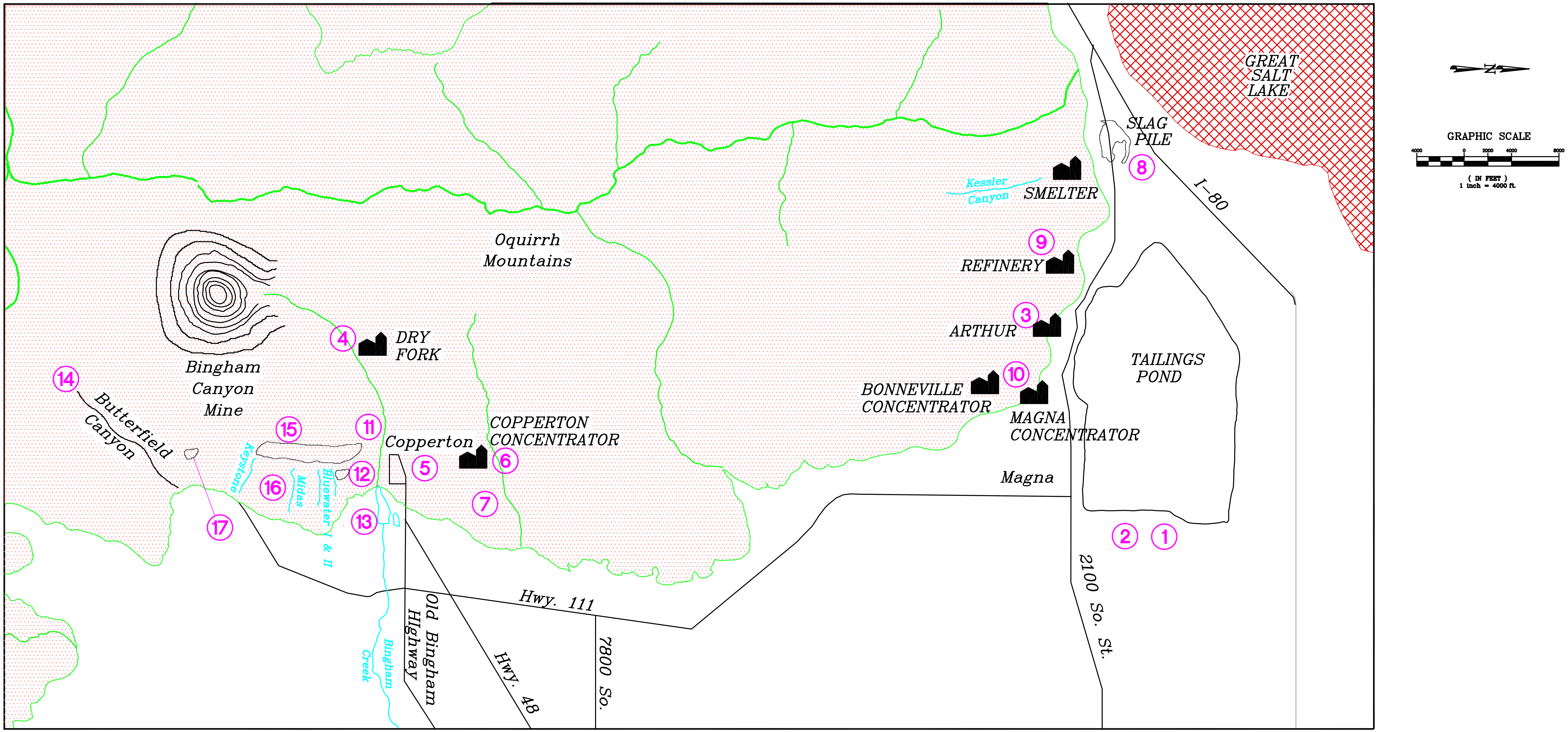
APPENDIX B - TAILINGS MODERNIZATION PROJECT
FUGITIVE DUST ABATEMENT PROGRAM
(PAGES ADDRESSING THE EXISTING IMPOUNDMENT ONLY)

APPENDIX C - FINAL CLOSURE PLAN, GROUND WATER ISSUES
KENNECOTT TAILINGS IMPOUNDMENT
(WITHOUT PLATES)

APPENDIX D – ENVIRONMENTAL GEOCHEMISTRY OF THE BINGHAM CANYON PORPHYRY COPPER DEPOSIT, UTAH

APPENDIX E – GEOCHEMICAL EVOLUTION OF SULPHIDE-BEARING WASTE ROCK SOILS AT THE BINGHAM CANYON MINE, UTAH

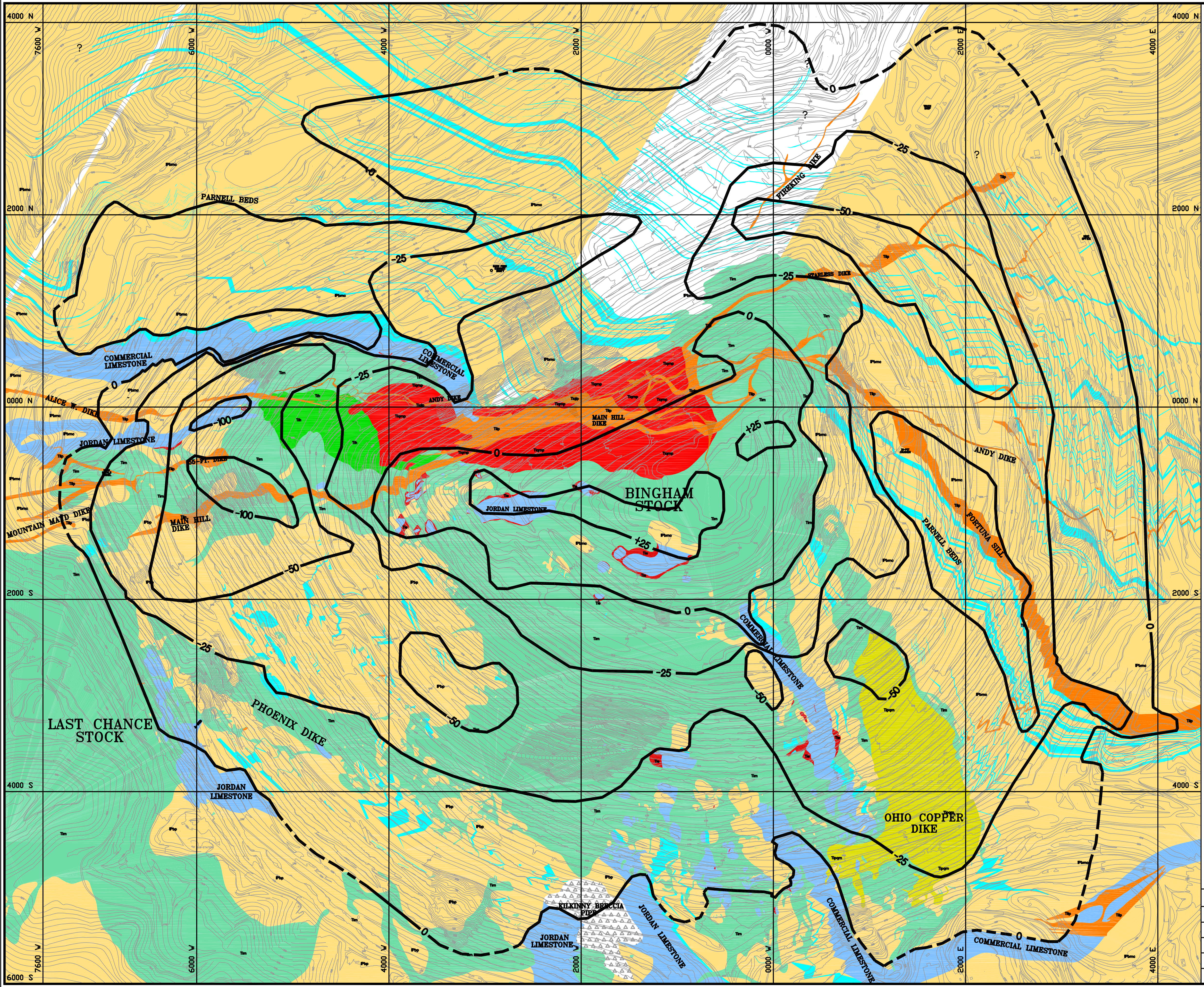
APPENDIX F – VEGETATIVE COMMUNITY ANALYSIS OF BIOSOLIDS TEST PLOTS AFTER FIVE YEARS OF GROWTH



RECLAMATION PROJECT SITES

1. TAILINGS IMPOUNDMENT REVEGETATION
2. TAILINGS IMPOUNDMENT TALL TREE PROGRAM
3. ARTHUR REHABILITATION /RECLAMATION
4. BINGHAM CANYON ENTRANCE ROAD
5. COPPERTON/BINGHAM CANYON CORRIDOR PROJECT
6. COPPERTON CONCENTRATOR 4TH LINE EXPANSION
7. REVEGETATION DEMONSTRATION PLOT
8. WETLANDS CREATION/ENHANCEMENT
9. REFINERY BORROW PIT
10. NORTH MILL AND CONCENTRATOR
11. PRECIPITATION PLANT LAUNDERS
12. BLUEWATER I REPOSITORY
13. LARGE BINGHAM CREEK RESERVOIR
14. BUTTERFIELD WASTE ROCK REMOVAL ACTION
15. BINGHAM CANYON MINE–SLUDGE STORAGE/WASTE DUMPS
16. EASTSIDE COLLECTION SYSTEM
17. LARK WASTE ROCK/ CRAPO REPOSITORY

PLANT PROJECTS GROUP		KENNECOTT UTAH COPPER
SCALE: 1"=8500'	DATE	ORIENTATION MAP OF RECLAMATION AREAS
DESIGNED BY LJW	8/11/92	
DRAWN BY RMG	8/11/92	
CHECKED BY		
PROJECT ENGINEER		
PROJECT MANAGER		Job No. --- Dwg. No. 451-T-013 REV A



EXPLANATION

IGNEOUS ROCK TYPES

TERTIARY — Eocene

Quartz Latite Porphyry (Tiqlp)
Andy dike and apophyses. Medium brown and light greenish-gray, hornblende-biotite quartz latite porphyry. Hornblende is altered to phlogopite and/or chlorite within the pit area. Hosts late stage chalcopyrite and pyrite mineralization. Distinguished from other latitic dikes by the presence of relatively large quartz phenocrysts and higher percentage of aphanitic groundmass. Groundmass usually contains considerable hornblende.

Latite Porphyry (Tilp)
Fortuna sill, Main Hill and Starless dikes, and apophyses. Light to medium gray, hornblende-augite-biotite quartz latite porphyry. Ferromagnesian minerals are altered to phlogopite and chlorite in pit area. Locally contains ore grade chalcopyrite, bornite, and pyrite mineralization, both disseminated and in veins.

Endoskarn (Tie)
Intrusive rock, the composition of which is changed due to assimilation of calcareous sedimentary rocks. Usually found at contact zone between monzonite and major limestone units. Texture is igneous; composition is extremely variable. Dominant minerals include actinolite, orthoclase, phlogopite, and epidote. Calcite veining is common.

Hybrid Quartz Monzonite Porphyry (Tih)
Quartz monzonite porphyry, the composition of which is changed due to assimilation of monzonite. Medium gray, amphibole-biotite quartz monzonite porphyry. Amphibole is altered to biotite; plagioclase is altered to clay and serisite. Calcite veining is locally present. Contains ore grade chalcopyrite-pyrite mineralization.

Quartz Monzonite Porphyry (Tiqmp)
Bingham Stock. Light gray, amphibole-biotite quartz monzonite porphyry. Amphibole is altered to phlogopite and quartz; plagioclase is altered to sericite and clay. Calcite veining is locally present. There are no exposures of unaltered rock. Contains pyrite, chalcopyrite, bornite and molybdenite mineralization. Inferred source of mineralizing fluids.

