3 Affected Environment

The affected environment described in this section addresses the environment of all on-site project alternatives.

3.1 GEOLOGY/SOILS/MINERAL RESOURCES

3.1.1 General

Within this section, information sources that are not specifically cited are based on data from the following references listed in Chapter 8.0:

- Baker Consultants, Inc., 1999
- Environmental Solutions, Inc., 1987
- Environmental Solutions, Inc., 1993a
- Environmental Solutions, Inc., 1993b
- Sergent Hauskins & Beckwith, 1984
- Gold Fields Mining Corporation, 1987

Baker Consultants, Inc. 1999, *Draft Report Hydrologic and Geochemical Study, Proposed Mesquite Mine Expansion, Imperial County, California,* provides details for a comprehensive hydrogeologic and geochemical study for the mine pit areas, and is the primary reference for discussion of those subjects within this chapter. The other references listed above were prepared in conjunction with previous activities at the Mesquite Mine and provide additional data encompassing the overall mine site and local and regional setting.

Additional incorporated references are specifically cited in the text, where appropriate.

3.1.2 Scope and Regulatory Status

Discussion of the existing geology/soils/mineral resources environment focuses on topics that are pertinent to: (1) seismic effects that could potentially affect the proposed mine expansion and associated facilities; (2) the effects that development and operation of those facilities could have on geology/soils/mineral resources; and (3) geochemical characteristics of rocks in the mine pit areas that have potential to affect water quality.

The Colorado River Regional Water Quality Control Board (RWQCB) in Palm Desert, California, is responsible for issuing Waste Discharge Requirements (WDRs) for the proposed expansion.

Demonstrated project compliance with California Code of Regulations (CCR) Title 27 requirements for mine waste management units would be required for the issuance of the WDRs. Title 27 is designed, in part, to ensure that containment systems for heap leaching of ore maintain integrity during earthquakes. In accordance with Title 27, the proposed leach pad expansion could not be built on land that has been ruptured by Holocene faults (i.e., faults active within the past 10,000 years).

Uniform Building Code (UBC) Seismic Zone 4 requirements, the most stringent in the UBC, would be met during the design and construction of all facilities and structures that are subject to the UBC. Other appropriate civil-structural design criteria include the American Institute of Steel Construction "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings;" the American Concrete Institute Building Code Requirements for Reinforced Concrete; and the American Society for Testing and Materials, for various construction materials.

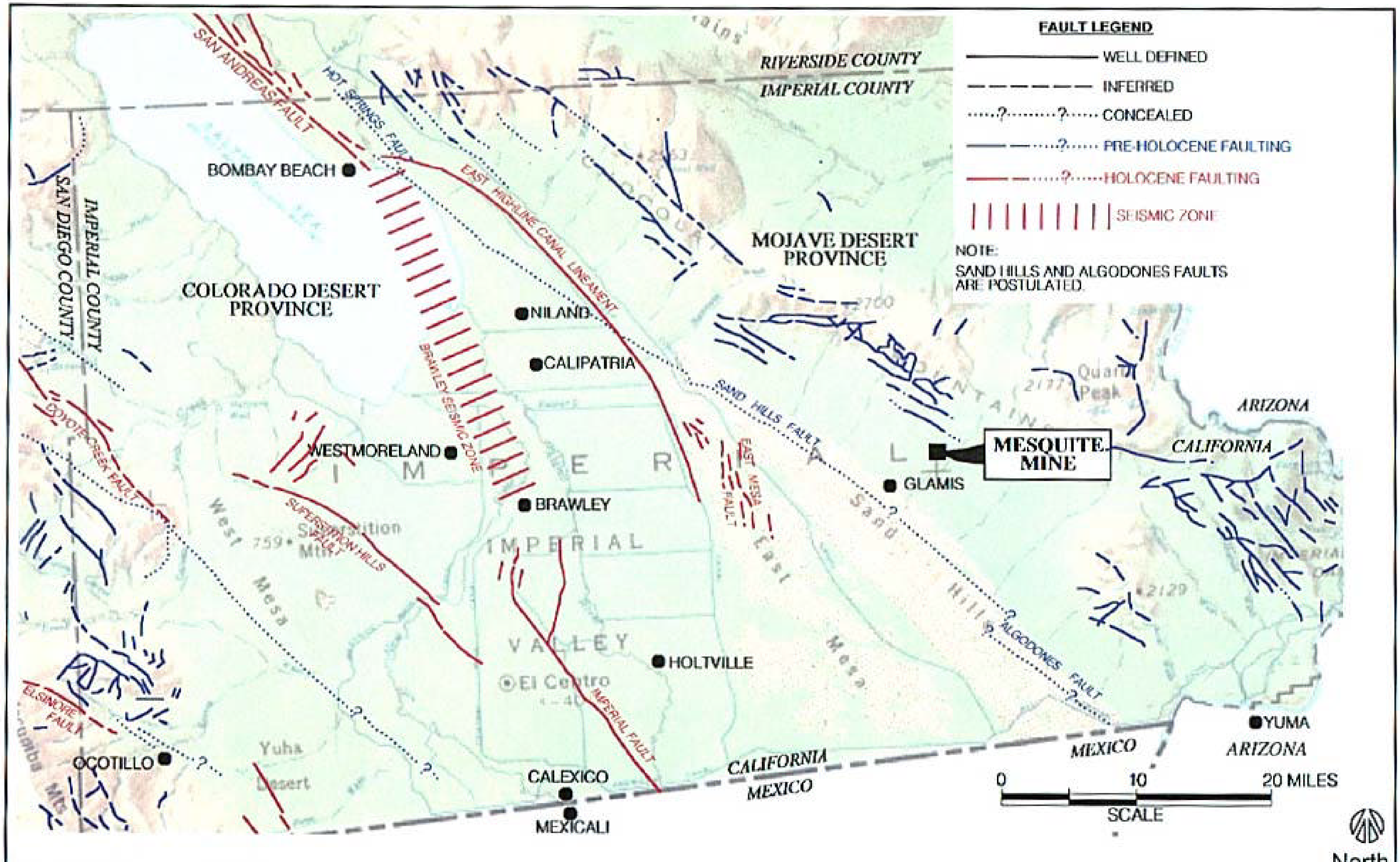
3.1.3 Geologic Setting

3.1.3.1 Regional Geology

The Proposed Action is located at the eastern margin of the Colorado Desert Physiographic Province near its boundary with the Mojave Desert Physiographic Province. The region is characterized by topographical features expressed as northwest-trending mountain ranges separated by valleys. The dominant feature in the area is the Salton Trough (Figure 3.1-1), a large northwest/southeast-trending depression that extends from near Palm Springs to the head of the Gulf of California in Mexico.

The floor of the Salton Trough and the gently sloping trough margins are part of the Colorado Desert province. The mountains east of the Salton Trough, including the Chocolate, Cargo Muchacho, Picacho, and Palo Verde mountains, are part of the Mojave Desert Province. The Mesquite Mine site is located near the top of the gently sloping (average of about 80 feet per mile) trough margin. The gentle slope extending southwestward from the project site area is a piedmont fan, which is an alluvial surface underlain at shallow depth by an eroded rock surface (pediment). Other than the presence of an intricate braided network of shallow incised channels, the piedmont fan surface is relatively featureless. The gently sloping surface terminates at the Algodones Dunes, about 6 miles southwest of the project site.

The Chocolate Mountains reach a maximum elevation of about 2,400 feet at Mount Barrow, about 7 miles north of the project area. The mountains are composed of Precambrian to Mesozoic Age basement rocks (Figure 3.1-2). These are overlain by Tertiary and Quaternary Age nonmarine sediments and volcanic units that are exposed in the foothills. The materials comprising the outcrops near the project area are similar to the materials exposed in the mountains and foothills to the north.

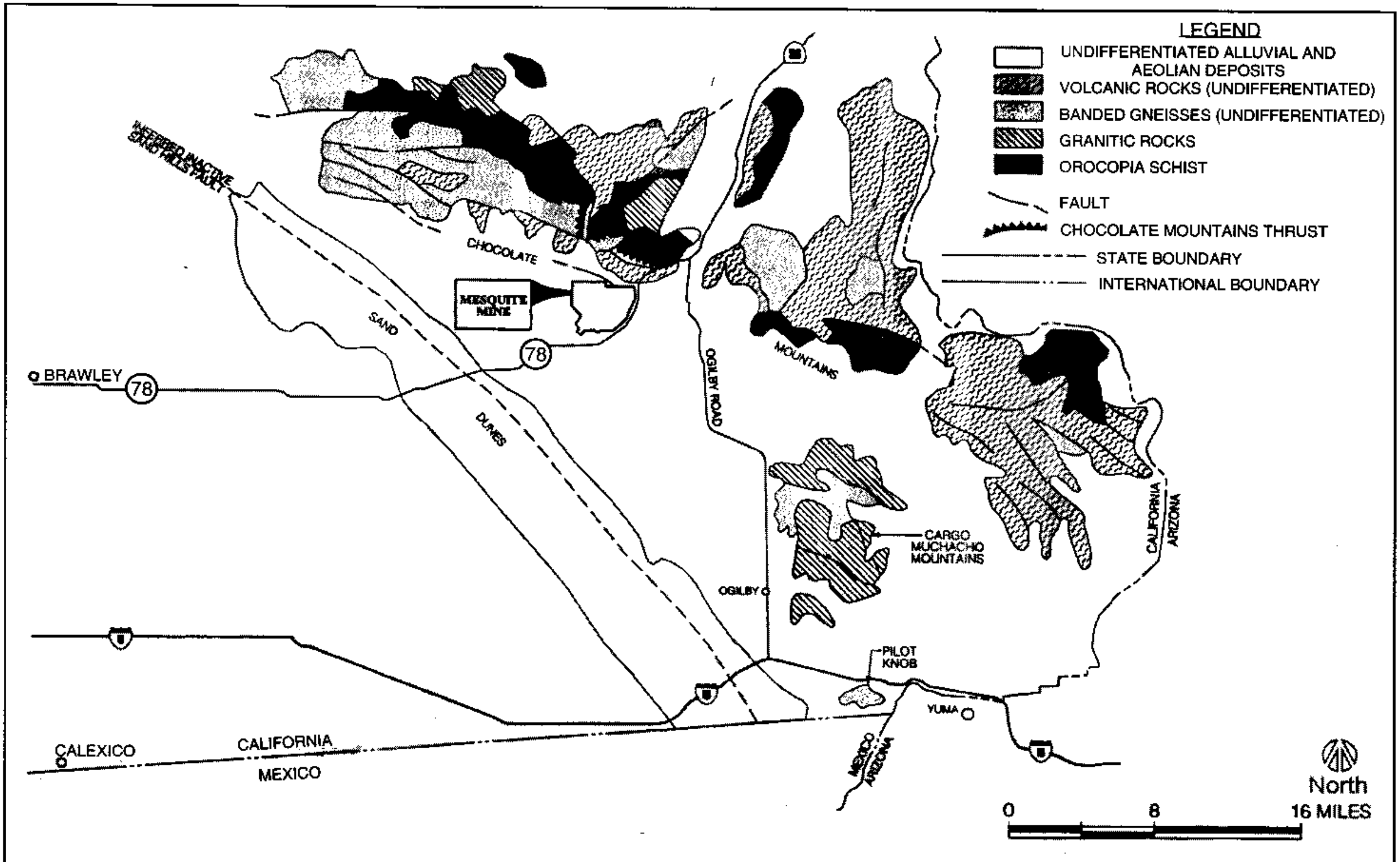


SOURCE: Environmental Solutions, Inc., 1992

Mesquite Mine Expansion EIR/EIS

Physiographic Map

FIGURE 3.1-1



SOURCE: Environmental Solutions, Inc., 1992.

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Mesquite Mine Expansion EIR/EIS

Regional Geologic Map

FIGURE 3.1-2

3.1.3.2 Tectonic Setting

The site lies several miles east of the eastern Salton Trough boundary. This large trough formed as a result of crustal spreading between the North American and Pacific tectonic plates along the San Andreas Fault System. During Pliocene time (2 to 5 million years ago), Baja California rifted from the mainland of Mexico along what is now the Gulf of California. Spreading progressed northward into the Salton Trough from the gulf, resulting in the widening and elongation of Imperial Valley. Large horizontal displacements (transverse faulting) along the San Andreas Fault System formed the eastern boundary of the Salton Trough. As the gulf and Salton Trough continued to open, thick sediments were deposited causing subsidence at the flanks of Imperial Valley. Tectonic activity continues today as spreading continues in the trough area. This activity is primarily associated with fault systems 26 or more miles from the Mesquite Mine site.

3.1.3.3 Site Geology

Detailed geologic studies have been conducted in the vicinity of the Mesquite Mine site for previous mine developments, for the Mesquite Regional Landfill, and most recently, for the proposed mine expansion. Because of the extensive geologic information available for the site, studies specific to the proposed expansion have focused on detailed geochemistry and hydrogeology specific to the mine pit areas. Figures 3.1-3 and 3.1-4 provide a vicinity geologic map and cross sections showing premining geology in the mine vicinity. Figures 3.1-5 and 3.1-6 provide a detailed geologic map and cross sections for the mine pit areas, including in-pit basement rock details that are relevant to geochemistry. A detailed hydrologic and geochemical study for the proposed expansion is described in Baker Consultants, Inc. (1999).

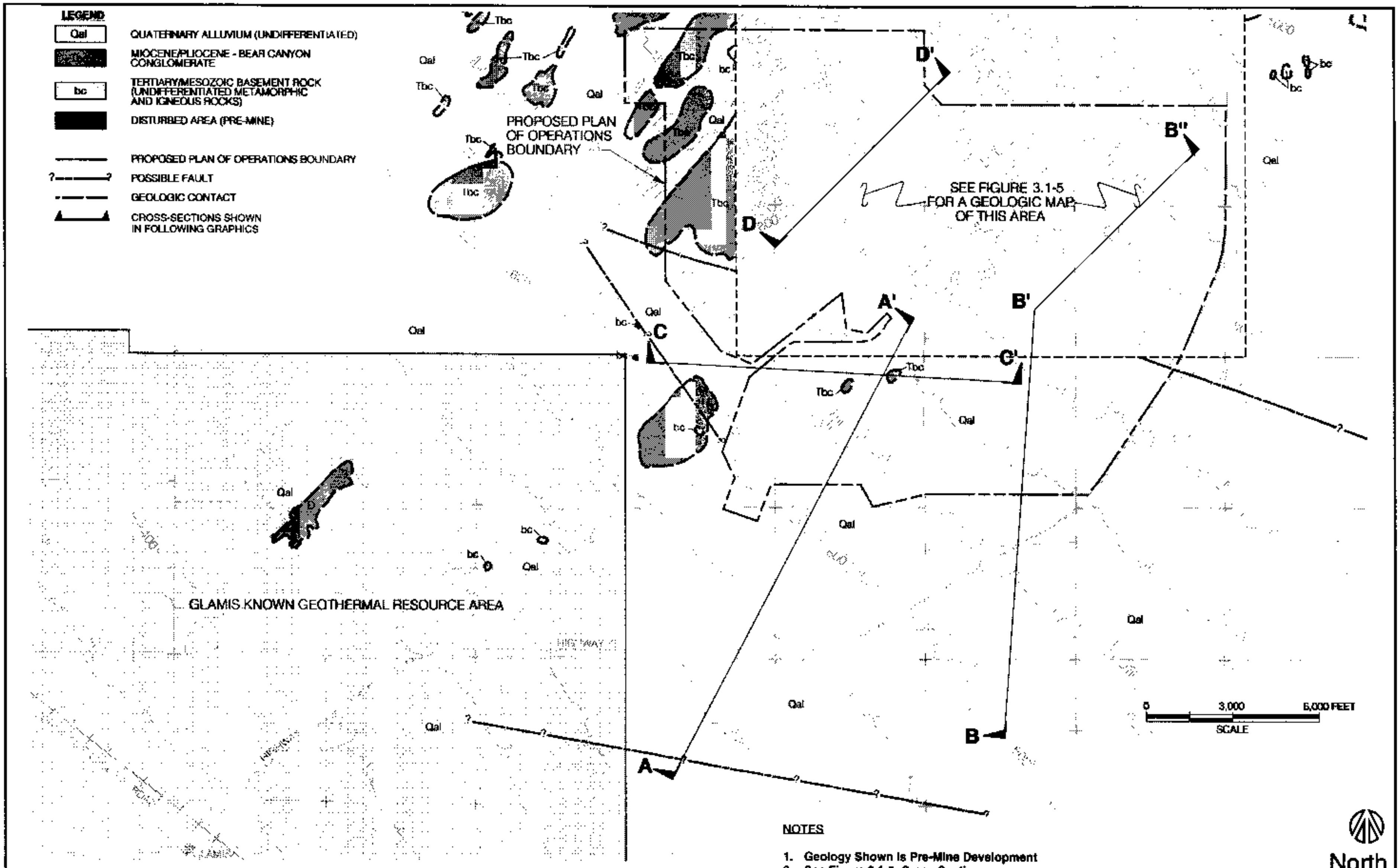
Three general geologic units occur in the site vicinity:

- Quaternary Alluvium (Qal)
- Tertiary Bear Canyon Conglomerate (Tbc)
- Undifferentiated igneous and metamorphic basement rocks (bc)

Quaternary Alluvium is the most prevalent geologic unit exposed on the ground surface in the mine vicinity. This unit consists of a relatively thin veneer covering the eroded rock of the pediment. Exposed alluvium is comprised of deposits from three different ages, differentiated according to the degree of dissection and the development of pedogenic soils (Environmental Solutions, Inc., 1993).

