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ENVIRONMENTAL PROTECTION

INITIAL GEOTECHNICAL ASSESSMENT
FINAL REPORT
GOOSEBERRY MINE
STOREY COUNTY, NEVADA

Submitted to:

Nevada Division of Environmental Protection
901 South Stewart Street, Suite 4001
Carson City, Nevada 89701

Submitted by:

AMEC Earth & Environmental, Inc.
780 Vista Boulevard, Suite 100
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May 2006
AMEC Job No. 6-417-000720

May 5, 2006
AMEC Job No. 6-417-000720

Nevada Division of Environmental Protection
901 South Stewart Street, Suite 4001
Carson City, Nevada 89701

Attention: Mr. Sam Jackson

RE: INITIAL GEOTECHNICAL ASSESSMENT
Gooseberry Mine
Storey County, Nevada

Dear Mr. Smale:

Enclosed is our initial geotechnical assessment final report for the above referenced project. This report includes the results of our assessment of on-site soil cover materials, shafts capping, and drainage near the existing tailings pond. An inventory of available soil cover materials is provided based on our exploration test-pit program. Initial capping recommendations are provided for the two observed shafts. Estimated peak discharge values for critical drainages are provided.

A sampling and analysis plan (SAP) has been provided under a separate report.

We appreciate the opportunity to provide these services for you. If you have any questions or require further information please don't hesitate to contact us.

Respectfully submitted,

AMEC Earth & Environmental, Inc.

Todd W. Johnson
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Addressee (3)

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1. INTRODUCTION

This report presents the results of our initial geotechnical study performed at the site of the Gooseberry Mine located in Storey County, Nevada. The location of the site with respect to existing facilities, along with topography, is presented on Figure 1, Vicinity Map. More detailed site plans showing the existing facilities, exploration test-pit and geophysical survey locations are presented on Figures 2A through 2E, Site Plans. Geophysical survey results are presented in Appendix C. Calculations for peak discharge of drainage basins near the existing tailings pond are presented in Appendix D. Site photographs showing typical site conditions at the potential cover soil area and the two shaft sites are provided in Appendix E.

1.1 Objectives and Scope

Details of the project were provided to us by Scott Smale of the Nevada Division of Environmental Protection (NDEP) and Terry Nueman of the Bureau of Land Management (BLM), Carson City District. Our scope of work was presented in AMEC proposal number PN05-10-4 dated October 28, 2005. In general, the objectives of this study were to:

- assess the potential use of on-site native soils as cover materials for mine reclamation and closure;
- provide initial closure recommendations for two shafts using non-evasive exploration techniques; and
- provide a drainage assessment of critical drainage basins located near the existing tailings pond facility.

In accomplishing these objectives, our scope has included the following:

1. Four site visits to conduct two separate field programs consisting of the excavation, sampling and logging of 20 test pits, and the completion of 10 seismic refraction and refraction microtremor geophysical survey lines;
2. A laboratory testing program; and
3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this summary report.

1.2 Authorization

Authorization to proceed with this study was provided by a letter notice to proceed dated February 1, 2006 by the NDEP.

1.3 Professional Statement

Supporting data upon which our recommendations are based is presented in the following sections of this report. The recommendations presented herein are governed by the physical properties of the soils encountered in the explorations, projected groundwater conditions, projected subsurface bedrock conditions at the two shaft sites based on geophysical surveying methods, and the structural layout and design data discussed in this report. If subsurface conditions other than those described in this report are encountered, or if project details are changed, this firm should be informed so that our recommendations can be reviewed and, if necessary, revised. The final plans and specifications should be reviewed by AMEC to ensure conformance to the recommendations presented in this report.

The intent of these investigations was to define subsurface soil and bedrock conditions, to provide construction recommendations for the design of the project, but not to investigate the site for potential soil or groundwater contamination. Although AMEC has explored subsurface conditions as part of this investigation, AMEC as part of this borrow investigation did not evaluate the potential borrow area site for the potential presence of contaminated soil and/or groundwater conditions.

This report has been prepared for the exclusive use of the NDEP for specific application to the Gooseberry Mine project in accordance with generally accepted geotechnical engineering practice common to the local area at this time. No other warranty, express or implied, is made.

2. PROJECT DESCRIPTION

The Gooseberry Mine was last operated by Pallas Resources in 1999. All mining operations ceased after the owners declared bankruptcy. The mine came under the control of Storey County in 1999 and is now part of the Brownfields Program. A number of geotechnically-related issues associated with reclamation and final closure of the mine are addressed in this report:

(1) Cover soils are required for reclamation and closure of the heap leach pad, the landfill, and the tailings ponds facilities. The purpose of the soil cover is to reduce the infiltration and deep percolation of water, and provide isolation and control of oxidation and/or leaching effects. An estimated 170,000 cubic yards of soil cover materials are needed for the project. It is preferred that the soil cover materials be identified as close to the site as possible for economic and logistical reasons.

There are no gradation or soil requirements dictated by the State for soil cover materials; however, some component of low permeability soils are necessary in order for the soil cover materials to act as a suitable capillary barrier. In addition, the soil cover materials should not contain a large amount of coarse–grained materials. The higher the component of coarse-grained soil materials present in soil cover materials will indicate that they have little moisture retention capacity. Computer numerical simulations can be used to predict the water balance performance of a cover system (e.g. Soil Cover, 2000) but is outside the scope of this project. The soil water characteristic curve (SWCC) is defined as the variation of water storage capacity (volumetric water content) within the pores of soil as a function of the soil suction. The ability of the soil to store water is a function of both soil suction and the physical characteristics of the soil (grain-size distribution, porosity, and structure). This study will provide the results of laboratory testing for on-site soil cover materials that includes SWCC data.

(2) Two existing open shafts present at the mine will also need to be capped. The primary objectives of the shaft closures are to protect public safety and to provide reasonable support for possible future development at the sites. There are no specific standards that have to be met for the shaft closures presented in Nevada Administrative Code (NAC) number 513.390. The proposed future use of the Gooseberry Mine site is currently unknown; the site is located within the rapidly growing Tahoe-Reno Industrial Park that is being used by commercial companies as warehouse and distribution centers. The area near the existing Gooseberry Mine buildings located adjacent to the existing two shafts is laterally extensive and flat and holds the most potential for possible future commercial and industrial developments.

(3) A drainage assessment of the site is also necessary in order to establish design peak flows from upgradient watersheds and runoff volumes to be used to design any necessary storm water diversion structures.

3. GEOTECHNICAL INVESTIGATION

3.1 Document Review

A limited review of available site history was conducted. Little information has been published on the mining history and geology of the Gooseberry Mine. Only minor descriptions of the geology, alteration, and Au-Ag mineralization of the area has been published in articles by the Nevada Bureau of Mines and Geology (Bonham, 1969; Rose, 1969). Some historical mining records are posted on the Info-mine (Infomine, 2006) web site. Although published underground mine maps showing the shaft and level developments are reported to be available, these maps were not available during this initial geotechnical assessment. SRK Consulting Inc. has conducted an unpublished mine hazardous waste study (2004) that was made available to AMEC. Terry Neuman of the BLM reported ground water conditions at the main Gooseberry

Mine shaft site. In addition, Dennis LaPrarrie, a former employee at the Gooseberry Mine, has reported shaft depth information.

3.2 Field Investigations

Two separate field investigations were conducted at the Gooseberry Mine. One investigation focused on identification of cover soil materials and the other focused on subsurface conditions near the existing two shafts.

3.2.1 Potential Soil Cover Area

The exploration test-pit program focused on potential cover soil areas identified during a surface reconnaissance, available County geologic maps (Bonham, 1969), and visible bedrock outcrops. The area located immediately north, northeast, and east of the heap leach pad and the tailings pond has the highest potential for the thickest nearby source of Quaternary alluvium soil deposits (Figs. 2A and 2B). All soil cover materials must not encroach onto lands owned by the Bureau of Land Management (BLM). Subsurface soil and groundwater conditions were investigated by excavating 20 test pits within the potential cover soil source areas as shown on Figure 2B. Exploration locations were determined in the field by measuring from adjacent roadway edges and from hand held GPS measurements. Exploration operations were performed under the continuous observation of an experienced member of our geotechnical staff.

The exploratory test pits TP-01 through TP-20 were excavated on February 2 and 3, 2006 using a Cat 325C tracked excavator with a 2-foot wide bucket that generally excavated to depths of 2.5 to 17.5 feet, the maximum reach of this equipment. Disturbed bulk samples were obtained from the test pits.