Porphyritic Quartz Monzonite (Tipqm)
Ohio Copper dike. Medium gray to greenish gray, porphyritic, amphibole-biotite quartz monzonite. Pale pink orthoclase and white plagioclase phenocrysts in a phaneritic groundmass. A distinct late phase of Bingham and Last Chance (quartz) monzonite. Calcite veining is locally present. Pyrite occurs in veins

Monzonite (Tim)
Bingham stock, Phoenix dike, and Last Chance stock. Medium to dark gray, augite-biotite-amphibole (quartz) monzonite. Where altered, augite is replaced by actinolite, chlorite, phlogopite, and quartz. Some plagioclase is replaced by orthoclase. Calcite veining is locally present. Contains pyrite, chalcopyrite, bornite and molybdenite mineralization. Original magnetite is replaced by sulfide minerals. Molybdenite occurs primarily in veins. Main ore host.

SEDIMENTARY ROCK TYPES

OQUIRRH GROUP

PENNSYLVANIAN — Upper

BINGHAM MINE FORMATION
MARKHAM RIDGE MEMBER

Quartzite and Calcareous Sandstone (IPbmm; sl; qzt)
Tan to light gray orthoquartzite and calcareous quartzite, interbedded with thin calcareous sandstone and sandy limestone beds. Locally laminated and crossbedded. Calcareous sandstone and sandy limestone beds are altered to hornfels. Quartzite (qzt), limestone (lst), and thin calcareous sandstone and sandy limestone (sl), are differentiated.

BINGHAM MINE FORMATION
CLIPPER RIDGE MEMBER

Quartzite, Limestone, and Calcareous Sandstone (IPbmc; sl; qzt; lst)
Tan to light gray orthoquartzite and calcareous quartzite, interbedded with limestone, and thin calcareous sanstone and sandy limestone beds. Locally laminated and crossbedded. Two large cherty limestones are interbedded near base. Limestones are altered to skarn. Calcareous sandstone and sandy limestone beds are altered to hornfels. Base of formation is at base of Jordan limestone bed. Quartzite (qzt), limestone (lst), and thin calcareous sanstone and sandy limestone (sl), are differentiated.

PENNSYLVANIAN — Middle

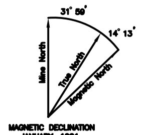
BUTTERFIELD PEAKS FORMATION

Quartzite, Calcareous Quartzite, and Calcareous Sandstone (IPbp; sl; qzt)
Tan to light gray orthoquartzite, calcareous quartzite and calcareous sandstone, cyclically interbedded with medium to dark gray, sandy, bioclastic limestone, containing thin-bedded lenses and nodules of black chert.

Breccia

1997 Topography

NOTES:
NET NEUTRALIZATION POTENTIAL (NNP) WAS CALCULATED FROM NEUTRALIZATION POTENTIAL (NP) MINUS THE ACID POTENTIAL (AP). AP IS BASED UPON ABOUT 80,000 TOTAL SULFUR VALUES FROM THE YEAR 2000 PIT SURFACE. NP IS BASED UPON 116 SOBEK NP ANALYSIS FROM OUTCROP AND BORING SAMPLES, ABOUT 250 BORING TOTAL CARBON SAMPLES, AND LITHOLOGIC DISTRIBUTION ON THE PIT SURFACE. NNP IS EXPRESSED IN TERMS OF TONS CALCIUM CARBONATE PER 1000 TONS OF ROCK. A NEGATIVE VALUE INDICATES THAT THE ROCK IS NET ACID GENERATING AND A POSITIVE VALUE INDICATES THAT IT IS NET NEUTRALIZING.



MAGNETIC DECLINATION
JANUARY, 1991

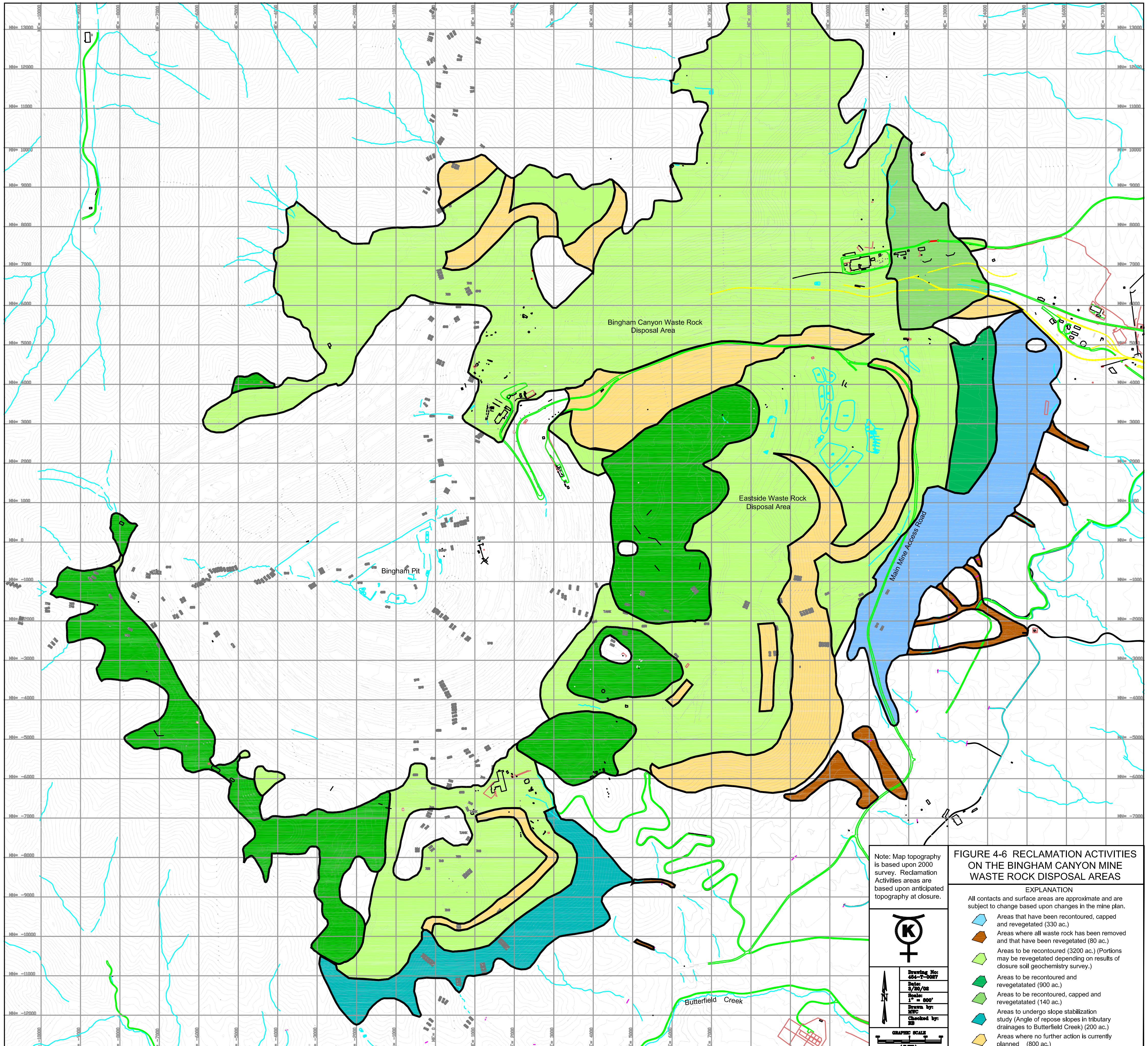
400 200 0 400
FEET

Date	Revision
4/10/02	0

Drawing Number
455-T-0035

Bingham Canyon Mine

FIGURE 3-4
GEOLOGIC MAP OF THE BINGHAM PIT SHOWING NET NEUTRAIZATION POTENTIAL


Bingham Canyon Waste Rock
Disposal Area
Eastside Waste Rock
Disposal Area
Bingham Pit
Main Mine Access Road
Butterfield Creek
Note: Map topography is based upon 2000 survey. Reclamation Activities areas are based upon anticipated topography at closure.
FIGURE 4-6 RECLAMATION ACTIVITIES ON THE BINGHAM CANYON MINE WASTE ROCK DISPOSAL AREAS
EXPLANATION
All contacts and surface areas are approximate and are subject to change based upon changes in the mine plan.
Areas that have been recontoured, capped and revegetated (330 ac.)
Areas where all waste rock has been removed and that have been revegetated (80 ac.)
Areas to be recontoured (3200 ac.) (Portions may be revegetated depending on results of closure soil geochemistry survey.)
Areas to be recontoured and revegetatated (900 ac.)
Areas to be recontoured, capped and revegetatated (140 ac.)
Areas to undergo slope stabilization study (Angle of repose slopes in tributary drainages to Butterfield Creek) (200 ac.)
Areas where no further action is currently planned (800 ac.)
Drawing No: 454-T-0027
Date: 3/20/02
Scale: 1" = 800'
Drawn by: MWC
Checked by: RB
GRAPHIC SCALE
N