The three ages of alluvium are shown in Figure 3.1-3 as a single undifferentiated Quaternary Alluvium Unit. Within this unit, intermediate and older age alluvium cover the majority of the site. The most recent alluvial unit is of Holocene age (less than 10,000 years old) and is constrained to the active channel floors. It consists of loose sands and gravels with a generally low silt content.

The intermediate alluvial unit is represented by a set of perched alluvial fan surfaces that lie up to four feet above the active channels. The intermediate alluvium is slightly coarser grained than the younger recent alluvium, being composed of poorly consolidated sand, gravel and silt that has

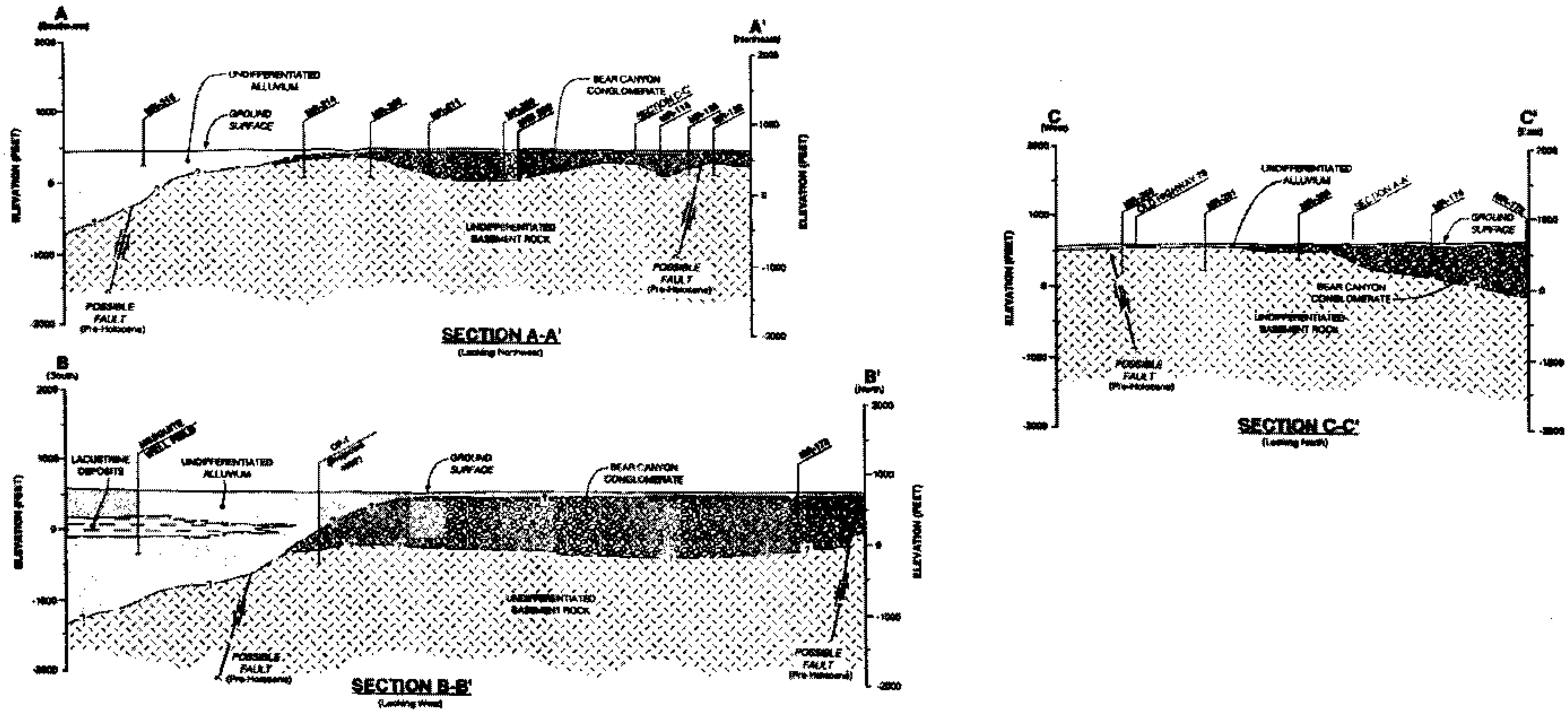


SOURCE: Environmental Solutions, Inc., 1993

Mesquite Mine Expansion EIR/EIS

Exposed Geologic Formations Outside the Mine Pit Area

FIGURE 3.1-3



NOTES:

1. All Sections Drawn on Pre-Mine Development Surface.
2. See Figure 3.1-3 For Cross Section Locations.

0 3,000 6,000 FEET
HORIZONTAL SCALE

0 1,500 3,000 FEET
VERTICAL SCALE

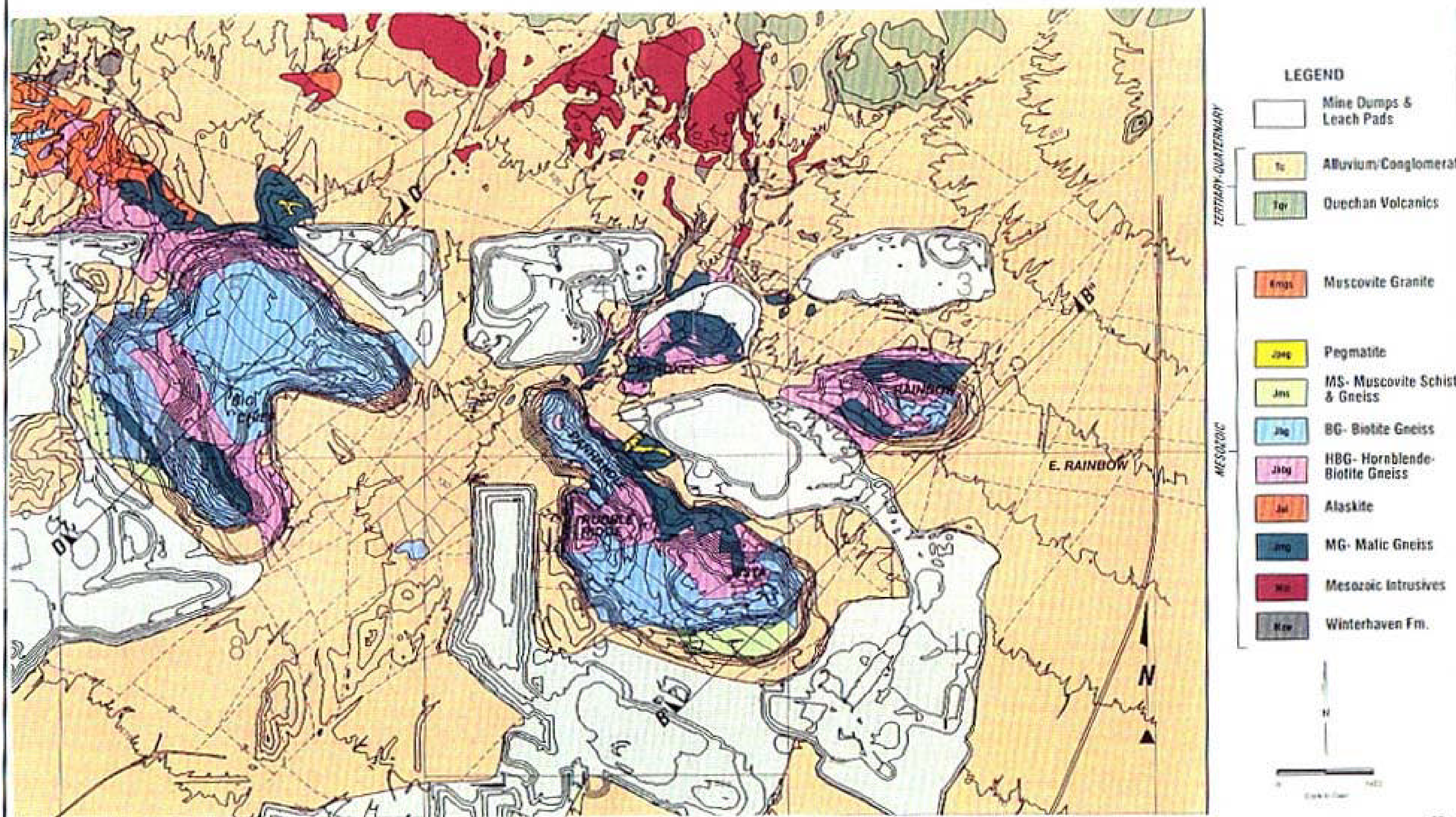
SOURCE: TRC, 2000.

6/19/00

Mesquite Mine Expansion EIR/EIS

Geologic Cross-Sections Outside the Mine Pit Area

FIGURE 3.1-4



North

7/6/00

SOURCE: Baker Consultants, Inc., 1999.

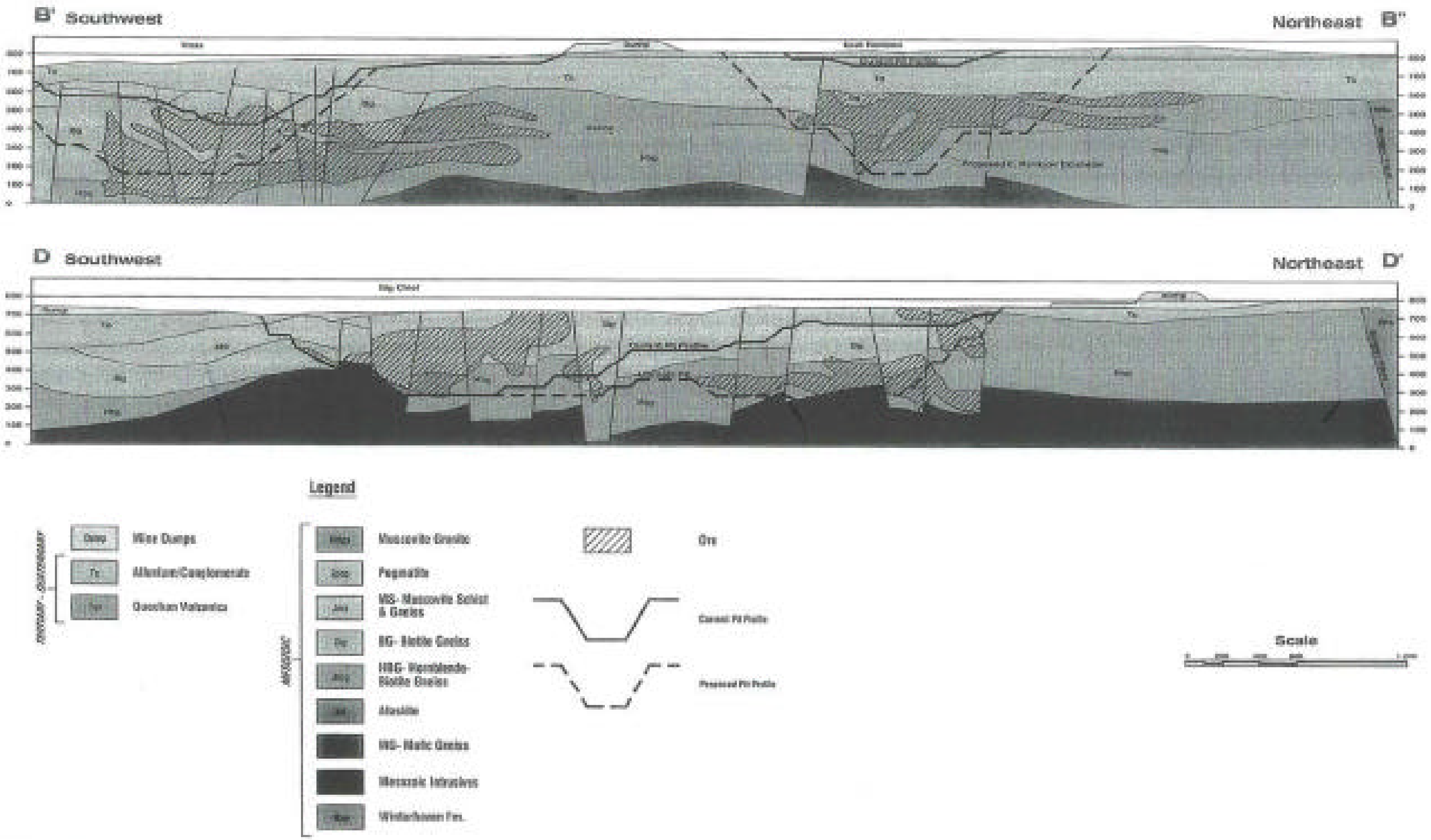
3.1-9

Mesquite Mine Expansion EIR/EIS

Existing Geology in Pit Areas

FIGURE

3.1-5



SOURCE: TRC, 2000, modified from Baker Consulting, Inc., 1999

Mesquite Mine Expansion EIR/EIS

Geologic Cross-Sections Through the Mine Area

FIGURE 3.1-6

undergone some weathering. A moderately-developed desert pavement and desert varnish have formed on the weathered surface. The weathered surface of the intermediate alluvium ranges between late Pleistocene and early Holocene age (8,000 to 17,000 years old) (Shlemon, 1993).

The third alluvial unit, the older alluvium, is represented by the highest alluvial fan surfaces. This older alluvium unit is conspicuous and widespread with a distinct yellowish-red color. It consists of poorly consolidated sands and gravels that are slightly indurated and weathered. The older alluvium surface displays a continuous and well-developed desert varnish and desert pavement (patina), and well-developed desert soil layers. The older alluvium surface is of late Pleistocene age (35,000 to 40,000 years old) (Shlemon, 1980 and 1993). Beneath the surface, the older alluvium is estimated to be 60,000 to 70,000 years of age.

All three alluvial units were deposited as eroded materials from the Chocolate Mountains. The maximum alluvial thickness overlying the bedrock and basement rock pediment is judged to be about 20 feet, though it varies due to an uneven buried pediment surface. Fine silt deposits associated with the recent Salton Sea, or ancient Lake Cahuilla that previously occupied the Imperial Valley Floor, inclusive of the old shorelines, lie far to the west of the site area and below an elevation of 100 feet.

The bedrock unit underlying the older alluvium is the Bear Canyon Conglomerate (Figure 3.1-4). It is Upper Miocene (5 to 11 million years old) to Lower Pliocene (3 to 5 million years old) in age (Dillon, 1975; Morton, 1977) and consists of nonmarine sedimentary rocks with interbedded basalt flows. The sedimentary units consist of poorly sorted and variably indurated sandstone, conglomerate, and breccia with a sandy to clayey matrix. The formation varies from slightly to moderately well-cemented; the cementation is provided by calcium carbonate and/or a clayey matrix. The conglomerate unit is locally exposed in rounded hills protruding above the piedmont fans (Figure 3.1-3). The thickness of the conglomerate varies and can be several hundred feet or more. In the eastern portion of the mine site, a thick Tertiary clay layer is interbedded with poorly sorted conglomerate indicating that thick clay accumulations may be part of the Bear Canyon Conglomerate lithology.

The basement rock consists of Tertiary volcanic rocks and pre-Tertiary age (greater than 65 million years old) igneous and metamorphic rocks. Foliation in the metamorphic members is well developed, and where exposed, this unit is fresh to moderately weathered. At the surface, the rock appears to be highly fractured and jointed. At depth, these discontinuities become fewer in number and tighter because of confinement by the weight of the overlying rock. Depth to basement rock in the mine vicinity varies from zero at outcrops to depths in excess of 1,000 feet. The gold ore to be mined occurs in gneiss and granitic basement rock in essentially free or native form. It is concentrated in microfractures in minute sizes and amounts.

3.1.3.4 Mine Pit Geochemistry

Mine pit geochemistry is important to consider in the environmental evaluation because of rock-ground water interactions that may occur in the pit walls and floor or in backfilled material following mining. The bottom portion of the mine pits would be excavated below the elevation at which ground water occurs in the fractured basement rock.

The principal rock types that would be exposed in the mine pits are:

- Quaternary Alluvium

- Tertiary Conglomerate, further differentiated in the Rainbow Pit as:
  - Conglomerate
  - Sand/Silt/Clay
  - Mineralized Conglomerate

- Basement Rock:
  - Cretaceous Muscovite Granite (leucogranite)
  - Jurassic Muscovite Schist and Gneiss
  - Jurassic Biotite Gneiss
  - Jurassic Hornblende-Biotite Gneiss
  - Jurassic Mafic Gneiss

Detailed descriptions of these units and their mineralogy are provided in Baker Consultants, Inc. (1999), along with descriptions of geochemical tests.

The two general geochemical parameters most important to Mesquite mine pit environmental evaluations are: (1) Net Neutralization Potential (NNP) calculated by Acid/Base Accounting (ABA); and (2) metal concentrations.