The test pit excavations were backfilled upon completion of the each test pit. The backfill was compacted to the extent possible with the equipment on hand; however, the backfill was not compacted to the requirements of structural fill. If structures or other project improvements are to be located near the test pit locations, the backfill should be removed and replaced in accordance with the compaction requirements of structural fill. Failure to properly compact the backfill could result in excessive settlement of improvements constructed over the test pit excavations.

The soils were classified in the field based on visual and textural examination in general accordance with ASTM D-2488, Standard Recommended Practice for Description of Soils (Visual Manual Procedure). Additional soil classification was subsequently performed in accordance with ASTM D-2487 (Unified Soil Classification System [USCS]) upon completion of laboratory testing as described below in the Laboratory Analysis section. The final logs represent our interpretation of the contents of the field logs and the results of laboratory testing.

Logs of the exploratory test pits and a brief description of sampling equipment and procedures are presented in Appendix A.

3.2.2 Shaft Sites

Seismic refraction compression wave (p-wave) and refraction microtremor (ReMi) shear wave (s-wave) surface seismic surveys were conducted on March 22-23, 2006 near the two existing open shafts at the Gooseberry Mine. The geophysical surveys were conducted near the two shafts in order to initially characterize the subsurface soil and bedrock conditions to help assess closure options. The two visible shafts are identified as the main shaft and the secondary decline shaft. The locations of the two mine shafts are presented in Figure 2A, Aerial Photograph.

The purpose of the seismic surveys was to identify any near-surface mine excavations (or voids) adjacent to the shafts (e.g. subhorizontally-oriented mine levels or adits, raises, etc.) that may impact closure and development. The survey lines were not placed directly over the existing shaft openings due to safety and technical issues. Shaft openings are always considered to be unstable and should never be approached without appropriate safety equipment. In addition, hammering (required for the seismic refraction survey) near the shaft opening would be very unsafe. Even if the survey lines were placed directly over the shaft opening, the resulting shaft anomaly would destroy or abnormally affect velocity data in subsurface bedrock adjacent to the shaft.

The benefits of using seismic refraction and ReMi survey methods are that they are relatively inexpensive, easy to perform, and are non-destructive in-situ tests that provide general conditions of the subsurface soils and bedrock. Seismic refraction gives a two-dimensional profile that would show a low velocity anomaly that varies laterally. If a stope-type failure is in process near the shafts, it should show up as a low p-wave velocity zone as the rock fractures are opening up. If tension cracks are present, they tend to block p-wave signals entirely. The ReMi technique provides a simplified characterization of relatively large volumes of the subsurface in 1-dimensional vertical (depth) profiles. There is no horizontal variability distinction in the s-wave (ReMi) results. The ReMi technique is described by Louie (2001). When ReMi is performed in conjunction with seismic refraction, ReMi can characterize a lower velocity horizon underlying a higher velocity horizon (velocity reversal) condition that is missed using standard seismic refraction.

Five, 120-foot long combined seismic refraction and ReMi lines were conducted around the perimeter of each existing mine shaft at the locations shown in Figures 2C and 2D. Lines 1 through 5 were conducted near the secondary decline shaft and Lines 6 through 10 were conducted near the main shaft. Descriptions of the procedures and equipment used to conduct the refraction and ReMi surveys are attached in Appendices C-1 and C-2, respectively. The linear survey lines were conducted on flat ground and as close to the shafts as logistically possible. Some of the lines were draped or bent around surficial objects (such as concrete pads or old vehicles) in order to achieve sufficient geophone penetration in the upper ground surface. The interpreted maximum subsurface depth of penetration for the seismic refraction surveys ranged from 15 to 27 feet. The interpreted maximum subsurface depth of investigation for the ReMi surveys ranged from 28 to in excess of 120 feet.

3.3 Laboratory Analysis

3.3.1 General

Laboratory testing was conducted on two composite soil samples from the potential cover soil area to aid in the classification of the soils retrieved from the geotechnical investigation and to determine material properties and suitability as potential cover soils. All testing was performed in accordance with the American Society for Testing and Materials (ASTM) standard test procedures, where applicable. The laboratory test results are provided in Appendix B.

3.3.2 Soil Cover Model Theory

Predicting the flow of water between the soil surface and the atmosphere is a critical issue in the design of soil covers for mine tailings, leach pads, acid generating waste rock and landfills. The flow of moisture between the soil and atmosphere mainly depends on atmospheric conditions (precipitation, solar radiation, temperature), and hydraulic conductivity of the soil and vegetation. Hydraulic conductivity for soils has a maximum value at saturation but decreases dramatically with decreasing water content. In an unsaturated soil, the hydraulic conductivity is significantly affected by combined changes in the void ratio and the degree of saturation of the soil (Fredlund and Rahardjo, 1993).

Unsaturated flow in soil is defined by two functions: soil water characteristic curve (SWCC which is a storage function) and hydraulic conductivity function. The storage function describes the relationship between soil suction (negative pore water pressure) and volumetric water content. The ability of the soil to store water is the function of both the soil suction and the physical characteristics of the soil (grain size distribution, porosity, structure, etc.). A critical point on the SWCC is the Air Entry Value (AEV), which is the suction value where the volumetric moisture content declines. The AEV value defines the soil suction pressure when the soils largest pore spaces begin to drain and transition from tension saturated to unsaturated conditions. At this transition point a corresponding large decrease in the hydraulic conductivity of the soil occurs. The hydraulic conductivity reflects the ability of the soil to transmit the water and it depends on the water content.

Computer numerical simulations can be used to predict the water balance performance of a cover system (e.g. Soil Cover, 2000) but is outside the scope of this project. The soil-water characteristic curve data will be captured for potential soil cover materials near this project and analyzed for suitability.

3.3.3 Composite Sample Description

Two composite samples (Composite number 1 and Composite number 2) from different areas of the potential cover soil area were made and are listed in Tables 1 and 2. The percentages of each soil type represented in each composite sample are listed in Table 3 and were determined based on the representative amounts and types of soils determined in the field investigation for the different resource zones (See Section 5.1). The soil types are described in detail since the SWCC results are partially dependent upon the physical characteristics of the soil mentioned above.

Table 1
Samples Included in Composite Number 1
(Representative of Zones A and A2 – See Section 5.1)

Exploration No.	Sample Depth (ft)	Unified Soil Classification System Group Symbol
TP-3	0-1.1	CH
TP-3	2.0-4.0	SP-SM
TP-3	7.0-9.0	SC
TP-4	0-1.2	ML/CH
TP-4	2.0-4.0	SC-SM
TP-5	6.0-8.0	GM
TP-6	4.5-6.5	SM
TP-7	0.3-3.2	CH
TP-7 Bulk	4.0-6.0	SM
TP-7	6.0-9.0	GM
TP-7	10.0-12.0	GM
TP-10	0-2.0	CH
TP-10 Bulk	5.0-8.0	GP-GM
TP-10	8.0-11.0	SM
TP-11	3.0-5.0	SM

Table 2
Samples Included in Composite Number 2
(Representative of Zone B – see Section 5.1)

Exploration No.	Sample Depth (ft)	Unified Soil Classification System Group Symbol
TP-13	0-1.3	GC
TP-13	1.3-3.5	GP
TP-15	0-1.3	CH
TP-15	1.3-4.0	GP-GM/SM
TP-15	7.0-8.0	GP-GM/SM
TP-16	0-1.3	CH
TP-16	1.3-5.0	GM

Table 3
Soil Type Percentages for the Two Composite Samples

Representative Soil Types in Cover Soil Source Areas (1) (USCS)	Percentage of Soil in Composite Sample No. 1	Percentage of Soil in Composite Sample No. 2
CH	14	11
SP-SM/SM	39	43
SC/SC-SM	7	0
GC	0	6
GP-GM/GP/GM	40	30
Notes: (1) Representative Soils Based on Test Pit Excavations conducted in this study		

The following laboratory tests were performed on the two composite samples at AMEC's laboratory in Sparks, Nevada: gradation analyses (ASTM C136/C117), Atterberg limits (ASTM D4318), moisture content (ASTM D2216), and modified Proctor (ASTM D1557). In addition, soil-moisture characteristic testing was conducted by Daniel B. Stephens and Associates at their laboratory in Albuquerque, New Mexico and includes: saturated hydraulic conductivity – flexible wall K-Sat (ASTM D5084), initial volumetric and gravimetric water content (ASTM D2216/D4643), dry bulk density (ASTM D2937/MOSA Chp. 13), calculated total porosity (MOSA Chp. 18), moisture characteristics – 7 points (ASTM D6836/ASTM D2325/MOSA Chp. 26), and calculated unsaturated hydraulic conductivity (ASTM D6836/SSSAJ 1980). The suitability of the tested soil materials for use as cover materials at the site is addressed in Section 5.1.