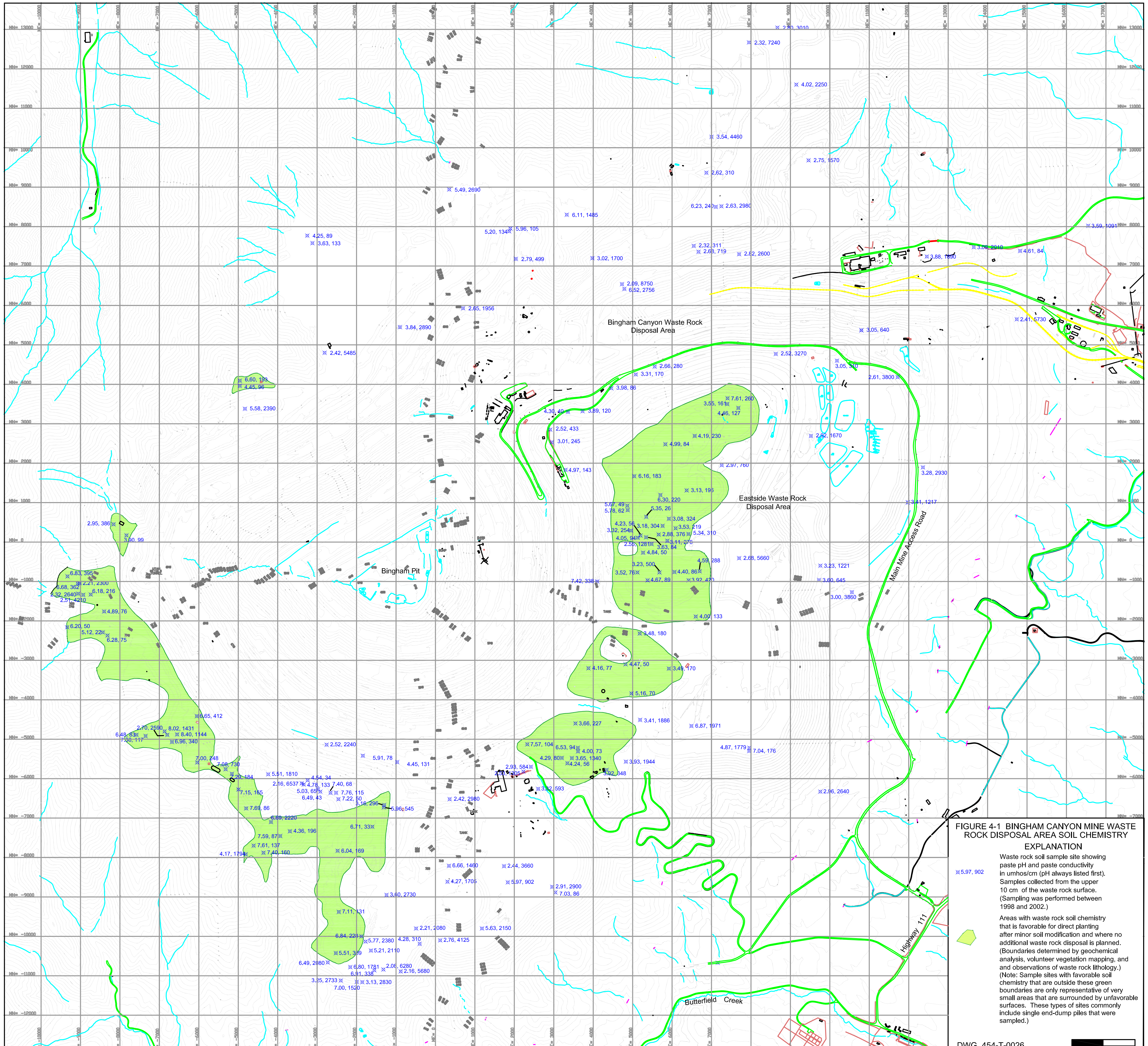


FIGURE 4-1 BINGHAM CANYON MINE WASTE ROCK DISPOSAL AREA SOIL CHEMISTRY

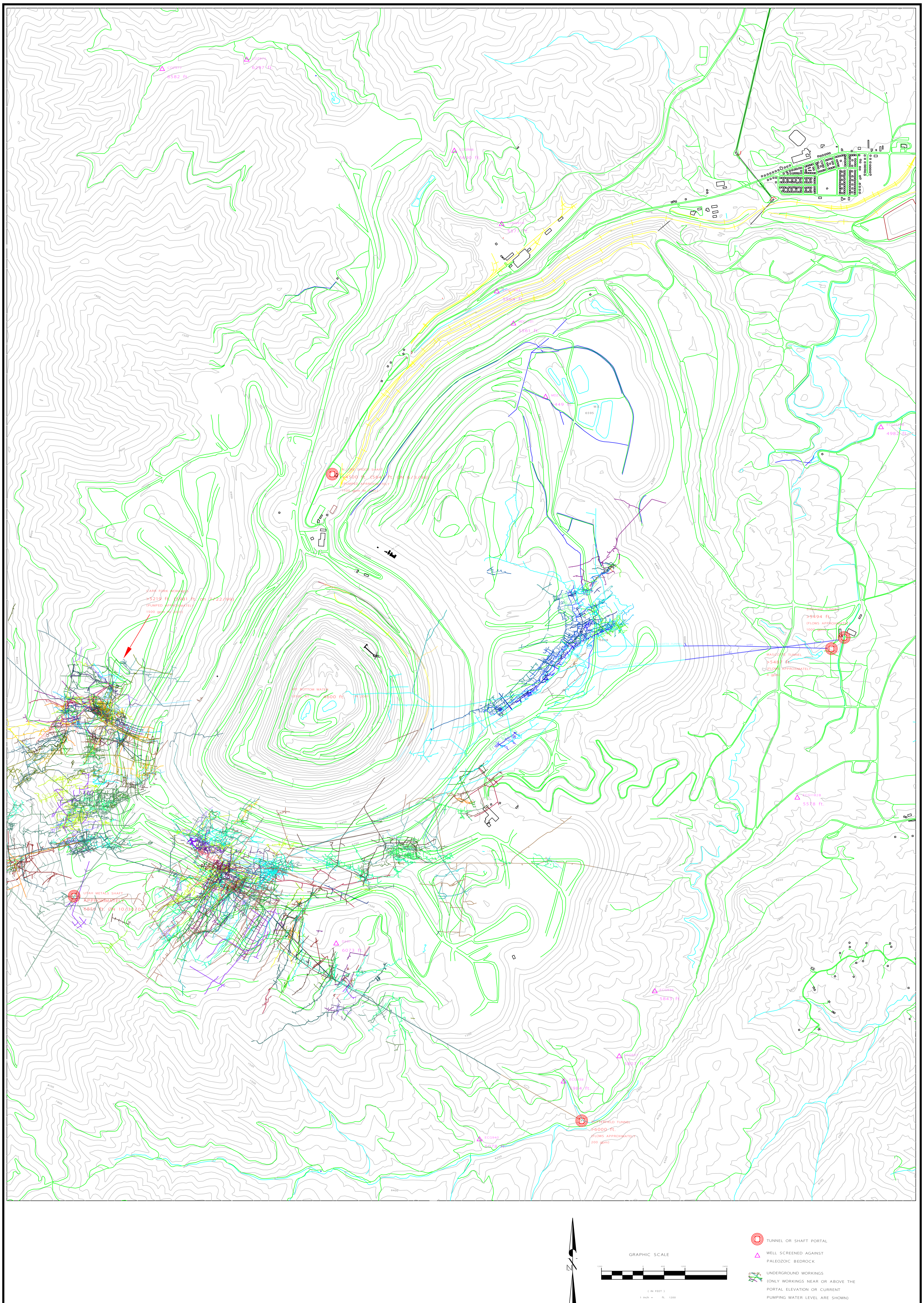
EXPLANATION

5.97, 902 — Waste rock soil sample site showing paste pH and paste conductivity in umhos/cm (pH always listed first). Samples collected from the upper 10 cm of the waste rock surface. (Sampling was performed between 1998 and 2002.)

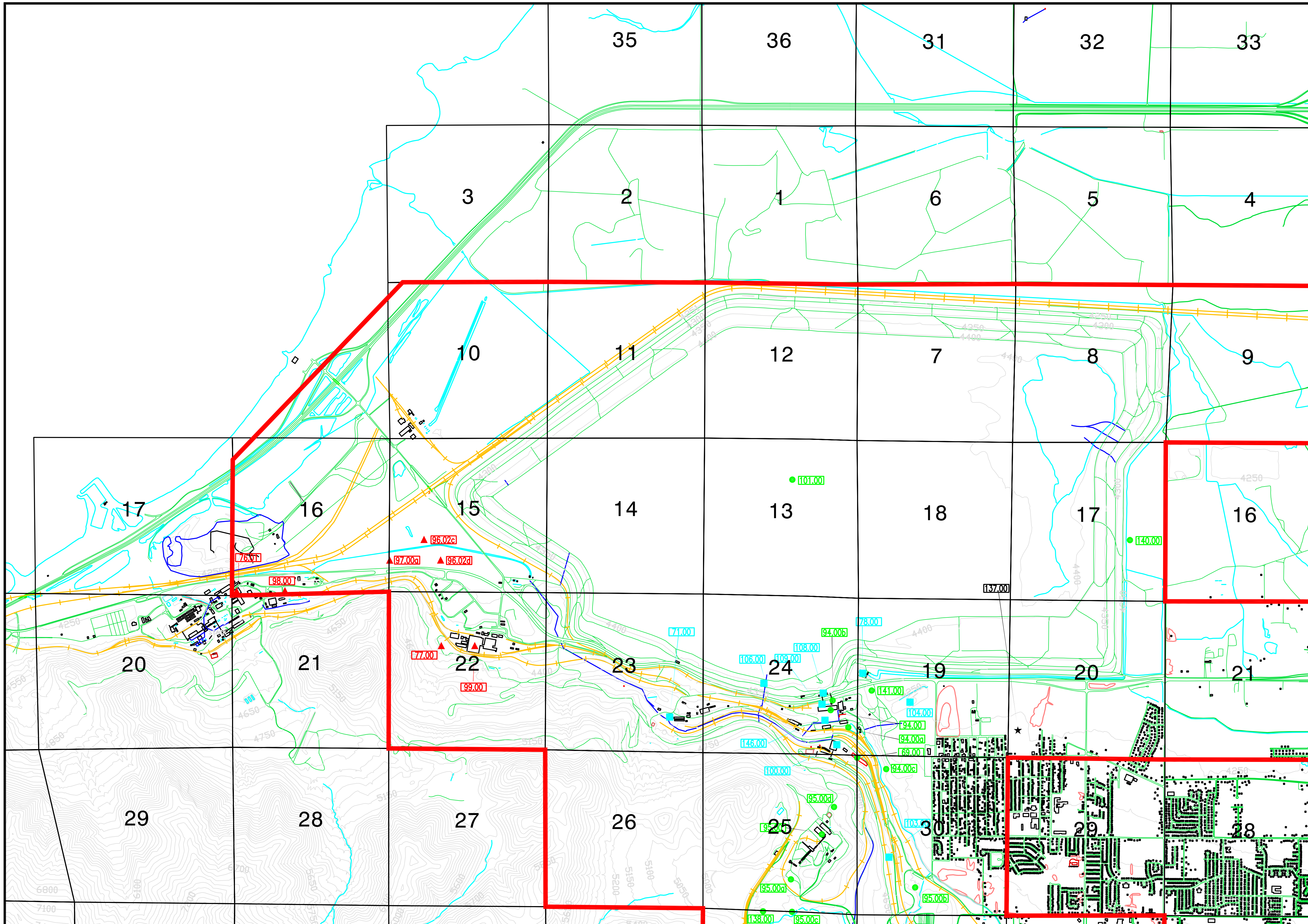
Areas with waste rock soil chemistry that is favorable for direct planting after minor soil modification and where no additional waste rock disposal is planned. (Boundaries determined by geochemical analysis, volunteer vegetation mapping, and and observations of waste rock lithology.) (Note: Sample sites with favorable soil chemistry that are outside these green boundaries are only representative of very small areas that are surrounded by unfavorable surfaces. These types of sites commonly include single end-dump piles that were sampled.)

DWG. 454-T-0026

0 800 1600



STRATEGIC RESOURCES GROUP		KENNECOTT UTAH COPPER	
SCALE: 1"= 1200'	DATE	FIGURE 3-7 WATER LEVELS IN THE PALEOZOIC BEDROCK AQUIFER AROUND THE BINGHAM CANYON MINE OPEN PIT SPRING 2001	
DESIGNED BY RKB	6/14/02		
DRAWN BY MWC	6/14/02		
CHECKED BY			
PROJECT ENGINEER			
PROJECT MANAGER		Job No. - - -	Dwg. No. 454-T-0014	REV



Priority 1 Sites

- ▲ 76.01 Standby Fuel Station
- ▲ 77.00 Refinery evaporation Ponds
- ▲ 77.03 Wetlands Mitigation Area (North of I–80, ISSR Site)
- ▲ 96.02 Modernized smelter footprint
- ▲ 96.02c Smelter Area Soils: Return Canal (S11)
- ▲ 96.02dd Smelter Area Soils: Slag Tailings Pipeline (S15)
- ▲ 97.00 Acid Plants Garfield
- ▲ 97.00a Smelter Area Soils: Weak Acid Coridor (S12)
- ▲ 98.00 Acid storage facility(acid tanks)
- ▲ 99.00 Refinery
- ▲ 143.00 Miscellaneous Spills

Priority 2 Sites

- ● 69.00 Magna Leaching Facility
- ● 94.00 Magna Concentrator
- ● 94.00a Magna Concentrator: Railroad Slope Site
- ● 94.00b Magna Concentrator: Concentrate Loading Site
- ● 94.00c Magna Concentrator: East Debris Site
- ● 95.00 Bonneville Crusher
- ● 95.00a Bonneville CrusherScrap Yard Site (B01)
- ● 95.00b Bonneville Crusher: Gate Hillside Site (B02)
- ● 95.00c Bonneville Crusher: Little Valley Settle Site (B04)
- ● 95.00d Bonneville Crusher: North Slope Site (B10)
- ● 101.00 Magna Tailings Pond
- ● 138.00 Little Valley
- ● 140.00 C –7 Ditch
- ● 141.00 Magna Groundwater Plumes
- ● 142.00 Road Construction (as shown)

