Remedial Action Report
Mine Area Operable Unit (OU1)

Lava Cap Mine Superfund Site
Nevada County, California

Prepared for

EPA CERCLIS
ID Number CAD983618892
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Region IX

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REMEDIAL ACTION REPORT

Record of Preparation, Review, and Approval

Lava Cap Mine Superfund Site –
Mine Area Operable Unit (OU1)

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I. INTRODUCTION

The Lava Cap Mine Superfund Site

The Lava Cap Mine Superfund Site is located in the historical gold-mining area in the foothills of the Sierra Nevada Mountains, approximately 5 miles southeast of Nevada City, Nevada County, California (see Figure 1 and drawings in Appendix A). The Site is comprised of the Mine Area, where the hardrock gold and silver mining operations took place, and downstream areas where waste materials generated at the mine were discharged. The Mine Area comprises the portion of the Site where active mining occurred, plus portions of several adjacent land parcels. The Mine Area covers approximately 20 acres. There are two residences remaining on the mine property in close proximity to the Mine Area, one houses the current property owner and the second houses a tenant. There are three additional residences along Tensy Lane in the lower stretches of the Mine Area.

The downstream areas of the Lava Cap Mine site include the Little Clipper Creek (LCC) drainage, the Clipper Creek drainage after it merges with LCC, and Lost Lake, a private lake located approximately 1-1/4 miles downstream of the mine property. The entire Lava Cap Mine site, including the Mine Area and downstream areas, is bordered on all sides by forest and low-density rural residential properties.

Mining Operations. Various entities operated Lava Cap Mine from 1861 to 1943, with several periods when the mine was not operating. The primary mining activities occurred between 1934 and 1943. During this period, a flotation plant was used to process the ore and create concentrates that were sent offsite for recovery of the gold and silver. For a short time, an onsite cyanide process was used to extract metals from a portion of the ore. The ore contained naturally-occurring arsenic and the processing left the arsenic from the mining processes in the finely ground tailings. The tailings were deposited in the LCC drainage on the mine property and in the downstream Lost Lake area, which was constructed as a tailings impoundment.

Regulatory History. In February 1978, the lessees of the mine property at that time submitted an application for a National Pollutant Discharge Elimination System (NPDES) permit to the California Regional Water Quality Control Board (RWQCB or Board), seeking to discharge 63 million gallons of mine water to LCC as part of a project to de-water the mine workings. RWQCB found high concentrations of arsenic in mine discharge water and did not issue a permit. In 1979, a decomposing log dam on the property released tailings into LCC and the Board issued a Cleanup and Abatement Order to the owner and lessees of the mine property. Various public and private entities conducted sampling over the next decade and continued to find high concentrations of arsenic in surface water, mine discharge, waste rock, and tailings.

The United States Environmental Protection Agency (USEPA) completed a Preliminary Assessment of the Site in April 1993. Sediment and soil samples were collected and analyzed in May 1994. Elevated concentrations of arsenic and lead were detected in both soil and sediment. The results were documented in a Site Inspection report completed in December 1994. USEPA conducted an Expanded Site Inspection in 1995, which noted the existence of approximately 80,000 cubic yards of waste rock and mine tailings and documented arsenic and lead contamination in the mine drainage flowing into LCC.

During a major winter storm on January 1, 1997, the upper half of the onsite log dam collapsed, releasing over 10,000 cubic yards of tailings into LCC. In May 1997, staff from the State of California's

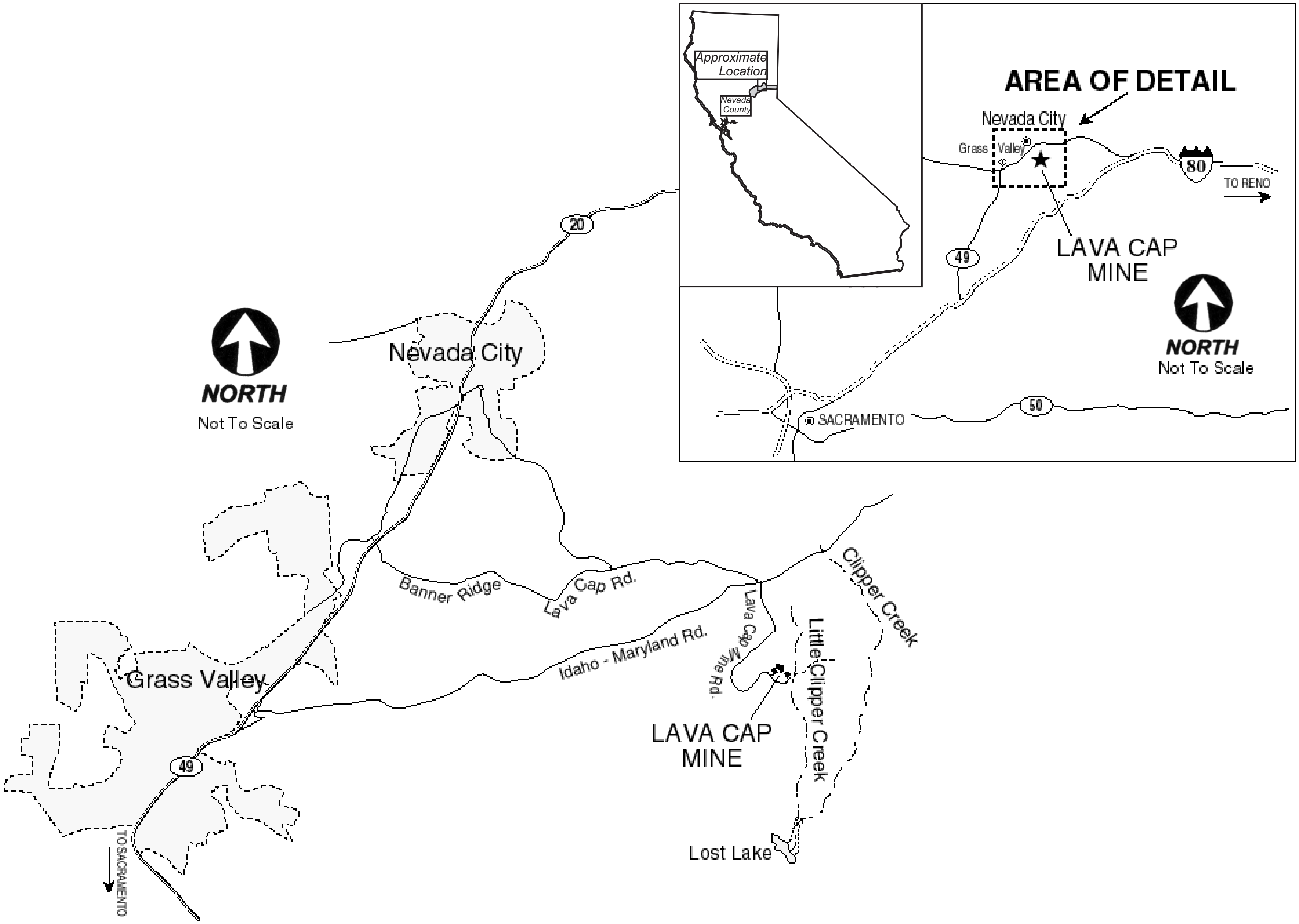

FIGURE 1-1
LOCATION OF LAVA CAP MINE SITE
LAVA CAP MINE
NEVADA COUNTY, CALIFORNIA

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Departments of Toxic Substances Control (DTSC) and Fish and Game and from Nevada County's Department of Environmental Health inspected the mine and downstream areas. They found extensive deposits of tailings in LCC and downstream in Clipper Creek (after it merged with LCC) and Lost Lake. In June 1997, DTSC issued an information sheet to the community, warning of potential hazards from contact with Lost Lake sediments.

USEPA Removal Actions. In October 1997, the USEPA Region IX Emergency Response Office determined that the high arsenic concentrations and the mobility of the extremely fine-grained tailings warranted a time-critical removal action under Superfund authority. During October and November 1997, USEPA removed 4,000 cubic yards of tailings from just upstream of the damaged log dam and stockpiled them on one of the waste rock piles. These tailings were placed on a liner and covered with another liner, clay cap, and waste rock. The project also included grading the tailings pile to reduce its slope, reinforcing the partially failed dam with large diameter rock, placing a waste rock layer on the tailings pile and diverting LCC and the adit drainage around the tailings pile. In 1998, USEPA stabilized another smaller tailings release and further improved drainage.

USEPA Superfund Studies and Investigations. In 1998, USEPA evaluated the Lava Cap Mine Site to determine if it warranted listing on the National Priorities List (NPL) as a Superfund site. USEPA formally listed the Lava Cap Mine Site on the NPL in January 1999. NPL listing allows USEPA to spend Superfund money to clean up the Site.

USEPA began an in-depth investigation of the nature and extent of contamination, called the Remedial Investigation or RI, in October 1999. The RI evaluated the Lava Cap Mine Site for contamination from various metals, including arsenic and cyanide. The investigation showed that arsenic is the most prevalent contaminant at the Site. As part of this effort, USEPA also studied the risks to both human and ecological health posed by the Site. These efforts identified arsenic as the primary chemical of concern for human health at the Site, and arsenic and other metals as potentially harmful to plant and animal species. As a result, Arsenic was the primary contaminant considered in developing the selected remedy. Both USEPA and the State of California consider arsenic a known human carcinogen. Potential noncancer effects from exposure to arsenic may include damage to tissues including nerves, stomach, intestines, and skin.

The RI Report was released for public comment in November 2001. The Feasibility Study (FS) for the Mine Area, was released for public comment in February 2004.

Sampling showed that tailings-impacted areas contained higher levels of arsenic than surrounding areas. For comparison, arsenic levels in nearby natural soils unaffected by the mine tailings were about 20 milligrams per kilogram (mg/kg) and about 25 mg/kg in nearby sediments. By far, the highest levels of arsenic at the Site were detected in sediments at the adit (up to 34,000 mg/kg) and in and around the cyanide and mill buildings (up to 31,200 mg/kg in soil and 14,300 mg/kg in ponded water). Arsenic levels in the waste rock and tailings pile were highest at the surface, averaging 1,340 mg/kg, and decreasing with depth to 223 mg/kg in the deepest sample. The estimated volume of tailings and waste rock in the Mine Area was 210,000 cubic yards; about 50,000 cubic yards of this estimated volume were tailings. Soils around the two residences closest to the tailings pile also contained elevated levels of arsenic (1,750 mg/kg and 1,230 mg/kg) (as described below, these two residences no longer exist).

Surface water from the collapsed adit and from seeps in the tailings pile and at the log dam all showed elevated arsenic concentrations relative to USEPA's drinking water maximum contaminant level (MCL) of 10 micrograms per liter (µg/L) (note that the MCL is being used as the surface water cleanup standard at the Site). The highest level, 910 µg/L, was detected at the adit during the low-flow period of late summer and early fall. Groundwater collected from monitoring wells completed beneath the waste rock/tailings in the Mine Area also contained elevated levels of arsenic with concentrations generally ranging between 100 and 500 µg/L. Residential wells on the mine property and immediately downgradient typically contained arsenic at concentrations between 10 and 60 µg/L

Operable Units. To facilitate implementation of the overall cleanup of the Lava Cap Mine Site, USEPA divided the site into four Operable Units (OUs) (Figure 2). The Mine Area OU (also called OU1) extends from the mine property down to Greenhorn Road and is the focus of this Remedial Action (RA) Report. The Mine Area OU includes the portion of the Site where hardrock mining operations took place and adjoining areas impacted by mine wastes. The Mine Area OU is primarily disturbed land of an abandoned industrial character. Specific features of the OU included (prior to the RA): the mine's process buildings (the mill building, assay building, cyanide building and other smaller co-located structures); the mine's disposal areas (which include waste rock and tailings, sometimes interspersed); the central mine shaft; the adit, from which contaminated mine drainage emanates as surface water flow; stretches of LCC that contain contaminated sediment and carry contaminated surface water flows; the failed log dam placed across LCC; and, two rental residences constructed on mine wastes or mine-impacted materials.

USEPA separated out the groundwater portion of the Site for additional study by designating the Groundwater OU (also called OU2). The Groundwater OU encompasses the groundwater underlying the entire Site (see map in Appendix A) and is the most complex OU of all. The mine workings, tailings at the mine and/or water discharging from the mine appear to have contributed to the elevated levels of arsenic found in portions of the local groundwater system.

USEPA designated the downstream areas of the Site as the Lost Lake Operable Unit (also called OU3). The Lost Lake OU is south of Greenhorn Road and areas of tailings accumulation along LCC, the Deposition Area along the LCC and Clipper Creek drainages upstream of Lost Lake, Lost Lake itself and the stretch of Clipper Creek below Lost Lake Dam to the confluence with Little Greenhorn Creek. Lost Lake Dam is approximately 1 ¼ miles downstream from the mine and was originally constructed as a tailings impoundment to capture tailings discharged into LCC below the mine. Approximately 500,000 cubic yards of tailings are present behind Lost Lake Dam in Lost Lake and the Deposition Area. The area was subsequently developed as a low-density, rural residential area.

On the mine property, there are two parcels of land located away from the mine's historic operations and disposal areas that are primarily residential in character (each contains a single residence). These two parcels, which contain limited quantities of contaminated materials that appear to have been associated with construction fill and road building activities, were originally included as part of the Mine Area OU. However, to allow for accelerated cleanup of these residential areas during the 2005 construction season, USEPA separated the two parcels from the rest of the Mine Area OU and designated them as the Mine Area Residences OU (also called OU4). For more information on the remedial action taken at OU4, see the April 9, 2007 Remedial Action Report for OU4.

II. MINE AREA OPERABLE UNIT BACKGROUND

The Mine Area OU is the subject of this RA Report. The Record of Decision (ROD) for the Mine Area OU was signed by USEPA in September 2004. As listed in the ROD, the USEPA's Remedial Action Objectives (RAOs) for the Mine Area OU include:

- protect against exposures to contaminants in soil, sediment, and surface water via ingestion, inhalation, or direct contact that present an unacceptable risk to human health;
- remediate contaminants that exceed cleanup goals in soils, sediments, and surface water to the extent technically and economically feasible;
- restore LCC to its beneficial use as a potential drinking water supply;
- protect ecological receptors from exposure to contaminants in soils, sediments, and surface water, that pose a significant risk;
- minimize the potential for migration of contaminants in soil and sediment that pose a threat to the beneficial uses of groundwater and surface water;

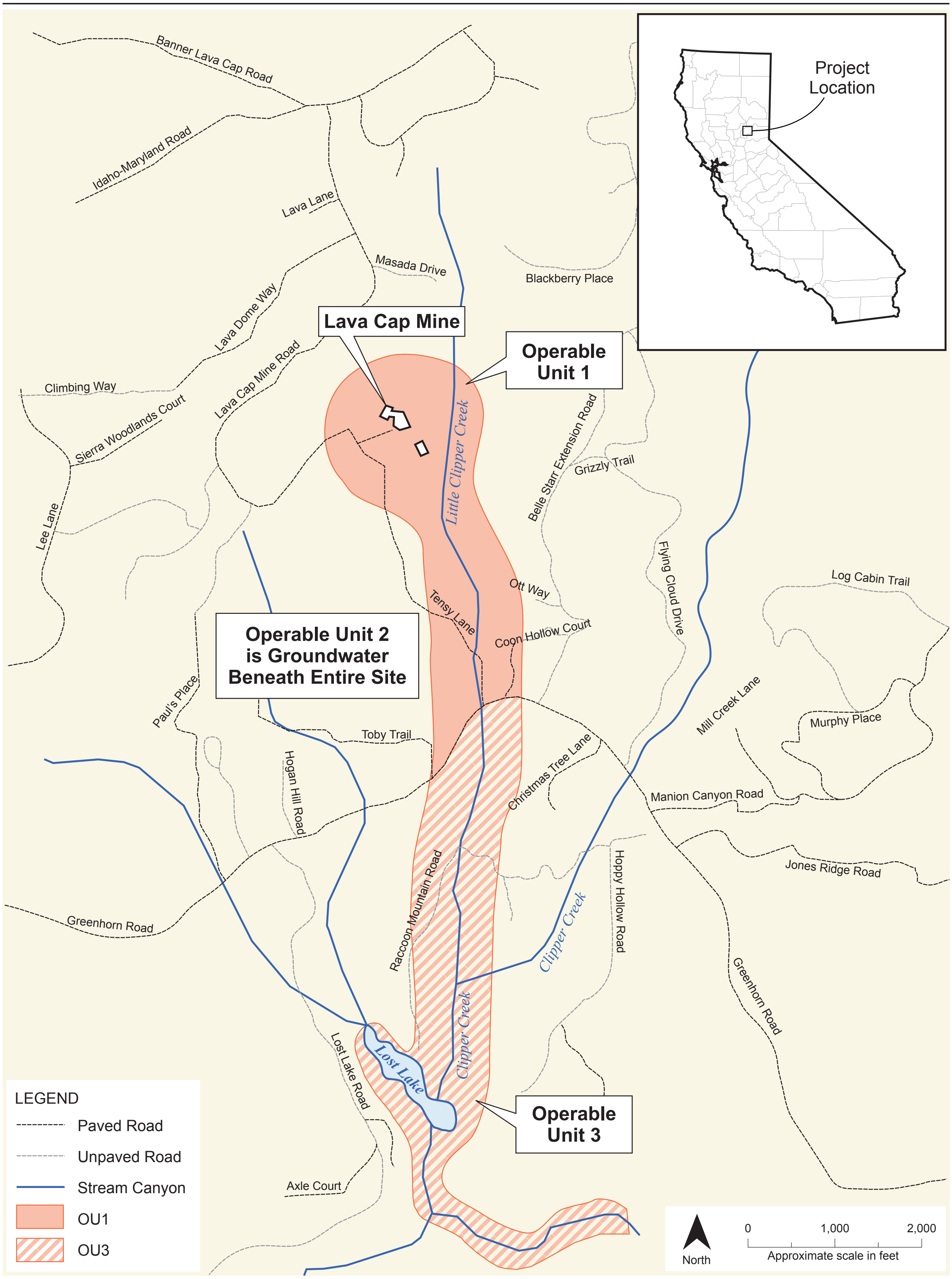


FIGURE 2
Lava Cap Mine Operable Units
Lava Cap Mine, Nevada County, California

- minimize the potential for release of contaminated tailings during a seismic event producing 60 percent of peak ground acceleration or 0.3 g (i.e. three-tenths the force of gravity); and

- minimize the potential for release of contaminated soils and sediments during surface water flow resulting from a 100-year storm event.