Each of the following sections presents a brief discussion of the completed laboratory tests and summaries of the test results.

3.3.4 Gradation Tests

To aid in classifying the soils encountered, gradations and the percent by weight of material passing a No. 200 sieve (silt and clay) were obtained on selected samples of soils. Results of the later test are presented in Table 4, Percent Passing the No. 200 Sieve.

Table 4
Percent Passing the No. 200 Sieve

Sample No.	Sample Area	Percent by Weight Passing No. 200 Sieve	Unified Soil Classification System Group Symbol
Composite Sample No. 1	Zone A/A2	23.0	SC
Composite Sample No. 2	Zone B	23.0	SM

3.3.5 Atterberg Limits Tests

Atterberg limits tests were performed on the portion of the materials passing the Number 4 sieve for the two composite samples obtained during the field program to aid in soil classification and correlation with other material properties of the soils tested. The results of these tests are summarized in Table 5.

Table 5
Atterberg Limits Test Results

Exploration No.	*in situ* Moisture Content (percent)	Plasticity Index			USCS Group Symbol
		Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index	
Composite Sample No. 1	7.2	34	22	12	SC
Composite Sample No. 2	10.1	NP	NP	NP	SM
Notes: NP = Nonplastic					

Results of the Atterberg limits tests indicate that the samples tested exhibit either low plasticity or nonplastic characteristics.

3.3.6 Modified Proctor Test Results

Modified Proctor compaction tests (ASTMD 1557) were conducted to determine the compaction characteristics of typical on-site soils and are summarized in the following table.

Table 6
Modified Proctor Test Results

Project Zone	Borrow Area	USCS Group Symbol	Optimum Moisture Content (percent)	Maximum Dry Density (pcf)
Composite Sample No. 1	Zones A /A2	SC	14.9	114.6
Composite Sample No. 2	Zone B	SM	11.5	117.0

4. SITE CHARACTERIZATION

4.1 General Geological Setting

The project site is located in the Sierra Nevada geomorphic province. The Sierra Nevada ranges from 40 to 100 miles in width, and elevations vary from 400 feet at the western boundary up to 14,000 feet to the east.

The site lies within the north portion of the Virginia Range. The site has been mapped by the Nevada Bureau of Mines and Geology (Bonham, 1969) as being underlain by volcanic rocks of the Tertiary Kate Peak Formation. Bonham (1969) describes this unit as consisting of flows, flow breccia, mudflow breccia, agglomerate, tuffs, and associated intrusives with lenses of silicic waterlain tuff, diatomite, shale, and sandstone. Included in the Kate Peak Formation are plugs of hornblende-biotite andesite, dacite, or rhyodacite porphyry. Quaternary stream deposits consisting of talus, slope wash, and alluvial fan deposits have been mapped east of the mine (Bonham, 1969).

One curved northwest- to east-striking fault of unknown age is mapped by Bonham (1969) as being located approximately 0.79 miles west and 0.40 miles south of the Gooseberry mine shafts. In addition, the mine is reported to be located on a fault that was not mapped by Bonham (1969). Our review of available geologic mapping indicates that no active faults have been mapped at the site.

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4.2 Local Surface Conditions

The 90-acre Gooseberry Mine facility is located in an area that rapidly is becoming industrialized in Storey County, Nevada in Section 25 Township 19N, Range 22E of the Mount Diablo Meridian. The site is located approximately 7 miles south of Interstate Highway 80 (I-80) and 26 miles east of Reno, Nevada. Access to the mine is via an unmarked single track extension south of USA Parkway from the Tracy Clark exit of I-80.

The site is bordered on the north and west by undeveloped mountains, to the south by a ridge and drainage divide, and on the east by an unnamed valley. Bureau of Land Management (BLM) land is outlined in Figure 2A.

The majority of the structures at the site are located on County property as shown in Figure 2A. Existing structures and facilities at the site include: Mine/mill complex; administration area with office buildings, laboratory, storage facilities, and yards; heap leach pad and associated ponds; tailings facility; landfill and other lesser areas of dumping; and waste rock dump. Chain-linked fences surround the tailings pond, the heap leach pad, and the main mine site. Old plastic water lines remain at or near the surface on the northeastern part of the site. One moderately-sized fill stockpile approximately 100-feet wide by 100-feet long and up to 6 feet tall is present near the northeast corner of the barren pond and consists dominantly of cobbles and boulders up to 6 feet in diameter (Photograph No. 2B, Appendix E).

Moderately thick cheat grass and lesser sagebrush and other weeds up to 2 feet tall covers the surface throughout the site. Rare isolated trees up to 12 feet tall are present near the drainage basins.

More detailed descriptions of the soil cover source areas and shafts are presented in the following sections.

4.2.1 Potential Soil Cover Area

Based on available geologic mapping, topography, and the initial site reconnaissance, the best areas for potential near-surface, cover soil source materials appear to be located directly north, northeast, and east of the heap leach pad and the tailings pond (Figures 2A and 2B). Three potential soil cover source areas cover approximately 15 acres and lie east of the Gooseberry Mine buildings, and north and northeast of the existing heap leach pad (Figures 2A and 2B, Site Plans). The three potential soil cover areas are grouped based on location and subsurface soil types and are described in detail in Section 5. The largest potential soil cover source area (Zones A, A1, and A2) covers approximately 10 acres and lies along the main access road to the mine along a gentle easterly- to southeasterly-facing slope (Photograph No. 2B, Appendix E). The second potential soil cover source area (Zone B) covers approximately 3 acres and lies east of the Martin Canyon drainage up on an alluvial fan terrace on a gently westerly-facing slope. The third potential soil cover source area (Zone C) lies immediately south of the barren pond and is the smallest area of the three only covering approximately 2 acres.

The potential cover soil source areas are located in Martin Canyon, an ephemeral drainage that ultimately discharges to the Truckee River. This area has been mapped by the Nevada Bureau of Mines and Geology as consisting of Quaternary alluvium soils. Numerous cobbles and boulders up to 4 feet in diameter are present on the surface within the alluvium and are more abundant along or near the main drainages. This area has low amounts of bedrock exposed at the surface (Fig. 2B). Several bedrock outcrops of the Kate Peak Formation were mapped by AMEC near the outer boundaries of the potential cover soil source areas and are shown in Figure 2B. Bedrock exposures are more abundant at the main mine site near the shafts and on top of topographic ridges.

Topography in the potential soil cover source area ranges from 5230 feet on the northeast to 5380 feet to the southeast. The ephemeral drainage that lies along Martin Canyon bisects the area of the potential borrow source area. Existing dirt access roads access most of the potential borrow source area with the exception of extreme southeastern portion that is isolated from the rest of the area by the Martin Canyon drainage. No surface water is present at the site, except for the tailings pond facilities.

4.2.2 Main Gooseberry Mine Shaft Area

The main Gooseberry shaft opening is approximately 12 feet wide by 13 feet long, covered by steel plates, and totally secured by a locked steel cage (Appendix E – Photograph Nos. 3 and 5). The main shaft is reported to extend to approximately 1,375 feet based on information from Dennis LaPrarrie (former employee at Gooseberry). Dennis reports that the first tunnel off of the main shaft is at 500 feet below the surface. An approximately 70-foot tall steel head frame exists over the main shaft site. Site conditions at the main shaft site are shown in Figure 2C, Site Plan.

The topography at the main shaft site is generally flat. A moderate to very steep south-facing cut slope approximately 15 feet high lies to the north of the existing main mine building and main shaft. Moderate amounts of tumble weeds and brush lie on the northeast corner of the main mine building site. Trace brush up to 2 feet tall lies near the main head frame area. At the time of the surface seismic study, there was approximately 1 to 4 inches of patchy snow on the surface near the northeastern corner of the main mine building. Most of the surface had no snow cover at the time of this investigation.

Andesite porphyry bedrock is exposed in a cut approximately 15 feet tall that lies approximately 40 feet north of the main shaft site. The andesite porphyry is variably altered and weathered, and contains distinct fracture sets. The andesite porphyry bedrock exposed in the cut lies approximately 145 feet south of the secondary decline mine shaft collar. Obvious fill near the main shaft site appears to be confined to an area west of the hoist room building (Figure 2C).