Priority 3 Sites

- ■ 71.00 Boston Consolidated Mill (Arthur Cocen.)
- ■ 78.00 Utah copper power plant (old plant)
- ■ 100.00 New Power Plant
- ■ 103.00 Rail Grave Yard
- ■ 104.00 Diving Board Tailings
- ■ 106.00 Magna Tailings Pond Landfill
- ■ 108.00 Tailings Slurry Pipeline
- ■ 109.00 Concentrate Slurry Pipeline
- ■ 144.00 Demolition Debris (multiple sites from demolition, will be addressed in site specific facilities)
- ■ 145.00 Railroad right of way (see tracks)
- ■ 146.00 Truck & Rail maintenance facilities

Non–Priority Sites

- ★ 70.00 Calera Smelter (Cobalt Leaching Facility)
- ★ 137.00 Magna Soils

Note: Sites such as pipelines and canals are placed in one location

- ▲ Priority 1 site
- ● Priority 2 site
- ■ Priority 3 site
- ★ Non–Priority site
- Boundary of Permit M/035/002

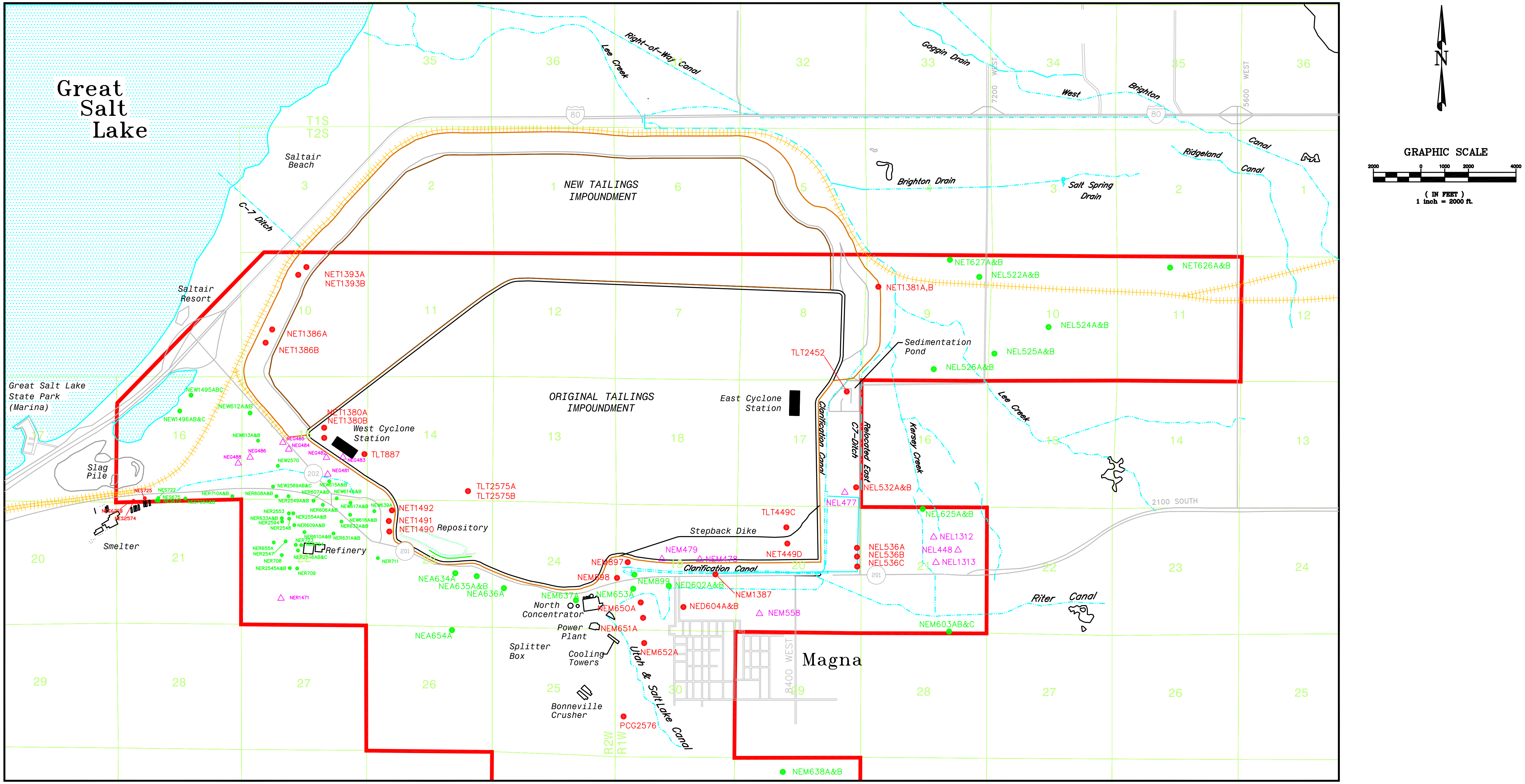
N

GRAPHIC SCALE

2000 0 1000 2000 4000

(IN FEET)

STRATEGIC RESOURCES GROUP		KENNECOTT UTAH COPPER
SCALE: 1" = 2000'	DATE	FIGURE 1–3
DESIGNED BY RKB	1/28/02	MAP OF HISTORICAL SITES WITHIN THE NORTERN BOUNDARIES OF PERMIT M/035/002
DRAWN BY MWC	2/02/02	
CHECKED BY		
PROJECT ENGINEER		Job No. ---
PROJECT MANAGER		Dwg. No. 454–T–0012 REV REV DATE



LEGEND

Railroad	KUC Production Well Location with Site ID
Footprint of Tailings Impoundment Complex	KUC Monitoring Well Location with Site ID
Division of Oil, Gas & Mining Permit Boundary for M/035/002	Groundwater Discharge Permit Well Locations with Site ID

STRATEGIC RESOURCES GROUP

SCALE: 1" = 2000'

		DATE
DESIGNED BY	RKB	1/23/02
DRAWN BY	MWC	1/23/02
CHECKED BY	RKB	1/23/02
PROJECT ENGINEER		
PROJECT MANAGER		

KENNECOTT UTAH COPPER

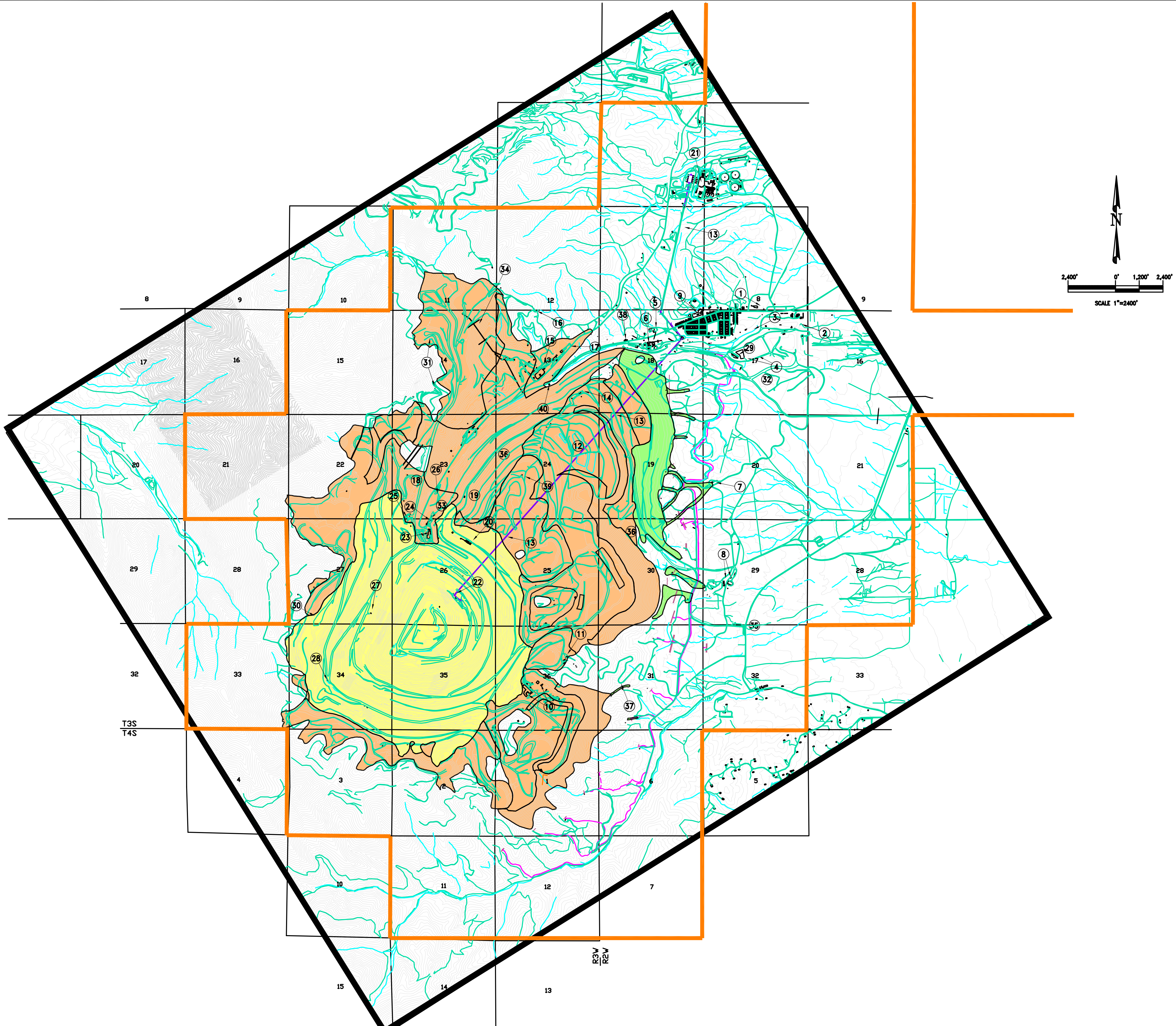
FIGURE 10-3

MAP OF WELL LOCATIONS WITHIN THE NORTHERN BOUNDARIES OF DOGM PERMIT M/035/002

Job No. --- Dwg. No. 454-T-0011 REV

Area	Description	Area	Description
1	Old Division Headquarters	21	Copperton Concentrator (not included in this permit)
2	Small Bingham Reservoir	22	In-Pit Crusher
3	Copperton Rail Yard	23	Truck Shop (6190)
4	Large Bingham Reservoir	24	Change House
5	Geology Building	25	Code 80 Fuel & Lube Station
6	Precipitation Plant	26	North Ore Shoot Shaft
7	Midas Pump Station	27	Carr Fork Exhaust Shaft & Pine Canyon Tunnel
8	Lark Mine Buildings	28	Utah Metals Tunnel
9	Bingham Middle School	29	Desilting Basin
10	Yosemite Shops	30	Apex Shaft
11	Explosives Storage	31	SX/EW Pilot Plant
12	6600 ARD Storage & Evaporation Ponds	32	Biosulphide Pilot Plant and Membrane Filtration Plant
13	Ore Conveyor and 5490 Tunnel	33	Main Substation
14	East Pump Station	34	Dry Fork Tunnel
15	Dry Fork Warehouse & Shops	35	Mine Entrance
16	West 1 Pump Station	36	Primary Mine Access Road
17	Reload Area	37	Yosemite Road
18	Explosives Shops	38	Lead Mine
19	Process Water Tank		Leach Water
20	Visitor's Center, Heliport, Mine Office	40	West Mountain Shaft

Bingham Canyon Mine
Surface Facilities
(Permit # M/035/002)



ENGINEERING SERVICES		KENNECOTT UTAH COPPER
SCALE: 1"=2400'	DATE	FIGURE 2-1 MAP OF SURFACE FACILITIES IN THE VICINITY OF THE BINGHAM CANYON MINE
DESIGNED BY RKB	1/3/02	
DRAWN BY MWC	1/9/02	
CHECKED BY		
PROJECT ENGINEER		
PROJECT MANAGER		Job No. --- Dwg. No. 454-T-0009 REV 0 REV DATE