Excavation and exposure of buried geologic materials can accelerate natural weathering of certain minerals within the material such as sulfide minerals that can generate acid, or carbonate minerals that can neutralize acid. ABA is a term encompassing an array of geochemical evaluations that can be used to determine the net difference between the Acid Generating Potential (AGP) and the Acid Neutralizing Potential (ANP) that occurs in a given rock due to these minerals. The net difference between AGP and ANP is the NNP. The NNP is commonly expressed in terms of tons of calcium carbonate ($CaCO_3$) per kiloton of rock. It is generally accepted that materials with NNP values of less than -20 tons of $CaCO_3$ per kiloton are potentially acid generating; whereas materials with NNP values of greater than +20 tons of $CaCO_3$ per kiloton of rock are clearly net neutralizing. A second approach to predicting acid generation from static tests utilizes the ratio of ANP to AGP (Hutchison and Ellison, 1992). Using this approach, materials with an ANP/AGP ratio of less than 1 are considered potentially acid generating, while a ratio of greater than 3 is considered clearly net neutralizing. Further characterization of materials falling within the range of uncertainty for static tests (i.e., with an NNP falling between -20 and +20, or an ANP/AGP ratio between 1 and 3) is necessary if overall prediction of acid generation potential requires such characterizations. For example, further testing could be warranted if the amount of material represents a notable portion of the rock to be excavated, or the pit wall that will be in contact with water. If the amount of material in the range of uncertainty is negligible compared to the overall geologic formations that will be excavated, then further testing of the uncertain materials will not provide much benefit. When further testing is necessary, it normally consists of augmenting the ABA data with kinetic testing (e.g., humidity cell or column leach) to determine if net acid production would occur.

Metal concentrations are important because some of the metals can dissolve and become mobile in ground water. The types and concentrations of metals that become mobile is largely dependent on pH and, therefore, NNP. The following subsections provide data on the ABA and metals analyses of rocks in the mine pits.

Acid/Base Accounting

Several sources of data are available for ABA characterization of rock materials collected from the Mesquite Mine. These data have consistently indicated that the Mesquite wall rocks and overburden materials have a net capacity to neutralize acid. These data are consistent with operating experience at the mine.

The Environmental Impact Report/Environmental Assessment (EIR/EA) for the VCR expansion project at Mesquite (Environmental Solutions, Inc., 1987) reported results of ABA rock samples analyzed by Core Laboratories, Inc., of Wheat Ridge, Colorado. Results indicate the materials were alkaline in nature and generally net neutralizing. The mean pH reported was 7.9 and the mean AGP, ANP and NNP values reported were 14.4, 63.6 and 49.2 tons $CaCO_3$ per kiloton of rock, respectively.

Between 1992 and 1995, ABA testing of waste rock and ore from the Big Chief and Vista Pits was performed by the Mesquite metallurgical laboratory. Results of this testing were reported in SMI (1998). Results indicate that the materials tested were slightly alkaline and generally net neutralizing. AGP and ANP values ranged from 0 to 56 tons $CaCO_3$ per kiloton and 9.2 to 233 tons $CaCO_3$ per kiloton, respectively. Total sulfur content was generally low, ranging from 0 to 1.2 percent.

During the last two years, additional ABA determinations were performed on representative rock types collected from the Rainbow Pit and from the north half sections (Sections 5 and 6) at the site. Eighteen core samples and 13 pulp samples obtained from exploration boreholes drilled as part of the Rainbow Pit Expansion of the Mesquite Mine were submitted by SMI for ABA testing by Energy Laboratories, Inc. of Casper, Wyoming (SMI, 1998b). The rock types that were selected for analysis were those that were expected to be exposed in the Rainbow Pit. Additional ABA testing was performed in the spring of 1999, when 111 rock samples were collected during exploration drilling in the north half sections. The latter samples were submitted to American Assay Laboratories of Sparks, Nevada. The results from the ABA determinations performed in the Rainbow Pit and north half sections are summarized in Table 3.1-1 and indicate that the rock types encountered in the Rainbow and north half sections are typically net neutralizing with positive NNP values. Detailed results and discussion of this testing are provided in Baker Consultants, Inc. (1999). That report also

Table 3.1-1

Summary of Acid-Base Accounting Characteristics, Rainbow Pit and North Half-Sections Proposed Mesquite Mine Expansion

Rock Type	Parameter	Units	Rainbow Pit			North Half-Sections		
			Min.	Max	Mean(1)	Min.	Max	Mean(1)
Quaternary Alluvium (Qal)	Carbonate	% $CaCO_3$	--	--	--	--	--	--
	Carbonate	% C	--	--	--	0.010	0.579	0.067
	Sulfide	% S	--	--	--	<0.001	0.006	0.001
	ANP	T $CaCO_3$/kT	--	--	--	1	48	6
	AGP	T $CaCO_3$/kT	--	--	--	0.03	0.19	0.04
	NNP	T $CaCO_3$/kT	--	--	--	1	48	5
Tertiary Sand/Silt/Clay	Carbonate	% $CaCO_3$	1.6	10.8	4.3	--	--	--
	Carbonate	% C	--	--	--	--	--	--
	Sulfide	% S	<0.01	<0.01	<0.1	--	--	--
	ANP	T $CaCO_3$/kT	16	108	43	--	--	--
	AGP	T $CaCO_3$/kT	0.31	0.31	0.31	--	--	--
	NNP	T $CaCO_3$/kT	16	108	43	--	--	--
Tertiary Conglomerate	Carbonate	% $CaCO_3$	0.6	10.6	3.1	--	--	--
	Carbonate	% C	--	--	--	--	--	--
	Sulfide	% S	<0.01	<0.01	<0.01	--	--	--
	ANP	T $CaCO_3$/kT	6	106	31	--	--	--
	AGP	T $CaCO_3$/kT	0.31	0.31	0.31	--	--	--
	NNP	T $CaCO_3$/kT	6	106	31	--	--	--
Tertiary Mineralized Conglomerate	Carbonate	% C	1	5.7	3	--	--	--
	Carbonate	% S	--	--	--	--	--	--
	Sulfide	T $CaCO_3$/kT	<0.01	<0.01	<0.01	--	--	--
	ANP	T $CaCO_3$/kT	10	57	30	--	--	--
	AGP	T $CaCO_3$/kT	0.31	0.31	0.31	--	--	--
	NNP	T $CaCO_3$/kT	10	57	30	--	--	--
Cretaceous Muscovite Granite (Leocogranite)	Carbonate	% $CaCO_3$	--	--	--	--	--	--
	Carbonate	% C	--	--	--	0.034	0.255	0.083
	Sulfide	% S	--	--	--	<0.001	0.003	0.002
	ANP	T $CaCO_3$/kT	--	--	--	3	21	7
	AGP	T $CaCO_3$/kT	--	--	--	0.03	0.09	0.05
	NNP	T $CaCO_3$/kT	--	--	--	3	21	7
Jurassic Biotite Gneiss	Carbonate	% $CaCO_3$	0.7	4	1.2	--	--	--
	Carbonate	% C	--	--	--	--	--	--
	Sulfide	% S	<0.01	0.16	0.2	--	--	--
	ANP	T $CaCO_3$/kT	7	40	12	--	--	--
	AGP	T $CaCO_3$/kT	0.31	5	0.73	--	--	--
	NNP	T $CaCO_3$/kT	5	40	11	--	--	--

Table 3.1-1

Summary of Acid-Base Accounting Characteristics, Rainbow Pit and North Half-Sections Proposed Mesquite Mine Expansion

Rock Type	Parameter	Units	Rainbow Pit			North Half-Sections		
			Min.	Max.	Mean(1)	Min.	Max.	Mean(1)
Jurassic Hornblende Biotite Gneiss	Carbonate	% $CaCO_3$	0.1	5.8	1.5	--	--	--
	Carbonate	% C	0.012	0.696	0.178	0.011	0.579	0.055
	Sulfide	% S	<0.01	1.38	--	<0.001	0.017	0.001
	ANP	T $CaCO_3$/kT	1	58	--	1	48	5
	AGP	T $CaCO_3$/kT	0.31	43	--	0.03	0.53	0.04
	NNP	T $CaCO_3$/kT	1	47	9.7	1	48	5
Jurassic Mafic Gneiss	Carbonate	% $CaCO_3$	5.2	25.5	9.4	--	--	--
	Carbonate	% C	0.624	3.060	1.128	0.011	0.817	0.204
	Sulfide	% S	<0.01	2.05	0.20	<0.001	0.069	0.002
	ANP	T $CaCO_3$/kT	52	255	94	1	68	17
	AGP	T $CaCO_3$/kT	0.31	64	6.3	0.03	2.15	0.05
	NNP	T $CaCO_3$/kT	34	239	69	1	68	17

Source: Baker Consultants, Inc., 1999.
(1) Geometric mean. Values below detection were calculated at the detection limit.

includes specific data for each of the individual samples analyzed. All of the 111 samples from the north half sections and approximately 90 percent of the samples from the Rainbow Pit possess an ANP/AGP ratio of 3 or more, indicating these materials are clearly net neutralizing. Furthermore, the samples from both areas typically have sulfide concentrations at or near the detection limit, indicating generally low potential for sulfide reactivity. The sulfide concentrations in the samples overall are uniformly low, with 95 percent of the samples containing less than 0.1 percent sulfide (as % Sulfur).

None of the samples had a ANP/AGP ratio of less than 1, and only four samples have ratios occurring in the range of uncertainty (ANP/AGP between 1 and 3). Even though these four samples represent a small fraction of the total material that will be excavated or remain in the pit walls, two of the four samples were selected for kinetic testing. The two samples were selected because they contained the highest total sulfur concentrations observed in the Rainbow Pit and, consequently, may provide a worst-case estimate of chemical constituents that could be leached.

One selected sample was tested using a laboratory humidity cell test and one using a column leach test (hornblende biotite gneiss and mafic gneiss, respectively). These types of testing simulate an accelerated weathering process and allow samples of contact water to be collected and analyzed. Results of this testing is reported in SMI (1998). The pH values measured were slightly to moderately alkaline, ranging from 7.9 to 10.1. Neither sample generated acid and both samples exhibited a moderately high neutralizing capacity. Prior to the 20-week kinetic tests, the samples were initially inoculated with an iron-oxidizing bacteria, *Thiobacillus ferrooxidans,* to accelerate the weathering process. At 20-weeks, the samples showed no acid generation and other parameters, such as iron and sulfate concentrations in leachate, gave no indication that acid production was likely to occur. Therefore, there was no need to continue testing beyond the 20-week period. These kinetic tests support the ABA data in indicating that rock to be mined is not likely to be acid-generating. The kinetic tests indicate that even the most sulfidic members of the hornblende biotite gneiss and mafic gneiss rock units are not likely to generate acid.

Metals

Whole rock analyses have been performed on rock samples collected from the VCR Project Area (ESI, 1987), Rainbow Pit (SMI, 1998) and the North Half-Sections (Newmont, 1999). The primary purpose of these analyses is to assay for gold and characterize metals and other chemical constituents associated with gold mineralization. However, the relative abundance of total metals identified in whole rock analyses can also be used to determine if unusually high levels of metals occur that could potentially leach into mine pit lakes or ground water.

Naturally-occurring concentrations of selected metals in samples of Mesquite Mine ore and overburden analyzed for the VCR Project were reported to be below Total Threshold Limit Concentrations (TTLCs) used by the State to categorize material as hazardous waste (22 CCR 66261.24). Mine rock is not subject to hazardous waste regulations, but the referenced study provided the TTLC as a basis for comparison (ESI, 1987).

Whole rock analyses of rocks from the Rainbow Pit (SMI, 1998b) indicate that the chemical composition of the conglomeratic units was consistent with typical surficial soils, sandstones and shales. However, the gneisses contained arsenic, and occasionally selenium and silver, in concentrations that the referenced study identified as higher than average values observed in diabase and igneous rocks in the earth's crust.

A complete tabulation of results from whole rock analyses performed on rock samples from the Rainbow Pit and north half sections is provided in Baker Consultants, Inc. (1999). The chemical composition of the major rock types encountered at these two locations is summarized in Table 3.1-2. Consistent with prior studies, data in Table 3.1-2 show that total metal concentrations in the rock are relatively low. Maximum values for each constituent are well below the respective TTLCs in all cases, and in most cases they are below the respective TTLC by one to two orders of magnitude. Mean concentrations for each constituent are near or below the average value for the earth's crust overall, except for arsenic from both areas and bismuth and thallium from the north half sections. While the mean values for these three constituents are about an order of magnitude greater than the crustal average, these concentrations are not notably high for a mine site. Overall, the data in Table 3.1-2 are consistent with previous studies indicating that the concentrations of total metals in the rock are generally low.

3.1.4 Soils

A soil survey conducted by Borst (1983) for the Mesquite Mine facility, covered the southern half of Section 5 and Sections 8, 17, 20, 21, and 29 of T13S, R19E, SBBB. Based on the similar physiography throughout the project area and on prior analysis of aerial photographs, soils in the expansion area are expected to be similar and occur in approximately the same relative percentages as in the soil survey area. The data presented in this section are based on the soils reported by Borst (1983).

Four major types of soil are present in the approximate proportions shown in Table 3.1-3. All four major soil types are low in nutrients, and tend to occur in thin layers. The most common type, Chuckwalla gravelly loam, contains high concentrations of salts that tend to preclude plant growth. Consequently, soils present in this area are either barren or support sparse amounts of vegetation.

Soils associated with ephemeral drainages are relatively loose and retain the greatest amount of moisture from occasional rainfall. These areas generally support the most substantive plant communities at the project site. The top surface of the higher areas between the drainages generally consists of a relatively dense "desert pavement" that minimizes the ability of rainfall to percolate into the soil.

3.1.5 Mineral Resources

In the Mesquite mine pits, gold ore and minor amounts of silver ore are found disseminated in microfractures of gneiss and granitic basement rock. Exploration and condemnation borings have

Table 3.1-2

Whole Rock Analysis Summary, Rainbow Pit And North Half-Sections, Proposed Mesquite Mine Expansion

Parameter	Rainbow Pit (Mg/Kg)			North Half-Sections (Mg/Kg)			Ttlc (2) (Mg/Kg)	Crustal Average (3) (Mg/Kg)
	Min.	Max.	Mean(1)	Min.	Max.	Mean(1)		
Aluminum	1,260	95,500	9,640	1,800	31,500	9,540	--	81,000
Antimony	<0.05	1.3	0.12	--	--	--	500	0.2
Arsenic	3.8	137	18.0	2	92	9.87	500	1.8
Barium	2.6	206	40.1	10	357	80.0	10,000	425
Beryllium	0.5	0.7	0.28	--	--	--	75	2.8
Bismuth	<0.5	0.25	0.076	<3	7	3.19	--	0.2
Boron	<0.55	6.15	2.41	<3	14	4.46	--	10
Cadmium	<0.05	0.15	0.065	0.2	1.7	0.43	100	0.2
Calcium	1,190	480,000	11,900	900	53,100	14,800	--	36,300
Chromium	<2.25	23.4	8.23	6	145	20.2	2,500	100
Cobalt	0.55	24.2	5.64	2	18	7.84	8,000	25
Copper	7.5	132	21.6	5	93	22.0	2,500	55
Iron	3,720	42,700	14,900	6,200	47,600	25,000	--	50,000
Lanthanum	--	--	--	2	60	15.2	--	30
Lead	<0.75	10.8	4.06	<3	20	4.44	1,000	13
Lithium	1.3	14.4	5.42	--	--	--	--	20
Magnesium	460	16,300	3,380	400	14,500	570	--	20,900
Manganese	11.8	495	181	111	1,051	419	--	950
Mercury	<0.05	0.2	0.062	<0.01	0.27	0.046	20	0.08
Molybdenum	<0.1	5.8	0.55	<1	13	1.76	3,500	1.5
Nickel	1.05	29.1	6.64	2	33	11.6	2,000	75
Phosphorus	210	1,070	485	40	1,850	520	--	1,050
Potassium	300	8,000	1,990	1,000	6,800	2,500	--	25,900
Selenium	0.05	1.6	0.21	--	--	--	100	0.05
Silica	<89	1,790	204	--	--	--	--	277,200
Silver	<0.05	1.45	0.22	--	--	--	500	0.07
Sodium	180	2,240	684	200	3,200	600	--	28,300
Strontium	11.8	84.8	47.5	9	201	44.6	--	375
Thallium	<0.05	0.25	0.079	<2	52	6.53	700	0.5
Tin	<0.05	0.6	0.18	--	--	--	--	2
Titanium	<0.75	374	24.4	100	1,400	200	--	4,400
Vanadium	27.2	12.8	--	<6	71	31.7	2,400	135
Zinc	151	30.6	--	12	214	38.6	5,000	70

Source: Modified from Baker Consultants, Inc., 1999.

(1) Geometric mean. Values below detection were calculated at the detection limit.

(2) Total threshold limit concentration for hazardous waste (California Code of Regulations, Title 22, Section 66261.24).

(3) Reference: American Geologic Institute, 1989, *AGI Data Sheets*, Data Sheet 57.1.

Table 3.1-3

Soil Characteristics[1]
Proposed Mesquite Mine Expansion

Soil Type	Approximate Relative Percentage Of Ground Cover[2]	Nutrients[3]	Salts[4]	General
Unidentified Sandy Loam	10	Low	Nontoxic	Thin, barren, little erosion protection.
Chuckwalla Gravelly Loam	40	Low	High[5]	Desert pavement, barren, low infiltration capability.
Carrizo Very Gravelly Coarse Sand	15	Low	Nontoxic	Ephemeral stream channels, high infiltration, sparse shrub and tree vegetation.
Carrizo Variant Very Gravelly Loamy Sand	35	Low	Nontoxic	As above, with incipient desert pavement.
Total Area (%)	100	N/A	N/A	N/A

Source: Environmental Solutions, Inc., 1993.