For the Mine Area OU, the arsenic cleanup goals determined by USEPA to be protective of human health and the environment and to meet regulatory requirements are 10 µg/L for surface water; 25 mg/kg in sediment; and 20 mg/kg in soil. The selected cleanup goals ensure that the RA will reduce human health and ecological risks from the Site to acceptable levels. The 10 µg/L limit for surface water is the drinking water MCL while the soil and sediment goals represent the background concentrations estimated for the surface soil in the forested areas upgradient of the Site and for sediment in local streams not impacted by mine tailings.

Mine Area OU Remedy Summary

The remedy selected in the 2004 Mine Area OU ROD is summarized in this section. It should be noted that the mine drainage component of the Mine Area OU remedy is still in the remedial design phase and has been designated as a separate RA; therefore, it is not addressed in this RA Report. As part of the phased implementation of the Mine Area OU remedy, treatment of the mine drainage is planned to be the final remedy component constructed. This phasing allows time for evaluation of any changes in mine drainage characteristics resulting from implementation of the Mine Area OU remedy components and provides an opportunity for additional pilot testing of passive treatment technologies for the mine discharge. The Mine Area OU ROD requirements (excluding the mine drainage), include:

- **Mine Buildings and Surrounding Area** – Remove tanks, vats, sumps, and contaminated soil from in and around the main mine buildings (Mill, Assay and Cyanide Buildings) and ship the highly-contaminated materials offsite for disposal; restrict unauthorized access to the buildings through the installation of fencing; cover areas around the mine storage buildings with a vegetative cap.

- **Waste Rock -** Contour, cover and revegetate the entire waste rock disposal area to promote runoff and reduce surface infiltration

- **Mine Tailings and Rock Buttress –** Consolidate all tailings and adjacent contaminated soil from around the site and from LCC in the Tensy Lane area into the tailings pile; regrade and cap the tailings with a low-permeability engineered cover system, including a vegetative layer; replace the failed log dam with a rock buttress at the downstream end of the tailings pile.

- **LCC and Smaller Mine Area Drainage Channels –** Construct engineered channels to divert LCC and all other clean surface water flows around the mine buildings, tailings pile and waste rock pile.

- **Mine Area Residences** – The ROD called for one residence (referred to as the Upper Rental residence) to be demolished because it was constructed immediately on or adjacent to the waste rock pile. After demolition, this area was to be addressed as part of the waste rock area with contouring and installation of a vegetative cover. After the ROD was signed, it was determined that a second residence would need to be demolished. This second residence is referred to as the Lower Rental residence and the remedy requirements for this area are summarized below in the Explanation of Significant Differences section. Two other residential areas at the mine were addressed as part of the Mine Area Residences OU and are not covered in this RA Report.

- **Institutional Controls –** Because mine waste and contaminated materials were to be capped and left in place, institutional controls are required to minimize potential future exposure. The ROD requires implementing land use restrictions to protect the remedy from physical disturbance and prohibit residential use of land parcels where such use is inconsistent with the constructed remedy (such land use restrictions shall be implemented as land use covenants under California civil code, Section 1471 (c)).

- **LCC from the Mine to Greenhorn Road** – Excavate the tailings and arsenic-contaminated sediment that has accumulated along the LCC drainage and surrounding floodplain as far south as Greenhorn Road; consolidate these materials under the tailings pile cap on the mine property; and regrade the excavated areas. Following remedy implementation, this downstream area will not require land use restrictions and is available for any future use.

Explanation of Significant Differences

An Explanation of Significant Differences was prepared to memorialize charges in the remedy required at the Lower Rental residence and surrounding area. The ROD called for excavating contaminated soils from around the Lower Rental residence, consolidating the contaminated materials under the tailings pile cap and returning the parcel to residential use. A soil sampling program was conducted around the Lower Rental residence as part of the remedial design process. The sampling indicated that the lateral and vertical extent of arsenic contamination was much larger than previous data had indicated. The depth and areal extent of the contaminated soil surrounding the Lower Rental residence made it technically impracticable to remove the contaminated materials and maintain the property in residential use. Instead, EPA determined that the area should be addressed consistent with other waste rock/tailings impacted areas and be capped and revegetated. Capping the area necessitated demolition of the Lower Rental residence. This remedy component is referred to as the Lower Rental Residence Area in the remainder of the RA Report.

Remedial Design

Remedial design activities began in May 2005. A 30 percent design submittal was completed in July 2005 followed by a pre-final design submittal in November 2005. Following resolution of agency comments, the final design was completed in February 2006 and approved in March 2006. The construction bid process was initiated during February 2006 and completed in April 2006 with the selection of a construction contractor.

The remedial design addressed the following components:

- Mine buildings
- Waste rock pile
- Tailings pile cap
- Rock buttress
- LCC channel and smaller drainage channels
- Lower rental residence area
- LCC downstream of the mine (Tensy Lane area)
- On-site source of clean borrow soil

Mine Buildings – Soil and wastes inside of the mill and cyanide buildings were highly contaminated with arsenic and were, therefore, designated for removal from the buildings. Material excavated from the buildings was to be analyzed and the results compared to California soluble threshold limit concentrations (STLC) and USEPA toxicity characteristic leaching procedure (TCLP) values. Depending on the laboratory results, the material would be either consolidated with the tailings for long-term management (if it meets STLC and TCLP limits) or disposed of at an appropriate offsite facility.

Surface soil in the immediate vicinity of the mill, assay, and cyanide buildings impacted by historic processing activities was to be excavated and consolidated in the tailings pile. Any water present in the sumps in the mill and cyanide buildings was to be removed and the sumps filled with concrete.

Physical features that remain from former processing activities, including tanks and vats were planned to be removed and disposed of. Larger items were to be left in place after removal of any loose debris or accumulated solids. The handful of smaller storage buildings located in the Mine Area OU that contain varying amounts of household and construction materials plus miscellaneous trash/debris were to be left undisturbed during the remedy implementation.

Waste Rock Pile – Stockpiled waste rock areas were to be graded to facilitate runoff and reduce surface-water infiltration. The maximum design slope of the graded main waste rock pile was 3 to 1. Following grading, the waste rock piles were to be covered with 12 to 18 inches of soil and vegetated to further reduce infiltration and minimize potential disturbance by human activities. The design called for the sloped areas to receive 18 inches of soil and specific flatter areas near the mine buildings and structures 12 inches of soil.

Surface-water diversions were included above the mine shaft and upper end of the waste rock piles to reduce flow of surface water into the waste rock and shaft.

Tailings Pile Cap – The tailings pile cap was designed as a low-permeability, engineered cover system intended to significantly reduce infiltration into the tailings pile. The specific minimum requirements for the cap were defined in the ROD.

The tailings pile was to be graded to slopes of 4:1 or flatter prior to placement of the cap, with the grading and stormwater controls sufficient to ensure that standing water does not accumulate on the cap. The base component of the tailings pile cap design consisted of a nonwoven geotextile liner placed on top of the graded tailings and waste rock. The geotextile liner forms a base for placement of the geomembrane liner and replaces the 6-inch-thick sand layer listed in the ROD as a component of the tailings cap. The second component of the cap is the 60-mil linear low-density polyethylene (LLDPE) liner placed on top of the nonwoven geotextile layer. Based on manufacturer's specifications, the LLDPE material to be used in the tailings pile cap would have a permeability of about 1×10^{-12} centimeters per second (cm/sec). Along the borders of the tailings pile cap, the LLDPE thickness was to be increased to 80-mil to account for the heavier load during construction of the perimeter channels and for long-term use of the border area for a maintenance access road. Above the LLDPE is another nonwoven geotextile/geodrain layer that forms a base for placement of the 18-inch soil layer that represents the top of the tailings cap. The soil layer was to be vegetated to provide erosion control.

All soil contaminated with arsenic in excess of 20 mg/kg near the tailing pile and waste rock areas was planned to be excavated and consolidated under the tailings pile cap.

Rock Buttress – A rock buttress was planned at the downhill end of the tailings pile to contain tailings and waste rock occupying the LCC canyon bottom. In accordance with the ROD, the rock buttress was designed to achieve internal and external seismic stability under static and pseudo-static conditions. Stability criteria include a factor of safety greater than 1.5 under static conditions and 1.1 under pseudo-static conditions. The final design submittal included details of the analysis conducted to evaluate stability of the rock buttress design. The slope stability analysis was based on a Maximum Credible Earthquake for the site of magnitude 6.5, which results in a ground acceleration of 0.5 g.

The design called for the buttress to be placed directly on bedrock, after removing the log dam remnants, tailings located within and downstream of the buttress footprint. To reduce remedy cost, the buttress was to be constructed of onsite waste rock material screened to remove the fine-grained components and smaller rocks. The contaminated materials excavated from the buttress excavation were to be placed beneath the tailings pile cap.

To prevent seepage through the buttress, an 80-mil LLDPE liner, bracketed above and below by a non-woven geotextile layer, was included on the upstream face of the buttress. A 4-foot-wide chimney drain, equipped with a 6-inch-diameter perforated high-density polyethylene (HDPE) collector pipe was included on the upstream side of the buttress. The sand-filled chimney drain was intended to collect seepage from the upstream tailings and waste rock and provide a dewatered condition directly upstream of the buttress. The chimney drain was designed with a 12-inch-diameter outlet pipe that conveys the collected water to the downstream side of the buttress.

Little Clipper Creek Channel and Smaller Drainage Channels – The engineered LCC channel called for along the eastern edge of the tailings and waste rock pile extended from upstream of any waste rock/tailings to beyond the rock buttress and was sized to handle the estimated return flow from a 100-year storm event. All of the smaller channels to be constructed in the Mine Area OU were also designed to handle a 100-year storm event. The hydraulic analysis for the LCC channel and all of the smaller drainage channels is included in the final design submittal.

All of the channels located adjacent to or on top of tailings or waste rock were to be lined with 80-mil LLDPE liner to limit infiltration. For the channels surrounding the tailings pile cap, this underlying liner was to be joined with the tailings cap liner. The design at the upstream end of the LCC channel included excavation and keying into bedrock to allow capture of subsurface flow through the upper alluvial layer and minimize the possibility of continued infiltration of surface water into the waste rock. An Arizona-style crossing was included in the reach of the engineered LCC channel just above the rock buttress to provide access to the eastern portion of the mine property. A second Arizona crossing was included in the NW channel where it crosses the north end of the tailings pile to provide access to LCC upstream of the mine.

Lower Rental Residence Area – The lower mine residence was located west of the tailings pile and to the south of the waste rock pile. The contaminated areas surrounding the residence were to be addressed in essentially the same fashion as the waste rock pile (described above), including placement of an 18-inch thick vegetative soil cap in the areas with slopes flatter than 3:1. The vegetative soil cap was intended to limit direct contact with the contaminated materials, minimize erosion of this material and reduce infiltration into the contaminated material. In the areas where the slopes were steeper than 3:1, the vegetative soil cap was replaced by a rock mulch cover approximately 1 foot thick. The rock mulch cover provides erosion control and reduces possible contact with contaminated materials. The rock mulch was to be placed after the brush and organic debris was cleared from the slopes.

Little Clipper Creek Downstream of the Mine – The design called for sediment/soil contaminated with arsenic in excess of 25 mg/kg in or adjacent to the LCC channel between the log dam and Greenhorn Road to be excavated and the excavated material to be placed under the tailings pile cap. Following excavation, the native LCC stream channel was to be restored and the area graded to ensure runoff towards the stream with no areas of ponding. Confirmation soil sampling conducted concurrent with the excavation efforts was to be used to verify that the full lateral and vertical extent of contamination had been addressed.

On-site Source of Clean Borrow Soil – During the remedial design process and implementation of the OU4 remedy, it became apparent that the availability of acceptable off-site borrow sources in the local area was very limited and the cost of these materials was high. A sampling program was implemented to evaluate the arsenic concentrations present in on-site soils located in the forested areas away from the historic mining operations. Several areas were identified that had low arsenic concentrations. One area appeared to be of adequate size to generate the volume of borrow soil needed for remedy construction. USEPA made arrangements with the property owner to allow use of the area. Despite the need for extensive logging, brush clearing and excavation to access the on-site borrow source, the change resulted in significant cost savings (more than $600,000) and eliminated hundreds of truck trips to and from the site that would have been needed to import the borrow soil.

III. CONSTRUCTION ACTIVITIES

Mobilization for construction activities was initiated in late May 2006. Site preparatory work included clearing and grubbing of vegetation, which began almost immediately. Primary construction was completed by January 2007 when work was halted for the winter. After January 2007, the work remaining included installation of portions of the vegetative cap in the western portion of the waste rock area, the lower mine residence area and the southwestern segment of the tailings pile cap; final grading and cleanup in the onsite borrow area; backfilling and LCC reconstruction in the Tensy Lane area and minor punch list items. The bulk of the outstanding work was completed in June through August 2007, with final LCC enhancements and revegetation work in the Tensy Lane area completed in December 2007.

The major components of the remedy construction include the following, each of which is summarized below:

- Mine buildings
- Mine storage buildings area
- Waste rock pile
- Tailings pile cap
- Rock buttress
- LCC channel and smaller drainage channels
- Lower rental residence area
- LCC downstream of the mine (Tensy Lane area)

The final record drawings prepared by CH2M HILL and dated March 2008 depict the specific as-built details of the constructed remedy (see Appendix A for key as-built drawings).

Mine Buildings – The first step in implementing the remedy in the historic mill and cyanide buildings was to evaluate potential safety concerns within the buildings, delineate areas to be avoided and provide supplemental shoring as necessary. All soil, waste rock and other processing waste remaining in the buildings was excavated using small equipment (e.g., Bobcats) and hand shoveling. Larger wood and metal debris was placed in the lower portion of the cyanide building. All of the material removed from the building was stockpiled awaiting waste characterization. The soil excavated from the two high concentrations areas found up on the ridge to the south of the mine buildings area was also placed in this stockpile. The waste characterization results confirmed the high levels of arsenic in the materials. Because the extract concentrations exceeded California STLC values (they were below USEPA TCLP limits), USEPA and DTSC determined that it should be shipped offsite for disposal. A total of 2,108 tons of material were transported under appropriate manifests to Chemical Waste Management's Kettleman Hills Landfill. The limited volume of water remaining in the sumps in the mill and cyanide buildings was mixed into the concrete used to fill the sumps rather than hauling it offsite for disposal.

The upper 12 inches of soil in the immediate vicinity of the mill, assay, and cyanide buildings was excavated and consolidated into the tailings pile. The excavated soil was replaced with 12 inches of clean backfill materials. The large vats located immediately behind the cyanide building were completely dismantled and the upper 12 inches of soil surrounding the tank pads was removed similar to the other areas surrounding the buildings. The bench just above and east of the cyanide building that contained an additional two tank pads was handled in the same way.

The entire area surrounding the historic mill, cyanide and assay buildings, as well as the mine shaft, was enclosed with a 6-foot tall, barbed-wire topped chain link fence with access restricted to a single, locked gate.

Mine Storage Buildings Area – Several abandoned vehicles, a mobile home and other types of debris, located in the vicinity of some of the mine storage buildings, where placement of a vegetative cap was required were moved. The vehicles were provided to an auto salvage company and transported offsite. The remainder materials were disposed offsite as standard construction debris. The other primary activity required prior to placement of the vegetative cap was clearing and grubbing of existing vegetation. In the areas surrounding the mine storage buildings, all larger trees (with a diameter greater than approximately 4 inches) were left in place and all smaller trees and brush were removed.

All of the flat benches around the mine storage buildings were covered with a 12-inch thick vegetative cap and sprayed with hydroseed to accelerate growth of vegetation. The sloped areas were covered with an approximately 12-inch thick rock mulch layer. In selected areas, the rock mulch was replaced by a clay-rock mulch created from materials generated in the borrow area that were not suitable for use in the vegetative caps.