4.2.3 Secondary Decline Shaft Area

An 8.5 feet wide by 8.5 feet long second shaft opening lies approximately 300 feet north of the main shaft (Figure 2D and Photograph Nos. 4 and 6, Appendix E). This shaft is reportedly a decline shaft that could have been used as a second escape way route, for ore/waste transportation, and/or as a ventilation source. The shaft is partially open and contains various timbers and rusty steel materials next to the opening. A short chain-linked fence surrounds the decline shaft. A small hoist (steel) building lies to the north of the open shaft. Diamond drill core from previous exploration drill holes are stacked directly north of the small hoist building, and also to the northeast of the shaft. Gravel access roads lie to the south and the west of the decline shaft. A conveyor belt lies approximately 65 feet due south of the decline shaft collar. Some brush up to 2.5 feet tall lies on the surface near the decline shaft.

The topography at the existing decline shaft site is generally flat. The surrounding area lies on a gentle easterly-facing slope. The elevation of the decline shaft is approximately 25 to 30 feet higher in elevation relative to the main Gooseberry mine shaft collar elevation.

The eastern side of the decline shaft site is underlain by up to 8 feet of obvious fill that is located on a benched flat pad (Figure 2D and Photograph No. 4, Appendix E). Fill of unknown thickness is also located south of the decline shaft and south of the gravel access road.

The depth and steepness of the decline shaft is unknown but it reportedly joins the main shaft at depth based on information from Dennis LaPrarrie (former employee at Gooseberry). Dennis also reports that there are tunnels at 100 foot vertical intervals off of the decline shaft. The first level is reportedly at 100 feet below the surface.

4.2.4 Other Holes

A 1.0-foot diameter open hole lies approximately 25 feet north of the northeastern corner of the main mine building (Figure 2C). The depth and purpose of this open hole are unknown. A substantial amount of brush partially covers the open hole which made it difficult to assess from the surface. A 4-inch diameter cased open hole also lies approximately 8 feet southwest of the northwestern corner of the concrete slab (Figure 2C). The concrete slab lies directly east of the main shaft. The depth of the 4-inch diameter hole is unknown.

4.3 Geotechnical Profile at the Potential Soil Cover Area

At the test pit locations, the soils encountered are generally consistent and consist of a thin near-surface fat clay layer that overlies coarse-grained alluvial soils consisting of silty sand, silty gravel, and lesser clayey sand. The alluvial soils are underlain by variable volcanic bedrock materials. For our soil cover assessment the soils have been grouped into 5 zones (A, A1, A2, B, and C; Figure 2B). More details of the 5 zones mentioned above (Section 4.2.1) and are provided in Section 5.

The near-surface soil consists of dark brown, moist, high plasticity, soft to stiff sandy fat clay. The upper 6 to 12 inches at the surface contains major roots and have been classified as topsoil.

The underlying soils consist of silty gravel, silty sand, gravel with silt and sand, and clayey sand to depths of 0.6 to more than 17.0 feet below the surface. These coarse-grained soils are typically slightly moist, dense to very dense, and may contain moderate to significant amounts of subangular cobbles and boulders up to 4 feet in diameter.

Bedrock consisting of basalt, basaltic andesite, and rhyodacite was encountered at TP-02, TP-04, TP-06, TP-07, TP-11, TP-18, TP-19, and TP-20 at depths ranging from 0.7 to 13.0 feet. The bedrock is generally very dense, weakly weathered, exhibits very strong to strong competency, and was very difficult to excavate. Some tuff bedrock located in the northeast part of the site (TP-01) is highly weathered, exhibited weak competency, and was very easy to excavate. Excavator refusal was encountered at depths of 3.8 to 14.0 feet at TP-3, TP-4, TP-6, TP-7, TP-11, TP-13, and TP-20.

4.4 Geotechnical Profile at the Shaft Areas (Geophysical Results)

The subsurface conditions at the two mine shafts are based on the seismic refraction and ReMi geophysical results (Appendix C). Tables 7, 8, 9, and 10 summarize the average characteristic p-wave and s-wave velocities for the various subsurface soil/bedrock layers and the range in interpreted depths of each layer at both shafts. The summaries also present average bedrock conditions from which an interpretation of subsurface voids can be made.

Table 7
Summary of P-Wave Results From the Seismic Refraction Surveys at the Main Gooseberry Mine Shaft Area (Lines 6 through 10)

Layer Number(1)	P Wave Range (ft/sec)	P Wave Velocity Average (ft/sec)	Approximate Layer Thickness (Range) (ft)	Average Layer Thickness (ft)
1	830 – 2,600	1,424	2.0 – 7.0	3.7
2	1,800-8,900	4,078	5.0-14.0	11.2
3	4,800-12,400	6,944	>4.0 to >11.0	>7.2

Notes: (1) Corresponds to near-surface layer and larger numbers correspond to deeper layers

Table 8
Summary of S-Wave Results From the Refraction Microtremor Surveys at the Main Gooseberry Mine Shaft Area (Lines 6 through 10)

Layer Number(1)	S-Wave Range (ft-sec)	S Wave Velocity Average (ft/sec)	Approximate Layer Thickness (Range) (ft)	Average Layer Thickness (ft)
1	440 - 660	558	2.0 – 4.0	2.9
2	1,000 – 2,200	1,640	5.0 – 10.0 (2)	8.5
3	1,300 – 2,300	1,883	40.0 – 63.0	52.0
4	2,800 – 3,200	2,967	unknown	unknown

Notes: (1) number one corresponds to near-surface layer and larger numbers correspond to deeper layers
(2) data excludes layer number 2 in line No. 10 that is 30 feet thick

Table 9
Summary of P-Wave Results From the Seismic Refraction Surveys at the Secondary Decline Mine Shaft Area (Lines 1 through 5)

Layer Number(1)	P Wave Range (ft/sec)	P Wave Velocity Average (ft/sec)	Approximate Layer Thickness (Range) (ft)	Average Layer Thickness (ft)
1	560 – 1,600	1,120	2.0 – 5.0	2.9
2	1,100 – 4,700	3,344	5.0 – 15.0	8.6
3	3,600 – 6,900	4,950	>2 to >15	>7.9

Notes: (1) number one corresponds to near-surface layer and larger numbers correspond to deeper layers

Table 10
Summary of S-Wave Results From the Refraction Microtremor Surveys at the Secondary Decline Mine Shaft Area (Lines 1 through 5)

Layer Number[1]	S-WaveRange (ft-sec)	S WaveVelocity Average (ft/sec)	Approximate Layer Thickness (Range) (ft)	Average Layer Thickness (ft)
1	430 - 630	528	2.5 – 4.0	3.3
2	1,200 – 2,000	1,633	6.5 – 11.0	8.5
3	1,300 – 2,900	2,160	5.0 – 15.0	8.8
4	1,200 – 2,400	1,560	14.0 – 32.0 (2)	22.8
5	1,500 – 6,000+	3,500	Unknown	unknown

Notes: (1) number one corresponds to near-surface layer and larger numbers correspond to deeper layers
(2) data excludes layer number 4 in line No. 10 that is 68 feet thick

The results of the surface seismic surveys indicate that a majority of the subsurface bedrock adjacent to the two shafts are associated with low p-wave and s-wave velocities. These low velocities suggest that the bedrock is either moderately to highly fractured and may indicate effects of stress relief near the shaft excavations. P-wave velocities for intact, unfractured and unweathered volcanic rocks range from 15,680 to 21,000 ft/sec while s-waves average 10,500 ft/sec (Berkman, 1976; Dobrin, 1976) which are significantly higher than those velocities documented near the two mine shafts at the Gooseberry Mine. In addition, the low p-wave velocities less than 2000 ft/sec determined at the two shafts sites in the upper one to two layers suggest very strongly weathered, completely weathered, and/or crushed rock conditions (Hunt, 2005).

Dipping subsurface bedrock units that are relatively deep (10 to 20 feet below the surface) were observed in the north end of Line 6, the south and north ends of Line 9, the west and east ends of Line 2, the east end of Line 3, and the south end of Line 5.

P-wave velocities typical of fill (1,000 to 2,800 ft/sec) were identified surrounding the secondary decline shaft at the eastern end of line 3, the northern end of Line 4, and the southern end of Line 5. Shallow less compacted fill generally has lower p-wave velocities. The fill thickness surrounding the decline shaft is interpreted to range from 2 to 19 feet. The condition and depths of the potential fills needs to be confirmed with other investigation techniques such as test pits or borings.