N/A = Not Applicable

(1) Soil characteristics from Borst, 1983.
(2) Ground coverage percentage are estimates based on Borst, 1983.
(3) Surface horizon concentrations of major plant nutrients: nitrogen, phosphorous and organic matter.
(4) Concentrations of major salts in soil, not necessarily confined to the surface horizon.
(5) High concentrations of salts are toxic to plants, preventing establishment or growth.

been drilled to determine the extent of the ore bodies. Ore grade material has not been encountered beneath the sites proposed for the expanded heap leach or OOISAs.

The Glamis Known Geothermal Resource Area is adjacent to the west boundary of the project area. The potential for development of these resources is considered low. Geothermal resources have not been produced from the land underlying the mine, and the geology here is not conducive to hosting geothermal resources (i.e., active geothermal plants in Imperial Valley extract resources from sediments at an average depth of 8,000 feet, whereas total sediment thickness underlying the mine ranges from 0 to 1,000 feet). Furthermore, drilling programs conducted at the mine have not encountered geothermal resources.

While marketable sand and gravel may exist on public land encompassed by the Mine, BLM would not permit a sand and gravel operation on active claims associated with the Mine due to potential mining conflicts. Sand and gravel production from existing pits in Imperial County are adequate to meet construction needs (e.g., road building; housing) in the valley. Active sand and gravel pits do exist approximately 5 miles southwest of the mine. The proposed Mine expansion would not affect mining at these locations.

The land encompassed by the mine is not considered by BLM as prospectively valuable for oil and gas. The geology underlying the mine is not conducive to hosting oil and gas deposits.

3.1.6 Faulting and Seismicity

Extensive data are available for faulting and seismicity in the vicinity from both regional studies and site-specific studies. Numerous regional studies have occurred due to the proximity to the San Andreas Fault system, the regional potential for development of natural resources (e.g., water, geothermal power, minerals), and various projects that have been conducted or proposed (e.g., a nuclear power plant proposed for the Yuma, Arizona area) and ongoing mineral development projects.

Detailed faulting and seismicity studies have been conducted for the Mesquite site for previous mine developments and, more recently, for the Mesquite Regional Landfill. This section summarizes relevant information from the Faulting and Seismicity Technical Report for the Mesquite Regional Landfill (Environmental Solutions, Inc., 1992), which is hereby incorporated by reference. This technical report presents a compilation of published and unpublished regional information and site specific information for lands that would be affected by the currently proposed expansion.

Regional Faulting

The Imperial Valley is at the southern end of the active San Andreas Fault System. Figure 3.1-1 shows the southernmost traces of this system, and other active faults in proximity to the Mesquite Mine. As shown in the figure, the active faults that potentially could affect the site include the southern section of the San Andreas, East Mesa, East Highline Canal (lineament), Imperial-Brawley,

Brawley Seismic Zone, Superstition Mountain/Superstition Hills, and Elsinore Faults. Historic surface fault rupture has occurred on all of these faults, except the East Mesa Fault and East Highline Canal Lineament. Estimated maximum probable and maximum credible earthquake (MPE and MCE) magnitudes for each of these active faults are presented in Table 3.1-4. The MPE is the largest earthquake likely to occur with a 100-year return period at a given probability. The MCE is the largest possible earthquake considering the known tectonic framework of an individual fault.

Numerous faults have been mapped in the Chocolate Mountains to the north of the project site. The mapped faults are dominantly northwest-trending, normal or curvilinear thrust faults associated with uplift of the range. All mapped faults are pre-Holocene (i.e., greater than 10,000 years old) (Dillon, 1975; Murry et al., 1980; Higgins, 1990; Jennings, 1992; Maulchin and Jones, 1992). No surface faults have been mapped on the piedmont fans in the project vicinity between the foot of the range and the eastern side of the Imperial Valley.

The closest known Holocene (active) fault to the site is the East Mesa Fault (Heath, 1992). This fault consists of several north-south trending, left-stepping, en echelon normal listric (down-to-the-west) faults with possible lateral movement.

This faulting is related to the pull apart process within the spreading center and not movement along the San Andreas Fault (Heath, 1992). Although the closest known traces of this fault are approximately 12 miles from the Mesquite Mine, a distance of 9 miles is used for the seismicity analysis in this EIR/EIS, based on conservative recommendations provided by Heath (Environmental Solutions, Inc. 1993a). There have been no notable historic earthquakes associated with this fault (United States Geological Survey [USGS], 1992).

Some geologic references for the area indicate the possible existence of a postulated fault (Sand Hills Fault) beneath the Algodones Sand Dunes, as illustrated in Figures 3.1-1 and 3.1-2. The postulated fault may represent the inactive eastern boundary of the Salton Trough spreading center (Heath, 1992). No evidence has been documented to indicate the Sand Hills Fault has ruptured in Holocene time. The active faults currently associated with the eastern boundary of the Salton Trough are now coincident with the East Mesa Fault and possibly the East Highline Lineament. These parallel faults trend north-south and are west of the Algodones Sand Dunes as shown in Figure 3.1-1.

The Algodones Fault, located in the extreme southeastern corner of Imperial County (Maulchin and Jones, 1992), does not join with the postulated Sand Hills Fault. Based on extensive fault studies, this feature does not project into California, as previously mapped, and is considered inactive (Heath, 1992).

Present day transform-faulting coincides with the active southern San Andreas Fault, which continues, but steps over to the south, connecting with the Brawley Seismic Zone (Heath, 1992). Other active fault zones associated with the transform system include the northwest-trending Imperial/Brawley, San Jacinto, and Elsinore faults as shown in Figure 3.1-1. These faults are characterized by dominant, right-lateral movement, and collectively form the boundary between the

Table 3.1-4

Earthquake Seismicity Parameter Proposed Mesquite Mine Expansion

Fault	Distance And Direction From Site (Miles, Direction)	Maximum Earthquake (M)		Peak Horizontal Ground Acceleration (G)(1)		High Repeatable Acceleration (G)(2)		Duration Of Strong Ground Shaking (Seconds)
		Credible (3)	Probable (4)	Credible	Probable	Credible	Probable	
East Mesa	9.0, W	6.5	6.0	0.20	0.17	0.13	0.11	18
East Highline Canal Lineament	15.0, W	6.5	6.0	0.13	0.09	0.09	0.06	18
Imperial/ Brawley	26.0, W	7.0	6.8	0.08	0.07	0.05	0.05	24
Brawley Seismic Zone	29.0, W	6.25	5.8	0.05	0.04	0.03	0.03	18
Superstition Mountain/ Superstition Hills (San Jacinto Fault Zone)	37.0, W	7.5	7.0	0.07	0.05	0.05	0.03	30
San Andreas	45.0, W	8.25(5)	7.5	0.08	0.04	0.05	0.03	36
Elsinore	52.0, W	7.5	7.0	0.04	0.03	0.02	0.02	30

Source: Environmental Solutions, Inc. 1993.

(1) Joyner & Fumal, 1986

(2) The highest accelerations that are generally sustained for a period of time during an earthquake and are typically 65 percent horizontal ground acceleration.

(3) Maximum Credible magnitudes shown are Moment Magnitudes (Mw) after Maulchin & Jones (1992) and Slemmons (1982). The surface wave magnitudes (Ms) used by Slemmons (1982) are assumed to approximate moment magnitude (Mw). The Mw is the appropriate magnitude scale required for estimating peak accelerations from modern attenuation relationships.

(4) Maximum Probable magnitudes shown were determined using available data relative to: type and amount of displacement, historic seismic events and empirical relationships of fault segment rupture lengths vs. magnitude after Slemmons (1982).

(5) The maximum credible event was calculated using empirical data after Slemmons (1982) for three segment fault lengths totaling 328 miles.

North American and Pacific tectonic plates. All of the regional transform faults are believed to terminate or die out in spreading centers similar to the Salton Trough.

The 1992 Landers earthquake, located about 100 miles to the north of the project site, proved that more than one fault within the same system can rupture simultaneously. In the event that the southern San Andreas Fault was to rupture, other nearby associated faults with the same tectonic framework could rupture. The earthquake magnitude of such a combined event would be dictated primarily by the fault's length and sense of movement. Magnitudes have been assigned to the regional active faults that could influence the project site and are listed in Table 3.1-4.

As shown on Table 3.1-5, if three segments of the San Andreas Fault were to rupture simultaneously between the southern end of the Salton Sea (Bombay Beach) and Slack Canyon (near Parkfield, California in San Luis Obispo County), the total rupture length would be a maximum of 328 miles. Assuming a maximum rupture length of 328 miles, a MCE of M8.25 could occur, resulting in a maximum ground acceleration of 0.08 gravity (g) at the Mesquite site (Slemmons, 1982).

Site Faulting

Siting of the proposed heap leach pad expansion must comply with Title 27, which requires that a new heap leach pile not be built on land that has been rupture by Holocene faults (active within the past 10,000 years). There are no known Holocene faults in the immediate vicinity of the Mesquite Mine (Environmental Solutions, Inc., 1993).

Two sets of pre-Holocene faults exist that are important to the Mesquite Mine mineralization, but would not affect the expansion. An older set strikes to the northwest and is of Oligocene age (i.e., 24 to 37 million years old), the time which gold mineralization occurred locally. A younger fault set strikes to the northeast and displays left lateral oblique slip faulting, which resulted in the displacement of the Bear Canyon Conglomerate. Based on detailed investigations (Environmental Solutions, Inc., 1993), this younger fault set is Pre-Holocene in age (i.e., greater than 10,000 years old). Faults mapped in the mine pits and postulated faults have not ruptured the 35,000- to 40,000-year old alluvial surfaces within the project vicinity.

Seismicity

Most of the large historic earthquakes in the area have occurred on the Imperial-Brawley and San Jacinto fault systems with earthquakes occurring as main shocks followed by after shocks or swarms of small events (Damiata, et al., 1986). Figure 3.1-7 shows the distribution and magnitude of historic earthquakes with epicenters located within 100 km (60 miles) of the site. Within the search radius, there have been over 400 earthquakes with Richter magnitudes of M4.0 or greater.

Earthquakes plotted closest to the site include two events recorded at latitude 33.000, longitude 115.000. These events are based on early earthquake records and include a M5.5 in 1872 and a M4.0 in 1943. The early earthquake records are based on limited information so there is little control over

Table 3.1-5

Fault Parameters
Proposed Mesquite Mine Expansion

Fault	Length (Miles)(1)	Fault Type(2)	Slip Rate (Mm/Year) (3)	Recurrence Interval (Year)(3)
East Mesa	11	N	ND	ND
East Highline Canal Lineament	34	N (ND)	ND	ND
Imperial/Brawley	41	rv	8.6	700
Brawley Seismic Zone	28	rv	ND	ND
Superstition Mountain/Hills San Jacinto Fault Zone	141	rl	1 to 10	150 to 468
San Andreas	328(4)	rl	25 to 34	140 to 360
Elsinore	110	rl	W	694

Source: TRC, 2000

(1) Jennings, 1992,
(2) N = Normal, rv = reverse, rl = right lateral.
(3) Wesnousky, 1986
(4) San Andreas Fault length includes the following three segments:

Salton Sea to Cajon Pass	=	128 miles
Cajon Pass to Highway 166	=	106 miles
Highway 166 to Slack Canyon	=	96 miles
Total Length	=	330 miles

ND = Not Determined for this EIR/EIS

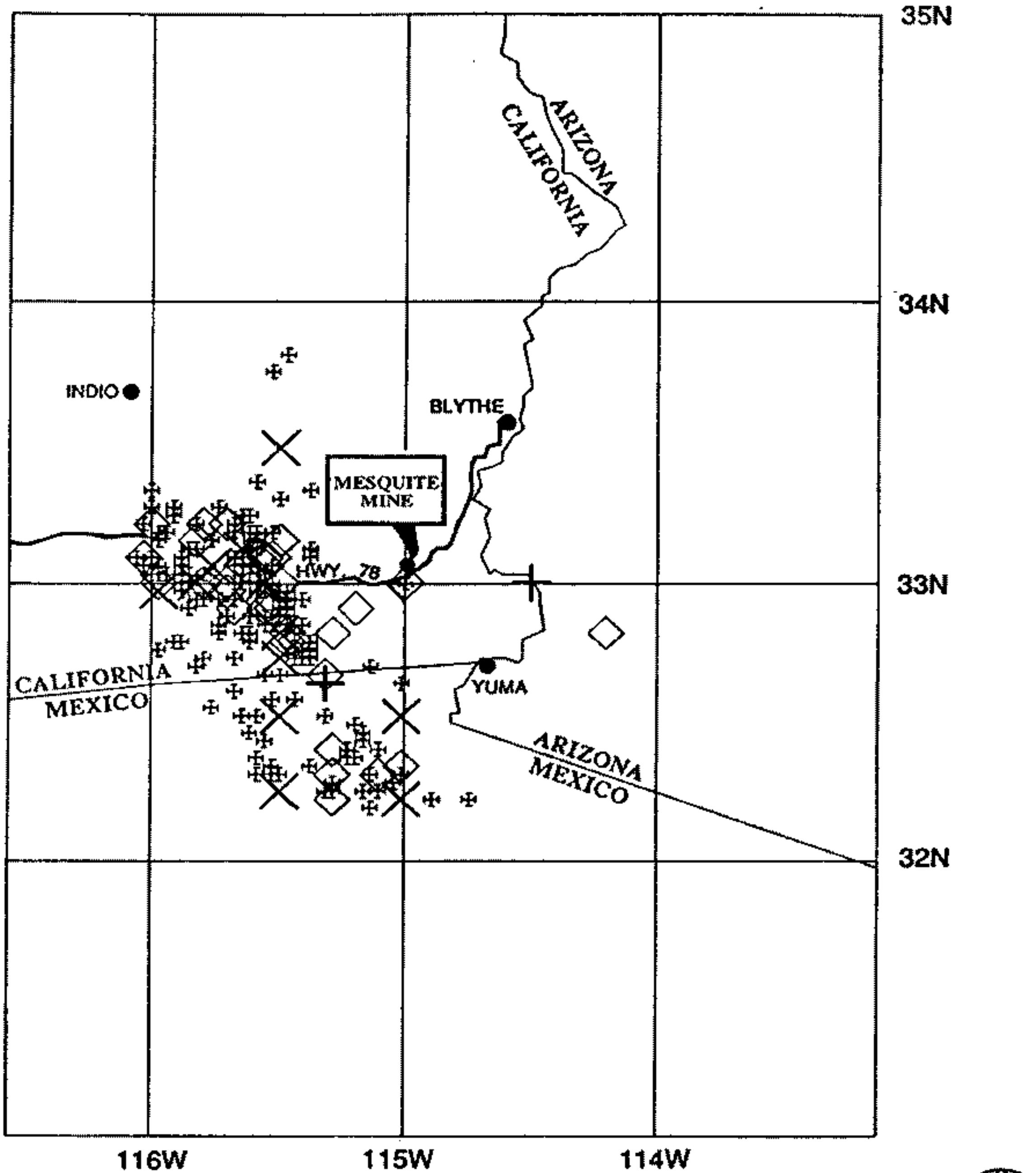
epicenter location. The 1872 earthquake location was estimated based on newspaper reports of ground shaking in Yuma and San Bernardino. The epicenter was plotted between these widely spaced locales, but is only estimated to have occurred "in or near the Imperial Valley" (Toppozada, et al., 1981). The M4.0 earthquake occurring in 1943 was probably plotted based on similar reports of ground shaking and data from limited Southern California regional seismograph stations available at that time. The USGS database designates the accuracy of the 1943 epicenter as a "D" quality location, meaning that the level of confidence of the location is greater than 15 km (9 miles). Because there are no known active faults in the vicinity of these two early epicenters, it is likely that these earthquakes occurred farther to the west, in what is now known as the more active seismic region of the Imperial Valley.

Based on the data presented in Tables 3.1-3 and 3.1-4, the worst-case scenario for horizontal ground acceleration at the Mesquite Mine would be an MCE earthquake of M6.5 located 9 miles from the site along the East Mesa Fault. Peak horizontal accelerations for such an event would range up to 0.20 g for the MCE. MPE and associated acceleration would be M6.0 and 0.17 g, respectively. The high repeatable accelerations would be about 0.13 g and 0.11 g from the MCE and MPE events, respectively.

These earthquake characteristics are generally confirmed by a report titled *Peak Acceleration from Maximum Credible Earthquakes in California*, published by the California Department of Conservation, Division of Mines and Geology (CDMG) (Maulchin and Jones, 1992). This report was prepared specifically for the California Department of Transportation (Caltrans) in determining appropriate seismic accelerations to be used for designing highways, bridges, etc. It is not considered to be a replacement for existing state fault maps, but it does provide valuable information concerning seismic conditions in Imperial County. Figure 3.1-8 shows the site location with respect to a map from the referenced report, which shows peak accelerations for the MCE for various distances from the regional faults that were considered. The peak acceleration at the Mesquite Mine site, estimated for the MCE earthquake using the CDMG map, would be slightly less than the ground acceleration of 0.20 g for an MCE on the East Mesa Fault.

Other secondary effects sometimes associated with major earthquakes include liquefaction, induced landsliding, flooding, and subsidence. Liquefaction, flooding, and subsidence are not applicable to the site because ground water is deep (i.e., at least 140 feet) beneath the site, there is not appreciable nearby surface water, and the thin ground surface layer is supported by the dense Bear Canyon Conglomerate and underlying bedrock.

Induced landsliding is not likely to be an important issue because of the lack of steep natural slopes that might be capable of sliding into mine facilities. Mine pit slopes might experience minor movement during a large earthquake, but considering the relatively low peak accelerations expected to be possible at the site and planned pit slope benching, excessive movement is not likely to occur.