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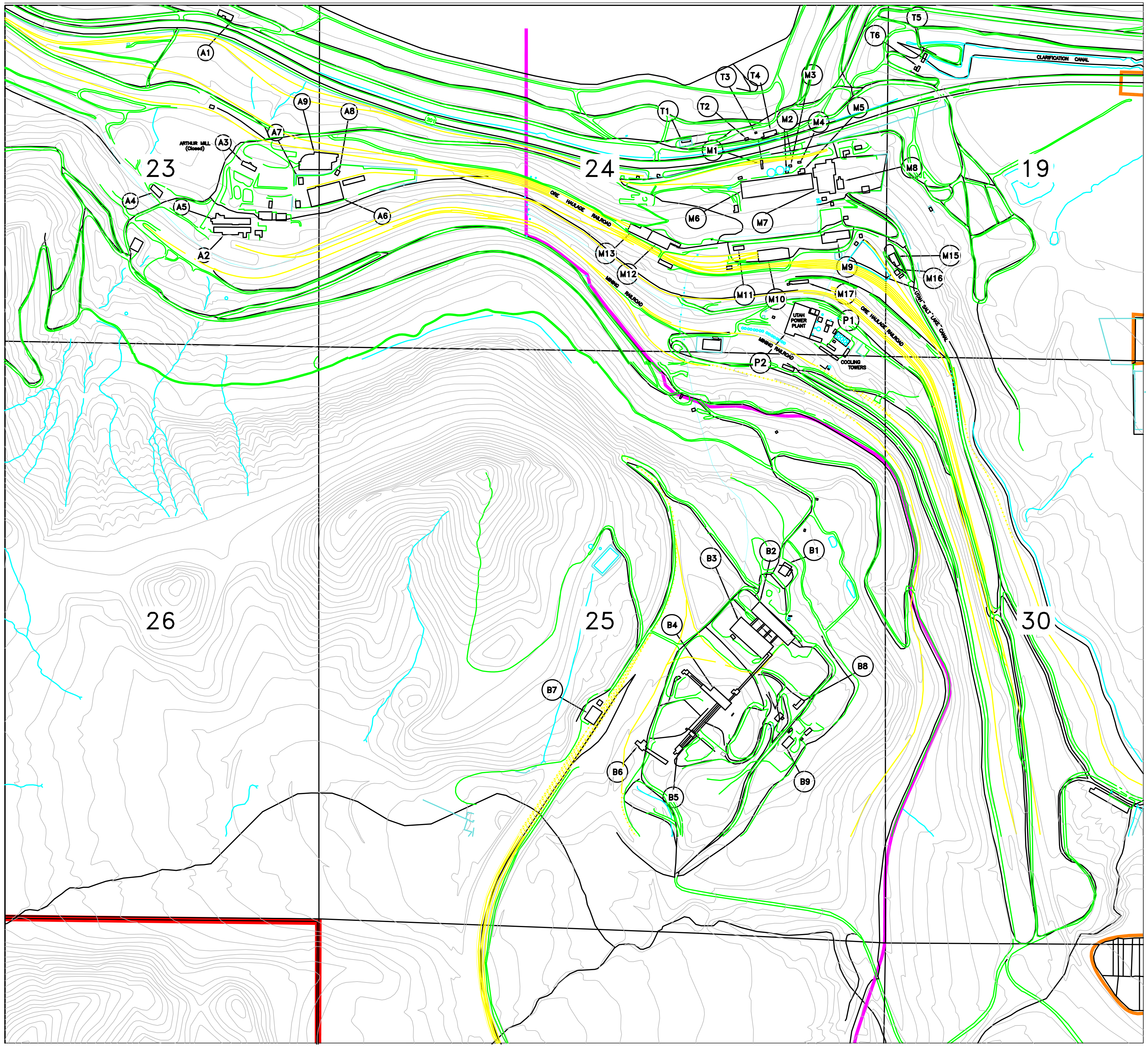
R3W R2W



R3W R2W

N

SURFACE FACILITIES

ARTHUR AREA	
A1	Arthur Tailings Pump House
A2	Machine Shop
A3	Arthur Administration Building
A4	Arthur Substation
A5	Arthur Carpenter Shop
A6	Arthur Central Warehouse
A7	Acetylene & Oxygen Building
A8	Radioactive Material Storage Building
A9	Central Lab

TAILINGS AREA	
T1	Tailings Compound
T2	Adverse Pumphouse
T3	Magna Cyclone Station
T4	Magna Tailings Pumphouse
T5	Pump Station No.1
T6	Tailings Pipeline

NORTH (MAGNA) CONCENTRATOR FACILITY	
M1	Car Loading
M2	Thickener Control Room
M3	Filter Plant Pump House
M4	Mt. Fuel Gas House
M5	Magna Heating Plant
M6	Magna Filter Plant
M7	Magna Flotation Plant
M8	Magna Administration Office
M9	Electric & Pipe Shops
M10	Engine House
M11	Magna Main Substation
M12	North Service Garage
M13	Railroad Car Repair Shop
M14	UPP Pump House
M15	Pump Station No. 3A
M16	Pump Station No. 3
M17	Water Storage

BONNEVILLE AREA CRUSHING FACILITY	
B1	Bonneville Substation
B2	Grinding Plant
B3	Fine Ore Storage
B4	Symons Building
B5	Syntrons Building
B6	Drive House No. 1
B7	Dumper Building (Primary Crusher)
B8	Bonneville Administration Offices
B9	Boiler Shop & Warehouse

POWER PLANT AREA	
P1	Reverse Osmosis Building
P2	Utah Power Plant

GRAPHIC SCALE

500 0 250 500 1000

(IN FEET)
1 inch = 500 ft.

NOTE:
1. TOPOGRAPHY DERIVED FROM 1994 AERIAL SURVEY BY AERO GRAPHICS

DOGM PERMIT BOUNDARY
KUC PROPERTY BOUNDARY
TAILINGS PIPELINE CORRIDOR
ALL SECTIONS ARE WITHIN T1S
CONTOUR INTERVAL = 20 FEET

ENGINEERING SERVICES

SCALE: 1"=500' | DATE
DESIGNED BY
DRAWN BY PT 1/98
CHECKED BY
PROJECT ENGINEER
PROJECT MANAGER

KENNECOTT UTAH COPPER

FIGURE 2-2
MAP OF ARTHUR, SOUTH TAILINGS, MAGNA AND BONNEVILLE SURFACE FACILITIES

Job No. --- Dwg. No. 454-T-0008 REV 2 DATE 1/09/02

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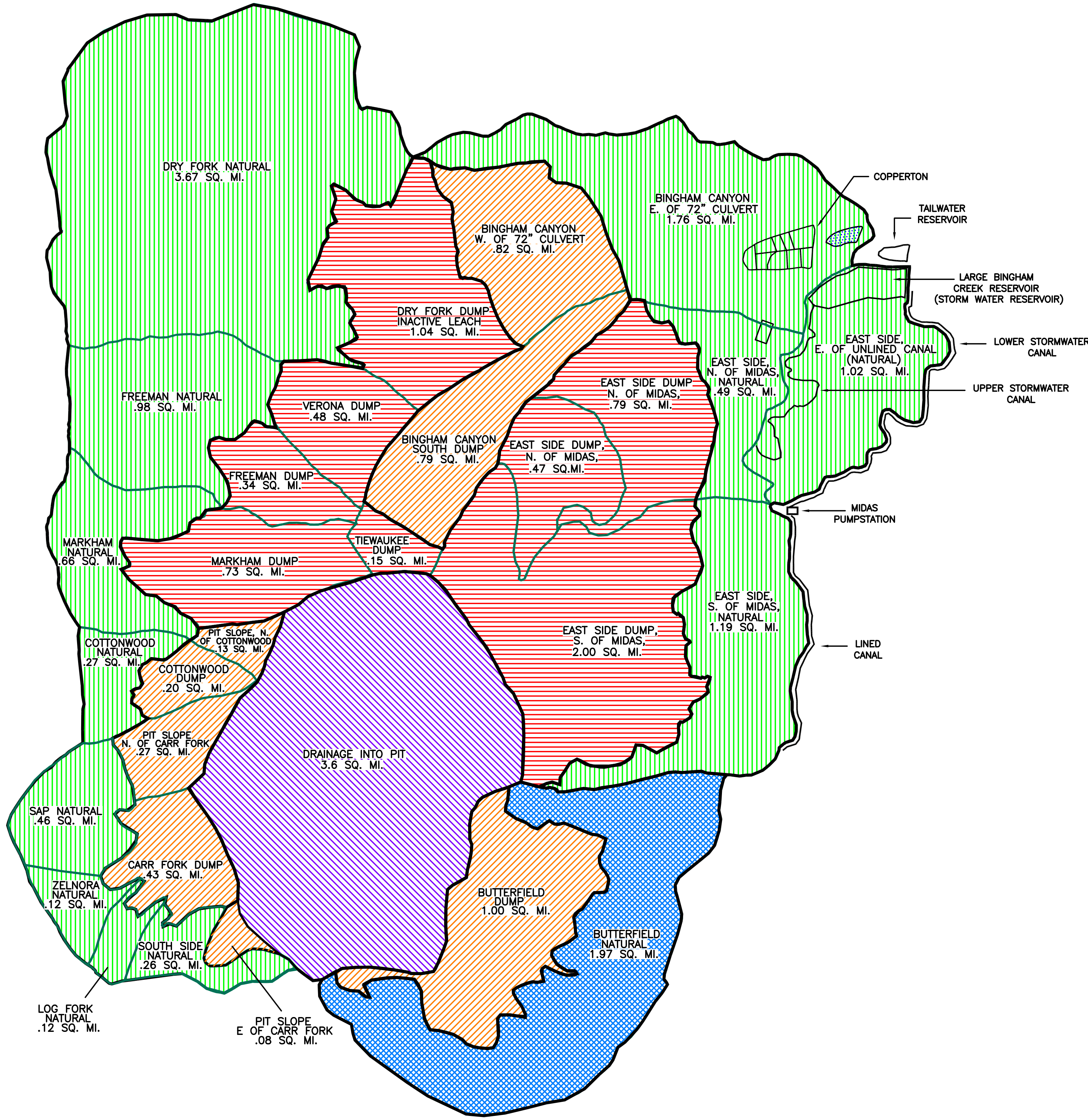


	TOTAL AREA		LEGEND
	Sq. Mi.	Acres	
(red)	6.0	3800	WATERSHEDS THAT CONTAIN WASTE ROCK DISPOSAL AREAS WHERE LEACH WATER WAS APPLIED IN THE PAST TO RECOVER COPPER. ALL LEACH WATER APPLICATIONS WERE TERMINATED IN 2000. MAY ALSO INCLUDE SOME UNDISTURBED GROUND.
(orange)	3.7	2400	WATERSHEDS THAT CONTAIN WASTE ROCK DISPOSAL AREAS WHERE LEACH WATER WAS NEVER APPLIED. MAY ALSO INCLUDE SOME UNDISTURBED GROUND.
(purple)	3.6	2300	BINGHAM CANYON MINE OPEN PIT WATERSHED. NOTE: ALL OF THE CARR FORK AND COTTONWOOD WASTE ROCK DISPOSAL AREAS, UPGRADIENT NATURAL DRAINAGES, AND PORTIONS OF THE MARKHAM WATERSHEDS (TOTAL OF 1400 ACRES) DRAIN TOWARDS THE PIT ALTHOUGH THEY ARE LISTED UNDER OTHER CATAGORIES.
(green)	11.0	7000	UNDISTURBED WATERSHEDS WITHIN THE CAPTURE ZONE OF THE MINE'S RUNOFF COLLECTION SYSTEMS. APPROXIMATELY 4200 ACRES OF THIS AREA ARE LOCATED IMMEDIATELY UP GRADIENT OF WASTE ROCK DISPOSAL AREAS.
(blue)	2.0	1300	UNDISTURBED WATERSHED WITH DRAINAGE THAT DOES NOT REPORT TO THE MINE'S RUNOFF COLLECTION SYSTEMS.