There were several minor changes made to the remedy in the mine storage building area based on field conditions or contractor recommendations, including:

- The pipe connected to the discharge line from the property owner's pond was extended all the way to the existing drainage channel running along the mine access road, eliminating the planned SW-1 channel.
- Another small drainage channel, G-4, was not constructed because the drainage patterns and existing topography in the forested areas around the lowest mine storage building were different than expected, eliminating the need for this channel.
- The area surrounding the lowest mine storage building was expected to be flat enough to warrant a vegetative cap. However, because the actual extent of level ground was very small, the entire area was covered by rock mulch.
- The extent of the vegetative cap and rock mulch covered area between the mine shaft and the mine storage buildings was reduced to account for difficulties in accessing portions of this area.

These minor changes did not constitute modifications of the remedy and did not change or impact the remedial action objectives.

Waste Rock Pile – To initiate construction in the stockpiled waste rock areas, all vegetation was removed during clearing and grubbing activities. This included removal of a few heavily forested pockets with large trees.

All waste rock areas requiring grading to facilitate final slopes were run through a screening process to remove the finer-grained material and generate rock for buttress construction. Because the waste rock being screened contained higher percentages of fine-grained materials than planned and in some of the waste rock areas soil was encountered shallower than expected, less material was generated for buttress construction than planned. To generate additional materials, more areas of waste rock than had originally been planned were run through the screening process. Ultimately, an area of waste rock located immediately south of the mine shaft was excavated, generating almost 7,400 cubic yards of material that was used in buttress construction without screening. Additional details on buttress construction are provided below.

The former rental residence (known as the upper rental residence) located at the far western edge of the waste rock area was demolished as planned. The remnants of the house were shipped offsite for disposal as normal construction debris.

Following final grading to ensure that the slope of the main waste rock pile was less than the 3 to 1 grade called for in the design, the waste rock piles were covered with 18 inches of clean borrow soil and hydroseed was applied to accelerate revegetation. A series of photographs illustrating waste rock pile cover construction are included in Appendix A.

At the base of the main waste rock pile, a ditch, diversion box and collection sump were constructed to capture the mine discharge draining from the collapsed adit. Excavation efforts for dewatering uncovered additional components of the former adit (connected support timbers and railroad tracks), but a well-defined base was not apparent. A subgrade French drain was added to enhance flow of adit discharge into the surface drainage ditch.

Tailings Pile Cap – The tailings pile cap construction proceeded generally according to plan. Initially, clearing and grubbing was completed in the area where seeps had been occurring and along the margins of the area to be capped where perimeter ditches were required. In addition, the buried, large-diameter HDPE pipe installed during the original USEPA emergency removal action was removed. Several monitoring wells and piezometers installed through the tailings pile during the remedial investigation were abandoned as planned. One piezometer (named 5PZ-1) was kept and its casing extended to match final tailings pile grade. Originally, two deeper monitoring wells located just north of the rock buttress were also going to be kept for use as long-term groundwater monitoring. However, the size of the buttress excavation was expanded for construction safety and these monitoring wells had to be abandoned.

Prior to construction of the engineered cap, tailings, contaminated soil and other contaminated materials from around the site were consolidated into the tailing pile. The volume of material placed in the tailings pile was considerably larger than planned. The three primary reasons for the increased soil were:

1) Buttress excavation materials – The depth to bedrock and shape of the native soils at the base of the rock buttress excavation required that more materials be excavated that originally planned. Further, because the tailings pile above the buttress excavation was unstable, a large hole was needed to make it safe for construction. Just over 11,000 cubic yards of additional materials (beyond the planned volume of about 22,000 cubic yards) were generated during buttress excavation and placed in the tailings pile

2) Waste rock screening materials – As described above, the percentage of fine-grained materials in the screened waste rock was much higher than anticipated. Almost 10,600 cubic yards of these additional fine-grained materials were placed in the tailings pile.

3) LCC in the Tensy Lane area – As is described in detail below, the volume of tailings and contaminated soil excavated from the Tensy Lane area and placed in the tailings pile was many times larger than originally planned (17,800 cubic yards compared to planned volume of just over 3,800 cubic yards).

In addition to the extra materials, other activities that impacted the final footprint and grades of the tailings pile cap included a westward expansion of a portion of the cap into an area where additional waste rock was removed for processing and the lowering of the final buttress elevation by 5 feet (described below in the Rock Buttress section).

All materials generated during excavation of the drainages ditches adjacent to the tailings pile and through the waste rock and mine storage building areas were also placed in the tailings pile. The small veneer of soil contaminated with arsenic along the slopes adjacent to the tailings pile was excavated and consolidated under the tailings pile cap.

Following placement of all materials, the tailings pile was graded to slopes of 4:1 or flatter and the top surface prepared for placement of the cap. The first layer of the engineered cap is a nonwoven geotextile liner. The LLDPE geomembrane liner was placed on the geotextile. The LLDPE was a 60-mil thick material over most of the cap. However, thicker 80-mil material was placed beneath the perimeter ditches and along the first 15 feet of the cap perimeter adjacent to the ditches. Above the LLDPE is another nonwoven geotextile layer. Finally, an 18-inch soil layer was placed and vegetated with hydroseed. Extensive quality assurance/quality control (QA/QC) testing was performed on the geomembrane liner including off-site materials testing, non-destructive field testing of every seam, off-site destructive testing of selected seams and material testing at an off-site laboratory testing. A series of photographs illustrating the tailings pile cap construction process are included in Appendix A.

Small wedges of tailings to the east and west of the main tailings pile were also capped in the same manner as the main pile. Following completion of the tailings pile cap, settlement monuments were installed in selected areas to track any long-term settlement of the tailings pile.

Rock Buttress – Buttress construction started with clearing vegetation and removing the large trees located on either side of the historic log dam and constructing a pipeline to divert the adit drainage around the construction area. The log dam was then dismantled and the timbers placed in the tailings pile.

Excavation of the tailings to create space for the rock buttress was challenging and time consuming. The saturated tailings were unstable and difficult to excavate. This resulted in the need to expand the size of the excavation to provide adequate room to safely construct the buttress. In addition, the native materials encountered on the western side of the excavation were not as stable as desired and seeps were present, requiring adjustments to the extent of buttress excavation and the buttress construction process. As described above, the waste rock screening process did not produce as much screened waste rock for buttress construction as expected. This material limitation also contributed to changes in the buttress design and the construction process.

In response to the observed field conditions, the buttress design elevation was lowered by 5 feet (to 2,745 feet above mean sea level) to reduce the size of the buttress and the alignment was shifted slightly. These changes also resulted in minor changes to the alignment of the LCC channel and spillway on eastern side of the buttress and the G3 channel on the western side of the buttress. Also, a portion of the buttress was constructed of unscreened waste rock. Supplemental seismic calculations were completed to ensure that the revised design and construction materials still met the seismic stability requirements outlined in the ROD.

The base of the rock buttress was placed directly on bedrock of the historic LCC canyon at an elevation ranging from approximately 2,706 feet at the upstream northern end to 2,694 at the downstream end. A 12-inch-diameter drain pipe, connected to the chimney on the upstream side of the buttress, was installed at the base of the buttress and encased in concrete. The eastern edge of the buttress was placed against the bedrock canyon wall. The western edge was placed on native soils. To address the potential for erosion caused by the seeps in the lower western wall, a layer of geotextile fabric was placed along the lower 15- to 22-feet of the western edge of the buttress. Per the original design, screened waste rock was used to construct the buttress from the base up to an elevation of 2,716 feet. At that point, to account for the limited volume of screened rock available, unscreened waste rock was used except for a 5-foot-thick wedge of screened waste rock on the downstream face of the buttress. At the 2,716 foot elevation, a layer of geotextile fabric was placed to inhibit potential downward migration of the finer-grained fraction of the unscreened waste rock. At elevation 2,737, buttress construction reverted back to use of only screened waste rock because it was determined that sufficient screened rock remained in the stockpile to complete the buttress up to 2,745. Throughout buttress construction, each lift of 6- to 8-inches was compacted to an in-place density of approximately 95%.

An 80-mil LLDPE liner bracketed above and below by a non-woven geotextile layer, was placed on the upstream face of the buttress. The vertical, 4-foot-wide, chimney drain, equipped with a 6-inch-diameter perforated HDPE collector pipe was installed at the upstream toe of the buttress. The chimney drain was constructed in lifts approximately 1-foot-thick with the fine-grained materials from waste rock screening placed as backfill on either side of the chimney drain. A piezometer was placed in the sump located at the base of the chimney drain to monitor liquid levels and ensure that water is draining through the buttress and not accumulating in the sump.

Once the buttress was completed to the target elevation, a concrete spillway was constructed near the eastern edge to transmit LCC flow over the buttress. An energy dissipater comprised of large rocks was constructed at the base of the spillway to limit erosion. Settlement monuments were installed across the top of the buttress and on the buttress face to track any long-term movement of the buttress. A series of photographs illustrating rock buttress construction are included in Appendix A.

Little Clipper Creek Channel and Smaller Drainage Channels – The engineered LCC channel was installed starting upstream of the waste rock/tailing pile, running along the eastern edge of the tailings pile and extending to the rock buttress. Per the design, the channel was constructed to handle the return flow from a 100-year storm event using rip rap bedding and rip rap rock imported from offsite. The upstream end of the LCC channel includes a large collection apron underlain by 80-mil LLDPE liner anchored into the bedrock beneath the channel. The entire length of the channel is lined with 80-mil liner that is connected to the tailings cap liner. The downstream end of the LCC channel just above the buttress includes an Arizona-style crossing to allow vehicle access to the eastern portions of the mine property. A series of photographs showing the LCC channel construction process are included in Appendix A.

All of the smaller drainage channels constructed in the Mine Area OU were constructed in a similar manner as the LCC channel except that the two channels located away from the waste rock and tailings areas (the NW1 channel and most of the NW channel) were not lined with the LLDPE liner. The NW channel just above the confluence with LCC includes an Arizona-style crossing to allow vehicle access to the LCC stream gauging station above the remedy area.

Lower Rental Residence Area – Prior to demolition of the lower rental residence a number of appliances and a propane tank were removed and stockpiled onsite for future disposal. The debris from demolition of the house and two small garages and any materials remaining stored in the buildings was transported offsite for disposal as construction debris.

The clearing and grubbing of the lower mine residence area included removal of all brush and smaller trees (4-inch diameter and smaller). Larger trees were left in place. The slopes on either side of the small drainage separating the residence area from the lower mine storage building and the tailings pile were covered with an approximately 1-foot-thick layer of rock mulch imported from offsite or clay-rock mulch generated from the onsite borrow area.

The top deck of the lower residence area was covered with an 18-inch-thick soil cap. Because the construction trailers were located in the lower mine residence area, installation of this soil cap was one of the last construction activities completed. The 18-inch cap was comprised primarily of clay-rock mulch from the borrow area because the clean soil supply had been exhausted. The purpose of the cap in the lower residence area is primarily to inhibit erosion of and direct contact with contaminated materials rather than limiting infiltration so this clay-rock mulch material was deemed acceptable.

Also, the G5 perimeter drainage ditch that had been planned for the lower mine residence area was eliminated because the drainage patterns along the mine access road and across the top of the mine residence area made it unnecessary.

Little Clipper Creek Downstream of the Mine (Tensy Lane Area) – Prior to any construction activities in the Tensy Lane area, the 8-foot tall deer fence in the work area south of the Tensy Lane crossing had to be removed. The property owner requested that the new fence be installed on the west side of LCC, eliminating the need to replace the full extent of the deer fence post-construction. Also, the mine discharge flowing in LCC was removed from the channel and piped downstream, nearly to Greenhorn Road beyond the construction area.

Per the design, the initial construction activities completed in the Tensy Lane area included removal of 2 to 3 feet of contaminated soil/sediment from the LCC stream channel and the adjacent flood plain deposition areas and transport of the contaminated materials to the tailings pile. However, confirmation samples collected at the base of the excavated areas consistently contained elevated arsenic concentrations. Therefore, an additional ~two feet of material was removed. Contaminated materials were still apparent after 4 to 5 feet of excavation. The trees in the heavily forested area north of Tensy Lane were preventing deeper excavation and large portions of the roots had already been exposed. To ensure thorough remediation on these residential properties south of the mine, USEPA decided to proceed with removal of all tailings and contaminated soil/sediment. This required removal of many large trees. After logging and limb removal, the unimpacted portions of the trees (i.e., everything above the root balls) were transported offsite for lumber milling. Once the area was cleared, soil removal resumed with much of the area excavated to bedrock, particularly on the north side of the Tensy Lane crossing. The deepest portion of the excavation was immediately north of where Tensy Lane crosses LCC. At this location, the base of the excavation was almost 15 feet below the culvert that conveys LCC beneath Tensy Lane. It should be noted that some tailings remain beneath the Tensy Lane where it crosses the LCC drainage, because additional excavation would have compromised road stability. The design called for removal of 3,830 cubic yards of material, but the final volume was nearly 17,800 cubic yards. During the removal activities, the excavated material was screened to separate out rocks larger than 3- to 4-inches in diameter prior to transport back to the tailings pile. These rocks were stockpiled for subsequent use in reconstruction of the LCC channel and erosion control.

After evaluating various options for backfill and restoration of the area along LCC and discussing options with the three property owners, it was determined that sufficient backfill would be imported to restore LCC approximately to its original alignment and to make use of the existing culvert under Tensy Lane. This option required import and placement of 7,600 cubic yards of backfill. Note that although the LCC channel was replaced near its original alignment, the overall topography and grade in this area is significantly different than prior to remedy construction. This work could not be completed prior to demobilization in January 2007 and was postponed until final construction activities resumed in June 2007.

Following backfilling and initial LCC reconstruction, a geomorphologist provided recommendations on stream channel enhancements to provide a more natural appearance and accelerate habitat restoration. In addition to hydroseeding, a select number of shrubs and trees were planted on each property to enhance revegetation of the Tensy Lane area. Gates and short fence segments were installed to limit access into the reconstructed area.

IV. CHRONOLOGY OF EVENTS

Table 1 shows the chronology of events from signing of the Mine Area OU ROD through the final RA inspection.

Table 1
Chronology of Events
Lava Cap Mine Area OU Remedial Action Report

Date	Event
September 28, 2004	ROD signed defining the selected remedy for the Mine Area OU
January 2005	Remedial Design (RD) initiated for the Mine Area Residences OU remedy (a portion of the Mine Area OU was split off and became the Mine Area Residences OU)
May 2005	RD initiated for the Mine Area OU remedy
February 2006	Final RD documents submitted to USEPA
March 2006	USEPA approved the remedial design for the Mine Area OU remedy
April 2006	RA construction contractor selected.
May 2006	Mine Area OU RA mobilization; construction initiated.
August 2006	Initiate placement of the engineered tailings pile cap materials.
December 2006	Complete installation of the tailings pile cap LLDPE liner.
January 2007	Majority of OU RA construction completed. Work halted because winter weather severely inhibited construction progress.
June-August 2007	Primary Mine Area OU RA construction completed, including the tailings pile cap.
October-November 2007	Final Mine Area OU construction complete with LCC reconstruction and revegetation along Tensy Lane.
2008 to Present	Routine O&M including periodic site inspections, streamflow gauging, chimney drain water level monitoring, buttress drain monitoring, settlement monument surveying, minor erosional repairs, and vegetation removal from the G3 channel.
November 2008	Repair buttress spillway concrete cracks/spalling.
February 8, 2010	USEPA and the State conduct final inspection of the RA

TABLE 2

Mine Building Waste Materials - Summary of STLC and TCLP Analyses

Lava Cap Mine Area OU RA Report

Location	Sample Description	Total Concentration (mg/kg)			STLC Concentration (mg/L)			TCLP Concentration (mg/L)		
		Arsenic	Lead	Cadmiuim	Arsenic	Lead	Cadmium	Arsenic	Lead	Cadmium
	STLC and TCLP limits:				**5 mg/L**	**5 mg/L**	**1 mg/L**	**5 mg/L**	**5 mg/L**	**1 mg/L**
Mill Building	Debris adjacent to mid-level tank pads	3,500	100	1.9	100	2.8	0.064	0.22	ND	0.02
Mill Building	Middle of upper level - soil/tailings pile	7,400	1,300	13	66.6	25.3	0.31	4.9	0.39	0.13
Mill Building	Near access door- ~15' from east end	2,600	50	1.1	48	1.2	ND	ND	ND	0.006
Cyanide Building	Soil accumulated in upper level drain	2,700	160	2.7	24.4	2.2	0.068	0.27	ND	0.009
Cyanide Building	Lower level highly-contaminated, discolored material	37,000	810	43	839	1.7	1.1	3.2	ND	0.27
Cyanide Building	Soil south of northwestern tank foundations	1,200	99	2.2	21.8	4.7	0.086	0.9	ND	0.02
Cyanide Building	Large soil pile in western corner	2,800	130	3.1	65.9	12.7	0.15	0.24	ND	0.02
Cyanide Building	Soil accumulated on southern tank pad	1,100	24	1.1	1.6	1.0	0.0089	ND	ND	0.005
Cyanide Building	Room at south end (behind large roller)	4,600	180	18	99	10.0	1.7	ND	ND	0.35
Cyanide Building	Just north of large roller at south end	1,200	28	0.57	27	1.4	ND	ND	ND	ND
Cyanide Building	West side of building, along access road	1,300	48	1.1	21	1.6	ND	ND	ND	0.008
Cyanide Building	Middle of lower level, east of corner pile	1,600	70	1.5	27	2.0	ND	ND	ND	0.01
Ridge East of Buildings	Middle of northern excavation area[a]	24,000	1,700	1.7	1,300	2.1	ND	0.53	ND	ND

Notes: Except as noted below, only arsenic, lead and cadmium exceeded STLC or TCLP criteria.