LEGEND

EARTHQUAKE MAGNITUDES:

4 ✠ 5 ◇ 6 ✕ 7 +

0 40 80 MILES

NOTE:
EPICENTERS SHOWN OCCURRED BETWEEN 1800 AND 1992 WITH MAGNITUDES GREATER THAN 4.0.

REFERENCE: U.S. GEOLOGICAL SURVEY, NATIONAL EARTHQUAKE INFORMATION CENTER DATA TAKEN FROM THE EARTHQUAKE DATA BASE SYSTEM

SOURCE: Environmental Solutions, Inc., 1992.

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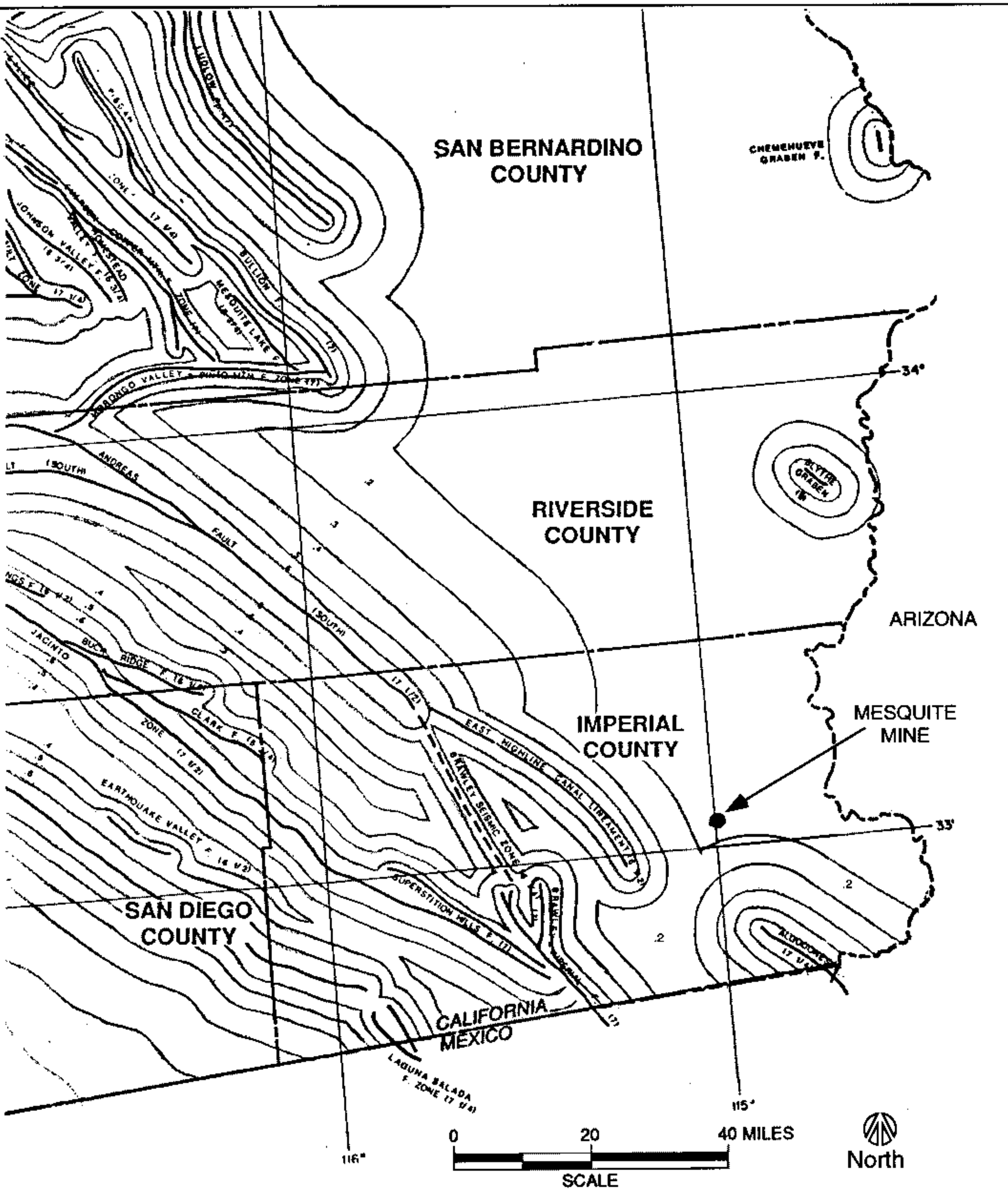
Mesquite Mine Expansion EIR/EIS

Historic Epicenter Map

FIGURE 3.1-7



SOURCE: Environmental Solutions, Inc. 1992

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Proposed Mesquite Mine Expansion EIR/EIS

Peak Acceleration From MaximumCredible Earthquakes

FIGURE 3.1-8

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3.2 WATER RESOURCES

3.2.1 Scope and Regulatory Status

The description of the existing environment for water resources focuses on the Mesquite Mine site and immediate adjacent areas that could be potentially affected by: (1) precipitation run-off or ground water quality changes originating from the site, and (2) the proposed extension of the mine pits. Ground water extraction for operations under the proposed expansion would occur from the existing Mesquite Mine well field located approximately 3 miles south of the proposed site. Ground water extraction would be within the withdrawal rate and quantity analyzed in previous CEQA/NEPA evaluations and approved under existing permits. These previous evaluations addressed ground water withdrawal in detail and determined the related environmental impacts to be less than significant (Mesquite Regional Landfill EIR/EIS, The Butler Roach Group, Inc., 1995). Use of the Mesquite Mine well field would be regulated by the Imperial County Planning Department through the Conditional Use Permit (CUP) process.

The Colorado River RWQCB is the regulatory agency responsible for protection of surface and ground water quality at the site. If deemed necessary by RWQCB, revised Waste Discharge Requirements (WDRs) could be required for the expansion. Demonstrated compliance with Title 27 of the CCR would be required for the RWQCB to issue WDRs. The RWQCB would consider the following aspects of the expansion during their review of an application for WDRs:

- The expanded leach pad location with respect to potentially active (Holocene) faults.
- The leach pad expansion liner and leachate control system designs.
- Precipitation run-off control, on and around facilities with potential to degrade ground and surface water, including proposed changes to existing storm water drainage diversions.
- Monitoring systems in the unsaturated (vadose) zone and ground water to verify leach pad performance and provide an early warning of leakage.
- Heap leach pad rinsing and closure procedures to mitigate any potential long-term threat to beneficial water uses.
- Financial assurances that funds are available for heap leach pad expansion closure.

3.2.2 Surface Water

Regionally, the Mesquite Mine is located within the Salton Sea Drainage Basin, a closed hydrologic system in which surface drainage flows to an internal point, or sink (the Salton Sea) and subsequently evaporates. Within this basin, the source of surface water is primarily imported irrigation water from the Colorado River, which enters the basin via the All American Canal. The Coachella Canal, approximately 15 miles southwest of the site and 1 mile west of the Algodones Sand Dunes, is the closest perennial surface water feature.

Precipitation normally takes the form of intense but isolated rainstorms. Precipitation run-off, which occasionally occurs in several relatively small, normally dry washes that traverse the site, does not drain to the Salton Sea. Instead, the brief flows that occur in these washes percolate into the shallow, loose wash bottom soils and/or evaporate. Excess flow from any infrequent larger flows would terminate at the Algodones Sand Dunes, which form a natural topographic barrier above the adjacent desert floor.

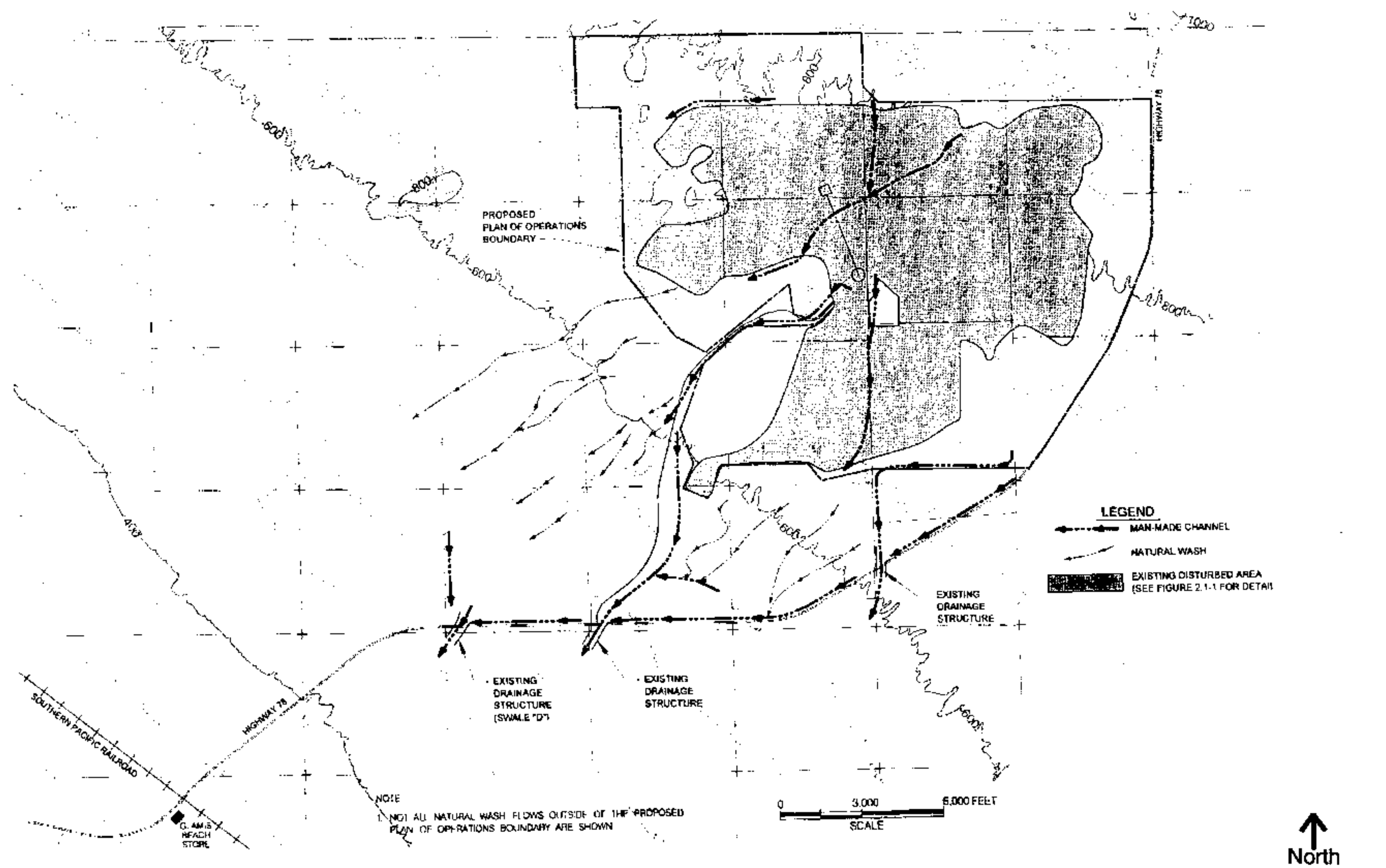
Flows that do occur in the washes, upgradient from the dunes, usually last for periods of less than one hour, during which time the flow is highly turbid due to natural erosion of the unvegetated wash bottoms and sides. Observations at the Mesquite Mine indicate that such short duration, measurable flows occur infrequently. The magnitude of run-off that can occur in the area during large storms was calculated for the design of three swales provided in an 8.5-mile realignment of State Route 78 (SR 78) around the Mesquite Mine area, completed in 1988. The combined peak flow for the 10-year storm at these three swales is about 4,000 cubic feet per second (cfs) (Environmental Solutions, Inc., 1987b). The majority of the drainage area contributing to this flow is from the flanks of the Chocolate Mountains, upgradient from the mine. Figure 3.2-1 shows the existing drainage configuration through and around the mine site.

Mining that has occurred to date in the Big Chief, Vista and Rainbow pits has progressed downward into ground water that occurs in the joints and fractures of the basement rock, so that ground water now seeps into the mine pits. Without the proposed expansion, removal of water from the mine pits (e.g., for dust control) would cease and lakes would occur in the pit bottoms. The pit lakes would be isolated from surface water. Because the hydrology and water quality of the pit lakes would be a result of interactions primarily between ground water seepage and evaporation, the pit lakes are discussed in more detail along with ground water in Section 3.2.3.

3.2.2.1 Waters of the United States

The U.S. Army Corps of Engineers (ACOE), under Section 404 of the Clean Water Act, regulates the discharge of dredged or fill material into "Waters of the United States" (33 USC 1251-1376). Permits must be obtained from the ACOE prior to initiating discharges into jurisdictional "Waters of the United States." Pursuant to applicable regulations (40 CFR 230.10), no permit for the discharge of dredged or fill material would be granted by the ACOE if:

- There is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem;
- If the discharge causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable state water quality standard;



SOURCE: Butler Roach Group, Inc., 1994; revised TRC, 2000

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Mesquite Mine Expansion EIR/EIS

Existing Drainage

FIGURE 3.2-1

- Violates any applicable toxic effluent standard or prohibition;
- Jeopardizes the continued existence of species listed as endangered under the federal Endangered Species Act;
- Causes or contributes to substantial degradation of the "Waters of the United States"; or,
- Unless appropriate and practicable steps have been taken which would minimize potential adverse impacts of the discharge on the aquatic ecosystem.

Pursuant to 33 CFR 325.4, the ACOE may take into account the existence of controls imposed under other federal, state, or local programs which would achieve the objective of the desired condition, or the existence of an enforceable agreement between the applicant and another party concerned with the resource in question.

"Waters" are broadly defined at 33 CFR 328.2 to include non-tidal waters, including intermittent watercourses (commonly known as 'isolated waters')(33 CFR 328.3(a)(3)) and tributaries to such watercourses (33 CFR 328.3(a)(5)). "Isolated Waters of the United States" include "All other waters such as *intrastate* lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce…", including those "which are or would be used as habitat by birds which cross state lines; or which are or would be used as habitat for endangered species; or used to irrigate crops sold in interstate commerce" (51 CFR 41217).

The limits of ACOE jurisdiction on "non-tidal Waters of the United States" extend to the "ordinary high water mark" (OHWM), in the absence of adjacent wetlands (33 CFR 328.4(c)(1)); or beyond the OHWM to the limits of the adjacent wetlands, when adjacent wetlands are present (33 CFR 328.4(c)(2)); or to the limits of the wetlands when only wetlands are present (33 CFR 328.4(c)(3)).

Surveys were performed by Jones & Stokes (August, September 1999) to identify "Waters of the United States," including wetlands in and around the Project area. The surveys inventoried each of the principal through-going ephemeral washes within the Project area, as well as all tributaries, to determine which met the criteria of "waters" and "Waters of the United States." No wetlands were identified within the proposed expansion; however, approximately 20 acres of land within the proposed Mine expansion areas were evaluated as being within the OHWM of the washes, and thus may be "waters" and "Waters of the U.S." under the applicable definitions. An official determination of Waters of the U.S. will be made by the ACOE as part of the concurrent Section 404 process. A map of the "waters" relative to proposed expansion areas is provided in Section 4.1.2.