NOTE: DRAINAGE AREAS ARE LISTED IN ORDER OF GENERALLY IMPROVING WATER QUALITY.

GRAPHIC SCALE

0 2100 4200 8400

(in feet)
1 inch = 4200 ft.

N

NO.	DATE	REVISION	BY	CHK	APP
2	1/22/02	REDRAWN	MWC		
1	6/30/94	REDRAWN	PT	LJW	LJW

REFERENCE DRAWINGS	NUMBER
ORIGINAL VERSION OF MAP	451-T-0020
SUB-DRAINAGE BASIN MAP	451-T-023

ENGINEERING SERVICES

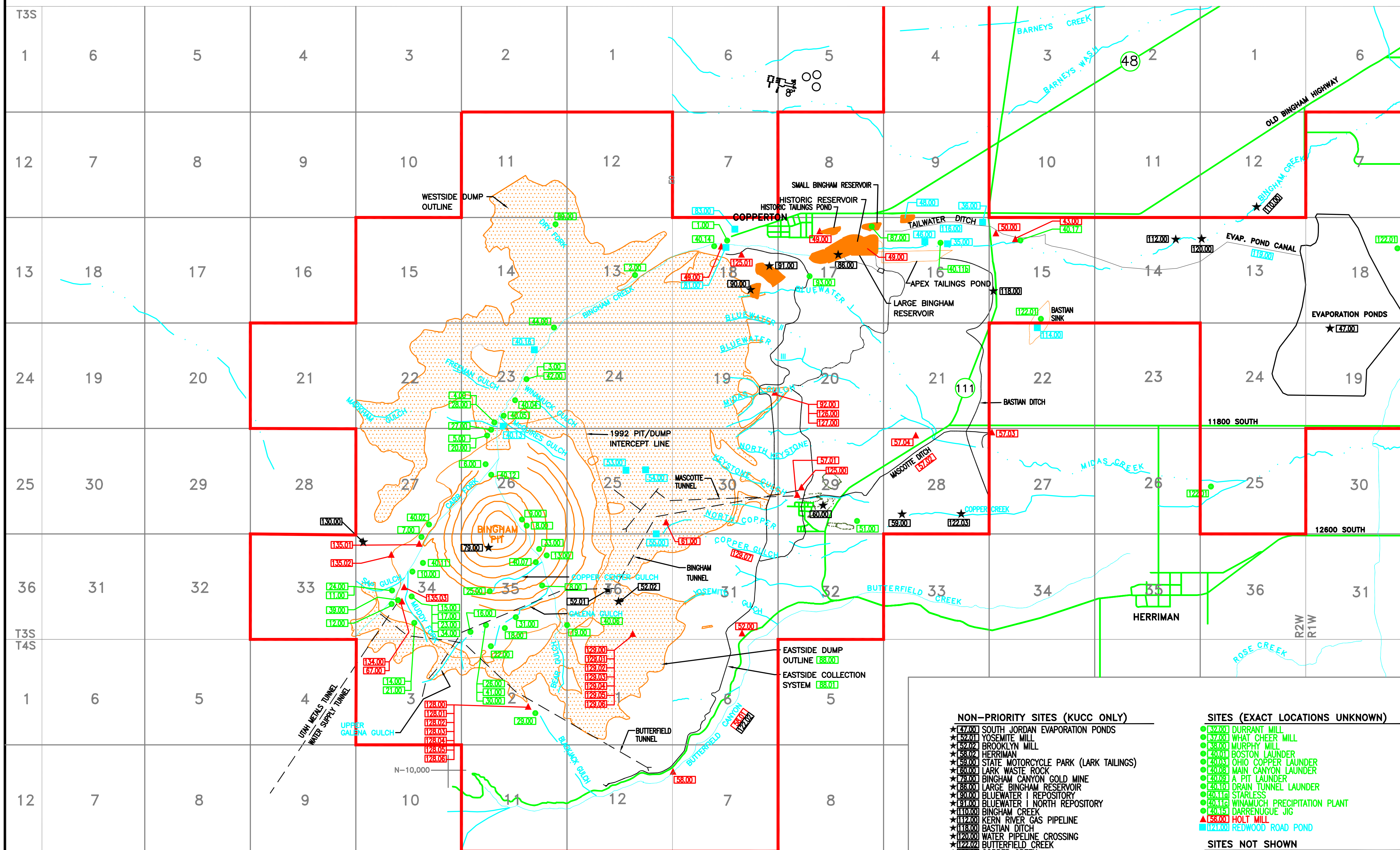
APPROVAL	DATE			DATE
		SCALE:	1"= 4200'	
		DESIGNED BY	PT	6/94
		DRAWN BY	MWC	1/8/02
		CHECKED BY	BV	6/00
		PROJECT ENGINEER		
		PROJECT MANAGER		

KENNECOTT
UTAH COPPER

FIGURE 10-1 MAP OF BINGHAM CANYON MINE AREA SHOWING WATERSHEDS AND SURFACE WATER COLLECTION SYSTEMS

Job No. --- Dwg. No. 454-T-0007 REV 2

4540007.dwg 01/30/03 10:27 krthiede



BINGHAM CREEK ROD HISTORICAL FACILITIES

- 1.00 LEAD MINE MILL
- 2.00 UTAH COPPER CO. MILL
- 3.00 WINNAMUCK MILL
- 4.00 MARKHAM MILL
- 5.00 WALLS MILL
- 6.00 SHAWMUT MILL
- 7.00 UTAH APEX MILL
- 8.00 ROGERS MILL (MOVED 1 MILE DOWN GRADIENT)
- 9.00 BOSTON CONSOLIDATED MILL
- 10.00 STEWART NO.2 MILL
- 11.00 HIGHLAND BOY MILL
- 12.00 BINGHAM–NEW HAVEN COPPER & GOLD MILL
- 13.00 COLUMBIA COPPER CO. MILL
- 14.00 LAST CHANCE MILL
- 15.00 NEW ENGLAND GOLD & COPPER CO. MILL
- 16.00 JORDAN MILL (GALENA MILL)
- 17.00 STEWART NO.1 MILL
- 18.00 SPANISH MILL (NIAGARA MILL)
- 19.00 TELEGRAPH MILL (US MINING CO. MILL)
- 20.00 BEMIS MILL
- 21.00 WEST MTN. MINING CO. CONCENTRATOR
- 22.00 SILVER SHIELD MILL
- 23.00 BINGHAM MINING & MILLING CO. MILL
- 24.00 UTAH CONSOLIDATED GOLD MINE MILL
- 25.00 BINGHAM GOLD MINING CO.
- 26.00 UTAH CONCENTRATOR (AKA UTAH MILL)
- 27.00 HEASTON CONCENTRATOR JIGS
- 28.00 MASSASOIT MILL
- 30.00 UTAH MILL (AKA UTAH CONCENTRATOR)
- 31.00 BROOKS MILL
- 33.00 EAGAN & BATES MILL
- 34.00 BINGHAM–NEW ENGLAND MILL
- 35.00 ROBBE CELLS
- 40.02 APEX YARDS
- 40.04 TIEWAUKEE DUMP
- 40.05 McGUIRES GULCH
- 40.06 GALENA GULCH
- 40.07 COPPER CENTER GULCH
- 40.11 INGERSOLL GULCH
- 40.11b McGREGOR PLANT
- 40.12 COPPER PLACER PLANT
- 40.13 CUPRUM PRECIPITATION PLANT
- 40.14 C.W. WATSON'S JIG
- 40.16 VERONA URANIUM PLANT
- 40.17 NEW YORK & UTAH MILL
- 41.00 UTAH SMELTER
- 42.00 WINNAMUCK SMELTER
- 43.00 REVERE SMELTER
- 44.00 YAMPA SMELTER
- 83.00 YELLOW CAKE PLANT

NON–BINGHAM ROD HISTORICAL FACILITIES

- 29.00 QUEEN MILL
- 36.00 PROLER
- 46.00 MIXED TAILS
- 48.00 CEMETERY POND
- 49.00 COPPERTON DUMPS (3 LOCATIONS)
- 50.00 REVERE SWITCH TAILINGS POND
- 51.00 OHIO COPPER CO. MILLS
- 52.00 REVERE MILL
- 53.00 FORTUNE MILL
- 54.00 NEW MAMMOTH MILL
- 55.00 DALTON & LARK MILL
- 57.01 MASCOTTE TUNNEL
- 57.02 MASCOTTE DITCH
- 57.03 MASCOTTE POND
- 57.04 MASCOTTE TAILINGS
- 58.00 BUTTERFIELD MINE WASTE ROCK
- 58.01 BUTTERFIELD CANYON
- 61.00 COPPER GULCH MINES
- 81.00 PRECIPITATION PLANT IN COPPERTON
- 87.00 SMALL BINGHAM RESERVOIR
- 88.00 EAST SIDE DUMPS
- 88.01 EAST SIDE COLLECTION SYSTEM
- 89.00 DRY FORK DUMPS
- 92.00 MIDAS POND
- 93.00 EAST SIDE RESERVOIR
- 114.00 BASTIAN SINK
- 116.00 TAILWATER DITCH
- 119.00 EVAPORATION PONDS CANAL
- 122.01 MINE WASH AREAS (3 LOCATIONS)
- 125.00 BINGHAM TUNNEL
- 125.01 5490 TUNNEL
- 126.00 OLD BINGHAM TUNNEL
- 127.00 UNNAMED ADIT
- 128.00 TO 128.06 BLACK JACK GULCH MINES
- 129.00 TO 129.06 YOSEMITE & SAINTS REST MINES
- 129.07 COPPER GULCH
- 135.01 APEX (PARVENU) TUNNEL
- 135.02 ARMSTRONG TUNNEL
- 135.03 HIGHLAND BOY TUNNEL

NON–PRIORITY SITES (KUCC ONLY)

- ★ 47.00 SOUTH JORDAN EVAPORATION PONDS
- ★ 52.01 YOSEMITE MILL
- ★ 52.02 BROOKLYN MILL
- ★ 58.02 HERRIMAN
- ★ 59.00 STATE MOTORCYCLE PARK (LARK TAILINGS)
- ★ 60.00 LARK WASTE ROCK
- ★ 79.00 BINGHAM CANYON GOLD MINE
- ★ 86.00 LARGE BINGHAM RESERVOIR
- ★ 90.00 BLUEWATER I REPOSITORY
- ★ 91.00 BLUEWATER I NORTH REPOSITORY
- ★ 110.00 BINGHAM CREEK
- ★ 112.00 KERN RIVER GAS PIPELINE
- ★ 118.00 BASTIAN DITCH
- ★ 120.00 WATER PIPELINE CROSSING
- ★ 122.02 BUTTERFIELD CREEK
- ★ 122.03 COPPER CREEK

SITES (EXACT LOCATIONS UNKNOWN)

- 32.00 DURRANT MILL
- 37.00 WHAT CHEER MILL
- 38.00 MURPHY MILL
- 40.01 BOSTON LAUNDER
- 40.03 OHIO COPPER LAUNDER
- 40.08 MAIN CANYON LAUNDER
- 40.09 A PIT LAUNDER
- 40.10 DRAIN TUNNEL LAUNDER
- 40.11a STARLESS
- 40.11c WINAMUCH PRECIPITATION PLANT
- 40.15 DARRENUGUE JIG
- 56.00 HOLT MILL
- 121.00 REDWOOD ROAD POND

SITES NOT SHOWN

- ★ 123.00 SW JORDAN VALLEY GROUNDWATER PLUME
- ★ 124.00 UPPER BINGHAM CREEK GROUNDWATER CONTAMINATION

LEGEND

- ▲ =PRIORITY ONE SITES
- ■ =PRIORITY TWO SITES
- ● =PRIORITY THREE SITES
- ★ =NON–PRIORITY SITES
- — =PERMIT BOUNDARY (M/035/002)