4.5 Groundwater and Soil Moisture Conditions

No groundwater was encountered in any of the test pit excavations at the time of this study. The Bureau of Land Management has reported that the depth to ground water at the main vertical Gooseberry mine shaft is 500 to 700 feet below the surface (personal communication, Nueman, 2006).

Most of the soils encountered in the test pit excavations were in a slightly moist to moist condition.

5. DISCUSSION AND RECOMMENDATIONS

5.1 Cover Material Assessment

The potential cover soil source area has been grouped into five zones as shown in Figure 2B and identified as A, A1, A2, B, and C. The five zones are grouped based on subsurface soil and bedrock conditions encountered in the test pits and their general geographic locations (See Section 4.2.1). Adjacent zones A, A1, and A2 are located directly north and northeast of the heap leach pad. Zone B is located on the eastern side of the Martin Canyon drainage on top of an elevated alluvial fan bench. Zone C is the smallest zone and is located immediately south of the barren pond. Table 11 summarizes the total thicknesses of fine-grained near-surface fat clay soils and the thickness of deeper coarse-grained soils encountered in those test pits within the 5 zones.

Because the soils are generally consistent within their designated zone, the two composite samples submitted for laboratory testing (see Section 3.3) were selected to represent all of the soils encountered in that zone.

The average thicknesses for each soil type were used to calculate the estimated representative volumes for each zone. The averages soil thicknesses presented are very conservative and in almost all cases do not include the total amount of available coarse-grained soil materials encountered in the test pits. The average thicknesses of soil are based on the upper 9.0 to 13.5 feet or refusal. Fine-grained near-surface clay soils were grouped separately from the deeper coarse-grained soils in case future studies required estimated available volumes of available topsoil and/or clay. Fine-grained soil thicknesses in Zones A, A1, and A2 ranged from 0 to 1.6 feet thick. The average thicknesses determined for the coarse-grained soil materials were generally set as the minimum thickness available within all of the test-pits in that designated zone. Coarse-grained soil thicknesses in Zones A, A1, and A2 ranged from 8.9 to 12.0 feet thick (Table 11).

Table 11
Summary of Available Thicknesses of Fine-Grained and Coarse-Grained Soils by Zone and Test-Pit

Zone	Test Pit No.	Thickness of Surficial Fine-Grained Soil (ft)	Thickness of Coarse-Grained Soil (ft)
A	TP-3	1.1	8.9
	TP-4	1.2	6.8
	TP-5	1.3	15.7
	TP-10	2.0	9.0^+
	TP-11	0	9.9
	AVERAGE	**1.1**	**8.9**
A1	TP-12	0	9.0^+
	TP-17	0	9.0^+
	AVERAGE	**0**	**9.0**
A2	TP-5	1.3	15.7
	TP-6	1.5	10.0
	TP-7	2.0	11.0
	AVERAGE	**1.6**	**12.0**
B	TP-13	0	6.5
	TP-14	1.0	0
	TP-15	1.3	6.7
	TP-16	1.3	7.7
	AVERAGE	**0.9**	**6.5**
C	TP-18	2.8 (from 3.0-5.8')	3.0 (at surface from 0 to 3.0 ')
	TP-19	0.7	1.0
	TP-20	1.8	1.7
	AVERAGE	**1.3**	**0.7**

Notes: 1) Average thicknesses listed were used in the resource calculations in Table 11 and are considered to be very conservative
2) Average thicknesses are based on upper 9 to 13.5 feet or refusal.

These soil units may be mined using typical mass-grading procedures with scrapers using the top-to-bottom construction/mining methods.

Table 12
Total Estimated On-Site Soil Cover Materials

Zone	Width (ft)	Length (ft)	Average Surficial Fine-Grained Soil Thickness (1) (ft)	Average Surficial Coarse-Grained Soil Thickness (1) (ft)	Total Surficial Fine-Grained Soil Volume (cubic yards)	Total Coarse-Grained Soil Volume (2) (cubic yards)
A	410	700	1.1	8.9	11,693	94,604
A1	100	360	0	9.0	0	12,000
A-2	200	500	1.6	12	5,926	44,444
B	200	600	0.9	6.5	4,000	28,889
C	200	500	1.3	0.7	4,815	2,593
Total Including Oversize materials					26,433	182,530
Total Reduced 10 percent for Oversize Material in Coarse-Grained Soils					26,433	164,277
GRAND TOTAL (No Oversize Materials)					190,710	

Notes: 1) Average thicknesses of soil for each resource zone derived from Table 11 for each soil type
2) Total coarse-grained soil volume includes oversize materials (cobbles and boulders)

The estimated total volumes of coarse-grained soil materials listed in Table 12 include an estimate of 10 percent oversize materials (cobbles and boulders). The oversize materials will not be suitable for reuse for reclamation. Accordingly, approximately 190,710 cubic yards of total available soil cover materials (including both fine-grained and coarse-grained soils) are available in the 5 zones. We estimate that this total value has an accuracy of ±25 percent.

The two composite soil samples have engineering properties (Saturated Volumetric Water Content, Ksat and the Soil Water Retention Curves - SWRC) at the 80 percent target remold density that are capable for use as an evapotranspiration soil cover. The thickness design of the cover is dependent on numerous factors.

Silty sand and clayey sand covers with similar SWRC's have been evaluated for use in arid regions. The range in thickness for the caps is mostly between 40 and 150 cm (15 to 60 inches). Plant cover, even in arid areas, has a dramatic effect of drainage through a soil cover. Young et al. (2006) have studied the performance of silty sand covers at Edwards Air Force Base in Lancaster, California. The average annual precipitation at that site is 5.8 inches and the annual potential evaporation is 78.7 inches. Drainage rates through the cover have been able to be reduced to as low as 0.5 cm per year for the thicker covers at the optimal plant coverage.

5.2 Initial Shaft Capping Assessment

The primary objectives of the shaft closures are to protect public safety and to provide reasonable support for possible future development at the sites. The surface seismic results indicate that there are no near-subsurface voids underlying the immediate subsurface adjacent to the shafts. Anomalous time delays or attenuation of p-wave first arrival signals, or general signal loss, would be characteristic of very loose ground or significant subsurface tension cracking that could indicate shallow subsurface voids. We also anticipate that the bedrock adjacent to both shafts is moderately to highly fractured. Based on these initial findings, we recommend that cast-in-place concrete plugs be used to cap the existing shafts. Prior to final design we recommend additional field investigations near the shaft openings to determine the subsurface bedrock and/or soil conditions.

Shaft closure options will have to account for the poor rock conditions identified in the initial field investigation (geophysical results) at both shaft sites. Due to the deep shaft excavations approaching 1400 feet and the high number of reported tunnels off of the shafts, complete backfilling of the shafts and associated excavations is not feasible or recommended. The recommended closure option for both shaft sites consists of a shallow shear key plug coupled with light-weight concrete fill, and an overlying structural reinforced concrete cap. Installing a shear key involves excavating a lip that is two or more feet larger in diameter than the shaft approximately 10 to 20 feet below grade. A reinforced concrete plug is installed on the lip and then lightweight concrete is used to fill the remainder of the shaft. A structural concrete cap at least twice the diameter of the underlying concrete fill plug would then be placed over the shaft to existing grade. The concrete plug/cap system may be established upon bedrock or structural fill but not upon non-engineered fill.

To reduce the potential for post-closure settlements, any fills present at the location of the concrete plug/cap will need to be removed and replaced with structural fill and/or concrete. All existing steel structures, including the head frame and the locked steel cage, will need to be demolished, removed from the site, and hauled to a county approved disposal site. Surface waters at both shaft sites will need to be diverted away from the main collar areas and may require engineered drainage systems. Long-term (gated or locked) access to the existing shafts is not proposed.

The low velocities measured in subsurface bedrock and fills from the seismic refraction and ReMi surveys indicate that heavily loaded structures built over the shaft sites may be subject to some settlement. Any structures built over the shaft sites will need additional geotechnical investigations to determine the depth and lateral extent of fill and rock quality. In any case, we recommend that settlement sensitive or heavily loaded facilities not be established over or adjacent to the shafts.

For final concrete plug/cap design an additional field investigation consisting of 3 to 4 test pits at each shaft site (at 90 degree angles to one another) to determine the subsurface conditions near the shaft openings. The subsurface materials would be logged for geology and geotechnical conditions that would help determine the appropriate "keyed" dimensions of the shallow shear key plug. In addition, existing construction materials near the shaft opening could be verified. Safety of the field personnel during the test-pit excavations would be a high priority and would likely involve tying off to properly secured equipment. The proposed field investigation would preferably be conducted after the demolition and removal of all surface structures. Drilling is not recommended.

