IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

DRAFT
ENVIRONMENTAL IMPACT STATEMENT/ ENVIRONMENTAL IMPACT REPORT

VOLUME II
(Appendices B-O)

State Clearinghouse No. 95041025

NOVEMBER 1997

Applicant

Glamis Imperial Corporation

Prepared By:

U.S. Department of the Interior
Bureau of Land Management
El Centro Resource Area
El Centro, California

County of Imperial
Planning/Building Department
El Centro, California

LIST OF APPENDICES

The following Appendix is contained in this Volume I of the Draft EIS/EIR:

The following Appendices are contained in this Volume II of the Draft EIS/EIR:

LIST OF APPENDICES

This page intentionally left blank
for reproduction purposes.

APPENDIX B   1997 SCOPING DOCUMENTS

U.S. Department of the Interior
Bureau of Land Management
News Release

For Immediate Release: June 11, 1997 CA 060-97-28
Contact: Public Affairs Staff, (909) 697-5215

BLM and Imperial County to Revise Draft EIS/EIR for Proposed Imperial Project Gold Mine

The Bureau of Land Management (BLM) and the County of Imperial will revise the Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the proposed Imperial Project open pit, heap leach gold mine in Imperial County.

BLM and Imperial County felt the need to clarify the proposed action and provide greater detail about the proposed project since releasing the Draft EIS/EIR for public review in November 1996. The agencies will incorporate this new information into a revised Draft EIS/EIR, which also will address the concerns identified by members of the public during the public comment period. The revised Draft EIS/EIR is scheduled for re-release in September 1997.

The Draft EIS/EIR evaluates potential impacts to the environment, wildlife, recreation, cultural resources, socioeconomics, water resources, vegetation, and other natural resources that would be impacted from the construction and operation of the proposed gold mine.

The proposed site is located in eastern Imperial County, approximately 45 miles northeast of El Centro and 20 miles northwest of Yuma, AZ. The proposed project area would encompass approximately 1,589 acres of public lands administered by the BLM, of which 1,256 acres would be disturbed.

The proposed Imperial Project would be operated by the Chemgold Corporation. Approximately 150 million tons of ore and 450 million tons of waste rock would be mined from three open pits during the operation of the mine. If approved, the Project would begin in 1998.

For more information regarding the proposed Imperial Project Draft EIS/EIR contact Keith Shone or Thomas Zale at (619) 337-4400.

-BLM-

[Federal Register: August 1, 1997 (Volume 62, Number 148)]
[Notices]
[Page 41409-41410]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr01au97-116]

DEPARTMENT OF THE INTERIOR

Bureau of Land Management
[CA-067-7122-6606; CACA-35511]

Imperial Project Gold Mining Operation, Imperial County, CA;
Environmental Statement

AGENCY: **Bureau of Land Management**, Interior.

ACTION: Notice of Withdrawal of the Imperial Project Draft Environmental Impact Statement and Notice of Intent to Prepare Environmental Impact Statement on the Imperial Project Proposed Gold Mining/Processing Operation, Imperial County.

SUMMARY: Notice is hereby given that the **Bureau of Land Management** (BLM) has withdrawn the Imperial Project, Draft Environmental Impact Statement (DEIS), distributed for public review November, 1996. Based on a review of public comment received, it was determined that it was necessary to withdraw the DEIS and to prepare and circulate a new DEIS. The comments received on the DEIS will be treated as scoping comments, however, new comments may be submitted.

DATES: Written scoping comments must be received no later than September 2, 1997.

ADDRESSES: Written scoping comments should be addressed to the Area Manager, Attn: Imperial Project, El Centro Resource Area, 1661 South Fourth St., El Centro, California 92243.

FOR FURTHER INFORMATION CONTACT: Douglas Romoli (909) 697-5237.

SUPPLEMENTARY INFORMATION: The comments submitted on the withdrawn

DEIS (circulated November, 1996) will not receive a written response. Instead, the written comments will be considered in preparation of the new DEIS. Prior commentors can submit comments during the scoping period for the new EIS.

Comments, including names and street addresses of respondents, will be available for public review at the above address during the business hours of 7:45 a.m. to 4:15 p.m., Monday through Friday, except holidays. Individual respondents may request confidentiality. If you wish to withhold your name or street address from public review or from disclosure under the Freedom of Information Act, you must state this prominently at the beginning of your written comment. Such requests will be honored to the extent allowed by law. All submissions from organizations or business, and from individuals identifying themselves as representatives or officials of organization or businesses, will be made available for public inspection in their entirety.

The Imperial Project is a proposal by Glamis Imperial Corporation (a sister corporation of the former project applicant Chemgold Inc.) to develop an open-pit, gold mining operation utilizing a heap leach process. The proposed site is located in eastern Imperial County, California, approximately 45 miles northeast of El Centro, California and 20 miles northwest of Yuma, Arizona. The project area is comprised of approximately 1,625 acres. Up to 150 million tons of ore would be leached, and 300 million tons of waste rock would be deposited at the proposed waste rock stockpiles or the mined-out portions of the three planned open pits. Typical, average mining rate would be 130,000 tons per day. Approximately 1,409 acres of surface disturbance would occur as a result of the Proposed Action. Mining activity would be performed 24 hours per day, seven days per week, and are projected to commence in 1998 and terminate around the year 2017. The proposed mine would include a lined heap leach pad to contain the ore heap and to collect process fluid from the heap for gold recovery. Waste rock would be hauled directly to a waste rock stockpile or to one of the on-site pits to be backfilled. A ground water production well field, consisting of up to four groundwater production wells, would be completed and used to provide water through a buried pipeline for processing operations, dust control, and on-site domestic uses. The proposed project would also include a power substation and construction of a short portion of a transmission line and a rebuild of an existing transmission line.

Dated: July 24, 1997.
Terry Reed,
Area Manager.
[FR Doc. 97-20194 Filed 7-31-97; 8:45 am]
BILLING CODE 4310-40-P

United States Department of the Interior

TAKE PRIDE IN AMERICA

BUREAU OF LAND MANAGEMENT
El Centro Resource Area
1661 South 4th Street
El Centro, California 92243-4561

IN REPLY REFER TO:

1791

July 30, 1997

Dear Interested Citizen:

Enclosed is the Federal Register Notice initiating a 30-day scoping period for the Glamis Imperial Project, proposed by Glamis Imperial Corporation (a sister corporation of the former project applicant Chemgold, Inc.), and formally withdrawing the earlier Draft Environmental Impact Statement (EIS), circulated beginning November, 1996. Owing to the large number of comments received, the Bureau of Land Management, decided to withdraw the document and circulate a new and revised Draft EIS/EIR. As a result, the written comments submitted for the November 1996 Draft EIS/EIR and those from the public hearings will not receive a written response. Instead, these comments will be treated as scoping comments in the preparation of the new and revised Draft EIS/EIR. Prior commenters may submit additional, written scoping comments during this 30-day written comment period, which terminates September 1, 1997. Please read the "Supplement Information" section regarding confidentiality.

The new and revised Draft EIS/EIR is anticipated to be circulated in the Fall of 1997. Public hearings will be held and a schedule of dates and times will be available when the new Draft EIS/EIR is circulated.

We appreciate your interest in your public lands and your commitment to participate in the scoping process.

Sincerely,

Terry A Read

Terry A Read
Area Manager

enc.

UNITED STATES DEPARTMENT OF THE INTERIOR

Bureau of Land Management

(CA-067-7122-6606); CACA-35511

AGENCY: BUREAU OF LAND MANAGEMENT

ACTION: Notice of Withdrawal of the Imperial Project Draft Environmental Impact Statement and Notice of Intent to Prepare Environmental Impact Statement on the Imperial Project Proposed Gold Mining/Processing Operation, Imperial County.

SUMMARY: Notice is hereby given that the Bureau of Land Management (BLM) has withdrawn the Imperial Project, Draft Environmental Impact Statement (DEIS), distributed for public review November, 1996. Based on a review of public comment received, it was determined that it was necessary to withdraw the DEIS and to prepare and circulate a new DEIS. The comments received on the DEIS will be treated as scoping comments, however, new comments may be submitted.

DATES: Written scoping comments must be received no later than September 2, 1997.

ADDRESS: Written scoping comments should be addressed to the Area Manager, Attn: Imperial Project, El Centro Resource Area, 1661 South Fourth St., El Centro, California 92243.

FOR FURTHER INFORMATION CONTACT: Douglas Romoli (909) 697-5237.

SUPPLEMENT INFORMATION: The comments submitted on the withdrawn DEIS (circulated November, 1996) will not receive a written response. Instead, the written comments will be considered in preparation of the new DEIS. Prior commentors can submit comments during the scoping period for the new EIS.

Comments, including names and street addresses of respondents, will be available for public review at the above address during the business hours of 7:45 a.m. to 4:15 p.m., Monday through Friday, except holidays. Individual respondents may request confidentiality. If you wish to withhold your name or street address from public review or from disclosure under the Freedom of Information Act, you must state this prominently at the beginning of your written comment. Such requests will be honored to the extent allowed by law. All submissions from organizations or business, and from individuals identifying themselves as representatives or officials of organization or businesses, will be made available for public inspection in their entirety.

The Imperial Project is a proposal by Glamis Imperial Corporation (a sister corporation of the former project applicant Chemgold Inc.) to develop an open-pit, gold mining operation utilizing a heap leach process. The proposed site is located in eastern Imperial County, California, approximately 45 miles northeast of El Centro, California and 20 miles northwest of Yuma, Arizona. The project area is comprised of approximately 1,625 acres. Up to 150 million tons of ore would be leached, and 300 million tons of waste rock would be deposited at the proposed waste rock stockpiles or the mined-out portions of the three planned open pits. Typical, average mining rate would be 130,000 tons per day. Approximately 1,409 acres of surface disturbance would occur as a result of the Proposed Action. Mining activity would be performed 24 hours per day, seven days per week, and are projected to commence in 1998 and terminate around the year 2017. The proposed mine would include a lined heap leach pad to contain the ore heap and to collect process fluid from the heap for gold recovery. Waste rock would be hauled directly to a waste rock stockpile or to one of the on-site pits to be backfilled. A ground water production well field, consisting of up to four groundwater production wells, would be completed and used to provide water through a buried pipeline for processing operations, dust control, and on-site domestic uses. The proposed project would also include a power substation and construction of a short portion of a transmission line and a rebuild of an existing transmission line.

Terry A Reed 7/24/97

Terry Reed Date

This page intentionally left blank
for reproduction purposes.

APPENDIX C-1 CHEMGOLD, INC. IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA, WASTE CHARACTERIZATION STUDY (DECEMBER 1995)

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

WASTE CHARACTERIZATION STUDY

EMA Report No. 0959-03
December 1995

Prepared for:

Chemgold, Inc.
P.O. Box 758
Winterhaven, California 92283

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

WASTE CHARACTERIZATION STUDY

EMA Report No. 0959-03
December 1995

Prepared for:

Chemgold, Inc.
P.O. Box 758
Winterhaven, California 92283

LIMITATIONS

This report was prepared by Environmental Management Associates, Inc. (EMA) in conformance with the scope of work prescribed by our CLIENT. The work has been conducted in an objective and unbiased manner and in accord with generally accepted professional practice for this type of work. No other warranty, either expressed or implied, is made as to the findings, recommendations, specifications or opinions presented herein.

ENVIRONMENTAL MANAGEMENT ASSOCIATES, INC.

Kent S. Samuelson
Senior Geologist

Richard F. DeLong,
Principal Geologist

Dwight L. Carey, D.Env., CEM-1118
Principal

Corporate Office:
1698 Greenbriar Lane, Suite 210, Brea, California 92621
(714) 529-3695 FAX: (714) 529-8543

Regional Office:
100 W. Grove St., Suite 100, Reno, Nevada 89509
(702) 828-3939 FAX: (702) 828-3940

EMA

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

WASTE CHARACTERIZATION STUDY

TABLE OF CONTENTS

LIST OF TABLES

APPENDICES

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

WASTE CHARACTERIZATION STUDY

1. INTRODUCTION

This report presents the results of a study to determine the acid generation potential (AGP), the acid neutralization potential (ANP), and the chemical characteristics of potential leachate generated from contact with waste rock and leached ore material which may be produced by the proposed Chemgold, Inc. (Chemgold) Imperial Project. This information is necessary to classify the waste to be generated with respect to the standards presented in Title 23, Chapter 15, Article 7 of the California Code of Regulations so that the material may be properly managed following closure of the project.

2. Analytical Methods

2.1. Acid Neutralization Potential

Some types of waste rock and spent ore can generate mineral acids upon exposure to water and the atmosphere (which is described as a material's "acid generating potential"), while other types may be acid neutralizing (which is described as a material's neutralization potential). Generally, rock with a high acid generating potential contains a sufficient quantity of sulfide minerals, which can react with water and atmospheric oxygen to produce sulfuric acid. The generated acid may then leach potentially toxic metals from the waste materials. Rock with low acid and high neutralizing potentials are generally environmentally benign.

The procedures used to predict the AGP reported herein generally conform with methods outlined in the California Mining Association's publication *Mine Waste Management* (1992), a highly regarded resource document on mine waste characterization and management. The prediction of AGP begins with obtaining materials which "... represent the worst-case, or the maximum, AGP. As the evaluation program evolves, the objective of the subsequent sampling programs would be to obtain representative samples from a range of geochemical groups within each of the lithologic units to be affected by mine development" (California Mining Association, 1992, p. 166).

Following sample collection, analytical testing is then performed to determine pH (using the saturated paste method) and to determine AGP consistent with the approach proposed by Smith and Barton-Bridges (1991), which includes the use of static and kinetic tests (if deemed necessary) in a three (3)-stage process:

- Stage 1: Both the acid potential (AP), using total sulfur (LECO furnace method), and the acid neutralization potential (NP) are determined. Both results are converted to common units and the ratio of NP to AP is calculated. If the NP/AP ratio is greater than 3, the waste is considered to be non-acid generating. If the NP/AP ratio is less than 3, Stage 2 testing should be conducted.

- Stage 2: The forms of sulfur in the waste rock, in particular the sulfide sulfur, is determined. The AP is recalculated on the basis of the sulfide sulfur values, and then the NP/AP ratio is recalculated. If the NP/AP ratio does not exceed 3, the waste may be acid generating, and Stage 3 testing should be conducted.

- Stage 3: A kinetic test using a humidity cell or column/lysimeter is performed. Concentrations of all leachable species of interest are determined on leach samples, plus those of potential products of acid generation.

2.2. Chemical Characteristics of Waste Rock Materials and Leachate

To determine chemical characteristics of the waste rock and leached ore, total metal concentrations (using the applicable approved acid digestion and analytical techniques) for the seventeen (17) Total Threshold Limit Concentration (TTLC) metals are analyzed. To determine chemical characteristics of the leachate which could be generated under proposed conditions from the waste rock and leached ore, metals concentrations in a laboratory-generated leachate (using the U.S. Environmental Protection Agency (EPA) Method 1312 Synthetic Precipitation Leaching Procedure (SPLP)) for the seventeen (17) TTLC metals are analyzed. The SPLP uses a laboratory-prepared "synthetic" acidic rainfall "to determine the mobility of both of organic and inorganic analytes present in samples of soils and wastes" which may be exposed to natural weathering processes. This differs from the extraction solutions used in the California WET or EPA Toxicity Concentration Leaching Procedure (TCLP) (EPA Method 1311), which each use organic acids typical of those found in municipal waste landfills.

3. IMPERIAL PROJECT WASTE STREAMS

3.1. Source of Waste

The mining waste to be generated from the proposed Imperial Project would consist of the following: (1) sub ore-grade waste rock removed during mining; and (2) spent ore remaining on the heap leach pad after precious metals have been extracted through a cyanide leaching process and the leached ore has been rinsed to reduce residual cyanide concentrations to levels consistent with California Regional Water Quality Control Board - Colorado River Basin Region (CRWQCB-CRBR) guidelines. The source of the ore and waste rock would be the material mined from the proposed co-joining West, Singer, and East Pits.

3.2. Descriptions of the Wastes

Variations in the chemical characteristics of the waste generated by the Imperial Project would be dependent upon: (1) the different rock types mined; and (2) whether the mined material is waste rock or ore-grade material. The Imperial Project ore bodies and associated waste rock material are comprised of two (2) main rock types: biotite gneiss and sericitic gneiss. Two (2) additional waste rock types will be encountered during mining: Tertiary volcanic rocks and Quaternary gravel deposits. All of these materials are more fully described as follows:

Biotite Gneiss: The biotite gneiss units range mineralogically from hornblende-biotite to quartz feldspathic gneiss rock types with irregular zones of biotite-chlorite gneiss. Local gradational sequences of the biotite gneiss develop into a schistose equivalent within this unit. Mineralized biotite gneiss is typically brecciated and contains hematite and limonite zones which are alteration products of the biotite and pyrite. Veinlets of mineralized hematite and calcite are common. Little or no sulfide minerals have been observed in the drill cuttings or core during sampling. Remnants of pyrite have been observed, but as hematitic pseudomorphs.

Sericitic Gneiss: Sericitic gneiss is the predominant rock type in the East Pit area. Units vary from quartz- and feldspar-rich muscovite gneiss to sericitic gneiss. Quartz muscovite gneiss and gradational quartz feldspathic gneiss occur as schistose equivalents. Mineralized sericitic gneiss is typically fractured, consisting of hematite-altered biotite-chlorite gneisses and schists. Quartz veinlets, and sericitic and hematitic gouge zones, also occur within the mineralized units.

Quaternary Gravel: The gravel units consist of mixed amounts of gneiss and volcanic rock deposited as fanglomerate layers. Gravel textures vary from granular to pebble-size subangular clasts in a fine-grained sand/silt matrix. Matrix cement consists of calcium carbonate. Cementation varies from poor to moderate. Cobble to boulder-size gravel also occurs as thin, discontinuous units. Gneissic clasts (composing approximately 75 percent of the gravel) consist of variations of hornblende-biotite to quartz-feldspathic gneiss.

Volcanic clasts (composing approximately 25 percent of the gravel) are typically dark, maroon-colored, fine-grained andesite and basalt fragments.

Tertiary Volcanic Rocks: The volcanic units consist of basalt to andesite flows which unconformably overlie the metamorphic units. Core specimens display massive and brecciated textures cemented with calcium carbonate.

Unaltered rock of each of these rock types will comprise the majority of the waste rock from the Imperial Project. Altered and mineralized biotite gneiss and sericitic gneiss will comprise the majority of the heap leach pad material prior to leaching. Based on observations made during sampling, all ore-grade and waste rock materials occur in an oxidized state.

4. SAMPLE COLLECTION

Twenty-three (23) representative samples of the various rock types described in Section 3.2 were collected by Chemgold personnel. A description of each of these samples is presented in Table 1. The samples consisted of reverse circulation (RC) drill cuttings composited at select intervals for isolating specific rock types and geochemical groups, as necessary. Because of the consistent nature of the deposit, rock units in the proposed central Singer Pit are considered equivalent to those of both the East Pit and West Pit and, therefore, no separate samples of the Singer mineralized zone were collected.

All Imperial Project lithologic units to be mined have been determined to be in an oxidized state. Thus, there are no rock units within the Project mine and process area known to contain significant sulfide minerals, and no units which would represent a worst-case scenario regarding maximum AGP. Therefore, representative sampling of each identified lithologic unit was determined to be the definitive sampling program for predicting ANP.

Table 1: Summary of Samples Collected

Sample Number	Sample Date	Sample Location	Sample Elevations[1]	Rock Type	Grade	Oxidation State
WP-1	10-11-94	West Pit	427 535 615	Biotite Gneiss	Ore	Oxidized
WP-2	10-11-94	West Pit	357 435 670	Biotite Gneiss	Ore	Oxidized
WP-3	10-11-94	West Pit	470 587	Biotite Gneiss	Waste	Oxidized
WP-4	10-11-94	West Pit	770	Volcanics	Waste	Oxidized
WP-5	10-11-94	West Pit	496 681	Gravel	Waste	Oxidized
WP-6	2-17-95	West Pit	-10	Biotite Gneiss	Ore	Oxidized
WP-7	2-17-95	West Pit	163	Biotite Gneiss	Waste	Oxidized
WP-8	2-17-95	West Pit	7	Biotite Gneiss	Ore	Oxidized
WP-9	2-17-95	West Pit	45	Gravel	Waste	Oxidized
EP-1	10-11-94	East Pit	575 617	Sericitic Gneiss	Ore	Oxidized
EP-2	10-11-94	East Pit	547	Sericitic Gneiss	Ore	Oxidized
EP-3	10-11-94	East Pit	452 477	Biotite Gneiss	Ore	Oxidized
EP-4	10-11-94	East Pit	420 507	Biotite Gneiss	Ore	Oxidized
EP-5	10-11-94	East Pit	561 687	Sericitic Gneiss	Waste	Oxidized
EP-6	10-11-94	East Pit	434 527	Biotite Gneiss	Waste	Oxidized
EP-7	10-11-94	East Pit	594	Volcanics	Waste	Oxidized
EP-8	10-11-94	East Pit	605 641	Gravel	Waste	Oxidized
EP-9	2-17-95	East Pit	110	Biotite Gneiss	Ore	Oxidized
EP-10	2-17-95	East Pit	-10	Biotite Gneiss	Waste	Oxidized
EP-11	2-17-95	East Pit	59	Biotite Gneiss	Ore	Oxidized
EP-12	2-17-95	East Pit	-1	Biotite Gneiss	Waste	Oxidized
EP-13	2-17-95	East Pit	682 692	Sericitic Gneiss	Waste	Oxidized
EP-14	2-17-95	East Pit	556 566	Sericitic Gneiss	Waste	Oxidized

[1] - Units are in feet above mean sea level. Multiple elevations represent sample elevations of a composite sample.

5. SAMPLE RESULTS

5.1. Sample Preparation

Each ore sample was processed with cyanide solution using a standard bottle roll procedure, then rinsed to reduce residual cyanide concentrations to simulate the rinsed leached ore for the waste characterization analyses. Waste rock was not leached or rinsed. Standard 2-millimeter particle size samples of the spent ore were used for the chemical characteristics analyses.

5.2. Acid Neutralization Potential Results

Table 2 presents the results of the pH and acid neutralization potential analyses of the waste rock and ore. All of the analyzed samples exhibited a pH of 8.75 or greater and, with one (1) exception, high ANP values. Sample EP-5 has a Stage 1 ANP of 2.4 using the total sulfur value. In accordance with the Smith and Barton-Bridges procedure (see Section 2.1), the Stage 2 procedure (AP considering only sulfide sulfur) was conducted for sample EP-5. Using only sulfide sulfur for calculating the AP, the resulting ANP is 4.0. Samples EP-13 and EP-14, acquired from the same drill hole as EP-5, represent material that exists directly above and below the interval from which sample EP-5 was taken. The total sulfur ANP values for these two (2) samples are 13.5 and 23, respectively. These values support the indication that the relatively low total sulfur ANP value for EP-5 is anomalous.

5.3. Chemical Characteristics of Waste Rock and Leachate

Table 3 presents the results of the analyses conducted to determine the chemical characteristics of the waste rock, and the leachate which may result from exposure of the waste rock to acidic rainfall. Total metal concentrations were, in all cases, an order of magnitude or more below the corresponding metal TTLC. Metal concentrations from the SPLP leachate were all very low.

Table 2: Acid Neutralization Potential of Ore and Waste Rock

SAMPLE NUMBER	SAMPLE LOCATION	pH	TOTAL SULFUR (percent)	ACID POTENTIAL	NEUTRALIZATION POTENTIAL	ACID NEUTRALIZATION POTENTIAL
Ore						
WP-1	West Pit	9.72	0.002	<0.1	79	>790.00
WP-2	West Pit	9.45	0.008	0.2	116	580.00
WP-6	West Pit	9.72	0.008	0.2	94	470.00
WP-8	West Pit	9.81	0.006	0.2	6.6	33.00
EP-1	East Pit	9.85	0.026	0.8	5.4	6.75
EP-2	East Pit	9.66	0.052	1.6	8.4	5.25
EP-3	East Pit	10.27	0.014	0.4	9.4	23.50
EP-4	East Pit	10.24	0.048	1.5	6.0	4.00
EP-9	East Pit	9.53	0.002	<0.1	116	>1,160.00
EP-11	East Pit	9.68	0.002	1.8	23	12.78
Waste Rock						
WP-3	West Pit	9.54	0.002	<0.1	79	>790.00
WP-4	West Pit	8.75	0.004	0.1	69	690.00
WP-7	West Pit	8.96	0.006	0.2	17.5	87.50
EP-5	East Pit	9.65	0.016	0.5	1.2	[1]2.40
EP-6	East Pit	9.43	0.032	1.0	27	27.00
EP-7	East Pit	8.75	0.008	0.2	76	380.00
EP-10	East Pit	9.22	0.004	0.1	27	270.00
EP-12	East Pit	9.36	0.006	<0.1	13	>130.00
EP-13	East Pit	9.03	0.008	0.2	2.7	13.50
EP-14	East Pit	9.01	0.058	0.2	4.6	23.00
Cemented Gravels						
WP-5	West Pit	9.21	0.030	0.9	34	37.78
WP-9	West Pit	9.61	0.004	0.1	17.5	175.00
EP-8	East Pit	9.09	0.010	0.3	39	130.00

[1] - Sample EP-5 has a sulfide sulfur Acid Neutralization Potential of 4.0.

5.4. Chemical Characteristics of Spent Ore and Leachate

Table 4 presents the results of the analyses conducted to determine the chemical characteristics of the spent ore, and the leachate which may result from exposure of the spent ore to acidic rainfall. Total metal concentrations were in all cases an order of magnitude or more below the corresponding metal TTLC. Metal concentrations from the SPLP leachate were all very low.

6. CONCLUSIONS

All sampled Imperial Project waste rock and spent ore materials have an ANP greater than 3, which indicates that the material can be properly classified as non-acid generating waste. Total metal concentrations for both the waste rock and spent ore were in all cases an order of magnitude or more below the corresponding metal TTLC, indicating that the wastes can be properly classified as Group C mining wastes in accordance with Title 23, Chapter 15, Section 2571(b)(3) of the California Code of Regulations (CCR).

7. REFERENCES

California Mining Association. *Mine Waste Management: A Resource for Mining Industry Professionals, Regulators and Consulting Engineers*. Lewis Publishers, Inc., 1992.

Smith, Adrian and J.B. Barton-Bridges. *Some Considerations in the Prediction and Control of Acid Mine Drainage Impact on Groundwater From Mining in North America.* Proceedings EPPIC Conference, Johannesburg, South Africa. May 1991.

Table 3: Chemical Characteristics of the Waste Rock and Leachate

Sample	Ag	As	Be	Be	Co	Co	Co	Cu	Hg	Mo	Ni	Be	Sb	Se	Tl	V	Zn
TOTAL METAL ANALYSES (parts per million equivalent)																	
TTLC	500	500	10,000	20	100	8,000	2,500	2,500	20	3,500	2,000	2,000	500	100	700	2,400	5,000
WP-3	<1	6.9	Be	8.4	<0.5	29	33	68	0.3	<5	14	10	<5	<0.2	<5	74	153
WP-4	<1	4.9	153	1.5	<0.5	20	20	31	<0.2	<5	54	10	<5	<0.2	10	44	153
WP-5	<1	10	29	1.5	<0.5	7.9	4.9	1.5	<0.2	<5	7.9	6.9	<5	<0.2	5.3	25	85
WP-7	<1	6.2	9.3	0.91	<0.5	12	<0.5	12	<0.2	<5	<2	36	<5	<0.2	<5	1	85
WP-9	<1	22	10	9.3	<0.5	10	8.4	8.4	<0.2	<5	3	14	<5	<0.2	<5	30	38
EP-5	<1	9.1	14	<0.5	<0.5	4.9	<0.5	107	0.2	7.9	9.3	29	<5	<0.2	<5	29	69
EP-6	<1	6.9	14	<0.5	<0.5	1.5	<0.5	12	0.3	<5	6.9	14	<5	<0.2	10	23	85
EP-7	<1	5.0	137	4.9	<0.5	14	29	15	0.2	<5	29	10	<5	<0.2	<5	44	72
EP-8	<1	6.9	44	<0.5	<0.5	8.4	8.4	31	0.2	<5	6.9	9.1	<5	<0.2	<5	30	105
EP-10	1.3	1.5	14	1.5	<0.5	20	4.9	5.3	<0.2	<5	2.1	29	<5	<0.2	<5	23	120
EP-12	1.5	1.5	1.5	1.5	<0.5	15	8.4	12	<0.2	<5	8.4	14	<5	<0.2	<5	11	54
SYNTHETIC PRECIPITATION LEACHING PROCEDURE (EPA METHOD 1312) ANALYSES (parts per million equivalent)																	
WP-3	<0.02	0.019	0.91	<0.01	<0.01	<0.02	<0.05	0.03	<0.0005	<0.1	<0.01	<0.05	0.2	<0.001	<0.1	<0.1	0.35
WP-4	<0.02	0.012	0.76	<0.01	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.01	<0.05	0.6	<0.001	<0.1	<0.1	0.32
WP-5	<0.02	0.011	1.3	<0.01	<0.01	<0.02	<0.05	0.02	<0.0005	<0.1	<0.04	<0.05	0.3	<0.001	<0.1	<0.1	0.50
WP-7	<0.01	<0.005	0.76	0.03	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.01	<0.05	<0.1	<0.001	<0.1	<0.1	0.04
WP-9	<0.02	<0.005	0.43	0.03	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.04	<0.05	<0.1	<0.001	<0.1	<0.1	0.32
EP-5	<0.01	0.017	0.49	<0.01	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.04	<0.05	0.3	<0.001	<0.1	<0.1	0.26
EP-8	<0.02	0.013	0.76	<0.01	<0.01	<0.02	<0.05	0.02	<0.0005	<0.1	<0.01	<0.05	1.1	0.001	<0.1	<0.1	0.32
EP-7	<0.02	0.035	2.1	<0.01	<0.01	<0.02	<0.05	0.04	<0.0005	<0.1	<0.04	<0.05	<0.1	<0.001	<0.2	<0.1	0.04
EP-8	<0.02	0.010	0.71	<0.01	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.04	<0.05	<0.1	<0.001	<0.1	<0.1	0.34
EP-10	<0.02	<0.005	0.55	0.03	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.04	<0.05	<0.1	<0.001	<0.1	<0.1	0.02
EP-12	<0.02	<0.005	0.76	0.03	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.04	<0.05	<0.1	<0.001	<0.1	<0.1	0.04

Table 4: Chemical Characteristics of the Spent Ore and Leachate

Sample	Ag	As	Ba	Be	Cu	Cu	Cr	Cu	Hg	Mo	Ni	Pb	Sb	Se	Tl	V	Zn
TOTAL METAL ANALYSES (parts per million equivalent)																	
TTLC	500	500	10,000	76	100	8,000	2,500	2,500	20	3,500	8,000	1,000	500	100	700	2,400	5,000
WP-1	<1	28	14	<0.5	<0.5	7.5	<2.5	25	0.8	<5	5.5	14	<5	<0.2	<5	42	128
WP-2	<1	76	24	5.5	<0.5	7.3	<2.5	192	0.7	<5	5.3	14	<5	0.4	<5	35	78
WP-6	<1	28	28	4.8	<0.5	25	3.7	14	<0.2	<5	1.4	25	<5	<0.2	<5	42	85
WP-8	<1	36	76	1.4	<0.5	22	3.1	24	<0.2	<5	2.2	76	<5	<0.2	<5	25	200
EP-1	<1	7.2	76	<0.5	<0.5	1.4	<2.5	24	0.2	<5	<1	9.0	<5	<0.2	<5	18	18
EP-1	<1	7.6	25	<0.5	<0.5	4.8	<2.5	32	<0.2	5	3.7	1.4	<5	0.4	<5	18	44
EP-3	14	4.8	14	1.4	<0.5	36	5.5	14	0.8	<5	25	14	<5	0.2	<5	42	342
EP-1	<1	4.8	20	<0.5	<0.5	7.5	3.7	28	0.7	4.8	28	14	<5	<0.2	7.1	18	36
EP-9	<1	12	1.4	2.3	<0.5	36	1.4	14	<0.2	<5	9.1	14	<5	<0.2	<5	42	78
EP-11	<1	3.4	32	1.4	<0.5	22	8.6	57	<0.2	<5	7.1	1.4	<5	0.5	<5	25	330
SYNTHETIC PRECIPITATION LEACHING PROCEDURE (EPA METHOD 1312) ANALYSES (parts per million equivalent)																	
WP-1	<0.02	0.018	1.2	<0.01	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.04	<0.05	0.5	<0.001	<0.1	<0.1	0.44
WP-2	<0.02	0.022	0.73	<0.01	<0.01	<0.02	<0.05	0.04	<0.0005	<0.1	<0.01	<0.05	<0.1	<0.001	<0.1	<0.1	0.46
WP-6	<0.02	0.018	0.78	0.03	<0.01	<0.02	<0.05	<0.02	0.0006	<0.1	<0.04	<0.05	<0.1	<0.001	<0.1	<0.1	0.44
WP-2	<0.02	0.017	0.72	0.03	<0.01	0.02	<0.05	<0.02	0.0005	<0.1	<0.01	<0.05	<0.1	<0.001	<0.1	<0.1	0.04
EP-1	<0.02	0.018	1.4	<0.01	<0.01	<0.02	<0.05	0.03	<0.0005	<0.1	<0.01	<0.05	<0.1	<0.001	<0.1	<0.1	0.46
EP-2	<0.02	0.018	0.97	<0.01	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.01	<0.05	<0.1	<0.001	<0.1	<0.1	0.37
EP-3	<0.02	0.018	1.2	<0.01	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.04	<0.05	0.2	<0.001	<0.1	<0.1	0.46
EP-1	<0.02	0.013	1.4	<0.01	<0.01	<0.02	<0.05	0.05	<0.0005	<0.1	<0.01	<0.05	0.5	<0.001	<0.1	<0.1	0.67
EP-9	<0.02	<0.005	0.92	0.03	<0.01	<0.02	<0.05	0.03	<0.0005	<0.1	<0.04	<0.05	<0.1	<0.001	<0.1	<0.1	0.04
EP-11	<0.02	<0.005	0.89	0.03	<0.01	<0.02	<0.05	<0.02	<0.0005	<0.1	<0.04	<0.05	<0.1	<0.001	<0.1	<0.1	0.16

APPENDIX A

Analytical Results

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX C-2 **CHEMGOLD, INC. IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA, SUPPLEMENTAL WASTE CHARACTERIZATION STUDY (SEPTEMBER 1996)**

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

SUPPLEMENTAL WASTE CHARACTERIZATION STUDY

EMA Report No. 1093-01
September 1996

Prepared for:

Chemgold, Inc.
P.O. Box 758
Winterhaven, California 92283

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

SUPPLEMENTAL WASTE CHARACTERIZATION STUDY

EMA Report No. 1093-02
September 1996

Prepared for:

Chemgold, Inc.
P.O. Box 758
Winterhaven, California 92283

LIMITATIONS

This report was prepared by Environmental Management Associates, Inc. (EMA) in conformance with the scope of work prescribed by our CLIENT. The work has been conducted in an objective and unbiased manner and in accord with generally accepted professional practice for this type of work. No other warranty, either expressed or implied, is made as to the findings, recommendations, specifications or opinions presented herein.

ENVIRONMENTAL MANAGEMENT ASSOCIATES, INC.

Daniel J. Davis
Daniel J. Davis, R.G.
Senior Geochemist

Dwight L. Carey
Dwight L. Carey, D.Env.
Principal

Corporate Office:
1698 Greenbriar Lane, Suite 210, Brea, California 92821-5919
(714) 529-3695 FAX: (714) 529-8543

Regional Office:
100 West Grove Street, Suite 100, Reno, Nevada 89509-4026
(702) 828-3939 FAX: (702) 828-3940

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

SUPPLEMENTAL WASTE CHARACTERIZATION STUDY

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

SUPPLEMENTAL WASTE CHARACTERIZATION STUDY

1. INTRODUCTION

Chemgold, Inc. (Chemgold) has proposed the development of a conventional open-pit, heap leach, precious metal mine, the Imperial Project (Project), to be located in eastern Imperial County, California, approximately 45 miles northeast of El Centro, California and 20 miles northwest of Yuma, Arizona. A joint Draft Environmental Impact Statement and Environmental Impact Report (EIS/EIR) is being prepared by the Bureau of Land Management (BLM) office in El Centro, California and the Imperial County Planning/Building Department.

In support of this EIS/EIR, Environmental Management Associates, Inc. (EMA) prepared, in December 1995, a report entitled "Chemgold, Inc., Imperial Project, Imperial County, Waste Characterization Study" (Waste Characterization). After publication of the Waste Characterization, questions were raised regarding the possible effects of Chemgold's proposed backfilling following the completion of mining of one (1) or more of the Project pits with the waste rock (overburden and interburden material) produced during active mining. This report supplements the Waste Characterization and presents the results of geochemical analyses of sampled potential waste rock and geochemical modeling that address the potential impacts to ground water quality in the area due to the planned backfilling of the pits with waste rock.

2. OBJECTIVE

EMA was requested to conduct a geochemical investigation to provide supporting documentation in analyzing potential impacts to ground water resources from the proposed backfilling of either or both the West Pit and/or the East Pit with waste rock material. Potential impacts to ground water resources could result from:

- Acid generation from the waste rock materials and consequent mobilization of dissolved constituents; and
- Mobilization of dissolved constituents due to the interaction of the backfilled waste rock and inflowing ground water.

The objective of the geochemical investigation is to provide representative information to:

- Evaluate the potential for acid generation from the waste rock backfill materials;

- Evaluate the potential for the mobilization of dissolved constituents from the backfilled waste rock materials in the pits when the pit(s) become saturated with inflowing ground water; and

- Evaluate the potential for impacts to ground water quality at the Project mine and process area and downgradient from the Project mine and process resulting from the interactions of the backfilled waste rock materials and the inflowing ground water.

3. LITHOLOGIES AND SAMPLING METHODS

A total of nine (9) samples, representing the four (4) lithologies of the waste rock material which may be backfilled into either the West Pit or the East Pit, were collected for geochemical analysis.

The four (4) Project waste rock lithologic types are:

(1) Biotite gneiss;

(2) Sericite gneiss;

(3) Volcanics;

(4) Gravels.

The biotite gneiss is generally dark brown and oxidized. It is primarily composed of quartz, plagioclase, biotite, and potassium feldspar, with abundant secondary calcite and minor muscovite and chlorite as alteration products. Oxidation products include hematite, goethite, jarosite, and manganese oxides.

The sericite gneiss is a light brown, strongly oxidized rock. It is composed of quartz, plagioclase, sericite, potassium feldspar, muscovite, and minor calcite. Hydrous iron oxides occur as oxidation products.

The volcanics are of basaltic composition, and the Project waste rock gravels are of fanglomeratic origin.

The samples were collected from reverse circulation (RC) drill hole cuttings composited from discrete depth intervals from exploration drill holes drilled in the areas of the West Pit and East Pit. Sample locations are shown on Figure 1, and sample rock type information are shown in Table 1.

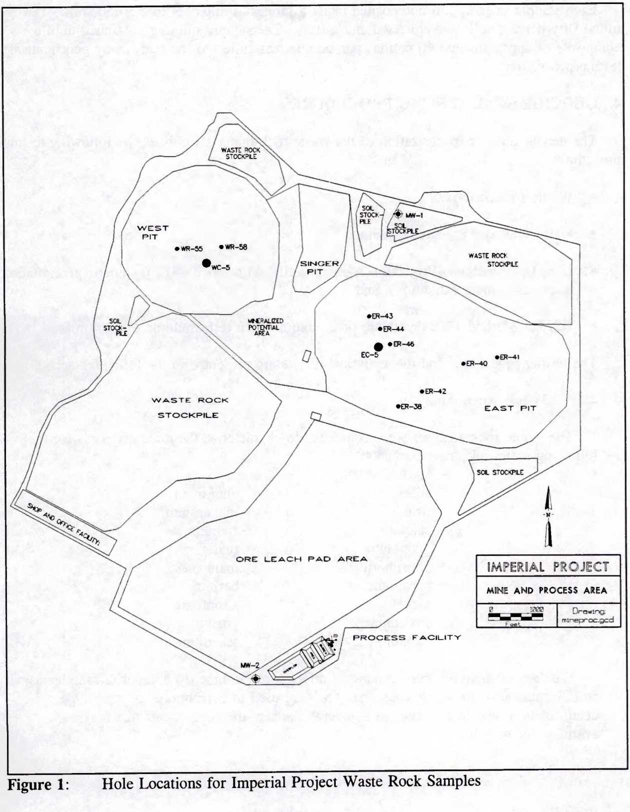


Figure 1: Hole Locations for Imperial Project Waste Rock Samples

Each sample interval was composited using a "Jones" splitter set to a 50:50 split. The initial fifty percent split was collected and mixed. The sample splitting continued until a composite of approximately 40 pounds per sample was collected for analysis by geochemical testing procedures.

4. GEOCHEMICAL TESTING PROCEDURES

The geochemical characterization of the waste rock materials utilized the following testing procedures:

- Whole rock analyses;
- Static acid/base accounting methods;
- U.S. Environmental Protection Agency (USEPA) Method 1312 (synthetic precipitation leach test, single extraction); and
- USEPA Method 1320 (synthetic precipitation leach test, multiple extraction).

The testing procedures and the analytical results are presented in the following sections.

4.1. Whole Rock Analyses

The whole rock analyses were conducted to characterize the mine materials for the following major and trace elements:

silica	aluminum
iron	magnesium
calcium	sodium
potassium	titanium
phosphorus	manganese
chromium	barium
nickel	strontium
zirconium	yttrium
niobium	scandium

Whole rock analyses were conducted on each of the nine (9) composite samples using an ICP method. The whole rock analyses were used to corroborate the rock type determinations and to evaluate, in a general manner, the components that may be available for mobilization.

4.2. Static Test Methods

Static tests were conducted on each of the nine (9) samples. The static test is an acid-base accounting procedure used as a screening technique for determining whether sample material has the potential to generate or consume acid. These tests assess the potential for sample material, based on sulfur analyses, to generate acid or consume acid by estimating the balance between the acid-generating and the acid-neutralizing capacity of the sample material. Separate tests are used to determine the acid generation potential and acid neutralization potential of the sample material.

The acid-generating potential (AGP) of the sample material involves determining the total amount of sulfur and sulfur species present. The sulfur species are the various oxidation states that sulfur may exist as in the rock. The two (2) most important sulfur species are sulfide sulfur (S^-), the reduced form of sulfur present in pyrite and other sulfide minerals, and sulfate sulfur (SO_4^{-2}), the oxidized form of sulfur produced, in part, from the oxidation of sulfide minerals. The total sulfur is a determination of the total concentration of all sulfur, both oxidized and reduced, in the sample material. This value can be conservatively used to evaluate the acid-generating potential of the sample material by assuming all forms of sulfur are acid-generating. Pyritic sulfur (S^-) is a more realistic estimation of the quantity of sulfur material that is likely to form acid upon oxidation. Sulfate sulfur (SO_4^{-2}) represents sulfur in its most oxidized form, some of which may be derived from oxidized sulfide material.

The acid neutralization potential (ANP) is determined by treating the sample material with a known excess of standardized hydrochloric acid. The sample material and acid are heated to ensure that all reactions between the acid and any neutralizing components present in the sample material go to completion. The acid neutralization potential is then measured by quantifying the amount of unconsumed acid by titrating with standardized sodium hydroxide.

Both the acid generation potential and the neutralization potential are expressed as tons of calcium carbonate ($CaCO_3$) per thousand tons of material. This value represents the amount of calcium carbonate that would be needed to neutralize 1,000 tons of material. The *net* acid generation potential of the material is determined by subtracting the acid generation potential from the acid neutralization potential, the result of which may be reported as either positive or negative. A negative result indicates a sample which can be expected to generate net acidity at some point in time. Alternatively, a positive result indicates a sample which will not be a net acid generator. Samples may be considered *potentially* acid-generating when the ratio of the neutralization potential to the acid generation potential is less than 1.20, i.e., $NP:AP < 1.20$, even when the sample is determined to be strictly acid-neutralizing based on the difference between the acid neutralization and acid generation potentials. This is equivalent to a 20 percent excess neutralization potential. This approach to the interpretation of static test results is advantageous since ratios are used instead of absolute values of the net neutralization potential, thus providing a constant factor of safety.

4.3. USEPA Method 1312 - Synthetic Precipitation Leach Test

The synthetic precipitation leach test (USEPA Method 1312) was conducted on one (1) sericite gneiss sample, one (1) gravel sample, and one (1) biotite gneiss sample. The purpose of USEPA Method 1312 is to simulate conditions under which precipitation might leach out constituents present in the sample material. Method 1312 is used by the USEPA and other federal agencies to determine the mobility of constituents present in soils and mine materials. In the USEPA Method 1312 analysis, a sample is saturated with deionized water buffered to pH 5.00 with a sulfuric acid/nitric acid mixture and bottle-rolled for 18 hours. After 18 hours, the resulting lixiviant is filtered and analyzed for dissolved constituents. The results of the lixiviant analyses are compared to appropriate water quality or other standards to determine what constituents in the sample material have the potential to mobilize and impact ground water and surface water.

4.4. USEPA Method 1320 - Multiple Extraction Procedure

The multiple extraction procedure (USEPA Method 1320) was conducted on one (1) biotite gneiss sample, two (2) sericite gneiss samples, one (1) volcanic sample, and two (2) gravel samples. The purpose of the USEPA Method 1320 analysis is to simulate leaching that a sample will undergo from repetitive precipitation events via a set of ten (10) sequential extractions. The initial extraction uses USEPA Method 1310, a toxicity extraction method. The sample is saturated with deionized water buffered with acetic acid to a pH of 5.00 and bottle-rolled for 24 hours. The leachate is filtered and analyzed for dissolved constituents. Extractions 2 through 10 are leached using a solution of distilled water buffered with a sulfuric acid/nitric acid mixture to a pH of 3.00 and each bottle-rolled for 24 hours. The leachate from each extraction is filtered and analyzed for dissolved constituents. The results of the leachate analyses are compared to appropriate water quality standards to determine the potential for impacts to water resources.

5. ANALYTICAL RESULTS

Laboratory data sheets for all of the analyses summarized in Table 2 through Table 5 are included as Appendix A.

5.1. Whole Rock Analytical Results

The results of the whole rock analyses are shown in Table 2. The sericite gneiss, biotite gneiss, and gravel samples have similar whole rock compositions, indicating that the gravel is composed primarily of gneissic material. The volcanic sample is lower in silica and higher in calcium and magnesium than the gneiss and gravel samples. This is expected in a rock of basaltic composition.

5.2. Static Test Results

The results of static test acid-base accounting analyses are shown in Table 3. The results show that one (1) of the nine (9) samples, the volcanic lithology, has small potential to generate acid. The pyritic acid-generating potential for the volcanic sample is a low 0.5 tons $CaCO_3$ per 1,000 tons of material, and the neutralizing potential is zero (0), yielding a low net neutralizing potential (NNP) of -0.5 tons $CaCO_3$ per 1,000 tons of material. The remaining eight (8) samples had NNP values that were greater than zero (0) and are moderately to substantially acid-neutralizing. The three (3) sericite gneiss samples had NNP values from 3.1 to 36.0 tons $CaCO_3$; the three (3) gravel samples have NNP values of 25.6 to 36.8 tons $CaCO_3$ per 1,000 tons of material; and the two (2) biotite gneiss samples have NNP values of 41.7 and 68.8 tons $CaCO_3$ per 1,000 tons of material.

5.3. USEPA Method 1312 Analytical Results

The results of USEPA Method 1312 analyses on the samples of sericite gneiss, gravel, and biotite gneiss are presented in Table 4. Constituent concentrations from ground water samples taken from the Project mine and process area are also shown for comparison (EMA, 1996).

The dissolved constituent concentrations in the leachate from the USEPA Method 1312 analyses are low, particularly when compared to the background ground water concentrations. Chloride, sulfate, sodium, and total dissolved solids (TDS) concentrations are all high in the ground water sample, which is typical of the ground water chemistry throughout the hydrologic basin (EMA, 1996). In the three (3) USEPA Method 1312 leachate samples, chloride ranges from 0.8 mg/l to 2.3 mg/l, compared to 162 mg/l in the ground water; sulfate is 24 mg/l in the gravel leachate sample and non-detect in the gneiss samples, compared to 310 mg/l in the ground water; sodium ranges from 6 mg/l to 21 mg/l, compared to 233 mg/l in the ground water; and TDS ranges from 180 mg/l to 250 mg/l, compared to 1,160 mg/l in the ground water.

The pH of the USEPA Method 1312 leachates from the sericite gneiss, gravel, and biotite gneiss is 7.81, 8.21, and 8.21, respectively, compared to the pH in the ground water of 7.61. Aluminum, barium, selenium, and zinc were present at low concentrations in the USEPA Method 1312 leachate samples, but were not detected in the ground water. Relatively high concentrations of manganese in the ground water sample are typical of all the ground water samples collected from the Project mine and process area.

The selenium concentrations of 0.05 mg/l and 0.07 mg/l in the sericite gneiss and gravel leachates, respectively, reach or exceed the California primary maximum contaminant level (MCL) of 0.05 mg/l of selenium for drinking water. Iron and manganese concentrations exceeded the secondary drinking MCLs of 0.3 mg/l and 0.05 mg/l, respectively, in two (2) of the leachate samples.

5.4. USEPA Method 1320 Analytical Results

The results of USEPA Method 1320 analyses on six (6) waste rock samples are provided in Table 5. The analytical results for extractions 1 through 10 are presented for each sample.

The dissolved constituent concentrations in the initial extraction leachate for each sample are greater than all subsequent extraction leachates. Sample E-5 (sericite gneiss) has the lowest concentrations of dissolved constituents in the first extraction leachate. Alkalinity is below the detection limit of 5 mg/l, calcium is 65.7 mg/l, manganese is 0.41 mg/l, and TDS is 430 mg/l. For the remaining five (5) samples, alkalinity ranges from 540 mg/l to 1,740 mg/l; calcium from 494 mg/l to 1,370 mg/l; manganese from 1.49 mg/l to 10.4 mg/l; and TDS from 2,090 mg/l to 5,930 mg/l. The concentrations of these constituents are all much greater than the applicable concentrations in the background ground water sample, which are also presented in Table 5. In addition, aluminum concentrations in the initial USEPA Method 1320 leachates ranged from 0.11 mg/l to 0.67 mg/l, compared to less than 0.02 mg/l in the ground water sample. Iron was below the detection limit of 0.3 mg/l in all of the initial USEPA Method 1320 extraction leachates, compared to a concentration of 0.60 mg/l in the background ground water sample. Sulfate and chloride concentrations were also generally low in the initial USEPA Method 1320 leachates, compared to the background ground water concentrations of 310 mg/l and 162 mg/l, respectively.

The concentrations of dissolved constituents in the leachates from extractions 2 through 10 were all low. Alkalinity was below the detection limit of 5 mg/l in all leachates from extractions 2 through 10. Aluminum, sulfate, calcium, and manganese were present in sample leachates from extractions 2 through 10. For most of the samples, iron was present in the later leachate extractions at concentrations above the detection limit of 0.3 mg/l.

6. GEOCHEMICAL MODELING

To test the effects of the ground water inflowing to the pits and equilibrating with the backfill material under earth surface conditions, geochemical models were run and the results evaluated relative to background ground water quality and to potential impacts to ground water quality downgradient from the pits.

The USEPA geochemical model MINTEQA2 (Allison, et al, 1991) was developed to apply fundamental principles of thermodynamics to solve geochemical equilibria using mass balance relations and an aqueous speciation-solubility-adsorption model. The computer code uses its own thermodynamic database, which may be modified as new or updated data become available.

MINTEQA2 was used to speciate the chemical forms of the dissolved constituents in the water that equilibrates with the backfill waste material and to determine the effects of mineral precipitation on the final dissolved concentrations of these constituents. Unless otherwise noted below, carbon dioxide was input at a partial pressure of $1.0 \times 10^{-3.5}$ atmospheres, equivalent to earth surface atmospheric conditions. Other specific input parameters are described in the sections for each model run.

6.1. Equilibration of Inflowing Ground Water with Backfill Material

The ground water analysis most representative of that ground water which will flow into the pits is WC-5A, collected from the corehole in the area of the West Pit (EMA, 1996). The most reactive mineral phase present in the waste rock lithologies is calcite. Therefore, in the geochemical model, ground water with a composition equivalent to sample WC-5A is equilibrated with an infinite mass of calcite. The assumption of an infinite mass of calcite being available to equilibrate with the inflowing ground water is based on the backfill waste rock material having a high surface area available to react and on calcite being reactive in the modeled system. In addition, carbon dioxide was input with a partial pressure of $1.0 \times 10^{-3.5}$ atmospheres, equivalent to the earth surface conditions under which the system will equilibrate.

The model results of the inflowing ground water equilibrating with calcite are provided in Appendix B. These results are summarized and compared to the background ground water quality in Table 6. The final model pH is 8.48, compared to the background value of 7.61. Dissolved manganese precipitated as a manganese hydroxide. The concentrations of all other dissolved constituents remained approximately the same as the background inflowing ground water concentrations.

6.2. Equilibration of USEPA Method 1312 Leachate

Geochemical models were run using as input the results of each of the three (3) USEPA Method 1312 analyses equilibrating with an infinite mass of calcite. These models were run to simulate only the contribution of those constituents which might leach from the wallrock as the ground water flowed into the pits.

The model results of the USEPA Method 1312 leachates equilibrating with calcite under atmospheric conditions are provided in Appendix C for the sericite gneiss sample, Appendix D for the gravel sample, and Appendix E for the biotite gneiss sample. These results are summarized and compared to the background ground water quality in Table 6. The final modeled pH ranged from 8.23-8.41, and the dissolved manganese and aluminum precipitated as insoluble hydroxides. The low concentrations of arsenic and mercury present in the USEPA Method 1312 leachates precipitated as barium arsenate and a mercury hydroxide during model equilibration. All other dissolved constituents have the same concentrations as the input concentrations.

6.3. Equilibration of USEPA Method 1320 Leachate

A geochemical model was run for one (1) sample of the first extraction from the USEPA Method 1320 analyses. The results of the USEPA Method 1320 analyses indicated, based on the high calcium and alkalinity concentrations, that the leachate is over-saturated relative to calcite; therefore, the geochemical model was run using the USEPA Method 1320 results as input and assuming that calcite could precipitate during equilibration with the backfill material. This model was run to simulate the contribution of constituents which might be derived from the wallrock under more rigorous leaching conditions than the USEPA Method 1312 analyses as the ground water flowed into the pits. Only the results of the first USEPA Method 1320 extraction were modeled since extractions 2 through 10 had very low concentrations of dissolved constituents for each of the samples.

The geochemical model results of the USEPA Method 1320 leachate from the sericite gneiss is provided in Appendix F. These results are summarized and compared to the background ground water quality in Table 6. As expected, the dissolved calcium and alkalinity precipitated as calcite. Manganese and aluminum precipitated as insoluble hydroxides, and some of the copper and zinc precipitated as insoluble oxides. The concentrations of all other dissolved constituents remained the same as the input concentrations.