N

GRAPHIC SCALE

5400 0 2700 5400 10800

(IN FEET)

ENVIRONMENTAL ENGINEERING PROJECTS GROUP

APPROVAL	DATE	SCALE: 1"= 5400'	DATE
		DESIGNED BY RKB	1/3/02
		DRAWN BY MWC	1/8/02
		CHECKED BY	
		PROJECT ENGINEER	
		PROJECT MANAGER	

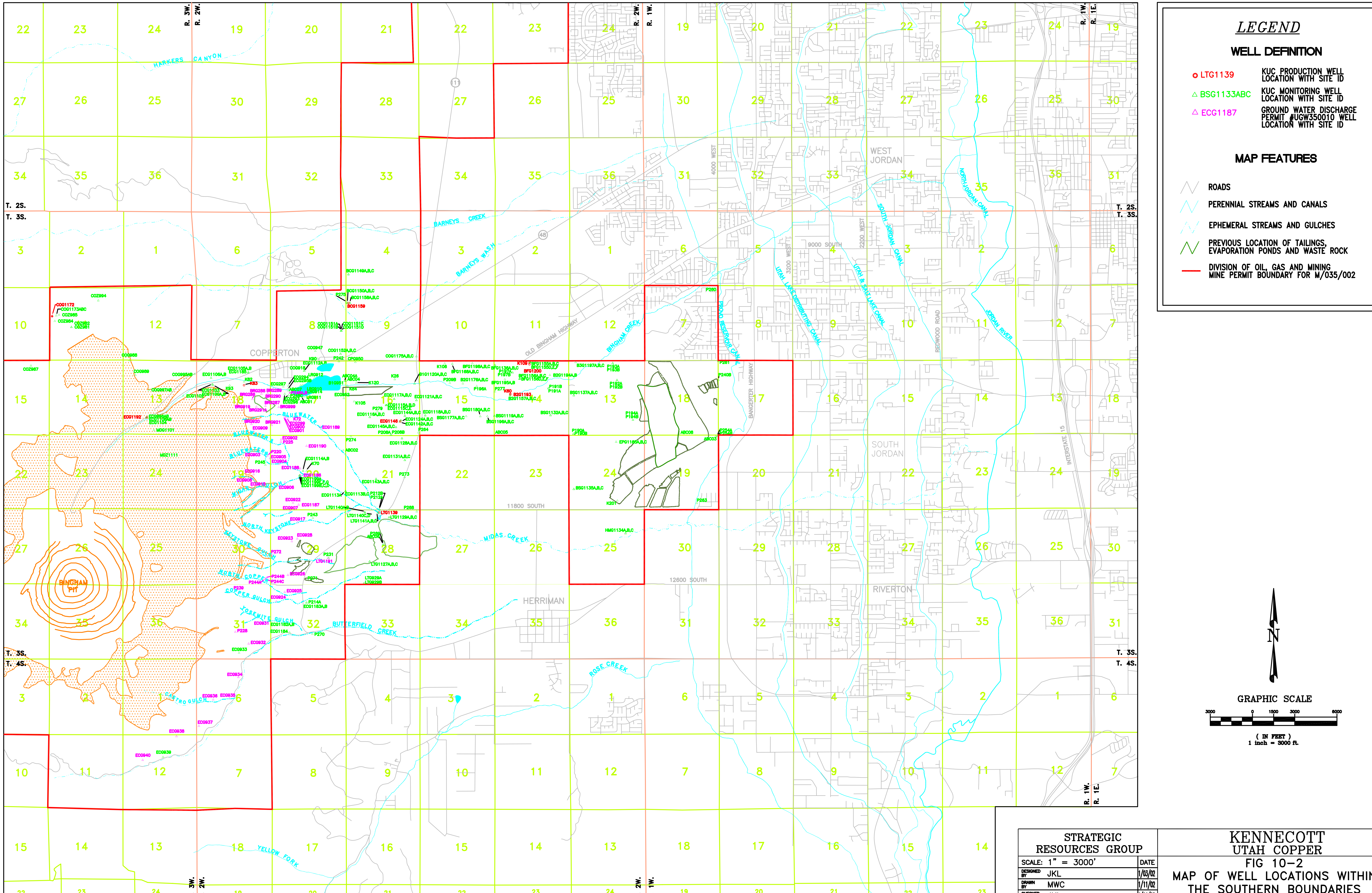
KENNECOTT UTAH COPPER

FIGURE 1–2

MAP OF HISTORICAL SITES WITHIN THE SOUTHERN BOUNDARIES OF PERMIT M/035/002

Job No. --- Dwg. No. 454–T–0006 REV L

N:\454\4540006 01/08/02 16:20 KMCOOK



STRATEGIC RESOURCES GROUP

SCALE: 1" = 3000'		DATE
DESIGNED BY	JKL	1/03/02
DRAWN BY	MWC	1/11/02
CHECKED BY	JKL	1/11/02
PROJECT ENGINEER	JCC	
PROJECT MANAGER		

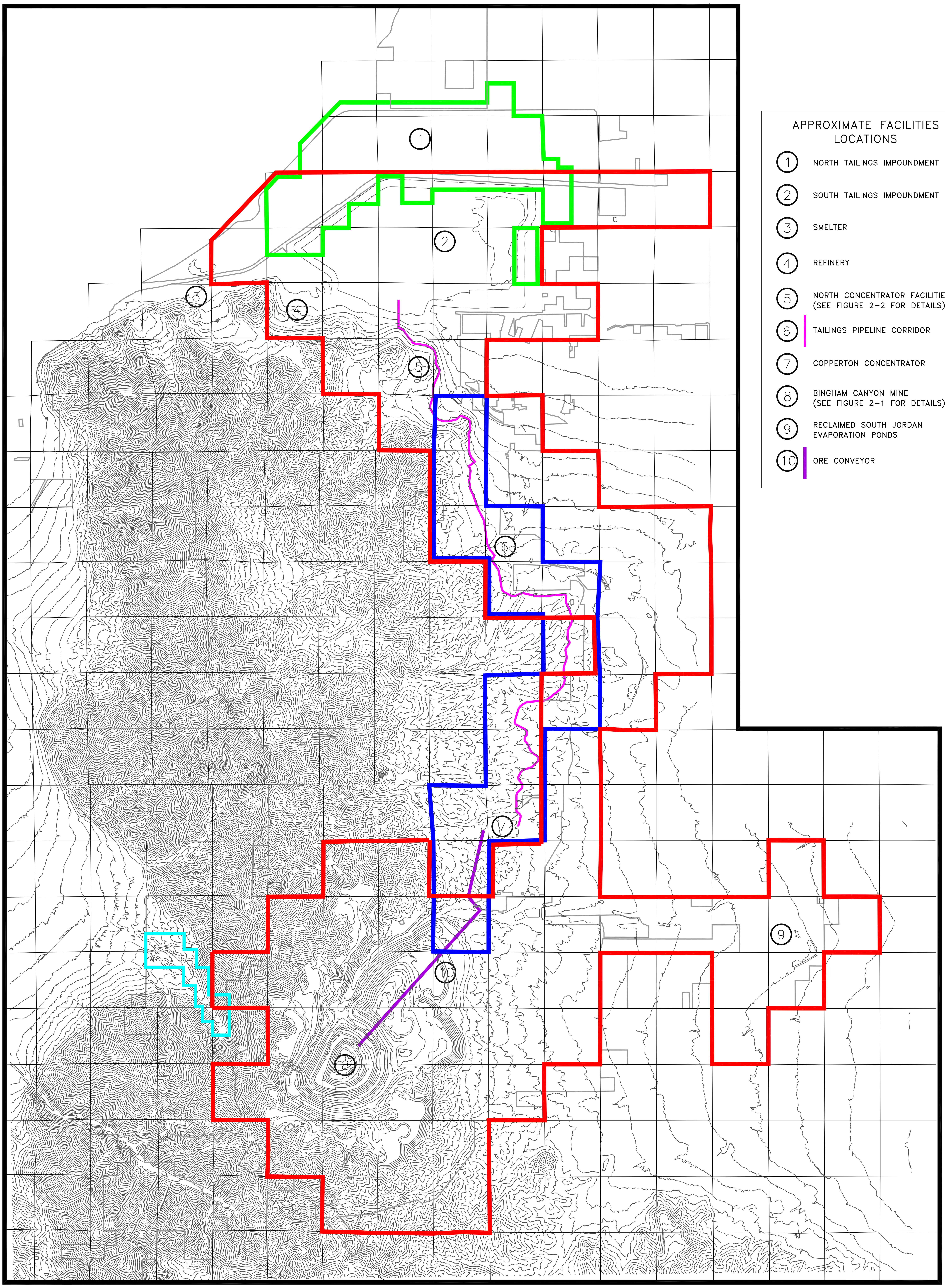
KENNECOTT UTAH COPPER

FIG 10-2

MAP OF WELL LOCATIONS WITHIN THE SOUTHERN BOUNDARIES OF DOGM PERMIT M/035/002

Job No. --- Dwg. No. 454-T-0002 REV

N:\DOCUMENTS\454\4540002 01/11/02 kjlucy



LEGEND

- NORTH IMPOUNDMENT PERMIT BOUNDARY (M\035\015)
- 1978 PERMIT BOUNDARY (M\035\002)
- PINE CANYON PERMIT BOUNDARY (M\045\004)
- COPPERTON CONCENTRATOR PERMIT BOUNDARY (M\035\011)
- KUC PROPERTY BOUNDARY