[a] This sample also had antimony at 22.0 mg/L, compared to the STLC limit of 15 mg/L. The total antimony was 120 mg/kg.

Table 3
Mine Area OU Soil - Confirmation Sampling Results
Lava Cap Mine Area OU Remedial Action Report

Sample ID	Location	Final Arsenic Concentration (mg/kg)
Slopes Adjacent to the Mine Area Drainage Ditches around the Waste Rock and Tailings Piles		
LCC-001	Slope east of LCC- near Station 17+50	29
LCC-002	Slope east of LCC- near Station 16+75	33
LCC-003	Slope east of LCC- near Station 16+00	85
LCC-005	Slope east of LCC- near Station 14+50	32
LCC-006	Slope east of LCC- near Station 13+75	19
LCC-007	Slope east of LCC- near Station 13+00	62
LCC-008	Slope east of LCC- near Station 12+00	66
LCC-009	Slope east of LCC- near Station 15+25	23
G1C-001	Slope west of G1 channel- near Station 10+75	170
G1C-002	Slope west of G1 channel- near Station 11+25	110
NWC-001	Slope east of NW channel- near Station 19+25	140
NWC-002	Slope east of NW channel- near Station 18+25	18
NWC-003	Slope east of NW channel- near Station 16+00	13
G6C-001	Slope south of G6 channel- near Station 11+75	68
G6C-002	Slope south of G6 channel- near Station 10+75	48
Excavation Areas on the Ridge Above and East of the Mine Buildings		
Upper-001	Upper excavation area	18
Upper-002	Upper excavation area	33
Lower-003	Floor of lower excavation area	58
Lower-004	West side of bedrock berm around lower area	500
Lower-004a	Deeper into bedrock at Lower-004 location	68
Lower-005	East side of bedrock berm around lower area	64
Lower-006	West side of bedrock berm around lower area	570
Lower-007	West side of bedrock berm around lower area	88
Lower-008	West side of bedrock berm around lower area	270
LCC Drainage in the Tensy Lane Area		
TNSW-06	North of Tensy Lane, east slope about 80' north of culvert	130
TNSW-07	North of Tensy Lane, east slope about 180' north of culvert	37
TNSW-08	North of Tensy Lane, east slopw about 280' north of culvert	15
TNSW-09	North of Tensy Lane, east slope about 108' north of culvert	140
TNSW-10	North of Tensy Lane, east slope about 196' north of culvert	390
TNSW-11	North of Tensy Lane, west slope about 162' north of culvert	71
TNSW-12	North of Tensy Lane, west slope about 80' north of culvert	24
TNSW-13	North of Tensy Lane, west slope near mine property fence	15
TNSW-14	North of Tensy Lane, east slope near mine property fence	72
TNSW-15	North of Tensy Lane, west slope about 375' north of culvert	78
TNSW-16	North of Tensy Lane, east slope about 425' north of culvert	120
TNSW-17	North of Tensy Lane, west slope about 340' north of culvert	76
TNSW-18	North of Tensy Lane, east slope about 300' north of culvert	49
TNSW-19	North of Tensy Lane, west slope about 280' north of culvert	86
TLS-14	South of Tensy Lane, floor of excavation	55
TLS-15	South of Tensy Lane, floor of excavation	56
TLS-16	South of Tensy Lane, east slope at southeast corner	63
TLS-17	South of Tensy Lane, west slope downstream of pond	65
TLS-18	South of Tensy Lane, west slope about 125' south of culvert	100

[Yellow highlight]: > 127 mg/kg which is the peak concentration detected in weathered bedrock on Mine Area parcel 39-160-21.

V. PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

This section summarizes the performance standards used to ensure that the Mine Area OU remedy was constructed as required by the ROD and the construction quality activities implemented to verify that construction was conducted in accordance with the remedial design documents.

Performance Standards

Overall, the engineered tailings pile cap and vegetative caps installed as part of the Mine Area OU remedy have been performing as intended. There have not been any breaches of the caps or excessive erosion or settlement observed in the capped areas. The mine wastes remain under control.

The primary performance standards for the Mine Area OU are as follows:

- Construct the physical components of the remedy (e.g., waste rock and tailings pile caps, LCC and other drainage channels, rock buttress) in accordance with the approved design.
- Confirm that the rock buttress meets seismic stability requirements.
- Record deed restrictions that prevent inappropriate uses of the property and prevent intrusive activities that interfere with the constructed remedy.
- Conduct waste characterization analyses on the highly-contaminated materials removed from in and around the mine buildings and in selected excavation areas. Transport any materials that exceed hazardous waste characteristic criteria (i.e., California STLC and USEPA TCLP) offsite to an appropriate disposal facility.
- Compare post-excavation confirmation sample results with background data sets to ensure that cleanup has been achieved.

The work conducted to confirm that the remedy was constructed as designed is summarized below in the Construction QA/QC section. The supplemental calculations conducted to confirm that the modified rock buttress still met the seismic stability criteria specified in the ROD are included as Appendix B to this RA Report. USEPA is still in the process of working with DTSC and the property owner to make sure that the appropriate deed restrictions are recorded on the Mine Area OU parcels. The remaining two criteria, waste characterization and confirmation sampling, are summarized in this section.

Mine Building Area Waste Characterization – All of the soil/waste material removed from the mine buildings was temporarily stockpiled in the Mine Storage Buildings Area awaiting waste characterization results. The soil removed from the two small, highly contaminated areas discovered on the top of the ridge east of the mine buildings was also stockpiled awaiting characterization. Prior to excavation, a total of 12 representative samples were collected from the mill and cyanide buildings and one characterization sample was collected from the excavation areas on the ridge above the mine buildings. The results of waste characterization analyses, including total constituent concentrations as well as California STLC and USEPA TCLP extract concentrations are summarized in Table 2. The table only lists arsenic, lead and cadmium results because these are the only analytes that exceeded either of the characterization criteria. None of the 13 samples exceeded any of the TCLP limits. However, 12 of the 13 samples exceeded at least one STLC limit. Based on the results presented in Table 2, all of the stockpiled materials were transported offsite for disposal.

Confirmation Sampling – Post-excavation confirmation samples were collected in three primary areas: the slopes adjacent to the drainage channels surrounding the waste rock and tailings piles; the excavation areas along the ridge above the Mine Buildings; and the LCC drainage in the Tensy Lane area (Table 3). The performance criteria described in the ROD was to remove contaminated soil or sediment that exceeded USEPA's cleanup targets of 20 mg/kg (soil) or 25 mg/kg (sediment). These cleanup goals represent sitewide background conditions developed during the RI/FS. The background evaluations were based on samples of loose, organic surficial forest soils and of sediments accumulated in unimpacted drainage channels. However, in all three areas of the Mine Area OU remedy where post-excavation confirmation samples were collected, all surficial materials had been removed leaving only weathered bedrock at the ground surface. As was demonstrated during evaluation of parcel 39-160-21 (located immediately uphill from the Mine Area OU remedy areas) as part of the Mine Area Residences OU remedial design, the weathered bedrock in the mine area that has not been impacted by mining activities contains higher naturally-occurring arsenic concentration than the surface soils that were sampled as part of the background soil investigation. A Technical Memorandum titled *Main Residence Parcel – Evaluation of Arsenic in Soil*, *Lava Cap Mine Superfund Site*, dated September 16, 2005, summarizes these findings for mine area parcel 39-160-21. As described in the Technical Memorandum, the arsenic concentrations detected in the naturally-occurring weathered bedrock range from 9.2 to 127 mg/kg.

In areas where all surface soils had been removed, confirmation samples were collected from the weathered bedrock present at the ground surface. Because of the higher, naturally-occurring arsenic concentrations present in the weathered bedrock, these confirmation samples contained arsenic above EPA's target cleanup goals. Although the weathered bedrock does contain arsenic at higher concentrations than the cleanup goals, the concentrations are still much lower than the contaminated materials that had been present in the various areas prior to construction. Most of the confirmation sample arsenic results fall in the same concentration range (9.2 to 127 mg/kg- see Table 3) as were detected in the weathered bedrock on mine area parcel 39-160-21.

Slopes Adjacent to the Tailings Pile Cap and Mine Area Drainage Channels. Typically, arsenic concentrations in near surface samples of Lava Cap Mine tailings fall in the 400 to 800 mg/kg range with occasional samples exceeding 1,000 mg/kg. As part of remedy construction, the thin layer of surface soil present on the lower slopes adjacent to the drainage channels surrounding the tailings pile and waste rock area was removed (if any surface soil was present) and placed in the tailings pile. Confirmation samples were collected to confirm that no tailings remained on these lower slopes. As shown in Table 3, fifteen confirmation samples were collected on these weathered bedrock slopes with arsenic results ranging from 13 to 170 mg/kg. Although two of the samples collected towards the north end of the area (adjacent to the G1 and NW channels) contained arsenic above the range of weathered bedrock concentrations detected on parcel 39-160-21(9.2 to 127 mg/kg), it is likely that they are still representative of the range of arsenic concentrations present in the naturally-occurring weathered bedrock in the Mine Area OU. There is no evidence of residual mine waste contamination in these areas.

Excavation Areas on Ridge above Mine Buildings. Highly-contaminated materials were excavated from two relatively small areas along the ridge to the east of the mine buildings. Pre-excavation arsenic concentrations exceeded 20,000 mg/kg in some samples from these areas. As shown on Table 3, final confirmation sample results were 18 and 33 mg/kg in the smaller upper excavation area. In the lower area, a composite sample from the excavation floor had an arsenic concentration of 58 mg/kg. However, portions of the weathered bedrock walls surrounding the lower bermed area still contain elevated levels of arsenic (up to 570 mg/kg in one of 6 samples). However, close inspection of these bedrock walls does not provide any indication that mine wastes are present. It appears that historic mine operations in this area may have resulted in isolated impacts to the bedrock walls of the bermed area. It should be noted that the arsenic concentrations are much lower than those present in the native bedrock materials removed from the mine which typically exceed 1,000 mg/kg.

LCC Drainage in the Tensy Lane Area – North and South. Several rounds of sampling were conducted in the Tensy Lane area during remedy construction as the full vertical extent of contamination in this area was becoming clearer. Ultimately, on the north side of the Tensy Lane crossing, essentially all materials were removed down to solid, competent bedrock, except beneath and immediately adjacent to Tensy Lane itself. This rock material is challenging to sample and analyze. On the south side of Tensy Lane, excavation extended down to a weathered bedrock material similar to that found on the mine property. Because the excavation extended to bedrock and most of the areas along the bottom of the excavation were to be covered with backfill, the final confirmation sample collection focused on the sidewalls/upper slopes of the excavated areas that would remain exposed at the completion of construction. On the south side of the Tensy Lane crossing, arsenic concentrations in the five confirmation samples ranged from 55 to 100 mg/kg (Table 3). This falls within the range of naturally-occurring arsenic concentrations detected in weathered bedrock on mine area parcel 39-160-21 (9.2 to 127 mg/kg).

On the north side of Tensy Lane, fourteen confirmation samples were collected from the east and west sides of the LCC drainage excavation. The materials sampled included weathered bedrock and some more competent bedrock. There was one anomalous concentration of 390 mg/kg with the remaining results ranging from 15 to 140 mg/kg (Table 3), essentially consistent with the mine area parcel concentrations. The location with the anomalous 390 mg/kg is located along the eastern side of the excavation about 200 feet north of Tensy Lane. This sample was chipped directly from fairly competent bedrock forming the eastern wall of LCC drainage at this location. There is no indication of any residual mine impacts at this location. It appears that this area may represent an outcrop of a more mineralized bedrock zone.

Construction Quality Assurance/Quality Control

A comprehensive construction quality assurance/quality control (QA/QC) program was implemented throughout the RA. This included full-time inspection and management of all RA construction activities by CH2M HILL construction management staff. In addition, extensive material testing was completed in accordance with the approved Construction Quality Assurance Plan (CQAP) dated March 2006.

Inspection and Construction Management Activities. CH2M HILL inspection and construction management staff (typically a construction manager and either one or two inspectors) provided continuous oversight of all construction activities. Some of the key inspection and oversight activities included:

- Observing all phases of construction and documenting the contractor's compliance or noncompliance with the approved plans and specifications
- Reviewing contractor submittals, samples, and supporting test reports and verifying that all documentation required by the specifications was received and in compliance
- Verifying that all materials used in the construction were as specified or approved by the design team
- Documenting any damage to compacted layers or grades resulting from operation of construction equipment
- Confirming that all lines and grades were verified by the project surveyor before subsequent component construction
- Inspecting earthfill operations to verify that construction methods met specification requirements and that gradation, relative compaction and moisture content met specified targets
- Observing the geomembrane as it was deployed, recording any panel defects and disposition of the defects and observing collection of required geomembrane samples
- Observing and recording all seaming and seam testing of the geomembrane liner and verifying that these activities were performed as required by the specifications

All inspection activities were documented in detailed daily reports prepared by each inspector.

Material Testing. A testing program was implemented to verify that all components of the cover system were constructed in accordance with design specifications, plans and regulatory requirements. The testing procedures and frequencies are summarized below.

The testing program is divided into material acceptance tests and compliance tests. The contractor performed material acceptance tests before construction to verify that the materials proposed for use will comply with the specifications. Compliance testing was performed primarily by the contractor, although CH2M HILL also conducted compliance tests to confirm the contractor's work. Compliance testing was completed throughout construction, including during placement of all earth materials and installation of synthetic cover system materials to confirm that all remedy components were constructed in compliance with the project plans and specifications.

Key earth and synthetic material acceptance tests conducted included:

- Gradation- Gradation tests were completed on the chimney drain materials, buttress material, buttress backfill, rip-rap, rock mulch, and import soil to confirm that the materials met the requirements of the specifications.
- Chemical quality of import soil (although on-site borrow soil was used for most capping and backfill efforts, imported soil was used in the Tensy Lane area and for a very small percentage of the on-site work), including total petroleum hydrocarbons, pH and total metals.
- Interfacial shear tests were conducted between the LLDPE geomembrane and the nonwoven geotextile material and between the geotextile and the overlying vegetation layer.

Extensive compliance testing was conducted during placement of a wide variety of earth materials and during installation of the geomembrane liner. As noted above, compliance testing was conducted primarily by the construction contractor with periodic confirmation testing by CH2M HILL.

Key components of the compliance testing program included:

- In-place density tests and development of compaction curves were completed at the frequencies designated in the CQAP for soil placed for vegetative covers, buttress material, chimney drain material, buttress backfill, pipe base and backfill, tailings cap material beneath the liner, and backfill. Compaction requirements ranged from 85 to 95 percent relative compaction depending on the material and use.
- Geomembrane compliance testing was required for a list of thirteen different ASTM tests to document that actual geomembrane product supplied for the project met all of the detailed material specifications.
- Geomembrane seams were tested continuously by the installation subcontractor concurrent with installation. Testing included both nondestructive and destructive tests. The continuous, nondestructive seam testing consisted of either pressure testing or vacuum box testing (both methods were employed). Test seams were prepared each day or every 500 feet (at a minimum) and underwent peel and shear testing. For every 1,000 feet of seams, a sample was collected for off-site destructive seam testing by a third-party testing laboratory. In addition, CH2M HILL periodically collected concurrent seam samples for confirmation destructive testing at a separate off-site laboratory

The results of all acceptance and compliance tests, which demonstrate that the construction activities and materials complied with the project plans and specifications, are maintained in the project files.

Overall, the construction QA/QC program did not identify any substantial problems. Minor deviations, such as incomplete compaction, were quickly rectified and confirmation tests demonstrated compliance with specified requirements.

VI. FINAL INSPECTION AND CERTIFICATION

Inspections

USEPA and California DTSC representatives visited the site periodically throughout the construction process to observe construction activities, receive updates on construction progress, and discuss modifications required because of observed field conditions.

The final inspection of the remedial action occurred on February 8, 2010. USEPA, California DTSC and USEPA RA Contractor representatives were present. The representatives reviewed the as-built drawings, directly inspected all major RA components and completed a final inspection checklist that covered all aspects of the remedy. No significant issues were identified during the final inspection.

USEPA and California DTSC representatives concurred that construction of the remedy had been completed in accordance with the approved remedial design plans and specifications and the remedy was operating as intended. This conclusion was documented in February 22, 2010 letter from USEPA to California DTSC.