7. DISCUSSION

Static tests and synthetic precipitation leach procedure analyses (USEPA Method 1312 and Method 1320) were conducted on samples of waste rock that will be used as backfill material in the pits after the mining operation ceases.

The results of the static tests show an overall high net neutralization potential (NNP) for the waste rock. Although the one (1) sample of basaltic volcanics had a slight acid-generating potential of 0.5 tons $CaCO_3$ per 1,000 tons of material, all other samples had moderate to substantial net neutralization potentials of from 10.3 to greater than 229 tons $CaCO_3$ per 1,000 tons of material, due primarily to the presence of secondary calcite and the lack of sulfide mineral phases from which acid could be generated. This, combined with the volcanic's very small percentage in the total waste rock lithology, will result in the average NNP of the waste rock being high.

The results of USEPA Method 1312 analyses show low concentrations of all constituents in the sample leachates compared to background water quality. The low concentrations of manganese and iron are present due to the dissolution of secondary oxides and oxyhydroxides. Selenium was present in two (2) samples at concentrations of 0.05 mg/l and 0.07 mg/l, at or greater than the drinking water MCL of 0.05 mg/l. Selenium may be present due to desorption from metal oxides.

The results of USEPA Method 1320 analyses show high dissolved constituent concentrations only in the first extraction. Extractions 2 through 10 generally show low concentrations except during the later extractions, when high iron concentrations are produced from oxide dissolution due to the low pH and lack of remaining buffering capacity in the sample. The high calcium and alkalinity concentrations are due to the dissolution of calcite during the initial extraction and contribute to the high total dissolved solids (TDS) concentrations in each leachate. The manganese and aluminum concentrations are due to the dissolution of manganese oxides and oxyhydroxides. The alkalinity, TDS, calcium, manganese, and aluminum concentrations are initially greater than the concentrations present in the background ground water. This is due to the more rigorous leaching of the USEPA Method 1320 extraction than the natural processes with which the ground water has equilibrated.

The geochemical models showed that metal oxides and oxyhydroxides will form from the dissolved constituents in the ground water and leachate samples, similar to the manganese and iron oxides present in the waste rock lithologies. In addition, the pH will be buffered to approximately 8.4 by the calcite in the waste rock and by the atmospheric partial pressure of carbon dioxide. Thus, the geochemical models show reasonable results for a ground water equilibrating with calcite under earth surface conditions.

8. CONCLUSIONS

Analyses were conducted on samples of waste rock that may be used as backfill material in the Project pits following cessation of mining. Static tests and synthetic precipitation leach analyses (USEPA Method 1312 and Method 1320) were conducted to evaluate potential effects of the interaction of ground water flowing into the pit(s) with the backfilled waste rock material. The results of the analyses reveal the following:

(1) There is no potential for acid conditions to form in the any of the Project pits; and

(2) The interactions of the inflowing ground water with the backfilled waste rock material in the pits will not produce any substantial changes to ground water quality in the Project mine and process area or downgradient.

Geochemical models were run to evaluate the water quality after equilibration of the inflowing ground water with the backfilled waste rock material. The models were run assuming equilibration with calcite, the reactive mineral phase in the backfilled waste rock, and with a partial pressure of carbon dioxide of $1.0 \times 10^{-3.5}$ atmospheres, equivalent to earth surface atmospheric conditions. The results of the geochemical models show that the pH of the impounded water in the pits will be approximately 8.3 to 8.5, and that the dissolved constituent concentrations will be approximately equal to the existing background ground water concentrations.

The results of the laboratory analyses and the geochemical modeling show that, compared with the existing background water quality in the Project mine and process area, no substantial change to water quality at the Project mine and process area or downgradient of the mine site will occur.

9. REFERENCES

Environmental Management Associates, 1996: *Supplemental Hydrology Study, Imperial Project, Imperial County, California*. September 1996.

Allison, J.D., D.S. Brown, and K.J. Novo-Gradac, 1991: *MINTEQA2/PRODEFA2, A Geochemical Assessment Model for Environmental Systems: Version 3.0 Users Manual.* U.S. Environmental Protection Agency Office of Research and Development; Environmental Research Laboratory, Athens, Georgia. EPA/600/3-91/021.

Table 1: Rock Sample Types and Sample Locations

Pit	Sample	Rock Type	Sample Drill Hole	Sample Depth (ft)
East	E-1	sericite gneiss	ER-44	700-820
East	E-2	sericite gneiss	ER-46	700-870
East	E-3	gravel	ER-40/ER-41/ER-42	0-300/0-120/0-200
East	E-3	gravel	ER-38/ER-43/ER-46	0-200/0-350/0-110
East	E-5	sericite gneiss	ER-44	525-560
East	E-6	volcanic	ER-43/ER-46	410-440/525-560
West	W-1	biotite gneiss	WR-55	580-780
West	W-2	biotite gneiss	WR-58	580-760
West	W-3	gravel	WR-58	0-180

Table 2: Results of Whole Rock Analyses

Analyte[1]	E-1 Sericite Gneiss	E-2 Sericite Gneiss	E-3 Gravel	E-4 Gravel	E-5 Sericite Gneiss	E-6 Volcanic	W-1 Biotite Gneiss	W-1[2] Biotite Gneiss	W-2 Biotite Gneiss	W-3 Gravel
SiO_2	65.17	65.49	66.54	66.32	73.85	47.76	66.06	65.99	61.98	67.33
Al_2O_3	14.64	14.87	13.40	13.80	13.60	14.15	13.82	13.77	14.83	13.60
Fe_2O_3	5.07	4.81	4.95	4.83	1.96	6.15	[illegible].08	3.94	5.53	4.29
MgO	0.60	0.70	1.00	1.16	0.41	3.01	0.22	0.23	0.81	1.01
CaO	2.29	1.37	3.27	3.01	0.37	10.58	3.0[illegible]	3.94	3.12	3.24
Na_2O	2.54	3.43	2.99	2.84	1.44	2.25	3.98	3.94	2.54	2.84
K_2O	5.13	4.49	3.45	3.27	4.91	1.11	4.02	4.24	4.80	4.76
TiO_2	0.58	0.55	0.51	0.50	0.38	0.83	0.44	0.46	0.69	0.44
P_2O_5	0.08	0.12	0.10	0.11	0.03	0.19	0.09	0.12	0.26	0.09
MnO	0.11	0.12	0.09	0.08	0.03	0.12	0.08	0.06	0.13	0.06
Cr_2O_3	0.003	0.002	0.005	<0.001	0.003	0.016	0.09	0.003	0.003	0.003
Ba	736	955	1,172	1,095	516	1,020	756	756	974	1,415
Ni	<20	<20	22	<20	<20	39	<20	<20	<20	<20
Sr	218	221	257	278	97	553	104	105	190	294
Zr	173	163	145	198	175	139	117	107	136	144
Y	25	19	17	17	26	16	17	18	21	17
Nb	16	19	22	14	22	15	14	13	16	12
Sc	<10	<10	<10	<10	<10	15	<10	<10	<10	<10
LOI[3]	3.7	3.1	3.0	3.2	2.0	13.3	3.3	3.3	4.4	2.6
SUM	100.01	99.32	99.56	99.39	99.11	99.79	99.13	99.30	99.31	100.56

[1]Units: oxides in percent, metals in ppm
[2]Rerun sample
[3]Loss on Ignition

Table 3: Static Test Results

Sample Number	Sample Rock Type	Sulfur Species (%)			ANP	AGP (pyritic)	NNP	ANP:AGP
		Total	Sulfate	Pyritic	tons $CaCO_3$/kT			
E-1	sericite gneiss	<0.01	<0.01	0.01	36.4	0.4	36.0	91.0
E-2	sericite gneiss	0.02	<0.01	<0.01	20.5	<0.3	20.5	>68.4
E-3	gravel	<0.01	<0.01	0.01	37.2	0.4	36.8	93.0
E-4	gravel	<0.01	<0.01	0.02	26.2	0.6	25.6	43.7
E-5	sericite gneiss	<0.01	<0.01	<0.01	3.1	<0.3	3.1	>10.3
E-6	volcanic	<0.01	<0.01	0.02	<0.1	0.5	-0.5	<0.2
W-1	biotite gneiss	<0.01	<0.01	<0.01	68.8	<0.3	68.8	>229
W-2	biotite gneiss	<0.01	<0.01	0.01	42.1	0.4	41.7	105
W-3	gravel	0.05	<0.01	0.01	31.0	0.4	30.6	77.5

ANP: acid-neutralizing potential
AGP: acid-generating potential
NNP: net-neutralizing potential

Table 4: EPA Method 1312 Results

Analytes (mg/l)	Ground Water Quality (Sample WC-5A [EMA, 1996]) (mg/l)	Sample		
		E-2 sericite gneiss	E-4 gravel	W-2 biotite gneiss
Alkalinity (as $CaCO_3$)	210	38	40	34
Chloride	162	1.8	2.3	0.[illegible]
Fluoride	0.8	0.2	0.2	0.1
Nitrate/Nitrite (as N)	0.06	<0.01	<0.0[illegible]5	<0.05
Phosphorus	0.[illegible]4	0.02	0.07	0.05
Sulfate	310	<10	24	<10
pH	7.61	7.81	[illegible].24	8.21
Aluminum	<0.0[illegible]5	0.3[illegible]	0.[illegible]1	0.32
Antimony	<0.005	<0.0[illegible]	<0.005	<0.0[illegible]
Arsenic	<0.0[illegible]5	<0.01	0.01	0.02
Barium	0.[illegible]4	0.38	0.24	0.21
Beryllium	0.001	0.3[illegible]	<0.001	<0.0[illegible]
Bismuth	<1	<1	<1	<1
Boron	0.74	0.25	0.2[illegible]	0.13
Cadmium	<0.005	<0.0[illegible]	<0.005	<0.005
Calcium	59.4	7.81	27.0	11.8
Chromium	<0.0[illegible]5	<0.01	<0.01	<0.01
Cobalt	<0.03	<0.01	<0.03	<0.03
Copper	<0.0[illegible]5	<0.01	<0.01	<0.01
Gallium	<0.5	<0.5	<0.5	<0.[illegible]4
Iron	0.60	0.10	<0.03	0.[illegible]5
Lead	<0.003	<0.0[illegible]	0.017	0.005
Lithium	0.[illegible]4	<0.01	<0.01	<0.01
Magnesium	[illegible].74	[illegible].8	0.7	0.8
Manganese	0.74	0.1[illegible]	0.0[illegible]	0.04
Mercury	<0.0002	<0.0002	<0.0002	0.0004
Molybdenum	<0.05	<0.05	<0.05	<0.05
Nickel	0.[illegible]4	0.3[illegible]	0.[illegible]4	<0.04
Potassium	12	<5	<5	<5
Scandium	<0.0[illegible]5	<0.01	<0.01	<0.01
Selenium	<0.0[illegible]5	0.3[illegible]	0.07	<0.01
Silver	<0.01	<0.01	<0.01	<0.01
Sodium	233	8	21	6
Strontium	1.30	0.21	0.09	0.35
Thallium	<0.002	<0.002	<0.002	<0.002
Tin	<0.05	<0.05	<0.05	<0.05
Titanium	<0.01	<0.01	<0.01	<0.01
Vanadium	<0.05	<0.05	<0.05	<0.05
Zinc	<0.01	0.35	0.21	0.19
Total Dissolved Solids	1,160	180	220	250

Table 5: EPA Method 1320 Results

SAMPLE E-1 (SERICITE GNEISS)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Alkalinity (as $CaCO_3$)	1,040	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	3.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride	0.1	0.3	0.5	0.6	0.6	0.5	6.0	6.0	0.1	<0.1
Nitrate/Nitrite (as N)	1.90	5.6	3.22	3.47	8.9	20.4	2.59	3.44	6.5	2.75
Phosphorus	<0.01	4.36	2.9	0.08	2.53	2.35	0.98	3.66	0.03	<0.01
Sulfate	12	29	29	20	20	20	20	20	29	20
pH	5.45	4.36	4.26	3.90	3.40	1.82	3.66	2.71	3.33	3.59
Aluminum	0.11	0.22	0.51	0.08	0.57	0.46	0.26	0.27	0.25	0.25
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	689	14.5	14.5	11.0	10.4	10.3	6.0	6.0	5.0	4.9
Chromium	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	0.13	0.03	0.05	0.05	0.05	0.07	0.05	0.06	0.06	0.08
Gallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Lead	0.004	0.008	<0.003	<0.003	0.005	<0.003	<0.003	<0.003	0.003	0.004

SAMPLE E-1 (SERICITE GNEISS)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Lithium	<0.01	<0.01	<0.01	0.01	0.01	<0.04	<0.01	<0.01	<0.01	<0.01
Magnesium	4.9	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4
Manganese	7.37	0.54	0.63	0.62	0.62	0.80	0.65	<0.04	1.14	2.63
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	<0.04	<0.04	<0.01	<0.01	0.01	<0.04	<0.04	<0.01	<0.04	<0.04
Potassium	22	<5	<5	<5	<5	<5	<5	<5	<5	<5
Scandium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.04	<0.01	<0.01	<0.01	<0.01
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.01	0.01	<0.01	0.03	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	10	1	<1	1	1	<1	<1	<1	1	1
Strontium	1.50	0.06	0.05	0.04	0.04	0.04	0.02	0.03	0.04	0.06
Thallium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06
Titanium	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	1.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TDS	3,050	110	60	40	50	20	40	40	30	30

Imperial Project
Supplemental Waste Characterization Study
September 1996

SAMPLE E-3 (GRAVEL)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Alkalinity (as $CaCO_3$)	540	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	4.2	<0.5	4.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride	0.3	1.7	4.5	0.2	<0.1	1.7	<0.1	<0.1	<0.1	<0.1
Nitrate/Nitrite (as N)	2.96	63.5	2.98	5.5	8.2	3.60	2.33	3.12	12.6	2.31
Phosphorus	0.04	0.08	0.04	0.06	0.13	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	22	35	20	18	20	20	20	20	20	20
pH	0.04	1.92	0.04	3.72	3.67	2.65	5.05	0.08	2.20	3.26
Aluminum	0.04	0.37	0.08	0.35	0.18	<0.001	<0.001	0.08	0.08	<0.05
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	<0.01	0.37	0.02	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01
Barium	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	494	17.3	11.6	6.6	4.5	4.5	1.7	0.3	1.7	0.7
Chromium	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Gallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	<0.3	<0.3	4.0	8.6	13.6	13.6	14.0	13.7	20.1	15.3
Lead	<0.003	0.005	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Lithium	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	4.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.3	0.2
Manganese	2.01	0.58	0.63	0.51	0.50	0.41	0.44	0.50	0.49	0.34

SAMPLE E-3 (GRAVEL)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	<0.01	<0.04	0.01	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.01
Potassium	18	<5	<5	<5	<5	<5	<5	<5	<5	<5
Scandium	<0.01	<0.04	<0.04	<0.01	<0.04	<0.04	<0.04	<0.01	<0.01	<0.01
Selenium	<0.01	<0.01	<0.01	<0.01	<0.04	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.04	<0.01	<0.04	<0.01	<0.04	<0.01
Sodium	18	1	<1	2	1	<1	<1	1	<1	<1
Strontium	0.69	0.01	0.01	<0.04	0.02	0.01	0.01	0.01	0.01	<0.01
Thallium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TDS	2,090	100	60	50	60	70	50	50	50	60

SAMPLE E-5 (SERICITE GNEISS)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Alkalinity (as $CaCO_3$)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	2.0	<0.5	<0.5	0.5	<0.5	<0.5	0.2	<0.5	<0.5	<0.5
Fluoride	0.2	0.2	0.4	0.2	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
Nitrate/Nitrite (as N)	3.52	7.10	3.05	4.20	4.43	7.4	2.43	2.47	2.76	2.40
Phosphorus	0.21	2.86	0.57	0.38	0.23	0.44	0.57	<0.01	<0.01	<0.01
Sulfate	16	20	20	20	20	20	20	20	20	20
pH	2.86	3.53	3.66	3.42	3.36	2.34	3.66	4.07	3.34	4.63
Aluminum	0.30	0.44	0.37	0.29	0.62	0.12	0.06	0.12	0.06	0.06
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001
Barium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	65.7	13.5	9.6	5.0	3.3	2.9	0.2	1.5	2.9	0.6
Chromium	0.21	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	0.03	0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Gallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	<0.3	<0.3	<0.3	0.5	1.4	4.1	8.5	12.5	14.5	16.3
Lead	<0.003	0.005	0.005	0.009	<0.003	0.007	0.005	<0.003	<0.003	<0.003
Lithium	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	2.3	0.5	0.3	0.3	0.1	0.1	<0.1	0.2	<0.1	<0.1
Manganese	0.41	0.13	0.11	0.09	0.09	0.11	0.12	0.14	0.11	0.12

SAMPLE E-5 (SERICITE GNEISS)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	<0.04	<0.01	<0.01	<0.01	<0.01	<0.04	<0.01	<0.01	<0.04	<0.01
Potassium	8	<5	<5	<5	<5	<5	<5	<5	<5	<5
Scandium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.01	<0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	5	1	<1	2	<1	<1	<1	[illegible]	<1	<1
Strontium	0.69	0.13	0.08	0.04	0.03	0.03	0.02	0.02	<0.01	<0.01
Thallium	0.022	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TDS	430	60	50	30	30	70	40	50	60	60

SAMPLE E-6 (VOLCANIC)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Alkalinity (as $CaCO_3$)	1,740	20	20	<5	<5	<5	<5	<5	<5	<5
Chloride	6.0	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride	<0.1	0.1	0.3	0.4	0.4	0.4	0.2	0.2	0.1	0.2
Nitrate/Nitrite (as N)	7.4	6.3	2.91	3.46	3.86	3.66	2.62	3.42	10.8	3.30
Phosphorus	0.35	0.48	0.29	1.8	1.86	1.04	0.50	0.29	0.22	0.06
Sulfate	59	28	25	24	26	20	20	20	20	20
pH	5.12	5.16	5.12	3.97	3.82	2.87	4.95	4.64	4.38	2.71
Aluminum	0.32	0.08	0.11	0.30	0.34	0.28	0.23	0.17	0.20	0.09
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Beryllium	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	1,370	33.0	17.7	15.9	14.8	13.4	11.7	13.3	14.5	10.7
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Gallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.4	1.0	2.0	2.5
Lead	<0.003	<0.003	0.004	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Lithium	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	11.7	0.5	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.4
Manganese	3.28	0.13	0.10	0.13	0.23	0.37	0.42	0.55	0.50	0.40

SAMPLE E-6 (VOLCANIC)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	<0.01	0.07	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Potassium	41	<5	<5	<5	<5	<5	<5	<5	<5	<5
Scandium	<0.01	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.01
Selenium	<0.01	<0.01	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.01
Silver	<0.01	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.01
Sodium	49	3	<1	2	3	<1	1	3	1	<1
Strontium	5.18	0.07	0.07	0.07	0.07	0.07	0.05	0.05	0.07	<0.01
Thallium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TDS	5,930	180	70	90	80	80	40	70	80	60

SAMPLE W-1 (BIOTITE GNEISS)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Alkalinity (as $CaCO_3$)	1,120	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	3.4	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride	<0.1	<0.1	0.7	0.7	0.6	0.7	0.4	0.7	<0.1	<0.1
Nitrate/Nitrite (as N)	1.50	6.10	2.92	4.71	5.4	5.4	2.49	3.10	3.18	3.66
Phosphorus	0.03	0.03	0.03	2.7	2.50	2.50	1.38	0.03	0.03	<0.01
Sulfate	47	27	20	22	20	22	20	20	20	20
pH	5.05	4.19	4.15	3.60	4.19	2.33	3.64	3.42	3.40	2.95
Aluminum	0.41	4.19	0.90	0.75	0.74	0.63	0.65	0.47	0.65	0.75
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	1,080	17.9	14.9	10.7	9.1	8.3	6.2	4.4	2.0	1.3
Chromium	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	0.05	<0.01	<0.01	<0.01	<0.01	0.02	0.01	0.02	<0.01	0.01
Gallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.9
Lead	<0.003	0.003	0.004	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Lithium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	2.8	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1	<0.1
Manganese	10.4	0.75	0.62	0.60	0.54	0.55	0.71	0.96	0.92	1.37

SAMPLE W-1 (BIOTITE GNEISS)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Potassium	17	<5	<5	<5	<5	<5	<5	<5	<5	<5
Scandium	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	4	2	<1	1	1	<1	1	1	1	<1
Strontium	0.70	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Thallium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TDS	4,470	130	60	50	50	80	20	30	20	

Imperial Project
Supplemental Waste Characterization Study
September 1996

SAMPLE W-3 (GRAVEL)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Alkalinity (as $CaCO_3$)	1,140	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	9.3	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	<0.5	<0.5	<0.5
Fluoride	1.0	0.9	0.9	0.4	0.2	0.2	<0.5	<0.5	<0.5	<0.1
Nitrate/Nitrite (as N)	3.98	6.1	3.06	2.98	5.1	5.9	2.30	2.94	2.98	2.41
Phosphorus	0.10	4.28	4.28	0.66	0.24	0.03	<0.01	<0.01	<0.01	<0.01
Sulfate	260	32	20	19	17	20	20	20	20	20
pH	5.36	3.90	4.28	4.17	3.27	2.29	4.28	4.80	4.62	4.88
Aluminum	0.67	4.28	0.08	0.39	0.08	0.15	0.08	0.14	0.14	4.88
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	0.01	0.02	0.07	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	805	19.6	13.0	7.8	5.3	3.9	1.8	2.2	1.2	0.9
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Gallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	<0.3	<0.3	1.2	4.8	8.9	14.2	14.4	15.3	13.8	7.2
Lead	<0.003	<0.003	<0.003	<0.003	0.004	<0.003	<0.003	<0.003	<0.003	<0.003
Lithium	0.02	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	4.9	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.3	0.2
Manganese	1.49	0.37	0.43	0.36	0.30	0.30	0.27	0.35	0.23	0.11

SAMPLE W-3 (GRAVEL)										
Analytes (mg/l)	Extraction									
	1	2	3	4	5	6	7	8	9	10
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Potassium	17	<5	<5	<5	<5	<5	<5	<5	<5	<5
Scandium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	20	2	<1	1	1	<1	<1	2	1	<1
Strontium	1.26	0.10	0.06	0.04	0.03	0.02	0.01	0.02	0.01	<0.01
Thallium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	0.51	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	2.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TDS	3,430	100	70	50	60	80	40	50	60	50

Imperial Project
Supplemental Waste Characterization Study
September 1996

Table 6: Geochemical Model Results

Analyte (mg/l)	Background Groundwater (WC-5A) (mg/l)	Sample (mg/l)				
		Groundwater	1312			1320
		WC-5A	E-2	E-4	W-2	E-1
pH	7.61	8.48	8.29	8.23	8.41	8.48
Sulfate	310	310	ND	24	ND	40
Strontium	1.30	1.30	0.21	0.09	0.35	1.5
Beryllium	0.03	0.01	0.30	ND	ND	ND
Boron	0.74	0.01	0.25	0.20	0.13	ND
Chloride	201	162	1.8	2.3	0.8	3.4
Fluoride	0.8	0.01	0.30	0.002	0.003	0.100
Lithium	0.47	0.27	ND	ND	ND	ND
Magnesium	16.1	16.1	0.6	0.7	0.8	1.9
Potassium	12	12.	ND	ND	ND	22
Nitrate N	0.76	0.27	ND	ND	ND	1.9
Phosphorus	0.03	0.009	0.09	0.10	0.004	ND
Calcium	59.4	13.9	19.6	28.6	11.5	9.5
Alkalinity (CO_3)	201	100	59.6	51.8	77.1	92.5
Iron	0.60	0.01	0.38	ND	ND	ND
Sodium	233	233	8	24	6	10
Manganese	0.47	3.1×10^{-21}	5.5×10^{-21}	9.7×10^{-21}	2.4×10^{-21}	ND
Barium	0.03	0.01	0.38	0.10	0.19	ND
Arsenic	<0.01	ND	ND	8.6×10^{-8}	2.5×10^{-8}	ND
Zinc	<0.01	ND	0.38	0.21	0.19	1.9
Lead	<0.003	ND	ND	0.017	0.005	0.004
Selenium	<0.01	ND	0.05	0.07	ND	ND
Aluminum	<0.02	ND	0.0004	0.0004	0.0006	0.0007
Mercury	<0.0002	ND	ND	ND	1.3×10^{-6}	ND
Chromium	<0.01	ND	ND	ND	ND	0.03
Copper	<0.01	ND	ND	ND	ND	0.06

ND: not detected in the input analytical data

APPENDIX A

ANALYTICAL RESULTS OF WASTE ROCK ANALYSES

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX B

MODEL OUTPUT FOR EQUILIBRATION OF GROUND WATER (WC-5A) WITH WASTE BACKFILL MATERIAL

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX C

MODEL OUTPUT FOR EQUILIBRATION OF 1312 LEACHATE - SAMPLE E-2 SERICITE GNEISS

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX D

MODEL OUTPUT FOR EQUILIBRATION OF 1312 LEACHATE - SAMPLE E-4 GRAVEL

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX E

MODEL OUTPUT FOR EQUILIBRATION OF 1312 LEACHATE - SAMPLE W-2 BIOTITE GNEISS

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX F

MODEL OUTPUT FOR EQUILIBRATION OF 1320 LEACHATE - SAMPLE E-1 SERICITE GNEISS

The information otherwise contained in this Appendix/Attachment has been removed from this version of the Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the Bureau of Land Management El Centro Resource Area Office

This page intentionally left blank
for reproduction purposes.

APPENDIX D IMPERIAL PROJECT SITE JURISDICTIONAL DETERMINATION (SEPTEMBER 22, 1997)

IMPERIAL PROJECT SITE
JURISDICTIONAL DETERMINATION

September 22, 1997

Prepared for:

Glamis Imperial Corporation
Post Office Box 1177
Winterhaven, CA 92283

Prepared by:

LSA Associates, Inc.
3403 10th Street, Suite 520
Riverside, CA 92501
LSA Project #CGI730

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

At the request of Glamis Imperial Corporation (Glamis), LSA Associates, Inc. (LSA) conducted a jurisdictional determination for the Imperial Project site. The determination was performed to describe and quantify "Waters of the United States" (U.S.) (see Regulatory Background Section for definitions) that are subject to the jurisdiction of the U.S. Army Corps of Engineers (Corps).

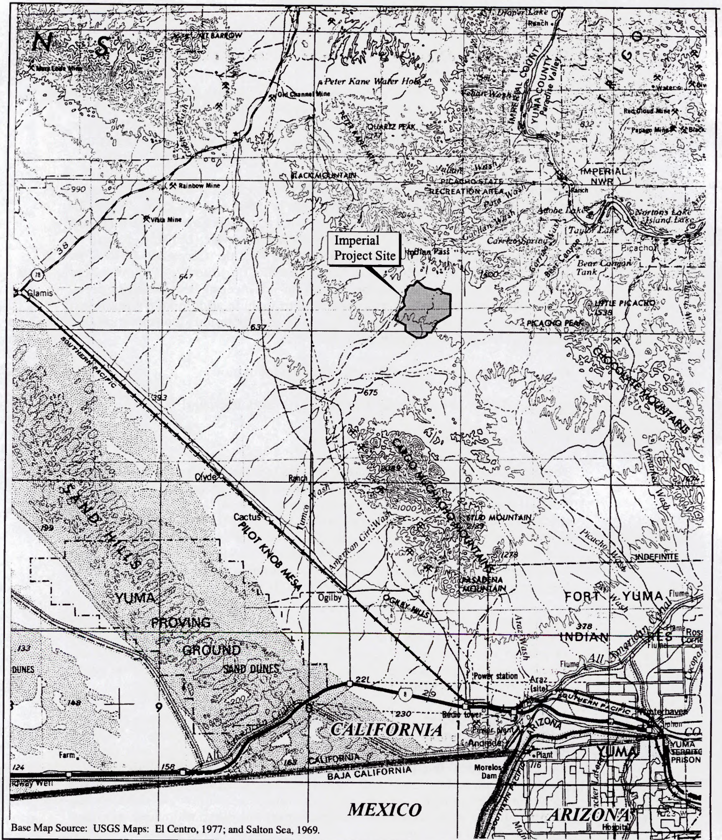
Jurisdictional determinations were previously prepared for the site by Environmental Management Associates (EMA) (March 1996) and LSA (May 23, 1997). The previous determination results were reviewed by the Corps, Environmental Protection Agency (EPA), and U.S. Fish and Wildlife Service (USFWS). As part of the agency review, on-site meetings were held with the Corps and USFWS on March 14, 1997; and the Corps, USFWS, and EPA on June 17, 1997, to assess site conditions. As a result of the second on-site meeting, the extent of previously identified jurisdiction was expanded to include additional tributaries to major waterways. The final results of the jurisdictional determination are presented herein. This report presents:

- Background information on pertinent regulations;
- A description of the determination methodology; and
- Conclusions of the determination.

The 1,589-acre Imperial Project site is located in an unincorporated area in the eastern portion of Imperial County, California about 45 miles northeast of El Centro, California and 20 miles northwest of Yuma, Arizona (Figure 1). This site is shown on the U.S. Geological Survey (USGS) 7.5' Hedges quadrangle and is located within Sections 31, 32, and 33, Township 13 South, Range 21 East; and within Sections 4, 5, 6, 7, and 8, Township 14 South, Range 21 East, San Bernardino Meridian. The site and all adjacent lands are public lands administered by the Bureau of Land Management (BLM).

The Imperial Project site is located on a broad, south- and west-facing alluvial plain south of Indian Pass in the Chocolate Mountains. The Cargo Muchacho Mountains are approximately four miles south of the site and Peter Kane Mountain is approximately six miles north. Elevation over the site ranges from about 760 feet to about 925 feet.

Precipitation in the project area tends to occur in short, intense events with average annual rainfall of 3.6 inches as measured at the nearby Gold Rock Ranch (GSI/Water 1993 *in* EMA 1996). The site is drained by four primary water courses including Indian Wash as designated on USGS 7.5' Hedges Quadrangle. All four watercourses and their tributaries are ephemeral (intermittent) conveying surface flows only during and immediately following precipitation events. All four watercourses drain toward the southwest, ultimately terminating at the Algodones sand dunes.



Base Map Source: USGS Maps: El Centro, 1977; and Salton Sea, 1969.

9/12/97(CG1730)

Figure 1

N

LSA

0 2 Mi. 4 Mi.

Regional Location Map

REGULATORY BACKGROUND

The Corps regulates discharges of dredged or fill material into "Waters of the U.S." These "waters" include "wetlands" and non-wetland bodies of water that meet specific criteria. Corps regulatory jurisdiction pursuant to Section 404 of the Clean Water Act is founded on a connection or *nexus* between the water body in question and interstate commerce. This connection may be direct, through a tributary system linking a stream channel with traditional navigable waters used in interstate or foreign commerce, or may be indirect, through a nexus identified in the Corps regulations. The following definition of Waters of the U.S. is taken from the discussion provided at 33 CFR 328.3:

> The term Waters of the U.S. means:
>
> (1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide.
>
> (2) All interstate waters including interstate wetlands;
>
> (3) 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;
>
> (4) All impoundments of waters otherwise defined as Waters of the U.S. under the definition;
>
> (5) Tributaries of waters defined in paragraphs (a) (1)-(4) of this section.

Further definition of Waters of the U.S. is found in 33 CFR 330.2:

> (e) Isolated waters means those non-tidal Waters of the U.S. that are:
>
> (1) Not a part of a surface tributary system to interstate or navigable Waters of the U.S.; and
>
> (2) Not adjacent to such tributary water bodies.

The jurisdictional extent of Waters of the U.S. encompasses areas displaying visible signs of at least intermittent water flow, extending laterally to the "ordinary high water mark (OHWM)," or the limit of any wetlands extending beyond that mark, and upstream to that point where the OHWM is no longer perceptible (33 CFR 328.4). The OHWM is defined as "that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area" (33 CFR 328.3). The upstream limit of Corps jurisdiction is that point on the stream where the OHWM is no longer perceptible.

The Corps and EPA define wetlands as follows:

> "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted to life in saturated soil conditions."

In order to be considered a jurisdictional wetland under Section 404, an area must possess *three* wetland characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology. Each characteristic has a specific set of mandatory wetland criteria that must be satisfied in order for that particular wetland characteristic to be met. Several parameters may be analyzed to determine whether the criteria are satisfied.

SUMMARY OF JURISDICTIONAL DETERMINATION TO DATE

In the *Imperial Project Waters Study* (EMA, March 1996) detailed data is presented on the extent and character of potential jurisdictional Waters of the U.S. on the subject property. EMA gathered information through review of aerial photographs and site maps and through extensive on-site surveys by a registered geologist, a botanist, and an ecologist. Information presented for all watercourses on site includes an alpha-numeric designation system, dimensions (length, width, and depth) and area, dominant vegetation, and hydrology indicators. A key factor applied by EMA in determining which of the watercourses qualified as Waters of the U.S. was the presence of ironwood and palo verde trees in excess of five feet in height. Those reaches of a watercourse where woody vegetation was rooted within a channel defined by an OHWM were identified as Waters of the U.S. The Waters of the U.S. were considered to extend up- and down-stream to the next confluence with a mapped tributary.

The conclusion of the waters study was that a series of disjunct reaches of various water courses met the definition of Waters of the U.S. The total jurisdictional area was considered to be 21.98 acres. Areas of watercourses not considered to meet the definition of Waters of the U.S. were identified solely as "waters."

Upon review of the waters study and following an on-site meeting to review the study results, the Corps submitted a letter dated March 25, 1997 to Chemgold concluding that the delineation of Waters of the U.S. was not complete. As indicated in the letter, the basis for the Corps' conclusion was that it may have been inappropriate to omit certain reaches of a given wash where tree species were absent. The Corps indicated that it may be more appropriate to consider the entire length of the wash with the indicator tree species present to be within the Corps jurisdiction. Additionally, the Corps indicated that the side channels and all other water conveyances must be investigated and delineated for Corps jurisdiction. The conclusions presented in the Corps' letter were reiterated by Mr. Terry Dean (Corps San Diego Field Office) during a meeting on April 11, 1997.

Based on comments received from the Corps and other involved agencies, a revised Jurisdictional Determination was prepared by LSA. The revised determination was done through aerial photograph interpretation and a site visit to "spot-check" site conditions and field-truth aerial photograph signatures. The results of the determination were summarized and submitted to the Corps, EPA, and USFWS in a draft report dated May 23, 1997. The total on-site jurisdictional determination identified in the draft report was 40.43 acres. The involved agencies reviewed the report and commented that the jurisdictional area on the site could include additional tributaries and channels in braided areas. Additional efforts were undertaken to address the agency comments and incorporate the subject areas in the jurisdictional determination. The methodology and results of the additional efforts are presented herein.

METHODS FOR JURISDICTIONAL DETERMINATION

DRAFT DETERMINATION

Based on the content of the Corps' letter dated March 25, 1997, and on discussions at the meeting of April 11, 1997 with Mr. Terry Dean, it was determined that a site survey should be performed to refine the conclusions of the *Imperial Project Waters Study* (EMA, March 1996). Jack Easton, LSA Biologist, surveyed the subject property to identify and evaluate areas of potential jurisdiction and refine the conclusions presented in the *Imperial Project Waters Study.*

Aerial Photograph Interpretation

Prior to initiating the site survey, Mr. Easton reviewed a color aerial photograph (dated October 20, 1991, scale 1" = 500') and an overlay at the same scale depicting the results of the EMA study. The overlay was a reproduction, on clear acetate, of Plate No. 2 of EMA's *Imperial Project Waters Study* showing Waters of the U.S., other waters, and trees within the OHWM channels. The characteristic signature of areas identified by EMA as Waters of the U.S. was compared to areas identified as other waters. Areas of other waters were then marked on the overlay as:

1) likely Waters of the U.S. - this included watercourse reaches where Waters of the U.S. had been identified up and downstream but not in the intervening (subject) reach.

2) possible Waters of the U.S. - this included primarily tributaries where no Waters of the U.S. had been identified or, where Waters of the U.S. had been identified only in downstream areas.

Field Survey

With the aerial photograph and overlay, Mr. Easton conducted site surveys on April 24 and 25, 1997. Each of the areas marked on the overlay (likely and possible Waters of the U.S.) were examined and local conditions were noted. Site conditions noted included dominant vegetation, drainage patterns (i.e., braided watercourses and incised, active, and inactive channels), and watercourse widths.

Indicators that were used to identify drainage patterns included watermark lines, recent sediment and debris deposits, and surface scour. Watermark lines (a clear natural line impressed on the bank) were the most commonly observed indicators of drainage patterns and were therefore used as the primary factor in identifying the OHWM.

Along some watercourses, an active channel was not discernable on the entire on-site length of the watercourse. Rather, the active channel was present only along disjunct reaches of the watercourse with intervening areas exhibiting indications of sheetflow or braiding over a wide area. In these conditions, where an active channel was the prevalent condition, that entire length of the watercourse was considered to be Waters of the U.S. The upstream point where the active channel (and with it, the OHWM) terminated, or was no

longer the prevailing condition, was considered to the be the upstream limit of the Waters of the U.S.

A measuring tape was used to compare and verify observed watercourse widths with those reported by EMA, measurements were rounded to the nearest foot. A map wheel was used to measure watercourse lengths. In all areas, width and length measurements closely matched those reported by EMA. The comprehensive data collection effort by EMA yielded accurate dimensions for all drainage courses on site. Based on the verified accuracy of EMA's measurements, their comprehensive data collection, and since the study was intended to be a refinement of EMA's conclusions, it was determined that the dimensions reported by EMA were suitable for use in refining the jurisdictional determination for the site.

Photographs were taken of representative areas including active and inactive channels, the limits of the OHWM, and of vegetation considered to be habitat for migratory birds.

The results of the draft jurisdictional determination were presented to the Corps and other involved regulatory agencies in a report (LSA, May 23, 1997).

FINAL DETERMINATION

Following review of the draft report by the Corps, EPA, and USFWS, an on-site meeting was held on June 17, 1997 to discuss the report, site conditions, and the extent of Corps jurisdiction. During the meeting, agency personnel identified typical tributaries and braided channels for inclusion in the jurisdictional area. Based on the aerial photograph signatures of the typical areas to be added, additional tributaries and braided channels were identified throughout the site for inclusion in the jurisdictional area. The additional areas were shown on an acetate overlay. Copies of the overlay and an aerial photograph at the same scale were submitted to the involved regulatory agencies for their review and comment.

Comments received from the Corps (Terry Dean, pers. comm., July 17, 1997) indicated that without additional field truthing, *any* potential Waters of the U.S. visible on the aerial photograph should be identified as Waters of the U.S. for purposes of this determination.

As no additional field surveys were performed, all areas of potential Waters of the U.S. were identified using an acetate overlay with a color aerial photograph (1" = 500'). Based on field data collected by EMA and LSA, knowledge of site conditions, and width dimensions scaled from the aerial photograph, drainage courses on the site were assigned to five classes according to width. An average or standard width was assigned to Classes I-IV. For Class V, the Waters of the U.S. were variable in width and were wide enough to be measured as a polygon.

Using the 1" = 500' overlay, drainage course lengths were measured for each of Classes I-IV and polygon areas were measured for all drainage courses in Class V. All measurements were made using a digitizer tablet and geographic information system (GIS) software. The jurisdictional area (Waters of the U.S.) was calculated for Classes I-IV by multiplying the measured length by the assigned width for each class.

RESULTS

JURISDICTIONAL WATERS OF THE UNITED STATES

LSA's evaluation of the Imperial Project site found a total of 114.5 acres that are identified as Waters of the U.S. and are subject to Corps permit authority. The 114.5 acres include some upland areas (i.e., islands within braided systems) that are not within the jurisdictional Waters of the U.S. but were included as a matter of expediency. It is expected that a detailed, intensive site survey of all areas encompassing Waters of the U.S. would reveal that the actual extent of jurisdiction is less than 114.5 acres.

The 114.5-acre jurisdictional area consists of ephemeral drainage courses and their tributaries.

- An "ordinary high water mark" is evident along each of the jurisdictional drainage courses or is presumed to be present based on aerial photograph interpretation and in the absence of additional field truthing.

- These intermittent streams support, or are tributary to areas that support, vegetation that may be used as habitat by birds that are protected under Migratory Bird Treaties. Further, the vegetation supported by the intermittent streams is substantially different (in species composition and relative percent cover) from the vegetation of the adjacent upland areas.

- These drainages are non-tidal, not a part of a surface tributary system to interstate or navigable waters, and not adjacent to such tributary water bodies.

Based on these three points, identified drainage courses on the site are considered to meet the definition of "Isolated Waters of the U.S." and are therefore subject to the jurisdiction and permitting authority of the Corps. Tributaries to Isolated Waters of the U.S. are also subject to the Corps' jurisdiction and permitting authority. Due to the absence of any hydrophytic vegetation, none of the jurisdictional drainage courses meet the definition of "wetlands." It is expected that hydric soils are also absent although, a field inspection of soil conditions was not conducted.

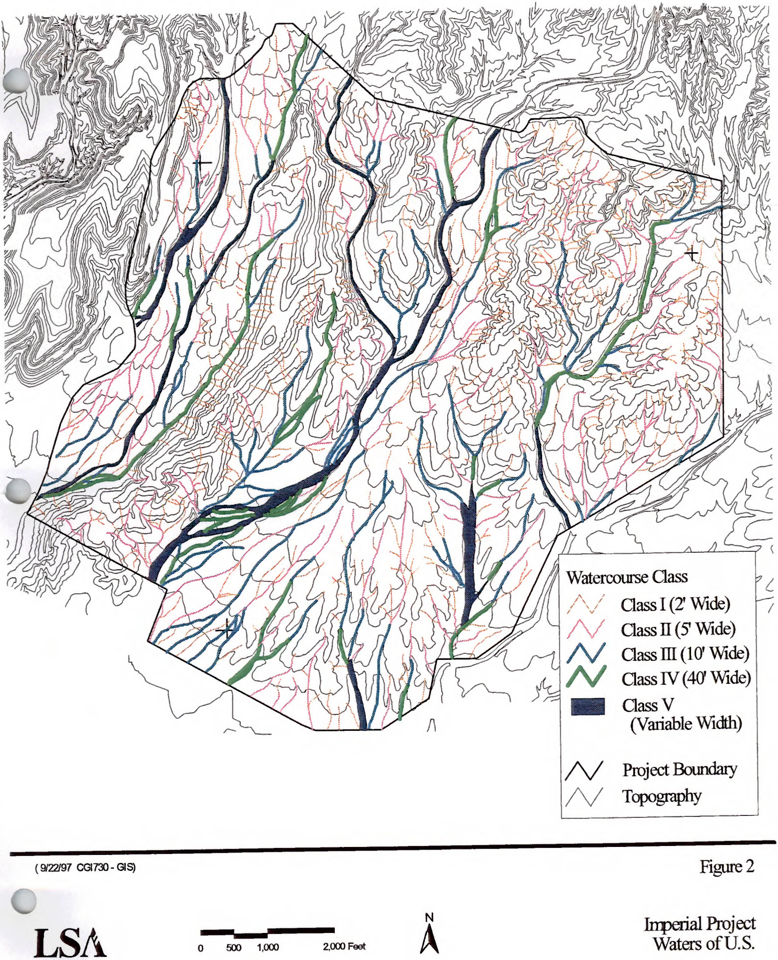
Figure 2 shows the Waters of the U.S. as identified through this jurisdictional determination.

Table A presents a summary of the extent of jurisdictional area (Waters of the U.S.) on the Imperial Project site.

Table A - Jurisdictional Waters of the U.S. by Assigned Drainage Course Class

Drainage Course Class	Length (feet)	Width (feet)	Area (square feet)	Area (acres)
I	156,000	2	312,000	7.16
II	97,000	5	485,000	11.13
III	63,000	10	630,000	14.46
IV	30,000	40	1,200,000	27.55
V	N/A	N/A	2,360,000	54.18
Total	**---**	**---**	**4,987,000**	**114.49**

This page intentionally left blank
for reproduction purposes.



(9/22/97 CGI730 - GIS)

Figure 2

LSA

Imperial Project
Waters of U.S.

This page intentionally left blank
for reproduction purposes.

REFERENCES

Environmental Laboratory. 1987. *Corps of Engineers Wetlands Delineation Manual,* Technical Report Y-97-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Environmental Management Associates (EMA). March 1996. *Imperial Project Waters Study,* EMA Report #0959-04. Unpublished report prepared for Chemgold, Inc.

Hickman, J.C., ed. 1993. *The Jepson Manual: Higher Plants of California.* University of California Press, Berkeley and Los Angeles, CA. 1400 pp.

LSA Associates, Inc. May 23, 1997. *Jurisdictional Determination: Imperial Project Sit (Draft).* Unpublished report prepared for Glamis Imperial Corporation.

Munz, P.A. 1974. *A Flora of Southern California.* University of California Press, Berkeley, CA. 1086 pp.

Reed, P.B. Jr. 1988. *National List of Plant Species that Occur in Wetlands: California (Region 0).* U.S. Fish and Wildlife Service Biol. Rep 88(26.10). 135 pp.

This page intentionally left blank
for reproduction purposes.

APPENDIX E-1 **HYDROLOGY BASELINE REPORT FOR THE IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA (FEBRUARY 1996)**

HYDROLOGY BASELINE REPORT
FOR THE
IMPERIAL PROJECT

IMPERIAL COUNTY, CALIFORNIA

Prepared for:

Chemgold, Inc.
1891 Rail Avenue
Yuma, Arizona 85365

Prepared by:

WESTEC Project 95145
Report 1451

February 1996

TABLE OF CONTENTS

LIST OF TABLES, FIGURES, AND APPENDICES

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 BACKGROUND

Chemgold, Inc. (CHEMGOLD) proposes to develop a precious metals mining operation, the Imperial Project, in Imperial County, California. The proposed mine and process area will be located within the Colorado Desert portion of the Basin and Range physiographic province along the southwestern flank of the Chocolate Mountains in southeast California (Figure 1-1). Project development will include excavation of two open pits, the East and the West Pit. A third, smaller open pit, the Singer Pit, may be located between the East and West Pits. A waste rock stockpile, a heap leach pad, solution collection ponds, solution processing facilities, and other ancillary facilities will be constructed southwest of the open pits as shown in Figure 1-2. The estimated annual project water requirement is approximately 1,170 acre-feet of groundwater. This equates to an average of 725 gallons per minute (gpm) for an operational life of up to 20 years. Peak demand is estimated to be about 1,000 gpm for short periods of time.

CHEMGOLD retained WESTEC, Inc. (WESTEC) to assess the local hydrogeological characteristics including delineating the groundwater flow conditions and water chemistry in the mine project area. The study consisted of review of the existing and published information, compilation of project related hydrogeologic information, well design and construction, calculations of well yields, and evaluation of long-term water pumping on surrounding groundwater resources.

This report characterizes the hydrogeology of the project area. This area includes the mine site and processing facilities located southwest of Indian Pass on the pediment slopes of the Chocolate Mountains, and the alluvial basin area located southwest of the Chocolate Mountains and northwest of the Cargo Muchacho Mountains. The primary purpose of the study was to evaluate the existing hydrogeologic conditions of the mine project area. The issues addressed during this study included:

- Evaluation of existing groundwater flow conditions and recommend placement of groundwater quality monitoring wells.
- Evaluation of surrounding groundwater resources to supply estimated mine project water requirements, and recommendation of placement of groundwater supply wells.
- Estimation of pit water inflow encountered during mining operations.

1.2 MINING HISTORY

The Imperial Project is located on the eastern border of the Imperial Valley on the southern flank of the Chocolate Mountains in southeastern California. The first gold mining in the region is attributed to early Spanish communities in the Cargo Muchacho Mountains in the late 1700's. After the Mexican War in 1848 and with the advent of the California Gold Rush in 1849, mining interest in the region increased, coming to a peak between 1870 and 1930. Production from nearby mines at Picacho, Tumco, and American Girl peaked in the early 1900's, producing a cumulative total of approximately 500,000 ounces of gold. Scattered, small-scale dry wash placer operations were attempted throughout the region and many small tailings piles from these operations are still visible. Advances in heap leaching technology in the 1970's and an increase in gold prices led to exploration and subsequent development of open pits at the Picacho mine in 1979, and the Mesquite and American Girl mines in 1980 (Environmental Management Associates (EMA), 1996).

Little recorded mining history exists for the project area itself. Near the north-central project boundary, bedrock exposed in several of the dry washes was first prospected by Dick and Alice Singer. Between 1982 and 1985, Gold Fields Mining Corporation conducted a regional geophysical exploration program consisting of aeromagnetic, gravity, and resistivity surveys and stream wash geochemical studies. Gravity anomalies, low-grade mineralization in exposed bedrock, and a limited drilling program led to the discovery of minor mineralization on the margins of the current Imperial Project (EMA, 1996).

In 1987, Glamis Gold Exploration, Inc. (GGX) acquired the property and began exploration drilling through a joint venture agreement with a third party. In 1994, GGX became the sole owner and operator of the property and initiated an accelerated development drilling and pre-feasibility program. This program ultimately culminated in the delineation of three ore bodies designated by the proposed East, Singer, and West Pits. Continued exploration drilling between the proposed open pits may ultimately discover additional mineral reserves (EMA, 1996).

2.0 GEOLOGY

2.1 REGIONAL GEOLOGIC SETTING

The Imperial Project ore deposit is located on the southern flank of the Chocolate Mountains, structurally aligned and equidistant between the Picacho and Mesquite deposits. All three of these deposits are situated in the upper plate of the late Mesozoic Chocolate Mountains thrust (Liebler, 1988; Willis, 1988). The Chocolate Mountains thrust is a member of the Vincent-Orocopia-Chocolate Mountains thrust system which can be traced across southern California and southwestern Arizona (Willis, 1988). All of these thrusts have transported gneissic and intrusive rocks over greenschist facies Pelona and Orocopia schists. Movement of the upper plate of the Chocolate Mountains thrust is believed to be at least 48 kilometers (30 miles) northeastward, occurring during latest Mesozoic. Upper plate rocks consist of gneisses and multiple episodes of plutonic intrusion. These rocks were subjected to several phases of amphibolite facies regional metamorphism (Willis, 1988).

The areal geology consists of Jurassic age upper plate metamorphic rocks, overlain by Tertiary andesite-basalt flows, fanglomerates, and Quaternary alluvium. A thin veneer of flood basalt caps the gravel and alluvium, forming distinct ridges and pediment landforms (Figure 2-1). The project area is topographically situated between 700 and 900 feet above mean sea level (amsl), on nearly flat terrain. The region is characterized by gravel pediments cut by south trending ephemeral washes.

2.2 SITE GEOLOGY

2.2.1 Lithology

The generalized stratigraphic sequence consists of Jurassic gneisses and schists overlain by Tertiary and Quaternary gravels. The Imperial Project stratigraphic section has been cut by a low angle thrust sheet, and in general the mineralization parallels the thrust sheet. The footwall or the lowermost unit that will be exposed during mining activities is a Jurassic undifferentiated metamorphic which form the footwall to the orebody (Figure 2-2).

Generally above the undifferentiated gneisses which has sericitic schist zones that appear to be structurally and/or hydrothermally localized. Biotite gneiss varies from a white quartzofeldspathic rock to a dark gray hornblende-biotite gneiss. Often the biotite gneiss has a shatter breccia texture that is variably cemented by iron oxides, clays and, less commonly, quartz or carbonate. The sericitic schist is a white, red to tan iron oxide stained rock composed predominantly of sericite with minor quartz. Due to the oxidized state exhibited throughout the deposit, no fresh pyrite or sulfide mineralization has been detected in core samples or drill hole cuttings.

Tertiary conglomerate and Quaternary gravels overlie the Jurassic metamorphics. The conglomerate is typically a moderately well indurated, clay, carbonate and iron oxide cemented material with coarse subangular gneissic fragments in a moderate to coarse grained sand matrix with considerable mica component. Conglomerates and alluvium cover 95 percent of the project area and range in thickness from 10 to 1,000 feet.

2.2.2 Structure

Dominant regional structural features include the Chocolate Mountains thrust fault, which placed basal gneissic rocks over the younger Orocopia Schist, and the San Andreas fault system. The Chocolate Mountain thrust is part of the Vincent-Orocopia-Chocolate Mountain thrust system which can be traced through southeastern California and southwestern Arizona. The upper plate rocks, consisting of amphibolite grade gneisses and granitic gneisses, have been thrust at least 30 miles northeastward over the greenschist facies Pelona and Orocopia schists. These rocks form a northwest-trending antiform structure within the Chocolate Mountains. Regional structural events have created detachment fault features at the Picacho and American Girl Mines, and intricate strike-slip fault systems at the Mesquite Mine.

The dominant structural feature in the project area is a west-northwest trending thrust sheet that moved Jurassic gneisses and schists over metamorphic and sedimentary rock units. The thrust sheet appears as a network of curved faults (flower faults) which dip approximately 30 degrees to the south. High angle, east-west striking normal faults (step faults) drop the stratigraphy to the south. High angle, north to northeast trending faults bound the mineralized zones, forming the east and west economic limits. The full extent of these north-trending faults is not yet well understood.

3.0 HYDROLOGY

3.1 REGIONAL SURFACE WATER

The Imperial Project is located within the Salton Sea Drainage Basin, a closed hydrologic basin in which all surface flows drain toward the Salton Sea, a saline water body which has no outlet (Figure 3-1). The Algodones Sand Dunes, a natural topographic constraint located approximately 12 miles topographically downgradient from the project to the southwest, prevents any surface water which flows from or through the project area from reaching the Salton Sea (EMA, 1996). Surface flows either evaporate or infiltrate into the wash bottoms or outwash areas east of the Algodones Sand Dunes. There are no free-standing surface waters within the Imperial Project area or in the immediate vicinity.

Precipitation in the project area is limited. Annual rainfall ranges from less than 5 inches per year on the valley floor and alluvial slopes to 5.5 inches in the mountains. Evaporation rates in the project area are estimated to be about 100 inches per year (Environmental Solutions, Inc., 1993). The region's low precipitation rate, coupled with the high evaporation rate and the presence of highly permeable soils in the washes, precludes the formation of perennial or intermittent steams and results in limited recharge of the groundwater reservoir by infiltration of waters of meteoric origin.

In the project area, the valley floor slopes in a southwesterly direction from an elevation of approximately 900 feet near Indian Pass to 600 feet near the intersection of Indian Pass Road and Ogilby Road. The ground surface is relatively even except for occasional northeast-southwest oriented washes. Vegetation in the project area is typically Sonoran. Accumulations of phreatophyte-type vegetation are not evident, indicating that shallow supplies of groundwater are not present (EMA, 1996).