In addition to the exploration test-pit excavations, geotechnical mapping of the ~15-foot high cut bedrock exposure located about 34 feet north of the existing main shaft is recommended. Fracture orientation, fracture coatings, and fracture density data results from the bedrock mapping could be projected to the area of the proposed concrete plug/cap and would be useful in the final closure design.

5.3 Drainage Assessment

The existing tailings impoundment and heap leach pad are located approximately 500 feet east, and 1650 feet southeast, respectively, of the main Gooseberry mine shaft within existing drainage channels (Figure 2E). For this study, the runoff volume determinations for the seven drainage basins draining into the aforementioned facilities were calculated using the 100-year, 24-hour duration event (Appendix D). The precipitation depth for the design storm event was from the Precipitation Frequency Atlas for Nevada (Bonnin et al., 2006) is 3.88 inches.

The runoff volume determination used for on-site areas was based on the TR-55 Graph Method described by McCuen (1982). The TR-55 Graph Method employs the following estimated values to determine peak discharge volumes: return period for design, the precipitation volume (depth) in inches, runoff curve number, drainage area (in square miles), and estimates of time-of-concentration based on slope gradient, hydraulic length, time in hours from the center of mass of rainfall excess to the peak discharge, and time lag. Both the Lag Method and the Velocity Methods were calculated and are shown in Appendix D. The results of both methods are summarized in the following table.

Table 13
Estimated Peak Discharge Values

TR-55 Graph Method(1)	Affected Facility	Estimated Peak Discharge (cfs)	
		Lag Method	Velocity Method
Basin No. 1	Tailings Impoundment	106	124
Basin No. 2	Tailings Impoundment	65	70
Basin No. 3	Heap Leach Pad	55	67
Basin No. 4	Heap Leach Pad	182	212
Basin No. 5	Heap Leach Pad	139	161
Basin No. 6	Heap Leach Pad	189	233

Notes: (1) McCuen (1982)
(2) Basin locations are shown in Figure 2E.
(3) Peak Discharge calculations are presented in Appendix D.

We recommend using the Lag Method peak discharge values. The method of determining and calculating the peak discharge values using the Velocity Method are too generalized and interpretive in our opinion.

The existing drainage channel near the heap leach pad lies on the northern margin. The plan is to stabilize the slopes of the heap leach pad by recontouring them to approximately 3:1 (H:V). The stabilization of the heap leach slopes will encroach upon the existing drainage channel to the north. The tailings ponds and reworked tailings areas (Figures 2A and 2E) are located on a slightly elevated topographic ridge and are surrounded by two north-northeast flowing drainage channels. The peak discharge values associated drainage basins near the reworked tailings and ponds are considered insignificant.

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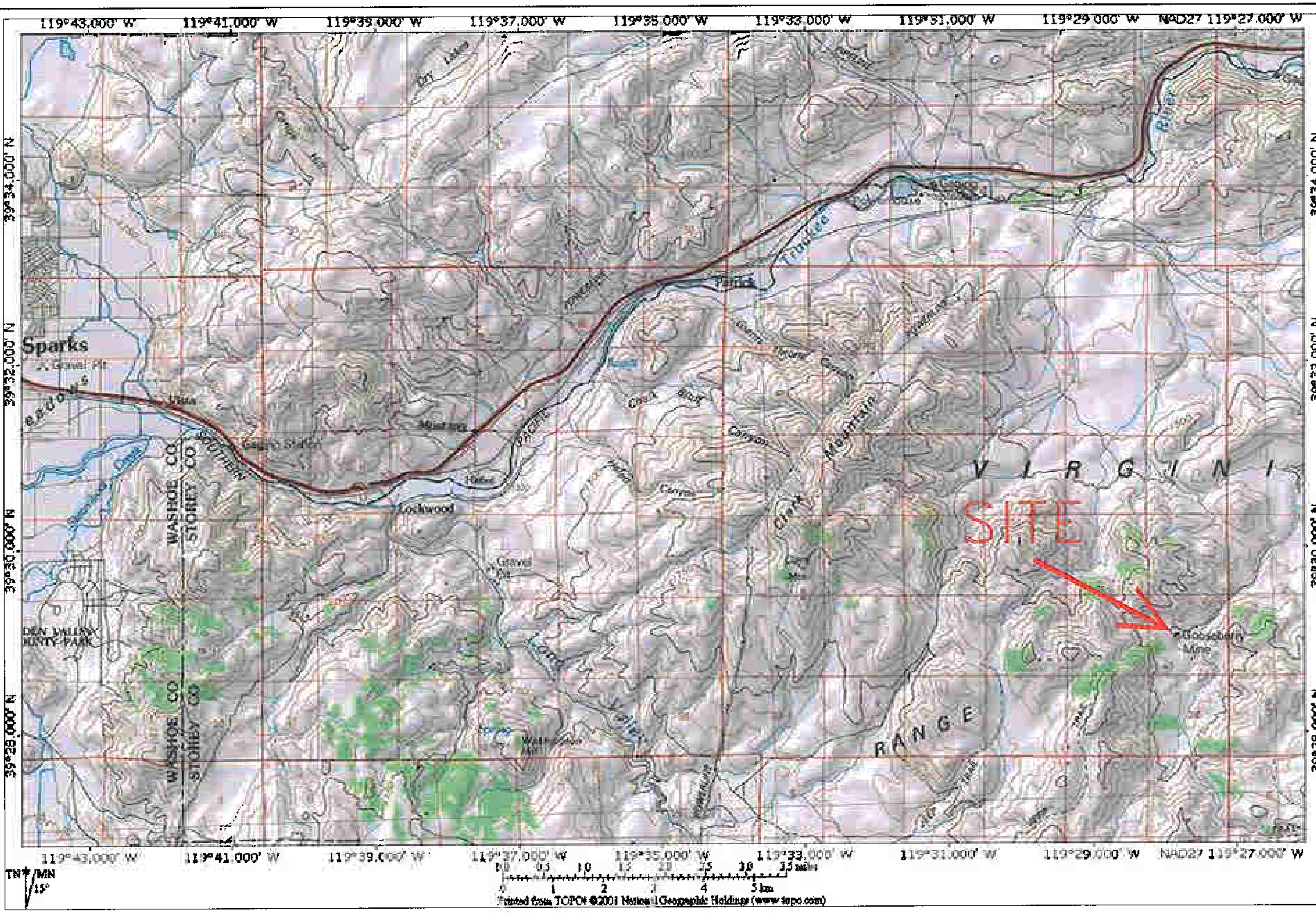

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JOB NO.	6-417-000720
DESIGN	---
DRAWN	TJ
DATE	4/06
SCALE	graphical