Health and Safety

Because of the elevated concentrations of arsenic, considered a known human carcinogen, present throughout the Mine Area OU, a comprehensive health and safety (H&S) program was implemented throughout the RA construction process to ensure safety of construction and oversight personnel and site visitors. This included routine use of appropriate personal protective equipment (PPE). In addition to routine construction PPE, such as safety boots, safety glasses, hearing protection (as necessary) and hard hats, Tyvek suits were used to minimize potential contact with arsenic and construction workers wore Level C respirators for dustier activities. Aggressive dust control was also implemented during all excavation of arsenic-contaminated materials to minimize potential worker exposure to airborne contaminants. No significant health and safety problems associated with potential exposure to arsenic were encountered during construction.

The large-scale excavation of saturated mine tailings required for buttress construction did pose significant construction H&S concerns. The instability of the tailings raised concerns with potential slope failure that could trap equipment and personnel and greatly increased the potential for equipment to tip over or get stuck in the tailings. To address these concerns, the size of the excavation was expanded to reduce the uphill slope, aggressive dewatering was implemented and large mats were brought in to provide a more stable work surface for excavation equipment.

The construction contractor had only one minor lost work time incident. A water truck rolled over causing minor damage to the vehicle when it ventured too far up a steep slope. In addition, there were several incidents of minor damage to construction vehicles, including cracked windshields, tire damage and small dents.

Institutional Controls

As noted above, because mine waste and contaminated materials were capped and left in place in the Mine Area OU, institutional controls are required to minimize potential future exposure to these materials. The ROD requires that land use restrictions be implemented to protect the remedy from physical disturbance and to prohibit residential use of land parcels where such use is inconsistent with the constructed remedy.

USEPA has been working with the property owner in an attempt to get deed restrictions recorded that will provide the appropriate protections for the remedy. However, to date, the property owner has not agreed to record the restrictions. USEPA will continue to work with California DTSC and the property owner to ensure that the necessary deed restrictions are recorded for the appropriate parcels in the Mine Area OU. Currently, the routine O&M inspections are used to confirm that the remedy components have not been compromised.

Operational and Functional Certification

Per USEPA guidance, a remedy becomes Operational and Functional (O&F) either one year after construction is complete, or when the remedy is determined concurrently by USEPA and the State to be functioning properly and performing as designed, whichever is earlier. As described above, the final inspection of the Mine Area OU RA was conducted on February 8, 2010 and no outstanding issues were identified indicating that construction is complete. Thus, the remedy will be deemed O&F on February 8, 2011.

VII. OPERATION AND MAINTENANCE

Operation and maintenance (O&M) requirements for this portion of the Mine Area OU remedy are fairly minimal. To date, O&M has consisted of regular inspections of the entire OU area and minor maintenance and repairs. Routine maintenance activities have included addressing minor erosion problems, typically by hand, clearing debris and vegetation from drainage channels, and performing access road maintenance.

In November 2008, some concrete repair was required at the top of the buttress spillway to address cracks and accelerated deterioration of the concrete at the joint between the sloped spillway walls and the flat bottom.

VIII. SUMMARY OF PROJECT COSTS

Table 4 provides a summary of the capital costs incurred to implement the RA. These costs are compared to the estimated remedy costs from the ROD.

Table 4
Cost Summary
Lava Cap Mine Area OU Remedial Action Report

Cost Item	ROD Estimate (2004 Dollars)	Adjusted ROD Estimate (2006 Dollars)[1]	Actual Final Cost (2006 Dollars)
RA Capital Cost	$4,900,000	$5,400,000	$7,900,000
Post RA Annual O&M Cost	$38,000	$42,000	$42,000
Present Worth of 50 Years of O&M[2]	$950,000	$1,050,000	$1,050,000
Total Projected Net Present Value (NPV)	$5,850,000	$6,450,000	$8,950,000
Difference Between Post-Construction NPV Estimate and ROD NPV Estimate	+$2,500,000 or 39%		

[1]ROD cost estimate was adjusted from 2004 dollars to 2006 dollars using a 5% annual inflation rate.
[2]Per the ROD, the present worth estimates assume 50 years of O&M and a 3.2% discount rate.

Although the actual costs were considerably higher than those estimated in the ROD, the costs were still within the -30/+50 estimates. The cost differences were due to three primary factors:

- The cost estimates developed for the ROD underestimated the premium that construction contractors would place on conducting the relatively large amount of concurrent earth moving activities within a fairly small area with limited construction access. In addition, rising prices on fuel and heavy equipment increased costs. The final negotiated construction bid was 15% higher than the inflation-adjusted ROD cost estimate.

- Difficulties with various components of the buttress construction resulted in increased project costs. These included an approximate 50% increase in the volume of material excavated to facilitate buttress construction as compared with the volume included in the construction bid. In addition, the higher-than-expected fraction of fine-grained materials in the waste rock pile resulted in the need for additional materials processing and handling to generate sufficient material for buttress construction.

- The discovery of extensive additional tailings deposits along LCC in the Tensy Lane area resulted in significant additional remedy costs. The supplemental activities included excavation and transport to the tailings pile of nearly 14,000 cubic yards of additional material, completely clearing the heavily forested area, import and placement of 6,500 cubic yards of additional backfill material, complete LCC channel reconstruction, and an extended construction period leading to increased overhead and oversight costs.

IX. OBSERVATIONS AND LESSONS LEARNED

- Large-scale excavation of the saturated mine tailings was very challenging and time consuming. This was due in mort part because the instability of the tailings posed significant construction safety concerns during excavation of the area needed for buttress construction. As noted above, these concerns were addressed by expanding the size of the excavation, increasing dewatering efforts and modifying excavation techniques. The remedy cost estimates did not fully account for these challenges. Future remedial actions implemented in the Lost Lake OU must thoroughly consider these constructability and cost impacts. Remedial alternatives that minimize working on and excavating saturated tailings should be evaluated favorably.
- There were several areas of the remedy where conducting a more comprehensive investigation during remedial design could have provided data leading to design changes and a more streamlined construction effort. However, it is not clear if these investigations would have generated significant cost savings. One example would be additional characterization of the grain size distribution throughout the waste rock piles. This would likely have indicated that the fraction of finer-grained materials was higher than anticipated and may have led to design changes in the material types targeted for use in rock buttress construction.
- Another example would have been a more thorough evaluation of the vertical distribution of contamination in the Tensy Lane area. Tailings accumulation in this heavily-forested area appeared to be the result of floodplain deposition during high flow events. Numerous hand auger borings were installed to what appeared to be native materials in the area to document the thickness of tailings accumulation. However, during construction it was discovered that tailings were present at greater depths than anticipated. Installation of borings down to bedrock during remedial design would have identified this condition and allowed for evaluation of additional remedial options and discussions with the affected property owners. Even if the remedial approach did not change (complete removal of tailings and tailings-impacted soils), the full scope of work required in the Tensy Lane area would have been incorporated into the construction sequencing, resulting in a much shorter construction effort than actually occurred.
- Maximizing use and reuse of onsite materials and materials generated during construction provided significant economic and environmental benefits to the RA implementation effort. Some of the more substantial “green” activities incorporated into remedial construction included:
  - Use of an on-site borrow source to provide the clean backfill needed to construct the vegetative caps installed over much of the Mine Area OU. This eliminated the need to purchase and import nearly 27,000 cubic yards of material
  - Use of waste rock to construct the rock buttress. This eliminated the need to purchase and import more than 22,000 cubic yards of material.
  - Use of the clayey material and rocks from the borrow area that were not suitable for the vegetative caps in place of the imported rock mulch in selected slope areas.
  - Use of large boulders encountered in the borrow area and during channel excavation to create the energy dissipater at the base of the buttress spillway, rather than importing rock.
  - Use of the vegetative mulch generated during processing the timber and brush as an additive in the vegetative cap materials to increase the organic content.
  - Screening the rocks out of the tailings/ impacted soil excavated from the Tensy Lane area. Rather than transporting these rocks onsite for placement in the tailings pile, they were reused for channel construction, backfill and erosion control in the Tensy Lane area.

X. CONTACT INFORMATION

U.S. Environmental Protection Agency Region IX, SFD-7-2
75 Hawthorne Street
San Francisco, CA 94105
(415) 972-3162

The project manager for USEPA is:
Rusty Harris-Bishop, Remedial Project Manager (during RA)
Brunilda Davila, Remedial Project Manager (current)

EPA used the following RA contractor to construct the remedy:

CH2M HILL	*Contract Number:*	*68-W-98-225*
2485 Natomas Park Drive, Suite 600	*Work Assignment Numbers:*	*251-RARA-093Y*
Sacramento, CA 95833		

The project manager for CH2M HILL is:
David Towell/CH2M HILL Los Angeles (during RA)
1000 Wilshire Boulevard, 21st Floor
Los Angeles, CA 90017
(213) 228-8285

Thomas A. Lae/CH2M HILL Sacramento (current)
2485 Natomas Park Drive, Suite 600
Sacramento, CA 95833
(916) 286-0246

Appendix A
Select Key As-Built Drawings
and Site Photographs

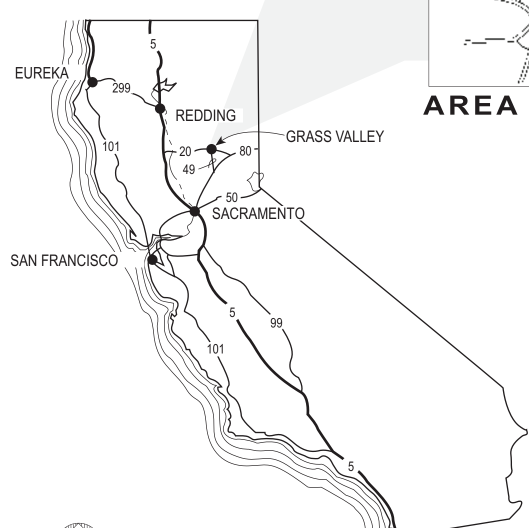
DRAWINGS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

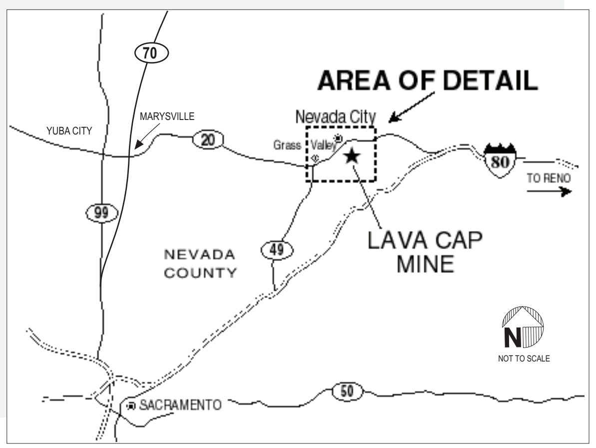
LAVA CAP MINE

MINE AREA (OU1) - REMEDIATION

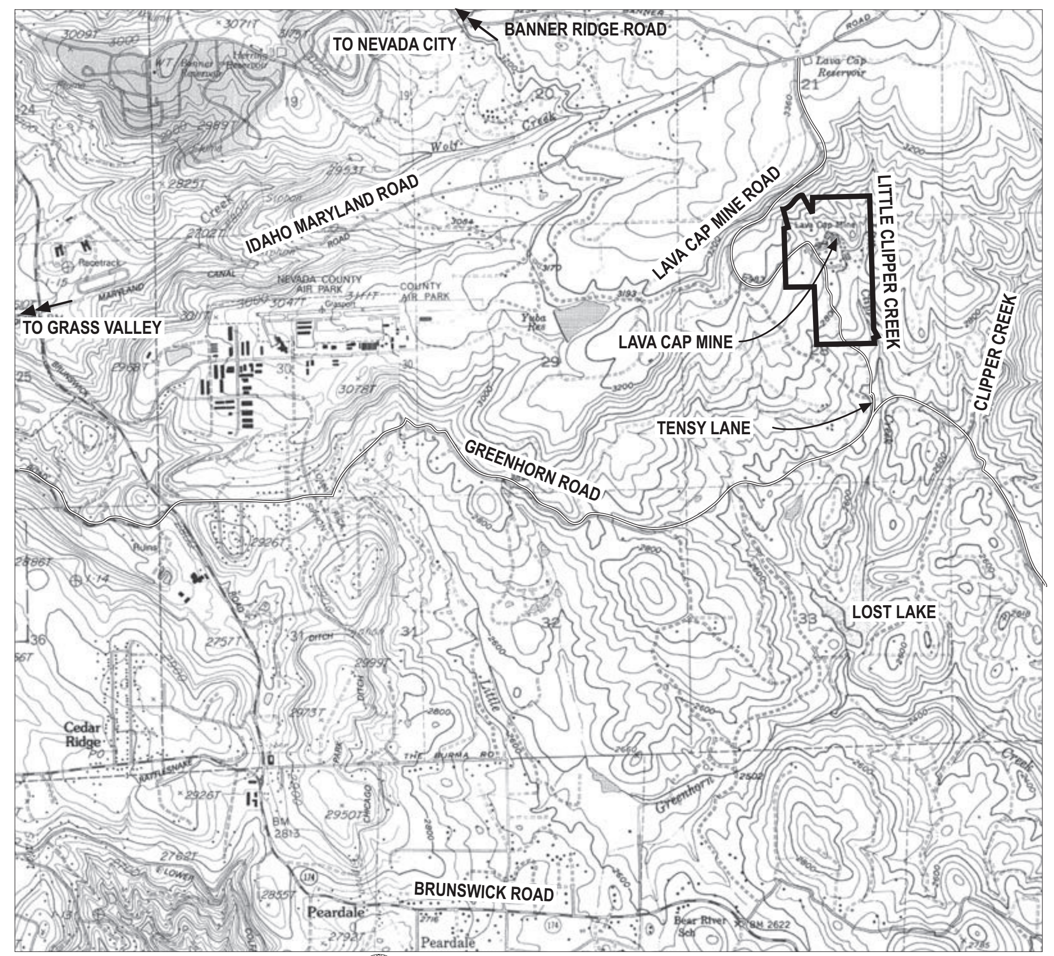
NEVADA CITY, CALIFORNIA



VICINITY MAP



AREA MAP



LOCATION MAP

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Revisions Drawn By K BROOKS Date MARCH 2008

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INDEX TO DRAWINGS

CH2MHILL

MARCH 2006

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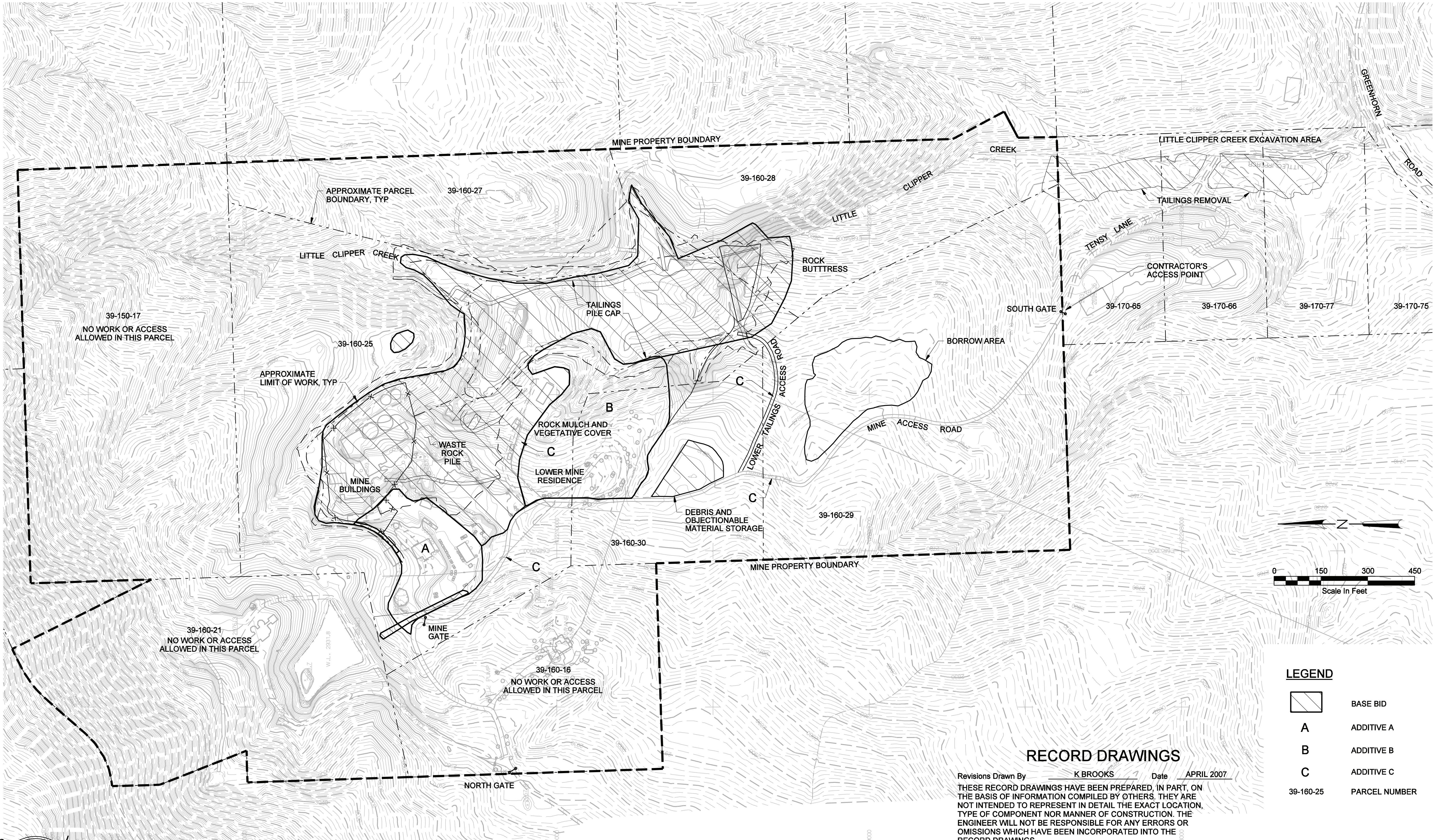