The Colorado River, located approximately 7 miles northeast of the project at its closest point, represents the closest perennial surface water source (EMA, 1996). However, the Colorado River is located on the north-northeastern side of the Chocolate Mountains and does not flow into the Salton Sea Drainage Basin. Perennial water distribution systems within the Salton Sea Drainage Basin which are within the vicinity of the Imperial Project are the All-American Canal and the Coachella Canal. The All-American Canal, located approximately 16 miles to the south, transports water from the Colorado River and is the primary source of water within the Salton Sea Drainage Basin. The Coachella Canal, which is a branch of the All-American Canal, is located approximately 19 miles southwest of the project on the other side of the Algodones Sand Dunes (EMA, 1996).

3.2 SITE SURFACE WATER

Surface water drainages within the Imperial Project consist of a series of subparallel ephemeral washes which are fed by precipitation from infrequent winter storms and summer thunderstorms. No springs or seeps or perennial surface water flows have been identified in the project area.

4.0 HYDROGEOLOGY

4.1 REGIONAL HYDROGEOLOGY

The groundwater reservoir in the Imperial Valley consists of Cenozoic valley-fill deposits underlain by a basement complex of pre-Tertiary rocks. The hydrogeologic unit underlying eastern Imperial Valley is comprised of the Amos, Ogilby and East Mesa hydrogeologic areas (see Figure 4-1). The California Department of Water Resources incorporated both the Amos and Ogilby basins into one combined Amos/Ogilby hdrologic unit (California Department of Public Works, 1964). The East Mesa and Amos/Ogilby basins have a combined overall size of approximately 860 square miles within Imperial County. However, pervious alluvium containing the stored groundwater extends for hundreds of additional square miles southward into Mexico. The much finer-grained sediments in the agricultural portion of Imperial County form the western edge of the basin. Within the Amos/Ogilby and East Mesa hydrologic basins, the thickness of the pervious alluvium varies from east to west, extending from a relatively thin layer of 10 feet or less near the Chocolate Mountain front to a maximum reported depth of approximately 10,000 feet toward the center of the valley to the west (Loeltz, 1975).

The Imperial Project lies within the Ogilby Valley Basin which is a northwesterly trending, elongated area of about 220 square miles which lies in the southeastern portion of Imperial County, California (Department of Water Resources, 1975). It is bounded on the northeast by the Chocolate Mountains, on the north by the divide which separates the Ogilby Basin from the Amos Basin, and on the southwest by the Algodones Sand Dunes. The Cargo Muchacho Mountains and Pilot Knob near the United States-Mexico border are situated on the south end of the basin. The Amos Valley Basin is also northwesterly trending, about 220 square miles and lies in the eastern portion of Imperial Valley. It is bounded on the northeast by the Chocolate Mountains, on the north by the East Salton Sea Basin, to the southwest by the East Mesa hydrologic area and to the southeast by the Ogilby Basin. Although the Ogilby Basin is sometimes considered separate from the adjacent Amos Basin to the north, the California Department of Public Works (1964) has incorporated both the Amos and Ogilby basins as the Amos/Ogilby Hydrologic Unit due to similarities in geologic and hydrologic characteristics.

Data from the USGS (Dutcher et al., 1972 and Loetz, et al, 1975) has suggested that the Amos/Ogilby basins may be hydraulically continuous with the East Mesa subbasin. The East Mesa area, located on the west-southwestern side of the Algodones Sand Dunes, is a large alluvial area which receives a significant amount of recharge from the Colorado River and All-American Canal. The combined extent of the East Mesa hydrolgraphic area and the Amos/Ogilby basins is approximately 860 square miles.

The Amos/Ogilby Basin has not been included as part of the Colorado River Aquifer System based on information published by the USGS (Wilson, 1994). The bedrock associated with the Chocolate Mountains acts as a hydrologic divide preventing movement of water between the Colorado River located on the eastern side of the mountain range and the Amos/Ogilby Basin located on the western slopes of the Chocolate Mountains.

The USGS (Dutcher, 1975) has estimated that the storage capacity of usable and recoverable water in the Amos/Ogilby Basin is approximately 126,000,000 acre-feet, and the capacity of East Mesa subunit is approximately 103,000,000 acre-feet. Estimated annual recharge to the East Mesa, and Amos/Ogilby areas due to all sources is 100,000 acre feet (Environmental Solutions, Inc., 1993).

4.2 REGIONAL WELLS

The availability of surface water from irrigation canals and the low density land use in eastern Imperial County has resulted in very little groundwater usage. Groundwater has been extracted from the Mexican portion of the alluvial aquifer for agricultural purposes, but the portion of this agricultural water which reinfiltrates back to the groundwater is not known (Loeltz, 1975).

Information on the historic use of groundwater in the vicinity of the project area is limited. The earliest documented usage of water was the importation of water for local use in Glamis by the Southern Pacific Railroad. The earliest documented construction of a well in the eastern Imperial Valley was the Gold Rock Ranch well in 1935, to a total depth of 521 feet, to provide water for domestic use by local residents. The Gold Rock Ranch well, located approximately 4.5 miles southwest of the proposed Imperial Project well field, is the closest water supply well to the project site. The Gold Rock Ranch well is reported to have been pumped at a continuous rate of 150 gallons per minute for two years to provide water for the Glamis-Ogilby Road construction (Fox, 1984).

In 1937, the Vista Mine Well was constructed to a total depth of 690 feet. The well, which was reported to have a yield of 800 gallons per minute, provided water for mining operations in the area at that time. In 1984, Wells GF1, GF2 and GF3A were completed in close proximity to the original Vista Mine Well. During a continuous 120-hour pump test, Well GF1 discharge was measured at 2000 gpm with a drawdown of 40 feet below the static water level (Fox, 1984). Other wells within the vicinity of the Imperial Project are the production wells at the Mesquite Mine and American Girl Mine, as shown in Figure 4-2. Both of these wells were completed in the Amos/Ogilby Basin alluvium.

More recent use of groundwater in eastern Imperial Valley occurred in 1972 when the Glamis Well was constructed to a total depth of 681 feet. This well, reported to have a yield of 300 gallons per minute with 73 feet of drawdown, was constructed for domestic use. Two additional deep wells were constructed on the western side of southern Imperial Valley. The United States Bureau of Reclamation constructed a well in the southwest part of the basin to evaluate the feasibility of constructing a desalinization disposal facility. The other well, which was to supply groundwater for the Mining Management Company, was constructed in 1980 to a total depth of 735 feet. Due to a partially collapsed well casing, this well has never been fully developed (Fox, 1984). A summary of information on groundwater wells in the southern part of the Imperial Valley basin is presented in Table 4.1.

Current estimated groundwater pumping from the wells in the Amos/Ogilby basin is approximately 1700 acre-feet per year. This includes an annual withdrawal of approximately 1500 acre-feet per year from the Mesquite Mine, approximately 6 acre-feet per year from Gold Rock Ranch, and approximately 200 acre-feet per year from the American Girl Mine (Environmental Solutions, 1993; P.M. DeDyker & Associates, 1994) . This estimate does not include the Glamis or the Boardman wells.

TABLE 4.1
IMPERIAL VALLEY GROUNDWATER WELLS

WELL IDENTIFICATION	PURPOSE	RATED YIELD (gpm)	TOTAL DEPTH (ft)	PERFORATED INTERVAL (ft)	SEALED DEPTH (ft)	DATE COMPLETED	APPROXIMATE WATER LEVEL (ft)	
							DEPTH	ELEVATION
WT - 2	Production/ Monitoring	28	442	154 - 404	n/a	10/82	185	550
SM - 63	Production	10	477	n/a	n/a	n/a	185	575
SM - 241	Production	10	520	n/a	n/a	n/a	200	560
Singar Wall	Production	15	470	n/a	n/a	n/a	220	575
GW - 1	Monitoring	<15	430	317 - 416	0 - 291	10/85	313	277
GW - 2	Monitoring	<10	310	207 - 305	0 - 190	10/85	270	360
GW - 3	Monitoring	1 - 2	310	196 - 296	0 - 193	10/85	213	437
GW - 4	Monitoring	2	320	209 - 309	0 - 190	10/86	223	502
GW - 5	Monitoring	2	359	259 - 359	0 - 250	10/88	270	n/a
GW - 6	Monitoring	1 - 2	338	238 - 338	0 - 222	01/90	250	n/a
MCR - 80	Production*	<26	1,017	402 - 1,002	0 - 50	03/83	197	523
GF - 1	Production	3,000 - 6,000	822	506 - 810	0 - 20	12/83	474	79
GF - 2	Production	2,300 +	908	658 - 885	0 - 50	03/85	462	78
GF - 3A	Production	2,250+	940	690 - 930	0 - 50	03/86	469	77
MBH - 1	Observation	n/a	600	510 - 590	0 - 300	11/84	467	81
MBH - 2	Observation	n/a	640	510 - 630	0 - 400	11/84	470	80
MBH - 3	Observation	n/a	683	510 - 680	0 - 400	11/84	458	79
Boardman Wall	Production	n/a	735	n/a	n/a	1980	309	95
Glamis Wall	Production	300	520	n/a	n/a	1972	235	100
Gold Rock Ranch Wall	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	8/88	280	119

Source: Hydrologic Assessmant Report Masquita Ragional Landfill

Production* = Intandad for Larga Scale Production, but Insufficient Yield

n/a = Not Availabla

4.3 SITE HYDROGEOLOGY

Groundwater occurs within three aquifers underlying the project area, a confined alluvial aquifer, an unconfined alluvial aquifer, and a bedrock aquifer. The alluvial aquifers consist of consolidated and unconsolidated sands and gravels, while the bedrock aquifer is comprised of metamorphic rocks. Infiltration and water movement in the alluvial sediments is rapid and, consequently, they are considered a better aquifer source than the bedrock aquifer.

Groundwater flow within the project area is primarily from the higher elevations of the Chocolate Mountains toward the southwest to the alluvial basin in the valley. The general groundwater gradient is northeast to southwest, which corresponds to the low relief pediment surface extending in a southwestward direction from the foot of the Chocolate Mountains (western side) toward the alluvial basin (Loeltz, 1975). Water table contours generally parallel the range front. Groundwater movement in the alluvial deposits in the valley occurs in a south-southwest direction.

The alluvial and bedrock aquifers were characterized during the site hydrogeological investigation by installing a combination of piezometer, monitoring wells, and a test production well. Collected data was utilized to determine static groundwater elevations, to evaluate the water chemistry, and to estimate the in situ aquifer hydraulic properties associated with each aquifer system. The production test well was installed 4.5 miles southwest of the proposed mine processing facilities to define aquifer hydrologic parameters and to evaluate the groundwater supply to meet anticipated project water requirements. Figure 4-3 shows the locations of the piezometers, monitoring well, and production test well at the Imperial Project site. The construction and installation of these wells are described in Section 5.0.

As stated above, three different aquifers occur in the project site; a unconfined alluvial aquifer, a confined alluvial aquifer and a bedrock aquifer. An unconfined aquifer has a free water table, so that the water in the aquifer is not under pressure beneath impermeable beds. A confined aquifer is bound above and below by impermeable beds, therefore the water in the aquifer is under pressure greater than atmospheric.

Figure 4-3 shows static groundwater elevations ranging from a high of 360 feet at MW-1, just northeast of the mine site, to a lower elevation near well H-3 of 70.5 feet, and a higher elevation near well H-5 of 85 feet msl. WESTEC believes that this difference in static water levels is due to the wells being completed in the different aquifers.

The wells near the mine site, H-1, H-3, ER-2, WR-2, WR-31,and MW-1, are all completed; an unconfined alluvial aquifer and mine site wells EC-5, WC-5, and WR-1 have been completed in the bedrock aquifer. The wells installed approximately 4 miles southeast of the mine site, wells PW-1, H-4, H-5, and H-6, are completed in confined aquifers which are not hydrologically connected to the aquifers at the mine site. Figure 4-4 is a cross section through the project site showing well and piezometer locations with the screened intervals of each well and static water level elevations. The screened intervals in wells H-4, H-5, and H-6 are in deeper portions of the stratigraphic section than the screened intervals of the other wells. The geologic logs of well H-4 and H-6 indicate a confining layer of silt and clay in the alluvium above the screened intervals indicating the wells are completed in a confined alluvial aquifer. Well H-5 was completed in the bedrock, and it is likely that the bedrock above the screened section is also acting as a confining layer.

The groundwater flow direction in the unconfined alluvial aquifer near the mine site is toward the southwest, at a gradient of 0.02. The flow direction in the confined alluvial aquifer is presumed to be toward the southwest as well, although an additional well, completed in the lower aquifer, would be needed to confirm this.

4.3.1 Aquifer Testing

Three different methods of aquifer testing were performed at the project site; falling head tests, slug tests, and a constant rate pumping test. Each of these tests were used to evaluate the hydrogeologic characteristics of the geologic materials underlying the site.

Falling head and slug tests were performed in the piezometer wells to determine in situ aquifer hydraulic properties. Both tests were performed in the piezometers located in the bedrock. Falling head tests could not be performed in the alluvial piezometers because the increased permeability of the alluvial materials would not allow a sufficient column of water be maintained in the well during the tests. Each falling head test involved filling the piezometer with water to the top of the casing and recording the water level drop over timed intervals.

Each slug test involved lowering a polyvinyl chloride (PVC) slug of known volume into a well and submerging it below the static water level, causing an instantaneous change in the water level. The water level in the well was measured prior to the time that the slug was lowered. Water levels in the well were measured at timed intervals as the water column recovered to the original static water level. Water levels were recorded using a pressure transducer, submerged in the piezometric well, with automatic electronic signal recording equipment. The field-measured data from the falling head and slug tests (water level in the well vs. time) and piezometer well geometry (screen, filter pack, well, and casing dimensions) were used to determine hydraulic conductivity values using the Hvorslev technique. Test results, aquifer parameters and well information are presented in the following sections.

A constant rate pump and recovery test was performed in the production test well to determine the transmissivity and storage coefficient of the alluvial sediments within the vicinity of the well. The pump and recovery test will be explained in more detail in Section 7.1. Aquifer hydrological parameters determined from the tests were used to evaluate the potential impact to the alluvial aquifer system from groundwater withdrawal during projected mining operations at the Imperial Project.

4.3.2 Alluvial Aquifer

In the project area, the alluvial deposits derived from the Chocolate Mountains provide the greatest source of groundwater. Near the mountain front, these deposits are relatively thin, but thicken rapidly toward the valley floor to the southwest. The alluvial deposits in the project range from 10 feet to over 1,000 feet and thicken toward the Imperial Valley.

Information about the piezometers and monitoring well installed in the alluvial deposits is summarized in Table 4.2. Well MW-1 refers to the monitoring well installed upgradient (to the north) in the area between the proposed East and West pits. The H-series wells listed in the table are piezometers located southwest of the project site in the alluvial valley basin. Piezometer well WR-31 is installed in the alluvial sediments underlying the proposed waste rock dump area, and well ER-2 is a piezometer installed in the alluvium south of the east pit (see Figure 4.3).

TABLE 4.2
ALLUVIAL PIEZOMETER AND MONITORING WELL DATA

HOLE NUMBER	DATE MONITORED	TOTAL DEPTH (feet bgs)	SURVEYED COLLAR ELEVATION (feet amsl)	DEPTH TO WATER (feet bgs)	STATIC WATER ELEVATION (feet amsl)
H - 1	1/03/96	1,000	736	657.2	78.8
H - 3	1/03/96	1,100	765	631.5	70.5
H - 4	1/03/96	1,000	617	544.6	72.4
H - 6	12/95	920	710[1]	631.5	78.5
WR - 2	1/03/96	945	765	694.5	70.5
WR - 31	1/03/96	900	774	682.5	91.5
ER - 2	1/03/96	930	787	682.5	104.5
MW #1	1/03/96	640	840	479.7	360.3

1 = Approximate Collar Elevation
n/a = Not Available

H-4 was the only well in the alluvium from which slug test results were interpretable. H-3 was also tested but the results were ambiguous. Well H-4 was completed in the confined alluvial aquifer. The slug test results for H-4 indicated a hydraulic conductivity of 2.8×10^{-2} cm/sec, which agrees well with a hydraulic conductivity value of 5.6×10^{-3} cm/sec (16 ft/day) obtained from the constant rate pumping and recovery test described in section 7.1.

4.3.3 Bedrock Aquifer

The bedrock in the project area is composed of gneissic and granitic rocks and except for rare occurrences of bedrock outcrop, most of the surface is covered by alluvium. In the bedrock, groundwater may be stored in the network of fractures and joints created by faulting. Although the system of fractures and joints is capable of high transmissivities, their localized occurrence limits the volume of water transmitted to wells. Furthermore, transmission capacities would be high if the fractures were highly interconnected. Because of the relatively small volume of water contained in the fracture system, it is doubtful that well yields exceeding 40 gpm could be sustained for more than a few years.

Table 4.3 summarizes the well data for the four piezometers installed in the bedrock aquifer. Piezometers installed in the proposed East Pit and West Pit are designated as EC-5 and WC-5, respectively. Piezometer H-5 is located approximately 12,000 feet southwest from the proposed mine processing facilities. Piezometer WR-1 is located on the southwest side of the East Pit.

TABLE 4.3
BEDROCK PIEZOMETER WELL DATA

HOLE NUMBER	TOTAL DEPTH (feet bgs)	SURVEYED COLLAR ELEVATION (feet amsl)	SCREENED INTERVAL (feet bgs)	DEPTH TO WATER (feet bgs)	STATIC WATER ELEVATION (feet amsl)
WC - 5	800	818	760 -800	606	211
EC - 5	800	807	760 - 800	720	88
H - 2[1]	1340	685	- - -	- - -	- - -
H - 5	1080	686	1,040 - 1,080	594.5	85.5
WR-1	910	821	open	734	87

[1] Well H-2 plugged.

The static water levels of 88 feet amsl in the East Pit and 211 feet amsl in the West Pit piezometers indicate that groundwater occurs at a much lower elevation in the East Pit. The difference may be the result of the fracture controlled nature of groundwater in the bedrock or due to unknown groundwater barriers created by faulting between the two pits.

The hydraulic conductivities corresponding to the falling head and slug tests conducted in the piezometers located in the East and West pits are shown in Table 4.4. The tests indicated that the bedrock formation has a very low hydraulic conductivity, on the order of 10^{-6} to 10^{-7} cm/sec (10^{-8} to 10^{-9} ft/sec). Falling head tests conducted in EC-5 and WC-5 show hydraulic conductivities of 3.5×10^{-7} to 1.4×10^{-6} cm/sec while the slug tests conducted in the same holes show hydraulic conductivities of 3.8×10^{-7} and 8.4×10^{-7} cm/sec, respectively. The slug test on Well H-5 indicates a hydraulic conductivity of 1.05×10^{-2} cm/sec. Although the well was screened in the bedrock, the geologic log indicates the bedrock is highly fractured in the screened interval. Reported hydraulic conductivity values for igneous and metamorphic rocks which form the site bedrock aquifer unit range from 10^{-2} cm/sec to less than 10^{-11} cm/sec, depending on the degree of fracturing present in the formation (Freeze and Cherry, 1979).

The field test data and hydraulic conductivity calculations for the falling head tests and slug tests are included in Appendix A.

TABLE 4.4
SLUG AND FALLING HEAD TEST DATA FOR BEDROCK PIEZOMETERS

HOLE NUMBER	TEST	HYDRAULIC CONDUCTIVITY		FORMATION
		cm/sec	ft/sec	
EC - 5	Slug	3.8×10^{-7}	1.2×10^{-8}	Bedrock
WC - 5	Slug	8.4×10^{-7}	2.7×10^{-8}	Bedrock
EC - 5	Falling Head	3.5×10^{-7}	1.1×10^{-8}	Bedrock
WC - 5	Falling Head	1.4×10^{-6}	4.6×10^{-8}	Bedrock
H - 5	Slug	1.05×10^{-2}	3.4×10^{-4}	Bedrock

4.3.4 Pit Inflow

Both the East and the West Pits will intersect groundwater during mining operations. It is anticipated mining will encounter groundwater at 100 and 200 feet amsl in the East and West Pits, respectively. An estimate for dewatering quantities was calculated for each pit using the Jacob-Lohman Equation. This equation can be used to provide preliminary estimates of natural groundwater inflow into a pit (Hanna et al., 1994). This equation assumes that the well fully penetrates an ideal confined aquifer that is infinite in areal extent and has uniform transmissivity and storativity. A more detailed description of the method used is included in Appendix B.

Using the current mine pit configuration the equation was used to obtain a estimate of groundwater inflow into each of the pits. The transmissivity and storage values were selected from the slug test data analysis; the drawdown value selected is the static groundwater elevation minus projected total pit depth. The radius of 800 feet was selected by measuring the diameter of the pit at the 200 foot level. The time factor of 100 days was selected to avoid factoring in the increased flow effects due to draining the bedrock aquifer to the base of the pit. Using these parameters, the estimated groundwater inflow contributed from the bedrock aquifer into the East and West pits after 100 days was calculated to be 300 ft^3/day (1.5 gpm) and 150 ft^3/day (0.7 gpm), respectively.

The estimate of the pit inflow rate does not include other factors such as runoff, direct precipitation, or evaporation. These three factors will affect the overall water balance within the pit-groundwater system. The magnitude of the effect of these three factors cannot be included within this simple calculation. However, runoff will be diverted away from the pit. Evaporation is approximately 100 inches per year, and should offset precipitation of approximately 5.5 inches per year and pit groundwater inflow.

TABLE 4.5
PIT INFLOW/OUTFLOW CALCULATIONS

INFLOW(+) or OUTFLOW (-)	EAST PIT (ft^3/yr)	WEST PIT (ft^3/yr)
Precipitation &Groundwater	$+1.0 \times 10^6$	$+9.4 \times 10^5$
Evaporation	-1.7×10^7	-9.4×10^6
Difference	-1.6×10^7	-8.45×10^6

Simple calculations assuming a pit lake area similar to the pit lake area used in the inflow calculations, radius of 800 feet with an evaporation rate of 100 inches/per year, yield a total evaporation of 1.7×10^7 ft^3/year for the East Pit, and 9.4×10^6 ft^3/year for the West pit. Pit inflow due to precipitation of 5.5 inches/yr and inflows of 1.6 gpm and 0.7 gpm for the East and West pits indicate total pit inflows of 1.0×10^6 and 9.4×10^5 ft^3/year for the East and West pits respectively. Each of these pit inflow estimates is approximately 10 percent of the estimated total evaporation for each pit, indicating that the formation of a pit lake is not probable (Table 4.5). Additionally, CHEMGOLD is planning to backfill the West Pit with overburden material from the East Pit mining.

5.0 WELL INSTALLATIONS

Three types of wells have been installed at the project: a monitoring well, a water level piezometer, and a water supply test well. A brief summarization of installation of each type is described below; a more detailed description of the installation is included in Appendix C.

5.1 MONITORING WELL

A monitoring well (MW-1) was drilled and installed by Harris Drilling Company and CHEMGOLD personnel using an air/mud rotary drilling rig. The monitoring well was installed upgradient of the proposed mine pit area and is shown in Figure 4.3.

A diagram of the monitoring well design is included as Figure 5.1. Monitoring well MW-1 was installed to a depth of 640 feet and was constructed with 1½-inch-diameter schedule 80 PVC pipe, with 60 feet of 0.04 slot schedule 80 PVC screen in the water table.

WESTEC recommends that a second monitoring well be installed downgradient of the proposed leach pad. The recommended location is shown on Figure 4.3 as MW-2. Piezometer H-3 was installed downgradient of the proposed waste dump and can also be used as a monitoring well.

5.2 PIEZOMETER WELLS

Eight piezometers were installed in and around the proposed mine project area to evaluate static groundwater elevations, to determine geologic formations, and to estimate in situ aquifer hydraulic properties. The locations of the eight piezometers are shown in Figure 4.3. Each of the piezometers was installed in a reverse circulation exploration borehole. The boreholes were drilled with a 5¾-inch-diameter hammer bit to the total depth. The holes were backfilled to the desired screen depth with cuttings. After backfilling, 1½-inch schedule 80 PVC pipe with 20 feet of perforated casing was installed at the desired depth, and 25 to 80 feet of cuttings were placed around the perforated casing. The gravel pack was capped with approximately 5 feet of coarse bentonite. Well data for the piezometers installed in the alluvial and bedrock aquifers is summarized in Table 4.2 and Table 4.3. Geologic logs for the piezometer wells are included in Appendix D.

5.3 WATER SUPPLY TEST WELL

A production test well, PW-1, was installed at the Imperial Project site to test aquifer hydrologic parameters and to evaluate the groundwater supply to meet anticipated project water requirements. Well PW-1 is in the SW 1/4, SE ½, Section 15, Township 14 South, Range 20 East San Bernardino Baseline and Meridian and is shown in Figure 4-3. The well is located approximately 4.5 miles southwest of the proposed process and mine facilities.

PW-1 was drilled using a mud rotary drilling system equipped with a tricone bit. Forty feet of 18-inch conductor casing was installed and a 17.5-inch borehole was drilled from 40 feet to a total depth of 960 feet. The well was constructed of 12-inch schedule 40 low carbon steel, with 200 feet of 0.090 mill slot well screen placed at the base of the well. The well screen extended from 918 feet below ground surface (bgs) to 718 feet bgs. A well cap was welded to the top of the casing to prevent tampering with the test well. A construction diagram for well PW-1 is shown in Figure 5-2. These well features conform with California Well Standards. A geologic and well construction log is included in Appendix D.

6.0 MINE SITE WATER SUPPLY

6.1 PUMP TEST

Production test well PW-1 was installed in the alluvial basin confined aquifer approximately 4.5 miles from the proposed Imperial mine and process facilities. The purpose of the well was to test hydrogeologic parameters and evaluate groundwater supply for the Imperial Project.

A 48-hour constant rate pumping and recovery test was performed on the production test well, described in Section 5.3, at a sustained pumping rate of 500 gallons per minute (gpm). Groundwater was derived from about 200 feet of saturated alluvial deposits at a depth of between 718 and 918 feet (screened interval) in well PW-1 during the test. Piezometer H-4, located approximately 91 feet west of the test well, was used as an observation well to measure the behavior of the hydraulic head in the aquifer during the pump test. Depth-to-water measurements in the production test well and the piezometer were taken throughout the pumping test. After conclusion of the pumping test, water level recovery measurements were made in the well and the piezometer.

Total drawdown of water level in the production test well at the end of the 48-hour pumping test was about 130 feet. Most of the drawdown during the pump test occurred during the first five minutes, after which the rate of decline of the water level was significantly less. A portion of this drawdown was attributable to well losses at the intake zone.

Field measured water-level data from the aquifer stress test was analyzed to determine aquifer hydraulic properties. Aquifer hydraulic characteristics were obtained by analysis and evaluation of both the pump test and recovery test data using two computational methods, the Theis and Jacob methods (Kruseman, 1991). The drawdown curve of water levels measured in the observation piezometer matched reasonably well with a Theis Curve for a confined aquifer showing leakage through one of the confining layers. Field measurement data and computations are included in Appendix E.

Transmissivity values of the alluvial deposits in the vicinity of the production test well were calculated to range from about 7,200 gallons per day per foot (gpd/ft) (965 ft^2/day) to 42,508 gpd/ft (5,696 ft^2/day). With a saturated thickness of 200 feet (well screen length), an average hydraulic conductivity of the alluvial aquifer was calculated to be about 116 gpd/ft^2 (16 ft/day). Water-level observations made in piezometer H-4 were used to estimate the storage coefficient of the alluvial deposits. Hydraulic storage coefficient values ranging from 0.001 to 0.02 were calculated from the pump test and recovery test data. Published storage values for confined aquifers are 0.005 or less, with storage values for unconfined aquifers ranging from 0.3 to 0.01 (Freeze and Cherry, 1979).

6.2 EVALUATION OF GROUNDWATER USAGE

The proposed Imperial Mine project would extract groundwater from water supply wells located southwest of the mine in the Amos/Ogilby alluvial basin. Potential effects of proposed water supply withdrawals on the conditions in the alluvial basin and in surrounding vicinity wells were evaluated using conventional well hydraulic numerical analyses (Kruseman, 1991). Projected drawdown of groundwater levels in the vicinity of a pumping well as a function of time was calculated. For this analysis, it was assumed that a water supply well would be constructed in the vicinity of the test production well, PW-1. This well would be capable of supplying the anticipated average water demand of 725 gallons per minute (gpm) or approximately 1,170 acre-feet per year for 20 years (the maximum anticipated life of the operation).

The hydraulic conductivity of the alluvium in the area of potential influence was assumed to be similar to that determined from the pumping and recovery test conducted in the production test well. Drawdown of groundwater levels was calculated using a saturated aquifer thickness of 300 feet, 400 feet, 500 feet, and 600 feet, respectively, as drilling indicated that the aquifer was at least 300-feet thick. An average hydraulic conductivity value of 16 ft/day, obtained from the pump and recovery test calculations, was used. A storage coefficient value of 0.02 and 0.002 was used in the groundwater level drawdown calculations.

Distributions of projected drawdown of alluvial groundwater levels after 20 years of continuous pumping are shown Table 6.1 for a saturated aquifer thickness of 300 feet, 400 feet, 500, and 600 feet respectively, and storage coefficient values of 0.02 and 0.002. Groundwater drawdowns of 1.6 to 1.8 feet are projected to occur at distances of approximately 50,000 feet from the well with a storage coefficient of 0.02. With a storage coefficient value of 0.002 projected drawdowns at 50,000 feet from the well increase to 4.0 to 6.4 feet.

TABLE 6.1
DRAWDOWN AFTER 20 YEARS

Pumping Rate (gpm)	Aquifer Thickness (ft)	Transmissivity (ft^2/day)	Storage Coefficient	Distance to Drawdown Contour in feet			
				1,000	10,000	20,000	50,000
725	300	4,800	0.02	19.2	8.6	5.4	1.8
725	400	6,400	0.02	14.9	6.9	4.5	1.7
725	500	8,000	0.02	12.2	5.8	4.0	1.6
725	600	9,600	0.02	10.4	5.1	3.4	1.5
725	300	4,800	0.002	24.4	13.8	10.6	6.4
725	400	6,400	0.002	18.8	10.8	8.5	5.3
725	500	8,000	0.002	15.4	9.0	7.1	4.6
725	600	9,600	0.002	13.0	7.7	6.1	4.0

As groundwater extraction continued for the proposed mine project life, the localized cone of depression that would form around the pumping well would potentially affect the water levels at several other wells within the vicinity. A comparison of the projected drawdown estimates in the surrounding wells and the total water column in each, based on available information, is shown in Table 6.2 and Figure 6-1. Drawdown estimates in the Gold Rock Ranch well, the Mesquite Mine GF-3A well, and the American Girl Mine 26-2 well after 20 years have been calculated. Estimated drawdowns have been calculated for an aquifer 500 feet thick, and with a storativity value of 0.02, assuming a project water demand of 725 gpm. These estimated drawdown projections assume the following: (1) wells are located within the same aquifer basin as the proposed mine project water supply well; (2) they do not account for aquifer recharge, 100,000 acre feet/year for the combined basins; and (3) the aquifer may be much thicker than assumed.

TABLE 6.2
DRAWDOWN IN GOLD ROCK RANCH, MESQUITE MINE, AND AMERICAN GIRL MINE WELLS

PUMPING RATE (gpm)	LENGTH OF TIME PUMPING (years)	TRANSMISSIVITY (sq. ft./day)	GOLD ROCK RANCH WELL (125 ft. water column) 4 miles from well Feet of Drawdown	MESQUITE MINE WELL (470 ft. water column) 9 miles from well Feet of Drawdown	AMERICAN GIRL MINE WELL (26-2) (110 ft. water column) 9 miles from well Feet of Drawdown
725	20	8,000	3.7	1.8	1.8

The Gold Rock Ranch well, located approximately 4.5 miles southwest of the proposed mine project water supply well, may have the most potential drawdown. A drawdown of 3.7 feet is projected in the Gold Rock Ranch well after 20 years of pumping. The estimated drawdown at the Gold Rock Ranch well represents 3 percent of the 125-foot depth of water in the well. At the Mesquite Mine well, the projected maximum drawdown of 1.8 feet represents about 0.5 percent of the 470-foot depth of water in that well, and the 1.8 feet of drawdown at the American Girl Mine well would represent about 1.5 percent of the 110 feet of water available at that location.

Based on the comparison of the water to be extracted at the Imperial Project in relationship to the estimated usable and recoverable stored water and estimated recharge, the project should not significantly impact the alluvial groundwater resources of the East Mesa and Amos/Ogilby Basins. CHEMGOLD's estimated extraction rate of 1,170 acre feet/year represents about 1 percent of the annual recharge of 100,000 acre feet/year estimated for the combined East Mesa and Amos/Ogilby Basins, or 2 percent of the 50,000 acre feet/year of recharge estimated for the Amos/Ogilby Basin. Over a 20-year projected project life, CHEMGOLD will use an estimated 23,400 acre feet of water. This would represent approximately 0.01 percent of the estimated 229,000,000 acre feet of useable and recoverable water in the East Mesa and Amos/Ogilby Basins.

7.0 WATER CHEMISTRY

7.1 REGIONAL WATER CHEMISTRY

The regional groundwater chemistry in the Amos/Ogilby Basin is characterized by the geographic and geologic controls that govern the occurrence, movement, and chemical quality of the groundwater. Variations in the chemical quality of the water contained in the rocks are due to differences in location with respect to the water table and recharge areas, to compositional differences in sources of recharge, and to high evaporation rates associated with the hot arid climate.

Groundwater is generally saline in the portion of the Amos/Ogilby Basin underlain by alluvial materials. The salinity has resulted from storm water infiltration leaching soluble evaporates from sedimentary rocks located above the water table (Loeltz, 1975).

An extensive hydrologic characterization of the Amos/Ogilby Basin has never been completed, but a sufficient number of water samples have been collected to permit a cursory evaluation of groundwater quality. Some generalizations can be made in regards to sampling location and depth based on the chemical analyses of the water samples. Water at higher altitudes contains fewer metals and has a lower conductivity than water at lower altitudes. Groundwater extracted from deep wells tends to be more mineralized than shallow groundwater (Loeltz, 1975; Dutcher, 1972).

Generally in areas where leakage from the canals is a significant recharge source, the chemical quality of the water resembles that of Colorado River water, which is characterized by sulfate as the predominant anion. Where leakage has not been substantial, sodium or bicarbonate is generally the principal anion. Water quality analyses for wells in the vicinity of the mine project are shown in Table 7.1. Chemical analyses of water samples extracted from the Singer Well, a shallow well completed in bedrock, indicate that the water generally contains calcium and sodium sulfates. The other wells listed in Table 7.1 are all located in alluvial materials. Analyses of water samples collected from the alluvial wells indicate the groundwater is characteristically higher in sodium chloride.

Chemical quality data for the alluvium and bedrock aquifer shows the water quality to be characterized by high values of salinity, total dissolved solids (TDS), chloride, fluoride, sulfate, and certain metals. Total dissolved solids values in the wells range from 1,100 mg/l in the Vista and

TABLE 7.1
REGIONAL WATER CHEMISTRY ANALYSIS

ELEMENT (mg/l)	Current Water Quality Standards	Glamis Well 4/25/72	Glamis Well 2/04/84	Boardman Well 2/04/84	Vista Well 1/09/62	Vista Well 6/06/62	Vista Well 12/09/63	Vista Well 8/30/82	Gold Rock 1/19/49	Gold Rock 5/20/64	Gold Rock 9/29/68	Gold Rock 12/09/71	Singer Well 10/30/74	Singer Well 2/04/84
Alkalinity (Bicarb)					85	88	94	87	104	67	84			
Arsenic	0.05(1)							0.015					0.002	0.005
Barium	1.0(1)							<0.01						
Cadmium	0.005(1)							<0.01						
Calcium		79			52	57	53	48	149	116	24	50	495	
Chloride	250(2)		1371	1333	430	414	430	445	667	897	348		6107	286
Chromium	0.05(1)		<0.01	<0.01				0.07						<0.01
Cobalt								<0.02						
Conductance (umho/cm)			5490	5560										2250
Copper	1.0(2)							0.06					0.05	
Cyanide (WAD)	0.2(1)							<0.01						
Fluoride			2.81	2.80	3.2	3.2	3.4	1.74	n/a	1.8	1.9*		1.0	1.6
Iron	0.3(2)		1.1	0.37				5.0					7.0	0.82
Lead								<0.01					0.09	
Magnesium					2.6	5.1	3.4	4.4	21	12	5.8		162	
Manganese	0.05(2)		0.12	0.05				0.06					1.0	0.06
Mercury	0.002(1)							<0.001						
Nickel	0.1(1)							<0.01						
Nitrate Nitrogen	10(1)				3.1		3.4	1.8					26	
pH (pH units)		6.8	7.73	7.75	7.7	7.6	7.6	6.89	n/a	7.7	7.5		7.20	7.85
Potassium		86			n/a	n/a	6.1	6.2				4.3		
Scandium														
Selenium	0.05(1)							<0.001						
Silver	0.1(2)		0.067	0.032				<0.01						0.005
Sodium		1135			n/a	n/a	368	372	n/a	590	n/a	312	3775	
Sulfate	250(2)		168	155	248	250	244	261	242	275	125		2531	415
TDS	500(2)		3046	3080	1170	1140	1185	1145	1510	1950	844		13334	1328
Turbidity								30						
Zinc	5.0(2)							0.64					1.0	

0.05(1)	Current California Primary Maximum Contaminant Levels
0.05(2)	Current California Secondary Maximum Contaminant Levels

TABLE 7.1
REGIONAL WATER CHEMISTRY ANALYSIS

ELEMENT (mg/l)	Current Water Quality Standards	GF - 1 Well 8/30/82	GF - 1 Well 3/21/83	GF - 1 Well 12/05/83	GF - 1 Well 5/02/84	GF - 1 Well 10/25/85	GF - 1 Well 12/12/85	GF - 1 Well 05/21/86	GF - 2 Well 4/19/85	GF - 2 Well 4/21/85	GF - 2 Well 10/25/85	GF - 2 Well 5/21/86	GF - 3A Well 4/21/86	GF - 3A Well 7/16/91
Alkalinity (Bicarb)														
Arsenic	0.05(1)	0.015	0.004	0.005	0.006	0.001	0.014	n/a	0.004	0.004	<0.001	n/a	0.006	<0.001
Barium	1.0(1)													
Cadmium	0.005(1)													
Calcium														
Chloride	250(2)	445	443	399	441	425	436	n/a	403	404	404	n/a	386	410
Chromium	0.05(1)	0.07	<0.01	0.02	<0.01	0.02	<0.01	n/a	0.01	0.01	<0.01	n/a	<0.01	0.01
Cobalt														
Conductance (umho/cm)		1940	2150	1900	2150	1779	1954	1950	1980	1980	1699	1886	1643	1092
Copper	1.0(2)													
Cyanide (WAD)	0.2(1)													
Fluoride		1.74	4.80	4.30	2.50	3.50	2.30	n/a	1.9	2.1	1.6	n/a	1.82	2.5
Iron	0.3(2)	5.00	0.36	0.13	0.01	0.82	0.53	n/a	0.08	0.09	0.09	n/a	0.10	0.17
Lead														
Magnesium														
Manganese	0.05(2)	0.06	0.01	<0.01	0.01	0.01	<0.01	n/a	0.01	<0.01	0.09	n/a	<0.01	3.3
Mercury	0.002(1)													
Nickel	0.1(1)													
Nitrate Nitrogen	10(1)													
pH (pH units)		6.89	7.06	7.28	6.90	7.81	7.81	7.80	8.13	8.01	7.68	7.60	7.94	8.00
Potassium														
Scandium														
Selenium	0.05(1)													
Silver	0.1(2)													
Sodium														
Sulfate	250(2)	261	239	252	274	265	266	n/a	240	237	252	n/a	237	250
TDS	500(2)	1145	1084	1216	1178	1162	1137	1309	1072	1108	1088	1217	1069	2100
Turbidity														
Zinc	5.0(2)													

0.05(1)	Current California Primary Maximum Contaminant Levels
0.05(2)	Current California Secondary Maximum Contaminant Levels

Goldfield wells to greater than 3,000 mg/l in the Glamis and Boardman wells. Suitability of the groundwater as drinking water is poor to marginal. Treatment of the groundwater is generally required prior to potable use. However, despite exceeding drinking water standards, the water quality is suitable for non-potable use such as mining and milling operations.

7.2 SITE WATER CHEMISTRY

Water quality characteristics of groundwater samples collected from the mine site piezometers, the monitoring well, and the test well are shown in Table 7.2. Samples were collected by CHEMGOLD. Sample PW-1 was taken at the end of the 48-hour constant rate pump test conducted in the test well and is probably most representative of the alluvial aquifer quality.

Iron, aluminum and manganese concentrations exceeded California Domestic Secondary Water Quality and Monitoring Standards in a number of the wells sampled. These metal concentrations may be due to the use of drilling fluids during the drilling of the wells. The fluoride concentration in sample PW-1 collected after the 48-hour pumping test was 1.6 mg/l, slightly exceeding the California maximum contaminant concentration of 1.4 mg/l. Other trace element concentrations were below applicable water quality standards.

Stiff and Piper diagrams of groundwater samples collected from the mine site are shown in Figure 7.1 . Included in the diagrams are water quality data for samples collected from the piezometers, the monitoring well, and the production test well. For comparison, the water quality analyses from the Vista well have been included in the diagrams. The Vista well was the only regional well that had a complete suite of analyses required for inclusion in the Stiff and Piper plots. The data indicates that groundwater collected from piezometers EC-5 and H-1 and the production test well, PW-1, was sodium chloride in character. Groundwater samples collected from the other wells had sulfate and carbonate as the major anions, with sodium being the predominant cation. Total dissolved solids levels in the samples ranged from 600 to 1,500 mg/l. Laboratory analytical results are included in Appendix F.

Chemical analyses show increased levels of aluminum, manganese, and iron in the piezometers and monitoring wells. These metal concentrations may be due to the drilling fluids used during the installation of these wells. Despite exceeding some of the secondary drinking water standards, the water quality is suitable for non-potable use such as mining and milling operations.

TABLE 7.2
SITE WATER CHEMISTRY ANALYSIS

ELEMENT (mg/l)	Units	Current Water Quality Standards	EC - 5 8/30/95	WC - 5 8/30/95	MW # 1 8/30/95	WR - 2 8/30/95	94H - 1 Well 11/28/94
Alkalinity (BiCarb)	mg/l		56B	141B	138B	151B	116B
Aluminum	mg/l	0.2(2)	2.4	0.3	0.5	0.4	
Antimony	mg/l	0.006(1)	<0.5	<0.5	<0.5	<0.5	
Arsenic	mg/l	0.05(1)	<0.005	<0.005	<0.005	0.006	
Barium	mg/l	1.0(1)	<0.1	0.1	0.2	<0.1	
Beryllium	mg/l	0.004(1)	<0.1	<0.1	<0.1	<0.1	
Bismuth	mg/l		<0.1	<0.1	<0.1	<0.1	
Cadmium	mg/l	0.005(1)	<0.0004	<0.0002	0.0004	0.0016	
Calcium	mg/l		84	85	83	30	24
Chloride	mg/l	250 (2)	480	88	92	82	210
Chromium	mg/l	0.05(1)	<0.1	<0.1	<0.1	<0.1	
Cobalt	mg/l		<0.1	<0.1	<0.1	<0.1	
Conductance	umhos/cm						
Copper	mg/l	1.0(2)	<0.1	<0.1	<0.1	<0.1	
Cyanide (WAD)	mg/l	0.2(1)	<0.005	<0.005	<0.005	<0.005	
Fluoride	mg/l		0.1	0.2	0.2	0.7	0.62
Gallium	mg/l		<0.1	<0.1	<0.1	<0.1	
Iron	mg/l	0.3(2)	7	0.8	1.4	1.7	
Lanthanum	mg/l		<0.1	<0.1	<0.1	<0.1	
Lead	mg/l			0.002	0.009	0.014	
Lithium	mg/l		<0.1	<0.1	<0.1	<0.1	
Magnesium	mg/l		4.1	34	31	4.8	2.7
Manganese	mg/l	0.05 (2)	0.4	<0.1	<0.1	0.1	
Mercury	mg/l	0.002(1)	<0.0005	<0.0005	<0.0005	<0.0005	
Molybdenum	mg/l		<0.5	<0.5	<0.5	<0.5	
Nickel	mg/l	0.1(1)	<0.1	<0.1	<0.1	<0.1	
Nitrate Nitrogen	mg/l	10(1)	1.2	2.2	0.1	<0.1	<0.1N
pH	ph units	6.8 - 8.5	7.44	7.72	7.99	7.67	7.20
Phosphorous	mg/l		<0.1	<0.1	<0.1	<0.1	
Potassium	mg/l		4.9	5.4	6	8.5	7.4
Scandium	mg/l		<0.1	<0.1	<0.1	<0.1	
Selenium	mg/l	0.05(1)	<0.001	<0.001	<0.001	<0.001	
Silver	mg/l	0.1(2)	<0.0005	<0.0005	<0.0005	<0.0005	
Sodium	mg/l		400	140	130	170	210
Strontium	mg/l		2.9	1.6	1.8	1	
Sulfate	mg/l	250 (2)	340	300	290	140	120
TDS	mg/l	500 (2)	1454	856	799	590	666
Thallium	mg/l	0.002(1)	<1	<1	<1	<1	
Tin	mg/l		<1	<1	<1	<1	
Titanium	mg/l		<1	<0.1	<0.1	<0.1	
Vanadium	mg/l		<0.1	<0.1	<0.1	<0.1	
Zinc	mg/l	5.0(2)	0.6	0.3	0.3	2.8	

0.05(1)	Current California Primary Maximum Contaminant Levels
0.05(2)	Current California Secondary Maximum Contaminant Levels

TABLE 7.2
SITE WATER CHEMISTRY ANALYSIS

ELEMENT (mg/l)	Units	Current Water Quality Standards	WR - 2 11/28/95	WC - 5 11/28/95	MW #1 Well 11/28/95	PW-1 Well 11/19/95
Alkalinity (BiCarb)	mg/l		183B	172B	183B	32B
Aluminum	mg/l	0.2(2)	1.3	1.5	1.7	<0.1
Antimony	mg/l	0.006(1)	<0.5	<0.5	<0.5	<0.002
Arsenic	mg/l	0.05(1)	<0.005	<0.005	0.005	0.009
Barium	mg/l	1.0(1)	<0.1	<0.1	<0.1	<0.1
Beryllium	mg/l	0.004(1)	<0.1	<0.1	<0.1	<0.0002
Bismuth	mg/l		<0.1	<0.1	<0.1	<0.1
Cadmium	mg/l	0.005(1)	0.0002	<0.0002	0.0006	<0.0002
Calcium	mg/l		29	30	38	57
Chloride	mg/l	250 (2)	110	110	110	320
Chromium	mg/l	0.05(1)	<0.1	<0.1	<0.1	<0.1
Cobalt	mg/l		<0.1	<0.1	<0.1	<0.1
Conductance	umhos/cm		n/a	n/a	n/a	n/a
Copper	mg/l	1.0(2)	<0.1	<0.1	<0.1	<0.1
Cyanide (WAD)	mg/l	0.2(1)	<0.005	<0.005	<0.005	<0.005
Fluoride	mg/l		0.6	0.5	0.5	1.6
Gallium	mg/l		<0.1	<0.1	<0.1	<0.1
Iron	mg/l	0.3 (2)	2.7	1.8	3.4	0.4
Lanthanum	mg/l		<0.1	<0.1	<0.1	<0.1
Lead	mg/l		0.009	<0.01	0.015	<0.002
Lithium	mg/l		<0.1	<0.1	<0.1	0.1
Magnesium	mg/l		4	4.8	6	1.5
Manganese	mg/l	0.05 (2)	0.3	<0.1	0.3	<0.1
Mercury	mg/l	0.002(1)	<0.0005	<0.0005	<0.0005	<0.0005
Molybdenum	mg/l		<0.5	<0.5	<0.5	<0.5
Nickel	mg/l	0.1(1)	<0.1	<0.1	<0.1	<0.1
Nitrate Nitrogen	mg/l	10(1)	0.8	1.1	0.6	1.9
pH	ph units	6.8 - 8.5	7.83	7.86	7.6	8.2
Phosphorous	mg/l		0.1	<0.1	0.3	<0.1
Potassium	mg/l		5.7	5.7	6.9	0.1
Scandium	mg/l		<0.1	<0.1	<0.1	<0.1
Selenium	mg/l	0.05(1)	<0.001	<0.001	<0.001	<0.001
Silver	mg/l	0.1(2)	<0.0005	<0.0005	<0.0005	<0.0005
Sodium	mg/l		210	210	200	260
Strontium	mg/l		1.2	0.8	1.2	0.8
Sulfate	mg/l	250 (2)	190	200	200	180
TDS	mg/l	500 (2)	678	690	712	906
Thallium	mg/l	0.002(1)	<1	<1	<1	0.001
Tin	mg/l		<1	<1	<1	<1
Titanium	mg/l		<0.1	<0.1	<0.1	<0.1
Vanadium	mg/l		<0.1	<0.1	<0.1	<0.1
Zinc	mg/l	5.0(2)	0.3	0.2	0.9	<0.1

0.05	Current California Primary Maximum Contaminant Levels
0.05	Current California Secondary Maximum Contaminant Levels

8.0 SUMMARY

This report characterizes the hydrogeology of the Imperial Project area. This area includes the mine site and processing facilities located southwest of Indian Pass and the alluvial basin area located southwest of the Chocolate Mountains and northwest of the Cargo Muchacho Mountains. The primary purpose of the study was to characterize and assess the existing hydrogeologic conditions of the mine project area.

The Imperial Project is located within the Salton Sea Drainage Basin, a closed hydrologic basin in which all surface flows drain toward the Salton Sea, a saline water body which has no outlet. Surface flows either evaporate or infiltrate into the wash bottoms or outwash areas east of the Algodones Sand Dunes. There are no free-standing surface waters within the Imperial Project area or in the immediate vicinity.

Precipitation in the project area is limited. Annual rainfall ranges from less than 5 inches per year on the valley floor and alluvial slopes, to 5.5 inches in the mountains. Evaporation rates in the project area are estimated to be about 100 inches per year. The region's low precipitation rate, coupled with the high evaporation rate and the presence of highly permeable soils in the washes, precludes the formation of perennial or intermittent steams and results in limited recharge of the groundwater reservoir by infiltration of waters of meteoric origin. Surface water drainages within the Imperial Project consist of a series of subparallel ephemeral washes which are fed by precipitation from infrequent winter storms and summer thunderstorms. No springs, seeps or surface water have been identified in the project site area.

The Colorado River, located approximately 7 miles northeast of the project at its closest point, represents the closest perennial water source. However, the Colorado River is located on the other side of the Chocolate Mountains and does not flow into the Salton Sea Drainage Basin. The All-American Canal, located approximately 16 miles to the south, transports water from the Colorado River and is the primary source of water within the Salton Sea Drainage Basin. The Coachella Canal, which is a branch of the All-American Canal, is located approximately 19 miles southwest of the project on the other side of the Algodones Sand Dunes.

The USGS (Dutcher, 1975) has estimated that the storage capacity of usable and recoverable water in the Amos/Ogilby Basin is approximately 126,000,000 acre-feet, and the capacity of East Mesa subunit is approximately 103,000,000 acre-feet. Estimated annual recharge to the East Mesa, and Amos/Ogilby areas due to all sources is 100,000 acre feet (Environmental Solutions, Inc., 1993).

Groundwater occurs within three aquifers underlying the project area; a confined alluvial aquifer, an unconfined alluvial aquifer, and a bedrock aquifer. The alluvial aquifers consist of consolidated and unconsolidated sands and gravels, while the bedrock aquifer is comprised of metamorphic rocks. The alluvial aquifer consists of consolidated and unconsolidated sands and gravels, while the bedrock aquifer consists of metamorphic rocks. Groundwater flow within the project area is primarily from the higher elevations of the Chocolate Mountains toward the alluvial basin of the valley floor. The general groundwater gradient is northeast to southwest. Water table contours parallel the range front. Groundwater movement in the alluvial deposits within the project area occurs in a south-southwest direction.

The alluvial and bedrock aquifers were characterized during the site hydrogeological investigation. A combination of piezometer and monitoring wells were installed to determine static groundwater elevations, to evaluate the water chemistry, and to estimate in situ aquifer hydraulic properties, associated with each aquifer system. A production test well was installed to define aquifer hydrologic parameters and to evaluate the potential of groundwater to meet anticipated project water requirements. The slug test results for H-4 in the confined aquifer indicated a hydraulic conductivity of 2.8×10^{-2} cm/sec. Aquifer tests indicated that the bedrock formation has a very low hydraulic conductivity, on the order of 10^{-6} to 10^{-7} cm/sec (10^{-8} to 10^{-9} ft/sec).

Transmissivity values of the alluvial deposits in the vicinity of the production test well were calculated to range from about 7,200 gallons per day per foot (gpd/ft) (965 square feet per day (ft^2/day) to 42,508 gpd/ft (5,696 ft^2/day). With a saturated thickness of 200 feet (well screen length), an average hydraulic conductivity of the alluvial aquifer was calculated to be about 116 gpd/ft^2 (16 ft/day). Water-level observations made in piezometer H-4 were used to estimate the storage coefficient of the alluvial deposits. Hydraulic storage coefficient values ranging from 0.001 to 0.02 were calculated from the pump test and recovery test data.

The proposed Imperial Mine project would extract groundwater from water supply wells located southwest of the mine in the Amos/Ogilby alluvial basin. Potential effects of proposed water supply withdrawals on the conditions in the alluvial basin and in surrounding vicinity wells was evaluated using conventional well hydraulic numerical analyses. Projected drawdown of groundwater levels in the vicinity of a pumping well as a function of time were calculated.

Distributions of projected drawdown of alluvial groundwater levels after 20 years of continuous pumping were calculated for a saturated aquifer thickness of 300 feet, 400 feet, and 500 feet respectively, and a storage coefficient value of 0.02. Groundwater drawdowns of 1.6 to 1.8 feet are projected to occur at distances of approximately 50,000 feet from the well. The Gold Rock Ranch well, located approximately 4.5 miles southwest of the proposed mine project water supply well, may have the most potential drawdown of the regional wells. A drawdown of 3.7 feet is projected in the Gold Rock Ranch well after 20 years of pumping. The estimated drawdown at the Gold Rock Ranch well represents 3 percent of the 125-foot depth of water in the well. At the Mesquite Mine well, the projected maximum drawdown of 1.8 feet represents about 0.5 percent of the 470-foot depth of water in that well, and the 1.8 feet of drawdown at the American Girl Mine well would represent about 1.5 percent of the 110 feet of water available at that location.

The volume of groundwater contained in the alluvial sediments was estimated to determine the impact of continuous groundwater withdrawal from the aquifer during the operation of the Imperial Mine project. The conservative calculations indicated that a substantial amount of groundwater is contained in pore storage within the alluvial deposits, and the projected water requirements for the project should not cause a significant drawdown of groundwater levels in the Amos/Ogilby Basin.