FIGURE 1
VICINITY MAP
GOOSEBERRY MINE
NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION
STOREY COUNTY, NEVADA

AMEC DRAWING NO. 720-Fig1.dwg

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CLIENT NEVADA DIVISION OF ENVIRONMENTAL PROTECTION

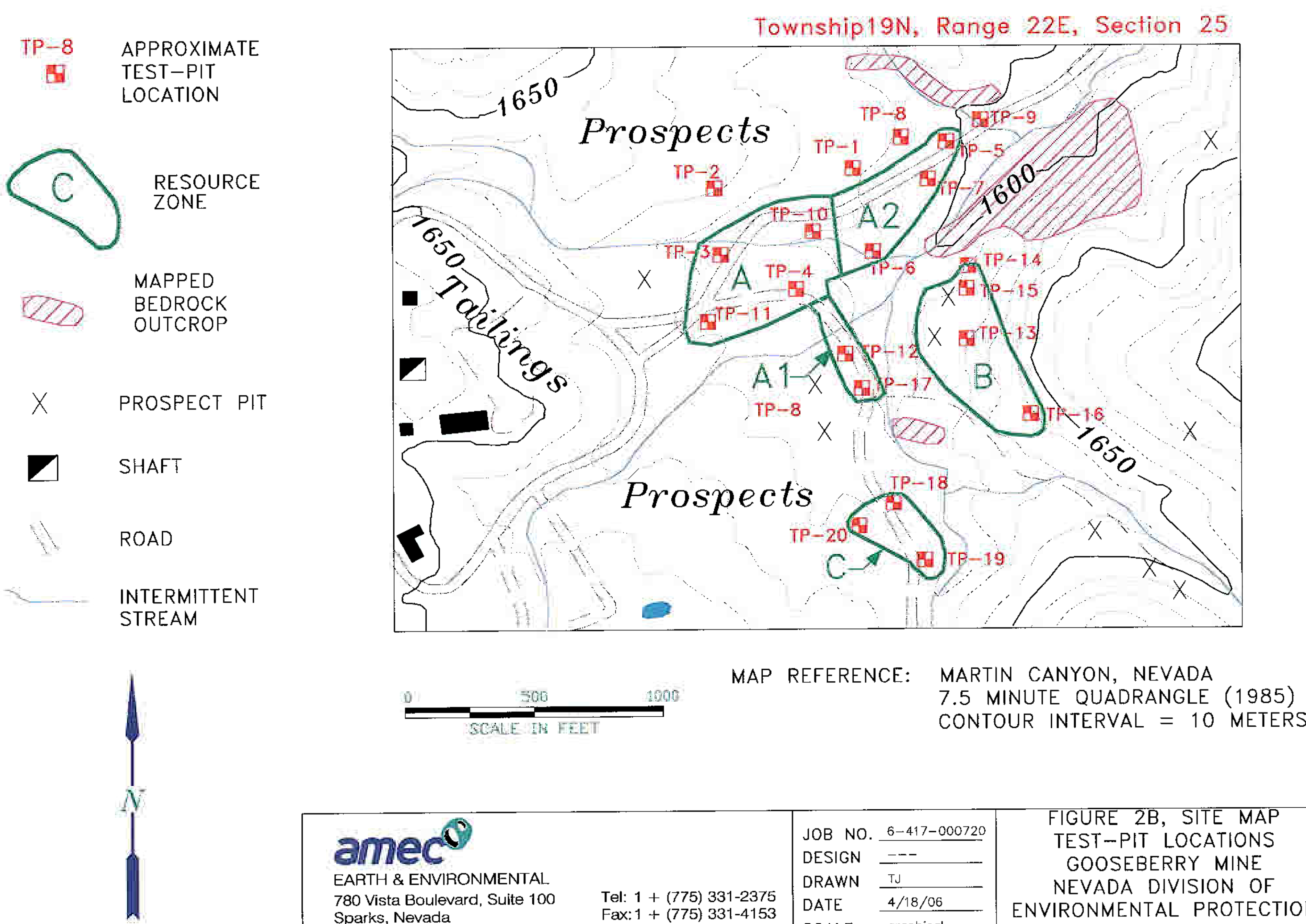
PROJECT GOOSEBERRY MINE, STOREY COUNTY, NEVADA

TITLE AERIAL PHOTOGRAPH

MAP REFERENCE: SRK CONSULTING, INC. (DRAWING NO. 147704)

DWN BY: LM	DATUM: –	DATE: 04/18/06
CHK'D BY: MB	REV. NO.: A	PROJECT NO: 6-417-000720
PROJECTION: --	SCALE 1" = 300 FT.	FIGURE No. FIGURE 2A

J:\ENGINEER\AEE-PROJECTS-BY-JOB-NO\2006\6417\000720\Cover Soil, Drainage, Shaft Report\Figures\FIG 2A site map.dwg - 8.5x11 PDF - Apr. 21, 2006 2:08pm - todd.johnson



MAP REFERENCE: MARTIN CANYON, NEVADA
7.5 MINUTE QUADRANGLE (1985)
CONTOUR INTERVAL = 10 METERS

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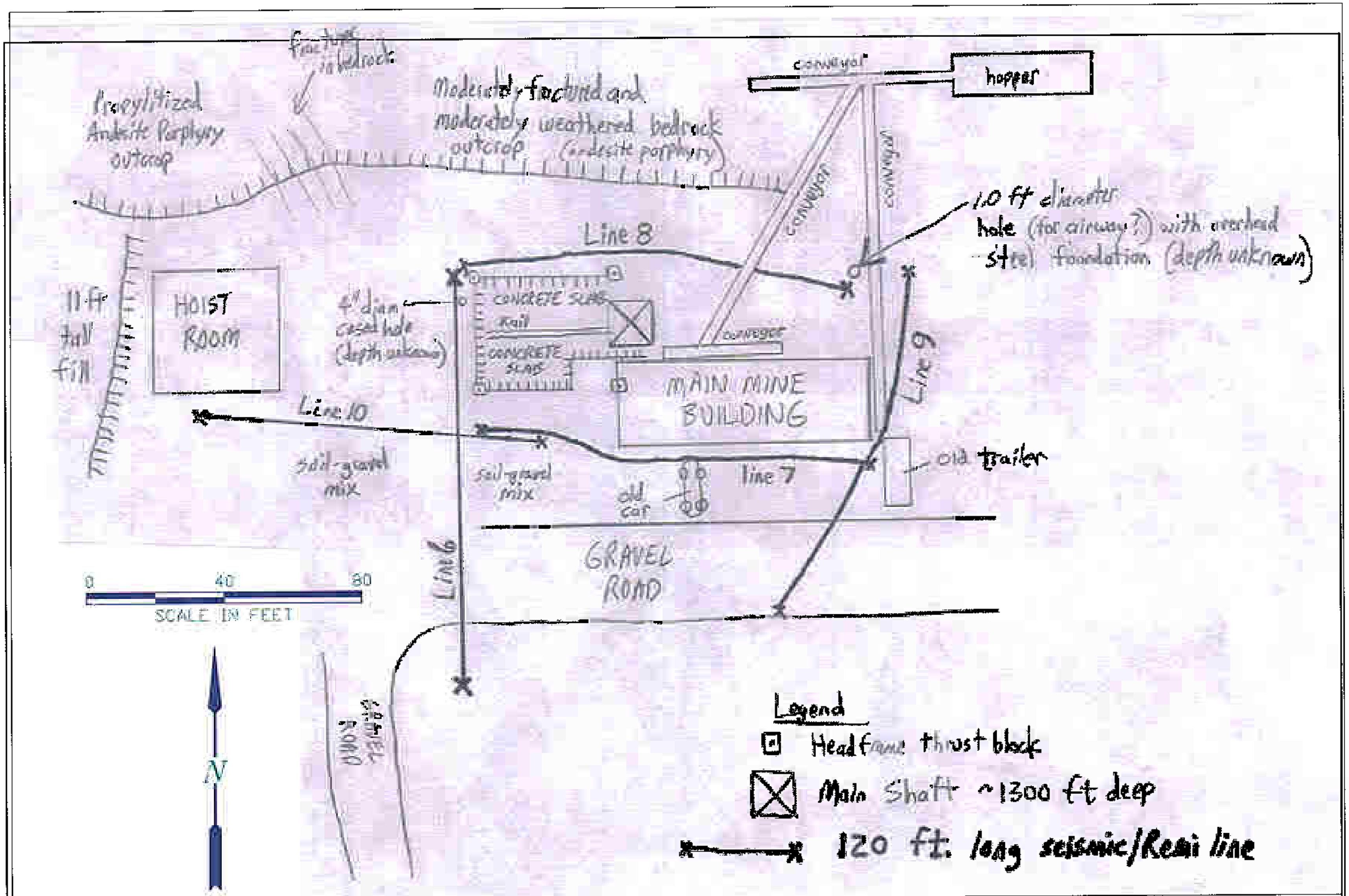
DATE	4/18/06
SCALE	graphical

FIGURE 2B, SITE MAP
TEST-PIT LOCATIONS
GOOSEBERRY MINE
NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION
STOREY COUNTY, NEVADA