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LEGEND

(hatched)	BASE BID
A	ADDITIVE A
B	ADDITIVE B
C	ADDITIVE C
39-160-25	PARCEL NUMBER

REGISTERED PROFESSIONAL ENGINEER TIMOTHY JOHN KASHUBA C0-39651 Exp 12-31-09 CIVIL STATE OF CALIFORNIA
12-1-06

DSGN	T KASHUBA				
DR	J CHELONIS				
CHK	D TOWELL				
APVD	D TOWELL	NO.	DATE	REVISION	BY / APVD

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
MINE AREA (OU1) - REMEDIATION
LAVA CAP MINE

MINE AREA (OU1) - PHASE 1 REMEDIAL DESIGN

PROJECT WORK AREAS

SHEET	3
DWG	C-1a
DATE	APRIL 2007
PROJ	335400

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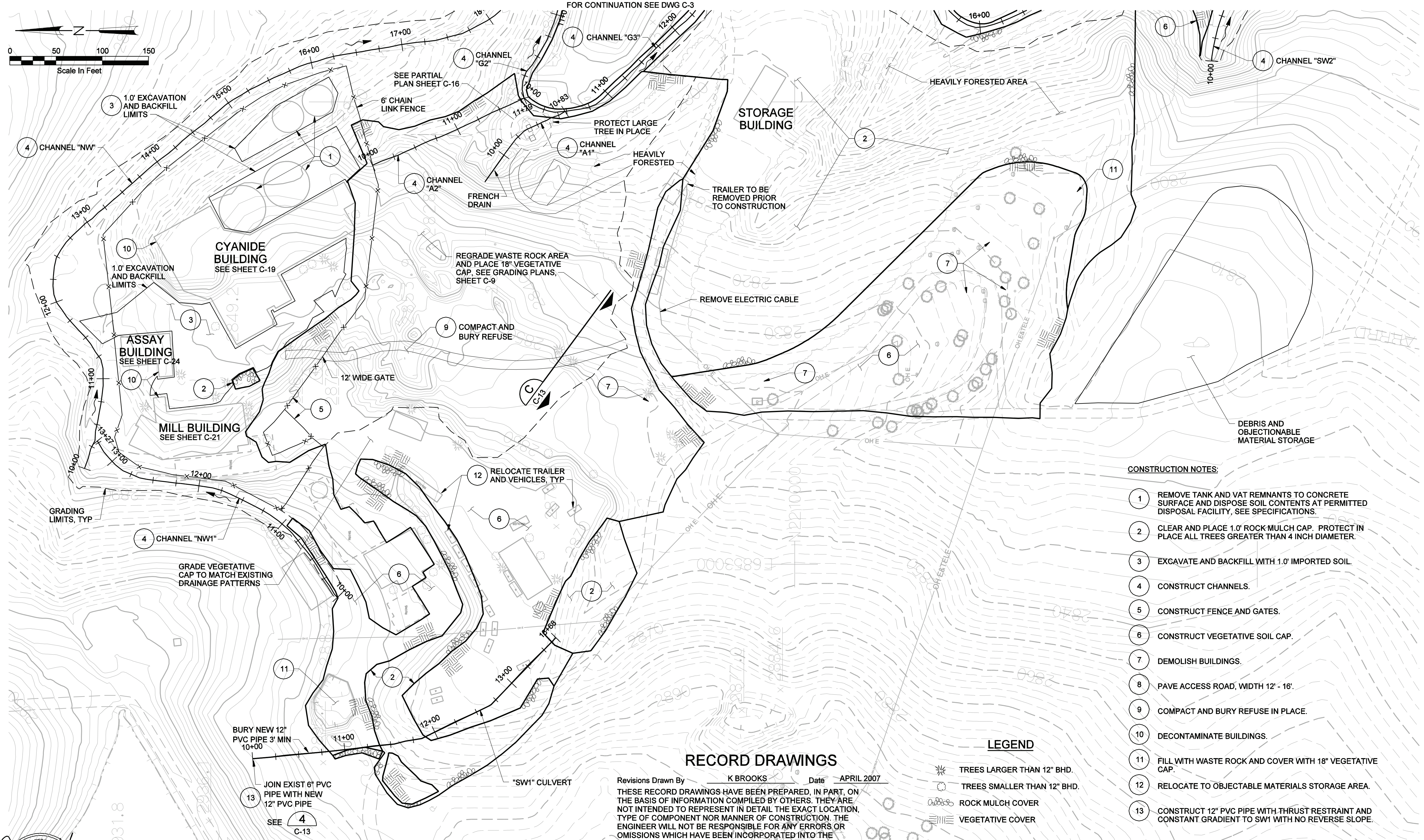
FOR CONTINUATION SEE DWG C-3



FOR CONTINUATION SEE DWG C-4

CONSTRUCTION NOTES:

1. REMOVE TANK AND VAT REMNANTS TO CONCRETE SURFACE AND DISPOSE SOIL CONTENTS AT PERMITTED DISPOSAL FACILITY, SEE SPECIFICATIONS.
2. CLEAR AND PLACE 1.0' ROCK MULCH CAP. PROTECT IN PLACE ALL TREES GREATER THAN 4 INCH DIAMETER.
3. EXCAVATE AND BACKFILL WITH 1.0' IMPORTED SOIL.
4. CONSTRUCT CHANNELS.
5. CONSTRUCT FENCE AND GATES.
6. CONSTRUCT VEGETATIVE SOIL CAP.
7. DEMOLISH BUILDINGS.
8. PAVE ACCESS ROAD, WIDTH 12' - 16'.
9. COMPACT AND BURY REFUSE IN PLACE.
10. DECONTAMINATE BUILDINGS.
11. FILL WITH WASTE ROCK AND COVER WITH 18" VEGETATIVE CAP.
12. RELOCATE TO OBJECTABLE MATERIALS STORAGE AREA.
13. CONSTRUCT 12" PVC PIPE WITH THRUST RESTRAINT AND CONSTANT GRADIENT TO SW1 WITH NO REVERSE SLOPE.

LEGEND

- TREES LARGER THAN 12" BHD.
- TREES SMALLER THAN 12" BHD.
- ROCK MULCH COVER
- VEGETATIVE COVER

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12-1-06

DSGN	T KASHUBA	NO.	DATE	REVISION	BY	APVD	
DR	J CHELONIS						
CHK	D TOWELL						
APVD	D TOWELL						

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
MINE AREA (OU1) - REMEDIATION
LAVA CAP MINE

MINE AREA (OU1) - PHASE 1 REMEDIAL DESIGN

SITE PLAN - MINE BUILDINGS

SHEET	4
DWG	C-2
DATE	APRIL 2007
PROJ	335400

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RECORD DRAWINGS

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CONSTRUCTION NOTES:

1. REMOVE WASTE MOUND AND PLACE IN TAILINGS PILE TO BE CAPPED.
2. CLEAR AND PLACE 1.0' ROCK MULCH CAP.
3. CONSTRUCT ANCHOR TRENCH
4. CONSTRUCT DRAINAGE CHANNELS.
5. REMOVE MATERIAL AND DISPOSE AT PERMITTED DISPOSAL FACILITY, SEE SPECIFICATIONS.
6. REMOVE EXISTING HDPE CULVERT.
7. PAVE ACCESS ROAD, WIDTH 12'-16'.
8. GRADE AND CAP TAILINGS.
9. CONSTRUCT BUTTRESS.
10. RELOCATE TO OBJECTIONABLE MATERIAL STORAGE AREA.
11. ADJUST WELL TO GRADE, SEE TABLE, THIS SHEET.
12. DESTROY WELL, SEE TABLE, THIS SHEET.
13. SALVAGE LARGE ROCK FOR USE AS RIP RAP
14. PLACE CULVERT WITH FLARED END SECTION

WELL ELEVATIONS

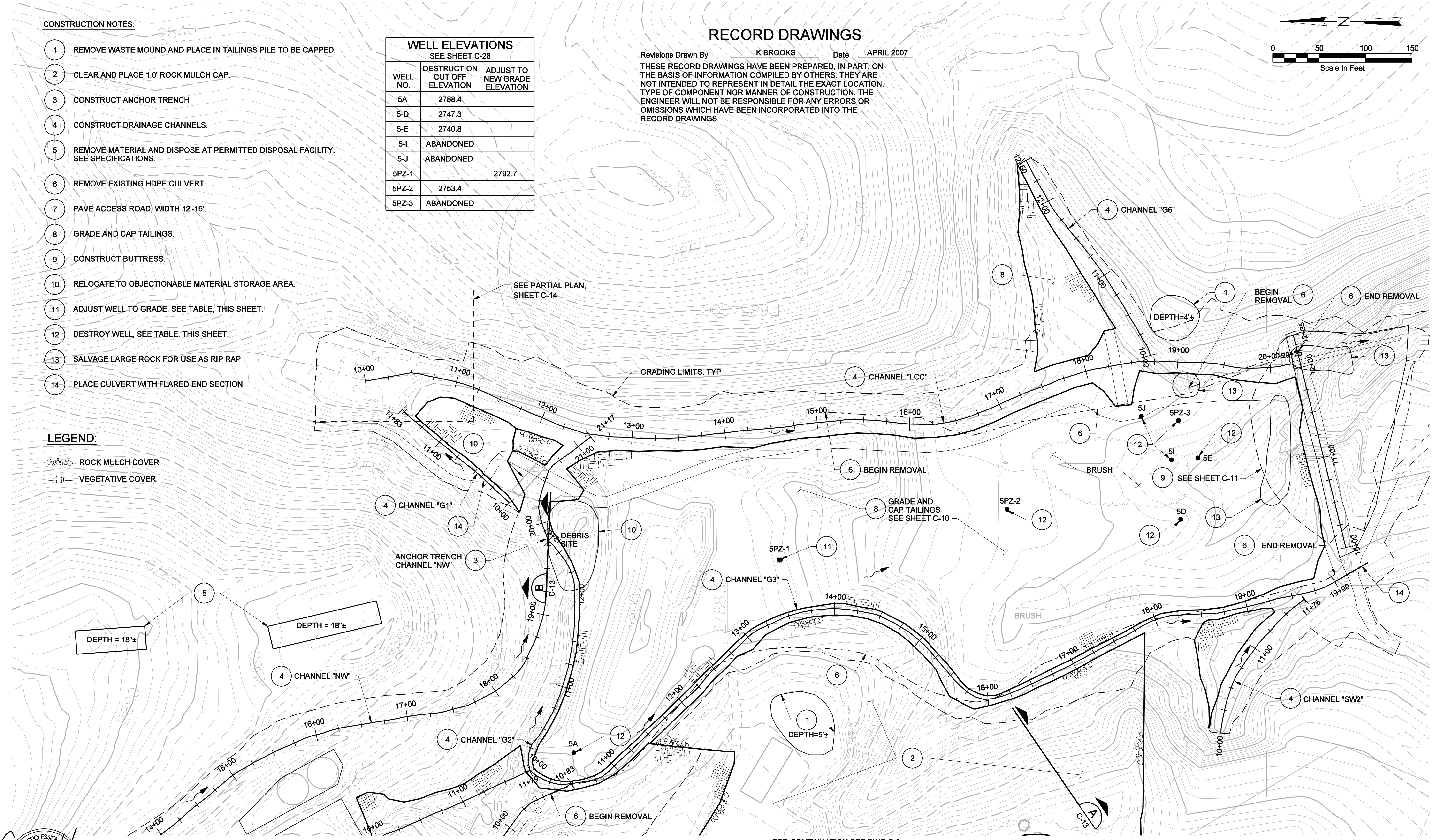
SEE SHEET C-28

WELL NO.	DESTRUCTION CUT OFF ELEVATION	ADJUST TO NEW GRADE ELEVATION
5A	2788.4	
5-D	2747.3	
5-E	2740.8	
5-I	ABANDONED	
5-J	ABANDONED	
5PZ-1		2792.7
5PZ-2	2753.4	
5PZ-3	ABANDONED	

LEGEND:

ROCK MULCH COVER

VEGETATIVE COVER



FOR CONTINUATION SEE DWG C-5

FOR CONTINUATION SEE DWG C-2

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DR	J CHELONIS
CHK	D TOWELL
APVD	D TOWELL

NO.	DATE	REVISION	BY	APVD

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
MINE AREA (OU1) - REMEDIATION
LAVA CAP MINE

MINE AREA (OU1) - PHASE 1 REMEDIAL DESIGN

SITE PLAN - TAILINGS CAP

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DWG	C-3
DATE	APRIL 2007
PROJ	335400

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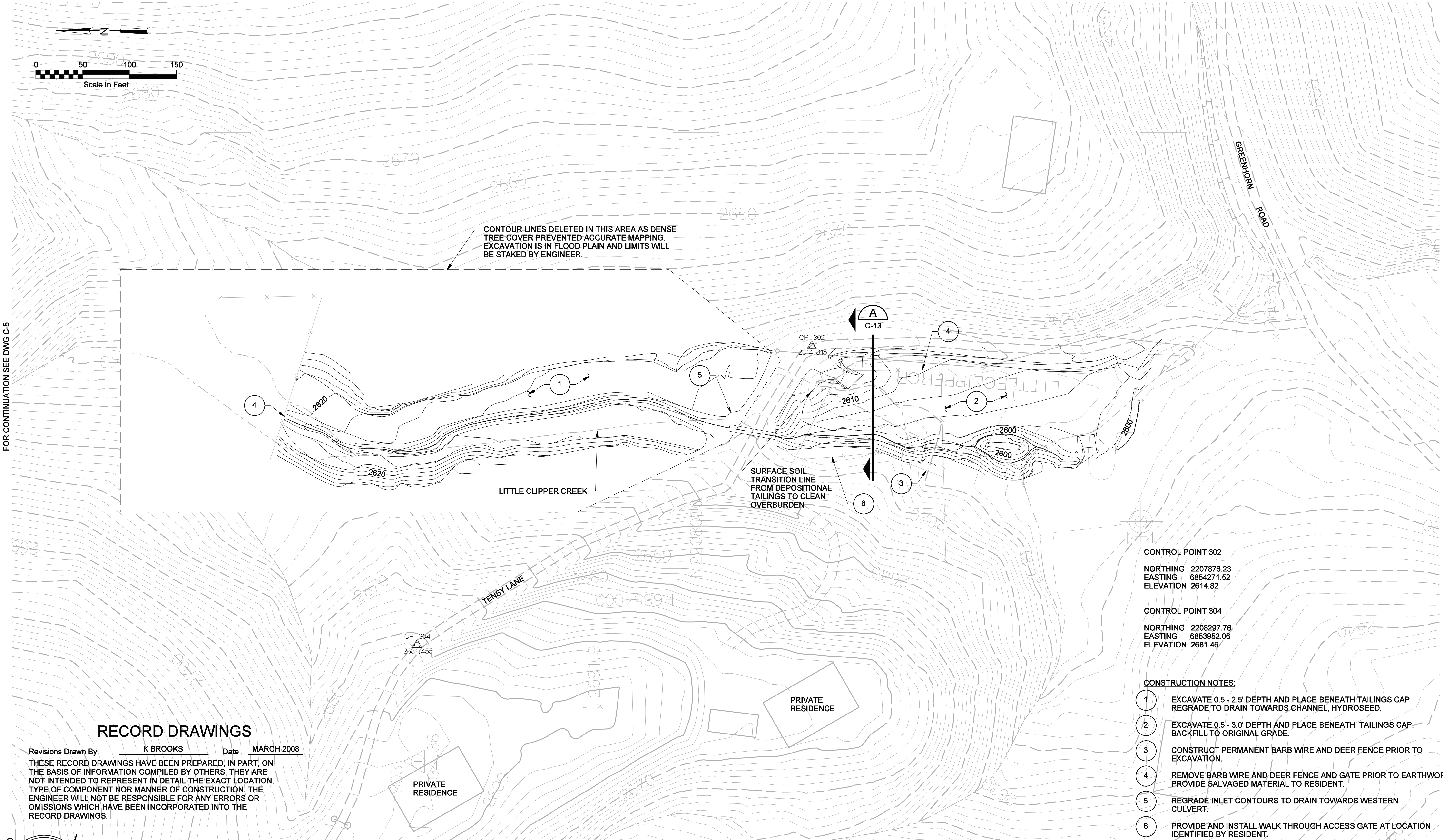