The regional groundwater chemistry in the Amos/Ogilby Basin is characterized by the geographic and geologic controls that govern the occurrence, movement, and chemical quality of the groundwater. Variations in the chemical quality of the water contained in the rocks are due to differences in location with respect to the water table and recharge areas, to compositional differences in sources of recharge, and to high evaporation rates associated with the hot arid climate. In general, water at higher altitudes appears to be less mineralized than water at lower altitudes. Groundwater extracted from deep wells tends to be more mineralized than shallow groundwater. Chemical quality data for the alluvium and bedrock aquifers in the region shows the water quality to be characterized by high values of salinity, TDS, chloride, fluoride, sulfate, and certain metals. Despite exceeding the drinking water standards, the water quality is suitable for non-potable use such as mining and milling operations.

Water quality characteristics of groundwater samples collected from the Imperial Project mine site piezometers show iron and aluminum concentrations exceeded California Domestic Secondary Water Quality and Monitoring standards. Other trace elements and fluoride concentrations were below applicable water quality standards.

9.0 RECOMMENDATIONS

Based on data and results from the hydrogeologic baseline study, WESTEC has the following recommendations:

- Consider installation of an additional monitoring well downgradient of the leach pad to establish baseline water quality conditions

- Install a second water production well within 1,000 feet of site PW-1. At this distance, there should not be undue interferences between the two wells. WESTEC recommends that construction and installation of the second production well be similar to well PW-1

- The maximum pumping rate for production well PW-1 should not exceed 550 gpm

10.0 REFERENCES

California Department of Water Resources, 1975, California's Groundwater

Dutcher, L.C., W.F. Hardt, and W.R. Moyle, Jr, 1972, *Preliminary Appraisal of Groundwater in Storage, with Reference to Geothermal Resources in the Imperial Valley Area, California*. U.S. Geologic Survey, Circular 649

Environmental Management Associates, *1996 Draft Environmental Impact Statement/ Environmental Impact Report*

Environmental Solutions, Inc., *1993 Hydrogeologic Assessment Report Mesquite Regional Landfill*

Fox, Robert C. *1984 Groundwater Resources Appraisal, Amos Basin, Imperial County, California;* Technical Report

Freeze, R.A. and J.A. Cherry, 1979, Groundwater, Prentice Hall

Hanna, T.M., E.A. Azrag, and L.C. Atkinson, 1994, *Use of an Analytical Solution for Preliminary Estimates of Groundwater Inflow to A Pit,* Mining Engineering, Vol. 46 No. 2, pp 149-152

Kruseman, G.P. and N.A. de Ridder, 1991, *Analysis and Evaluation of Pumping Test Data, Second Edition,* International Institute for Land Reclamation and Improvement

Liebler, G.S. 1988, *Geology and Gold Mineralization at the Picacho Mine, Imperial County, California*, in Schafer, R.W., et al. eds. Bulk Minable Precious Metal Deposits of the Western United States; Symposium Proceedings Geological Society of Nevada

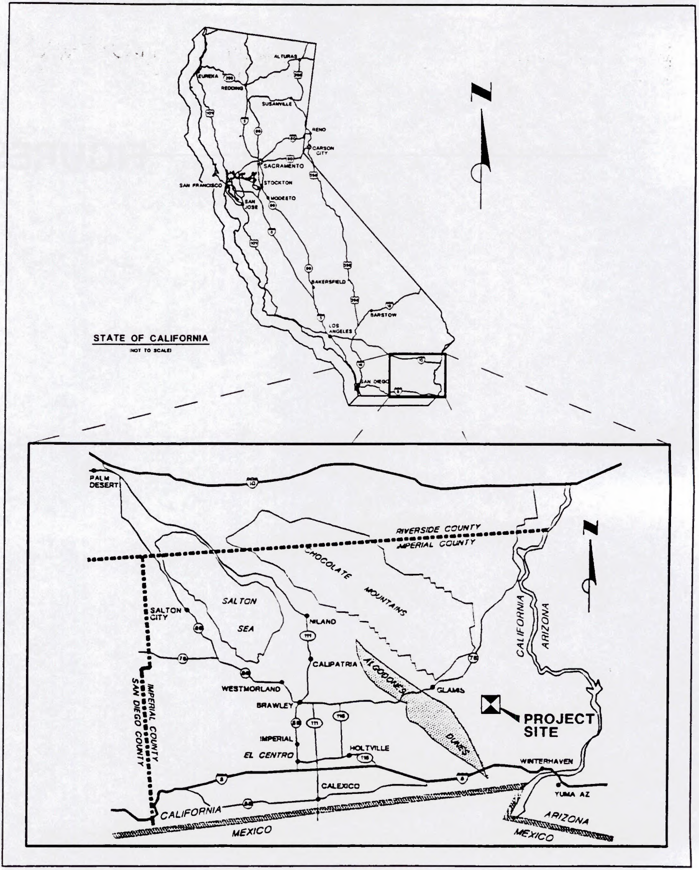
Loeltz, O.J., B. Irelan, J.H. Robison, and F.H. Olmsted, 1975 *Geohydrologic Reconnaissance of the Imperial Valley, California*. U.S. Geological Survey, Professional Paper 486-K

Willis, A.F., 1988, *Geology and Mineralization of the Mesquite Open Pit Gold Mine*, in Schafer, R.W. et al., Bulk Minable Precious Metal Deposits of the Western United States; Symposium Proceedings: U. S. Geological Society of Nevada

Wilson, Richard P. and Sandrant, Owen-Joyce, 1994. *Method to Identify Wells that Yield Water That Will Be Replaced by Colorado River Water in Arizona, California, Nevada, and Utah*, U.S. Geological Survey, Water-Resources Investigations Report 94-4005

FIGURES

95145-8 1/96 JOH



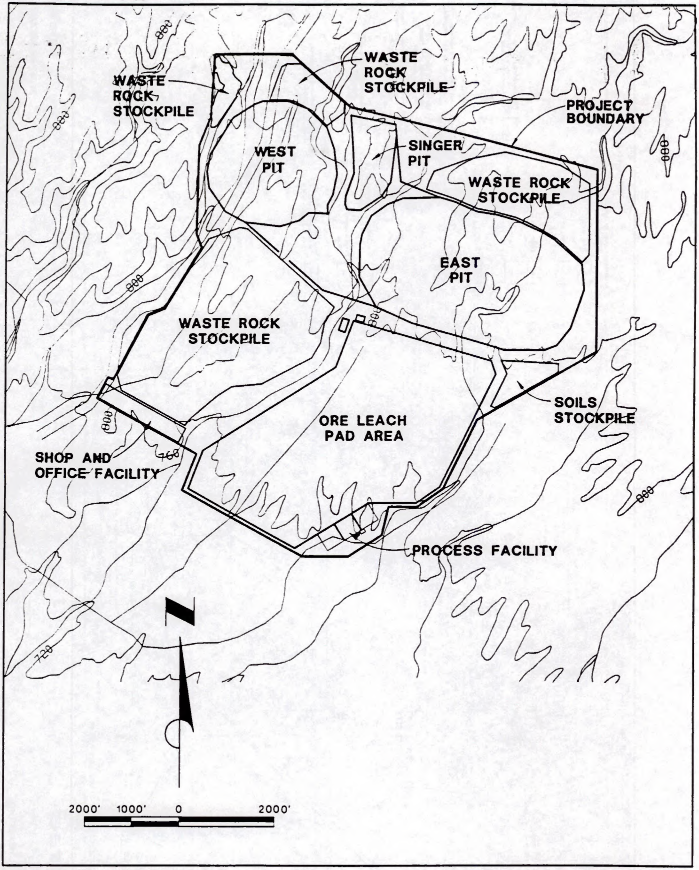
WESTEC®

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

FIGURE 1-1

LOCATION MAP

95145-8 2/96 JOH

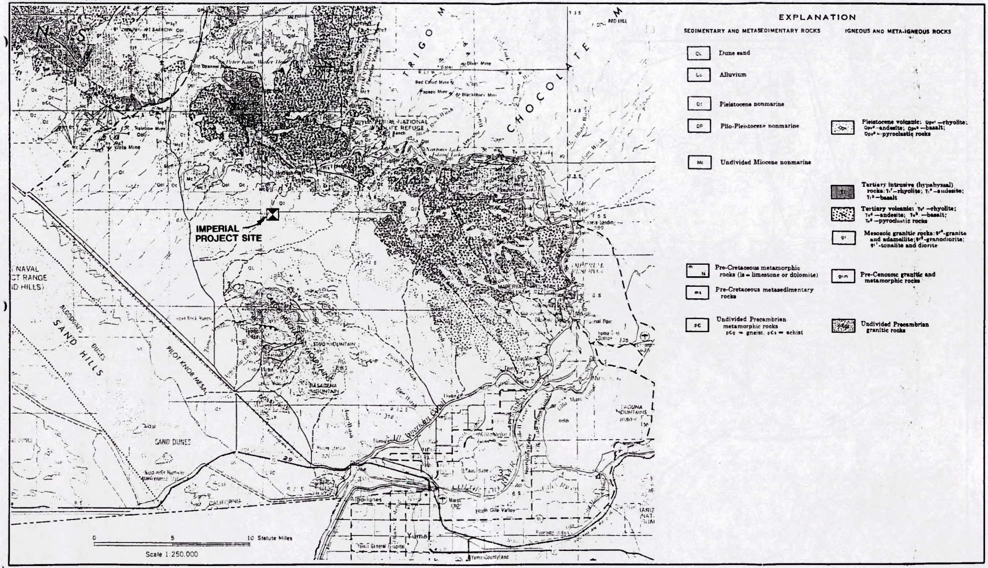


WESTEC®

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

FIGURE 1-2

SITE FACILITIES LAYOUT



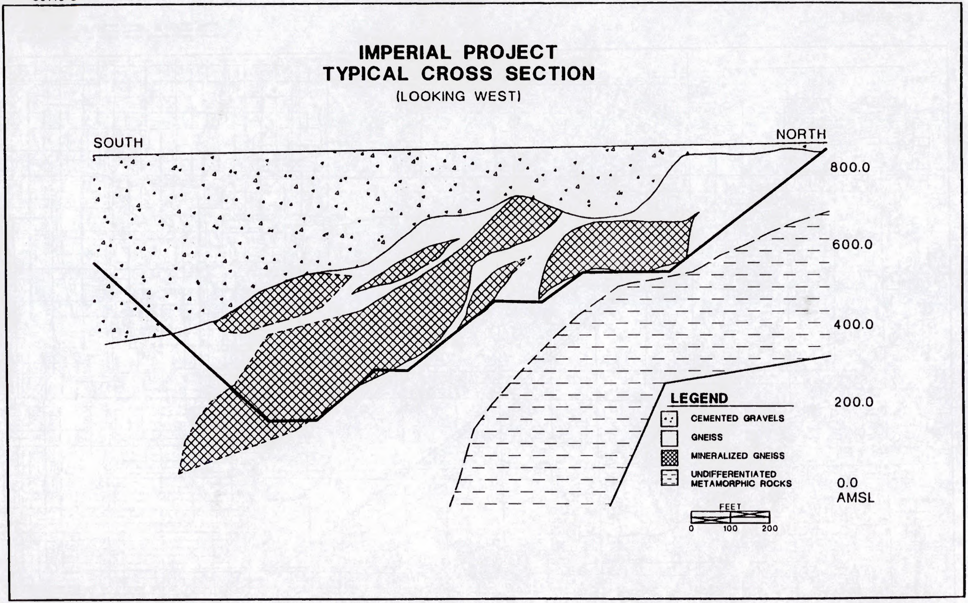
WESTEC

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

FIGURE 2-1

REGIONAL GEOLOGY

95145-8 1/96 JOH



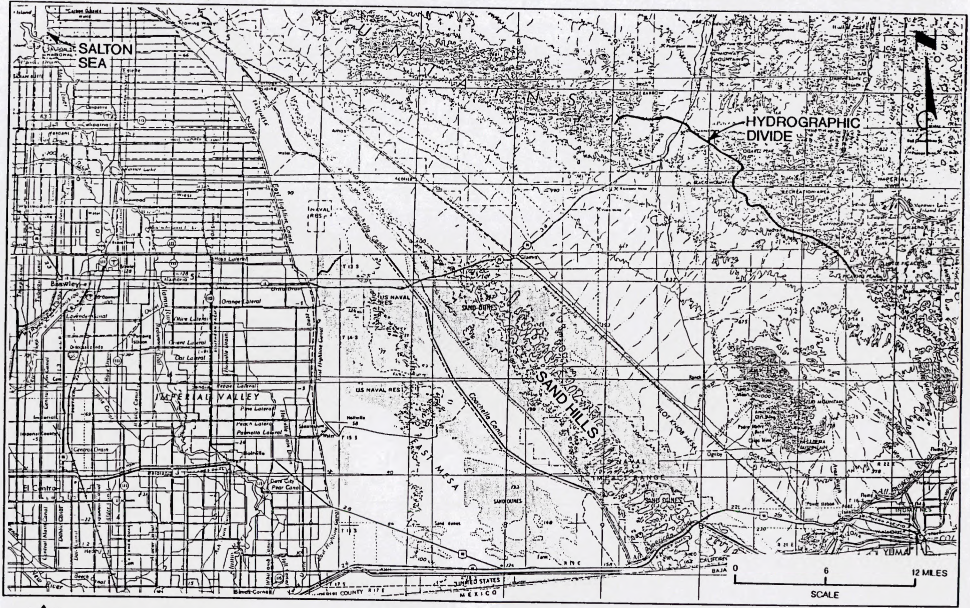
WESTEC®

FIGURE 2-2

SITE GEOLOGY - CROSS SECTION

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

95145-8 1/96 JOH



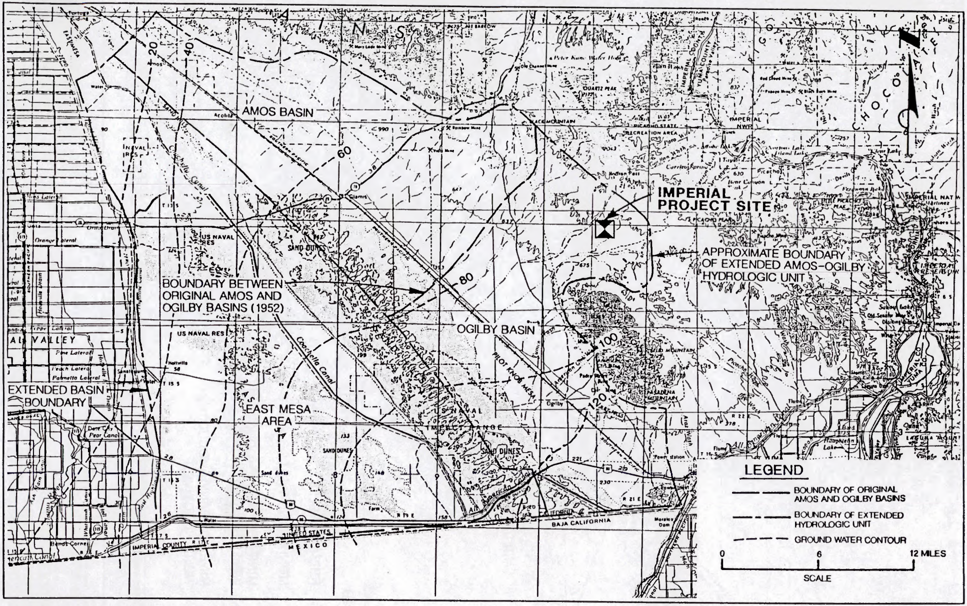
WESTEC®

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

FIGURE 3-1

REGIONAL HYDROGRAPHIC BASIN

95145-8 1/96 JOH

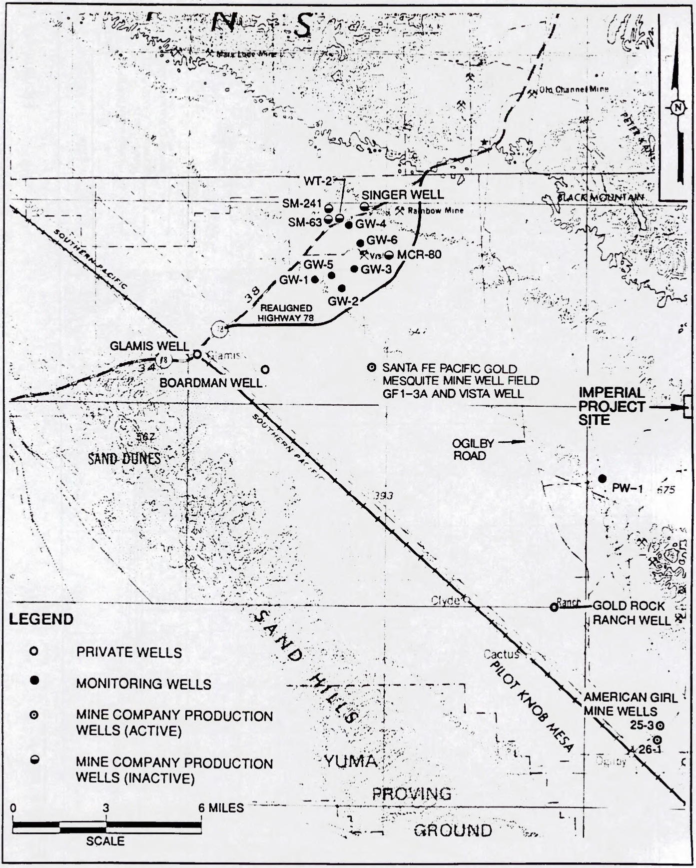


WESTEC®

FIGURE 4-1

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

REGIONAL HYDROGEOLOGIC BASINS



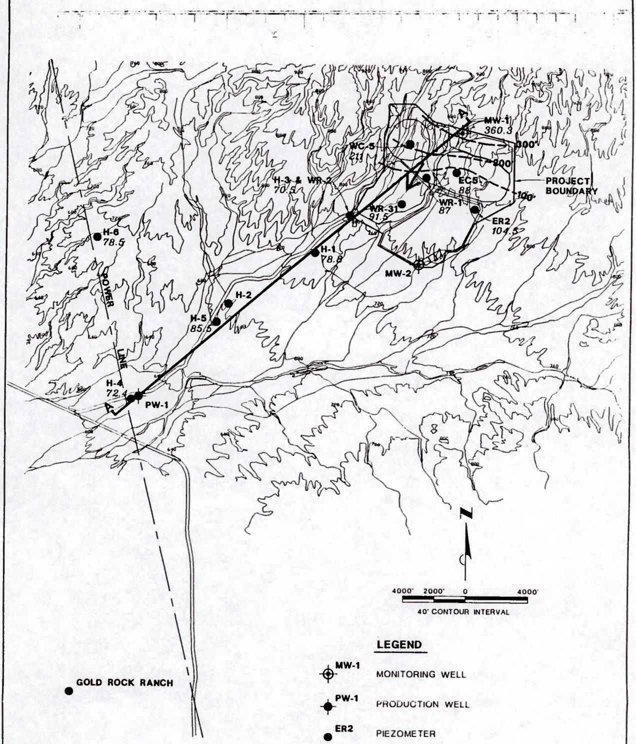
WESTEC®

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

FIGURE 4-2

REGIONAL WELL LOCATIONS

95145-8 1/96 JOH



LEGEND

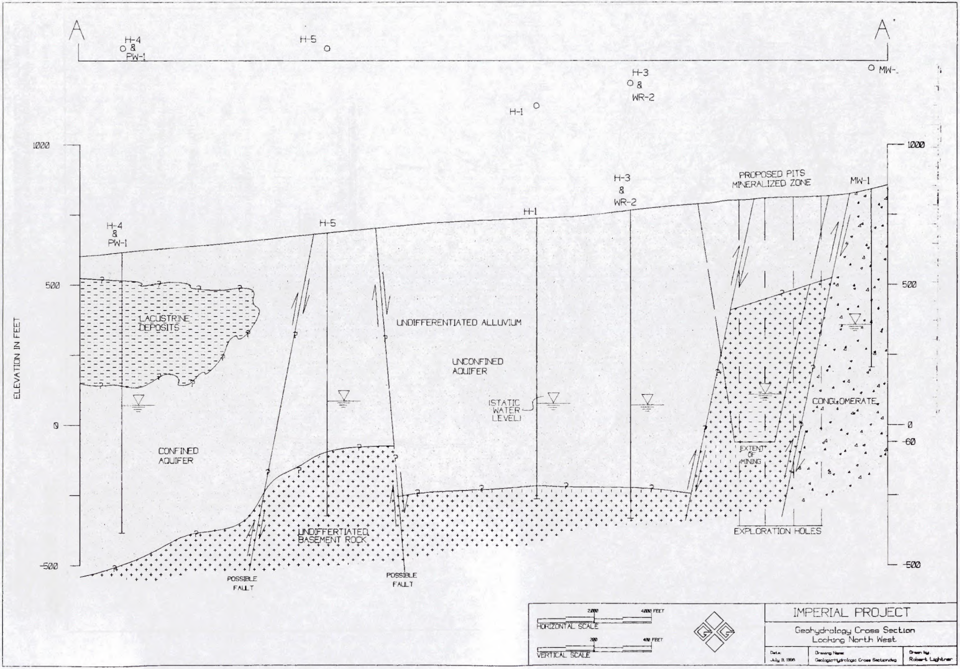
MW-1	MONITORING WELL
PW-1	PRODUCTION WELL
ER2	PIEZOMETER
107.5	STATIC WATER ELEVATION FT. AMSL
←	GROUNDWATER FLOW DIRECTION
------100'	APPROXIMATE GROUNDWATER ELEVATION CONTOUR (FT. AMSL)
A — A'	CROSS SECTION

WESTEC®

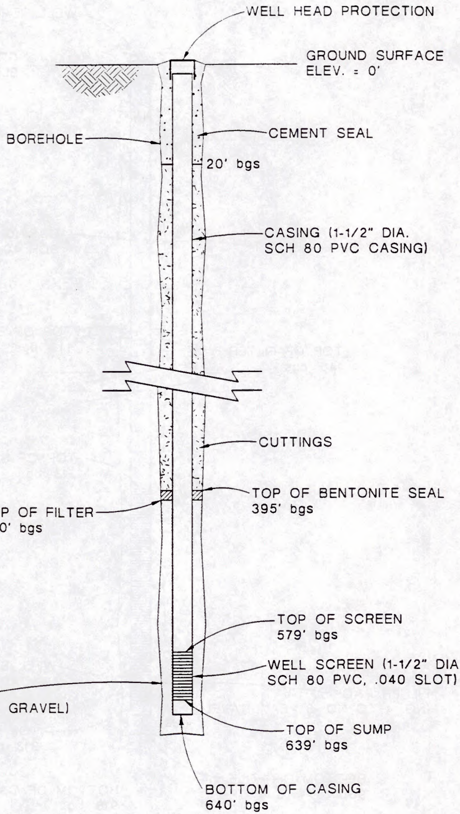
CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

FIGURE 4-3

SITE PIEZOMETERS, MONITORING WELLS, PRODUCTION WELLS AND GOLD ROCK RANCH LOCATION MAP



A
A'
H-4 & PW-1
H-5
H-3 & WR-2
H-1
MW-1
1000
500
0
-60
-500
ELEVATION IN FEET
PROPOSED PITS
MINERALIZED ZONE
LACUSTRINE DEPOSITS
UNDIFFERENTIATED ALLUVIUM
UNCONFINED AQUIFER
(STATIC WATER LEVEL)
CONFINED AQUIFER
CONGLOMERATE
EXTENT OF MINING
EXPLORATION HOLES
UNDIFFERTIATED BASEMENT ROCK
POSSIBLE FAULT
POSSIBLE FAULT
2000
4000 FEET
HORIZONTAL SCALE
200
400 FEET
VERTICAL SCALE
IMPERIAL PROJECT
Geohydrology Cross Section
Looking North West
Date:
July 9, 1998
Drawing Name:
Geologic-Hydrologic Cross Section.dwg
Drawn by:
Robert Lightner

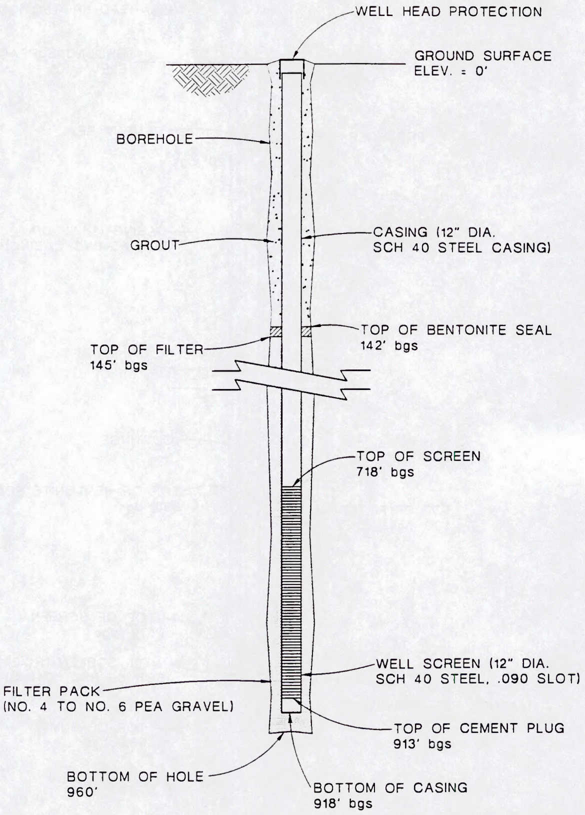


WESTEC®

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

FIGURE 5-1

MONITORING
WELL DESIGN



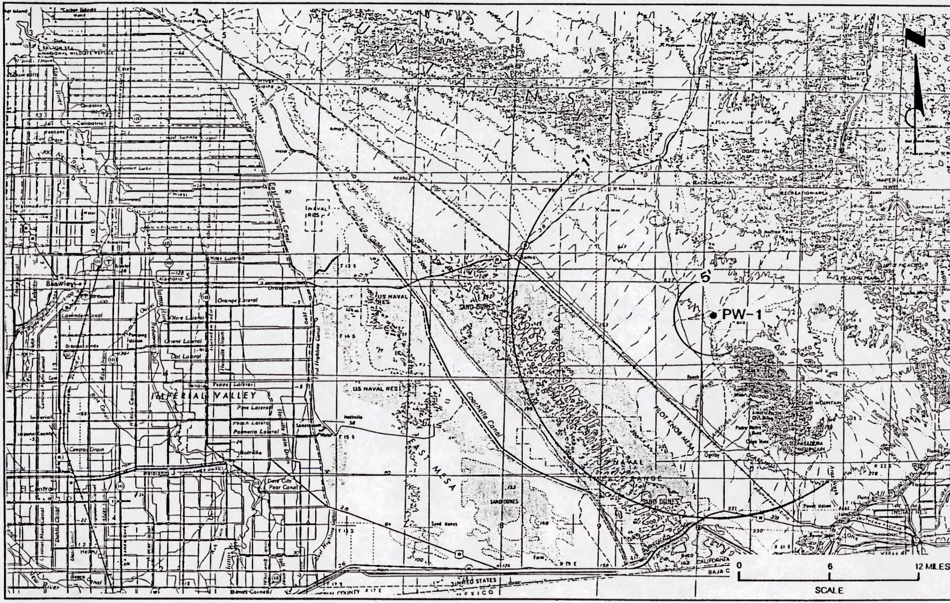
WESTEC®

FIGURE 5-2

PRODUCTION WELL DESIGN

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

95145-8 2/96 JOH

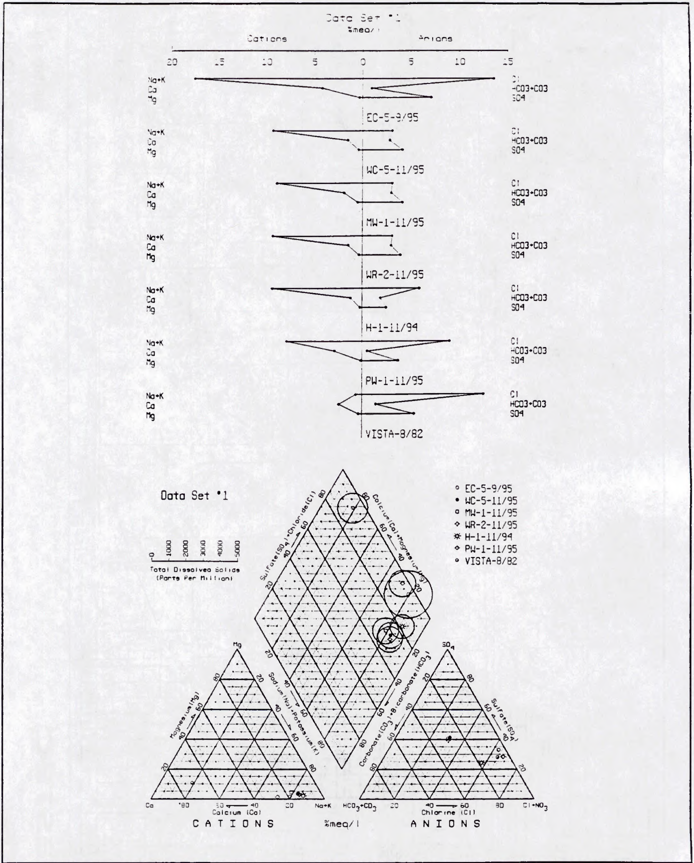


WESTEC®

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

FIGURE 6-1

DRAWDOWN CONTOURS WITH TRANSMISSIVITY OF 8,000 FT²/DAY



WESTEC

FIGURE 7-1

CHEMGOLD, INC.
IMPERIAL PROJECT
HYDROLOGY BASELINE REPORT

STIFF AND PIPER DIAGRAMS

APPENDIX A

FALLING HEAD / SLUG TEST

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX B

PIT INFLOW CALCULATIONS

PIT FLOW CALCULATIONS

The Jacob-Lohman formula is shown below:

$$Q = \frac{4 \pi T \Delta h}{\ln \left(\frac{2.25\ T\ t}{r_w^2 S} \right)}$$

where:

Q = Inflow in $feet^3/day$
T = Transmissivity in $feet^2/day$
Δh = Drawdown in feet
t = Time in days
r_w = Radius of the pit/inflow area in feet
S = Storativity

For the purposes of this groundwater inflow estimate WESTEC used the following:

EAST PIT

T = 1.0 $feet^2/day$
Δh = 200 feet
t = 100 days
r_w = 800 feet
S = 0.02

WEST PIT

T = 0.5 $feet^2/day$
Δh = 110 feet
t = 100 days
r_w = 600 feet
S = 0.02

This calculation was used to determine a groundwater inflow estimate for the East Pit. The transmissivity and storage values were selected from the slug test data analysis; the drawdown value selected is the static groundwater elevation minus projected total pit depth. The r_w factor, a radius of 800 feet, and 600 feet was selected by measuring the diameter of the pit at the projected static water level. The time factor of 100 days was selected to avoid factoring in the increased flow effects due to draining the bedrock aquifer to the base of the pit. The estimated a groundwater inflow contributed from the bedrock aquifer into the East and West pits after 100 days was calculated to be 300 $feet^3/day$ (1.5 gpm) and 150 ft^3/day (0.7 gpm), respectively.

APPENDIX C

WELL INSTALLATIONS

WELL INSTALLATIONS

Three types of wells have been installed at the project: a monitoring well, a water level piezometer, and a water supply test well. Installation of each type is described below.

MONITORING WELL

A monitoring well (MW-1) was drilled and installed by Harris Drilling Company and CHEMGOLD personnel using an air/mud rotary drilling rig. The monitoring well was installed upgradient of the proposed mine pit area, and is shown in Figure 4.3 in the body of the report.

A diagram of the monitoring well design is included in the text as Figure 5.1. Monitoring well MW-1 was installed to a depth of 640 feet and was constructed with 1½-inch-diameter schedule 80 PVC pipe, with 60 feet of 0.04 slot schedule 80 PVC screen in the water table.

The PVC casing was placed in the hole and then backfilled with washed 1/4-inch gravel to a depth of about 400 feet. A bentonite plug was placed over the gravel and a mixture of drill cuttings and gravel was placed above the plug to within approximately 20 feet of the surface. Approximately 20 feet of bentonite grout was placed into the annular space. The upper 10 feet of well casing is 1½-inch steel casing extending approximately 2 feet above the surface. The surface construction features consist of a 4-inch-diameter piece of steel surface casing with a locking cap. The geologic log for the monitoring well is included in Appendix D.

PIEZOMETER WELLS

Eight piezometers were installed in and around the proposed mine project area to evaluate static groundwater elevations, to determine geologic formations, and to estimate in-situ aquifer hydraulic properties. The locations of the eight piezometers are shown in Figure 4.3 in the report. Each of the piezometers was installed in a reverse circulation exploration borehole. The boreholes were drilled with a 5¾-inch-diameter hammer bit to the total depth. The holes were backfilled to the desired screen depth with cuttings. After backfilling, 1½-inch schedule 80 PVC pipe with 20 feet of perforated casing was installed at the desired depth, and 25 to 80 feet of cuttings was placed around the perforated casing. The gravel pack was capped with approximately 5 feet of coarse bentonite. Well data for the piezometers installed in the alluvial and bedrock aquifers is summarized in Table 4.2 and 4.4. Geologic logs for the piezometer wells are included in Appendix D.

WATER SUPPLY TEST WELL

A production test well, PW-1, was installed at the Imperial Project site to test aquifer hydrologic parameters and to evaluate the groundwater supply to meet anticipated project water requirements. Well PW-1 is in the SW 1/4, SE ½, Section 15, Township 14 South, Range 20 East San Bernardino Baseline and Meridian and is shown in Figure 4-3 of the report.

PW-1 was drilled using a mud rotary drilling system equipped with a tricone bit. Forty feet of 18-inch conductor casing was installed and a 17½-inch borehole was drilled from 40 feet to a total depth of 960 feet. The well was constructed of 12-inch schedule 40 low carbon steel, with 200 feet of 0.090 mill slot well screen placed at the base of the well. A 5-foot cement plug was placed at the base of the well screen in the event that CHEMGOLD decides to deepen the well in the future. While the well was being installed, 42 feet of cave material filled the base of the hole. Consequently, the well screen extended from 918 feet below ground surface (bgs) to 718 feet bgs. The filter pack/sand pack material was a mixture of sieve size No. 4 to No. 6 pea gravel and extended from the base of the well, 918 feet bgs, to 145 feet bgs. A 3-foot seal consisting of hydrated coarse bentonite hole plug was installed above the sand pack. A neat cement and bentonite grout mixture was placed into the annular space from 142 feet bgs to the surface. A well cap was welded to the top of the casing to prevent tampering with the test well. These construction features conform with California well standards. A construction diagram for well PW-1 is shown in Figure 5-2 of the report.

The well was developed by airlifting for approximately eight hours. The well was also surged with a turbine pump which had been temporarily installed for the aquifer testing. The well was developed until discharge groundwater was clear and free of turbidity, and until water quality parameters (pH, specific conductance, and temperature) were stabilized. A water quality sample (PW-1, Table 6.2) was collected during the aquifer test. A geologic and well construction log is included in Appendix D.

APPENDIX D

GEOLOGIC LOGS FOR PIEZOMETER, MONITORING WELL, AND PRODUCTION WELL

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX E

PUMP TEST FIELD DATA AND CALCULATIONS

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX F

WATER QUALITY ANALYSES

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

This page intentionally left blank
for reproduction purposes.

APPENDIX E-2 **CHEMGOLD, INC. IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA SUPPLEMENTAL HYDROLOGY STUDY FOR THE IMPERIAL PROJECT, IMPERIAL COUNTY (SEPTEMBER 1996)**

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

SUPPLEMENTAL HYDROLOGY STUDY FOR THE IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

EMA Report No. 1093-01
September 1996

Prepared for:

Chemgold, Inc.
P.O. Box 758
Winterhaven, California 92283

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

SUPPLEMENTAL HYDROLOGY STUDY

EMA Report No. 1093-01
September 1996

Prepared for:

Chemgold, Inc.
P.O. Box 758
Winterhaven, California 92283

LIMITATIONS

This report was prepared by Environmental Management Associates, Inc. (EMA) in conformance with the scope of work prescribed by our CLIENT. The work has been conducted in an objective and unbiased manner and in accord with generally accepted professional practice for this type of work. No other warranty, either expressed or implied, is made as to the findings, recommendations, specifications or opinions presented herein.

ENVIRONMENTAL MANAGEMENT ASSOCIATES, INC.

John O. Heggeness

John O. Heggeness, R.G.
Senior Geologist

Dwight L. Carey

Dwight L. Carey, D.Env.
Principal

Corporate Office:
1698 Greenbriar Lane, Suite 210, Brea, California 92821-5919
(714) 529-3695 FAX: (714) 529-8543

Regional Office:
100 West Grove Street, Suite 100, Reno, Nevada 89509-4026
(702) 828-3939 FAX: (702) 828-3940

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

SUPPLEMENTAL HYDROLOGY STUDY

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHEMGOLD, INC. IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

SUPPLEMENTAL HYDROLOGY STUDY

1. INTRODUCTION

Chemgold, Inc. has proposed the development of a conventional open-pit, heap leach, precious metal mine, the Imperial Project (Project), to be located in eastern Imperial County, California, approximately 45 miles northeast of El Centro, California and 20 miles northwest of Yuma, Arizona. The Project would be located south of State Route 78 and north of Interstate Highway 8, and would be accessed via Ogilby Road and Indian Pass Road (Figure 1). A joint Draft Environmental Impact Statement and Environmental Impact Report (EIS/EIR) is being prepared by the Bureau of Land Management (BLM) office in El Centro, California and the Imperial County Planning/Building Department.

In support of this EIS/EIR, WESTEC, Inc. prepared, in February 1996, a report entitled "Hydrology Baseline Report of the Imperial Project, Imperial County California" (WESTEC Report). Following the publication of the WESTEC Report, additional hydrogeologic data regarding Chemgold, Inc.'s proposed Imperial Project (Project) was generated by Chemgold, and certain additional questions regarding the area hydrogeology were raised. This report supplements the WESTEC Report and documents that additional hydrogeologic information developed by Chemgold, presents the results of water sampling and analyses conducted by Environmental Management Associates, Inc. (EMA) since the publication of the WESTEC Report, and utilizes this information to supplement some of the discussions presented in the WESTEC Report.

This report contains the following:

- Documentation of the analyses of the two (2) Project monitoring wells, MW-1 and MW-2, conducted by Chemgold subsequent to the publication of the WESTEC Report;
- Documentation of the sampling and analyses of MW-1, MW-2, EC-5 and WC-5 conducted by EMA subsequent to the publication of the WESTEC Report, as well as sampling and analyses of water from the existing Gold Rock Ranch well and Imperial Irrigation District's (IID's) All American Canal;
- A discussion of the methods used for constructing monitoring well MW-2 and information regarding the physical characteristics of the other Project wells and coreholes;
- A short discussion of the monitoring program requirements of the California Regional Water Quality Control Board, Colorado River Basin Region; and

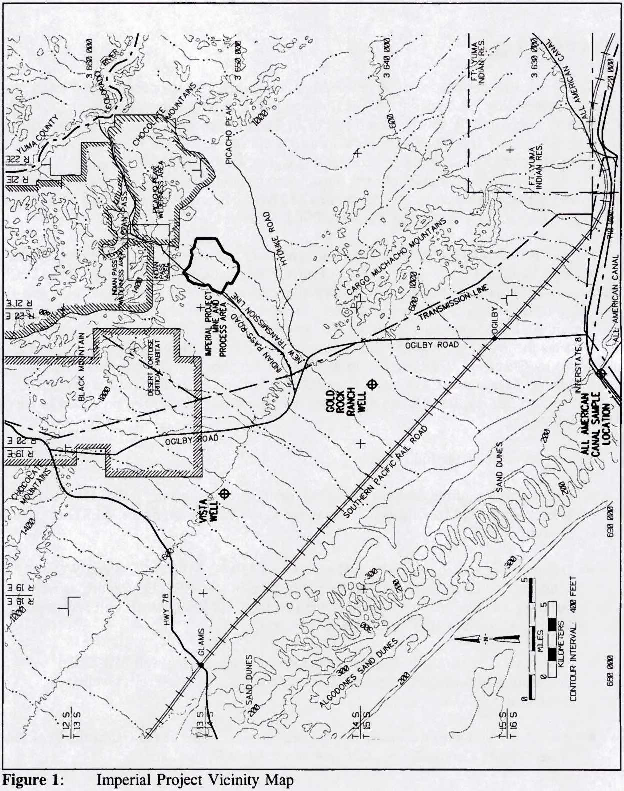


Figure 1: Imperial Project Vicinity Map

- A discussion of the recommended maximum pumping rate for water supply well PW-1 and the additional ground water production wells.

2. CHEMGOLD PROJECT GROUND WATER SAMPLING AND ANALYSES AVAILABLE SINCE THE WESTEC REPORT

Table 2 summarizes the analyses of ground water samples collected by Chemgold from the two (2) Project monitoring wells, MW-1 and MW-2, subsequent to the samples reported in the WESTEC Report. Laboratory data sheets are included in Appendix A. As indicated in Table 2, each of these samples were collected unfiltered and placed in laboratory-prepared sample collection bottles containing preservatives appropriate to the analyses.

3. EMA GROUND WATER SAMPLING OF AUGUST 1996

3.1. Introduction

Environmental Management Associates, Inc. (EMA) was retained to undertake sampling and analyses of the existing Project ground water monitoring wells and specified coreholes completed in the water table located within the Project mine and process area, and to undertake sampling and analyses of both the Gold Rock Ranch well and the IID's All American Canal. This section of this report documents this sampling and analysis.

3.2. Field Methodology and Observations

EMA staff supervised the sampling of the wells, coreholes and surface water source from August 28 through 30, 1996. Ground water samples were extracted from monitoring wells MW-1 and MW-2, and coreholes EC-5 and WC-5, located within the Project mine and process area, and from the water well located at Gold Rock Ranch, a small campground facility with a general store located approximately seven (7) miles southwest of the Project mine and process area. An additional sample was collected from the IID's All American Canal at the point west of the junction of Ogilby Road and Interstate 8 where Interstate 8 crosses the All American Canal. The locations of the Project wells and coreholes sampled are shown in Figure 2. The locations of the Gold Rock Ranch well and All American Canal sampling point are shown in Figure 1.

Prior to obtaining ground water samples from the onsite wells and coreholes, an attempt was made to purge at least three (3) casing volumes of water from each well or corehole through bailing in order to obtain samples as representative as possible of the ground water in the aquifer. Bailing was accomplished with the use of a truck-mounted winch using stainless-steel wire and either a 0.75-inch PVC or 1.0-inch or 1.5-inch stainless steel bailer (supplied by Chemgold). Conductivity, pH and temperature of the purged water from each well and corehole was field tested at least three (3) times per

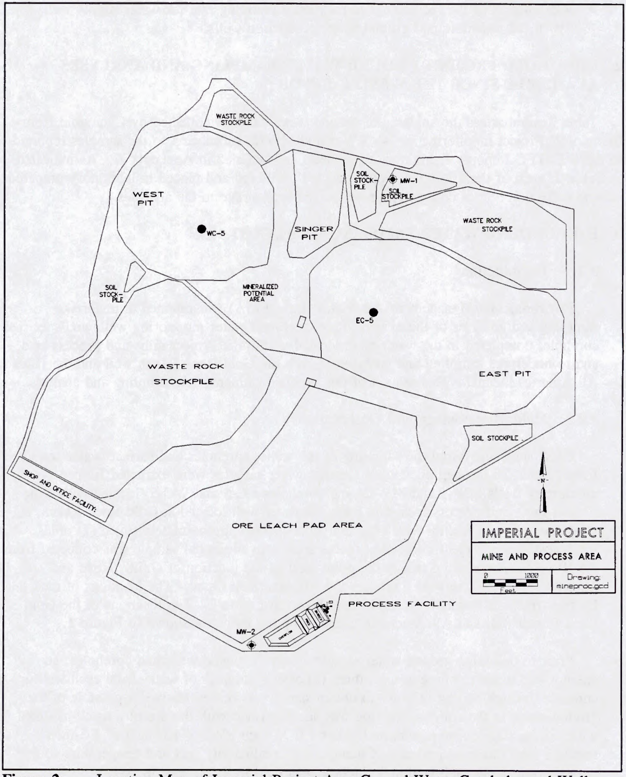


Figure 2: Location Map of Imperial Project Area Ground Water Coreholes and Wells

well or corehole prior to sampling. Purge water was disposed of on the ground.

The bailed ground water from WC-5, MW-1 and MW-2 appeared cloudy and contained a large amount of sediment, although both turbidity and sediment appeared to be decreasing with time. The bailed water from EC-5 was substantially less turbid and contained less sediment than the water bailed from the other wells and corehole, although it contained a substantial quantity of what appeared to be drilling fluid additives used during the drilling process. As the bailing progressed, field-tested conductivity, pH and temperature stabilized in the bailed water from each well or corehole. Due to time limitations, the reductions in turbidity and sediment, and the stabilization of field-tested conductivity, pH and temperature, purging was terminated after approximately 10 hours bailing each corehole (WC-5 and EC-5), and after approximately 4 hours bailing each well (MW-1 and MW-2), which resulted in the purging of the casing volumes indicated in Table 1.

Table 1: Well Sample Purge Volumes

Well Number/ Sample Location	Total Depth (ft bgs)	Depth to Water (ft bgs)	Casing Inside Diameter (inches)	Casing Volume (gal)	Casing Volumes Removed	Samples Collected[1]
WC-5	800	609.42	1.20	13	1.1	WC-5A/WC-5B
EC-5	800	722.22	1.20	5.4	2.4	EC-5A/EC-5B
MW-1	640	484.82	1.20	10	1.5	MW-1A/MW-1B
MW-2	880	626.18	1.75	26	1	MW-2A/MW-2B
Gold Rock Ranch	521	397	n/a	n/a	n/a	Gold Rock
All American Canal	n/a	n/a	n/a	n/a	n/a	A A Canal

[1] "A" samples filtered, "B" samples unfiltered. Both Gold Rock Ranch and AA Canal samples filtered
n/a not applicable or unknown

The Gold Rock Ranch ground water well supplies domestic water for the Ranch, and runs intermittently each day. Because the well is used each day, the well was purged by pumping for approximately 5 minutes before sampling.

Samples of the ground water from the Project wells and coreholes were obtained using the PVC or stainless steel bailer suspended on a stainless steel wire. The bailed water to be sampled was first placed in another filtering bailer which had been washed (see below). Except as noted below, one (1) set of samples from each well and corehole, designated the "A" samples, were field-filtered with a 0.45 μm filter into the laboratory-prepared sample bottles which contained preservatives appropriate for the analysis. Because of the quantity of sediment in the samples, several filters were required for filtration of each sample. A second set of samples from each of the wells and coreholes, designated the "B" samples, were collected unfiltered in the laboratory-prepared sample bottles to duplicate the sample collection conditions which were used by Chemgold for its previous samples of ground waters from these wells and coreholes.

The unpreserved sample of WC-5A was not filtered in the field but filtered instead by the laboratory. All of the EC-5A samples were also not preserved nor filtered in the field, but were filtered by the laboratory. All of the collected samples were stored either in a refrigerator or on blue ice during collection, and were stored on blue ice during shipping. Chain-of-custody records were completed for the samples, and the samples were delivered to *Core Laboratories* on September 4, 1996.

All bailing and sampling equipment was cleaned with Liquinox and tap water, rinsed with tap water, and rinsed again with distilled water between wells and prior to each bailing and sampling activity.

Samples of the Gold Rock Ranch ground water well were collected from the tap immediately downstream of the well head and upstream of the storage tank. Samples were collected in a clean, unpreserved sample container, then field-filtered with a 0.45 μm filter into the laboratory-prepared sample bottles which contained preservatives appropriate for the analysis. Samples of the All American Canal were collected with a clean, unpreserved sample container, then field-filtered with a 0.45 μm filter into the laboratory-prepared sample bottles which contained preservatives appropriate for the analysis.

Core Laboratories was given instructions to analyze ground water samples from wells MW-1, MW-2, coreholes EC-5 and WC-5, and samples from the Gold Rock Ranch ground water well and the All American Canal for selected for Profile II analysis.

3.3. Results of Laboratory Analysis

Table 2 presents the analyses of both the filtered and unfiltered samples from the Project monitoring wells, and Table 3 presents the analyses of the filtered and unfiltered samples from the Project coreholes and the analyses of the samples collected from the Gold Rock Ranch well and the All American Canal. Laboratory data sheets are included as Appendix B.

3.4. Results and Discussion

The filtered samples from the Project wells and coreholes were collected to accurately establish the existing ground water chemistry of the Project mine and process area, while the unfiltered samples were collected for comparison to earlier unfiltered samples of the same Project wells and coreholes. The analyses presented in Table 2 and Table 3 indicate that all of the filtered samples from all of the Project wells and coreholes met all of the applicable California primary maximum contaminant levels (MCLs) for drinking water, and met all of the applicable secondary MCLs except as follows:

- All filtered samples exceeded the California secondary MCL for manganese and TDS;
- Monitoring well MW-2 exceeded the secondary MCLs for chloride and sulfate; and
- Corehole WC-5 exceeded the secondary MCLs for sulfate and iron.

All of the analyses from the filtered samples from the Project wells and coreholes also fell within the range of analyses from regional wells, as reported in the WESTEC Report.

Table 3 also shows the sample results from the Gold Rock Ranch well, which exceeded the secondary MCLs for chloride and TDS. These analyses are similar to the regional ground water quality reported in Table 7.1 of the WESTEC Report, which shows that the Vista, Gold Rock Ranch, Singer, and GF wells each exceed the secondary MCLs for chloride, sulfate and TDS. Table 3 also shows that the sample of water from the All American Canal exceeded the secondary MCLs for sulfate and TDS.

Table 2: Water Quality Data from Project Monitoring Wells

Element	Units	Current Drinking Water Quality Standards	Well Number							
			MW-1	MW-1	MW-1 A	MW-1 B	MW-2	MW-2	MW-2 A	MW-2 B
Collection Date			04/22/96	08/15/96	08/29/96	08/29/96	07/11/96	08/15/96	08/29/96	08/29/96
Field Filtering			unfiltered	unfiltered	filtered	unfiltered	unfiltered	unfiltered	filtered	unfiltered
Alkalinity	mg/l		163	171	163	186	246	163	95	195
Aluminum	mg/l	1.0 (1)/0.02 (2)	<0.1	5.3	<0.02	1.37	0.7	1.3	<0.02	4.03
Antimony	mg/l	0.006 (1)	<0.04	<0.003	<0.005	<0.005	<0.003	<0.003	<0.005	<0.005
Arsenic	mg/l	0.05 (1)	0.02	<0.005	<0.01	0.09	<0.005	<0.005	0.09	0.11
Barium	mg/l	1.0 (1)	0.2	<0.1	0.17	0.21	0.2	0.1	0.04	0.08
Beryllium	mg/l	0.004 (1)	<0.002	<0.002	<0.001	0.001	<0.002	<0.002	<0.001	0.002
Bismuth	mg/l		<0.1	<0.1	<1	<1	<0.1	<0.1	<1	<1
Boron	mg/l				0.50	0.53			0.05	5.06
Cadmium	mg/l	0.005 (1)	<0.0002	<0.002	<0.005	<0.005	<0.002	<0.002	<0.005	<0.005
Calcium	mg/l		53	34	49.4	57.1	64	80	67.3	108
Chloride	mg/l	250 (2)	91	39	56.1	61.1	130	120	641	606
Chromium	mg/l	0.05 (1)	<0.1	<0.1	<0.01	0.03	<0.1	<0.1	<0.01	0.07
Cobalt	mg/l		<0.1	<0.1	<0.03	<0.03	<0.1	<0.1	<0.03	<0.03
Conductance	μmhos/cm				832	832			2460	2460
Copper	mg/l	1.0 (2)	<0.1	<0.1	<0.01	<0.01	<0.1	<0.1	<0.01	0.03
Fluoride	mg/l	1.4 (1)	0.2	0.3	0.6	0.6	0.2	0.2	0.6	0.6
Gallium	mg/l		<0.1	<0.1	<0.5	<0.5	<0.1	<0.1	<0.5	<0.5
Iron	mg/l	0.3 (2)	<0.1	0.2	<0.03	4.39	0.6	1.7	<0.03	6.64
Lead	mg/l		<0.002	<0.005	<0.003	0.049	<0.003	<0.005	<0.003	0.024
Lithium	mg/l		<0.1	<0.1	0.04	0.06	<0.1	<0.1	0.58	0.07
Magnesium	mg/l		6.7	3.4	5.3	5.7	28	31	19.0	27.5
Manganese	mg/l	0.05 (2)	0.1	<0.1	0.70	1.10	<0.1	0.70	0.06	0.50
Mercury	mg/l	0.006 (1)	<0.0005	<0.0005	<0.0002	<0.0002	<0.0005	<0.0005	<0.0002	<0.0002
Molybdenum	mg/l		<0.1	<0.1	<0.05	<0.05	<0.1	<0.1	0.12	0.08
Nickel	mg/l	0.1 (1)	<0.1	<0.1	<0.04	0.04	<0.1	<0.1	<0.03	0.08
Nitrate Nitrogen	mg/l	10 (1)	<0.1	<0.1	0.13	0.05	0.2	0.3	0.07	<0.05
pH	mg/l	6.8 - 8.5	7.47	7.70	7.69	7.51	7.70	7.49	7.70	7.64
Phosphorous	mg/l		<0.1	<0.1	0.07	0.31	<0.1	<0.1	0.03	0.08
Potassium	mg/l		0.7	4.1	6	10	8.6	5.3	10	20
Scandium	mg/l		<0.1	<0.1	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01
Selenium	mg/l	0.05 (1)	<0.001	<0.001	<0.01	<0.01	<0.001	0.001	<0.01	<0.01
Silver	mg/l	0.1 (2)	<0.0005	<0.002	<0.01	<0.01	<0.002	<0.002	<0.01	<0.01
Sodium	mg/l		160	150	159	135	140	150	537	463
Strontium	mg/l		4.5	0.3	4.28	4.19	1.3	1.3	2.57	2.61
Sulfate	mg/l	250 (2)	210	160	230	211	320	270	360	230
TDS	mg/l	500 (2)	656	529	620	640	728	804	1780	1690
Thallium	mg/l	0.002 (1)	<0.0005	<0.001	<0.002	<0.005	<0.001	<0.001	<0.002	<0.005
Tin	mg/l		<1	<0.5	<0.05	<0.05	<1	<0.5	<0.05	<0.05
Titanium	mg/l		<0.1	<0.1	<0.01	<0.01	<0.1	0.1	<0.01	0.01
Vanadium	mg/l		<0.1	<0.1	<0.05	<0.05	<0.1	<0.1	<0.05	<0.05
Zinc	mg/l	5.0 (2)	<0.1	<0.1	<0.01	0.06	<0.1	0.1	<0.01	0.26

(1) California Primary Maximum Contaminant Limit (2) California Secondary Maximum Contaminant Limit

Table 3: Water Quality Data From Project Coreholes and Non-Project Sources

Element	Units	Current Water Quality Standards	EC-5 A	EC-5 B	WC-5 A	WC-5 B	Gold Rock	AA Canal	Trip Blank
Collection Date			8/30/96	8/30/96	8/28/96	8/28/96	8/30/96	8/30/96	8/27/96
Filed Filtering			filtered	unfiltered	filtered	unfiltered	filtered	filtered	
Alkalinity	mg/l		400	910	201	202	75	154	<5
Aluminum	mg/l	0.02 (2)	<0.02	0.54	<0.02	0.32	<0.02	<0.02	<0.02
Antimony	mg/l	0.006 (1)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	mg/l	0.05 (1)	<0.01	0.03	<0.01	<0.01	0.01	<0.01	<0.01
Barium	mg/l	1.0 (1)	<0.01	0.07	0.03	0.08	0.16	0.12	<0.0
Beryllium	mg/l	0.004 (1)	0.002	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	mg/l		<1	<1	<1	<1	<1	<1	<1
Boron	mg/l		0.12	0.24	0.74	3.29	0.90	0.16	<0.05
Cadmium	mg/l	0.006 (1)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	mg/l		32.8	221	59.4	85.1	31.0	86.4	<0.1
Chloride	mg/l	250 (2)	204	1450	162	144	351	119	<0.5
Chromium	mg/l	0.05 (1)	<0.01	0.11	<0.01	0.08	<0.01	<0.01	<0.01
Cobalt	mg/l		<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Field Conductance	μmhos/cm		1683	1683	1290	1290	880	1920	n/a
Copper	mg/l	1.0 (2)	<0.01	0.07	<0.01	0.32	<0.01	<0.01	<0.01
Fluoride	mg/l		0.8	0.8	0.8	0.8	3.0	0.8	<0.1
Gallium	mg/l		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	mg/l	0.3 (2)	0.16	2.36	0.60	2.66	<0.03	<0.03	<0.03
Lead	mg/l		<0.003	0.008	<0.003	0.014	<0.003	<0.003	<0.003
Lithium	mg/l		0.16	0.20	0.07	0.08	0.16	0.16	<0.01
Magnesium	mg/l		5.3	37.7	16.1	27.4	0.5	32.8	<0.1
Manganese	mg/l	0.05 (1)	2.01	20.1	0.07	0.35	<0.01	<0.01	<0.01
Mercury	mg/l	0.002 (1)	0.0005	0.0027	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	mg/l		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	mg/l	0.1 (1)	<0.04	0.10	<0.04	0.14	<0.04	<0.04	<0.04
Nitrate Nitrogen	mg/l	10 (1)	0.44	<0.05	0.16	0.14	1.52	0.35	<0.05
pH	mg/l	6.8 - 8.5	8.48	7.43	7.61	7.59	7.74	8.16	12.84
Phosphorous	mg/l		0.16	0.07	0.03	0.14	0.02	<0.01	<0.01
Potassium	mg/l		26	18	12	10	6	6	<5
Scandium	mg/l		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	mg/l	0.05 (1)	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Silver	mg/l	0.1 (2)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	mg/l		194	349	233	176	300	137	<1
Strontium	mg/l		0.67	5.46	1.30	1.35	1.01	1.23	<0.01
Sulfate	mg/l	250 (2)	140	130	310	324	130	309	<10
TDS	mg/l	500 (2)	4440	6010	1160	1060	920	820	20
Thallium	mg/l	0.002 (1)	<0.002	<0.005	<0.002	<0.005	<0.002	<0.002	<0.002
Tin	mg/l		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	mg/l		<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/l		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	mg/l	5.0 (2)	<0.01	0.12	<0.01	0.14	0.02	0.01	<0.01

(1) California Primary Maximum Contaminant Limit (2) California Secondary Maximum Contaminant Limit

Piper and Stiff diagrams were constructed for the filtered samples from Project monitoring wells MW-1 and MW-2, for the filtered samples from coreholes EC-5 and WC-5, for the current Gold Rock Ranch and All American Canal samples, and for the data presented in the WESTEC Report for the Vista well and the Project ground water production well PW-1 (insufficient information was available in the WESTEC Report to prepare diagrams for the other reported wells) (see Figure 3). The Stiff diagrams indicate that the dominant cation species are sodium and potassium for all samples, while the dominant anion varies from sulfate and carbonate/bicarbonate near the Project mine and process area to chloride and sulfate in the alluvial basin. The Piper diagrams also show that the dominant cations for all the water samples are sodium and potassium. The Piper diagrams also show that near the Project mine and process area there is no clearly dominant anion, but shows that the dominant anion is chloride in the alluvial aquifer downgradient from the Project mine and process area.