3.2.3 Ground Water

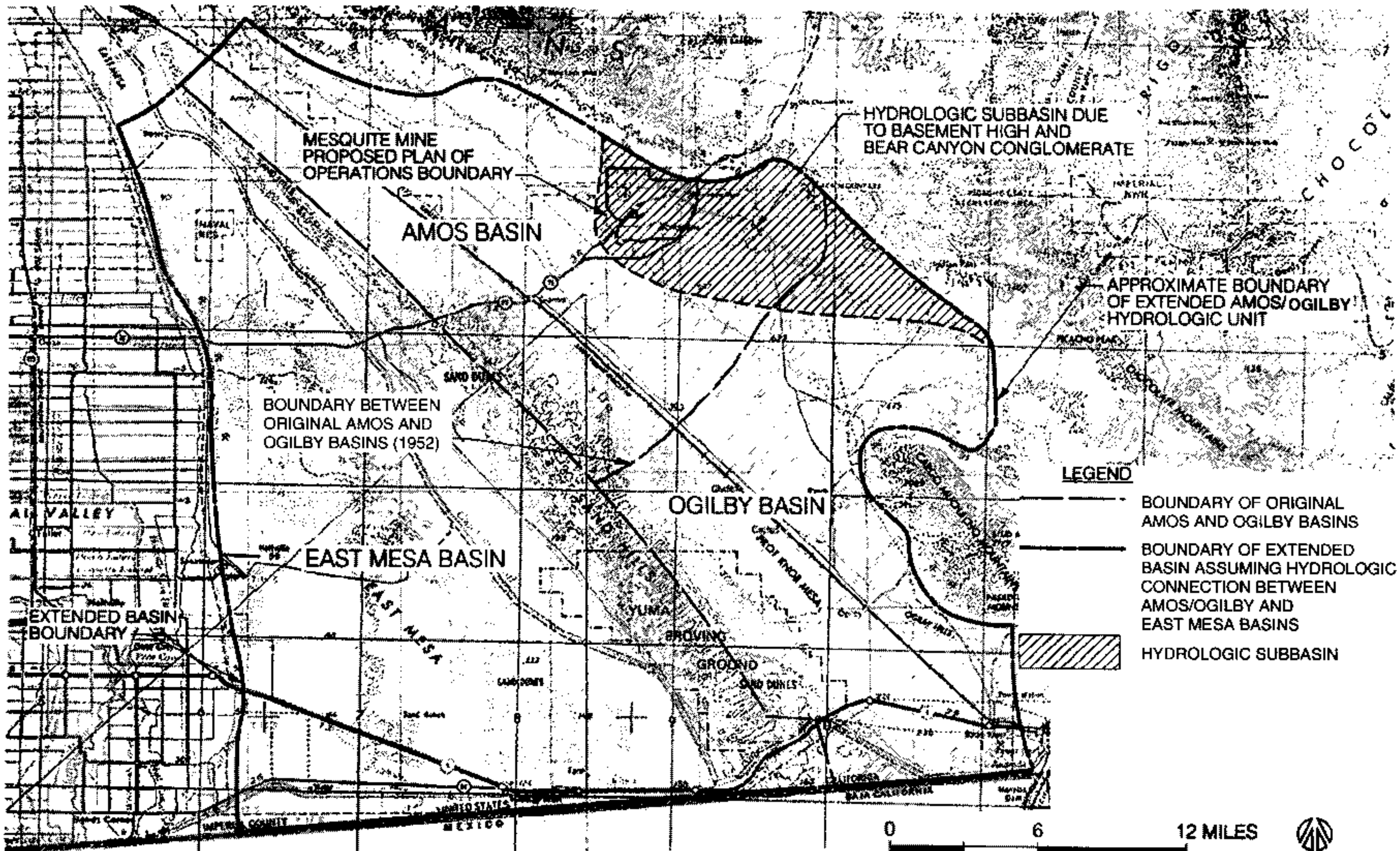
Detailed hydrogeologic studies have been conducted in the vicinity of the Mesquite site for previous mine developments, for the Mesquite Regional Landfill, and most recently, for the proposed expansion. Baker Consultants, Inc. 1999, *Draft Report Hydrologic and Geochemical Study, Proposed Mesquite Mine Expansion, Imperial County, California*, provides a comprehensive hydrogeologic and geochemical study for the mine pit areas, and is the primary reference for discussion of ground water flow into the mine pits, the occurrence of mine pit lakes, and related water chemistry. The Hydrogeology Technical Report for the Mesquite Regional Landfill (Environmental Solutions, Inc., 1993) contains additional detailed information on site and regional ground water resources. Relevant information from these studies is summarized in this section. The Hydrogeology Technical Report for the Mesquite Regional Landfill (Environmental Solutions, Inc., 1993) and the Draft Report Hydrologic and Geochemical Study (Baker Consultants, Inc., 1999) are hereby incorporated by reference.

3.2.3.1 Occurrence

Regional and Site Subbasin Ground Water Occurrence

Hydrologically, the project area was originally included in the Amos Basin (California Department of Public Works, Division of Water Resources, 1952), a 150-square-mile area extending south from the Chocolate Mountains (see Figure 3.2-2). Limits of the Amos Basin were not well defined and its separation from the adjacent Ogilby Basin to the south was based on ground water use rather than on geologic or hydrologic factors (St. Clair Research Systems, Inc., The Butler/Roach Group, Inc., 1984). A more recent designation incorporates both the Amos and Ogilby basins into one combined, approximately 300-square-mile Amos-Ogilby Hydrologic Unit (California Department of Water Resources [DWR], 1964). Studies performed by Environmental Solutions, Inc. (1992b) using data presented in DWR (1964) and USGS (1972 and 1975) reports indicate that the Amos-Ogilby Basin is probably also hydraulically connected to the East Mesa Basin to the west of the Algodones Sand Dunes, which approximately doubles the size of the alluvial aquifer.

Figure 3.2-3 shows the locations of wells and borings used to determine vadose zone and ground water conditions in the vicinity of the Mesquite Mine. The borings shown on this figure include wells completed for subsurface monitoring, geotechnical borings and mineral exploration borings, selected from the thousands of wells and borings completed by the Mine in the project area. Most of the geotechnical borings were installed for design of the original Mesquite Mine facilities. Geotechnical Borings ESI-1 and ESI-2 were continuously cored borings conducted to confirm interpretations that the vadose zone above basement rock consists of low-permeability material. The wells shown were completed for several purposes, including: early attempts to develop water supply sources near the mine; the development of the Mesquite Mine well field (GF-1, -2, and -3A) approximately 3 miles to the south of the mine site; monitoring wells for mine processing activities; and initial monitoring wells for the approved Mesquite Regional Landfill. These wells provide a substantial history of ground water level data.



SOURCE: BRG Consulting, Inc., 2000.

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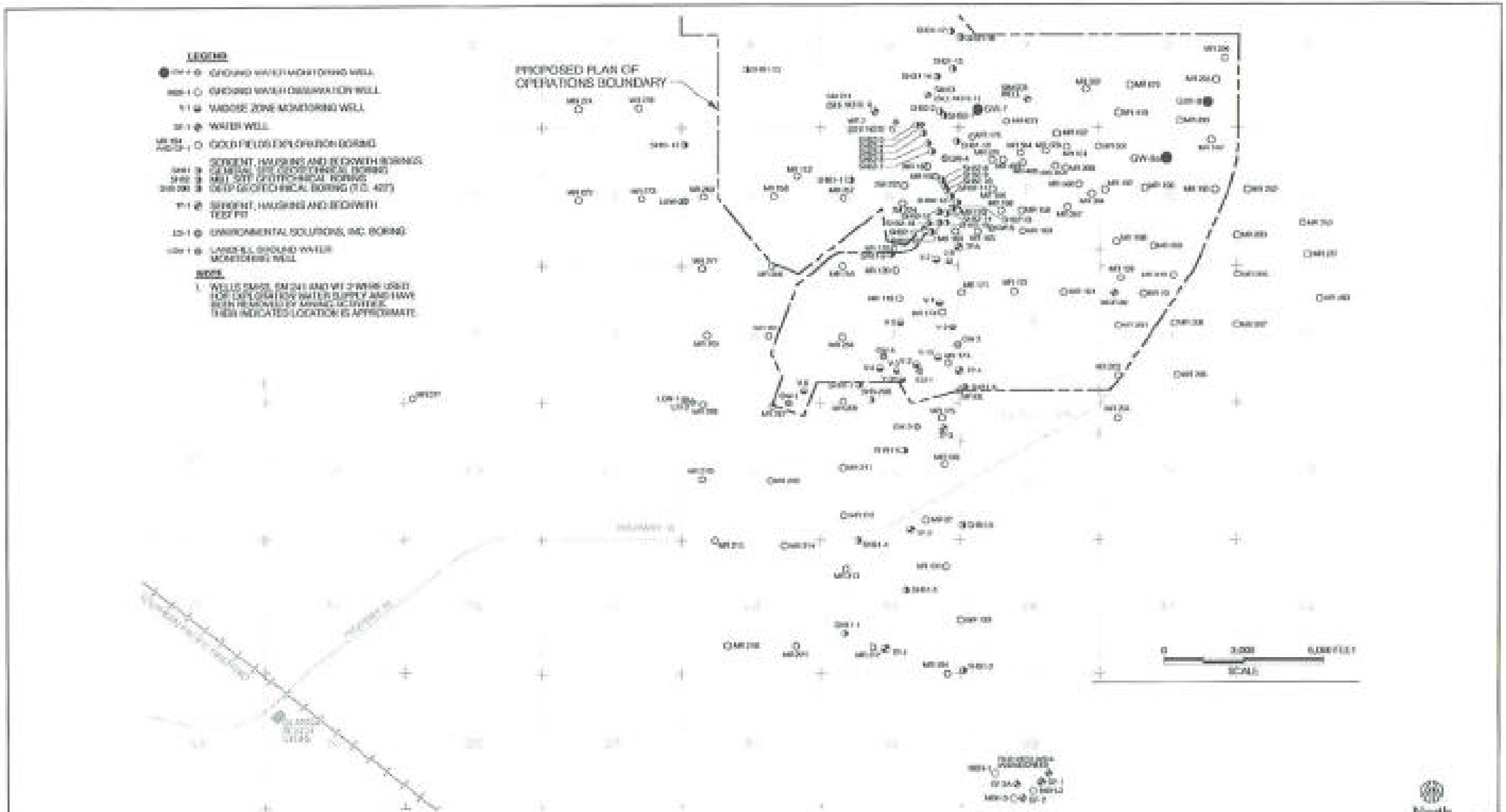
Mesquite Mine Expansion EIR/EIS

Groundwater Basin Boundaries

FIGURE 3.2-2



SOURCE: TRC, 1999

Mesquite Mine Expansion EIR/EIS

Locations of Borings and Wells

FIGURE 3.2-3

An important result of this series of hydrologic and geotechnical investigations conducted for the Mesquite Mine has been the definition of a minor ground water subbasin that underlies the general area of the mine site. The subbasin is defined by a zone where low-permeability conglomerate bedrock or basement rock is present at shallow depths (Figure 3.1-4), and water-bearing alluvium does not exist.

The southern boundary of the ground water subbasin is defined by a buried basement rock high that separates the project area from the main Amos-Ogilby alluvial basin to the south. The postulated limits of this subbasin are shown on Figure 3.2-2. The existing Mesquite Mine well field, which would be used to supply water for the expansion activities, is located about 1 mile south of the subbasin boundary and, therefore, taps into the deep alluvium of the Amos-Ogilby Basin. Table 3.2-1 shows these wells (GF-1, -2 and -3) have estimated maximum yields of 2,500 gallons per minute (gpm) each, compared to wells completed in the subbasin that yield less than 28 gpm. Figures 3.2-3 and 3.2-4 show the approximate locations of the wells listed in Table 3.2-1.

The ground water flow in the subbasin is generally from the northeast toward the southwest in the same direction as the surface ground slope. Prior to mining, ground water generally occurred at depths ranging from about 200 to 300 feet in the mine pit and ore processing areas. The source of ground water recharge to the subbasin underlying the Mesquite Mine area is the small amount of precipitation infiltration that occurs in the upgradient watershed bounded by the drainage divide of the Chocolate Mountains. Precipitation rates in the area are on the order of 3 inches per year, while lake evaporation potential is approximately 80 inches per year. As a result of the limited watershed and low precipitation, and the low permeability of ground water recharge is minimal. This condition is reflected in long-term water level data for the Mesquite Mine Monitoring Wells (GW-1 to -9). These wells generally have shown only very small water level fluctuations (i.e., typically less than 5 feet), including changes that were measured during the drought of the late 1980s and the September 1991 to May 1992 period when rainfall was more than twice the yearly average. An exception occurs at GW-7, located adjacent to the Big Chief and Vista pits, where draw down appears to be occurring due to seepage into the mine pits.

In contrast to the ground water subbasin conditions at the Mesquite Mine site, the thick, water-bearing alluvial deposits of the Amos-Ogilby Basin store and transmit substantial amounts of ground water. The Amos-Ogilby Basin is the source of ground water for the existing Mesquite Mine wells, located about 3 miles south of the mine site. The main source of recharge to these deposits is underground flow from the Colorado River and the All American Canal in the southeasternmost portion of the Imperial Valley (USGS, 1972 and 1975); however, the project area is not within an area that is considered in or part of the Colorado River system for purposes of water rights jurisdiction. Some recharge also is derived from infiltration of precipitation at the Algodones Sand Dunes and from relatively minor amounts from infiltration from the adjacent mountain slopes. The magnitude of total recharge is estimated to be on the order of 100,000 acre-feet per year, if the anticipated hydrogeologic connection between the Amos-Ogilby and East Mesa Basins exists. If this interbasin connection does not exist, the estimated recharge would be on the order of 50,000 acre-feet per year.

Table 3.2-1

Summary Of Vicinity Wells, Proposed Mesquite Mine Expansion

	Well Identification	Purpose	Rated Yield (Gpm)	Total Depth (Ft)	Perforated Interval (Ft)	Sealed Depth (Ft)	Dated Completed	Approximate Water Level (Ft)	
								Depth	Elevation
Wells Completed in Bedrock or Basement Rock of the Subbasin	WT-2	Production/ Upgradient Monitoring	28	442	154-404	N/A	October 1982	185	550
	SM-63	Production	10	477	N/A[1]	N/A	N/A	185	575
	SM-241		10	520				200	560
	Singer Well		15	470				220	575
	GW-1	Downgradient Monitoring Well	< 15	430	317-416	0-291	October 1985	313	277
	GW-2		< 10	310	207-305	0-190		270	360
	GW-3		1-2	310	196-296	0-193		213	437
	GW-4	Upgradient Monitor. Well	2	320	209-309	0-190	October 1986	223	502
	GW-5	Downgradient Monitoring Well	2	359	259-359	0-250	October 1988	270	N/A
	GW-6		1-2	338	238-338	0-222	January 1990	250	N/A
	GW-7	Upgradient Monitoring Well	--	ND[3]	ND	ND	May 1995	ND	544
	GW-8A		--	ND	423-522	ND	July 1997	260	555
	GW-9		--	500	374-473	ND	June 1997	287	568
	LGW-1	Downgradient Monitor.Well	< 10	450	300-450	0-285	February 1993	357	210
	LGW-2	Upgradient Monitor.Well	< 10	190	130-190	0-130	Nov. 1992	141	490
	MCR-80	(4)	< 26	1,017	402-1,002	0-50	March 1983	197	523
Wells Completed in Amos-Ogilby Basin Avenue	GF-1	Production	`	822	506-810	0-20	Dec. 1983	474	79
	GF-2		2,300+	908	658-885	0-50	March 1985	462	78
	GF-3A		2,250+	940	690-930	0-50	March 1986	469	77
	MBH-1	Observation	N/A	600	510-590	0-300	Nov. 1984	467	81
	MBH-2			640	510-590	0-400		470	80
	MBH-3			683	510-680	0-400		458	79
	Boardman Well	Production	N/A	735	N/A	N/A	Nov. 1980	309	95
	Glamis Well	Production	300	520	N/A	N/A	Nov. 1972	235	100
	Cahuilla Ranger Station	Production	50	300	210	N/A	July 1992	114	80[2]
	Gold Rock Ranch Well	Production	N/A	521	N/A	N/A	1935	397	83
	American Girl Mine 26-1	Production	50	N/A	N/A	N/A	N/A	280	119
	American Girl Mine 26-2	Production	400	393	N/A	N/A	August 1988	280	119

Source: Environmental Solutions, Inc., 1993.

1 N/A = Not Available
2 Estimated based on approximate ground surface of 195 feet above mean sea level.
3 ND Not Determined for this EIR/EIS
4 Intended for large-scale production, but insufficient yield.
gpm = gallons per minute ft = feet

Mine Pit Area Ground Water Occurrence

Prior to mining, ground water in the areas of the mine pits ranged in depth from about 200 to 300 feet. Mining in the Big Chief, Vista and Rainbow pits has extended downward to ground water, and dewatering at the mine pits has created localized cones of depression in the ground water near the pits (Figure 3.2-5). Dewatering in the mine pit area began in 1987 when the Big Chief pit reached the ground water level anticipated from prior observations at wells and exploratory borings.

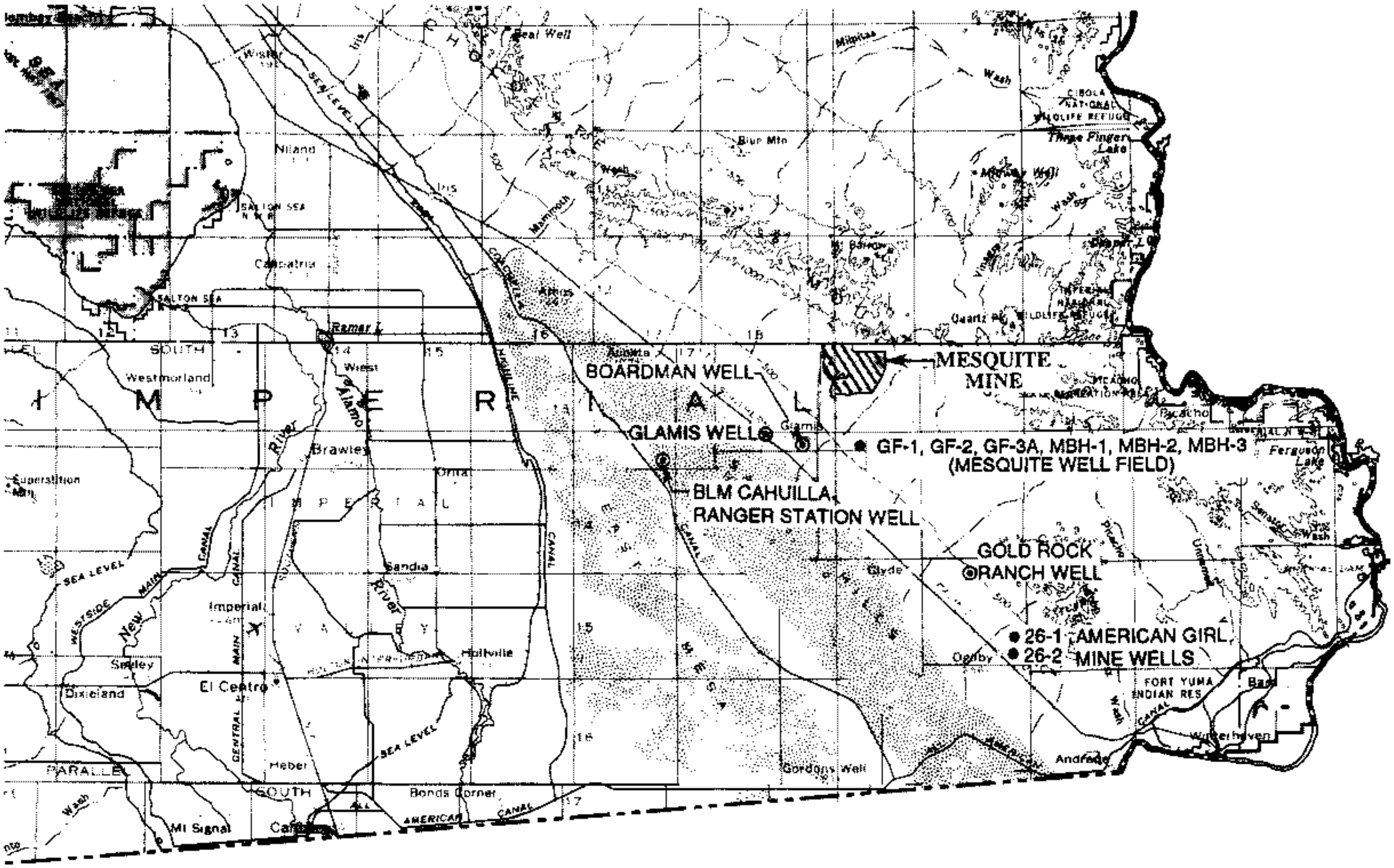
Flow net and water balance calculations have been completed to estimate the quantity of ground water flow through the mine pit areas (Baker Consultants, Inc., 1999). Results of the water balance are shown in Table 3.2-2 and indicate that a total of about 80 gpm (130 acre-feet/year) of ground water may flow into the mine pits under current conditions. Most of this inflow (about 50 gpm) occurs into the Big Chief pit. The long-term water balance for the mine pits is dominated by ground water inflow and evaporation. Without pumping water from the pit lakes (e.g., for dust control), the water levels in the currently permitted mine pits would rise until the water surface area is large enough to evaporate water at the same rate as it seeps into the pits.