AMEC DRAWING NO. 720-Fig2B.dwg



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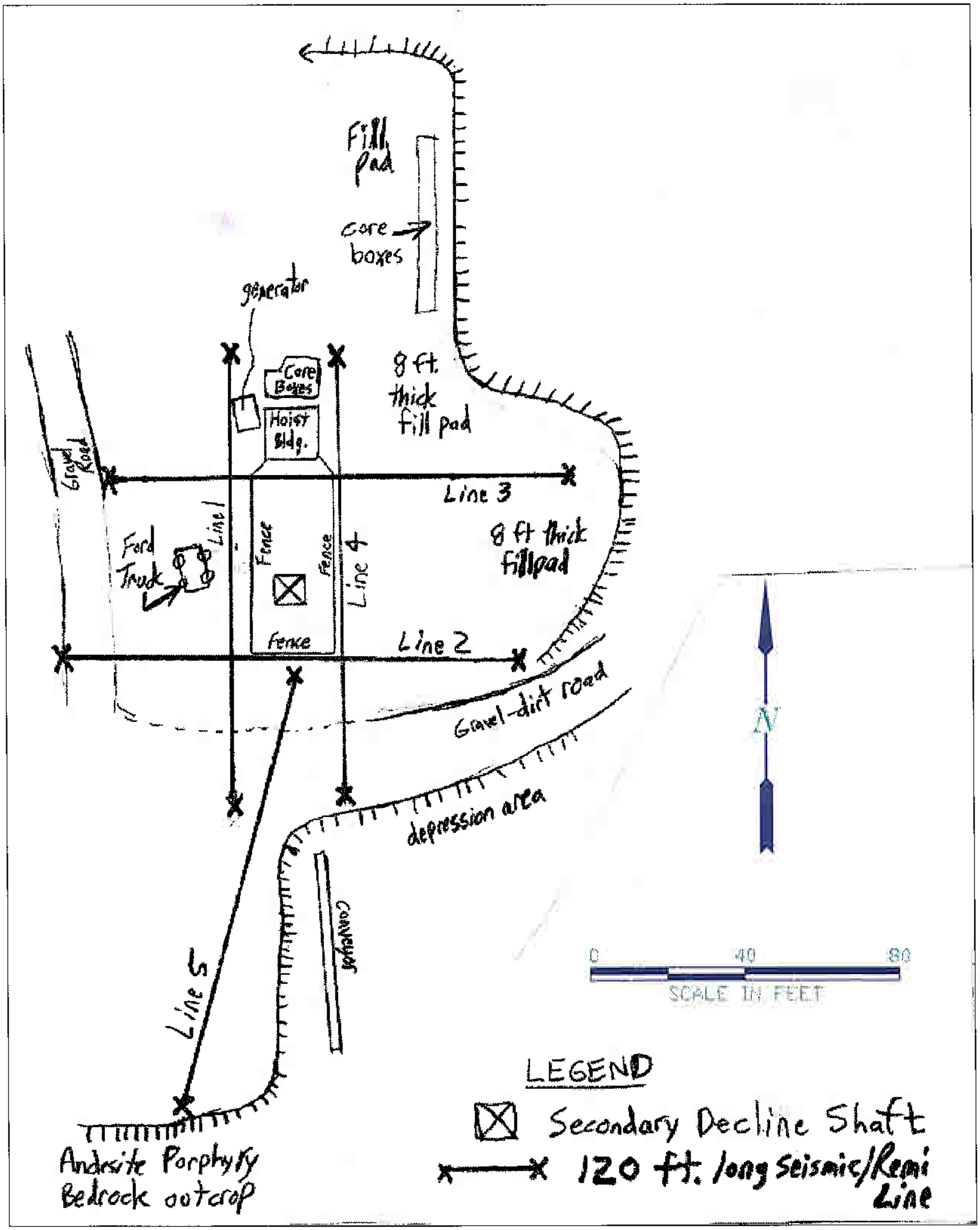
SCALE	1" = 40 FEET

FIGURE 2C, SITE MAP
MAIN MINE SHAFT
GOOSEBERRY MINE
NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION
STOREY COUNTY, NEVADA

AMEC DRAWING NO. 720-FIG2C.DWG



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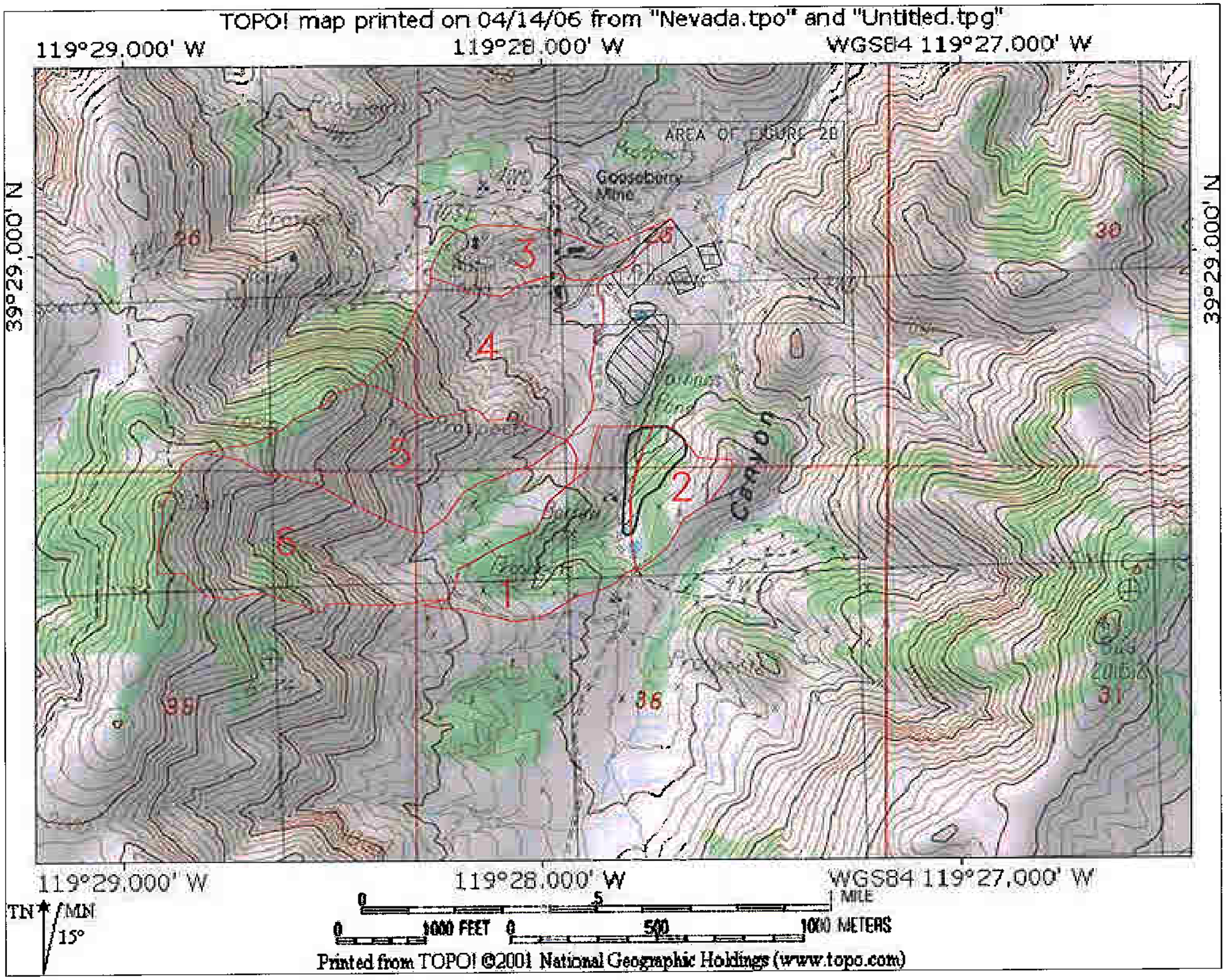
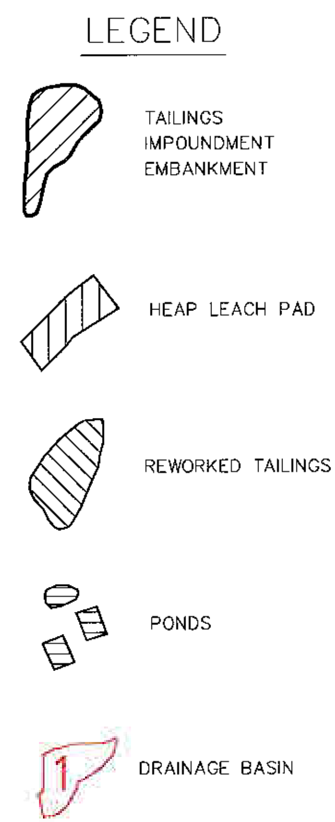
SCALE	1" = 40 FEET

FIGURE 2D
DECLINE SHAFT AREA
GOOSEBERYY MINE
NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION
STOREY COUNTY, NEVADA

AMEC DRAWING NO. 6417000720–FIG2D.DWG





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SCALE	graphical

FIGURE 2E, SITE PLAN
DRAINAGE ASSESSMENT
GOOSEBERRY MINE
NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION
STOREY COUNTY, NEVADA

AMEC DRAWING NO: 6417000720 Fig2E.dwg