Comparisons of the analyses of the current filtered and unfiltered samples indicate that the concentrations of some metals in the filtered samples were substantially lower than the concentrations of the same metals in the unfiltered samples. While iron and aluminum concentrations in both monitoring wells were below detection levels in the filtered samples, the unfiltered samples had substantial concentrations of both. Manganese concentrations were substantially lower in the filtered samples than the unfiltered samples, and the concentrations from the unfiltered samples correlate well with the regional manganese concentrations reported in the WESTEC Report. TDS, sulfate and chloride concentrations appear to be unaffected by the field-filtering prior to preservation. A comparison of the analyses of the late-August unfiltered samples and all of the other unfiltered samples from the same hole or well did not indicate any significant chemical species variations.

4. ADDITIONAL MONITORING WELL AND COREHOLE INFORMATION

The following presents a discussion of the construction methods used for monitoring well MW-2, as obtained from Chemgold, and a brief elaboration of the aquifer testing conducted by WESTEC, as obtained from WESTEC.

Monitoring Well MW-2 was drilled and installed in June 1996. As shown in Figure 4, the well was constructed with 2-inch diameter schedule 80 PVC to a total depth of 800 feet bgs. Forty feet of 0.040 inch screen was installed at the base of the well with 760 feet of blank casing extending to the surface. A pack of clean pea gravel was installed in the annular space to cover the screen and a bentonite seal was placed over the gravel pack. Three-quarter (3/4)-inch washed gravel extends from the bentonite seal to within 50 feet of the surface, and a cement seal was placed from the 50-foot depth to the surface.

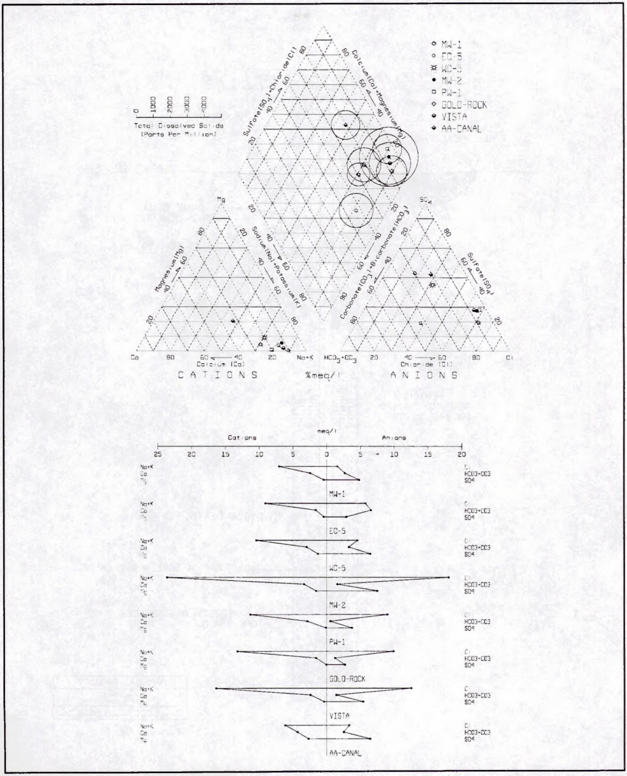


Figure 3: Piper and Stiff Diagrams

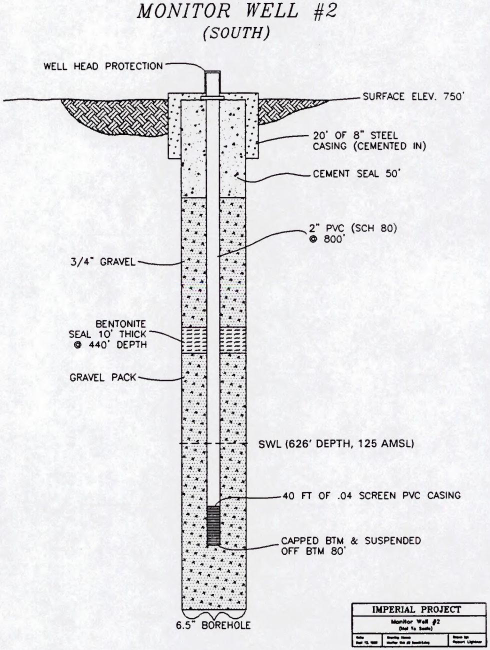


Figure 4: Monitoring Well MW-2 Construction Diagram

Aquifer testing was performed by WESTEC only on a limited number of wells and holes. A pumping test was performed only on production well PW-1 because the casings in all other holes were too small, and the water levels too deep, to allow a sufficient volume of water to be pumped from the holes to conduct a meaningful test. Falling head tests were performed on coreholes EC-5, WC-5, H-4 and H-5, but because of the long (40-foot) screened interval and high aquifer permeability in both H-4 and H-5, these holes could not be filled with enough water to accurately measure the falling head. However, WESTEC was able to conduct slug tests on all four (4) of these Project holes.

Table 4 lists each of the wells installed, or coreholes completed to sample ground water, for the Project, and indicates the proposed use, location, total depth, depth to static water level, and the aquifer each well or corehole is completed in.

Table 4: Summary of Physical Data From Selected Piezometer Holes, Monitoring Wells, and Production Wells

Hole Number	Location	Total Depth (ft bgs)	Depth to Static Water (ft bgs)	Aquifer
Piezometer Holes				
94H-1	Mine and Process Area	1,000	657.2	Alluvial (unconfined)
EC-5	Mine and Process Area	800	720	Bedrock
WC-5	Mine and Process Area	800	606	Bedrock
WR-2	Mine and Process Area	945	694.5	Alluvial (unconfined)
H-4	Mine and Process Area	1,000	544.6	Alluvial (confined)
H-5	Mine and Process Area	1,080	594.5	Bedrock
H-6	Mine and Process Area	920	631.5	Alluvial (confined)
Monitoring Wells				
MW-1	Mine and Process Area	640	479.7	Conglomerate (confined)
MW-2	Mine and Process Area	880	626	Bedrock
Production Wells				
PW-1	Water Supply Area	960	544.4	Alluvial (confined)

5. MONITORING PLAN

The California Regional Water Control Board, Colorado River Basin Region (CRWQCB) requires that each applicant for Waste Discharge Requirements (which authorizes the discharge of wastes to land) prepare and submit a monitoring plan, which must be approved by the CRWQCB prior to the commencement of discharges. Typically required by the CRWQCB in the monitoring plan is the installation and regular monitoring of a vadose (unsaturated) zone monitoring system, which would be installed to detect potential leaks of liquid waste or leachate into the vadose zone prior to any discharge into the underlying ground water, and wells completed in the uppermost aquifer both upgradient and downgradient of the waste management unit (WMU) to monitor the ground water in this aquifer prior to, during, and following the authorized discharge of waste to land. Both the vadose zone monitoring system and the ground water monitoring wells would be required to be sampled regularly for "constituents of concern," which would be identified, based upon the nature of the waste to be discharged and the constituents in the ground water, prior to discharge. Consistent sampling, analyses and reporting would be required by the CRWQCB, such that any significant changes in the monitoring results may indicate the introduction of constituents into the ground water from the waste.

6. PUMPING RATE OF PW-1

WESTEC recommended a average maximum pumping rate of 550 gpm for production well PW-1. This pumping rate was based on individual well specifics determined during the aquifer pumping test conducted by WESTEC. A average maximum pumping rate of 550 gpm from production well PW-1 was estimated as a safe withdrawal rate which would prevent possible damage to the well or pumping system due to excessive drawdown in the well. If the efficiency of the well can be increased by subsequent additional well development, the pumping rate of well PW-1 may be safely increased to that rate determined appropriate by the well production engineer. If and/or when additional production wells are installed for the Project, an average maximum pumping rate should be established by the well production engineer for each well which prevents excessive drawdown or possible damage to the specific well or pumping system.

APPENDIX A

ANALYTICAL RESULTS OF PREVIOUS SAMPLES

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX B

ANALYTICAL RESULTS OF AUGUST 1996 SAMPLING

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX F VEGETATION BASELINE SURVEY, IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA (AUGUST 1995)

VEGETATION BASELINE SURVEY

IMPERIAL PROJECT

IMPERIAL COUNTY, CALIFORNIA

Prepared for:

Chemgold, Imperial Project
P.O. Box 758
Winterhaven, CA 92283

Prepared by:

Samuel A. Bamberg, Ph.D.
Ingrid E. Hanne, M.S.
Bamberg Associates
26050 E. Jamison Circle
Aurora, Colorado 80015

August 1995

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

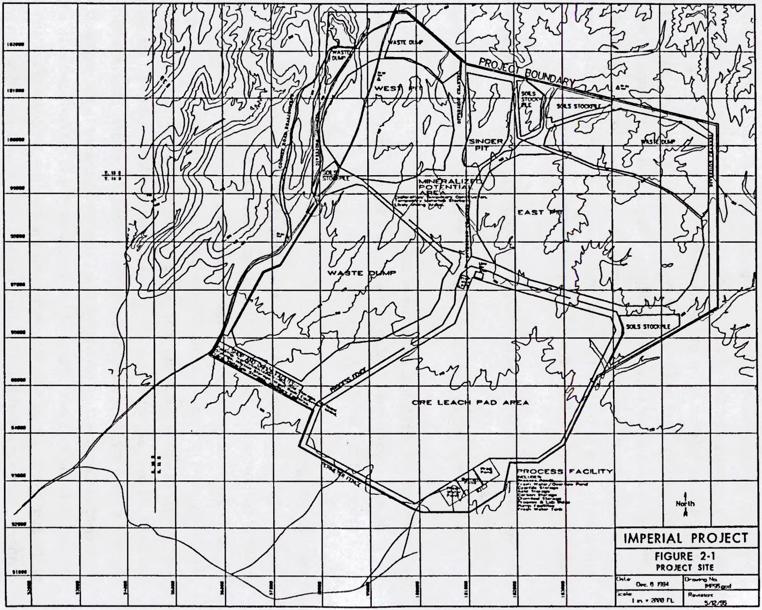
In this report we present the baseline vegetation analysis for the Imperial Project for Chemgold, Incorporated. This project is a proposed gold mine located in Imperial County, California, in the Sonoran Desert about 15 miles west of the Colorado River. Our study involved an intensive field trip to the site to coordinate, design the program, and to conduct the vegetation surveys. This baseline report presents information on the vegetation resources with emphasis on present vegetative conditions. This study provides information in sufficient detail to support state and federal environmental review and permitting requirements, and to determine impacts of proposed actions. Our quantitative descriptions include percent of vegetative cover in addition to density and diversity measurements.

The vegetation data we collected provides information for the following activities or requirements:

- support the application for a use permit and Plan of Operations and reclamation planning,
- support and supply information for an EIS, and
- provide species identification and estimated densities for permitting, clearing, and salvage of protected native plants.

2.0 SITE DESCRIPTION

The general study area encompassed the project site plus a buffer zone of about 200 feet for a total of approximately 1700 acres. The project site is at an elevation of 750 to 875 feet in a broad relatively flat dissected drainage basin southeast of the Chocolate Mountains. The Imperial Project is located in Imperial County, California, 45 miles northeast of El Centro and 5 miles west of Ogilby Road (see map on Figure 2-1). The landform consists of a type of dissected old river alluvial or piedmont deposits that have formed upland flats and gentle slopes interspersed with narrowly incised washes in broader drainages. The areas surrounding the project site are low mountain ranges; the Chocolate Mountains to the northwest, Cargo Muchachos to the southeast, Picacho Peak and Indian Pass to the north and east, and open to the southwest. Large drainage areas cross the site from the Indian Pass area to the northeast. Drainage is to the southeast in a series of well defined dry watercourses (washes) from the Indian Pass crest to the northeast to the Algodones Dunes in the southwest. The



IMPERIAL PROJECT
FIGURE 2-1
PROJECT SITE
PROJECT BOUNDARY
WASTE DUMP
WEST PIT
SINGER PIT
EAST PIT
SOILS STOCKPILE
MINERALIZED POTENTIAL AREA
ORE LEACH PAD AREA
PROCESS FACILITY
North

area topographically is characterized by low upland hills and flats with desert pavement surfaces interspersed with narrow dry washes.

The rock substrate over most of the site is a cemented alluvium covered by shallow soil with a broken discontinuous layer of basaltic cobbles and boulders from an eroded igneous outflow. The flats and uplands have lag gravel surfaces with a thin to non-existent residual soil layer overlying the cemented alluvium. These old erosional deflation surfaces are covered with gravel and boulders that have turned black due to oxidation of the rock minerals by the intense sunlight and heat, these surfaces on the rocks are referred to as desert varnish. The light and heat also bakes the soil surface around the rocks which forms a water impenetrable surface and, together with the varnished rocks, referred to as desert pavement. These surfaces support very little vegetation.

Narrow bands of sand and silt material accumulate in shallow washes and underneath shrubs. Shallow wash bottoms accumulate soil material up to a foot and a half deep. The larger, more active washes have a thin to deep veneer of recently deposited gravel and rock in the wash bottoms and fine sand along the channel sides. Channels are deeply incised in the washes, and the gravelly bottom channels support no vegetation. This erosional material moves through the site by the flushing action of water flow following infrequent storm events. Vegetation is absent in the active channels, but is abundant on the stable banks and shallow side washes.

The washes flow only after storms, otherwise they are dry. We observed no springs, seeps, or permanently wet areas or wetlands during our comprehensive surveys on the project site. Water pools for a short time after rains in depressions in the sandy, gravelly washes. We did not observe or collect any wetland plants or wet soils in the area. The weather this spring season of 1995 had abundant moisture with significant rains, and the washes flowed for a short period of time. The weather patterns the last three years have been a wet cycle with periods of heavy rainfall that have produced excellent plant growth.

The weather patterns the last three years have been extremely favorable for plant growth and productivity. Late fall and winter rains have been favorable in 1991, 1992, and 1993. The winter season of 1994/1995 has been cool and rainy. When we conducted the surveys in June, there was good growth by perennial trees and shrubs, and by herbaceous annuals. The vegetative growth this season, and for the past three years has been the highest in the past 15-20 years. The results have been an increase in the growth of the perennial shrubs, and significant cover and productivity by annuals. The results of the vegetation surveys should be interpreted as representing the highest cover and diversity possible for the Imperial Project area. During a series of years with low rainfall, the cover can be less than a fourth of the values measured during this very favorable year.

3.0 VEGETATION ANALYSIS METHODS

We adapted the field surveys methods to sample the type of desert vegetation present in the study area and to increase the data's usefulness in estimating cover and determining shrub density. The quantitative vegetation survey technique we used utilized transects of linear plots laid end to end along straight compass lines and oriented parallel to the slopes and gradients. The vegetation type and patterns were qualitatively related to the abiotic factors of topographic position, erosion features, and soil types. Each transect was made up of 10 or 12 plots of variable size. In each plot, vegetative variables were recorded on standardized field data forms.

We conducted the quantitative field surveys on June 2 and 3, 1995. The locations, number of samples, variables recorded, and data analysis methods were determined as described below.

Sampling Locations

Nine transects were located to sample the major vegetation types in topographic locations typical for the site.

Number of Samples

Ten or twelve plots per linear transect were sampled in each of the 9 locations.

Variables

The variables were chosen to determine vegetation characteristics. The variables in the transects measured for vegetation were:

- percent cover by each plant species,
- total percent vegetative cover (also vegetative litter, rock, and bare ground), and
- total number and average size of shrubs (for density).

The percent cover of each plant species within each linear meter plot was determined by a visual estimation technique. We grouped all the plants of one species as a unit and visually assigned a cover value. Individual shrubs by species were counted in each plot. The aspect and degree of slope were measured with a Brunton compass. We estimated total percent vegetative cover visually, with the rock, vegetative litter, and bare ground estimates adding up to 100% ground cover.

We analyzed the transects for the vegetation parameters of ground cover, density, and diversity. Total vegetative ground cover was determined by averaging the estimated cover for all plots in each transect. Perennial shrub and tree densities were calculated by adding up the shrub/tree counts in each plot, averaging this number for all plots in a transect, and then adjusting this average per plot to a hectare and acre basis. Diversity was the total number of perennial plant species (shrubs, cactus, and trees) recorded in the plots along transects.

4.0 RESULTS OF SURVEYS

Vegetation on the project study area is typical for this hot, dry desert region of southern California. The vegetation consists of drought resistant perennial species, and annual species that germinate after sufficient rains. In this section, we present the results of the qualitative and quantitative field surveys conducted. The vegetation types and characteristics are discussed in relationship to topography, soils, and other abiotic factors. The plant community analysis and vegetation parameters of concern for determining reclamation success are calculated and presented.

4.1 General Description

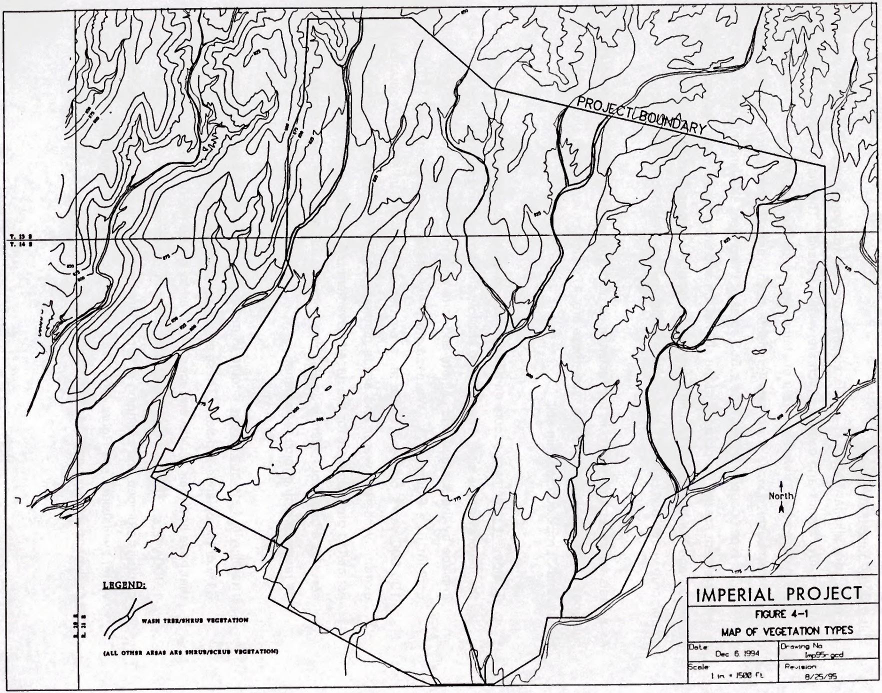
The vegetation on the project site is low desert scrub typical of the severe temperate desert areas. The low rainfall (annual average of 4 ½ inches measured during the past 10 years) and the high daytime temperature (up to 115 degrees fahrenheit in the summer) of the project area impose special requirements on the plant life. Vegetative cover is extremely low and species diversity is minimal. The existing vegetation is highly adapted to the desert heat and droughts. The vegetation community on the entire study area is a mixed desert scrub characterized by *Larrea tridentata* (creosote bush) and *Ambrosia dumosa* (burrobush). The perennial shrubs are the dominant vegetation, with a few herbaceous perennials present. Cover and productivity by annual species is dependent on seasonal moisture. In particular, the seasonal timing and amounts of rain are important. Autumn rains generally germinate the annuals, and late winter and spring rains promote growth. Rains were abundant this year after mid-December, so annual germination was moderate.

Previous human use impacting vegetation in the project site included roads and access trails and some previous trenching for exploration in the rock outcrop area. Plants have been periodically collected or cut, in particular, many of the older ironwood trees had been cut and were left as old stumps or resprouted bases on sides of washes throughout the project site.

4.2 Vegetation Types and Mapping

The vegetation in this portion of the Sonoran Desert is generally typed into one category, the creosote shrub type. For this report and reclamation purposes, we have divided the vegetation type in all locations of natural or semi-natural state into 2 types. These are: 1) a shrub/scrub vegetation type on the open, drier alluvial flats and slopes and 2) a tree/shrub vegetation type on sides of washes and drainages. Refer to Figure 4-1 for a map of these types. The shrub/scrub vegetation type is typical of the creosote type with shrubs being dominant and widely spaced. The tree/shrub vegetation type reflects the higher moisture availability in washes and drainages which results from rain run-off events. The vegetation on sides of the washes has greater diversity, variability, and ground cover.

The vegetation within each type differs in species distribution and abundance by location within the site, partly due to segregation of species into topographic features. There are broad patterns of vegetation related to topographic controls of soils and moisture. We have further divided the two vegetation types into subtypes based on species abundance due to their topographic positions.



PROJECT BOUNDARY
T. 13 S
T. 14 S
R. 20 E
R. 21 E
North
LEGEND:
WASH TREE/SHRUB VEGETATION
(ALL OTHER AREAS ARE SHRUB/SCRUB VEGETATION)
IMPERIAL PROJECT
FIGURE 4-1
MAP OF VEGETATION TYPES
Date Dec 6 1994
Drawing No Imp95rgcd
Scale 1 in = 1500 Ft
Revision 8/25/95

Shrub/Scrub Vegetation Type

The open, dry alluvial flats and gentle slopes have a shrub/scrub vegetation type which consists of low shrubs and cactus which are widely spaced. The major species of shrubs measured in the transects were (in order of abundance): *Encelia farinosa* (inciensio), *Ambrosia dumosa* (burrobush), *Larrea tridentata* (creosote bush), and *Opuntia bigelovii* (teddy-bear cholla). This type occupies 95% of the 1,565 acres of the project site, and includes all of the desert pavement areas. On portions of the alluvial flat and slope areas, desert pavement has developed and the vegetative ground cover is almost non-existent (less than 0.3%). The shrub/scrub vegetation is spotty and variable in distribution and species dominance.

As a basis for vegetation typing in the reclamation planning, we identified three topographic subtypes of shrub/scrub vegetation type, these are: 1) desert pavement, 2) alluvial flats and slopes, and 3) rock outcrop/thin soil.

- The desert pavement occurs on alluvial flats on old undisturbed surfaces and covers the majority of the site. These flat to shallow sloping sand and rock surfaces weather in-place by the sun and arid climate and form an impenetrable surface with high salt content (see Figure 4-2). We estimate these surfaces to be between 1,000 and 100,000 years old, and cover an estimated 35% of the uplands. Vegetation is extremely scarce, water and seeds generally cannot penetrate the surface. The estimated ground cover for the desert pavement is 0 to 0.5%. This subtype will not serve as a basis for reclamation planning since the soil and surface conditions cannot be restored during mine reclamation.

- The alluvial flats and slopes occurs in most upland areas and covers approximately 64% of the uplands and flats. These are areas within the desert pavement topography that have had their alluvial surfaces disturbed by erosion or deposition within the last 1,000 years. They are interspersed with desert pavement surfaces. Spacing of the plants is clumped and clumping is dependant on soil type, topographic position, and water availability (see Figure 4-3). Vegetative ground cover is higher than the desert pavement and was measured at 7 to 9%.

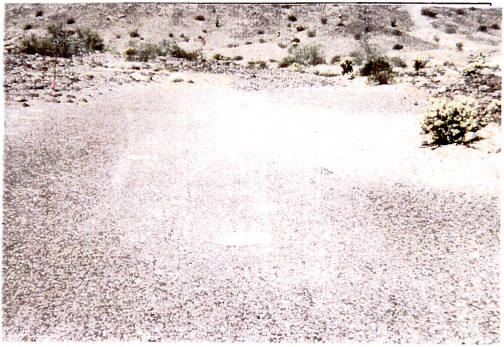


Figure 4-2 A desert pavement area showing lack of vegetation on gravel surface, Imperial Project, June 1995

Figure 4-3 Example of a broad upland flat and slope showing low vegetative cover, Imperial Project, June 1995

- The rock outcrop/thin soil areas occur on a small portion, about 1%, of the north-central portion of the site. Vegetation grows in the cracks of and between the rocks. The density of the vegetation is very low and is clumped around the available thin soil deposits and cracks in the rocks. The rocks have been highly baked by the sun and arid climate. An estimated 2 to 4 percent of the ground was covered by vegetation this season.

Tree/Shrub Vegetation Type

The tree/shrub vegetation type occurs o the sides and banks of washes created by the major water runoff from the upslope large drainage basins during significant precipitation events. This type covers a small percentage of the site at 5% (90 acres). Flooding and washing of the old alluvial material creates channels and disturbs the old, weathered surfaces. This allows better penetration of water and seed, and permits a higher cover than on the shrub/scrub vegetation type. A greater variety of plant species and a higher abundance of plants is the results. The major species include those found in the shrub/scrub vegetation type plus other species of trees and shrubs which occur principally in the washes. We identified two topographic subtypes of shrub/scrub vegetation type; these are: 1) broad major washes and 2) shallow subsidiary washes.

- The broad major washes form in the drainages that cross the study area and continue out onto the broad alluvial flats southwest toward the Algodones Dunes. These washes vary from almost flat to 15 feet deep and 8 to 225 feet (average 40 feet) wide. The sides of the washes are sandy and support trees and plants (normally above the high water mark), and occasional islands of thick vegetation form on raised islands of the wider sandy bottoms (see Figure 4-4). Vegetation in the major wash areas is the most abundant and diverse on the Imperial Site. Trees associated with the major washes include *Olynea tesota* (ironwood) and *Cercidium floridum* (palo verde), and several species of shrubs that occur mainly in washes such as *Bebbia juncea* (sweetbush) and *Hyptis emoryi* (desert lavender). Plant cover varies from 0% in sandy bottom areas to 66% (measured this year) on some sides and mid-wash vegetative clumps.

Figure 4-4 A large wash showing bare, sandy channel and well vegetated banks, Imperial Project, June 1995

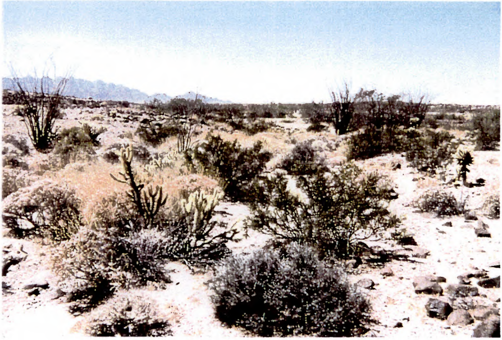


Figure 4-5 A shrub community in a shallow wash showing good vegetative cover, Imperial Project, June 1995

- The shallow subsidiary wash vegetation is similar to that in the major washes, and is equally as diverse and abundant including most of the upland species on the edges (see Figure 4-5). The washes are narrower (average 30 feet) and not as deep or broad, and have some finer soils washed or deposited in them. There are fewer and smaller trees. *Pleuraphis rigida* (big galleta), *Asclepias subulata* (ajameta-milkweed), *Calliandra eriophylla* (fairy duster), and *Hibiscus denudatus* (rose mallow) are additional species present. Slopes above and sides of these shallow washes support widely spaced barrel cactus. Vegetative cover is irregular on the bottoms and sides, and averaged from 35 to 45% during this year of excellent growth.

4.3 Plant Species Present

A list of the plant species found on the Imperial project site is given in Table A-1, Appendix A (nomenclature according to The Jepson Manual: Higher Plants of California, 1993, James C. Hickman, editor, University of California Press, Berkeley and Los Angles, California). The floristics of this area is typical for the southern hot (subtropical) California desert region. This is a low desert region with few frosts. There was a total of 112 plant species observed on the project site. There were no unusual plant assemblages or sensitive plant species present. There were several cactus species observed, and some species were fairly abundant such as *Opuntia bigelovii* (teddy-bear cactus). There are a few introduced species of plants, mainly grasses and mustards such as *Bromus tectorum* (downy chess) and *Brassica tournefortii* (mustard), that have become naturalized in the flora of the deserts.

4.4 Results of Quantitative Vegetation Surveys

The results of the survey are presented in the following sections. Total vegetative cover was abnormally high this year due to the abundant moisture this growing season and the three previous years. The identification and location of the transects are given in Table 4-1. We varied the size of the plots between transects to reflect the lower density of plants in some locations. The size was adjusted in order to obtain an adequate sample count.

4.4.1 Vegetative and Ground Cover

The results of the vegetative cover monitoring are presented in Table 4-2. The majority of perennial cover is by shrubs. The average total cover for all vegetation measured in the

Table 4-1 Identification and Locations for Vegetation Surveys for Imperial Project, June 1995						
Transect No.	Survey Date	Size (in meters)			No. of plots	Location
		width	length	total (m^2)		
NW-1	6/2/95	2	30	60	12	Northwest - wash in flats (1% grade)
NW-2	6/2/95	2	30	60	10	Northwest - wash in flats (1% grade)
NC-1	6/3/95	2	30	60	10	North Central - flats between drainages
NE-1	6/3/95	2	30	60	10	Northeast on slopes - upland pavement/float (dissected)
WC-2	6/2/95	2	30	60	10	West Central - upland slope
WC-1	6/2/95	2	10	20	12	West Central - shallow wash on upland
EC-1	6/3/95	2	10	20	10	East Central - along secondary entrenched wash - channel 20-25'; banks 15-25'
SE-1	6/3/95	4	30	120	10	Southeast - major broad wash on east side
NW-3	6/3/95	2	10	20	10	Northwest - main wash (deeply incised) - sandy bottom 35-40'; banks 25-35'

Table 4-2 Summary of Average Percent Ground Cover Results for Vegetation Transects, Imperial Project, June 1995.							
Transect No.	Rock	Bare	Litter	Plant*	Trees & Shrubs	Herbaceous	
						Annual	Perennial
NW-1	68	22	3	7	1	6	1
NW-2	66	24	4	7	1	5	1
NC-1	61	27	3	9	2	7	0
NE-1	69	24	3	7	3	3	3
WC-2	19	19	5	7	2	3	2
WC-1	8	40	14	38	33	10	2
EC-1	10	28	21	42	35	15	2
SE-1	29	30	8	34	33	10	0
NW-3	6	17	12	66	63	14	1

* Plant cover does not include canopy overlap.

transects varied from 7% to 66%. This wide variation was dependant on the location of the transects; uniform vegetation cover on the upland flats and slopes averaged about 7% for 5 transects, and cover associated with washes averaged 45%. There was abundant winter rains late in the season, and cover and productivity by annual species was moderate this year at 8% cover in the transects. This amount of vegetative cover represents a maximum for this type of vegetation in this desert location due to excellent growing conditions this season. Rock, bare ground, and litter also varied widely depending on the location and soil cover.

4.4.2 Perennial Plant Diversity and Density

Perennial plant diversity and densities is presented in Table 4-3. The highest number of perennial plant species per transect was 10 and the lowest was 5. The average number of perennial plant species was 7.6 per transect. This is a medium to low diversity for desert vegetation and is typical for this lower desert region. This desert with extremely low rainfall requires highly adapted plant species, especially for perennial species. The wide spacing of plants allows for maximum water availability for individuals. The large size of our plots maximized the diversity index.

Table 4-3 Summary of Shrub Density and Diversity Results, Imperial Project, June 1995.			
Transect No.	Shrub density		Shrub diversity
	shrubs/hectare	shrubs/acre	
NW-1	167	67	6
NW-2	367	147	6
NC-1	333	133	6
NE-1	383	153	8
WC-2	450	180	7
WC-1	6,167	2,467	8
EC-1	2,200	880	10
SE-1	567	227	10
NW-3	1,650	660	10

The density of shrubs and trees was widely variable depending on the location of the transect (see Table 4-3). The lowest density of shrubs was in upland shrub scrub vegetation type at 67 plants per acre (167 plants per hectare), and the highest was in the shallow washes at 2,467 plants per acre (6,167 plants per hectare). The average shrub density measure in the transects over the entire project site was 546 per acre (1,365 per hectare). However, the higher densities (average 1,058 per acre) were only in less than 4% of the project site area, and the lower densities (average 136 per acre) were in the remaining 96% area. An adjusted density based on averages in the two vegetation types calculates to 173 plants per acre (432 plants per hectare).

The most common shrubs as indicated by the densities (Table 4-4) are in order of abundance *Encelia farinosa* (inciensio), *Ambrosia dumosa* (burrobush), *Larrea tridentata* (creosote bush), and the cactus *Opuntia bigelovii* (teddy-bear cholla). The two common tree species, *Olneya tesota* (desert ironwood) and *Cercidium floridum* (palo verde), are mostly confined to washes

Table 4-4 Perennial Species Count in Transects, Imperial Project, June 1995.									
Plant Species	Transect No.								
	WC-1	WC-2	NW-1	NW-2	NW-3	NC-1	NE-1	EC-1	SE-1
Trees and Tall Shrubs									
Cercidium floridum	9	0	0	0	0	0	0	0	2
Olneya tesota	0	0	[illegible]	0	1	0	0	1	2
Shrubs									
Acacia greggii	0	0	0	0	[illegible]	0	0	0	0
Ambrosia dumosa	39	[illegible]	2	10	2	2	3	5	3
Bebbia juncea	0	0	0	0	[illegible]	0	0	7	14
Calliandra eriophylla	18	0	0	0	0	0	0	2	0
Encelia farinosa	54	[illegible]	1	[illegible]	12	[illegible]	[illegible]	8	23
Fouquieria splendens	1	1	0	0	0	1	[illegible]	0	0
Hibiscus denudatus	9	0	0	0	[illegible]	0	0	0	0
Hyptis emoryi	0	0	0	0	1	0	0	[illegible]	4
Krascheninnikovia lanata	0	0	0	0	0	0	0	[illegible]	3
Larrea tridentata	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]
Lycium andersonii	9	0	0	0	[illegible]	0	0	7	14
Stephanomeria pauciflora	0	0	1	0	1	0	0	0	3
Grasses									
Pleuraphis rigida	18	0	0	0	0	0	0	[illegible]	4
Cactus									
Ferocactus cylindraceus	0	0	0	0	0	0	1	0	0
Opuntia basilaris	0	3	0	0	0	2	0	0	2
Opuntia bigelovii	0	5	6	3	0	11	13	0	0
Opuntia echinocarpa	7	2	0	1	0	0	0	0	0

at relatively low densities.

4.2.3 Plant species of concern

There are four plant species of concern or sensitive species under review potentially occurring at the proposed site:

- *Escobaria vivipara* var. *alversonii* (foxtail cactus)
- *Opuntia munzii* (Munz's cholla)
- *Salvia greatei* (orocopia sage)
- *Palafoxia arida* var. *gigantea* (giant spanish needle)

These species are all Federal Candidate (C2) species, species that need more study. The potential habitats for these species is toward the north and west of the project site. The proposed project site was surveyed for the species by walking transects in likely areas, and in the site in general. None of these species were observed and there is no evidence that they occur within the proposed project site.

5.0 SUMMARY AND DISCUSSION

The biological resources within the Imperial Project are typical for the lower, hot climate of this Sonora Desert region in southeastern California. The vegetation of the Imperial Project site is a typical desert creosote bush shrub scrub. There were two general types present: a shrub/scrub vegetation dominated by widely spaced shrub plants on alluvial flats and slopes; and tree/shrub vegetation with small trees and a greater diversity of shrubs associated with the washes and drainages. The shrub/scrub vegetation type covered 96% of the study area within the project boundaries. Topographic and soil differences occur over the study area and this was reflected in the varied heterogeneous vegetation types and patterns on the project site.

The dominant shrubs are *Encelia farinosa* (inciensio), *Ambrosia dumosa* (burrobush), *Larrea tridentata* (creosote bush), and the cactus *Opuntia bigelovii* (teddy-bear cholla). The two common tree species, *Olneya tesota* (desert ironwood) and *Cercidium floridum* (palo verde), are mostly confined to wash areas at relatively low densities. Perennial shrubs are the dominant vegetation, with trees and a few herbaceous perennials present on the sides and islands of the washes. There were abundant winter rains late in the season, and cover and productivity by annual species was moderate this year at 8% cover in the transects. There are no sensitive habitats, assemblages of plants, or sensitive or endangered species present.

The average cover measured this season was 7% total plant cover in the shrub/scrub, and 45% cover in the tree/shrub wash vegetation. This vegetative cover was extremely high due to the excellent weather conditions this growing season, and represents a maximum to be expected in this desert location. Diversity (number of species) averaged 7.6 per transect, a medium to low diversity indicating the low number of perennial species and wide spacing of individual plants. Density of shrubs in shrub/scrub vegetation type was 67 plants per acre (167 plants per hectare), and the highest was in the shallow washes at 2,467 plants per acre (6,167 plants per hectare). The higher densities (average 1,058 per acre) were only in less than 4% of the project site area, and the lower densities (average 136 per acre) were in the remaining 96% area. An adjusted density based on averages in the two vegetation types calculates to 173 plants per acre (432 plants per hectare).

Reclamation of the area can be accomplished using methods we are presently using and testing at the nearby gold mining project near Picacho Peak and in the Cargo Muchacho Mountains. These methods include recontouring for moisture enhancement, no irrigation, and revegetation using native plant species from seed. Most of the larger washes in the central portion of the project site will not be disturbed during mine development. Plant specimens can be salvaged during mine construction, and include species of cactus and *Fouquieria splendens* (ocotilla). These plants can be marked prior to start of construction, and relocated to appropriate sites.

APPENDIX A

Table A-1 List of Plant Species at Imperial Project, June 1995.

Scientific Name	Common Name
Trees and Tall Shrubs	
Cercidium floridum	palo verde
Olneya tesota	desert ironwood
Phoradendron californicum	mistletoe (parasitic on trees)
Prosopis velutina	mesquite
Shrubs	
Acacia greggii	catsclaw
Ambrosia dumosa	burrobush
Asclepias subulata	milkweed
Bebbia juncea	sweetbush
Calliandra eriophylla	fairy duster
Ditaxis lanceolata	lance-leaved ditaxis
Ditaxis neomexicana	ditaxis
Encelia farinosa	inciensio
Fouquieria splendens	ocotillo
Hibiscus denudatus	rose mallow
Hymenoclea salsola	cheesebush
Hyptis emoryi	desert lavender
Krameria erecta	purple heather
Krameria grayi	desert ratany
Krascheninnikovia lanata	winterfat
Larrea tridentata	creosote bush
Lycium andersonii	box thorn
Nicotiana obtusifolia	tobacco
Porophyllum gracile	odora

Table A-1 List of Plant Species at Imperial Project, June 1995.	
Scientific Name	Common Name
Psorothamnus schottii	indigo bush
Simmondsia chinensis	jojoba
Stephanomeria pauciflora	wire lettuce
Grasses	
Achnatherum speciosum	desert needlegrass
Aristida purpurea	triple-awned grass
Bromus madritensis	red brome
Bromus tectorum	downy chess
Cynodon dactylon	bermuda grass
Erioneuron pulchellum	fluff grass
Muhlenbergia porteri	muhly
Pleuraphis rigida	big galleta grass
Schismus barbatus	mediterranean grass
Herbs	
Allionia incarnata	windmill
Amsinckia tessellata	fiddleneck
Asclepias subulata	ajamete
Atrichoseris platyphylla	gravel-ghost
Brassica tournefortii	mustard
Calycoseris wrightii	yellow tack-stem
Camissonia boothii	booth's evening primrose
Camissonia brevipes	evening primrose
Camissonia claviformis	club evening primrose
Camissonia refracta	narrow-leaved primrose
Chaenactis carphoclinia	pebble pincushion
Chaenactis stevioides	chaenactis

Table A-1 List of Plant Species at Imperial Project, June 1995.	
Scientific Name	Common Name
Chamaesyce albomarginata	white-fringed sandmat
Chamaesyce polycarpa	prostrate spurge
Chenopodium sp.	pigweed
Chorizanthe brevicornu	brittle spine-flower
Chorizanthe corrugata	corrugata
Chorizanthe rigida	spiny chorizanthe
Cryptantha angustifolia	narrowleaved forget-me-not
Cryptantha barbigera	bearded forget-me-not
Cryptantha circumscissa	western forget-me-not
Cryptantha dumetorum	flexuous forget-me-not
Cryptantha holoptera	winged cryptantha
Cryptantha maritima	white-haired forget-me-not
Cryptantha micrantha	Nevada forget-me-not
Cryptantha nevadensis	Nevada forget-me-not
Cucurbita palmata	coyote melon
Dalea mollissima	indigobush
Descuriana pinnata	yellow tansy mustard
Eremalche rotundifolia	desert five-spot
Eriastrum diffusum	eriastrum
Eriogonum inflatum	desert trumpet
Eriogonum pusillum	yellow turbin
Eriogonum thomasii	thomas buckwheat
Erodium texanum	desert heron's bill
Eschscholtzia minutiflora	little gold poppy
Euphorbia eriantha	beetle spurge
Fagonia laevis	smooth-stemmed fagonia

Table A-1 List of Plant Species at Imperial Project, June 1995.	
Scientific Name	Common Name
Geraea canescens	desert sunflower
Gilia spp.	gilia
Gilia latifolia	gilia
Guillenia lasiophylla	california mustard
Gutierrezia microcephala	sticky snakeweed
Hesperocallis undulata	desert lily
Horsfordia newberryi	yellow felt-plant
Langloisia setosissima	langloisia
Lepidium lasiocarpum	peppergrass
Loeseliastrum schottii	calico
Lotus strigosus	lotus
Mentzelia albicaulis	small-flowered blazing star
Mentzelia involucrata	sand blazing star
Mohavea confertifolia	ghost flower
Mirabilis bigelovii	four o'clock
Monoptilon bellioides	desert star
Nama demissum	purple mat
Nemacladus glanduliferus	thread plant
Nemacladus rubescens	rigid-stemmed thread plant
Oligomeris linifolia	linear-leaved cambess
Pectocarya platycarpa	broad-nutted comb-bur
Perityle emoryi	rock daisy
Phacelia crenulata	notch-leaved phacelia
Phacelia distans	fern phacelia
Phacelia fremontii	fremont phacelia
Plantago ovata	plantain

Table A-1 List of Plant Species at Imperial Project, June 1995.	
Scientific Name	Common Name
Psathyrotes ramosissima	turtleback
Salsola tragus	russian thistle
Salvia columbariae	chia
Sarcostemma cyanchoides	climbling milkweed
Streptanthella longirostris	small jewelflower
Tiquilia canescens	tiquilia
Trichoptilium incisum	yellow-head
Trixis californica	trixis
Uropappus lindleyi	silver puffs
Cactus	
Echinocactus polycephalus	cotton-top cactus
Ferocactus cylindraceus	barrel cactus
Mammilaria tetrancistra	nipple or fishhook cactus
Opuntia acanthocarpa	buckhorn cholla
Opuntia echinocarpa	golden cholla
Opuntia basilaris	beavertail cactus
Opuntia bigelovii	teddy-bear cholla
Opuntia ramosissima	pencil cactus

(Nomenclature according to The Jepson Manual, 1993)

Adapted from a list of plant species by Ted Rado, Consulting Biologist, Riverside.

This page intentionally left blank
for reproduction purposes.

APPENDIX G WASH VEGETATION AND HABITAT SURVEY, IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA (MAY 1997)

WASH VEGETATION AND HABITAT SURVEY

IMPERIAL PROJECT

IMPERIAL COUNTY, CALIFORNIA

Prepared by:

Samuel A. Bamberg, Ph.D.
Bamberg Associates
26050 E. Jamison Circle
Aurora, Colorado 80015

May l997

1.0 INTRODUCTION

This is a report on a baseline wash vegetation and habitat analysis for the Chemgold, Inc., Imperial Project. The proposed project is located in Imperial County, California, in the Sonoran Desert about 15 miles west of the Colorado River, 45 miles northeast of El Centro, and 5 miles west of Ogilby Road. This baseline report presents information on the vegetation and habitats in the washes which cross and drain from the project site. The study focused on biological resources in the washes with emphasis on present vegetative conditions, past and present uses, and habitat types and utilization by animals. This study provides information in sufficient detail to support county, state, and federal environmental review and permitting requirements, and to determine impacts and mitigation of proposed mining and support activities.

1.1 Background

Washes on the project site support, in part, a habitat termed 'microphyll woodland'. Microphyll woodland has been determined by the United States Fish and Wildlife Service, and the California Department of Fish and Game as a sensitive habitat type. Microphyll woodland is characterized by short trees of *ironwood (olneya tesota)* and *palo verde (Cercidium floridum)* and medium to tall shrubs. This habitat is widespread and common in the Sonoran Desert of southeastern California and southern Arizona and occurs along and in well-developed dry washes. Microphyll woodland on the project site covers approximately 140 acres of which 84 acres will be disturbed by mining activities. The remainder of the wash acreage is characterized as desert shrub/scrub type, which contains a mixture of low and taller shrubs, but does not support trees (Bamberg Associates, 1995).

Agricultural development for irrigated crops along major streams and washes has been the principal impact to this habitat type, with secondary impacts from historic wood-cutting and recent recreation use by off-road vehicles and campers. Deer are reported to use the wash habitats for foraging and travel corridors. Deer are widely distributed in and around the project site (Rado, 1995).

1.2 Objectives of the study

The objective this study is to characterize the present conditions of the specific wash habitats on the proposed mine site. The vegetation and habitat data collected provides information for the following activities or requirements:

1) support and supply supplemental information for the Environmental Impact Statement (EIS),
2) support the mitigation plans and measures proposed in the EIS, Plan of Operations, and reclamation planning,
3) provide species identification and estimated densities for permitting, clearing, and salvage of sensitive native plants,
4) provide information for habitat reclamation in those wash habitats displaced by mine activities.

1.3 Project diversions and wash disturbance proposed

The proposed mine project design requires diversion of five wash reaches (total of 33.6 acres). These areas lie in the upper drainages of the three primary washes in the northern part of the site. Other mine facilities will disturb or impact an additional 50.0 acres for a total of 83.6 acres of disturbed microphyll wash habitat. Approximately 56 acres of microphyll woodland habitat within the three primary wash systems will remain undisturbed.

2.0 SITE DESCRIPTION

The project site ranges in elevation from 760 to 925 feet in a broad relatively flat, dissected drainage basin southeast of the Chocolate Mountains. The landform at the project site consists of dissected river alluvial or piedment deposits that have formed upland flats and gentle slopes interspersed with narrowly incised washes in the broader drainages. Two large drainage areas cross the site from the Indian Pass area to the northeast. Drainage is to the southeast in a series of well defined dry watercourses (washes) from the Indian Pass crest to the northeast to the Algodones Dunes in the southwest. Topographically, the area is characterized by low upland hills and flats with desert pavement surfaces interspersed with narrow dry washes.

2.1 Project site characteristics

The rock substrate over most of the site is a cemented alluvium covered by shallow soil with a broken discontinuous layer of basaltic cobbles and boulders from an eroded igneous outflow. The dry washes are incised into this cemented alluvium which in places is exposed as channel bottoms. The washes flow only after storms, otherwise are dry. Water pools in shallow depressions in the sandy, gravelly washes for a short time after rain events. No springs, seeps, or permanently wet areas or wetlands were observed during comprehensive surveys of the project site.

In the larger washes, a veneer of gravely and sandy soil up to three (3) feet thick forms the active channel. In the smaller washes, this accumulation can be up to one (1) foot in thickness. Narrow bands of sand and silt accumulate on the banks of the larger incised drainages, under trees and shrubs growing within the the drainages, and along the bottoms and sides of the shallow washes. The gravel in the bottom of the larger incised washes support little or no vegetation. This is generally caused by the flushing action of the gravel during significant flow events. Significant vegetation does however occur on the banks of the larger drainages and within the shallow side washes.

The vegetative baseline survey for the Imperial Project was conducted during June of 1995 (Bamberg Associates, 1995). That survey followed a period where weather conditions for three out of the four previous years were extremely favorable to plant growth and productivity. The winter season of 1994/95 was cool and rainy providing good growth of perennial trees and shrubs, and herbaceous perennials and annuals.

The growth measured during the baseline survey was estimated at the highest in the past 15-20 years, and therefore, the results reported in the baseline vegetation survey should be considered as the highest cover and diversity possible for the Imperial Project.

Since the 1995 baseline survey (22 months), the project area weather conditions have been extremely dry with less than 0.25 inches of rain and no flow in the washes. There has been no annual germination, and little or no visible growth of trees or shrubs during the current wash habitat survey. Observed plant cover and productivity during this present study are therefore much less than those reported during the 1995 baseline survey.

2.2 Wash vegetation and habitats

There were two major type of vegetation on the project site: 1) a shrub/scrub vegetation type on the open, drier alluvial flats, slopes and shallow washes, and 2) a tree/shrub vegetation type on sides of washes and drainages. The tree/shrub vegetation type reflects the higher moisture availability in washes and drainages from rain run-off events. The vegetation on sides of the washes has greater diversity, variability, and ground cover. The vegetation within each type differs in species distribution and abundance by location within the site, partly due to segregation of species into topographic features.

The shrub/scrub vegetation type occupies approximately 91% of the project site. The shrub/scrub vegetation is spotty and variable in distribution and species dominance. On portions of the alluvial flat and slope areas, desert pavement is well-developed and the vegetative ground cover is almost non-existent (less than 0.3% average cover) (Figure 2.1).

The tree/shrub (microphyll woodland habitat) vegetation type occurs on the sides and banks of washes created by the major water runoff from large upslope drainage basins during significant precipitation events. This type of vegetation covers a small percentage of the site at about 9% (140 acres). Two topographic subtypes of tree/shrub vegetation type were identified; these are: 1) broad major washes and 2) shallow subsidiary washes. The major species include those found in the shrub/scrub vegetation type plus other species of trees and shrubs which occur principally in the washes.

The broad major washes form in the three drainages that cross the study area and continue out onto the broad alluvial flats southwest toward the Algodones Dunes. These washes vary from almost flat to 15 feet deep and 8 to 225 feet (average 40 feet) wide. The sides of the washes are sandy and support trees and plants (normally above the high water flow levels), and occasionally thick vegetation forms on raised islands in the sandy bottoms of the wider washes. Vegetation in the major wash areas is the most abundant and diverse on the project site. Trees associated with the major washes include ironwood (*Olynea tesota*) and palo verde (*Cercidium floridum*). Several species of shrubs also occur mainly in washes such as sweetbush (*Bebbia juncea*) and desert lavender (*Hyptis emoryi*). Plant cover varies from 0% in sandy bottom areas to 76% (measured in 1997) on some sides of washes and mid-wash vegetative clumps (Figure 2.2).

The shallow subsidiary wash shrub/scrub vegetation is similar to that in the major washes, and is equally diverse and abundant, including most of the upland species on the edges except trees. The washes are narrower (average 30 feet) and not as deep or broad, and have some finer soils deposited in them. There are fewer and smaller isolated trees or they may be absent(Figure 2.3). Additional species present are big galleta grass (*Pleuraphis rigida*), ajameta-milkweed (*Asclepias subulata*), fairy duster (*Calliandra eriophylla*), and rose mallow (*Hibiscus denudatus*). Slopes immediately above, and the sides of these shallow washes, support widely spaced barrel cactus (*Ferocactus cylindraceus*). Vegetative cover is irregular on the bottoms and sides, and averaged from 35 to 45% during 1995, a season of excellent growth. This cover type was not sampled in 1997.