The total estimated current 80 gpm inflow to the pits is low considering the extent to which the pits penetrate the water table. This is because the basement rock typically has a low permeability. The water seepage that does occur is primarily from larger joints and fractures in the basement rock where permeability is the highest. This conclusion is consistent with low well yields typical of the subbasin, as described previously and shown in Table 3.2-1.

The flow net calculations (Baker Consultants, Inc., 1999) were performed to estimate the total amount of ground water flow occurring through the area surrounding the mine pits. The calculations utilized the results of the water balance (Table 3.2-2) to estimate the total quantity of ground water flow through the upper 300 feet of the saturated zone across the mine pit areas. The flow boundary lines used for the flow net calculations are shown in Figure 3.2-5. The calculations estimate the total ground water inflow to the mine pit areas (in the upper 300 feet of the saturated zone and between the easternmost and westernmost flow boundary line) to be approximately 100 gpm. The portion of this flow that does not seep into the mine pits flows around the mine pits and through the site to downgradient areas.

3.2.3.2 Usage

With the exception of Mesquite Mine-related uses, the only known historic use of ground water in the subbasin was by Richard Singer, at a well that lies within a claim block previously sold to the mine. The Singer Well (See Figure 3.2-3) was drilled into bedrock to a depth of approximately 470 feet. The well produced about 15 gpm and was used at a rate of about 100 gallons per week for showers, laundry, cooling, and some minor ore processing. Water from the Singer Well is not suitable for drinking purposes.



LEGEND

◎ LOW CAPACITY DOMESTIC WELLS

● HIGH CAPACITY INDUSTRIAL WELLS

0 10 20 MILES

SCALE

North

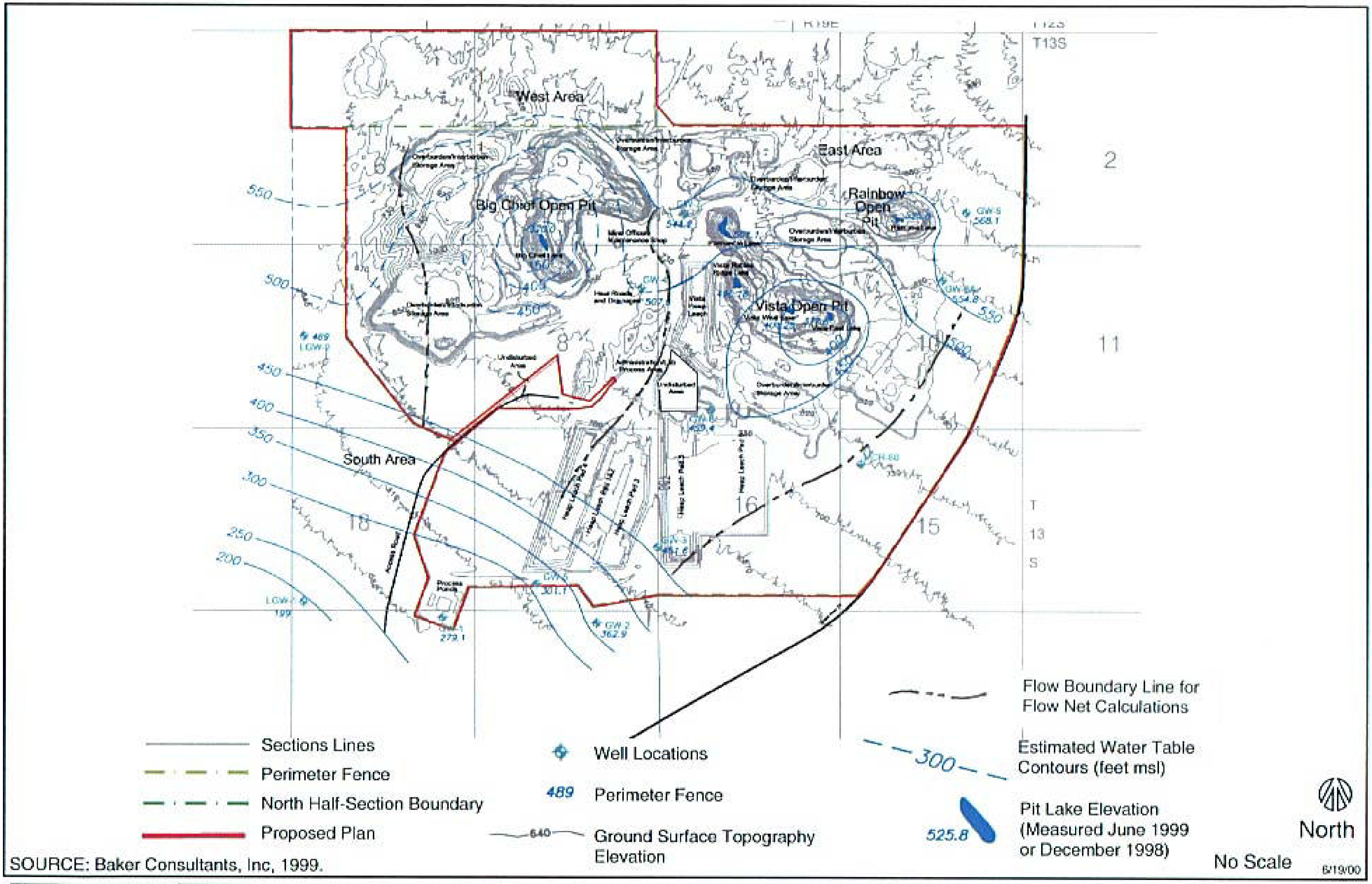
SOURCE: Env. Solutions, Inc., 1992

3/14/00

Mesquite Mine Expansion EIR/EIS

Locations of Area Wells

FIGURE 3.2-4



SOURCE: Baker Consultants, Inc, 1999.

Mesquite Mine Expansion EIR/EIS

Existing Groundwater Elevations

FIGURE 3.2-5

In addition to the Singer Well, the Mesquite Mine used ground water from the subbasin for a pilot test facility and exploration drilling from 1982 to 1986. This water was obtained from several low-capacity (10 to 28 gpm) wells completed in the bedrock or basement rock, identified as SM-63, SM-241 and WT-2 in Table 3.2-1 and in Figure 3.2-3.

Since early 1986, when full-scale operation of the Mesquite Mine began, water requirements have been supplied by the Mesquite Mine well field located approximately 3 miles south of the proposed site in alluvial deposits of the Amos-Ogilby Basin. The well field was located distant from the Mesquite Mine area because earlier attempts at developing large-scale production wells closer to the mine (i.e., in the subbasin area) were unsuccessful. The Mesquite Mine well field includes three large-diameter wells, large high-production pumps, two monitoring wells, a 5-mile electric power line, and a 4-mile above-ground pipeline.

The Mesquite Mine well field is approved for extracting up to 4,033 acre-feet of water per year (Imperial County CUP No. 684-84), based on maximum estimates of potential water demands for dust control, heap leaching and evaporation.

3.2.3.3 Aquifer Characteristics

Ground water in the subbasin that underlies the Mesquite Mine occurs primarily in two hydrogeologic units, basement rock and Bear Canyon Conglomerate. Hydraulic conductivities that have been estimated or measured in these units as part of site-specific ground water investigations are summarized in Table 3.2-3.

Based on data from pumping tests conducted on wells near the Mesquite mine pit, Sergent, Hauskins & Beckwith (1984) estimated the hydraulic conductivity of the basement rock within the Big Chief Mine Pit area to be less than 5 x 10^{-6} centimeters per second (cm/sec). Hydraulic tests conducted in Boring ESI-2 (See Figure 3.2-3) indicated that the hydraulic conductivity of the majority of the unfractured basement rock encountered in that boring is very low, on the order of 10^{-7} cm/sec. Based on exploration boring log reviews by Baker Consultants, Inc. (1999), Well GW-1 is thought to be screened in a basalt or andesite volcanic unit. The volcanic unit encountered in this well is hypothesized to be part of the Tertiary age volcanics of the basement rock as described in Section 3.1.3.3. Results of a pumping test at Well GW-1 (Environmental Solutions, Inc., 1993) indicate that the hydraulic conductivity of the volcanic unit at GW-1 is about 6 x 10^{-5} cm/sec. These results indicate a hydraulic conductivity that is an order of magnitude higher than the Pre-Tertiary igneous and metamorphic units of the basement rock (Table 3.2-3). Well GW-1 encountered the volcanic unit in the ore processing area, about two miles downgradient of the mine pits. This volcanic unit does not occur below the ground water table in the mine pit areas and does not directly affect ground water seepage or drawdown in the mine pit areas.

Table 3.2-2

Existing Pit Lake Water Balance Summary
Proposed Mesquite Mine Expansion

Pit Lake Name	Pumping[1] Q_{pump} (gpm)	Direct Precipitation Q_{DP} (gpm)	Evaporation Q_E (gpm)	Net Ground Water Inflow Q_{GW} (gpm) [2]
Big Chief	43	0.2	6.2	49
Rainbow	2	0.1	2.5	4.4
Vista				
East	7	0.1	2.5	9.4
West	0	0.1	2.8	2.7
Panhandle	0	0.4	10.9	11
Rubble Ridge	0	0.2	4.9	4.7
Vista Subtotal	--	--	--	28
TOTAL				**81.4**

99-116 (6/22/00/jb)

Source: Baker Consultants, Inc., 1999.

(1) e.g., Pit lake pumping for dust control.

(2) Derived using the following formula with rounding to two significant digits.
$Q_{GW} = Q_{pump} + Q_E - Q_{DP}$

Table 3.2-3

Summary Of Hydraulic Conductivity Estimates For The Subbasin
Proposed Mesquite Mine Expansion

Hydrogeologic Unit	Estimated Hydraulic Conductivity		Reference
	cm/sec	ft/day	
Basement Rock (undifferentiated)	$<5 \times 10^{-6}$	1.5×10^{-2}	SHB, 1984a
	6.3×10^{-5} to 2.1×10^{-4} **1**	1.8×10^{-1} to 5.8×10^{-1} **1**	Environmental Solutions, Inc., 1993 (GW-1 Pump Test)
	$<1.67 \times 10^{-7}$ to 4.8×10^{-7}	$<4.7 \times 10^{-4}$ to 1.4×10^{-3}	Environmental Solutions, Inc., 1993 (ESI-2 Packer Test)
	8.1×10^{-6} to 2.0×10^{-5} (geometric mean 1.6×10^{-5})	2.3×10^{-2} to 5.6×10^{-2}	SMI, 1998a
Conglomerate	3.3×10^{-7} to 2.9×10^{-4} (average 10^{-6})	9.4×10^{-4} to 8.2×10^{-1}	Environmental Solutions, Inc., 1993 (ESI-2 Packer Test)
	2.1×10^{-6} to 1.2×10^{-4} (average 10^{-5})	6.0×10^{-3} to 3.4×10^{-1}	Environmental Solutions, Inc., 1993 (ESI-1 Packer Test)

99-116 (11/5/99/mc)

Source: TRC, 2000.

1 The lower end of this range (i.e., 6.3×10^{-5} cm/sec and 1.8×10^{-1} ft/day) were interpreted to represent the overall rock mass, whereas the higher end of this range (2.1×10^{-4} cm/sec and 5.8×10^{-1} ft/day) were interpreted to represent initial dewatering of fractures in rock adjacent to walls of the well boring.

cm/sec = centimeters per second
ft/day = feet per day

The results of packer pressure tests conducted in the cored Borings ESI-1 and ESI-2 indicate that the hydraulic conductivity within the top portion of the Bear Canyon Conglomerate varies from 8 x 10^{-5} cm/sec at shallow depths to less than 10^{-6} cm/sec at about 100 feet. Water has been encountered in the Bear Canyon Conglomerate primarily in the ore processing areas in the southern portion of the Mesquite Mine site. In the mine pit areas, located in the northern and central portions of the site, the Bear Canyon Conglomerate primarily occurs above ground water.

Hydraulic parameters for the main, alluvial portion of the Amos-Ogilby Basin were determined by pumping tests conducted when the Mesquite Mine well field was installed in 1983, 1985, and 1986. The estimated hydraulic conductivity of the sand and gravel portions of the alluvium aquifer determined for these tests is on the order 10^{-2} cm/sec, or three to four orders of magnitude greater than hydraulic properties of the subbasin that underlies the Mesquite Mine site. The alluvium aquifer does not occur beneath the mine site. It begins offsite to the south and west where thick accumulations of alluvium are present (Section 3.2.3.1).

3.2.3.4 Ground Water Quality

The quality of ground water in the vicinity of the Mesquite Mine has been described in several investigations conducted to support the EIR/EIS and Plan of Operation documents prepared for the VCR Mining Project, Mesquite Project, Mesquite Regional Landfill and Rainbow Pit Expansion (ESI, 1987; ESI, 1993, BRG, 1995; SMI, 1997). The typical ground water chemistry reported for the ground water subbasin in which the mine is located is shown in Table 3.2-4 (excerpted from ESI, 1993). The data in the table represent ground water quality conditions observed in various colluvial and bedrock hydrostratigraphic units for selected sampling events between 1982 and 1993.

The Mesquite Mine began operation in 1985. The locations of monitoring wells for which data is shown are provided in Figure 3.2-3, although WT-2, SM-63 and the Singer Well no longer exist. Ground water quality data for the Mine monitoring wells (i.e., the "GW" series wells) has been collected and routinely reported to the RWQCB throughout the 15 years that Mesquite has been operating. Under current mine operation permit requirements, ground water quality is monitored on a quarterly basis in wells GW-1 through GW-7 for the following chemical constituents: pH, specific conductance, temperature, arsenic, copper, cyanide (total), cyanide (free), iron, nitrate/nitrite, silver, sulfate and TDS.

Work by Baker Consultants, Inc. (1999) included detailed review of the last 5 years of monitoring data from Wells GW-1 through GW-6 for most of these monitoring parameters. Trends were evaluated for the parameters of pH, specific conductance, temperature, TDS, arsenic, copper, iron, sulfate and nitrate/nitrite. A complete listing of data evaluated and graphical representations of the data are included in the Baker report. None of the parameters evaluated show trends of adverse change in water quality. There are no known ground water quality impacts from the 15 years of activity that have occurred at the Mesquite Mine to date.