FOR CONTINUATION SEE DWG C-5

CONTROL POINT 302

NORTHING 2207876.23
EASTING 6854271.52
ELEVATION 2614.82

CONTROL POINT 304

NORTHING 2208297.76
EASTING 6853952.06
ELEVATION 2681.46

CONSTRUCTION NOTES:

1. EXCAVATE 0.5 - 2.5' DEPTH AND PLACE BENEATH TAILINGS CAP REGRADE TO DRAIN TOWARDS CHANNEL, HYDROSEED.
2. EXCAVATE 0.5 - 3.0' DEPTH AND PLACE BENEATH TAILINGS CAP, BACKFILL TO ORIGINAL GRADE.
3. CONSTRUCT PERMANENT BARB WIRE AND DEER FENCE PRIOR TO EXCAVATION.
4. REMOVE BARB WIRE AND DEER FENCE AND GATE PRIOR TO EARTHWORK. PROVIDE SALVAGED MATERIAL TO RESIDENT.
5. REGRADE INLET CONTOURS TO DRAIN TOWARDS WESTERN CULVERT.
6. PROVIDE AND INSTALL WALK THROUGH ACCESS GATE AT LOCATION IDENTIFIED BY RESIDENT.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
MINE AREA (OU1) - REMEDIATION
LAVA CAP MINE

MINE AREA (OU1) - PHASE 1 REMEDIAL DESIGN

SITE PLAN - LITTLE CLIPPER CREEK

SHEET	8
DWG	C-6
DATE	APRIL 2007
PROJ	335400

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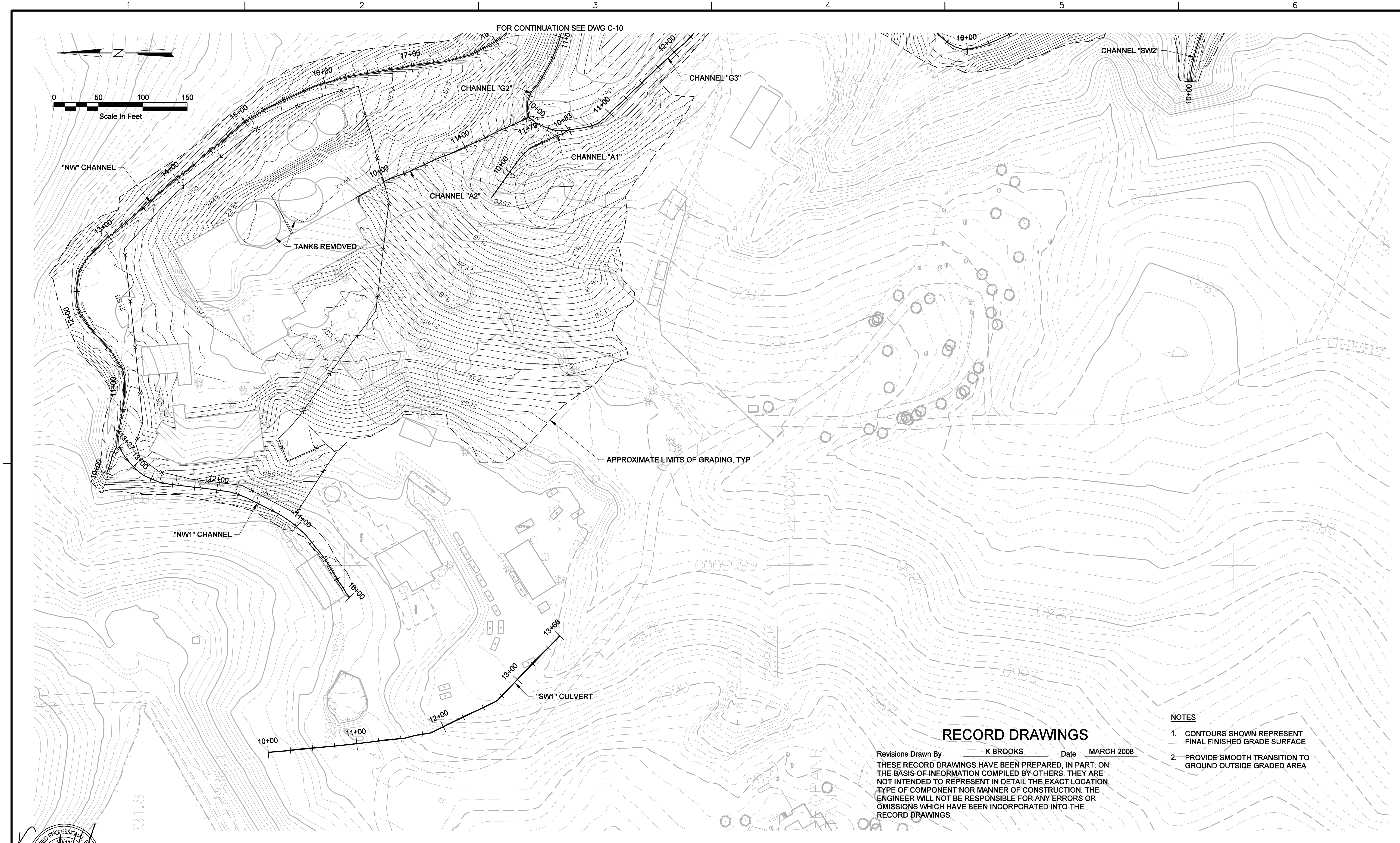

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NOTES

1. CONTOURS SHOWN REPRESENT FINAL FINISHED GRADE SURFACE
2. PROVIDE SMOOTH TRANSITION TO GROUND OUTSIDE GRADED AREA

REGISTERED PROFESSIONAL ENGINEER TIMOTHY JOHN KASHUBA C0-39651 Exp 12-31-09 CIVIL STATE OF CALIFORNIA

12-1-06

DSGN	T KASHUBA
DR	J CHELONIS
CHK	D TOWELL
APVD	D TOWELL

NO.	DATE	REVISION	BY	APVD

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
MINE AREA (OU1) - REMEDIATION
LAVA CAP MINE

MINE AREA (OU1) - PHASE 1 REMEDIAL DESIGN

WASTE ROCK PILE GRADING PLAN

SHEET	12
DWG	C-9
DATE	APRIL 2007
PROJ	335400

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BENCH MARKS AND SETTLEMENT MONUMENTS

POINT	NORTHING	EASTING	ELEVATION
BM1	2209530.50	6853988.18	2765.14
BM2	2210326.47	6853713.79	2817.80
SM1	2210223.31	6853565.33	2797.21
SM2	2210174.53	6853706.58	2797.65
SM3	2210208.55	6853832.26	2779.08
SM4	2210019.76	6853753.89	2794.44
SM5	2209882.38	6853757.98	2786.95
SM6	2209788.23	6853661.77	2772.16
SM7	2209732.51	6853779.65	2770.72
SM8	2209637.96	6853744.16	2760.49
SM9	2209610.07	6853805.35	2757.82
SM10	2209676.57	6853856.03	2759.33
SM11	2209419.18	6853762.71	2744.67
SM12	2209442.72	6853857.56	2745.20
SM13	2209462.45	6853919.02	2745.87
SM14	2209384.34	6853893.70	2721.14
SM15	2209400.84	6853934.56	2724.11
SM16	2209368.19	6853948.60	2709.79

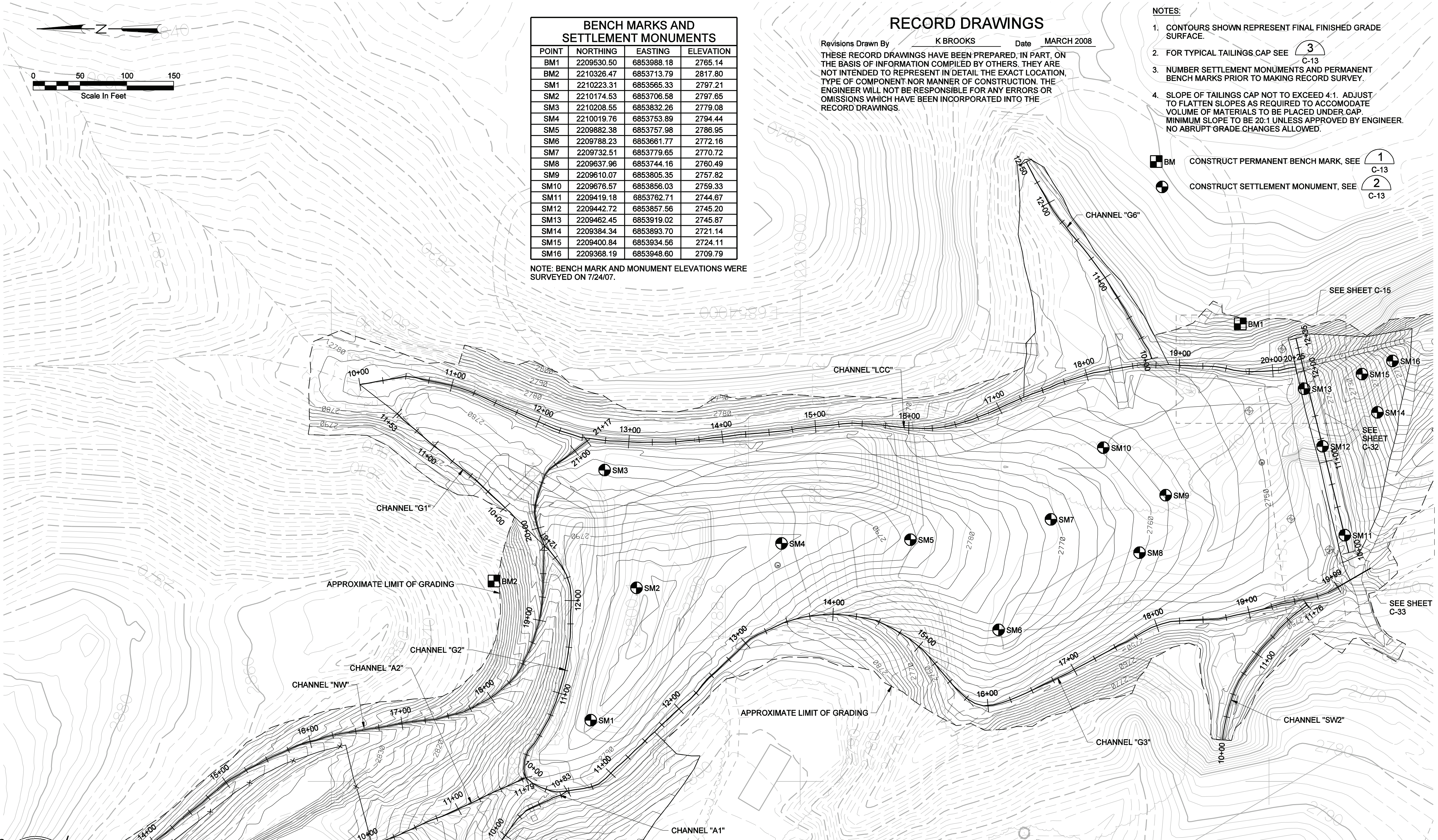
NOTE: BENCH MARK AND MONUMENT ELEVATIONS WERE SURVEYED ON 7/24/07.

NOTES:

1. CONTOURS SHOWN REPRESENT FINAL FINISHED GRADE SURFACE.
2. FOR TYPICAL TAILINGS CAP SEE 3/C-13
3. NUMBER SETTLEMENT MONUMENTS AND PERMANENT BENCH MARKS PRIOR TO MAKING RECORD SURVEY.
4. SLOPE OF TAILINGS CAP NOT TO EXCEED 4:1. ADJUST TO FLATTEN SLOPES AS REQUIRED TO ACCOMODATE VOLUME OF MATERIALS TO BE PLACED UNDER CAP. MINIMUM SLOPE TO BE 20:1 UNLESS APPROVED BY ENGINEER. NO ABRUPT GRADE CHANGES ALLOWED.

BM CONSTRUCT PERMANENT BENCH MARK, SEE 1/C-13

CONSTRUCT SETTLEMENT MONUMENT, SEE 2/C-13



FOR CONTINUATION SEE DWG C-9

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DSGN	T KASHUBA	
DR	K BROOKS	
CHK	D TOWELL	
APVD	D TOWELL	

NO.	DATE	REVISION	BY	APVD

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
MINE AREA (OU1) - REMEDIATION
LAVA CAP MINE

MINE AREA (OU1) - PHASE 1 REMEDIAL DESIGN

TAILINGS CAP GRADING PLAN

SHEET	13
DWG	C-10
DATE	APRIL 2007
PROJ	335400

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RECORD DRAWINGS

Revisions Drawn By K BROOKS Date MARCH 2008

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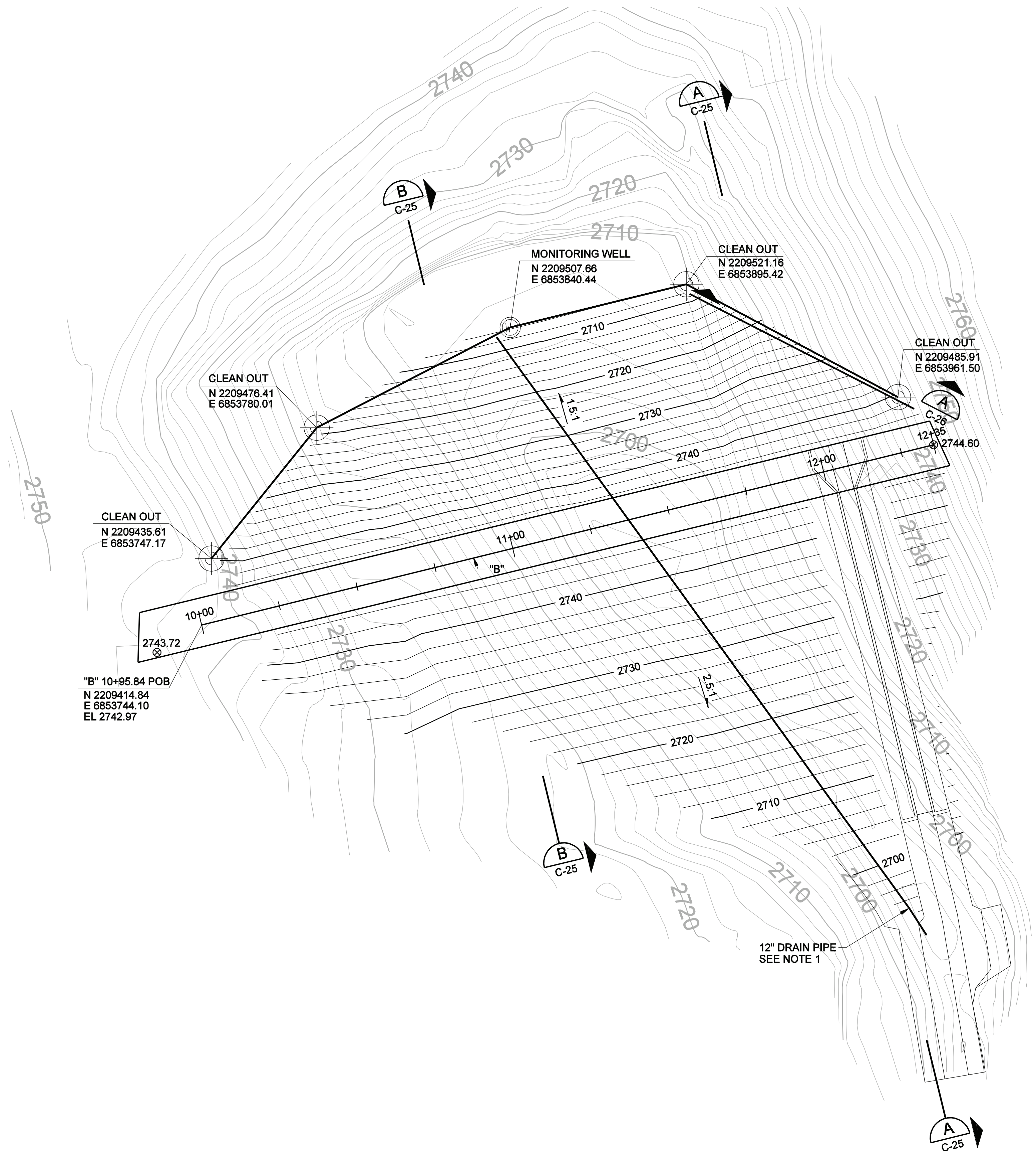

NOTE:

1. OUTLET OF DRAIN PIPE TO BE CONTINUOUSLY OPEN.CONSTRUCT ENERGY DISSIPATOR UTILIZING 5 CY OF 12 INCH RIPRAP.

N

0 20 40 60
Scale In Feet

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12-1-06

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DR	K BROOKS					
CHK	D TOWELL					
APVD	D TOWELL	NO.	DATE	REVISION	BY	APVD

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
MINE AREA (OU1) - REMEDIATION
LAVA CAP MINE