3.0 SURVEY AND ANALYSIS METHODS

Survey methods were designed to accommodate the linear configuration of the wash habitat. Vegetation surveys were conducted at nine sites of varying areas. The sample sites were selected within sections of washes proposed to be diverted or otherwise disturbed by mine activities, and were sampled up- and down gradient from the diversions. Multiple transects were sampled at each site, the number adjusted for site size and topography. Survey site locations and transect number and dimensions are presented in detail in Table 3.1. Additionally, complete censuses of microphyllous tree species were conducted along reaches of three main washes.

3.1 Vegetation transects

Vegetation surveys were conducted from January 21 to 24, 1997. Standard quantitative vegetation techniques were used. Vegetation variables were sampled along transects that comprise linear plots laid end to end, perpendicular to the washes. Each transect included both banks of the wash. Therefore, the number and dimensions of the plots depended on the width of the wash reach at each site. All vegetation variables and site descriptions were recorded on standardized field data forms. Wash survey areas and transects are shown in Figure 3.1.

Vegetation at each transect site was characterized by:

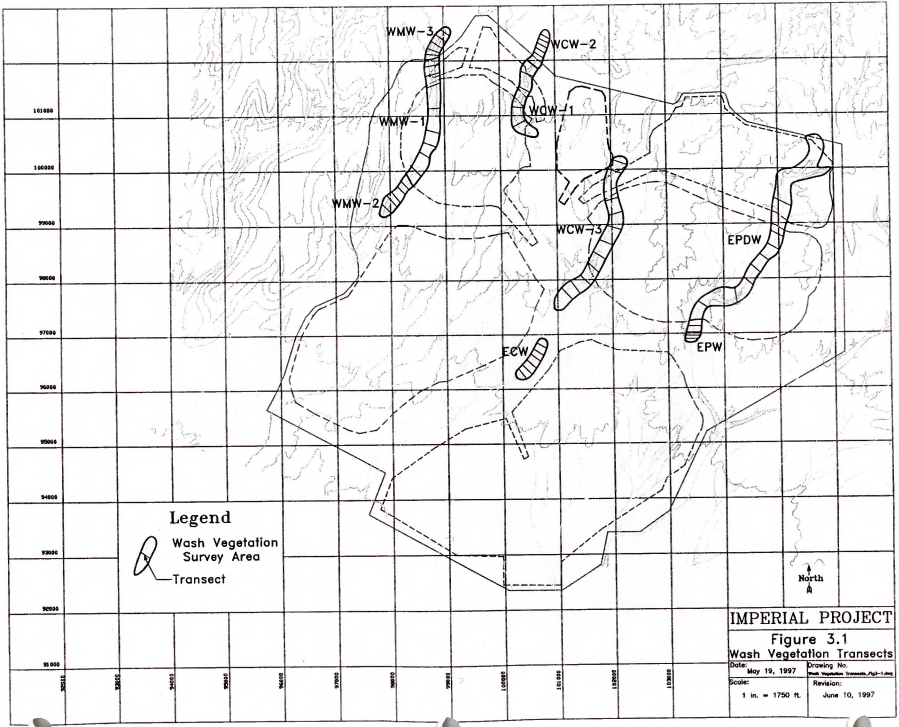
- percent cover by each plant species
- total vegetation cover per transect
- density per plant species
- plant species diversity

All plants (shrubs, trees, cacti, and grasses) rooted in a transect were tallied by species and each individual was assigned a cover value, based on visual estimation. In addition the diameter of all shrubs was recorded. Woodland trees were measured for width, height, and number of stems.

Figure 2.1 Upland habitat on the Imperial Mine site. Desert pavement is well-developed and vegetation is sparse in this habitat.

Figure 2.2 A broad wash on the Imperial Mine site. The sides of the washes are sandy and support trees and plants (normally above the high water mark). Occasional islands of thick vegetation form on raised islands in the sandy bottoms of the wider washes. Vegetation in the major wash areas is the most abundant and diverse on the Imperial Site.

Figure 3.1



WMW-3
WCW-2
WCW-1
WMW-1
WMW-2
WCW-3
EPDW
EPW
ECW
101000
100000
99000
98000
97000
96000
95000
94000
93000
92000
91000
Legend
Wash Vegetation Survey Area
Transect
North
IMPERIAL PROJECT
Figure 3.1
Wash Vegetation Transects
Date: May 19, 1997
Drawing No.
Scale: 1 in. = 1750 ft.
Revision: June 10, 1997

The cover of each individual plant was estimated as a percent of the total area of the plot it was rooted in. Cover per species was determined by adding the cover values of all individuals in that species. Total vegetation cover for each transect was calculated by adding the cover values of all individuals in all plots. Because of vegetation structure and overlap of tree and shrub canopy, this value was occasionally greater than the actual canopy coverage.

Plant species densities were calculated by adding the number of individuals of each species in a transect and adjusting this total per transect into an acre unit, i.e., numbers per acre. Plant species diversity was the total number of plant species recorded within all transects at each site.

3.2 Microphyllous tree census

Ironwood and palo verde are the dominant tree species that characterize the microphyllous woodland habitat. These species were sampled using a census technique. Reaches of washes were walked and all individuals of both species were tallied by size class. Three size classes were used:

1) less than 6 feet tall
2) 6 to 12 feet tall
3) greater than 12 feet tall

Shrub species observed in each sample reach were recorded. Site condition, evidence of human land use, and wildlife habitat utilization were also recorded for each reach.

3.3 Topographic and hydrologic analysis

Dimensions across sections of each watercourse reach were recorded, and roughly drawn for the bank and channel widths. The cross sections were photographed. Characteristics of the banks and channels for depth and configuration were noted to qualitatively determine recent flows and storm events. Effects on vegetation and deposition along the washes were also noted.

3.4 Habitat analysis and use

The structure of the wash habitats was determined from the quantitative measurement surveys and from qualitatively noting conditions of plants growth, productivity, mortality, parasitism, and other utility factors. Evidence of habitat use in the form of tracks, cut ends of branches denoting browsing, scat, distribution deer pellets groups, burrows, animal remains, and other signs of use, was noted. Species of trees and shrubs browsed were noted along with other signs of herbivory. In particular, many species of trees and shrubs had large patches of bark chewed indicating herbivory by small mammals in this dry period.

4.0 RESULTS OF SURVEYS

The results of the surveys are presented for general conditions of the washes in winter of 1996/97 followed by the results of the qualitative surveys. A qualitative discussion is also presented for the habitat conditions and use by wildlife.

4.1 General description of washes and habitat

The washes surveyed in this study were selected to represent the range of physical diversity exhibited by these landforms on the mine site. The surveyed washes ranged from almost flat to a depth of 12 feet and from 6 to 140 feet wide. All of the washes represent ephemeral streams that flow only during run-off events from large upslope drainage basins. None of these washes are supported by permanent surface- or groundwater sources. None of the washes display evidence of ponding water or soil saturation, nor do they support riparian or hydrophytic flora.

The sides and banks of the washes are sandy and support the majority of wash vegetation. These trees and shrubs are generally rooted above the high water level. Wash bottoms are flat, composed of a one to three foot layer of sand, gravel, and cobbles and underlain by well cemented alluvium. Little vegetation occurs in the wash bottoms except on occasional raised islands in the wider washes.

All of the surveyed washes show evidence of recent human visits. Automobile and off-road vehicle tire tracks were found running up the flat bottoms of all of the surveyed washes. Litter and shot gun shells were also often encountered. Many of the washes contain evidence of historic human use as well. It appears that ironwood in these areas were heavily logged about 100 years ago during the late 19th century. The wood was presumably used for firing boilers in river boats on the Colorado river, and possibly for firewood during early mining. The evidence for this heavy logging is based on living tree sizes and age classification, and resprouted stumps. All of the larger ironwood trees present are re-sprouted from cut stumps. These stumps have been cut with axes, as there was no evidence of chain saw marks on them (Figure 4.1). The re-sprouting response by the ironwood trees to this logging is striking. There are also numerous cut stumps of ironwood that did not resprout, and are present now as dead stumps that have not decayed (Figure 4.2). There were many mid-sized trees and seedlings counted in the tree census that have germinated and grown since the period of tree cutting. The present-day density of ironwood trees is, therefore, the result of regeneration during the past 100 years. No palo verde were cut, since these trees have pulpy wood of poor quality for use or burning.

4.2 Results of quantitative vegetation surveys

Vegetation was found to be typical for the microphyll woodland community that occurs in the surveyed washes. The habitat type is dominated by wide spaced ironwood and palo verde trees, with woody perennials and shrubs as co-dominants in the intervening spaces. Some large cacti and one perennial grass species were also present in some areas.

Figure 4.1 All of the larger ironwood trees sampled along washes on the Imperial MIne site are re-sprouted from cut stumps. These stumps appear to have been cut with axes, as there was no evidence of chain saw marks.

Figure 4.2 Numerous cut stumps of ironwood sampled in washes on the Imperial Mine site have not resprouted, nor have they decayed.

This page intentionally left blank
for reproduction purposes.

The following sections present the quantitative results of the vegetation surveys. A list of plants sampled during this survey is presented in Table 4.1. Vegetation variables for each sample site are presented in Tables 4.2 to 4.10. These data are summarized in Table 4.11.

4.2.1 Vegetative and ground cover

Vegetative cover is relatively high in the surveyed washes as compared to the surrounding upland areas. Mean vegetative cover values for perennial plants range from 33 to 76 percent at the nine surveyed sites. As expected, the tree species completely dominate vegetative cover, usually contributing between 40 to 80 percent of the total cover on a site. Shrub species and cacti usually contribute between 13 to 20 percent of total cover at the survey sites. Exceptions to this were site WCW-1, which has very low shrub and total cover; and site EPW, which has very high shrub cover. There was no cover or growth of herbaceous perennials, nor any germination and growth of annual species measured during these surveys. Plant growth of perennial trees and shrubs was limited to minor extensions of existing branches. The cover values were affected by some death of whole trees and shrubs, and the die back of branches.

4.2.2 Perennial plant diversity and density

Plant species diversity is also relatively high in the washes compared to the surrounding upland areas. The number of perennial plant species recorded growing in any given surveyed wash ranged from 9 to 16. These species include 2 trees, 13 shrubs, 4 cacti, a perennial forb, and a perennial grass. All of the plant species recorded during the survey are presented in Table 4.1.

Both common tree species, ironwood and palo verde, were recorded in all surveyed sites. A number of shrubs are common to most of the sites. Inciensio (*Encelia farinosa*) and creosote bush (*Larrea tridentata*) were the most frequently encountered species, followed by box thorn (*Lycium andersonii*) and burrobush (*Ambrosia dumosa*). Other common shrubs are desert lavender (*Hyptis emoryi*) and sweetbush (*Bebbia juncea*).

Cacti occur in six of the nine surveyed washes. Teddy-bear cholla (*Opuntia bigelovii*) and buckhorn cholla (*Opuntia acanthocarpa*) are the most common. Big galleta grass (*Pleuraphis rigida*) is the only perennial grass encountered in the washes during the survey. This grass is found only at sites where cacti also occur, generally on the banks of shallow washes.

All of the plant species in the surveyed washes occur in densities of one to five individuals in the transect areas. When these densities are extrapolated to larger areas, these plants occur in a range of densities from 36 to 580 individuals per acre. Both ironwood and palo verde trees appear to grow in relatively even distributions of 73 to 145 individuals per acre (Tables 4.2 to 4.10). These trees are clumped on the stable wash banks and not in channels.

4.3 Tree density and conditions

Tree census results are presented in Table 4.12. In all four washes, both ironwood and palo verde trees show an age distribution skewed towards the largest size class (> 12 feet tall). Sixty-one percent of the ironwood trees and 50 percent of the palo verde fall within this size class. The middle class (6-12 feet tall) contains 32% and 31% of the sampled ironwood and palo verde trees, respectively. Eight percent of the ironwood and 19 percent of the palo verde trees are in the seedling size class (< 6 feet tall). These trends suggest that both populations are composed of healthy and long-lived individuals. Both populations are replacing themselves through viable seedlings, and surviving individuals of mid-size. The critical life cycle stage for both species appears to occur in this smallest, youngest size class. The seedlings occurred singly, or in groups of two or three individuals. There was no evidence that seedlings were confined to nursery bushes or occurred in a specific type of wash site.

Tree density is apparently controlled by available space and moisture conditions along the wash corridors. Competition for moisture by roots is a known important factor in spacing of desert plants. The ratio of above-ground shoot biomass (weight of live plant tissue) to below-ground root biomass is typically 1 unit above ground to 5 or 6 units below ground. The roots of these desert trees were observed to spread out along the banks of washes far beyond the tree canopy. The practical significance of this shoot/root ratio is that microphyll trees will only survive at a naturally adjusted density. This density should be simulated during replanting of trees and shrubs during revegetation. Trees planted at greater densities will not survive in a reclamation that promotes natural communities.

4.4 Topographic/hydrologic conditions

The washes were observed to be stable for topographic and geomorphologic processes. There was no recent evidence of significant channel cutting or deposition of sediment in the channels or along the banks during the last one hundred years since ironwoods were cut. There were no recent cut banks nor have any large trees or ironwood stumps been disturbed or moved by recent storm events or flooding. The washes have had low flows during the recent wet period as evidenced by slight modifications in the gravel sediment in the wash channels.

Upland surfaces and channel configurations also have probally been modified little in the last 10,000 years. The upland and flat desert pavement surfaces are old adjusted surfaces that have been in place for an equal amount of time.

The sediment erosion and deposition cycle is in equilibrium. There is no present erosion from topographic surfaces on the project site. The sediment transport in and through the washes from the watershed above the project also appear to be in equilibrium. The channel dynamics indicate a stable habitat with no significant changes or trends that will prevent use, or reclamation, of the wash habitats.

4.5 Qualitative analysis of habitat and animal use
Wash habitats were observed to be lightly utilized during this winter period by several species of mammals, but exhibited very little bird use. Reptiles were either dormant or in burrows. There were no active tortoises, and very few lizard species, observed. The lack of animal activity is partly the result of the time of year, but also because of the drought which suppressed plant growth and productivity.

Deer were active on the project site at this time of year as evidenced by numerous old and fresh pellet groups, and by browsing of trees and shrubs (Figure 4.3). One active deer was observed along the main wash on the site. The most commonly browsed plant species, in order of use, were inciensio, palo verde, cheesebush, sweetbush, and ironwood. Other species with some use were burrobush, fairy duster, box thorn, winterfat, and jojoba. No annual or herbaceous plant growth was available for browse this season. Other wildlife observed or noted were feral burro tracks and scat observed on the northeast portion of the study area, coyote and fox tracks and scat (one live coyote was seen), and possible tracks of a bobcat. Small mammals observed were jackrabbits, cottontail, and burrows of packrats, kangaroo rats and mice. One desert tortoise shell was noted in a shallow wash on the northeast portion of the project site.

One striking feature of herbivory noted during the wash surveys was the eating and chipping of large areas of bark on branches of many trees and shrubs. The bark was peeled away and the cambium underneath eaten to bare wood (see Figure 4.4). It is assumed that this was mainly by small mammals such as ground squirrels, packrats, and kangaroo rats and mice based on the pattern and extent of the bark chipping. Many branches up in the trees were girdled and the bared wood was smooth. Small mammals are probably resorting to this type of herbivory since no new stem growth or annual plants were available. The effects of the trees and shrubs will be the pruning and death of the branches or whole plant during the next spring and summer.

5.0 SUMMARY AND DISCUSSION
The types of wash vegetation and habitats conditions were surveyed on the Imperial Project Site study area. The washes ranged in depth from almost flat to a depth of 12 feet and from about 6 to 140 feet wide. All of the washes represent ephemeral streams in drainages that flow only during run-off events from large upslope drainage basins. None of these streams are supported by permanent water sources, and show no evidence of ponding water, soil saturation, or support riparian or hydrophytic flora. The sides and banks of the washes are sandy or stable rock outcrop and support the majority of wash vegetation. Little vegetation occurs in the wash bottoms except on occasional raised islands in the wider washes.

This page intentionally left blank
for reproduction purposes.

Figure 4.3 Fresh deer pellet piles in a wash bottom on the Imperial Mine site.

Figure 4.4 A notable sign of herbivory in washes on the Imperial Mine site was the chipping and consumption of large areas of bark on branches of many trees and shrubs. The bark has been peeled away and the cambium underneath eaten to bare wood.

Washes were observed to be stable with no recent evidence of significant channel cutting or deposition of sediment in the channels or along the banks during the last one hundred years since ironwoods were cut. No wash banks nor large trees or ironwood stumps have been disturbed or moved by recent storm events or flooding. The washes have had low flows during the recent wet period as evidenced by slight modifications in the gravel sediment in the wash channels. The erosion and deposition cycle for sediment is in equilibrium. Sediment transport in and through the washes from the watershed above the project area also seem to be in equilibrium. Channel dynamics indicate a stable habitat with no significant changes or trends that will prevent use or reclamtion of the wash habitats.

All of the surveyed washes had evidence of recent human visits with automobile and off-road vehicle tire tracks in the flat bottoms of all of the surveyed washes. Many of the washes contain evidence of historic human use with severe ironwood logging during the late 19th Century. The areas on the mine site were clear-cut for all ironwoods trees. The re-sprouting response by the ironwood trees to this logging is striking. The present density of ironwood trees is the result of regeneration during the past 100 years. There are also numerous cut stumps of ironwood that did not resprout and are present as dead stumps that did not decay. In addition to the resprouted trees, there were many mid-sized trees and seedlings counted in the tree census. Palo verde stands do not appear to have been harvested like the ironwood trees. This species produces pulpy wood, of poor quality for use or burning.

Vegetation is typical for the microphyll woodland community that occurs in the surveyed washes. Washes are dominated by wide spaced ironwood and palo verde trees, with woody perennials and shrubs as co-dominants in the intervening spaces. Mean vegetative cover values for perennial plants ranged from 33 to 76 percent at the nine surveyed sites. Tree species dominated vegetative cover at 40 to 80 percent of the total cover, and shrub and cacti usually contribute between 13 to 20 percent of total cover. There was no cover or growth of herbaceous perennials, nor any germination and growth of annual species measured during these surveys. New plant growth of perennial trees and shrubs was limited to minor extensions of existing branches. The cover values were affected by some trees and shrub mortality and the die back of branches due to the recent drought.

Plant species diversity was measured at 9 to 16 perennial plant species per sample site growing in any given surveyed wash. These species include two trees, 13 shrubs, 4 cacti, a perennial forb, and a grass. Both common tree species, ironwood and palo verde, were recorded in all surveyed sites. Inciensio and creosote bush were the most frequently encountered species, followed by box thorn, burrobush, desert lavender and sweetbush. Teddy-bear cholla and buckhorn cholla were the most common cactus, and big galleta grass was the only perennial grass encountered in the washes. Perennial plants occur in a range of densities from 36 to 580 individuals per acre. Both ironwood and palo verde trees appear to grow in relatively even distributions of 73 to 145 individuals per acre on the stable wash banks.

In all four washes surveyed, both ironwood and palo verde trees show an age distribution skewed towards the largest size class (> 12 feet tall). Sixty-one percent of the ironwood trees and 50 percent of the palo verde were in the large size class.
The middle size class (6-12 feet tall) contains 32% of the sampled ironwood and 31% palo verde trees; and 8% of the ironwood and 19 percent of the palo verde trees were in the seedling size class (< 6 feet tall). These trends suggest that both populations are composed of healthy and long-lived individuals, and tree populations are replacing themselves through viable seedlings and surviving individuals of mid-size.

Tree density and survival is apparently controlled by available space along these wash corridors, and moisture conditions. Competition for moisture by roots also is an important factor in spacing of desert plants. The ratio of above-ground shoot biomass (weight of live plant tissue) to below-ground root biomass is typically 1 unit above ground to 5 or 6 units below ground. The roots of these desert trees were observed to spread out along the banks of washes far beyond the tree canopy. The practical significance of this shoot/root ratio is that microphyll trees will only survive at a naturally adjusted density. This density should be simulated during replanting of trees and shrubs during revegetation. Trees planted at greater densities will not survive in a reclamation that promote natural species.

Observation of animal use in wash habitats showed light utilization during this winter period by several species of mammals and very little bird activity. Reptiles were either dormant or in burrows. No active tortoises, and very few lizard species, were observed. The lack of animal activity is the result of the season and the recent drought which suppressed plant growth and productivity. Deer were active on the project site at this time of year, and one active deer was observed on site. Several species of shrubs were browsed but no annual or herbaceous plant growth was available this season. Other wildlife observed or sign noted included feral burro tracks, coyote and fox tracks and scat, and possible tracks of a bobcat. Small mammals observed were jackrabbits, cottontail, and burrows of packrats, kangaroo rats and mice. Herbivory noted during the wash surveys was the eating and chipping of large areas of bark and cambium on branches of many trees and shrubs. Trees and shrubs will be affected by pruning and death of the branches or whole plant.

6.0 REFERENCES
Bamberg Associates. 1995. Vegetation Baseline Survey, Chemgold Imperial Project. Baseline Report - August 1995.

Rado, T. 1995. Biological Survey Report, Chemgold Imperial Project, California. Baseline Report - May 1995.

Table 3.1 Identification and locations of wash vegetation survey sites, Imperial Mine, January, 1997.

Site	Survey Date	Transect Dimensions			No. of Transects	Location
		Width (ft)	Length (ft)	Total (ft^2)		
WMW-1	1/21/97	6	50	300	10	West Main Wash - diversion reach Begins at road - transects run east to west
WMW-2	1/21/97	6	50	300	6	West Main Wash - south of diversion Begins 500' from south edge - transects run east to west
WMW-3	1/23/97	6	50	300	5	West Main Wash - upstream Begins at edge of side channel Transects run from center of wash
WCW-1	1/24/97	6	50	300	5	West Central Wash - diversion stretch
WCW-2	1/23/97	6	50	300	5	West Central Wash - upstream from diversion Transects run from center of wash
WCW-3	1/24/97	6	50-100	300-600	6	West Central Wash - below diversion (onsite) Transects cross wash, running east to west
ECW	1/24/97	6	50	300	5	East Central Wash Begins at S end of confluence with NW side of wash Transects run from center of wash
EPW	1/24/97	6	50	300	5	East Pit Wash - below diversion Begins at road
EPDW	1/24/97	6	50	300	7	East Pit Diversion Wash Begins at road junction and runs upstream

Table 4.1 List of plant species encountered during wash surveys, Imperial Mine, January, 1997.

Scientific name	Common name	Species code
Trees		
Cercidium floridum	palo verde	Cefl
Olneya tesota	desert ironwood	Olte
Shrubs		
Acacia greggii	catsclaw	Acgr
Ambrosia dumosa	burrobush	Amdu
Bebbia juncea	sweetbush	Beju
Calliandra eriophylla	fairy duster	Caer
Encelia farinosa	inciensio	Enfa
Hibiscus denutatus	rose mallow	Hide
Horsfordia newberryi	yellow felt-plant	Hone
Hymenoclea salsola	cheesebush	Hysa
Hyptis emoryi	desert lavender	Hyem
Isocoma acradenia	golden bush	Isac
Krameria grayi	desert ratany	Krgr
Larrea tridentata	creosote bush	Latr
Lycium andersonii	box thorn	Lyan
Perennial Forbs		
Fagonia pachyacantha	smooth-stemmed fagonia	Fapa
Cacti		
Opuntia acanthocarpa	buckhorn cholla	Opac
Opuntia basilaris	beavertail cactus	Opba
Opunita bigelovii	teddy-bear cholla	Opbi
Opuntia echinocarpa	golden cholla	Opec
Grass		
Pleuraphis rigida	big galleta grass	Plri

Table 4.2 Perennial plant cover (percent), density (individuals/acre), and diversity at site WMW-1, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees										
Cercidium floridum	15	73	10	48					1	73
Olneya tesota			26	145	10	73	60	73	40	73
Shrubs										
Acacia greggii									4	73
Ambrosia dumosa			1	48			1	73	2	73
Bebbia juncea			2	48	4	145	5	73		
Calliandra eriophylla										
Encelia farinosa	4	73	9	242	3	145	11	145	2.5	145
Hibiscus denudatus			.5	48						
Horsfordia newberryi					2	73				
Hymenoclea salsola			1	48						
Hyptis emoryi					14	145				
Larrea tridentata							9	73		
Lycium andersonii			2	48					13	145
Cactus										
Opuntia acanthocarpa			2	97						
Opuntia bigelovii			1.5	48						
Grasses										
Pleuraphis rigida										
Total Cover	19		55		33		86		62.5	
Species Diversity	16									

Table 4.2 -continued. Perennial plant cover (percent), density (individuals/acre), and diversity at site WMW-1, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 6		Transect 7		Transect 8		Transect 9		Transect 10	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees										
Cercidium floridum	20	73								
Olneya tesota	15	73	40	73	8	73				
Shrubs										
Acacia greggii									40	218
Ambrosia dumosa			2	73						
Bebbia juncea			3	73					1	73
Calliandra eriophylla					8	145				
Encelia farinosa			9	218	6	73				
Hyptis emoryi	26	73					9	145	8	73
Larrea tridentata			2	73	4	73	2	145	2	73
Lycium andersonii	13	145	5	73					11	145
Cactus										
Opuntia acanthocarpa					3	73				
Grasses										
Pleuraphis rigida							14	145		
Total Cover	74		62		29		27		62	

Table 4.3 Perennial plant cover (percent), density (individuals/acre), and diversity at site WMW-2, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5		Transect 6	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees												
Cercidium floridum			40	145			15	73	47	145		
Olneya tesota	16	145	30	145	10	145	6	73	10	73	30	73
Shrubs												
Ambrosia dumosa											4	73
Bebbia juncea	1	73			6	145	9	73	2	73		
Encelia farinosa	3.5	218							2	73	.5	73
Horsfordia newberryi							2	73				
Hymenoclea salsola					7	145						
Hyptis emoryi											2	73
Larrea tridentata									2	73		
Lycium andersonii			13	145			7	73	9	73	4	73
Total Cover	**20.5**		**83**		**23**		**39**		**72**		**40.5**	
Species Diversity	**10**											

Table 4.4 Perennial plant cover (percent), density (individuals/acre), and diversity at site WMW-3, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees										
Cercidium floridum			32	145	6	73			24	73
Olneya tesota	15	73	12	73			5	73		
Shrubs										
Acacia greggii	2	73			11	145				
Bebbia juncea	9	218			1	73				
Calliandra eriophylla	3	145								
Encelia farinosa	7	145	2	145	3	218	11	363	2	73
Hyptis emoryi	4	73	7	73					19	145
Larrea tridentata			4	73	.5	73				
Lycium andersonii	2	73								
Total Cover	42		57		21.5		16		45	
Species Diversity	9									

Table 4.5 Perennial plant cover (percent), density (individuals/acre), and diversity at site WCW-1, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees										
Cercidium floridum			65	73	40	73				
Olneya tesota					6	73			40	73
Shrubs										
Acacia greggii							4	73		
Ambrosia dumosa					2	145			3	145
Calliandra eriophylla							3	73		
Encelia farinosa	1	73	2	73	10	218	6	363	6	363
Larrea tridentata	4	73	3	73					4	73
Lycium andersonii					8	73				
Cactus										
Opuntia basilaris							2	145		
Opuntia bigelovii	1	73								
Opuntia echinocarpa			2	73						
Grasses										
Pleuraphis rigida	1	73							1	73
Total Cover	7		72		66		15		54	
Species Diversity	12									

Table 4.6 Perennial plant cover (percent), density (individuals/acre), and diversity at site WCW-2, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees										
Cercidium floridum					60	73	10	73		
Olneya tesota			40	73					12	73
Shrubs										
Ambrosia dumosa	1	145							1	73
Encelia farinosa	5	218	6	218	14	145	17	290	9	290
Isocoma acradenia					3	145				
Larrea tridentata	2	73	10	145			3	73	3	73
Cactus										
Opuntia acanthocarpa	.5	73								
Opuntia basilaris	1	73								
Opuntia bigelovii	.5	73					1	73		
Grasses										
Pleuraphis rigida	3	218			3	73				
Total Cover	13		56		80		31		25	
Species Diversity	10									

Table 4.7 Perennial plant cover (percent), density (individuals/acre), and diversity at site WCW-3, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5		Transect 6	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees												
Cercidium floridum					60	36	82	145			30	73
Olneya tesota	20	44	98	109	6	36	24	145	21	145		
Shrubs												
Acacia greggii			5	36								
Ambrosia dumosa	6	97										
Bebbia juncea	18	145	9	109	3	109						
Encelia farinosa			1	36	5	145	17	145	3	145		
Hyptis emoryi							5	73	15	73		
Larrea tridentata							3	73				
Lycium andersonii	17	145									9	73
Total Cover	61		113		74		131		39		39	
Species Diversity	9											

Table 4.8 Perennial plant cover (percent), density (individuals/acre), and diversity at site ECW, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees										
Cercidium floridum	16	73			54	73			40	73
Olneya tesota			65	73			60	73		
Shrubs										
Ambrosia dumosa	5	218								
Bebbia juncea					9	73			7	73
Encelia farinosa	1	73	8	218	7	73	1	73	1	145
Hyptis emoryi			1	73						
Hymenoclea salsola	2	145								
Krameria grayi	4	73								
Larrea tridentata			12	145			2	73	12	73
Lycium andersonii	9	145			4	73				
Cactus										
Opuntia acanthocarpa					2	73			2	73
Opuntia bigelovii	2	73								
Total Cover	39		86		76		63		62	
Species Diversity	12									

Table 4.9 Perennial plant cover (percent), density (individuals/acre), and diversity at site EPW, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees										
Cercidium floridum	11	73			15	73	30	73		
Olneya tesota	19	145			25	73	12	73	6	73
Shrubs										
Ambrosia dumosa							2	73	1	73
Calliandra eriophylla							1	73	4	73
Encelia farinosa	4	73	6	73	3	436	12	363	6	145
Hyptis emoryi							6	73		
Krameria grayi	18	73								
Larrea tridentata	2	73			9	73				
Lycium andersonii	12	73	40	218	8	73	6	145	13	218
Cactus										
Opuntia basilaris							1	73		
Opuntia bigelovii					1	73			.5	73
Grasses										
Pleuraphis rigida	2	73	5	73	1	73	2	73	6	218
Total Cover	**68**		**51**		**62**		**72**		**36.5**	
Species Diversity	**12**									

Table 4.10 Perennial plant cover (percent), density (individuals/acre), and diversity at site EPDW, Imperial Mine, January, 1997.

Life Form / Plant Species	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5		Transect 6		Transect 7	
	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density	Cover	Density
Trees														
Cercidium floridum									30	145				
Olneya tesota	16	145			6	145	10	145			2	73	12	73
Shrubs														
Ambrosia dumosa					3	581	1	145			3	145		
Bebbia juncea					2	145			1	145				
Calliandra eriophylla	4	145									4	73		
Encelia farinosa	11	581	5	145	1	145	1	145	5	290	15	363	10	290
Hyptis emoryi	6	145	4	73										
Larrea tridentata			21	145	2	145	2	145			8	73		
Lycium andersonii	3	73			3	145	11	145			2	73	3	73
Perennial Forbs														
Fagonia pachyacantha	.5	73												
Cactus														
Opuntia acanthocarpa													5	73
Grasses														
Pleuraphis rigida	2	73			1	290					5	145	9	218
Total Cover	42.5		30		18		25		36		39		39	
Species Diversity	12													

Table 4.11 Summary of mean perennial plant cover (percent), density (individuals/acre), diversity, and total plant cover by transect, for nine wash survey sites. Imperial Mine. January, 1997.

SITE	MEAN			COVER BY TRANSECT									
	Cover	Density	Diversity	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
WMW-1	50.9	92	16	19	55	33	86	62.5	74	62	29	27	62
WMW-2	46.3	111	10	20.5	83	23	39	72	40.5				
WMW-3	36.3	129	9	42	57	21.5	16	45					
WCW-1	42.8	114	12	7	72	66	15	54					
WCW-2	41	127	10	13	56	80	31	25					
WCW-3	76.1	95	9	61	113	74	131	39	39				
ECW	65.2	95	12	39	86	76	63	62					
EPW	57.9	113	12	68	51	62	72	36.5					
EPDW	32.8	163	12	42.5	30	18	25	36	39	39			

Table 4.12 Results of microphyllous tree census. Imperial Mine, January, 1997.

Tree Species and Size Class	Washes			
	West Main Wash	West Central Wash	East Central Wash	East Pit Wash
Ironwood				
Seedling (<6 feet)	14	6	11	1
Medium (6 feet-12 feet)	46	17	14	56
Large (>12 feet)	87	33	51	84
Palo Verde				
Seedling (<6 feet)	15	5	14	4
Medium (6 feet-12 feet)	23	7	20	13
Large (>12 feet)	40	13	26	22

This page intentionally left blank
for reproduction purposes.

APPENDIX H BIOLOGICAL SURVEY REPORT, CHEMGOLD IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA (MAY 1995)

BIOLOGICAL SURVEY REPORT

CHEMGOLD IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA

Prepared for:

ENVIRONMENTAL MANAGEMENT ASSOCIATES
405 South State College Boulevard, Suite 211
Brea, California 92621

Submitted to:

U.S. BUREAU OF LAND MANAGEMENT
El Centro Resource Area Office
1661 South 4th Street
El Centro, California 92243

Prepared by:

TED RADO
3144 Celeste Drive
Riverside, California 92507

MAY 1995

TABLE OF CONTENTS

SUMMARY

Chemgold, Incorporated, proposes to operate a large-scale open pit mining operation north of the Cargo Muchacho Mountains in southeastern Imperial County. Systematic surveys of this project site and associated access road/utility line corridor were conducted between July and September 1994, and February and May 1995. Surveys documented the occurrence of the federally and State listed threatened desert tortoise. Although not present on the project site, commute traffic along the southern one mile of Olgilby Road may also affect the proposed threatened flat-tailed horned lizard.

A single observation of the State endangered gila woodpecker was also made in January 1995 during these site surveys. Followup surveys for additional breeding and nesting woodpeckers during the spring did not result in further gila woodpecker observations. This single observation is believed to represent a transient bird. Favorable gila woodpecker habitats are not present on the project site.

Additional species of sensitive plants and wildlife recorded during the project surveys included the Federal candidate chuckwalla, and California Species of Special concern sharp-shinned hawk, northern harrier and American badger. Two sensitive plant species, fairy duster and winged forget-me-not, were recorded from the project site.

No sources of perennial surface water, riparian habitats, wetland habitats or otherwise rare or unique habitats are present on the project site. Several washes crossing the site contain a low to dense tree assemblage dominated by ironwood and palo verde that is utilized by several game species, including mourning dove, Gambel's quail, desert cottontail, and deer.

1.0 INTRODUCTION

A. Objective

This biological survey report was prepared to summarize results of surveys for wildlife and plants that can be used during preparation of a subsequent biological assessment addressing the effects to listed and sensitive wildlife and plant species associated with a proposed large-scale mining operation in southeastern Imperial County. The objective of this survey and report was to identify the presence and distribution of listed and sensitive species of wildlife and plants, as determined through field inspection, database review and literature sources.

Collection of this information was made utilizing two principal methods: (1) a review of the existing database from the area, as determined through literature sources, agency records, and the California Natural Diversity Database (CNDDB); and (2) systematic site surveys of the project site, including the access route and utility corridors, for such species. Information sources used in part to prepare this biological survey report included a review of the California Natural Diversity Database (CNDDB) records for the following USGS quadrangles: Hedges and Olgilby. This basic information was supplemented with review of species-specific information sources on biology and distribution (Berry et al. 1984; Turner et al. 1980a, 1980b; CNPS 1994; Hall 1981), from agency documents (USBLM 1980; USFWS 1994a, 1994b) and from review of environmental documents addressing similar mining projects in the general vicinity (Environmental Solutions 1987; Condor Minerals Management 1991a, 1991b; DeDycker and Associates 1994).

B. Relationship to Regional Plans

The entire project area lies within the California Desert Conservation Area (CDCA), an approximately 25 million-acre area designated and managed largely under the guidance of the U.S. Bureau of Land Management (BLM). The attending regional plan for the CDCA provides guidance governing land uses and legislated mandates within this area (BLM 1980). The project area is within designated Class L (Limited Use) lands identified in the CDCA plan. Development within Class L lands is allowed subject to controls imposed by the USBLM.

The project also lies within the boundary of the Northern and Eastern Colorado Desert Coordinated Management Area. The U.S. Bureau of Land Management is developing a long-term regional management plan for this area. The plan will address a broad spectrum of land uses that include mineral exploration and development as well as protection of biological resources. No draft planning documents have been prepared to date.

The project area is also within the boundary of the Eastern Colorado Recovery Unit for the desert tortoise. Recovery planning for this species within the Eastern Colorado Recovery Unit specifies the creation of a 750-950 square mile reserve "centered" on the Chuckwalla Bench (USFWS 1994b). This reserve area lies to the north and northwest of the proposed mining project site.

The proposed mining site is not within any designated Area of Critical Environmental Concern (USBLM 1980), and lies outside of any recently designated wilderness areas.

C. Regulatory Framework

Pertinent State and Federal regulations governing a review of the proposed mining project for listed and sensitive species are the Federal Endangered Species Act of 1973, as amended, and the California Endangered Species Act of 1984. The Federal Endangered Species Act of 1973, as amended, prohibits the "take" (killing, harming or harassment) of federally listed species without special exemption. Section 7(a) of the Act allows for a Federal agency involved with permitting, funding or otherwise authorizing a project to formally consult with the U.S. Fish and Wildlife Service on any action that may adversely affect a listed species.

The California Endangered Species Act of 1984 also prohibits the "take" of any State listed species. A State "lead" agency is required to consult with the California Department of Fish and Game for any projects affecting State listed species. For non-State agencies, authorization for such take is available through an Endangered Species Management Permit under Section 2081 of the Fish and Game Code, that establishes measures for the protection of the affected species and its habitat during project actions.

D. Species of Special Management Concern

Listed and Federal candidate species that are known to occur in the general vicinity of the proposed mining project site are provided in Table 1.

Table 1. Candidate and Listed Species of Wildlife and Plants Known to Occur in the General Vicinity of the Proposed Mining Project

Common/Scientific Name	Status*
Plants	
Pierson's milk-vetch (Astragalus magdalena var. Piersonii)	CNPS1B/ PE/SE**
Borrego milk-vetch (Astragalus lentiginosus var. borreganus)	SP/CNPS4

Table 1. Continued

Common/Scientific Name	Status**
ribbed cryptantha (_Cryptantha costata_)	SP/CNPS 4
winged cryptantha (_Cryptantha holoptera_)	SP/CNPS 4
fairy duster (_Calliandra eriophylla_)	SP/CNPS 2
rock nettle (_Eucnide rupestris_)	SP/CNPS 2
hairy stickleaf (_Mentzelia hirsutissima_)	C3c/SP/ CNPS 2
slender-lobed four o'clock (_Mirabilis tenuiloba_)	SP/4
Wiggin's cholla (_Opuntia wigginsii_)	CNPS 3/ SP/C2
foxtail cactus (_Escobaria vivipara_ var. _alversonii_)	CNPS1B/ SP/C2
Algodones Dunes sunflower (_Helianthus niveus_ ssp. _tephrodes_)	CNPS 1B/ SP/C2**
Munz's cholla (_Opuntia munzii_)	CNPS 1B/ SP/C2**
giant spanish needle (_Palafoxia arida_ var. _gigantea_)	CNPS 1B/ SP/C2**
Orocopia sage (_Salvia greatei_)	CNPS 1B/ C2/SP
Wiggin's croton (_Croton wigginsii_)	SP/CNPS 3/ C3c**
Wildlife	
alkali skipper (_Pseudocopaedes eunus eunus_)	C2
cheeseweed owlfly (_Oliarces clara_)	C2

Table 1. Continued

Common/Scientific Name	Status**
Andrew's dune scarab beetle (Pseudocotalpa andrewsi)	C2**
brown-tassel trigonoscuta weevil (Trigonoscuta brunnotasselata)	C2
desert pupfish (Cyprinodon macularis)	FE/SE**
razorback sucker (Xyrauchen texanus)	FE/SE**
flannelmouth sucker (Catastomus latipinnis)	C2**
roundtail chub (Gila robusta)	C2**
Arizona southwestern toad (Bufo m. microscaphus)	C2/CSC**
Yavapai leopard frog (Rana yavapaiensis)	C2**
Couche's spadefoot toad (Scaphiopus couchi)	CSC*8
desert tortoise (Gopherus agassizii)	FT/ST
flat-tailed horned lizard (Phrynosoma mcallii)	FPT/CSC**
chuckwalla (Sauromalus obesus)	C2
Colorado Desert fringe-toed lizard (Uma n. notata)	C2/CSC**
bald eagle (Haliaeetus leucocephalus)	SE/FE**
brown pelican (Pelecanus occidentalis)	FT/ST**
Peregrine falcon (Falco peregrinus)	FE/SE**

Table 1. Continued

Common/Scientific Name	Status**
Yuma clapper rail (Rallus longirostris yumanensis)	FE/SE**
Aleutian Canada goose (Branta canadensis leucopareia)	FT/ST**
southwestern willow flycatcher (Empidonax traillii extimus)	PFE/SE**
black rail (Laterallus jamaicensis coturniculus)	C2/ST**
black tern (Chilodonias niger)	C2**
burrowing owl (Athene cunicularia)	C2/CSC
LeConte's thrasher (Toxostoma lecontei)	CSC
ferruginous hawk (Buteo regalis)	C2/CSC
northern harrier (Circus cyaneus)	CSC
large-billed savannah sparrow (Passerculus sanwichensis rostratus)	C2/CSC**
loggerhead shrike (Lanius ludovicianus)	CSC
gila woodpecker (Melanerpes uropygialis)	SE/C2
mountain plover (Charadrius montanus)	C2**
western least bittern (Ixobrychus exilis hesperus)	C2**
white-faced ibis (Plegadis chihi)	C2**
California leaf-nosed bat (Macrotis californicus)	C2/CSC

Table 1. Continued

Common/Scientific Name	Status**
greater western mastiff bat (<u>Eumops perotis californicus</u>)	C2/CSC
Occult little brown bat (<u>Myotis lucifugus occultus</u>)	C2/CSC
Southwestern cave myotis (<u>Myotis velifer brevis</u>)	C2/CSC
spotted bat (<u>Euderma maculatum</u>)	C2/CSC
Yuma hispid cotton rat (<u>Sigmodon hispidus eremicus</u>)	C2/CSC**
white-throated woodrat (<u>Neotoma albigula venusta</u>)	CSC
Yuma puma (<u>Felis concolor browni</u>)	C2/CSC
Colorado River cotton rat (<u>Sigmodon arizonae plenus</u>)	C2/CSC**
American badger (<u>Taxidea taxus</u>)	CSC***

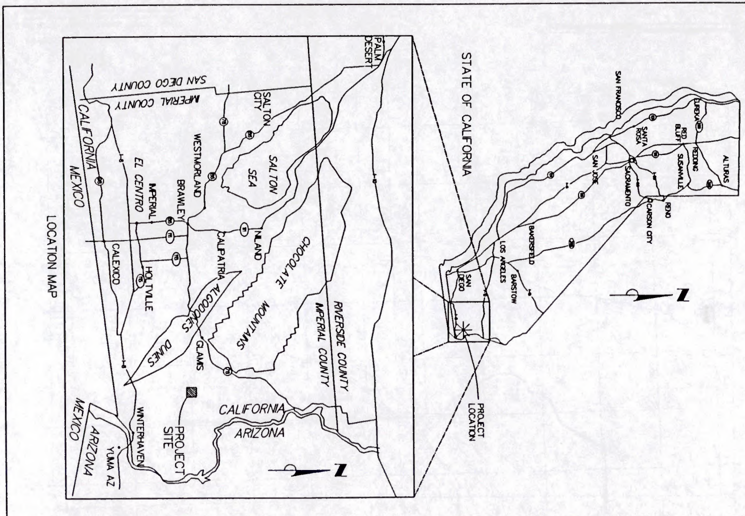
*FE=federally listed as endangered;
FPE=federally proposed for endangered status
FT=federally listed as threatened;
FPT=federally proposed for threatened status
SE=State listed as endangered;
ST=State listed as threatened;
C1=Federal Category 1 candidate species (sufficient information to warrant a listing proposal);
C2=Category 2 candidate species (more information on status needed);
C3c=Category 3 candidate species (too widespread-not threatened at present time)
SP=California special plant;
CSC=California species of concern
CNPS 1B=taxa determined by the California Native Plant Society to be rare, threatened and endangered; CNPS 2=species rare or endangered in California but common elsewhere; CNPS 3=more information on status needed; CNPS 4=species of limited distribution
**No potential habitats for species present on project site

2.0 PROJECT DESCRIPTION

Chemgold, Incorporated, plans to develop gold-bearing deposits within a 1,576-acre area north of the Cargo Muchacho Mountains. This project, designated as the "Imperial Project" by the company, lies approximately twelve miles north of Interstate Highway 8 and 15 miles northwest of Yuma (Figure 1). The project would entail the extraction of gold ore from up to three sites, possible crushing of ore to appropriate size, placement of ore on heap leach pads and separation of gold using a cyanide solution. Overburden would be removed and deposited in the south and southwestern portions of the site. Electrical power would be provided by utility lines connecting to an existing 161 kilovolt corridor 4.5 miles west of the project site. Water for this operation would either be provided on-site from development of water wells or imported via a constructed underground pipeline travelling along Indian Pass Road from the well field road (Figure 2). Associated project facilities would include an administration area, with office buildings; a maintenance yard and parking/storage and equipment laydown area; haul roads connecting the three ore pits to ore processing sites and to overburden deposition sites; and a perimeter security fence with an entrance station. In order to minimize any potential for flashflooding to occur across project sites during severe storms, a storm bypass or diversion channel will also be constructed. Project components are summarized in Table 2.

The Imperial Project will collectively encompass 1,576 acres and is expected to last approximately 10-20 years, depending upon extent of ore and other factors. In the initial stages of development, an ore pit will be excavated in the west-central portion of the project area. Operations involving the removal of ore and ore processing from this initial pit are expected to last approximately 4-8 years. As economically recoverable ore is removed from this pit, ore extraction operations will then shift to a second pit located in the east-central portion of the project area. Recovery of ore from this second pit is also expected to last about 4-8 years. Recovery from the third remaining pit is expected to last about 2-4 years. Following removal and processing of ore, the facilities and equipment shall be dismantled and/or removed, and implementation of a restoration program shall begin.

Proposed mining activities are expected to employee at total of 150 personnel during peak operations. Mining actions will operate continuously, on shifts staggered over a 24-hour day. Equipment associated with ore extraction and processing may include 8-10 haul trucks, 2-3 front-end loaders or shovels, 2-3 dozers, 2 drilling rigs, 2-3 water trucks, and various ancillary equipment. Equipment used for operations will be stored and maintained on the project site.

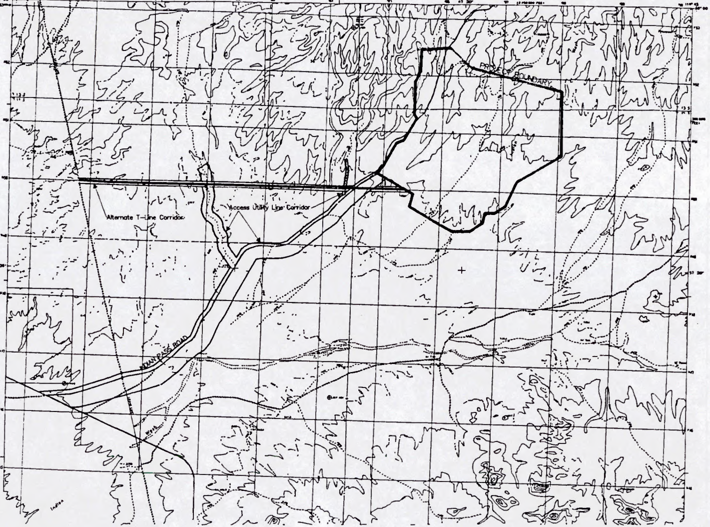


EMA
ENVIRONMENTAL MANAGEMENT ASSOCIATES

CORPORATE OFFICE:
405 S. State College Blvd., #211
Brea, California 92621
TEL (714) 529-3695
FAX (714) 529-8543

REGIONAL OFFICE:
100 West Grove Street, #100
Reno, Nevada 89509
TEL (702) 828-3939
FAX (702) 828-3940

DRAWN BY: LT	EXPLANATION
CHK'D: RFD	FIGURE 1: Imperial Project General Location Map
NO SCALE	
DATE: 05/23/95	
DRAWING NO. 1060-101	



EMA

ENVIRONMENTAL MANAGEMENT ASSOCIATES, INC.

TITLE: FIGURE 2 – CHEMGOLD IMPERIAL PROJECT FACILITY, showing boundaries of the mine and process area, associated road/utility line corridor, and alternate transmission line corridor

SCALE:

0 1 2

Miles

Table 2. Components that Comprise the Imperial Project Site Layout*

Component	Estimated Acreage Covered
West Pit	127
East Pit	254
Singer Pit	36
Mineral Potential Area	96
Pads	378
Process Facility Area	24
Lime Bin Areas/Fresh Water Pond	3
Waste Rock Stockpiles:	
East	96
West	43
South	240
Topsoil Stockpiles	
West	8
North	28
South	29
Ancillary Facilities:	
Office/Maintenance/Parking	16
Roads:	
Haul and Maintenance	29
Drainage Diversions	9
County Road Realignment	7
Powerline/Pipeline/Water Wells	29
Total Proposed Surface Disturbance	**1,452**
Total Undisturbed Areas	**124**
Total Project Area	**1,576**

*Source: Environmental Management Associates

Current site access is via Olgilby Road, a secondary paved road, and Indian Pass Road, a County maintained dirt road. Hyduke Road (A278), connects with an unmaintained dirt road leading into the southeast corner of the project site. This road is proposed as an alternate storm access route. Employee traffic is expected to originate principally from Yuma, Arizona, and El Centro, California. One-way commute traffic to the Imperial Project site is about 30 miles. Under full development, an anticipated total of between 40-60 vehicles per day will commute to the project site.

In order to facilitate ore processing, a water source would be developed either on the project site or near the utility/access corridor (Indian Pass Road) leading to the site. Currently, Chemgold is investigating the potential of developing on-site groundwater resources. However, in the event that this approach proves infeasible, the company may pipe in water from outside the

project area. A corridor extending for 150 feet north and 500 feet south of Indian Pass Road and 300 feet east and west of either of two jeep trails trending north from Indian Pass Road has been identified within which well sites and a water pipeline may be located (Figure 2). Construction of this water pipeline would involve placement of pipe segments along the surface. An approximately
10-inch diameter pipe would be buried to an average depth of about five feet. Construction activities would result in the temporary disturbance to surface soils and vegetation within a corridor 50 feet in width and approximately two linear miles in length. Associated construction equipment would include trackhoes, backhoes, welding trucks, pipe trucks, sidebooms, water trucks, and pickup trucks.

Electrical power would be provided by a constructed above-ground utility line connecting to an existing 161-kilovolt line about four miles west of the project site. A primary and a secondary route have been identified (Figure 2). The primary route would closely parallel the water pipeline route, within a 500-foot-wide strip extending south from and paralleling Indian Pass Road, a linear distance of 4.5 miles. A secondary route would be used in the event that the primary route proves infeasible. This secondary transmission line route would originate at this existing 161 kilovolt line at a point 1.3 miles farther north, and then travel due east to the project site, a distance of about 3.5 linear miles. Construction activities would result in the temporary disturbance to surface soils and vegetation within a corridor 50 feet in width and up to about 4.5 miles in length. Associated construction equipment would include sidebooms, water trucks, and pickup trucks.

3.0 Environmental Setting

A. General Description

The Imperial Project is located in southeastern Imperial County, approximately 12 miles west of the Colorado River (Figure 1). The project encompasses portions of unsurveyed Townships 13 South, Ranges 20 and 21 East, and 14 South, Ranges 20 and 21 East, San Bernardino Baseline Meridian. This general area consists of a broad westerly-facing alluvial plain extending between the Cargo Muchacho Mountains to the southeast, and Peter Kane Mountain to the northeast. Topography is characterized by a series of gently rolling ridgelines parallelled by interconnecting drainages. The southeastern portion of the project site is nearly level. Topography becomes increasingly hilly to the north and the northwest. Elevation on the project site ranges from 760 feet near the south boundary to 925 feet on a prominent ridgeline along the northern boundary.

Soils in the project area are dominated by desert pavement, consisting of a basalt rock rubble field extending southwest from

Peter Kane Mountain. A gravel-based alluvial soil is present in all major drainages, and over the west-central portion of the project site. Three primary washes and several secondary drainages are present. The largest wash, extending southwest along the base of a ridgeline at the western project boundary, parallels Indian Pass Road. Two smaller drainages also extend southwesterly from the central and eastern portions of the project site. These drainages consist of microphyll woodland habitat dominated by ironwood (*Olneya tesota*) and palo verde (*Cercidium floridum*), with a diverse plant association containing cat's-claw (*Acacia greggii*), purple heather (*Krameria erecta*), desert lavender (*Hyptis emoryi*), Anderson thornbush (*Lycium andersonii*) and yellow felt-plant (*Horsfordia newberryi*).

The remaining areas on the project site consist of desert succulent scrub habitat (Figure 3). Vegetation is typically sparsely distributed and "concentrated" at the bases of ridgelines and in "pockets" near small drainages. Dominant plants include creosote bush (*Larrea tridentata*), burrobush (*Ambrosia dumosa*), ocotillo (*Foaquieria splendens*), brittlebush (*Encelia farinosa*), and Bigelow cholla (*Opuntia bigelovii*). Although sparsely vegetated, several cactus species occur in this habitat, including Bigelow cholla, cottontop cactus (*Echinocactus polycephalus*), beavertail (Opuntia basalaris), diamond cactus (*Opuntia ramosissima*), and California barrel cactus (*Ferocactus cylindriceus*).

No sources of standing surface water, wetland habitats, or riparian habitats are present on or adjacent to the project site, associated access road corridor, or utility line corridor. Additionally, no aeolian sand deposits, including star dunes, sheet dunes, or wind-accumulated sand deposits are present.

Wildlife in the project area is characteristic of the Eastern Colorado Desert. Common reptiles include the zebra-tailed lizard (*Callisaurus draconoides*), side-blotched lizard (*Uta stansburiana*), western whiptial (*Cnemidophorus tigris*), and desert iguana (*Dipsosaurus dorsalis*). Microphyll woodland along larger washes is used by a variety of birds, that include mourning doves (*Zenaida macroura*), Gambel's quail (*Lophortyx gambelii*), Say's phoebes (*Sayornis saya*), and black-tailed gnatcatchers (*Polioptila melanura*). Birds frequenting desert succulent scrub habitat include the black-throated sparrow (*Amphispiza bilineata*), loggerhead shrike (*Lanius ludovicianus*), and cactus wren (*Campylorhynchus brunnecapillus*). Mammals include the antelope ground squirrel (*Ammospermophilus leucurus*), Merriam kangaroo rat (*Dipodomys merriami*), desert woodrat (*Neotoma lepida*) and black-tailed jackrabbit (*Lepus californicus*). Deer (*Odocoileus hemionus*)

EMA

Environmental Management Associates, Inc.