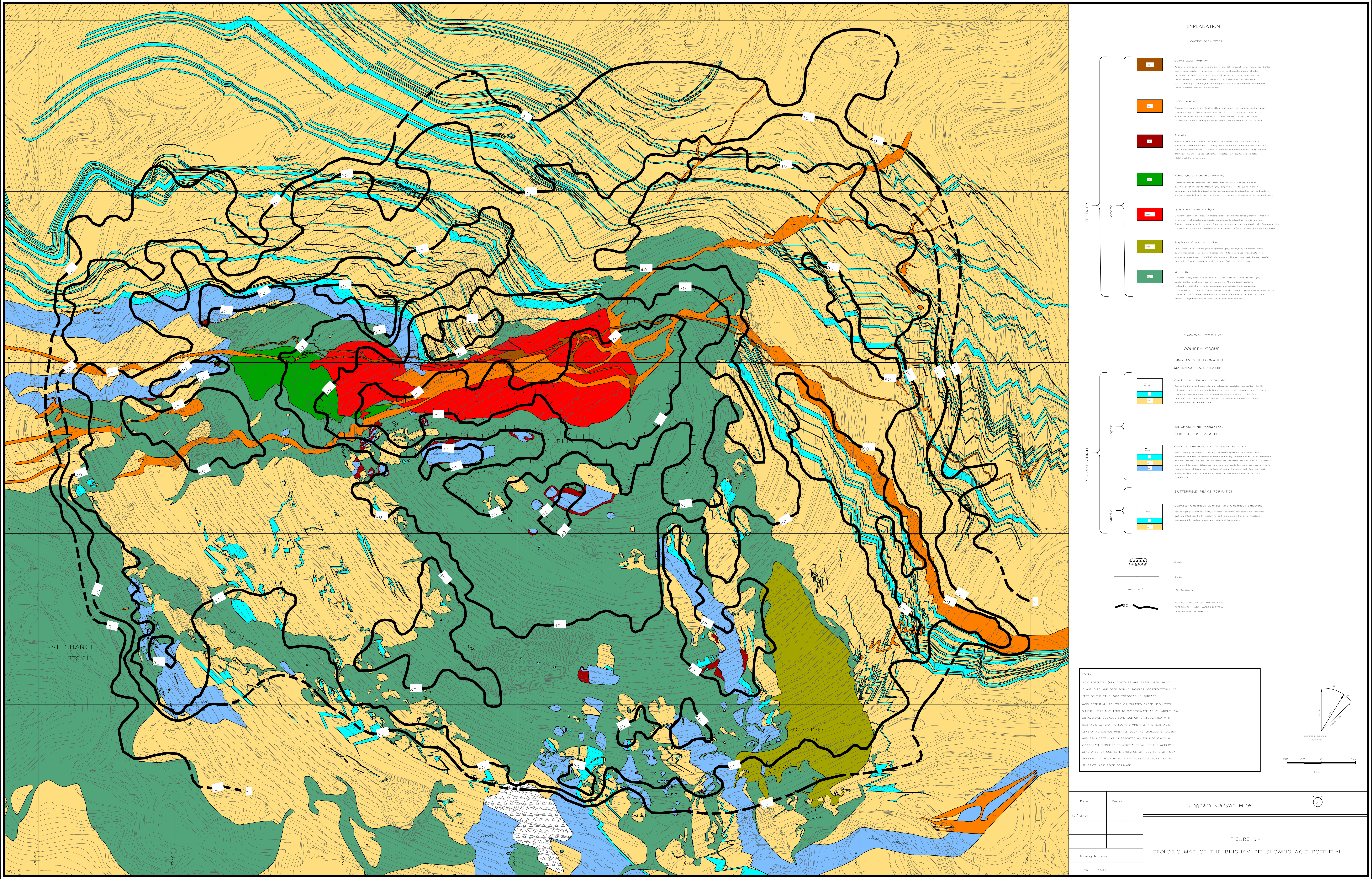
GRAPHIC SCALE

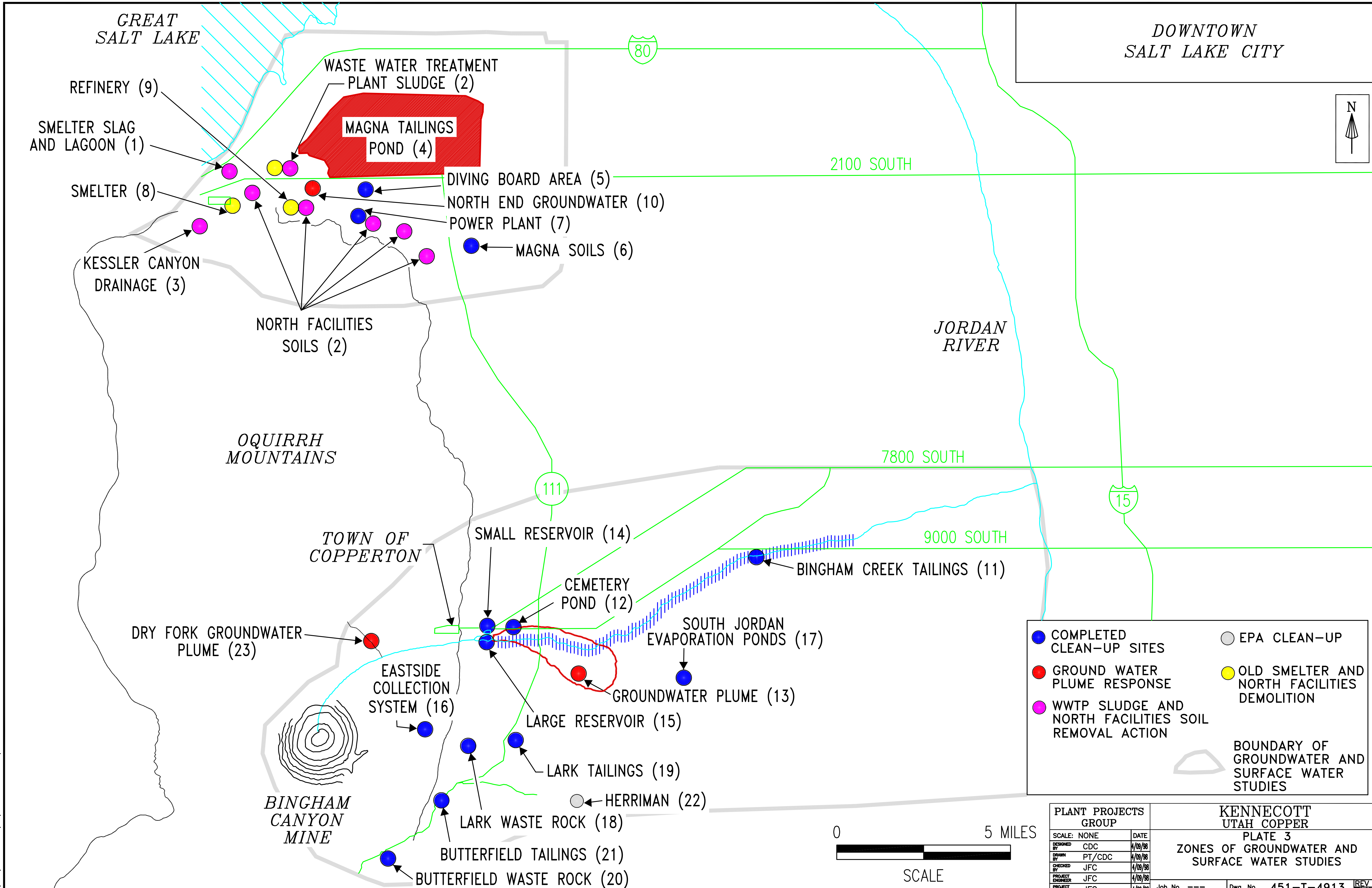
4500 0 2250 4500 9000

(IN FEET)
1 inch = 4500 ft.

N

STRATEGIC RESOURCES GROUP			KENNECOTT UTAH COPPER
SCALE: 1" = 4500'		DATE	FIGURE 1-1 DOGM PERMIT BOUNDARIES
DESIGNED BY	RKB	1/3/02	
DRAWN BY	MWC	1/3/02	
CHECKED BY			
PROJECT ENGINEER			
PROJECT MANAGER			Job No. --- Dwg. No. 454-T-0001 REV DATE


LAST CHANCE STOCK
EXPLANATION
IGNEOUS ROCK TYPES
TERTIARY
Eocene
Tiqlp
Quartz Latite Porphyry
Andy dike and apophyses. Medium brown and light greenish-gray, hornblende-biotite quartz latite porphyry. Hornblende is altered to phlogopite and/or chlorite within the pit area. Hosts late stage chalcopyrite and pyrite mineralization. Distinguished from other latitic dikes by the presence of relatively large quartz phenocrysts and higher percentage of aphanitic groundmass. Groundmass usually contains considerable hornblende.
Tilp
Latite Porphyry
Fortuna sill, Main Hill and Starless dikes, and apophyses. Light to medium gray, hornblende-augite-biotite quartz latite porphyry. Ferromagnesian minerals are altered to phlogopite and chlorite in pit area. Locally contains ore grade chalcopyrite, bornite, and pyrite mineralization, both disseminated and in veins.
Tie
Endoskarn
Intrusive rock, the composition of which is changed due to assimilation of calcareous sedimentary rocks. Usually found at contact zone between monzonite and major limestone units. Texture is igneous; composition is extremely variable. Dominant minerals include actinolite, orthoclase, phlogopite, and epidote. Calcite veining is common.
Tih
Hybrid Quartz Monzonite Porphyry
Quartz monzonite porphyry, the composition of which is changed due to assimilation of monzonite. Medium gray, amphibole-biotite quartz monzonite porphyry. Amphibole is altered to biotite; plagioclase is altered to clay and serisite. Calcite veining is locally present. Contains ore grade chalcopyrite-pyrite mineralization.
Tiqmp
Quartz Monzonite Porphyry
Bingham Stock. Light gray, amphibole-biotite quartz monzonite porphyry. Amphibole is altered to phlogopite and quartz; plagioclase is altered to sericite and clay. Calcite veining is locally present. There are no exposures of unaltered rock. Contains pyrite, chalcopyrite, bornite and molybdenite mineralization. Inferred source of mineralizing fluids.
Tipqm
Porphyritic Quartz Monzonite
Ohio Copper dike. Medium gray to greenish gray, porphyritic, amphibole-biotite quartz monzonite. Pale pink orthoclase and white plagioclase phenocrysts in a phaneritic groundmass. A distinct late phase of Bingham and Last Chance (quartz) monzonite. Calcite veining is locally present. Pyrite occurs in veins
Tim
Monzonite
Bingham stock, Phoenix dike, and Last Chance stock. Medium to dark gray, augite-biotite-amphibole (quartz) monzonite. Where altered, augite is replaced by actinolite, chlorite, phlogopite, and quartz. Some plagioclase is replaced by orthoclase. Calcite veining is locally present. Contains pyrite, chalcopyrite, bornite and molybdenite mineralization. Original magnetite is replaced by sulfide minerals. Molybdenite occurs primarily in veins. Main ore host.
SEDIMENTARY ROCK TYPES
OQUIRRH GROUP
PENNSYLVANIAN
Upper
BINGHAM MINE FORMATION
MARKHAM RIDGE MEMBER
IPbmm
sl
qzt
Quartzite and Calcareous Sandstone
Tan to light gray orthoquartzite and calcareous quartzite, interbedded with thin calcareous sandstone and sandy limestone beds. Locally laminated and crossbedded. Calcareous sandstone and sandy limestone beds are altered to hornfels. Quartzite (qzt), limestone (lst), and thin calcareous sandstone and sandy limestone (sl), are differentiated.
BINGHAM MINE FORMATION
CLIPPER RIDGE MEMBER
IPbmc
sl
qzt
lst
Quartzite, Limestone, and Calcareous Sandstone
Tan to light gray orthoquartzite and calcareous quartzite, interbedded with limestone, and thin calcareous sanstone and sandy limestone beds. Locally laminated and crossbedded. Two large cherty limestones are interbedded near base. Limestones are altered to skarn. Calcareous sandstone and sandy limestone beds are altered to hornfels. Base of formation is at base of Jordan limestone bed. Quartzite (qzt), limestone (lst), and thin calcareous sanstone and sandy limestone (sl), are differentiated.
Middle
BUTTERFIELD PEAKS FORMATION
IPbp
sl
qzt
Quartzite, Calcareous Quartzite, and Calcareous Sandstone
Tan to light gray orthoquartzite, calcareous quartzite and calcareous sandstone, cyclically interbedded with medium to dark gray, sandy, bioclastic limestone, containing thin-bedded lenses and nodules of black chert.
Breccia
Contact
1997 Topography
20
ACID POTENTIAL CONTOUR (DASHED WHERE APPROXIMATE. HATCH MARKS INDICATE A DEPRESSION IN THE SURFACE.)
NOTES:
ACID POTENTIAL (AP) CONTOURS ARE BASED UPON 80,000 BLASTHOLES AND DEEP BORING SAMPLES LOCATED WITHIN 100 FEET OF THE YEAR 2000 TOPOGRAPHIC SURFACE.
ACID POTENTIAL (AP) WAS CALCULATED BASED UPON TOTAL SULFUR. THIS MAY TEND TO OVERESTIMATE AP BY ABOUT 10% ON AVERAGE BECAUSE SOME SULFUR IS ASSOCIATED WITH NON-ACID GENERATING SULFATE MINERALS AND NON-ACID GENERATING SULFIDE MINERALS SUCH AS CHALCOLITE, GALENA AND SPHALERITE. AP IS REPORTED AS TONS OF CALCIUM CARBONATE REQUIRED TO NEUTRALIZE ALL OF THE ACIDITY GENERATED BY COMPLETE OXIDATION OF 1000 TONS OF ROCK. GENERALLY A ROCK WITH AP <10 TONS/1000 TONS WILL NOT GENERATE ACID ROCK DRAINAGE.
MAGNETIC DECLINATION
JANUARY, 1991
400 200 0 400
FEET
Date
Revision
12/12/01
0
Drawing Number
451-T-4933
Bingham Canyon Mine
K
FIGURE 3-1
GEOLOGIC MAP OF THE BINGHAM PIT SHOWING ACID POTENTIAL



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