Table 3.2-4

Selected Water Quality Data
Proposed Mesquite Mine Expansion

Parameter And Drinking Water Standard [1]		pH (units)	SC (µmho/cm)	TDS (mg/L)	Cl^- (mg/L)	F^{-2} (mg/L)	SO_4^{-2} (mg/L)	As[3] (mg/L)	Cr[3] (mg/L)	Fe[3] (mg/L)	Mn[3] (mg/L)	Hg (mg/L)
		6.5-8.5	900*	500*	250*	1.6[2]	250*	0.05	0.05	0.30*	0.05*	0.002
Well[4]	**Date**											
WT-2	11/22/82	7.88	1,650[4]	1,000	142	2.5	262	0.05	<0.01	0.80	0.08	NA
	3/21/83	7.23	1,760	1,004	137	3.1	274	0.014	<0.01	0.56	0.03	NA
	2/4/84	8.0	1,660	996	127	1.6	256	0.031	<0.01	0.03	<0.01	NA
	5/4/84	8.4	1,800	997	146	1.32	251	NA	NA	NA	NA	NA
	1/21/85	8.2	NA	1,040	136	NA	256	NA	NA	NA	NA	NA
	10/25/85	7.99	1,630	969	140	1.71	260	0.003	<0.01	0.07	0.07	NA
	12/12/85	8.36	1,561	938	110	1.58	266	0.026	<0.01	0.2	0.01	NA
SM-63	11/22/82	7.61	1,560	960	125	1.3	280	0.01	<0.01	0.12	0.01	NA
	3/21/83	7.14	1,650	992	104	3.3	274	0.014	<0.01	1.00	0.02	NA
Singer	2/4/84	7.85	2,250	1,328	286	1.6	415	0.005	<0.01	0.82	0.06	NA
GW-1	10/25/85	7.34	3,320	2,128	595	1.5	283	0.007	0.08	33	14	NA
	12/12/85	7.52	3,105	2,032	486	1.09	168	0.037	0.14	22	1.7	NA
	10/28/86	8.25	3,081	1,819	660	2.2	360	0.075	0.04	3.5	4.1	NA
	4/92	7.5	NA	1,802	NA	NA	NA	NA	NA	NA	NA	NA
	12/93	7.1	NA	1,943	NA	NA	NA	NA	NA	NA	NA	NA
GW-2	10/25/85	7.35	3,230	1,960	876	1.7	325	0.001	<0.01	0.19	0.84	NA
	12/12/85	7.75	3,485	1,992	863	1.02	330	0.007	<0.01	0.77	0.5	NA
	4/92	7.7	NA	1,645	NA	NA	NA	NA	NA	NA	NA	NA
	12/93	8.3	NA	2,003	NA	NA	NA	NA	NA	NA	NA	NA
GW-3	10/25/85	7.92	1,221	869	129	1.3	297	0.002	<0.01	0.04	0.04	NA
	12/12/85	7.23	1,346	890	134	1.81	292	0.017	<0.01	0.39	0.11	NA
	4/92	7.7	NA	1,136	NA	NA	NA	NA	NA	NA	NA	NA
	12/93	7.8	NA	837	NA	NA	NA	NA	NA	NA	NA	NA
GW-4	10/23/86	8.14	2,027	1,270	309	2.0	342	0.009	0.03	0.04	0.14	0.0009
	4/92	7.7	NA	1,191	NA	NA	NA	NA	NA	NA	NA	NA
	12/93	7.7	NA	1,255	NA	NA	NA	NA	NA	NA	NA	NA
GW-5	6/7/89	8.4	NA	1,170	302	2.5	229	0.071	0.20	0.03	1.6	<0.0005
	4/92	9.2	NA	1,191	NA	NA	NA	NA	NA	NA	NA	NA
	12/93	7.7	NA	1,255	NA	NA	NA	NA	NA	NA	NA	NA
GW-6	7/30/91	8.0	NA	1,273	430	1.2	300	<0.005	<0.005	32	0.21	<0.0001
	12/93	7.5	NA	1,495	NA	NA	NA	NA	NA	NA	NA	NA
MCR 80	1/18/85	7.28	3,306	1,800	609	NA	425	NA	NA	6.8	NA	NA

99-116 (6/22/00/jb)

Source: Environmental Solutions, Inc., 1993.

(1) California Domestic Water Quality and Monitoring Regulations. California Health and Safety Code and the CAC Title 22.
(2) 1.6 mg/L based on annual average air temperature of 73° F.
(3) Data presented as total (mg/L). Soluble (<0.45 µm) level data also available.
(4) Well locations are shown in Figure 3.2-3.
(5) The highlighted - dot-screened - numbers exceed drinking water standards.
***** Recommended secondary drinking water standard. Upper and short-term levels may be higher.
N/A = Not Applicable
µmhos/cm = micromhos per centimeter   mg/L = milligrams per liter

Because routine monitoring is specifically directed at specific constituents of interest, it does not include enough parameters to allow a cation/anion chemical charge balance. Recent studies (Baker Consultants, Inc, 1999) have included water sampling and analysis for a more extensive set of parameters. The results of these analyses are provided in Table 3.2-4. The wells sampled and analyzed represent both the basement rock (GW-4, GW-8A and GW-9) and the Bear Canyon Conglomerate (Wells GW-2, GW-3, GW-5 and GW-6) water-bearing units that occur in the subbasin. Work by Baker Consultants, Inc. (1999) indicates that Well GW-1 is screened in an andesite or basalt unit. Data for Well GW-7 is not included in Table 3.2-5, because the Baker Consultants, Inc., study did not determine the unit in which Well GW-7 is screened. This does not materially affect the environmental analysis due to the extensive amount of other ground water data available.

Ground water quality data has been collected from wells in the subbasin over a period of more than 17 years, including prior to mining. Data consistently show that the ground water in the subbasin is sodium-chloride/sulfate in character, and is of generally poor quality and unsuitable for drinking without treatment. It is naturally brackish and moderately to slightly alkaline. Concentrations of total dissolved solids range from about 800 to about 2,000 mg/L. Major dissolved species include sodium, calcium, magnesium, chloride, sulfate, bicarbonate and silica. Minor species include potassium, boron and fluoride. Table 3.2-6 provides a listing of certain State Water Quality Goals to provide a basis of comparison for the constituent concentrations characteristic of ground water in the subbasin.

The water quality commonly exceeds the primary drinking water standard for fluoride and secondary drinking water standards for specific conductance, total dissolved solids, chloride and sulfate. Agricultural water quality standards are also exceeded for boron, chloride and total dissolved solids. Other standards are also exceeded on occasion or in a limited number of wells. These dissolved constituent concentrations are natural and limit the potential beneficial uses of this water without treatment.

3.2.3.5 Pit Water Quality

The Mesquite mine pits currently extend into ground water. Water seeps into the pits and is evaporated or pumped and used for dust control. To the extent that seepage exceeds these uses, ground water ponds in the bottoms of the pits. The chemical composition of waters in four of the existing pit lakes has been monitored during five sampling events conducted between December 1997 and July 1999. During this period, lake depths have varied from approximately 3 to 4 feet to approximately 7 to 10 feet as a result of ground water inflows, mine pit dewatering activities and lake surface evaporation. A complete tabulation of water quality data available for the lakes is presented in Baker Consultants, Inc. (1999).

The mean water quality observed in the Big Chief lake, Vista West lake, Vista East lake and Rainbow lake is summarized in Table 3.2-7. The concentrations of chemical constituents reported in the table represent the geometric means of the eight water samples analyzed to date. Existing pit lake waters are generally alkaline, slightly to moderately saline and low in dissolved trace metals considering the context of mine pit lakes in a highly evaporative climate.

Table 3.2-5

Ground Water Chemistry
Proposed Mesquite Mine Expansion

Parameter	Concentration (mg/L except where noted)							
	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-8A	GW-9
Date Collected	7/19/99	7/19/99	7/20/99	7/20/99	7/19/99	7/19/99	8/26/97	7/19/97
pH(1)	7.73	8.01	8.07	8.16	8.18	9.38	7.94	8.13
Specific Conductance(2)	2,760	3,000	1,330	1,890	1, 750	2,060	--	--
Alkalinity (Total)(3)	140	64.3	239	224	198	44.7	212	248
Aluminum	0.082	0.121	<0.037	0.051	<0.037	<0.037	<0.037	<0.037
Antimony	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.0015	<0.003
Ammonia (as N)	0.25	0.15	<0.01	<0.01	<0.01	<0.01	--	--
Arsenic	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Barium	0.056	0.033	0.019	0.012	0.031	0.013	0.055	0.012
Beryllium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bismuth	--	--	--	--	--	--	<0.027	<0.027
Boron	1.67	1.71	1.17	1.27	1.15	1.61	1.12	1.18
Cadmium	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024
Calcium	76.9	131	24.6	37.2	42.3	19.5	32.7	15.7
Chloride	633	846	137	288	297	479	336	177
Chromium	<0.005	<0.005	0.012	<0.005	<0.005	<0.005	<0.005	0.01
Cobalt	--	--	--	--	--	--	<0.003	<0.003
Copper	<0.004	<0.04	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cyanide (Total)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cyanide (WAD)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	1.5	0.50	2.0	2.0	2.6	1.1	1.7	1.6
Gallium	--	--	--	--	--	--	<0.033	<0.033
Iron	0.03	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02
Lead	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	< 0.003
Lithium	0.050	0.12	0.055	0.054	0.061	0.087	0.055	0.073
Magnesium	11.1	5.08	5.23	10.6	8.34	9.1	6.69	6.09
Manganese	0.832	0.018	<0.002	0.008	0.006	0.004	0.108	<0.002
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	0.069	0.033	0.026	0.062	0.058	0.027	0.061	0.036
Nickel	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023	<0.023
Nitrate/Nitrite (as N)	0.12	2.38	0.025	0.78	1.55	0.09	0.75	0.48
Orthophosphate (as P)	<0.13	2.85	<0.13	<0.13	<0.13	<0.13	<0.13	0.13
Potassium	4.6	5.8	3.4	4.8	6.6	5.4	5.1	3.8
Scandium	--	--	--	--	--	--	<0.002	<0.002
Selenium	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048
Silica	25.5	17.3	29.3	26.6	24.3	5.84	23.6	27.1
Silver	<0.006	0.007	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Sodium	557	567	260	372	416	435	417	305
Strontium	1.90	2.75	0.437	0.791	1.06	0.622	0.881	0.364
Sulfate	439	325	270	386	321	348	346	226
Thallium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Tin	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	<0.007	<0.007	<0.007	<0.007	0.04	0.02	<0.007	<0.007
Total Dissolved solids	1,630	1,740	801	1,180	1,050	1,160	1,290	866
Total Suspended Soils	6	615	3.6	16.2	58.8	339	2.5	1.4
Vanadium	0.012	<0.007	0.045	<0.007	0.017	0.009	<0.007	<0.007
Zinc	0.665	0.59	0.124	0.163	0.311	0.069	0.688	0.375

99-116 (6/21/00/mc)

Source: Baker Consultants, Inc., 1999.

(1) Standard Units, (2) Micromhos per centimeter, (3) mg/L $CaCO_3$ = milligrams per liter of calcium carbonate

Table 3.2-6

California Water Quality Goals
Proposed Mesquite Mine Expansion

Parameter	Primary Mcl[1]	Secondary Mcl[1]	Agricultural Water Quality Goal (Units In Mg/L Except Where Noted)	Ambient Aquatic 4 Day Average	Ambient Aquatic 1 Hour Average
Aluminum	1	0.2	5	0.087	0.75
Ammonia (as N)	--	--	--	pH, temp dependent	pH, temp dependent
Antimony	0.006	--	--	0.03	0.088
Arsenic	0.05	--	0.1	0.19	0.36
Barium	1	--	--	--	--
Beryllium	0.004	--	0.1	--	--
Boron	--	--	0.70/0.75[2]	--	--
Cadmium	0.005	--	0.01	0.0019[3]	0.0091[3]
Chloride	--	250	106	230	860
Chromium (Total)	0.05	--	--	--	--
Cobalt	--	--	0.05	--	--
Copper	1.3[4]	1	0.2	0.023[3]	0.037[3]
Cyanide (Total)	0.2	--	--	0.0052	0.022
Fluoride	1.4 - 2.4[5]	--	1	--	--
Iron	--	0.3	5	--	--
Lead	0.012[4]	--	5	0.0062[3]	0.16[3]
Manganese	--	0.05	0.2	--	--
Mercury	0.002	--	--	0.000012[6]	<0.0021[7]

Table 3.2-6 (continued)

California Water Quality Goals
Proposed Mesquite Mine Expansion

Parameter	Primary Mcl[1]	Secondary Mcl[1]	Agricultural Water Quality Goal (Units In Mg/L Except Where Noted)	Ambient Aquatic 4 Day Average	Ambient Aquatic 1 Hour Average
Molybdenum	--	--	0.01	--	--
Nickel	0.1	--	0.2	0.32[3]	2.90[3]
Nitrate (as N)	10/45[8]	--	--	--	--
Nitrite (as N)	1	--	--	--	--
Nitrate plus Nitrite (as N)	10	--	--	--	--
pH	--	6.5-8.5 units	--	--	--
Selenium	0.02	--	0.02	--	--
Silver	--	0.1	--	0.00019[7]	0.0014[7]
Sulfate	--	250/500[9]	--	--	--
Thallium	0.002	--	--	--	--
Total Dissolved Solids	--	500/1,000[9]	450	--	--
Vanadium	--	--	0.1	--	--
Zinc	--	5	2	0.21[3]	0.23[3]

99-116 (6/21/00/mc)

Source: Baker Consultants, Inc., 1999.

(1) California Department of Health Services Maximum Contaminant Level (MCL).
(2) U.S. Environmental Protection Agency, Quality Criteria for Water, 1986 (May 1986) (The Gold Book) plus updates.
(3) Based on hardness of 230 mg/L measured in Big Chief Lake.
(4) MCL includes this "Action Level" to be exceeded in no more than 10 percent of samples at the tap.
(5) MCL varies with air temperature.
(6) Expressed as total recoverable.
(7) Expressed as dissolved.
(8) Expressed as NO_3.
(9) Second value is the upper level recommended by the California Department of Health Services.

The pH values range between 8.3 and 8.9, and the waters have a relatively high buffering capacity as indicated by total alkalinity concentrations ranging from 258 to 334 mg/L of $CaCO_3$. The concentration of total dissolved solids in the lakes ranged from 1,400 to 3,600 mg/L, with the highest TDS in the Vista West pit lake. The Vista West pit lake chemistry shown represents a single sample collected when the lake was very shallow and concentrated by evaporation. As expected, the general chemical signature of the pit lake water is similar to the ground water that seeps into the pits, with major dissolved constituents including sodium, calcium, magnesium, chloride, sulfate, bicarbonate and silica.

Drinking water and irrigation standards in Table 3.2-6 are not applicable to the lakes that will occur in the mine pites. However, the following comparison is made to show that the quality of water in the existing pit lakes will not be suitable for these uses without treatment. A comparison of Tables 3.2-6 and 3.2-7 shows that in one or more of the existing pit lakes, the mean of available water quality data exceeds the primary MCL for antimony, fluoride, nitrate/nitrite (as N) and selenium. Secondary MCLs are exceeded in one or more pit lakes for boron, chloride, sulfate and TDS. Aquatic standards are exceeded for aluminum and chloride.

Without the Proposed Action, pumping of water from the pit lakes (e.g., for dust control), would cease and the water levels in the existing pits would rise until the water surface area is large enough to evaporate water at the same rate as it seeps into the pits.

Table 3.2-7

Existing Pit Lake Water Quality
Proposed Mesquite Mine Expansion

Parameter	Concentration [1] (Mg/L Except Where Noted)			
	Big Chief	Vista West	Vista East	Rainbow
pH [2]	8.30	8.66	8.30	8.92
Specific Conductance [3]	2,073	6,580	2,550	3,250
Alkalinity (Total) [4]	262	266	258	334
Aluminum	<0.031	<0.031	0.034	0.122
Ammonia (as N)	<0.01	<0.01	<0.01	<0.01
Antimony	<0.002	0.005	0.002	0.019
Arsenic	0.0081	0.012	0.0096	0.045
Barium	0.021	<0.003	0.019	0.007
Beryllium	<0.002	<0.002	<0.002	<0.002
Bismuth	<0.027	--	<0.027	<0.027
Boron	1.58	4.30	1.52	3.01
Cadmium	0.002	<0.002	0.002	<0.002
Calcium	44.3	57.6	40.7	12.6
Chloride	271	1,110	327	447
Chromium	<0.008	<0.008	0.006	<0.008
Cobalt	<0.003	--	<0.003	<0.003
Copper	<0.006	0.003	<0.006	<0.006
Cyanide (Total)	<0.01	0.02	<0.01	<0.01
Cyanide (WAD)	<0.01	<0.01	<0.01	<0.03
Fluoride	1.0	2.3	1.5	3.5
Gallium	<0.033	--	<0.033	<0.033
Iron	<0.02	<0.02	0.029	0.048
Lead	<0.003	<0.003	<0.003	<0.003
Lithium	0.062	--	0.063	0.168
Magnesium	26.3	56.3	19.1	11.6
Manganese	0.003	<0.003	<0.003	0.003
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	0.043	0.156	0.038	0.167
Nickel	<0.023	<0.023	0.019	<0.023
Nitrate/Nitrite (as N)	2.64	18.7	1.16	0.22
Orthophosphate (as P)	0.008	0.030	0.020	0.036
Potassium	10.4	--	8.5	10.8
Scandium	<0.002	--	<0.002	<0.002
Selenium	0.020	0.083	0.010	0.022
Silica	19.9	19.6	19.0	22.7
Silver	<0.007	<0.007	<0.0007	<0.007
Sodium	472	1,441	482	732
Strontium	1.32	2.85	1.05	0.360
Sulfate	572	1,750	600	731

Table 3.2-7 (continued)

Existing Pit Lake Water Quality
Proposed Mesquite Mine Expansion

Parameter	Concentration [1] (Mg/L Except Where Noted)			
	Big Chief	Vista West	Vista East	Rainbow
Thallium	<0.003	<0.003	<0.003	<0.003
Tin	0.05	<0.01	0.05	<0.01
Titanium	<0.011	<0.011	<0.011	<0.011
Total Dissolved Solids	1,422	3,630	1,535	1,992
Total Suspended Solids	7.5	147	8.4	20.8
Vanadium	<0.007	<0.006	<0.007	<0.007
Zinc	<0.007	<0.007	0.004	<0.007

Source: Baker Consultants, Inc., 1999.

[1] The geometric mean was calculated for all constituents except pH where the arithmetic mean was used. Values below detection were calculated at one-half the detection limit.
[2] Standard Units
[3] Micromhos per centimeters
[4] mg/L $CaCO_3$ = milligrams per liter of calcium carbonate