TITLE: FIGURE 3 – CHEMGOLD IMPERIAL PROJECT, showing vegetation associations present within the vicinity of the mine and process area

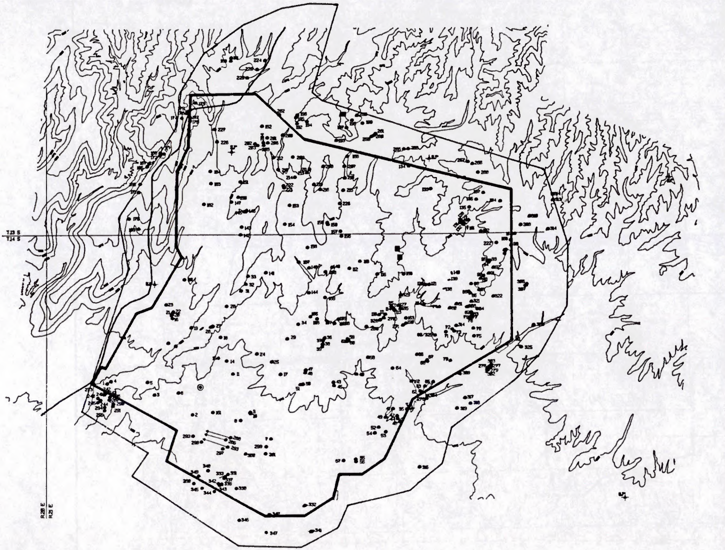
EXPLANATION

———	Project Boundary
———	Habitat Boundary
DSS	Desert Succulent Shrub
MW	Microphyl Woodland

SCALE:

0 1,000 2,000

FEET



EMA

Environmental Management Associates, Inc.

TITLE: FIGURE 4 - CHEMGOLD IMPERIAL PROJECT, showing results of transect surveys in the vicinity of the mine and process area (see Appendix C for specific data on map numbers)

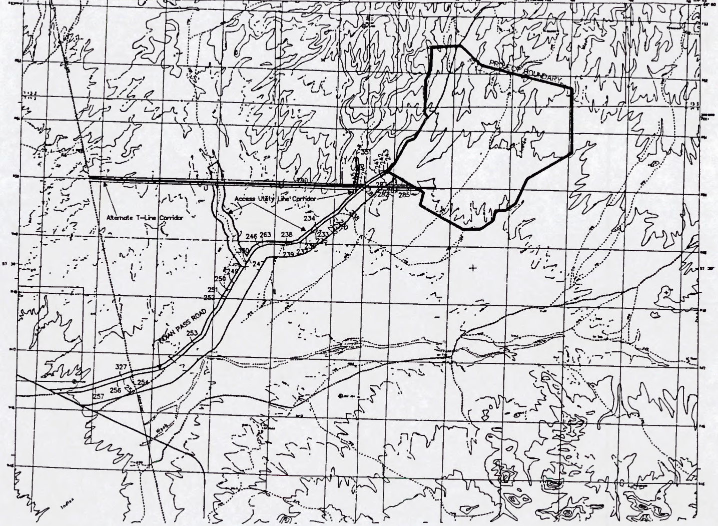
EXPLANATION

- Project Boundary
- Survey Boundary
- •123 Desert Tortoise Sign
- Gila Woodpecker observation
- Chuckwalla observation

SCALE:

0 1000 2000

FEET



SCALE:

0 1 2

Miles

ENVIRONMENTAL MANAGEMENT ASSOCIATES, INC.

TITLE: FIGURE 5 – CHEMGOLD IMPERIAL PROJECT, showing results of transect surveys conducted along road/utility line corridor (see Appendix C for specific data on map numbers) also frequent washes throughout this area, and travel cross-country across more open desert lands between washes. Larger mammalian predators include the kit fox (*Vulpes macrotis*), coyote (*Canis latrans*), and American badger (*Taxidea taxa*).

Human-related uses within the site have included seasonal camping along the largest wash system, deer and game bird hunting, off-road vehicle "free-play", bombing and strafing by military aircraft, and small-scale mining. Camping use has been concentrated along the eastern embankment of a large wash parallelling Indian Pass Road. Use is scattered, confined to winter and spring months, and has resulted in the creation of fire rings, destruction of mature ironwood and palo verde trees for firewood, off-road vehicle use, and deposition of trash.

Hunting pressure within and surrounding the project area is also concentrated in larger washes. Spent sporting rifle cartridges and shotgun shells are present. Off highway vehicle use in most moderate-to-large washes is probably a result of both camping and hunting uses.

Evidence of old bombing and strafing by military aircraft, a result of practice during World War II, is evident over most of the project site. This evidence includes old .50 caliber machine gun shells and clip pieces, and small bomb craters with shrapnel fragments. More recent military use in the area includes numerous fly-bys by jet aircraft and touchdowns by helicopters.

The Imperial Project site has also been subject to small-scale exploratory mining activities. These actions have included: the creation of secondary unmaintained routes extending over much of the site; excavation of test trenches in the central portion of the project area; exploratory drilling activity throughout the site; and placement of numerous claim markers throughout the site.

B. Biology of Federal and State Listed Species Known to Occur in the General Area of the Project

Many of the listed and sensitive wildlife and plant species recorded from the general vicinity of the project do not occupy habitats present on the project site. Several are fish and amphibian species (e.g., desert pupfish, razorback sucker, flannelmouth sucker, roundtail chub, Yavapai leopard frog, southwestern toad) closely associated with perennial sources of water not present on or near the mining site. Several bird species (e.g, bald eagle, brown pelican, Yuma clapper rail, Aleutian Canada goose, southwestern willow flycatcher, black rail, black tern, savannah sparrow, mountain plover, least bittern, white-faced ibis) are associated with wetland habitats also absent from the project site and surrounding area. Several remaining species (e.g., Andrew's dune scarab, Colorado Desert fringe-toed lizard, giant spanish needle, Algodones Dunes sunflower) are distributed within areas of fine windblown sand deposits also not present on or near the project site.

One federally and State listed species, the desert tortoise, is known to occur on the project site, based on prior observations of animals by Chemgold staff. Another Federal proposed-for-listing species, the flat-tailed horned lizard, has the potential to be harmed by project vehicles and equipment travelling north from State Highway 8 along Olgilby Road. The initial one mile of Olgilby Road, extending north from State Highway 8, crosses sandy-based soils favorable for this species. Flat-tailed horned lizards could be encountered while basking along road edges or crossing the pavement in this restricted area.

Flat-tailed Horned Lizard

The flat-tailed horned lizard is a medium-sized horned lizard, approximately six inches in total length, that ranges from southeastern California into extreme southwestern Arizona and Sonora, Mexico. Coloration is usually whitish, with a narrow dark stripe extending down the center of the back. A series of six elongated head scales, typical of the genus, are located at the base of the skull. The centermost of these head spines (called occipital horns) are unusually elongate, and, together with the long flattened tail and center dark dorsal stripe, separate this horned lizard species from all other members of the genus (Smith 1967).

The flat-tailed horned lizard is principally associated with sandy habitats, often interspersed with harder soils that allow colonies of harvester ants, a primary food source for this lizard. The flat-tailed horned lizard is generally considered to be difficult to locate, and relatively rare throughout its geographic range (Norris 1949, Klauber 1939). Regional surveys to determine relative abundance and distribution have confirmed this scarcity (Turner et al, 1978, 1980b), and also suggest declines where prior researchers have documented relatively high abundance, such as at the Algodones Dunes (Mayhew 1965).

In California, the geographic range of the flat-tailed horned lizard extends over approximately 2,700 square miles. A total of 330 square miles of this area, located in the East Mesa and Yuha Basin of central Imperial County, have been identified as optimal habitat for this species (Turner et al. 1980b; Rado, no date). A series of analyses of effects of to flat-tailed horned lizards and habitats have been undertaken. Rado (no date), initially reviewed factors such as agricultural development, pesticide spraying, recreational use, and mineral development within both optimal habitat and the geographic range of this species. He concluded that 52 percent of the geographic range of the flat-tailed lizard in California is within areas subject to one or more use-oriented activities, and that this included 57 percent of optimal habitat for the species. Subsequent re-evaluation in 1986 concluded that one or more use-oriented activities were occurring on 95 percent of flat-tailed horned lizard optimal habitat (Mayhew and Carlson 1986). Repeat surveys on flat-tailed horned lizard optimal habitat on Bureau of Land Management lands at East Mesa and Yuha Basin have also recorded declines in relative abundance in both areas (Olech, no date). The documented relative scarcity of this species, high degree of threats to habitat, and documented declines in populations have resulted in the proposal to list the flat-tailed horned lizard as a threatened species (58 Federal Register 62624-62629.

There are no records for the flat-tailed horned lizard within 10 miles of the proposed mining project site. Nearest locality records are from the vicinity of Olgilby (Townships 15 and 16 South, Range 20 East), along the eastern edge of the Algodones Dunes. Turner et al. (1980a), completing a range-wide inventory of Public Lands administered by the BLM for the flat-tailed horned lizard, did not document the species within any Townships encompassing the mining project site. Reasons for this apparent absence probably relate to substrate. The project site, access route leading to this site from Olgilby Road, and transmission line corridor consist of desert pavement, coarse gravel, and compacted gravelly sands not occupied by this species.

A potential exists that flat-tailed horned lizards could be encountered by project commuter traffic on Olgilby Road, immediately north of its junction with State Highway 8. Sand sheets, extending east from the Algodones Dunes approximately two miles farther west from the intersection of these highways, provide favorable flat-tailed horned lizard habitat. This sandy-based soil extends north for an approximate distance of one mile at this site.

Desert Tortoise

The desert tortoise was State listed as a threatened species on June 22, 1989 [California Code of Regulations, Section 670.5(b)(4) of Title 14], and federally listed as endangered under the emergency provisions of the Federal Endangered Species Act on August 4, 1989 (54 Federal Register 32326-32331). This latter listing was changed to threatened on April 2, 1990 (55 Federal Register 12178-12191). Reasons for listing included habitat loss and fragmentation and population declines as a result of disease, predation, and Man-induced factors.

The desert tortoise is widely distributed over portions of the Mojave, Sonoran, and Colorado deserts of the western United States and northwestern Mexico. Habitats occupied include plains and valleys in the Mojave Desert, bajadas and low mountain slopes in the Sonoran Desert, and thorn scrub forest in Mexico. Dominant vegetation includes creosote bush, burrobush, Joshua trees, ocotillo, palo verde, and several species of saltbush (Woodbury and

Hardy 1948; Schwartzmann and Ohmart 1977; Berry 1975, 1984).

The desert tortoise is a highly adapted, adept digger. Burrows are constructed to avoid harsh temperatures and to avoid predators. Burrows used by tortoises include a shallow "pallet" that is used regularly during seasonal activity periods, and a deeper, more extensive burrow that is used during periods of inactivity (Woodbury and Hardy 1948; Berry 1975). Burrows may be constructed almost anywhere, including under boulders, canopies of shrubs, wash embankments, or in the open (Woodbury and Hardy 1948, Berry 1972, Burge and Bradley 1976, Coombs 1977).

The species is herbivorous. Tortoises eat a variety of annual flowers, perennial grasses, a few half shrubs, and flowers of perennial shrubs. Desert tortoises also rely heavily on intermittent rainfall to re-hydrate, and will emerge in numbers immediately following the onset of spring and summer rains to drink (Medica et al. 1982).

Desert tortoises are mature at approximately 15-20 years of age (Woodbury and Hardy 1948). One to two clutches of 2-14 eggs are laid during the spring or early summer in or near the females burrow (Miller 1955; Turner et al. 1987). Eggs hatch in about 105-135 days (Coombs 1977). Individual animals may live for over 100 years (Woodbury and Hardy 1948).

Based on an extensive database compiled from over 2000 strip-transects and 30 study plots in California, desert tortoises are distributed over approximately 40,200 square miles. The majority of these lands contain tortoise densities of 0-20 animals per square mile (Berry and Nicholson 1984).

Desert tortoise populations have declined in recent years as a consequence of several factors. Man-induced activities, including urbanization, highway construction, livestock grazing, motorized recreation, utility and pipeline corridors, mineral exploration and development, and energy development, have contributed to habitat loss and degradation (Berry 1984). Populations have also suffered major declines as a result of disease outbreaks and excessive predation by ravens, a major predator of juvenile tortoises (USBLM et al. 1989).

A recovery plan for this species has recently been developed (USFWS 1994a). Goals of the recovery plan seek to initiate a series of monitoring, research, and protection measures to stabilize and increase selected population sites in California. The project area and associated access road leading to the site do not lie within or proximate to any of these selected sites, nor within any designated critical habitat for the desert tortoise. Based on regional transect data compiled by the BLM during the California Desert plan Program, desert tortoise densities throughout this general area range between 0-20 per square mile. The project site and access road leading to the site lies outside of any BLM-designated Category 1, 2, or 3 desert tortoise habitat.

The mining site and access/utility corridor are within the Eastern Colorado Recovery Unit for the desert tortoise. Management prescriptions for this unit call for establishing a reserve for protective management, focusing on the Chuckwalla Bench, northwest of the mining project area. The mining site and access/utility corridor are not within the proposed boundary of this Chuckwalla Desert Wildlife Management Area (USFWS 1994b).

C. Survey Methods

Survey efforts included the collection of prior project data from the area. Information sources included the California Diversity Database for the Hedges and Olgilby U.S.G.S. 7.5 minute quadrangles, California Native Plant Society records (CNPS 1988, 1994), discussions with Chemgold staff, and review of prior biological surveys conducted for the general area (Turner et al. 1980, Environmental Solutions 1987, USBLM no date, DeDycker and Associates 1994).

The entire project site, and a minimum 500-foot-wide "buffer" extending around the north, east, and south boundary, was systematically surveyed for listed and sensitive wildlife and plant species. A "buffer" along the western project boundary was not surveyed due to low observed tortoise sign in the western project area and increasingly rugged terrain. Surveys consisted of walking 30-foot-wide parallel transects across this area. Biologists conducting this survey recorded observations of live desert tortoises and other sensitive species encountered. Additionally, all tortoise sign, including carcasses, tracks, scat, burrows and pallets were recorded and mapped. For live desert tortoises observed, the following information was recorded: (1) sex; (2) size; (3) condition; and (4) evidence of disease. For carcasses, and estimate of relative time since death, as determined by degree of disarticulation and bone wear, was also made. For scat, an estimate of class, a function of age, was made. Information obtained for desert tortoise burrows and pallets included: (1) dimensions, in centimeters; (2) current condition; and (3) evidence of tortoises or associated sign.

The existing access road (Indian Pass Road) extending northeast from Olgilby Road for 5.0 miles to the southern project boundary, was also surveyed. The survey consisted of walking 30-foot-wide parallel transects to a width of 150 feet along the northerly portion of the road, and to a width of 500 feet along the southerly portion of the road. Data recordation was identical to that used on the project site.

Existing jeep trails extending for 1.1 miles and 0.4 miles north, respectively, of Indian Pass Road to a potential water well site were surveyed to a widths of 600 feet (e.g., 300 feet on each side of the existing road) and 300 feet (e.g., 150 feet on each side of the existing road) walking parallel transects spaced at 30-foot-wide intervals. Data recordation was identical to that used on the project site.

An alternative transmission line alignment extending east from an existing 161-kilovolt transmission line approximately 3.5 miles northwest of the project site was surveyed in an identical manner to that previously described. Parallel transects spaced at 30-foot-widths were walked within a 300-foot-wide corridor during this survey.

Concurrent with the above transect surveys field biologists recorded all other plant and wildlife species and sign observed. A listing of plants and wildlife observed during site inventories is provided in Appendix B.

Supplemental plant surveys were conducted between July 26-30, 1994, and again between February 27 to March 1, 1995, and between April 3 to 6, 1995. Plant surveys during 1995 were scheduled to provide coverage throughout the phenological periods for sensitive ephemeral species that could occur within the project area. All surveyed were conducted on foot. All washes greater than five feet in width were walked during both survey periods. Transects were also walked throughout the low rocky hills in the eastern and northern portions of the project site as well as on the large expanses of desert pavement that predominate in the southern and western portions of the project site. Approximately 35-40 miles were walked during each 1995 survey period.

Supplemental wildlife surveys were conducted between July 26, 1994 and May 13, 1995. These surveys involved "focused" inventories for rodents, deer sign, birds, and evidence of colonial roosting by bats. Specific survey dates are provided in Table 2. A total of four biologists participated in this survey effort. Resumes are provided in Appendix A.

Livetrapping for nocturnal rodents was undertaken between August 13-23, 1994. A total of 50 Sherman livetraps were set in a linear array in each of two areas. Site 1 consisted of desert succulent scrub habitat within a section of a low rocky ridgeline slope in the east-central portion of the project area. Site 2 consisted of a large wash dominated by microphyll woodland in the central portion of the project area. Traps were spaced at approximately 20 foot intervals and baited with mixed grain. Traps were opened shortly after sunset and closed shortly prior to sunrise in order to avoid harming animals. Captured rodents were identified and released unharmed and unmarked at the point of capture. Livetrapping was concluded after a total of 1,000 trap-nights of effort (e.g., 500 trap-nights within desert succulent scrub habitat and an identical concurrent effort in desert microphyll woodland habitat, conducted over a 10-night period).

Initial transect surveys demonstrated a wide use of the project area by deer. As a means of evaluating extent of deer use, two biologists inventoried all site drainages for deer and sign. In addition to identifying deer sign, relative age of scats (e.g., whether fresh or old), and the direction of travel of deer based on track inspection was also noted. Surveys included the project site and associated wash drainages extending for a distance of up to 1.5 miles from the project site.

During transect surveys, biologists searched for natural caves, shafts, large crevices or fissures, old mine shafts or tunnels, or other natural or man-made features that could serve as colonial roosts for bats. These area inspections were made over the entire project site and associated route/utility corridors. Additionally, these surveys included checks for natural springs, seeps, or man-made water tanks that have been noted as concentration sites for foraging bats in other desert areas (Miller and Stebbins 1964). Concurrent checks of wash banks were also made during this time for evidence of bat use, including deposits of guano.

Bird surveys were conducted during 1995 in four separate periods: February 27 to march 1; April 3 to 6; April 27-28; and May 12-13. Although habitats present on the project site were all inventories, principal emphasis was spent in area washes looking for sensitive species such as the gila woodpecker and LeConte's thrasher. Surveys during the first two periods typically began within 30 minutes of sunrise and lasted all day. All of the washes on the project site were walked once during each survey period. No pre-recorded tapes were played during the initial two bird survey periods. The focus on the latter two survey periods was for the gila woodpecker and LeConte's thrasher. Surveys during these latter two survey periods began at or 20 minutes prior to sunrise and continued for approximately six hours. All major washes were walked at least once each day. Special attention was paid to the location where a single male gila woodpecker was observed during January 1995, with a minimum time of 15-30 minutes spent each day in the vicinity of that location. A tape of the songs and calls of both the gila woodpecker and LeConte's thrasher was played for several minutes every 10-15 minutes during the survey in an effort to elicit response calls.

Table 2. Wildlife and Plant Surveys of Project Area

Type of Survey	Dates of Survey
Transects	
Project Site	July 12-14, 17-31; August 1-9; 18-25; September 1-2; 7-10 May 8-9
Route Corridor	August 11-17
Water Well Corridors	April 6, 27; May 10
Alternate T-line Corridor	August 29-31
Supplemental Plant Survey	July 26-29; February 27-March 3; April 3-6
Supplemental Bird Survey	July 26-29; February 27-March 1; April 3-6; April 27-28; May 12-13
Rodent Livetrapping	August 13-23
Deer Sign	September 11-15

D. Survey Results

General Overview

A total of 116 plant taxa were identified during site surveys. Plants identified were "typical" of wash and desert succulent scrub plant associations in the Colorado Desert. Species included a variety of taxa closely associated with microphyll woodland communities and several species of cacti. A listing of plants observed is provided in Appendix B.

Wildlife species and sign observed during site surveys included 18 reptiles, 50 birds, and 16 mammals (Appendix B). With the exception of the desert tortoise and chuckwalla, all reptile species are common, widely distributed, and lack special management status. Bird species observed included year-around residents, such as Gambel's quail, as well as seasonal migrants such as white-crowned sparrows (*Zonotrichia leucophrys*). Several species of game birds are present on the project site. In additional to quail, mourning dove and white-winged dove (*Zenaida asiatica*) were observed in moderate-to-larger washes. No raptor nests were observed on or near the project site. Raptors consist of low numbers of individual birds that utilize the project area for foraging.

Mammals include a variety of rodents. Dominant rodent species include the Merriam kangaroo rat (*Dipodomys merriami*) and the desert woodrat (*Neotoma lepida*). Livetrapping results are summarized in Table 3. Rodent trapping and observations of diurnal species indicate that the project site consists of a relatively low number of rodent species, some of which occur in high density. Rodent species composition also remains fairly consistent, irrespective of plant association sampled. Washes also contain significantly lower numbers of nocturnal rodents, possibly as a result of instability due to intermittent flashflooding. No listed or otherwise sensitive rodent species were livetrapped during this study.

Table 3. Results of Livetrapping for Nocturnal Rodents

Species	No. Captures	Frequency	Abundance
Succulent Scrub Habitat			
Merriam kangaroo rat	25	5.0	13.4
spiny pocket mouse	55	11.0	29.5
Bailey pocket mouse	23	4.6	12.3
desert woodrat	83	16.6	44.6
Total	186		
		Trap Success = 37.2%	
Microphyll Woodland Habitat			
Merriam kangaroo rat	9	1.8	16.6
spiny pocket mouse	8	1.6	14.8
Bailey pocket mouse	6	1.2	11.1
desert woodrat	31	6.2	57.4
Total	54		
		Trap Success = 10.8%	

*Total trap-effort of 1,000 trap-nights (e.g. 50 traps run for 10 nights in each habitat); nocturnal species only

Larger mammals include several predators. Kit fox (*Vulpes macrotis*) were frequently observed on the project site. Site use includes both foraging and denning. An active kit fox pupping den with at least two pups was observed on the project site during the current survey. Coyotes (*Canis latrans*) were also frequently observed.

Mule deer are widely distributed throughout the project site and surrounding area. Based on surveys of wash systems for deer and sign, washes are regularly used, with principal movements occurring with single to small numbers of deer travelling at night. Deer were observed singly or in small groups of 2-4 animals in all major east-west trending washes transecting the project site. Deer were also observed travelling between these washes, typically prior to sunrise. Transect surveys confirm that deer regularly use all washes in the project area, and washes extending to a distance of one or more miles outside of project area boundaries.

Additionally, fresh deer tracks and scat was common on the interspersed areas of desert pavement between these washes. Fresh deer tracks indicate free travel by deer throughout the area. No water sources are present on the project site that would serve to concentrate deer use at this location.

Listed Species

A single federally listed species, the desert tortoise, was recorded from the project area during surveys. Desert tortoises were observed throughout the project area and along the access/utility corridor (e.g., Indian Pass Road). Tortoise sign along the alternative transmission line corridor were restricted to intersecting washes in the eastern half of the alignment. Desert tortoises and sign recorded included a total of 33 observations of live animals (including "incidental" observations along routes by company staff and contractors), 247 burrows and pallets, 103 scat, 2 nesting sites (with egg fragments) and 14 carcasses (including disarticulated skeletal fragments) (Figures 4 and 5). Tortoises and sign were most frequently observed in the eastern half of the project area, dominated by two low ridgelines and a moderate-sized wash. Tortoises and sign decreased significantly in the western half of the project area. Reasons for this difference are not known, since topography and soils are similar. Proximity to Indian Pass Road, and regular camping and off-road vehicle use in this area may have contributed to historical declines from vehicle mortality and collection. Two tortoise carcasses found during the access/utility corridor survey showed clear evidence of vehicle-related mortality. Both animals were also killed within the preceding 1-2 years. Tortoises are present in very low densities in the western edge of the project area, dominated by a sharply rising ridgeline dominated by basalt pavement. Tortoise use at this area was restricted to interspersed "finger" drainages. A synopsis of field data is provided in Table 4 and shown in Figures 4 and 5. Field data are presented in Appendix C.

Table 4. Desert Tortoises and Sign Observed In the Chemgold Imperial Project Area

Type of Sign	Total No. Observations
Live tortoises (including incidental obs.)	33
Burrows/Pallets	247
Tortoise Scat	103
Carcasses (including fragments)	14
Nesting Sites	2
Total Adjusted Sign	322

The number of desert tortoises currently present on the project site and associated route/utility corridors is difficult to quantify. Based on regional data generated during the California Desert Plan Program for the species, between 0-20 tortoises per square mile are present. Extrapolating from this data, between 0-48 desert tortoises may currently occupy the project area, adjacent "buffer", road/utility corridor, and alternate transmission line corridor. Reviewing results of intensive site transect surveys for desert tortoises, approximately 33-57 desert tortoises currently occupy this project area and associated "buffers" extending around the project site, pipeline corridor, and alternate transmission line route (Table 5).

Table 5. Estimated Numbers of Desert Tortoises Currently in the Imperial Project Area*

Survey Data		
Number of Observations of Live Animals	=	32
Number of Burrows with Fresh Sign	=	16
No. Class 2 burrows (end not visible)	=	37
Estimated Actual No. Tortoises Seen	=	16**-32
Estimated No. Unobserved Tortoises in Burrows	=	16-25
Estimated Total Number of Tortoises	**=**	**32-57**
BLM Data		
Estimated Regional Tortoise Densities	=	0-20/sq. mi.
Total Acreages Affected (app.)		
Project Site	=	1003.5
Utility/Road Corridor	=	29.4
"Buffer" Surveyed	=	500.0
Total	=	1532.9
Estimated Total Number of Tortoises	**=**	**0-48**

*Includes project site, utility/road route, "buffer", and alternative transmission line route
**Assumes several repeat sightings of same size/sex animals in same area represent a single individual

An adult male Gila woodpecker was observed near the southwest corner of the project site in January 12, 1995, by a biologist monitoring exploratory drilling. The individual woodpecker was originally perched on a large ironwood tree in a large wash near the western border of the project site (Figure 4). Additional searches for this and other Gila woodpeckers, including using recorded bird calls in an effort to elicit a response, were negative. Subsequent search efforts were undertaken later in January, and again between February 27-March 1, April 4-6, April 27-28, and May 11-12, 1995 (Peter Woodman, pers. comm.). Gila woodpeckers are typically very vocal, and thus easy to locate.

They also exhibit a high degree of fidelity to their home territory and are year-round residents. Based on the negative results of this inventory, absence of prior site records, and inappropriate habitat on the project site, this single observation consisted of a transient bird.

A prior records search did not provide any prior supplemental data on the occurrence of any other State or federally listed species within the project site. Several listed and proposed species are known to occur in the Colorado River 15 miles east of the site, and at the Algodones Dunes, 12 miles west of the project site. The absence of any water/wetland habitats precludes any potential for the occurrence of listed and proposed wildlife or plant species closely associated with these habitats. Lack of sandy-based soils also precludes many species of plants and wildlife known to occur in the vicinity of the Algodones Dunes.

Other Sensitive Species

Plants

No State or federally listed, proposed, or candidate species were located on the Imperial Project site, or have been previously recorded from the project site. Two sensitive plant species, fairy duster and winged forget-me-not, were located on the project site and within the adjacent buffer zone. Fairy duster was common in virtually all of the washes throughout the site. A total of 285 individual plants were observed; conservatively, 500 or more plants occur on the site. Fairy duster was restricted to washes, where it was generally present along wash edges and banks. It was most commonly observed in smaller washes that were between 2-8 feet in width (Peter Woodman, pers. comm.).

Winged forget-me-not was uncommonly found in the larger washes throughout the project site. A total of 53 plants were located, although the actual number of plants on the project site is probably higher. Winged forget-me-not is found in washes throughout the Colorado Desert and into the eastern Mojave Desert of California and Nevada (Jepson 1994). It is also found in the Sonoran Desert in Arizona. The winged forget-me-not is classified as a List 4 (e.g., a "watch" list) species by the California Native Plant Society. While such plants are not "rare" from a Statewide perspective, they are uncommon enough that their status should be monitored regularly.

Wildlife

Several currently unlisted wildlife species that are either Category 2 candidates for Federal listing and/or designated State Species of Special Concern were recorded during project site surveys. These species are the chuckwalla, loggerhead shrike, sharp-shinned hawk, northern harrier and American badger. Although no natural or artificial caves or rock fissures that could support bat colonies are present, one or more sensitive bat species may forage in this area as well. Potentially occurring sensitive bat species include the Federal candidate California leaf-nosed bat, recorded from both the Hedges and Olgilby USGS Quadrangles (CNDDB records).

A total of three chuckwallas were observed during surveys of the project area. All were associated with fractured rocks, where small crevices afforded refuge (Figure 4). Although approximately half of the project site is comprised of rocky substrates consisting of basalt, this area comprises marginal chuckwalla habitat. Rocks present are typically small in size and form a shallow surface layer overlying powdery soils. Large rocks or boulders with fissures, rock rubble with vertical stratification, or weathering rock outcrops that provide optimal habitat for chuckwallas are absent from the project site.

Loggerhead shrikes were frequently observed during transect surveys of the project site, associated route/utility corridor, and within the alternate transmission line corridor. Based on the frequency of these observations, the project area supports both nesting and foraging habitat for this species.

A total of two northern harrier observations were made during the course of this survey. Both observations occurred in September and consisted of a single animal foraging over the western portion of the mining site. Based on these observations, the northern harrier utilizes the project site infrequently for foraging.

A single sharp-shinned hawk was observed in the northwestern portion of the project site during September. This single bird was observed foraging in the largest wash system along the western edge of the project site. No additional observations were made. Based on this single observation, the species probably infrequently forages in larger washes that bisect the project site.

No raptor nests are known to occur on the project site or within the adjacent buffer.

American badgers also infrequently utilize the project area for hunting. A single live badger was observed in a large wash approximately one mile north of the project site during deer surveys in September. Additional badger-excavated rodent burrows were observed in the northern portion of the project area during transect surveys.

No sensitive bat species were recorded during this survey, or have been previously documented from the project site. In addition, no rock fissures, tunnels or shafts favorable for colonial roosting were present on the Imperial Project site. However, several sensitive species of bats are known to occur in the Cargo Muchacho

Mountains, approximately six miles southeast of the Imperial Project site. Surveys of the American Girl Mining Project (DeDyker and Associates 1994) have documented the occurrence of the California leaf-nosed bat, Townsend's big-eared bat, and western mastiff bat. Two other sensitive bat species, the spotted bat and the cave myotis, may also have been heard during surveys of the American Girl Mining Project. Each of the above species may utilize the Chemgold imperial Project site for foraging. Although colonial bat roosting sites are not present on the Imperial Project site, individual bats may roost in palo verde or ironwood trees or may utilize small rock crevices.

The project site contains a potential prey base population of deer for mountain lions. The project area lies near the western edge of the historical range of the Yuma puma, a Federal candidate species. This light-colored race of mountain lion appears to have been closely associated with the lower Colorado River drainage. Nearest locality records to the Chemgold Imperial project site are the Colorado River, 12 miles south of Yuma (1903 record) and the Colorado River, 20 miles north of Picacho (no date) (Hall 1981). A contract survey conducted for the U.S. Fish and Wildlife Service in the 1980's to collect recent possible sightings of the Yuma puma did not result in any new records (Ted Rado, pers. observ.). No mountain lion observations, nor any sign of mountain lions, were recorded during the current survey of the Chemgold Imperial Project area.

4.0. CONCLUSION

Chemgold, Incorporated, plans to operate a large-scale open pit gold mining operation in southeastern Imperial County. Operations will involve extraction of gold-bearing ore, on-site processing, and placement of overburden in designated areas. Associated actions will include construction of haul roads, support facility areas, and a perimeter security fence. The project will last for approximately 10-20 years. Biological surveys of the project site and associated transportation and electrical supply corridors were conducted between the summer of 1994 and spring of 1995. Survey results should be utilized during the preparation of a biological assessment addressing the effects of proposed project actions on wildlife and vegetation and the development of measures to mitigate project-related effects to such species and their habitats.

5.0. LITERATURE CITED

Berry, K.H. 1972.
Report on tortoise relocation project, July 1971 to November 1971. Division of Highways, State of California, in partial fulfillment of Contract F-9353.

Berry, K.H. 1975
Desert tortoise relocation project: status report for 1973. Department of Transportation, State of California. Contract F-9353. 37 pp.

Berry, K.H. and L.L. Nicholson. 1984.
A summary of human activities and their impacts on desert tortoise populations and habitat in California. In: K.H. Berry (ed.): The status of the desert tortoise (*Gopherus agassizii*) in the United States. Rept. to the U.S. Fish and Wildlife Service from the Desert Tortoise Council on Order No. 11310-0083-81. Pp. 61-117.

Burge, B.L. and W.G. Bradley. 1976.
Population density, structure, and feeding habits of the desert tortoise (*Gopherus agassizii*) on a low desert study area in southern Nevada. In: N.J. Engberg, S. Allan, and R.L. Young (eds.). Desert Tortoise Council Proceedings of the 1976 Symposium. Pp. 51-74.

Burge, B.L. and W.G. Bradley. 1976.
Population density, structure, and feeding habits of the desert tortoise (Gopherus agassizii) on a low desert study area in southern Nevada. In: N.J. Engberg, S. Allan, and R.L. Young (eds.). Desert Tortoise Council Proceedings of the 1976 Symposium. Pp. 51-74.

Berry, K.H. (ed.) 1984.
The status of the desert tortoise (Gopherus agassizii) in the United States. Rept. to the U.S. Fish and Wildlife Service from the Desert Tortoise Council on Order No. 11310-0083-81. 838 pp.

California Department of Fish and Game. 1991.
Annual Report on the status of California State Listed Threatened and Endangered Animals and Plants. Sacramento, California. 192 pp.

California Native Plant Society. 1988.
California Native Plant Society's Inventory of Rare and Endangered Vascular Plants in California. Special Publ. No. 5, Sacramento, California. 168 pp.

California Native Plant Society. 1994.
California Native Plant Society's Inventory of Rare and Endangered Vascular Plants in California. Special Publ. No. 5, Sacramento, California, Fifth Edition. 338 pp.

Condor Minerals Management, Incorporated. 1991.
Final Supplemental Environmental Impact Report for the Proposed Chemgold Inc. Pichacho Mine Dulcina Pit Phase 2, Imperial County, California. Prepared for Chemgold, Incorporated, Yuma, Arizona.

DeDecker and Associates. 1994.
Draft Environmental Impact statement, Oro Cruz Operation of the American Girl Mining Project. Prepared by the U.S. Bureau of Land Management, El Centro Resource Area Office, California. 277 pp.

Desert Tortoise Recovery Team. 1993a.
Desert Recovery Plan for the Desert Tortoise (Mojave Population). Prepared for the U.S. Fish and Wildlife Service, Portland, Oregon. 173 pp. + append.

Desert Tortoise Recovery Team. 1993b.
Proposed Desert Wildlife Management Areas for recovery of the Mojave population of the desert tortoise. Prepared for the U.S. Fish and Wildlife Service, Portland, Oregon. 139 pp.

Environmental Solutions. 1987. Final Environmental Impact Report/Environmental Assessment for the proposed VCR mining project, Imperial County, California. Prepared for the U.S. Department of Interior, Bureau of Land Management El Centro Resource Area Office. 184 pp. + append.

Hall, E.R. 1981.
Mammals of North America. 2nd Ed. John Wiley and Sons, New York.

Klauber, L.M. 1939.
Studies of reptile life in the arid southwest. Bull. Zool. Soc. San Diego 14:1-100.

Mayhew, W.W. 1965.
Hibernation in the horned lizard <u>Phrynosoma</u> <u>mcallii.</u> Comp. Biochem. Physiol. 16:103-119.

Mayhew, W.W. and B.A. Carlson. 1986.
Status of the flat-tailed horned lizard (<u>Phrynosoma</u> <u>mcallii</u>) in California. Final report prepared for the California Department of Fish and Game under Contract no. 85/86 C-1355. 34 pp.

Medica, P.A., C.L. Lyons, and F.B. Turner. 1982.
A comparison of 1981 populations of desert tortoises (*<u>Gopherus agassizii</u>*) in grazed and ungrazed areas in Ivanpah Valley, California. <u>In</u>: K. Hashagan (ed.): Desert Tortoise Council Proceedings of the 1982 Symposium. Pp. 99-124.

Miller, A.H. and R.C. Stebbins. 1964.
The Lives of Desert Animals in Joshua Tree National Monument. UC Press, Los Angeles, California. 452 pp.

Munz, P.A. 1974.
A Flora of Southern California. University of California Press. 1086 pp.

Norris, K.S. 1949.
Observations on the habits of the horned lizard, Phrynosoma mcallii. Copeia 1949:176-180.

Olech, L.A. No date.
Status of the flat-tailed horned lizard (Phrynosoma mcallii) on Bureau of Land Management administered land in California. U.S. Dept. of Interior, Bureau of Land Management, El Centro, California. 12 pp. + append.

Rado, T. No date.
Analysis of actual and potential loss of flat-tailed horned lizard (Phrynosoma mcallii) habitat. Draft. U.S. Dept. of Interior, Bureau of Land Management, Sacramento, California. 30 pp.

Schwartzmann, J.L., and R.D. Ohmart. 1977.
Quantitative vegetational data of desert tortoise habitat (Gopherus agassizii) habitat in the lower Sonoran Desert. In: M. Trotter and C.G. Jackson, Jr. (eds.): Desert Tortoise Council Proceedings of the 1977 Symposium. Pp. 112-115.

Smith, H.M. 1965.
Handbook of Lizards. Cornell University Press, Ithaca, New York. 557 pp.

Turner, F.B., P.A. Medica, and H.O. Hill. 1980a.
The status of the flat-tailed horned lizard (Phrynosoma mcallii) at nine sites in Imperial and Riverside Counties, California. Prepared for the U.S. Dept. of Interior, Bureau of Land Management, Riverside, California. Contract YA-512-CT8-58.

Turner, F.B., J.C. Rorabaugh, E.C. Nelson and M.C. Jorgensen. 1980b.
A survey of the occurrence of the flat-tailed horned lizard (Phrynosoma mcallii) in California. Prepared for the U.S. Dept. of Interior, Bureau of Land Management, Riverside, California. Contract YA-512-CT8-58.

Turner, F.B. and P.A. Medica. 1982.
The distribution and abundance of the flat-tailed horned lizard, Phrynosoma mcallii. Copeia 1982:815-823.

Turner, F.B., K.H. Berry, D.C. Randall and G.C. White. 1987.
Population ecology of the desert tortoise at Goffs, California, 1983-1986. Prepared under contract between the Southern California Edison Company and the University of California, by a Memorandum of Understanding and Purchase Order (C1363901) between the Southern California Edison Company and the Bureau of Land Management, and by Contract DE-AC03-76-SF00012 between the U.S. Department of Energy and the University of California. 101 pp.

U.S. Bureau of Land Management. 1980.
The California Desert Conservation Plan, 1980. Prepared by the U.S. Dept. of Interior, Bureau of Land Management, California Desert Plan Program, Riverside, California. 173 pp.

U.S. Bureau of Land Management. 1989.
Environmental assessment for selected control of the common raven to reduce desert tortoise predation in the Mojave Desert, California. Jointly prepared by the U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, and California Department of Fish and Game. 33 pp.

U.S. Bureau of Land Management and California Department of Fish and Game. 1992.
California Statewide Desert Tortoise Management Policy. Prepared by the USBLM, California Desert District, Riverside, California, and the California Department of Fish and Game. 57 pp.

Woodbury, A.M. and R. Hardy. 1948.
Studies of the desert tortoise, <u>Gopherus agassizii</u>. Ecol. Mono. 18:145-200.

APPENDIX A

Qualifications of Biologists

Summary of Participation in Project Surveys

Ted Rado:	Tortoise surveys; general wildlife and plant inventory; deer sign survey; reptiles and amphibians; small mammal livetrapping; report preparation
Peter Woodman:	Tortoise surveys; general wildlife and plant inventory; plant surveys; bird surveys
Karen Jones:	Tortoise surveys; general wildlife and plant inventory; deer sign survey
Ken Sweat:	Tortoise surveys

TED RADO

Ted Rado has a B.A. degree in zoology and a M.A. degree in biology. Mr. Rado has a total of 12 years' experience as a wildlife biologist specializing in endangered species compliance with the U.S. Fish and Wildlife Service and the U.S. Bureau of Land Management. As a wildlife biologist with the U.S. Bureau of Land Management, his work included a position as an endangered species specialist at the BLM State Office in Sacramento. Mr. Rado was also employed as a field biologist with the Bureau in the Mojave Desert in Barstow, California, and as a desert tortoise specialist with the BLM in Riverside. As an employee of the U.S. Fish and Wildlife Service, Mr. Rado specialized in reviewing projects for compliance with the Endangered Species Act. In this capacity, Mr. Rado reviewed survey protocols with project consultants, met with developers to discuss issues and negotiate mitigation, prepared Biological Opinions for Federal agencies, and assisted in the preparation of regional conservation plans for Section 10(a) permits. He has also authored three Habitat Conservation Plans and participated in the preparation of six others.

For the past five years, Mr. Rado has worked in the California Desert Conservation Area as a consulting biologist. Work has included project field surveys, preparation of biological assessments and environmental assessments, and completion of State and Federal permitting documents for a variety of projects authorizing the lawful "take" of listed species. Section 10(a) permitting documents have been prepared by Mr. Rado and signed by the U.S. Fish and Wildlife Service for such projects as a State prison facility at Delano and a cogeneration plant near Fresno. Mr. Rado has also represented clients during negotiations with representatives of the U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, County government, and California Department of Fish and Game addressing compensation for listed species. Projects have included mining operations, pipelines, wind power generation, fiber-optic lines, and oilfield development.

PETER WOODMAN

Mr. Woodman has a B.A. degree in biology. Mr. Woodman has worked for 15 years as a biological consultant in the western United States. He is a widely recognized expert on the desert tortoise. As a consultant, he has completed numerous spring surveys of desert tortoise populations for the U.S. Bureau of Land Management. He has also completed endangered and sensitive species inventories for a variety of projects, including the U.S. Army at the Fort Irwin National Training Center, expansion of State Highway 58, a large-scale agricultural development southwest of Needles, a proposed hydroelectric project in the Sierra Nevada Range, a bird-of-prey survey in the California Desert, and a bird and marine mammal survey in Alaska.

Mr. Woodman has prepared a number of publications and technical papers on listed and sensitive species. Papers have been published on results of breeding and wintering bird surveys, desert tortoise distribution and density, and bird migration. Technical reports have included contract papers on desert tortoise ecology in Arizona and California for the U.S. Bureau of Land Management, portions of a contract study on the status of the desert tortoise prepared for the U.S. Fish and Wildlife Service, and inventories of desert plants and wildlife for the U.S. Department of Defense.

KAREN JONES

Karen Jones has a B.A. in biology. She has 7 years of experience as a wildlife biologist involving endangered species and fisheries biology. As a Scientific Aide with the California Department of Fish and Game, she conducted capture/recapture studies on chinook salmon in the Toulumne River and on several trout species in various lakes and streams in central California. During this period she also conducted a smoltification study on juvenile chinook salmon. Other fisheries experience includes a creel census of the Kings River, white bass eradication in California lakes, a Coded Wire Tag Program to determine return rate of juvenile releases, and a sampling survey on the San Joaquin river of California. As a Biological Technician with the U.S. Forest Service she conducted spotted owl surveys and nest location as well as cattle grazing surveys on the Stanislaus National Forest.

Ms. Jones has also worked as a staff biologist for an international consulting firm. Her duties included development of baseline survey techniques for endangered species, project setup and organization, project field supervisor, field surveys, construction monitoring, environmental compliance, biological assessments, permitting, report preparation, and a development of mitigation measures for a wide range of land use projects involving endangered species. In this capacity, she has worked with such species as the desert tortoise, flat-tailed horned lizard, blunt-nosed leopard lizard, San Joaquin kit fox, San Joaquin antelope squirrel, and a variety of sensitive plants. More recently, she has conducted a variety of projects in the California Desert Conservation Area as an independent consultant. Projects have included gold mining operations, pipelines, transmission lines, and water conveyance systems.

KEN SWEAT

Mr. Sweat has a B.A. degree in biology/mathematics. He is currently a graduate student at Arizona State University, working towards a Master's degree in botany with an emphasis on desert ecosystems. He has a total of 2 years' experience conducting surveys and monitoring projects in the California Desert region. Work has included participation in a desert tortoise survey in the western Mojave Desert for a highway project, and surveying portions of a large-scale interstate pipeline in the desert for tortoises and other sensitive species. He also worked as a team member during a spotted owl inventory in southern Utah.

APPENDIX B
Plant and Wildlife Species Observed

Plant Species Observed During Surveys of the Chemgold Imperial Project Site, Imperial County, California

Asclepiadaceae	**Milkweed Family**
Asclepias subulata	ajamete
Sarcostemma cynanchoides	climbing milkweed
Asteraceae	**Sunflower Family**
Ambrosia dumosa	burrobush
Atrichoseris platyphylla	parachute plant
Bebbia juncea	bebbia
Calycoseris wrightii	yellow tack-stem
Chaenactis carphoclinia var. *carphoclinia*	pebble pincushion flower
Chaenactis stevoides	Esteve pincushion flower
Encelia farinosa	brittle-bush
Hymenoclea salsola	cheesebush
Geraea canescens	desert sunflower
Gutierrezia macrocephala	matchweed
Microseris linearis	silver-puffs
Monoptillon belliodes	Mohave desert star
Perityle emoryi	Emery rock daisy
Porophyllum gracile	odora
Psathyrotes ramosissima	velvet rosette
Stephanomeria pauciflora	desert straw
Trichoptilium incisum	yellow-head
Trixis californica	trixis
Boraginaceae	**Borage Family**
Amsinkia tessellata	checker fiddleneck
Cryptantha angustifolia	narrow-leaved forget-me-not
Cryptantha circumscissa	western forget-me-not
Cryptantha barbigera	bearded forget-me-not
Cryptantha dumetorum	flexuous forget-me-not
Cryptantha micrantha	Nevada forget-me-not
Cryptantha maritima	white-haired forget-me-not
Cryptantha nevadensis	Nevada forget-me-not
Cryptantha holoptera	winged forget-me-not
Pectocarya platycarpa	broad-nutted comb-bur
Tiquilia canescens	tiquilia

Brassicaceae	**Mustard Family**
Descuriana pinnata	yellow tansy mustard
Brassica tournefortii	mustard
Guillenia lasiophyllum	
Streptanthella longirostris	small streptanthus
Lepidium lasiocarpum	peppergrass
Cactaceae	**Cactus Family**
Echinocactus polycephalus	cottontop cactus
Opuntia basalaris	beavertail cactus
Mammalaria tetrancistra	corkseed cactus
Opuntia bigelovii	Bigelow cholla
Opuntia acanthicarpa	golden cholla
Opuntia ramosissima	diamond cactus
Ferocactus cylindriceus	California barrel cactus
Campanulaceae	**Bellflower Family**
Nemacladus rubescens	
Nemacladus glanduliforus	
Chenopodiaceae	**Goosefoot Family**
Chenopodium sp.	
Salsola tragus	Russian thistle
Curcurbitaceae	**Gourd Family**
Curcurbita palmata	coyote mellon
Euphorbiaceae	**Spurge Family**
Chamaesyce polycarpa	prostrate spurge
Chamaesyce albomarginata	rattlesnake spurge
Ditaxis lanceolata	lance-leaved ditaxis
Ditaxis neomexicana	ditaxis
Euphorbia eriantha	beetle spurge
Fabaceae	**Pea Family**
Acacia greggii	cat-claw
Calliandra eriophylla	fairy duster
Cercidium floridum	palo verde
Olneya tesota	desert ironwood
Dalea mollissima	indigobush
Lotus strigosus	lotus
Psorothamnus schottii	indigobush
Calliandra eriophylla	fairy duster
Prosopis velutina var. Torreyana	mesquite

Fouquieriaceae	**Ocotillo Family**
Fouquieria splendens	ocotillo
Geraniaceae	**Geranium Family**
Erodium texanum	desert heron's bill
Hydrophyllaceae	**Waterleaf Family**
Nama demissum	purple mat
Phacelia distans	fat-leaf phacelia
Phacelia crenulata var. *ambigua*	notch-leaved phacelia
Phacelia crenulata var. *minutiflora*	small notch-leaved phacelia
Phacelia fremontii	Fremont phacelia
Krameriaceae	**Rattany Family**
Krameria grayia	white rattany
Krameria erecta	purple heather
Lamiaceae	**Mint Family**
Salvia columbariae	chia
Hyptis Emoryi	desert lavender
Loasaceae	**Loasa Family**
Mentzelia cf. albicaulis	blazing star
Mentzelia involucra	blazing star
Loranthaceae	**Mistletoe Family**
Phoradendron californicum	desert mistletoe
Malvaceae	**Mallow Family**
Eremalche rotundifolia	desert five-spot
Hibiscus denudatus	rock hibiscus
Horsfordia Newberryi	yellow felt-plant
Nytaginaceae	**Four O'Clock Family**
Allionia imbricata	windmill
Mirabilis cf. bigelovii	wishbone bush

Onagraceae	**Evening Primrose Family**
Camisonia boothii var. decorticans	woody-stemmed bottle-washer
Camisonia brevipes	yellow cups
Camisonia claviformis	brown-eyed primrose
Camisonia refracta	narrow-leaved primrose
Papaveraceae	**Poppy Family**
Eschscholtzia minutiflora	little gold poppy
Plantiginaceae	**Plaintain Family**
Plantago ovata	plaintain
Polygonaceae	**Buckwheat Family**
Chorizanthe brevicornu	brittle spine-flower
Chorizanthe corrugata	corrugata
Chorizanthe rigida	rigid spiny-herb
Eriogonum deflexum	skeleton weed
E. inflatum	desert trumpet
E. pusillum	yellow turbin
E. thomasii	Thomas buckwheat
Polemoniaceae	**Phlox Family**
Eriastrum diffusum	woolly-star
Langloisia setosissima var. punctata	lilac langliosia
Langloisia setosissima var. setosissima	bristly langloisia
Gilia latifolia	gilia
Loeseliastrum schottii	calico
Gilia sp.	gilia
Resedaceae	**Mignonette Family**
Oligomeris linifolia	linear-leaved cambess
Scrophulariaceae	**Figwort Family**
Mohavea confertiflora	ghost flower
Simmondsiaceae	**Box Family**
Simmondsia chinensis	jojoba

Solanaceae	**Potato Family**
Lycium andersonii	Anderson thornbush
Lycium andersonii var. deserticola	Anderson thornbush
Nicotiana trigonophylla	desert tobacco
Zygophyllaceae	**Caltrop Family**
Fagonia laevis	smooth-stemmed fagonia
Larrea tridentata	creosote bush
Monocotyledoneae	
Liliaceae	**Lily Family**
Hesperocaulis undulata	desert lily
Poaceae	**Grass Family**
Achnetherum speciosa	needlegrass
Aristida purpurea	triple-awned grass
Bromus madritensis	red brome
Bromus tectorum	downy chess
Erioneuron pulchellum	fluffgrass
Muhlenbergia porteri	Muhlenbergia
Pleuraphis rigida	big galleta grass
Schismus barbatus	split grass

Vertebrate Species Observed During Surveys of the Chemgold Imperial Project Site and Vicinity, Imperial County, California

Reptiles

FAMILY TESTIDINIDAE	**TORTOISES**
desert tortoise	*Gopherus agassizii*
FAMILY GEKKONIDAE	**GECKOS**
banded gecko	*Coleonyx variegatus**
FAMILY IGUANDIAE	**IGUANID LIZARDS**
side-blotched lizard	*Uta stansburiana*
desert horned lizard	*Phrynosoma platyrhinos*
desert spiny lizard	*Sceloporus magister*
zebra-tailed lizard	*Callisaurus draconoides*
desert iguana	*Dipsosaurus dorsalis*
long-nosed leopard lizard	*Gambelia wislizenii*
collared lizard	*Crotaphytus bicinctores*
tree lizard	*Urosaurus ornatus*
chuckwalla	*Sauromalus obesus*
FAMILY TEIIDAE	**WHIPTAILS**
western whiptail	*Cnemidophorus tigris*
FAMILY COLUBRIDAE	**COLUBRID SNAKES**
gopher snake	*Pituophis melanoleucus*
coachwhip	*Masticophis flagellum*
shovel-nosed snake	*Chionactis occipitalis**
patch-nosed snake	*Salvadora hexalepis*
FAMILY VIPERIDAE	**RATTLESNAKES**
sidewinder	*Crotalus cerastes*
western diamondback rattlesnake	*Crotalus atrox*

Birds

FAMILY CATHARTIDAE	**VULTURES**
turkey vulture	*Cathartes aura*

FAMILY ACCIPITRIDAE	**HAWKS**
red-tailed hawk	*Buteo jamaicensis*
northern harrier	*Circus cyaneus*
American kestrel	*Falco sparverius*
sharp-shinned hawk	*Falco striatus*
FAMILY STRIGIDAE	**OWLS**
great horned owl	*Bubo virginianus*
western screech owl	*Otus kennicottii*
FAMILY PHASIANIDAE	**QUAILS**
Gambel's quail	*Lophortyx gambelii*
FAMILY HIRUNDINIDAE	**SWALLOWS**
cliff swallow	*Petrochelidon pyrrhonota*
tree swallow	*Irdopocne bicolor*
barn swallow	*Hirundo rustica*
FAMILY APODIDIAE	**SWIFTS**
Vaux's swift	*Chaetura vauxi*
FAMILY COLUMBIDAE	**PIGEONS AND DOVES**
mourning dove	*Zenaida macroura*
white-winged dove	*Zenaida asiatica*
FAMILY CAPRIMULGIDAE	**NIGHTJARS**
lesser nighthawk	*Chordeiles acutipennis*
poor-will	*Phalaenoptilus nuttallii*
FAMILY PARIDAE	**VERDINS**
verdin	*Auriparus flaviceps*
FAMILY TROCHILIDAE	**HUMMINGBIRDS**
Anna's hummingbird	*Calypte anna*
FAMILY MIMIDAE	**MOCKINGBIRDS AND THRASHERS**
mockingbird	*Mimus polyglottos*
FAMILY TURDIDAE	**ROBINS**
American robin	*Turdus migratorius*