MINE AREA (OU1) - PHASE 1 REMEDIAL DESIGN

BUTTRESS GRADING PLAN

SHEET	14
DWG	C-11
DATE	APRIL 2007
PROJ	335400

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RECORD DRAWINGS

Revisions Drawn By K BROOKS Date MARCH 2008

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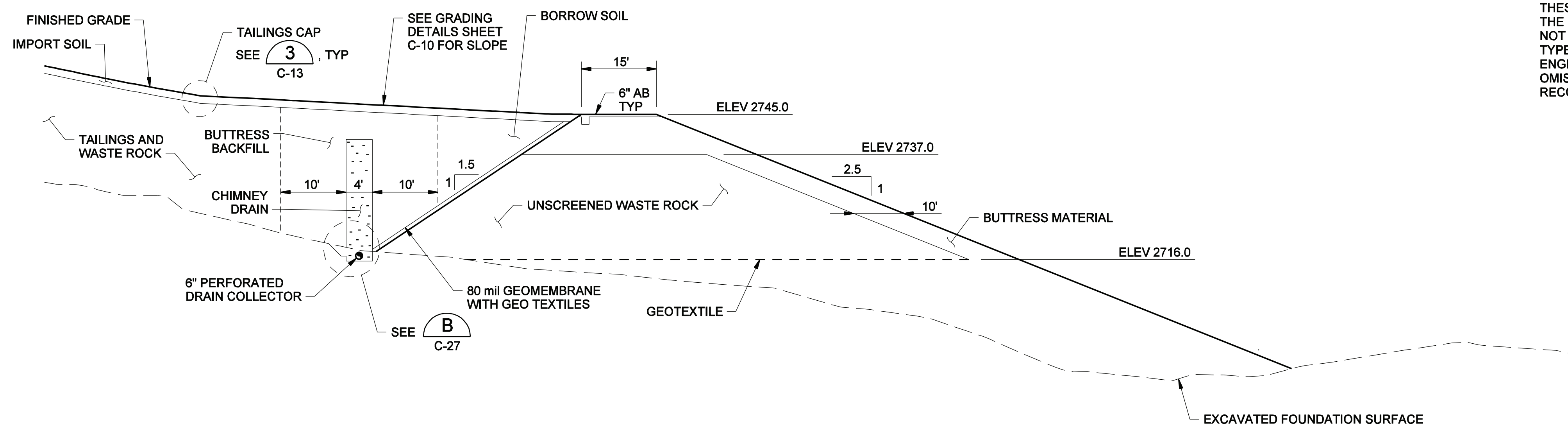
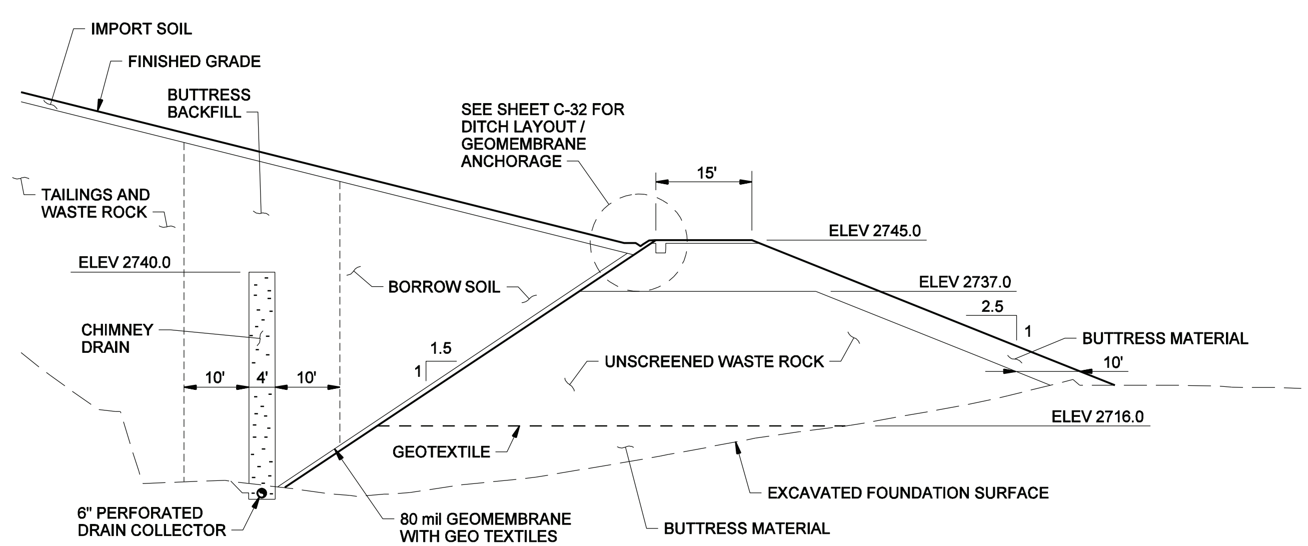


SECTION A
1"=15' C-11



SECTION B
1"=15' C-11

NOTE:

1. ALL GEOMEMBRANE SHALL BE PLACED WITH ONE LAYER OF NON-WOVEN GEOTEXTILE ABOVE AND ONE LAYER OF NON-WOVEN GEOTEXTILE BELOW THE GEOMEMBRANE.

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DSGN	J LIVINGSTON						
DR	J CHELONIS						
CHK	D TOWELL				KTB	TK	
APVD	D TOWELL	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
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0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
MINE AREA (OU1) - REMEDIATION
LAVA CAP MINE

MINE AREA (OU1) - PHASE 1 REMEDIAL DESIGN

BUTTRESS SECTIONS

SHEET	29
DWG	C-25
DATE	APRIL 2007
PROJ	335400

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Lava Cap Mine OU1 Construction - Rock Buttress

1

2

3

4

5

6

7

8

9

EPA

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Lava Cap Mine OU1 Construction - Little Clipper Creek Channel


1


2


3


4


5


6


7


8

EPA

CH2MHILL

ES082008001SAC

Lava Cap Mine OU1 Construction - Tailings Pile Cap

1

2

3

4

5

6

7

8

EPA

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Lava Cap Mine OU1 Construction - Waste Rock Pile Cover and Adit

1

2

3

4

5

6

7

8

EPA

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ES082008001SAC

Appendix B
Buttress Technical Memo

As-Constructed Buttress Stability – Lava Cap Mine OU1 Remediation

PREPARED FOR: Project Team

PREPARED BY: John Livingston/RDD

DATE: April 28, 2010

PROJECT NUMBER: 391282.PC.01

Based on as-constructed topography dated March 2008, a series of static and pseudo static stability analyses were made for the buttress that retains tailings in the canyon bottom of the Lava Cap Mine site. The final topography indicates that the top of the buttress is at elevation 2745 with a 16-feet wide top width and 2.5:1(H:V) downstream slope. Uphill of the buttress the ground slopes gently upward at approximately 10:1.

Stability analyses were performed using the computer application SLIDE version 5.032 created by RocScience Inc., of Toronto, Ontario, Canada. A minimum static factor of safety of 1.5 is generally considered the industry standard for long-term stability of a slope. The stability of the buttress under earthquake loading was evaluated through a pseudo-static analysis in which the slope materials are subjected to a horizontal force equal to a pseudo-static coefficient times the weight of the soil. For pseudo-static analyses, a minimum factor of 1.1 was used as the design criterion. A design pseudo-static coefficient of 0.25 was used in the analyses to represent strong earthquake shaking.

The shear strength parameters used in the stability analyses were based on typical material strength parameters for sharp and smooth rock surfaces of granular materials and observations of the tailings and waste rock during the remedial design and construction.

The results of the long term stability analyses are presented in Figure 1 along with the characteristics for each material included in the buttress and uphill of the buttress. The minimum calculated factor of safety was 1.91 which exceeds the normal required value of 1.5.

Stability results for the pseudo-static analysis are shown in Figure 2 with the minimum calculated factor of safety 1.05. This value can be rounded to 1.1 and is an acceptable result. The position of the lowest factor of safety is for a sliding surface against the raw waste rock with a 10-foot thick covering of the high quality buttress material on the downstream face. These types of shallow sliding surfaces are common in slope stability analysis and almost never cause major distress to the overall embankment. An inspection of the buttress would be warranted following a major earthquake.

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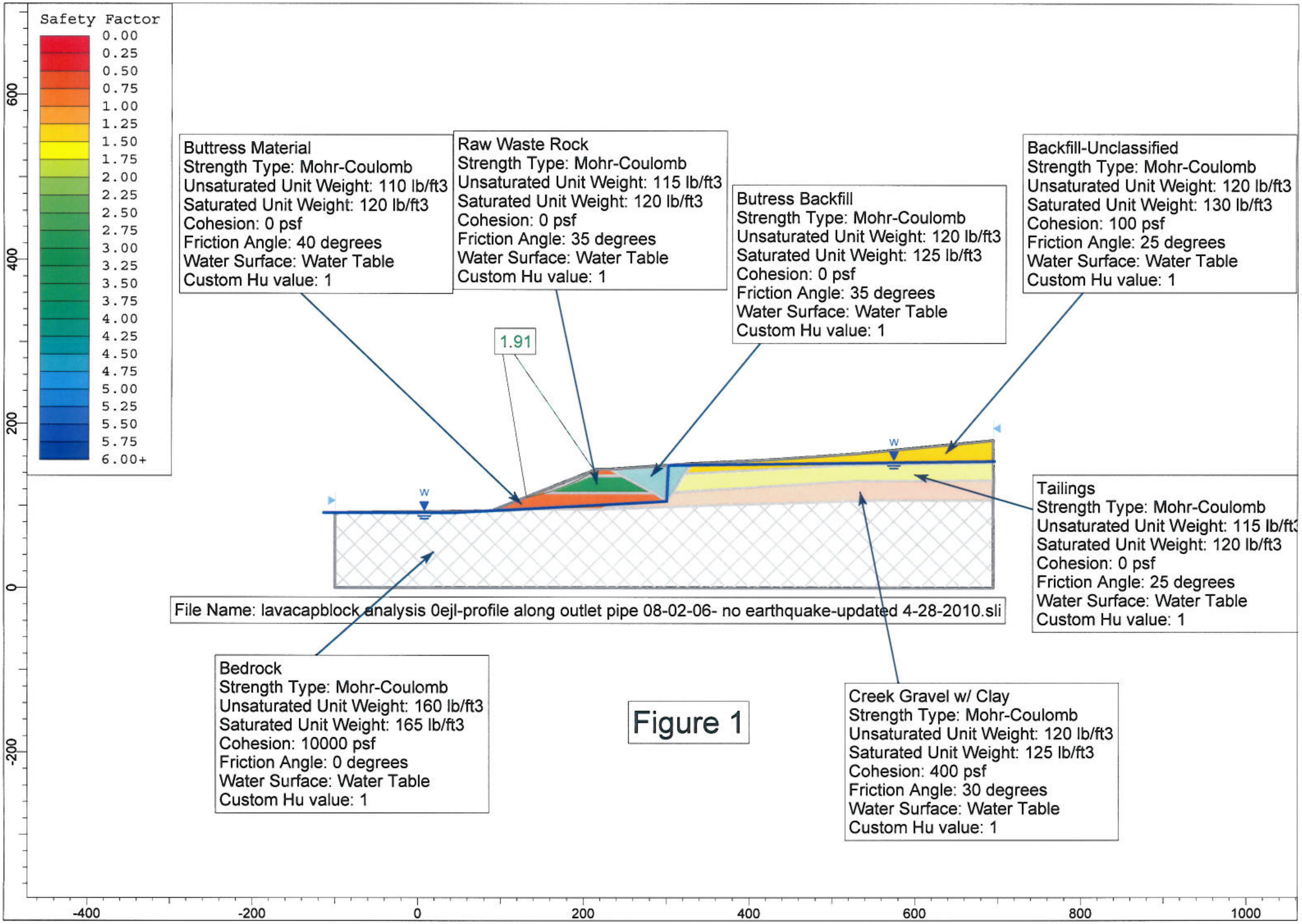
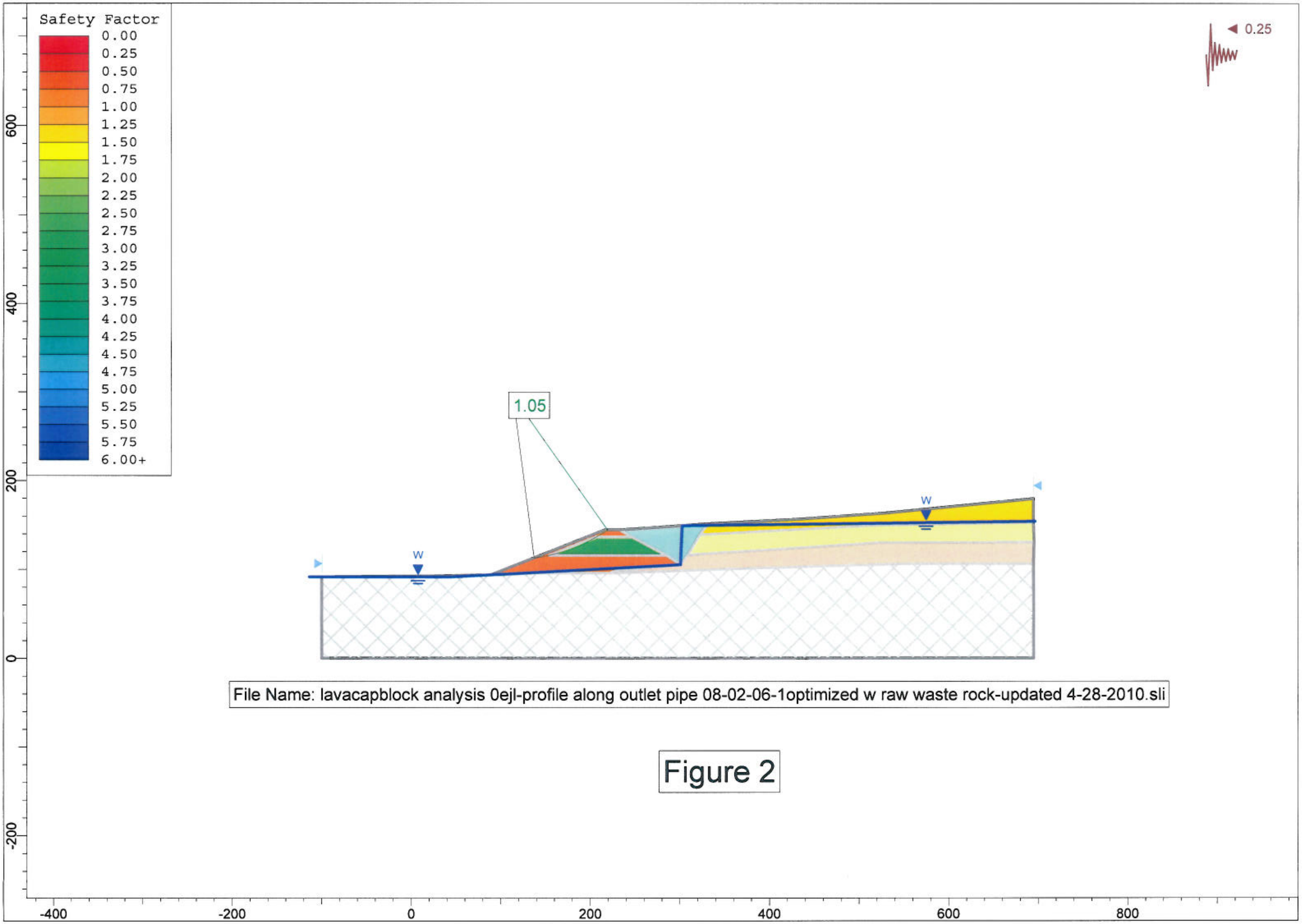


Safety Factor
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
4.75
5.00
5.25
5.50
5.75
6.00+
Buttress Material
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 110 lb/ft3
Saturated Unit Weight: 120 lb/ft3
Cohesion: 0 psf
Friction Angle: 40 degrees
Water Surface: Water Table
Custom Hu value: 1
Raw Waste Rock
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 115 lb/ft3
Saturated Unit Weight: 120 lb/ft3
Cohesion: 0 psf
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1
Butress Backfill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 120 lb/ft3
Saturated Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1
Backfill-Unclassified
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 120 lb/ft3
Saturated Unit Weight: 130 lb/ft3
Cohesion: 100 psf
Friction Angle: 25 degrees
Water Surface: Water Table
Custom Hu value: 1
1.91
W
W
Tailings
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 115 lb/ft
Saturated Unit Weight: 120 lb/ft3
Cohesion: 0 psf
Friction Angle: 25 degrees
Water Surface: Water Table
Custom Hu value: 1
File Name: lavacapblock analysis 0ejl-profile along outlet pipe 08-02-06- no earthquake-updated 4-28-2010.sli
Bedrock
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 160 lb/ft3
Saturated Unit Weight: 165 lb/ft3
Cohesion: 10000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1
Creek Gravel w/ Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 120 lb/ft3
Saturated Unit Weight: 125 lb/ft3
Cohesion: 400 psf
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1
600
400
200
0
-200
-400
-200
0
200
400
600
800
1000

Figure 1



File Name: lavacapblock analysis 0ejl-profile along outlet pipe 08-02-06-1optimized w raw waste rock-updated 4-28-2010.sli

Figure 2