FAMILY ICTERIDAE	**BLACKBIRDS**
boat-tailed grackle	*Cassidix mexicanus*
FAMILY CUCULIDAE	**CUCKOOS**
greater roadrunner	*Geococcyx californianus*
FAMILY PTILOGONATIDAE	**SILKY FLYCATCHERS**
phainopepla	*Phainopepla nitens*
FAMILY TROGLODYTIDAE	**WRENS**
cactus wren	*Campylorhynchus brunneicapillus*
rock wren	*Salpinctes obsoletus*
Bewick's wren	*Thryomanes bewickii*
FAMILY EMBERIZIDAE	**WOOD WARBLERS, ORIOLES, SPARROWS**
house finch	*Carpodacus mexicanus*
black-throated sparrow	*Amphispiza bilineata*
white-crowned sparrow	*Zonotrichia leucophrys*
dark-eyed junco	*Junco oreganus*
lesser goldfinch	*Spinus psaltria*
yellow-rumped warbler	*Dendroica coronata*
black-throated gray warbler	*Dendroica nigrescens*
Wilson's warbler	*Wilsonia pusilla*
Townsend's warbler	*Dendroica townsendii*
FAMILY STURNIDAE	**STARLINGS**
European starling	*Sturnus vulgaris*
FAMILY LANIDAE	**SHRIKES**
loggerhead shrike	*Lanius ludovicianus*
FAMILY MIMIDAE	**THRASHERS**
crissal thrasher	*Toxostoma dorsale*
FAMILY PICIDAE	**WOODPECKERS**
ladder-backed woodpecker	*Dendrocopos scalaris*
gila woodpecker	*Melenerpes uropygialis*

FAMILY TYRANNIDAE	**FLYCATCHERS**
ash-throated flycatcher	*Myarchus migratorius*
western kingbird	*Tyrannus verticalis*
Say's pheobe	*Sayornis saya*
western wood pewee	*Contopus sordidulus*
dusky flycatcher	*Empidonax oberholseri*
FAMILY SYLVIIDAE	**GNATCATCHERS**
blue-gray gnatcatcher	*Poliptila caerulea*
black-tailed gnatcatcher	*Poliptila melanura*
FAMILY CORVIDAE	**CROWS**
common raven	*Corvus corax*

<u>Mammals</u>

FAMILY VESPERTILIONIDAE	**LEAF-NOSED BATS**
western pipistrel	*Pipistrellus hesperus*
FAMILY CRICETIDAE	**NEW WORLD MICE**
desert woodrat	*Neotoma lepida*
FAMILY SCIURIDAE	**SQUIRRELS**
antelope ground squirrel	*Ammospermophilus leucurus*
round-tailed ground squirrel	*Spermophilus tereticaudus*
FAMILY HETEROMYIDAE	**KANGAROO RATS/POCKET MICE**
desert kangaroo rat	*Dipodomys deserti**
Merriam kangaroo rat	*Dipodomys merriami*
spiny pocket mouse	*Perognathus spinatus*
Bailey pocket mouse	*Perognathus baileyi*
FAMILY LEPORIDAE	**HARES**
desert cottontail	*Sylvilagus audubonii*
black-tailed jackrabbit	*Lepus californicus*
FAMILY FELIDAE	**CATS**
bobcat	*Felis rufus*
FAMILY CANIDAE	**FOXES/DOGS/WOLVES**
coyote	*Canis latrans*
desert kit fox	*Vulpes macrotis*

FAMILY MUSTELIDAE	**WEASELS, SKUNKS, BADGERS**
American badger	*Taxidea taxus*
FAMILY CERVIDAE	**DEER**
mule deer	*Odocoileus hemionus*
FAMILY EQUIDAE	**HORSE FAMILY**
wild burro	*Equus asinus*

*Observed in project "buffer" or along project access road

APPENDIX C

Desert Tortoises and Sign Observed During Surveys of the Chemgold Imperial Project Site, Adjacent "Buffer", Access Route, and Utility Line Routes, Imperial County, California

#	Sign	Class*	W (mm)	H (mm)	L (mm)	End Visible?	Habitat/Comments
1	Burrow	1	34	19	210+	No	DP**/22 Class 2 scats
2	Drinker	3					DP
3	Burrow	5	24	17	60	Yes	DP
4	Pallet	2	31	15	27	Yes	DP
5	Pallet	2	30	18	55	Yes	Edge small drainage
6	Burrow	3	32	16	90	Yes	Edge small drainage
7	Burrow	2	33	20	70+	No	DP
8	Scat	2					Single scat
9	Pallet	3	36	19	56	Yes	DP
10	Scat	2					DP/ 2 scats
11	Burrow	1	30	18	77+	No	Probable tortoise inside/ fresh tracks/ DP
12	Burrow	1	24	14	50+	No	DP/recent use w/smoothed entrance ramp
13	Burrow	2	32	16	85+	No	Edge small wash
14	Pallet	3	40	10	20	Yes	Small wash edge/collapsed
15	Pallet	3	27	15	48	Yes	Edge small drainage
16	Burrow	1	27	17	100+	No	Wash/Smoothed entrance ramp
17	Burrow	2	13	8	48+	No	Edge small drainage
18	Burrow	2	30	15	160+	No	Edge small drainage
19	Burrow	3	22	16	65	Yes	Edge small drainage
20	Pallet	2	20	10	25	Yes	Large wash bank
21	Pallet	2	36	18	28	Yes	Large wash bank
22	Pallet	2	36	19	30	Yes	Large wash bank
23	Burrow	2	22	17	50+	No	Edge large wash
24	Scat	3					1 scat
25	Scat	2					4 scat
26	Burrow	3	23	12	120+	No	Edge small drainage
27	Burrow	3	30	15	?		Woodrat nest use/drainage
28	Burrow	2	32	16	80+	No	Edge small drainage
29	Pallet	4	35	17	50	Yes	Side large wash
30	Pallet	4	30	14	30	Yes	Side small wash
31	Burrow	1	35	18	80+	No	DP/tortoise (260 MCL female inside)
32	Burrow	3	40	18	190+	No	DP/5 Class 5 scats
33	Burrow	4	30	16	82	Yes	DP
34	Burrow	3	28	16	150+	No	DP
35	Pallet	4	28	12	24	Yes	DP
36	Burrow	4	30	20	50	Yes	DP
37	Pallet	4	28	4	20	Yes	DP
38	Burrow	4	35	15	?	No	Edge drainage
39	Burrow	3	30	15	50+	No	DP

#	Sign	Class*	W	H (mm)	L	End Visible?	Habitat/Comments
40	Pallet	3	38	17	40	Yes	Edge small drainage
41	Pallet	4	26	12	20	Yes	Edge small drainage
42	Carcass	5					Edge small drainage/dead >10 years (260 MCL female)
43	Burrow	3	20	10	87+	No	Edge small wash
44	Burrow	4	30	16	75+	No	Edge small wash
45	Burrow	2	20	9	43+	No	Edge small drainage
46	Burrow	2	20	12	45+	No	Edge small drainage
47	Burrow	1	34	16	95+	No	Probable tortoise inside/2 Class 2 scats at ramp
48	Burrow	1	32	17	100+	No	4 Class 2 scats
49	Burrow	2	26	20	76	Yes	Edge small wash
50	Burrow	1	30	13	90+	No	Probable tortoise/3 Class 2 scats
51	Burrow	2	24	12	42	Yes	In small drainage
52	Scat	2					small wash/1 scat
53	Burrow	4	28	16	56	Yes	In wash bank small wash
54	Scat	3					wash/1 scat
55	Burrow	2	30	16	45	Yes	Wash edge/smooth ramp
56	Burrow	2	28	12	90+	No	DP
57	Burrow	3	26	13	245+	No	Small wash bank
58	Pallet	4	22	11	20	Yes	DP
59	Pallet	3	30	13	34	Yes	DP
60	Burrow	2	32	17	70+	No	DP
61	Burrow	2	32	18	60+	No	DP
62	Pallet	2	37	15	47	Yes	Large wash bank
63	Burrow	2	32	16	85	Yes	Large wash bank
64	Burrow	1	30	15	75+	No	Probable tortoise/ 1 class 2 scat and fresh tracks
65	Burrow	2	28	16	78	Yes	Wash bank
66	Pallet	4	20	12	27	Yes	Edge small drainage
67	Pallet	2	32	16	47	Yes	Edge small drainage
68	Burrow	1	36	18	50+	No	Probable tortoise/1 Class 2 scat and fresh ramp
69	Burrow	2	32	15	58	Yes	DP
70	Pallet	3	20	10	30	Yes	Edge small drainage
71	Carcass	5					DP/fragments/dead >10 yrs
72	Burrow	1	28	14	60+	No	Probable tortoise/4 Class 2 scats and fresh tracks
73	Burrow	4	30	20	88	Yes	DP
74	Pallet	4	20	10	20	Yes	DP
75	Burrow	4	24	13	60+	No	DP
76	Pallet	4	17	9	27	Yes	Edge small wash
77	Burrow	2	30	17	60+	No	Edge small wash
78	Burrow	2	30	18	60+	No	Edge small wash
79	Burrow	2	27	20	100+	No	Edge small wash
80	Pallet	2	26	17	34	Yes	DP
81	Burrow	2	34	18	68	Yes	Edge small wash

#	Sign	Class*	W	H	L (mm)	End Visible?	Habitat/Comments
82	Burrow	2	30	17	65	Yes	Edge small wash
83	Burrow	2	22	18	85	Yes	Edge small wash
84	Burrow	2	30	14	67	Yes	Edge small wash
85	Pallet	4	32	18	56	Yes	DP
86	Burrow	3	23	15	75	Yes	DP
87	Pallet	4	30	10	22	Yes	DP
88	Burrow	3	28	20	145+	No	Edge small wash
89	Pallet	4	32	18	62	Yes	DP
90	Burrow	4	32	15	115	Yes	DP
91	Burrow	5	25	23	110+	No	Edge small drainage
92	Kit Fox Den						Kit fox observed inside
93	Burrow	2	30	18	50	Yes	DP
94	Burrow	2	28	22	60	Yes	DP
95	Burrow	2	38	18	90+	No	DP
96	Pallet	4	20	15	20	Yes	DP
97	Burrow	3	30	13	30	Yes	Edge small drainage
98	Burrow	1	40	22	70+	No	Probable tortoise/fresh tracks
99	Carcass	5					DP/Dead >10 yrs (frags)
100	Burrow	4	20	12	45	Yes	DP
101	Caliche Holes						Wash bank/no sign
102	Pallet	4	20	8	15	Yes	DP
103	Burrow	1	30	20	100+	No	Wash bank/probable tortoise/2 Class 2 scats and fresh tracks
104	Burrow	1	30	20	100+	No	Wash bank/tortoise inside/270 MCL male
105	Scat	2					Road edge/1 scat
106	Scat	2					DP/1 scat
107	Burrow	4	32	14	38	Yes	Edge small wash
108	Pallet	3	26	12	64	Yes	DP
109	Scat	2					DP/ 2 scat
110	Burrow	3	29	17	75	No	DP
111	Burrow	4	30	15	?	No	DP/woodrat nest inside
112	Burrow	3	15	10	35	Yes	Edge small wash
113	Burrow	5	20	15	36	Yes	Wash edge/unlikely tortoise burrow
114	Burrow	3	30	18	40	Yes	Edge small wash
115	Burrow	1	30	15	80+	No	Edge wash/tortoise inside/ 260 MCL female
116	Burrow	2	32	16	90+	No	Small wash
117	Burrow	2	32	18	60+	No	DP
118	Carcass	4					DP/subadult male (MCL 120)/dead 3-5 yrs
119	Burrow	3	20	14	110+	No	DP
120	Burrow	3	30	23	62	Yes	DP
121	Carcass	5					DP/single fragment/dead >10 yrs

#	Sign	Class*	W	H (mm)	L	End Visible?	Habitat/Comments
122	Carcass	5					DP/single fragment/dead >10 yrs
123	Burrow	3	39	17	100+	No	Edge small wash
124	Burrow	3	28	19	95	Yes	Edge small wash
125	Burrow	2	18	8	120+	No	Edge small wash
126	Burrow	1	38	22	110	Yes	Nest site with scattered egg frags at ramp
127	Pallet	4	26	9	35	Yes	DP
128	Caliche Burrow		28	12	62	Yes	Wash bank
129	Pallet	3	27	13	40	Yes	Wash bank
130	Burrow	3	29	17	35	Yes	Wash bank
131	Burrow	3	28	17	50	Yes	Wash bank
132	Kit fox pupping den with app. 200 scat						
133	Burrow	3	30	20	60	Yes	Edge small wash
134	Burrow	2	34	16	75	Yes	Edge small wash
135	Pallet	5	37	22	55	Yes	Edge small wash
136	Burrow	5	30	20	60+	No	Edge small wash
137	Burrow	2	33	15	100+	No	1 Class 5 and 1 Class 3 scat
138	Scat	2					2 scat
139	Scat	3					1 scat
140	Pallet	2	27	12	40	Yes	Wash bank
141	kit fox den with numerous scat						
142	Pallet	4	30	10	30	Yes	Edge small drainage
143	Burrow	3	23	14	75+	No	Edge small drainage
144	Pallet	4	21	12	31	Yes	DP
145	Burrow	2	32	17	80+	No	Edge small wash
146	Burrow	2	32	16	45	Yes	Edge small wash
147	Burrow	3	34	19	95	Yes	Wash bench
148	Pallet	2	42	19	70	Yes	DP
149	Burrow	2	31	17	140+	No	Wash edge
150	Burrow	3	30	15	50+	No	Tortoise previously observed here by Chemgold staff/270 MCL male observed here on 10/4/94
151	Burrow	4	27	18	70	Yes	Wash
152	Pallet	4	19	10	32	Yes	Wash
153	Pallet	4	20	10	10	Yes	Small wash/collapsed
154	Pallet	4	30	15	20	Yes	Edge small wash
155	Burrow	2	28	15	100	Yes	Small wash
156	Burrow	3	32	18	60+	No	Top wash embankment
157	Burrow	3	31	16	40+	No	Top wash embankment
158	Burrow	2	36	18	150	Yes	Edge small wash
159	Pallet	3	30	15	55	Yes	Top wash embankment
160	Burrow	3	30	20	60+	No	Small wash
161	Pallet	3	40	20	50	Yes	Under tree in large wash
162	Pallet	3	30	20	50	Yes	Wash bank/egg shell remains

#	Sign	Class*	W	H (mm)	L	End Visible?	Habitat/Comments
163	Burrow	2	32	15	80+	No	Wash bank
164	Burrow	1	35	15	80+	No	Wash bank/Tortoise inside/270 MCL male
165	Burrow	1	25	15	100+	No	DP/1 Class 2 scat inside
166	Pallet	3	30	15	40	Yes	Wash bank
167	Burrow	3	25	12	60+	No	Wash bank
168	Pallet	3	30	10	30	Yes	Wash bank
169	Pallet	3	30	12	35	Yes	DP
170	Pallet	3	25	12	40	Yes	DP
171	Burrow	3	30	12	60	Yes	DP
172	Pallet	4	20	10	30	Yes	Wash bank
173	Pallet	4	20	10	25	Yes	Wash bank
174	Burrow	5	29	10	60	Yes	Caliche bank in DP
175	Pallet	4	40	18	30	Yes	Small drainage
176	Pallet	4	40	20	50	Yes	Small drainage
177	Burrow	5	44	25	85+	No	Caliche hole-no sign
178	Burrow	5	40	20	70	Yes	Caliche hole-no sign
179	Pallet	3	30	14	55	Yes	Wash bank
180	Pallet	5	28	18	34	Yes	Wash bank
181	Pallet	5	31	16	60	Yes	Wash bank
182	Burrow	4	18	9	70+	No	Edge of wash
183	Pallet	4	24	11	28	Yes	Edge of wash
184	Carcass	5					Wash edge/fragment/dead >10 yrs
185	Scat	2					Wash bank/ 1 scat
186	Live tortoise observed by Chemgold crew on road (no data)						
187	Live tortoise observed by Chemgold crew on road (no data)						
188	Live tortoise observed by biologist on road (Male/MCL 260)						
189	Live tortoise observed on road by biologist (Male/MCL 250)						
190	Burrow	2	32	25	64	Yes	Wash bank
191	Burrow	3	21	10	50	Yes	Wash edge/90 ft N road
192	Pallet	2	30	14	30	Yes	DP
193	Pallet	2	32	18	60	Yes	DP
194	Pallet	3	32	16	38	Yes	Edge small wash
195	Burrow	2	31	14	90+	No	DP
196	Burrow	4	30	16	60	Yes	DP
197	Pallet	4	30	12	30	Yes	DP
198	Pallet	2	24	16	35	Yes	Small Wash
199	Burrow	2	35	20	75	Yes	Small Wash
200	Pallet	2	25	13	31	Yes	Wash bank
201	Pallet	4	21	11	20	Yes	Wash bank
202	Scat	3					Wash/ 1 scat
203	Scat	2-3					Wash bank/ 2 scat
204	Burrow	5	23	14	62	Yes	DP/badger digout
205	Scat	3					DP/ 1 scat
206	Burrow	5	24	14	85+	No	DP
207	Burrow	5	23	11	31	Yes	Wash bank
208	Burrow	5	24	13	60+	No	DP

#	Sign	Class*	W	H (mm)	L	End Visible?	Habitat/Comments
209	Pallet	5	23	12	32	Yes	DP
210	Scat	4					DP/ 1 scat
211	Scat	2					1 scat
212	Pallet	2	22	11	30	Yes	Wash bank
213	Scat	2					DP/ 1 scat
214	Burrow	1	29	14	105	Yes	Tortoise inside/275 MCL male
215	Burrow	3	28	14	55	Yes	Bank small wash
216	Burrow	2	29	12	48+	No	DP/7 old scat
217	Scat	3					1 scat
218	Scat	2					3 scat
219	Burrow	3	30	14	85+	No	DP
220	Burrow	3	32	15	50	Yes	DP
221	Scat	3					2 scat
222	Scat	5					1 scat
223	Burrow	5	14	25	56	Yes	DP/probable kit fox
224	Burrow	5	11	15	?	No	Wash edge
225	Burrow	4	15	10	31	Yes	DP
226	Burrow	6	24	13	?	No	Large wash
227	Burrow	5	20	17	?	No	Large wash
228	Burrow	5	22	22	75	Yes	Large wash/prob. kit fox
229	Tortoise	(Male/MCL 275)					
230	Burrow	3	27	11	55	Yes	DP
231	Burrow	5	14	8	?	No	DP
232	Burrow	6	15	15	?	No	DP/Probable kit fox
233	Burrow	6	20	20	40	Yes	DP/Probable kit fox
234	Burrow	5	18	11	50	Yes	DP/Possible kit fox
235	Burrow	5	14	20	?	No	DP/Kit fox digout
236	Burrow	4	17	10	?	No	DP
237	Burrow	6	17	13	28	Yes	DP/Kit fox digout
238	Tortoise Tracks (from adult observed by driver at S end project site)						
239	Burrow	5	8	11	?	No	DP/unlikely tortoise
240	Pallet	4	20	8	15	Yes	DP/150 ft S road
241	Pallet	3	30	12	35	Yes	DP/450 ft S road
242	Burrow	2	28	18	100+	No	DP/450 ft S road
243	Burrow	2	34	17	70	Yes	DP/460 ft S road
244	Pallet	4	30	15	10	Yes	DP/500 ft S road
245	Pallet	2	35	17	30	Yes	DP/500 ft S road
246	Burrow	2	30	15	50	Yes	DP/50 ft S road
247	Pallet	4	40	20	40	Yes	60 ft S Road
248	Carcass	5					Road edge/single frag/ dead >10 yrs
249	Pallet	3	12	6	22	Yes	400 ft S road
250	Burrow	3	38	14	100+	No	250 ft S road
251	Burrow	3	20	8	40+	No	Small wash/450 ft S road
252	Pallet	3	22	12	37	Yes	Small wash/350 ft S road

#	Sign	Class*	W	H (mm)	L	End Visible?	Habitat/Comments
253	Carcass						300 ft S road/single frag/ dead >10 yrs
254	Carcass	2					350 ft S road/ 140 MCL male/ dead 1-2 years
255	Burrow	2	25	13	75	Yes	350 ft S road
256	Burrow	1	22	12	60+	No	Small wash/freshly excavated ramp
257	Pallet	3	24	13	30	Yes	Small wash/400 ft S road
258	Burrow	3	38	20	80	Yes	Small wash
259	Burrow	1	40	20	75+	No	Tortoise inside/300 MCL male
260	Pallet	3	20	15	30	Yes	Small wash
261	Burrow	2	34	18	65	Yes	Edge of wash
262	Burrow	1	20	12	40+	No	Probable tortoise inside/fresh tracks and 8 Class 3 scat
263	Pallet	4	25	11	20	Yes	Edge wash/90 ft N road
264	Pallet	4	30	8	20	Yes	DP
265	Burrow	2	25	12	60	Yes	Wash bank
266	Burrow	2	35	18	55+	No	Wash bank
267	Burrow	3	30	18	30+	No	Wash bank
268	Caliche hole		60	30	60	Yes	Wash bank/no tortoise sign
269	Live tortoise observed on road by biologist (female/220 MCL)						
270	Live tortoise observed on road by Chemgold crew (adult; no other data)						
271	Live tortoise observed on road by Chemgold crew (adult; no other data)						
272	Live tortoise observed at burrow/ 300 MCL male						
273	Live tortoise observed on road by water truck operator (adult; no other data)						
274	Burrow	2	25	12	43+	No	
275	Burrow	2	25	12	106+	No	1 Class 2 scat inside
276	Scat	4					1 scat
277	Burrow	2	35	25	90+	No	In wash
278	Burrow	2	30	15	106+	No	In wash
279	Burrow	2	15	7	17	Yes	In wash
280	Scat	3					Bank above wash/ 1 scat
281	Scat	2					DP/ 1 scat
282	Burrow	1	28	15	110+	No	DP/ 1 Class 2 scat inside
283	Burrow	1	30	15	?	No	wash edge/tortoise inside/270 MCL male
284	Burrow	2	30	15	80+	No	Wash edge
285	Burrow	3	34	18	60	Yes	DP
286	Burrow	3	30	12	110+	No	DP
287	Burrow	2	37	21	80	Yes	Edge small drainage
288	Burrow	2	40	18	78	Yes	Edge large wash
289	Burrow	3	21	13	100+	No	Edge small drainage

#	Sign	Class*	W	H	L	End Visible?	Habitat/Comments
			(mm)				
290	Pallet	3	30	13	40	Yes	DP
291	Burrow	2	33	19	100+	No	DP
292	Burrow	2	48	20	120+	No	Edge small drainage
293	Tortoise	100 ft E large wash/250 MCL female					
294	Burrow	3	42	14	60+	No	Edge small drainage
295	Burrow	3	32	13	80+	No	DP
296	Pallet	2	33	18	55	Yes	Edge large wash
297	Burrow	2	31	14	75	Yes	DP
298	Pallet	3	30	14	35	Yes	Small drainage
299	Pallet	2	27	18	50	Yes	DP
300	Burrow	1	40	20	60+	No	Edge wash/tortoise inside 250 MCL male
301	Pallet	2	43	30	60	Yes	Edge small drainage/ 1 Class 3 scat inside
302	Burrow	2	51	25	43+	No	In wash
303	Burrow	2	49	15	43	Yes	In wash/1 scat
304	Pallet	4	25	15	25	Yes	
305	Burrow	2	25	14	56+	No	
306	Burrow	2	28	18	90+	No	
307	Burrow	2	28	18	125+	No	
308	Scat	3					1 scat
309	Scat						1 scat
310	Burrow	2	33	17	100+	No	
311	Burrow	3	36	18	90+	No	
312	Burrow	3	28	18	43	Yes	
313	Pallet	No data collected					
314	Tortoise						230 MCL (sex unknown)
315	Scat	2					1 scat
316	Burrow	2	30	15	40	Yes	
317	Scat	5					1 scat
318	Carcass	3					No other info taken
319	Scat	2					1 scat
320	Carcass	2	260 MCL female, 300 yards N access road in wash				
321	Carcass	2	250 MCL male, dead 1-2 years				
322	Burrow	2	8	4	25+	No	At edge small drainage
323	Tortoise		280 MCL male, walking through area 10/3/94				
324	Carcass	5	Isolated worn fragments, dead > 10 years				
325	Tortoise		260 MCL male, observed in Burrow #74 10/10/94				
326	Tortoise		250 MCL male, observed in Burrow #97 10/4/94				
327	Tortoise		260 MCL male, observed 150 ft N access road and 200 yds W T-line 10/5/94				
328	Tortoise		240 MCL female, observed along road 10/18/94				
329	Tortoise		280 MCL male, observed 10/18/94				
330	Tortoise		250 MCL male, observed on Indian Pas Road 10/18				
331	Burrow	3	23	15	55	Yes	Wash edge
332	Burrow	2	25	16	65	No	Wash edge
333	Burrow	2	23	15	55	Yes	Wash edge

#	Sign	Class*	W	H	L (mm)	End Visible?	Habitat/Comments
334	Pallet	3	20	8	36	Yes	Wash edge
335	Pallet	2	25	12	26	Yes	DP
336	Pallet	2	23	15	36	Yes	Next to 334
337	Scat	2					2 scat
338	Pallet	3	22	13	35	Yes	Wash
339	Pallet	2	32	16	48	Yes	DP
340	Tortoise		220 MCL female, in wash, no sign URDS				
341	Pallet	3	22	13	35	Yes	Wash
342	Pallet	2	22	10	23	Yes	DP
343	Burrow	2	30	13	80+	No	Wash edge
344	Pallet	2	34	15	39	Yes	DP
345	Pallet	2	32	14	40	Yes	DP
346	Scat	2					2 scat
347	Pallet	2	28	13	30	Yes	Wash
348	Pallet	3	40	16	58	Yes	DP
349	Burrow	3	26	16	60+	No	DP
351	Tortoise		235 MCL male, no sign URDS				

*Definitions are as follows:

Pallets/Burrows: Class 1=currently active with tortoise or recent sign; Class 2=good condition, definitely tortoise, no recent sign; Class 3=fair condition, definitely tortoise; Class 4=deteriorated, definitely tortoise; Class 5=good condition, possibly tortoise; Class 6=deteriorated, possibly tortoise.

Scat: Class 1=wet or freshly dried, obvious odor; Class 2=Dry with glaze or some odor, no bleaching; Class 3=dry without glaze or odor, light brown, tightly packed; Class 4=dry without glaze or odor, loose material; Class 5=bleached

Carcasses: Class 1= fresh or putrid; Class 2=normal color, scutes adhering to bone; Class 3=scutes peeled off bone; Class 4=bones falling apart; Class 5=disarticulated

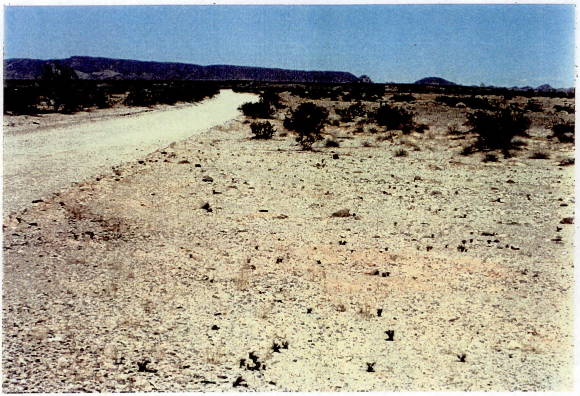
**DP="desert pavement"

APPENDIX D

Site Photographs

Central portion of Imperial Project site, looking southwest across project area.

Southern portion of project site, looking northeast across project area.



Access road/utility line corridor, looking east along the south side of Indian Pass Road.

Alternate transmission line corridor route, looking east towards the Imperial Project site from western edge of alignment.

Desert wash habitat in central portion of project area, looking south.

Desert tortoise carcass located during surveys of the Imperial Project.

This page intentionally left blank
for reproduction purposes.

APPENDIX I DESERT DEER AND THE CHEMGOLD IMPERIAL PROJECT (27 OCTOBER 1995)

DESERT DEER

AND THE

CHEMGOLD IMPERIAL PROJECT

Paul R. Krausman

Wildlife Ecology Studies
Oracle, Arizona

Prepared for:
Environmental Management Associates
Brea, California

27 October 1995

DESERT DEER AND THE CHEMGOLD IMPERIAL PROJECT

This report is prepared in response to the request of Environmental Management Associates to collect and review all available information pertaining to the deer which may range through or near the proposed Chemgold, Inc. Imperial project area, located in eastern Imperial County, California, and to provide an appropriate range of recommendations with regard to additional data collection, including any required field work, and/or mitigation measures.

I was also asked to make comments related to bighorn sheep that may range in the vicinity of the Imperial Project. Further discussion about bighorn sheep (in relation to the Imperial Project) is not warranted because the site of the project is not in or adjacent to bighorn habitat. This area does not constitute bighorn habitat and there is no evidence that it is a "corridor" between bighorn habitat.

The enclosed copies of the "Burro Deer Herd Management Plan", the "Burro Deer Herd D-12 Action Plan", and an article by Thompson and Bleich, and the report entitled "Use of Habitat by Colorado Desert Deer", represent the most recent printed information relating to deer that will be influenced by the Imperial Project. They also represent the available management documents for deer in southeastern California. I reviewed them plus the documents your office provided to me. In addition, I obtained information from discussions with Ted Rado (Wildlife Biologist, 3144 Celeste Drive, Riverside, Calif.), N. Andrew, and V. C. Bleich of the California Fish and Game Department. I also visited the Imperial Project on 18 July 1995 and examined much of the area that will be influenced by the project.

Very little is known about the desert deer inhabiting southeastern California; even the name is questionable. In 1897, Mearns described the burro deer (Odocoileus hemionus eremicus, Mearns 1897) as a subspecies. The classification was supported by Cowan (1936) and Hall (1981) but has been questioned by Anderson and Wallmo (1984), Hoffmeister (1986), and Krausman (1994). Brown (1984) argued that O. h. eremicus is different from the desert mule deer (O. h. crooki) but that the correct vernacular for O. h. eremicus is "bura" deer, from the Tohono O'odum and Yuma Indian name for the animal, and not the anglicized "burro" deer. Brown (1984) indicated that burro deer have shorter pelage, a less distinct dorsal stripe, and paler face and skull cap than desert mule deer. Older males (>8 yr) also are large with distinctive wide branching antlers with few tines. Krausman (1994) compared skulls of desert mule deer and burro deer and found significant differences in rostral breadth (i.e., width of snout).

However, Schaefer and Davis (1995) reported that the desert deer of southeastern California had "no unique mitochondrial DNA haplotype when compared to other mule deer populations of North America." Such information justifies an examination of the taxonomy of the deer (Wallmo 1981) to determine whether the populations of the area are different from others.

Information about the life history and ecology of the burro deer are as vague as the taxonomy. The management plan (Celentano and Garcia 1984) and action plan (Schaefer and Davis 1995) cover the entire herd management boundary of 7,026 mi^2 that includes portions of San Bernardino, Riverside, and Imperial counties. It will be difficult to indicate exactly how the removal of habitat (approximately 1,500 acres) from the Imperial Project will influence the population of deer. However, based on the available data I can offer some potential influences.

Whether the deer are burro or desert mule deer their ecology is similar. Krausman and Etchberger (1993) classified desert mule deer habitat components to include washes with dense vegetation (Krausman et al. 1985), rolling to steep topography (Ordway and Krausman 1986, Bellantoni 1991) and water availability (Hervert and Krausman 1986). This classification appears consistent with available data for burro deer. In late summer, deer move away from the river to the desert mountains and in the late spring they return to the river. Migration routes follow the major desert wash systems (Celentano and Garcia 1984:19). The washes in the Imperial Project were used by deer as evidenced by tracks and pellets. However, rolling to steep topography and water were not in the area. Deer probably use the area as a travel route from the rolling topography north of the project to water and other habitat components south of the project. I doubt there is a resident deer herd in the Imperial project area. In the Belmont Mountains, Arizona, desert mule deer were probably limited more by forage than any other factor, including water (Albert and Krausman 1993) and that area had more vegetation than the desert flats around the Imperial Project.

In other desert deer habitats, fawning often occurs in the higher elevations (Bellantoni and Krausman 1991, Fox and Krausman 1994). Although little is known about fawning around the Imperial Project, most fawning occurred in areas characterized by low, broken hills with vegetated washes near water. Blong (1993) reported that of 8 fawning sites identified in desert deer habitat, 4 were in riparian habitat and 4 were in desert uplands. The nearest water to the Imperial Project is over a mile away and the area is relatively flat. More fawning probably occurs in the foothills north of the project than in the relatively flat Imperial Project.

Based on my observations, and information from the management plans, the area in and around the Imperial Project is used by deer moving across the desert flats from mountain foothills to water sources or other important habitat components. The area was not consistent with habitat used to support resident herds or as important fawning habitat (Fox and Krausman 1994). However, that does not mean the Imperial Project will not influence deer. Any time habitat is removed there are consequences to the population. Because habitat relationships are so poorly understood in this area, I recommend that Chemgold, Inc. be sensitive to desert deer during their development of the Imperial Project. To mitigate for the altered habitat there are several mechanisms to minimize the impact on deer in the area. It is my understanding that all riparian areas will be modified so that waterflow will not be influenced, the leach pad will be enclosed within a 6 foot high fence, and habitat restoration will occur for all but one of the pits upon project completion. All of these activities will minimize the influence of the project on deer. The first by not reducing waterflow to the overall ecosystem and the second by keeping deer from areas that could be detrimental to them. The pit that remains open should be modified so that deer that enter can escape easily or it could be fenced to prevent any entry. If the open pit also serves as a source of water, safe entry by deer should be facilitated.

I suggest that the areas on all sides of the Imperial Project remain open and undeveloped for 1-5 miles so movements of deer are not restricted. Desert deer have some of the largest home ranges recorded for mule deer (Rautenstrauch and Krausman 1989, Krausman and Etchberger 1995) to obtain resources necessary for survival in patchy environments and they should not be isolated from these resources.

Other mitigations that have been suggested by various sources include water developments. However, there is little evidence to suggest that water catchments are beneficial for deer unless water is the limiting factor. Water was added to deer habitat in western Arizona to supplement existing water catchments with little influence (Krausman and Etchberger 1995). The population was limited by forage (Albert and Krausman 1993) and unless forage was enhanced, response by the population could not be expected.

Because so little is known about this population, it would be speculation to say that the deer are limited by water. They may just as well be limited by forage. If water catchments were added, the deer population should be monitored so the effectiveness of the mitigation is known.

Water catchments are a popular mitigation in the southwest (Tsukamoto and Stiver 1990). However, their influence is often unknown (Krausman and Etchberger 1995) because their effects on wildlife populations are not measured. If you can't measure it you can't manage it. An alternative mitigation to water catchments for this area could be to provide information about the deer that could be used for effective management.

In conclusion, the area that will be impacted by the Imperial Project is most likely used by deer to travel to various aspects of their habitat. It is unlikely this area supports a resident deer herd. To mitigate for the lost habitat the following is recommended.

1. Fence the area potentially detrimental to deer to prevent entrance by deer and keep gates closed.
2. Ensure water channels are not altered so that waterflow continues.

3. Restore the pits upon project termination and ensure that wildlife can enter and exit the open pit or fence to prevent entry.
4. Keep all sides of the project open for 1-5 miles to ensure movement through the area by deer.
5. Provide information about desert deer ecology that can be used for their management.
6. If water catchments are developed they should be monitored to determine the influence they have on the population. That should include a study prior to and after catchment placement.

Please contact me if you have any questions or would like further elaboration on any part of this report. The literature I cited in this report is listed below.

LITERATURE CITED

Albert, S. K., and P. R. Krausman. 1993. Desert mule deer and forage resources in southwest Arizona. Southwest. Nat. 38:198-205.

Anderson, A. E., and O. C. Wallmo. 1984. Odocoileus hemionus. Mammalian Spp. 219. 9pp.

Bellantoni, E. S. 1991. Habitat use by desert mule deer and collared peccary in an urban environment. M.S. Thesis, Univ. Arizona, Tucson. 71pp.

________, and P. R. Krausman. 1991. Habitat use by desert mule deer and collared peccary in an urban environment. Natl. Park Serv. Tech. Rep. 42. 39pp.

Blong, Bonnar. 1993. Use of habitat by Colorado desert deer. Calif. Dep. Fish and Game, Region 5. 38pp.

Brown, D. E. 1984. In search of the bura deer. Pages 42-44 in P. R. Krausman and N. S. Smith eds. Deer in the southwest: a symposium. Univ. Arizona, Tucson.

Celentano, R. R., and J. R. Garcia. 1984. The burro deer herd management plan. Calif. Dep. Fish and Game. 90pp.

Cowan, I. M. 1936. Distribution and variation in deer (Genus Odocoileus) of the Pacific Coastal Region of North America. Calif. Dep. Fish and Game 22:155-246.

Fox, K. B., and P. R. Krausman. 1994. Fawning habitat of desert mule deer. Southwest. Nat. 39:269-275.

Hall, E. R. 1981. The mammals of North America. Second ed. Vol 2. John Wiley & Sons, New York, N.Y. 1181pp.

Hervert, J. J., and P. R. Krausman. 1986. Desert mule deer use of water developments in Arizona. J. Wildl. Manage. 50:670-676.

Hoffmeister, D. F. 1986. Mammals of Arizona. The Univ. Arizona Press and Arizona Game and Fish Dep. 602pp.

Krausman, P. R. 1994. The bura deer? Page 251 in D. Gerlach, S. Atwater, and J. Schnell, eds. Deer. Stackpole Books, Mechanicsburg, Pa.

________, K. R. Rautenstrauch, and B. D. Leopold. 1985. Xeroriparian systems used by desert mule deer in Texas and Arizona. Pages 144-149 in R. Johnson, C. D. Ziebell, D. R. Patton, P. F. Ffolliott, and R. H. Hamre, Tech. Cords. Riparian ecosystems and their management: reconciling conflicting uses. U.S. Dep. Agric. For. Serv.

Gen. Tech. Rep. RM-120.

________, and R. C. Etchberger. 1993. Effectiveness of mitigation features for desert ungulates along the Central Arizona Project. Final Rep. 9-CS-32-00350, U.S. Bur. Reclamation, Phoenix, Ariz. 308pp.

________, and ________. 1995. Response of desert ungulates to a water project in Arizona. J. Wildl. Manage. 59:292-300.

Ordway, L. L., and P. R. Krausman. 1986. Habitat use by desert mule deer. J. Wildl. Manage. 50:677-683.

Rautenstrauch, K. R., and P. R. Krausman. 1989. Influence of water availability and rainfall on movements of desert mule deer. J. Mammal. 70:197-201.

Schaefer, B., and J. Davis. 1995. Burro deer herd D-12 Action Plan. Calif. Dep. Fish and Game. Mimeo. 17pp.

Thompson, J. R., and V. C. Bleich. 1993. A comparison of mule deer survey techniques in the Sonoran Desert of California. Calif. Dep. Fish and Game. 79:70-75.

Tsukamoto, G. K., and S. J. Stiver. 1990. Wildlife water development. Proc. Wildl. Water Develop. Symposium, Las Vegas, Nev. 192pp.

Wallmo, O. C., ed. 1981. Mule and black-tailed deer of North America. Univ. Nebraska Press, Lincoln. 605pp.

This page intentionally left blank
for reproduction purposes.

APPENDIX J BAT SURVEY OF THE CHEMGOLD IMPERIAL PROJECT SITE (JULY 11, 1997)

July 11, 1997

To: Environmental Management Associates
Attn.:Dwight Carey
1698 Greenbriar Lane, Suite 210
Brea, CA 92821

From: Patricia E. Brown, Ph.D.
Brown-Berry Biological Consulting
134 Wilkes Crest Road
Bishop, CA 93514

Regarding: Bat Survey of the Chemgold Imperial Project Site

Background

The Imperial Project Mine and process area is situated in eastern Imperial County (T13S, R21E, Sections 30-33 and T14S, R21E, Sections 4-6), 20 miles northwest of Yuma, Arizona at an elevation between 700 and 900 feet above sea level. The nearly flat terrain is cut by three major ephemeral washes and several tributaries containing mature desert microphyll woodland (ironwood, paloverde and smoke trees). No permanent water sources, underground historic mine features, cliffs or large boulders are found within the project boundaries.

Bats require undisturbed roosts and good foraging habitat. Roosts may be in rock crevices, caves, mines, trees, and buildings, and may vary seasonally with respect to thermal requirements. In the summer, warm maternity roosts are necessary to promote development of the poikilothermic young, while males may inhabit cooler areas where they can experience daily torpor. Some bat species congregate in night roosts between foraging bouts that are often different from those selected as diurnal retreats. The Vespertilionid bats mate in the fall and the females will store viable sperm until ovulation in early spring. California leaf-nosed bats also mate in the fall, and fertilization occurs then, although development of the embryo is delayed until spring. Different roosts may be used for courtship and mating. Some bats hibernate in the winter and seek out cold roosts that will remain above freezing. The period of hibernation is a function of the severity and length of the winter. Arousal of hibernating bats can cause depletion of stored fat, and may jeopardize their survival. The Molossid and leaf-nosed bats remain active year-round in the California desert. Some Mexican free-tailed bats will migrate south in the winter, and en route may utilize transient roosts.

Foraging habitat may vary between species depending on the insect prey. Some bats require drinking water on a regular basis, but the majority of desert bats are able to utilize metabolic water from their insectivorous diet. Generally, desert dry washes concentrate insects and are magnets for foraging bats, even in the absence of surface water. Some species, such as western mastiff and Mexican free-tailed bats, are capable of traveling 25 miles between roosting and foraging habitats, while other species feed within 5 miles of their diurnal retreats. Different bat species have different foraging and roosting requirements, as discussed below for those species likely to occur on the Imperial Project mine and process area.

Methods

On June 11, 1997 the Imperial Project mine and process area was traversed by vehicle and on foot looking for potential bat roosting and foraging habitat. Before dark, 4 mist nets were spread across washes in the east, south and central portions of the study area, and monitored for 5-6 hours after sunset. In addition, an Anabat ultrasonic detector with a delay switch and tape recorder was employed to remotely monitor echolocation signals. For the first half of the evening, the Anabat was placed in the central wash, and at 0130 hours it was moved to the large wash along the north boundary. Portable tunable mini-detectors were also used to monitor activity while walking around the project after dark. Another Anabat detector with zero crossing period meter and software allowed for direct storage and analysis of signals on a laptop computer.

Results

Although calm and clear weather prevailed the evening of the survey, no bats were captured in mist nets in over 20 mist net hours. Several bats were detected acoustically, including 2 audible passes over the property by western mastiff bats. The characteristic signals of pocketed free-tailed bats (*Nyctinomops femorosaccus)* were detected on 3 occasions, both by ear as well as displayed on the computer, as were the sounds of western pipistrelles (*Pipistrellus hesperus*) and California myotis (*Myotis californicus).* These two species were probably the small bats seen flying in the washes at dusk. The remote Anabat in the central wash recorded only 8 bat passes in 4 hours, while 83 passes were noted in the north wash between 0130 and 0500 hours (dawn). Most of the recorded signals are probably attributable to *Myotis* sp. or western pipistrelles.

Discussion

Since no mines, caves or large rock crevices occur on site, Townsend's big-eared bats (*Corynorhinus=Plecotus townsendii*), California leaf-nosed bat (*Macrotus californicus*), spotted bat (*Euderma maculatum*), western mastiff bat (*Eumops perotis*) and the other Molossids would not day roost on the project site. Bats that can roost in crevices in small rocks and in trees, such as under the loose bark of ironwood and palo verdes, are the most likely to occur on the Imperial Project. These include both little (*Myotis* sp.) and big brown bats (*Eptesicus fuscus*) as well as western pipistrelles (Pipistrellus hesperus). The desert pallid bat (*Antrozous pallidus pallidus*), a CDFG Species of Special Concern, was not detected during the current survey, but might be expected roosting on site. Radio-telemetry studies of this large, pale bat have shown that it can roost in narrow crevices in relatively small rocks, with all guano deposited within the rock. Pallid bats forage among desert wash vegetation and over creosote bush scrub for sphinx moths, grasshoppers, scorpions and other large arthropods. Other bat species could migrate through the project site and may roost in the trees for short periods of time. These include the hoary bat (*Lasiurus cinereus*) and yellow bat (*Lasiurus ega*). Peak migration periods would be early spring and fall.

Although the bat species roosting on the Imperial Project mine and process area is limited, several other species could forage over the area at night, including free-tailed bats of the genera *Tadarida, Nyctinomops* and *Eumops*. Of these, the western mastiff bat can forage within a radius of 50 miles from roosting habitat in boulders and cliff faces. The human-audible echolocation pulses of this bat have been heard over the Cargo Muchacho Mountains throughout the year, and were detected twice on this survey, but not until 2 hours after dark (suggesting that the bat did not roost nearby). Pocketed free-tailed (*Nyctinomops femorosaccus*) foraged over the site, and possibly big free-tailed bats (*N. macrotis*) could also occur. The only California records for *N. macrotis* are from the San Diego area, while *N. femorrosaccus* has been verified in several desert locations, including Box Canyon near Mecca, Anza Borrego and Joshua Tree National Monument. Although the signals of Mexican free-tailed bats (*Tadarida brasiliensis*) were not recorded on this survey, they are regularly heard as they fly over the Cargo Muchacho Mountains, and could be expected to forage over the Imperial Project. The different, but also human-audible, echolocation calls of the spotted bat (*Euderma maculatum*) have been detected a few times over the Cargo Muchacho Mountains, but were not heard during this survey.

Desert washes are the prime type of foraging habitat for the California leaf-nosed bat (*Macrotus californicus*). We have documented and banded populations of leaf-nosed bats in the Cargo Muchacho and eastern Chocolate Mountains. Radio-telemetry studies of this species conducted for American Girl Mining Joint Venture have shown that *Macrotus* forage in desert washes, usually within 5 miles of their roosts in warm mines. They feed on moths, grasshoppers and katydids that they glean from the foliage. At night between foraging bouts in the summer, they will roost in the wash trees, but in the colder winter months they return to mines for night roosting. Since no mines or caves occur on the project area, *Macrotus* would not be found roosting there during the day. The closest diurnal roost that I have visited for this species is in an adit just south of the La Colorado Mine in the Cargo Muchacho Mountains (about 4.5 miles from the southern boundary of the project area). Unless a closer, *Macrotus* day roost is discovered in the southeastern Chocolate Mountains, the Imperial Project area probably is not regularly visited by this species.

Conclusions and Mitigation

Generally speaking, the diversity and concentration of bats decreases with the distance from the desert mountain ranges, and therefore the cumulative impacts on bats are reduced in areas of flat terrain not adjacent to the mountains. The Imperial Project mine and process area will probably remove roosting habitat in trees and small rock crevices for single or small groups of bats, such as California myotis, western pipistrelles and pallid bats. To mitigate for lost roosting habitat, artificial habitat could be created by burying culverts under waste rock dumps. Although this procedure is not yet proven to be successful, several mining companies are experimenting with different roost designs. Foraging habitat will also be affected for a greater number of bats that roost both on and off-site, although similar habitat exists adjacent to the Imperial Project area. The desert washes offer the richest foraging habitat, and should be preserved whenever possible. To monitor any effects (positive or negative) that the Imperial Project mine and process area might have on the foraging habitat, annual surveys of bat activity could be conducted at the same season with the same protocol.

TABLE 1

BATS POSSIBLY OCCURRING ON IMPERIAL PROJECT MINE AND PROCESS AREA

Common name	Scientific name	Status	Roost	Forage
Plain-nosed bats	**Family Vespertilionidae**			
Western pipistrelle	*Pipistrellus hesperus**		H	H
California myotis	*Myotis californicus**		H	H
Yuma myotis	*Myotis yumanensis*	C2	L	M
Small-footed myotis	*Myotis ciliolabrum*	C2	L	L
Cave myotis	*Myotis velifer*	C2, CSC	L	L
Occult myotis	*Myotis lucifugus occultus*	C2, CSC	L	L
Big brown bat	*Eptesicus fuscus*		M	M
Pallid bat	*Antrozous pallidus*	CSC	H	H
Townsend's big-eared bat	*Corynorhinus townsendii*	C2, CSC	0	L
Spotted bat	*Euderma maculatum*	C2, CSC	0	L
Hoary bat	Lasiurus cinereus		M	M
Western yellow bat	*Lasiurus ega*		L	L
Free-tailed bats	**Family Molossidae**			
Western mastiff	*Eumops perotis**	C2, CSC	0	H
Big free-tailed	Nyctinomops macrotis	C2, CSC	0	L
Pocketed free-tailed	*Nyctinomops femorosaccus**	CSC	0	H
Mexican free-tailed	*Tadarida brasiliensis*		0	H
Leaf-nosed bats	**Family Phyllostomatidae**			
California leaf-nosed	*Macrotus californicus*	C2, CSC	0	M

Status
C2=Former USFWS Category 2 Candidate
CSC=CDFG Species of Special Concern

Possibility of occurrence for roosting or foraging
0=none L=low M=medium H=high

*detected during current survey

APPENDIX K FLAT TAILED HORNED LIZARD SURVEY IMPERIAL PROJECT POLE REPLACEMENT (20-24, 28-30 JUNE, 1997)

FLAT TAILED HORNED LIZARD SURVEY

IMPERIAL PROJECT POLE REPLACEMENT
ENVIRONMENTAL MANAGEMENT ASSOCIATES

CONDUCTED BY

MARIE S. BARRETT
T.L. BARRETT ENGINEERING

20-24, 28-30 JUNE 1997

Thursday, June 19, 1997 a field meeting with Nancy Nicolai, BLM, Tom Zale, BLM, Debbie MacAller, FWS, Carlsbad and Marie Barrett, T.L. Barrett Engineering was held on site to discuss the protocol for this project. The following are the notes of this meeting.

The surveyor was requested to: Prepare a data sheet for each pole and indicate: vegetation found; if area is known or unknown FTHL habitat. Surveyor will use standard data sheet with these additions. Time per survey is not required. Each survey will be 100 feet square with 10 foot transects; with pole in the center. Scat only will be surveyed on the south side of freeway; scat and two 50 M x 50 m areas for live FTHL(any other lizards seen will be indicated by surveyor and percentages/types of ground cover) will be surveyed on north side of freeway. Surveyor will survey unknown and known FTHL habitat and will not survey areas designated as Not FTHL habitat.

South side of Interstate 8/Sidewinder Road:

The closest to the freeway triple &double-pole electrical lines (marked with pink tape) will be surveyed using a 60 foot radius on the triple and a 50 foot radius on the double. After consultation with the Imperial Irrigation District, it was determined to survey from the rock burm which is north of double pole on south side of Sidewinder Road to the fence around the east onramp to I-8 (Attachment F1).

North side of Interstate 8 and Sidewinder Road:

- Survey first pole to north of offramp.
- Second pole (A352) - no access necessary will use existing access rd only
- Third pole can be accessed from any direction
- 0 to 1.3 mile is Unknown FTHL Habitat
- At .7 mi (just past mail boxes) survey two double poles on each side of Sidewinder Road (marked with pink flagging) Survey both guide poles (marked with pink flagging)
- 1.3 to 1.6 mi is known FTHL habitat
- 1.6 - 2.3 mi is unknown FTHL habitat
- 1.8 mi - South pulling station will be on road - do not survey; North pulling station will be a triangle using road as point; surveyor will make measurements, make a drawing and mark on map
- 2.0 mi these three poles can be accessed from Sidewinder Rd.
- 2.3 mi (Pole T539D) Not Habitat - don't survey

- 2.7 mi (Pole T5399D) marked with pink flag - Known habitat start surveying again
- 4.0 mile - Unknown FTHL habitat
- 4.6 mile (Pole T5423D) Out of FTHL area Stop Survey
- Live Surveys: Pole T5412D .1 mile (227°) from burm of Sidewinder Road and Pole T 5403D .13 mile from pole (219°). Marker is NE corner of 50m square.

Live surveys will take a total of eight hours in two 50 m squares. Transects will be 12 feet apart. They will be done from 7:30 am to 11:30 am depending on temperatures. They are not to be done if temperature is over 105°F. If a lot of scat is found in an area that is not marked to be surveyed for live lizards Ms. Nicolai will be contacted. Road surveys wil be conducted when temperatures are between 90-105°F. Roads will be surveyed at least once.

General Procedure: The scat survey followed the general outline of *Guidelines for General Relative Abundance for Flat Tailed Horned Lizard* (Attachment A1 & A2) and the live lizard survey followed guidelines found in *An Arizona-California Conservation Strategy, October, 1996.* These surveys were conducted between 20-23 June 1997. Table A represents a compilation of data gathered from FTHL Data Sheets for scat survey (Attachments B1- B65). Table B represents a compilation of data gathered from FTHL Data Sheets for the live lizard survey (Attachments C1-C2). Table C represents a compilation of data from road surveys and Table D is a compilation of scat surveys for pole placement on south side of I-8.

TABLE A - FTHL SCAT SURVEY

* = Desert pavement

Pole No/Habitat	FTHL Scat	Other Lizard Scat	Vegetation	Soil Type	Ants	Notes
C 3006 Known	none	3	1% creostoe	Dpt*/sandy wash	yes	Southof I-8 120'diameer
C 3007 Known	none	2	1-ironwood 2% creosote	Dpt/sandy wash	red	South of I-8
A942D Unknown	none	30+	3-ironwood 30%creosote	Dpt/sandy wash		North of I-8
T4705D Unknown	none	11	10% creosote	Dpt/sandy wash	red	
T4706D Unknown	none		5% creosote	Dpt/sandy wash		A3S2
T4704D Unknown	none			Dpt		
T4708D Unknown	none			Dpt/sparse sand		whiptail seen

Pole No./Habitat	FTHL Scat	Other Lizard scat	Vegetation	Soil Type	Ants	Notes
T4709D Unknown	none		5% creosote	Dpt/sparse sand	red	
T4710 Unknown	none	2	Little	Dpt/sparce sand		
T4711D Unknown	none	1	Little	Dpt	yes	
T4712D Unknown	none		Little	Dpt/25% sandy		
T4774D Unknown	none	8	25% creosote	Sandy/road way		
T4713D Unknown	none		Little	Dpt/sparse sand	red	
T4714D Unknown	none	3	3 bushes	Dpt/sparse sand	red	
T4715D Unknown	none		1 cresote/few bushes	Dpt/sparse sand		
T4716D Unknown	none	2	1 cresote/few bushes	Dpt/sparse sand	red	
Double Pole20G Unknown	none			Dpt/sparse sand		
Double Pole 74 Unknown	none	1	1 ironwood;1 cresote	Dpt/sandy wash		1 lropard seen
T4720D Unknown	none	20+	1 creosote	Dpt.sand		guide pole included
T4722D Known	none	3	10 creosote	Dpt/20% sand		
T4723D Known	none	1	2 creosote	Dpt/road		
T4724D Known	none		2 creosote	Dpt		
T4725D Known	none	4	15% creosote	50%sandy wash50%Dpt	red	
T4726D Known	none			Dpt		
T4727D Known	none	3	3 creosote;6 other bushes	Dpt/sand	black	
T4728D Unknown	none	5	4 creosote	Dpt/sandy wash		
T4729D Unknown	none	1	4 creosote	20%Dpt/ sand		

Pole No/Habitat	FTHL Scat	Other Lizard Scat	Vegetation	Soil Type	Ants	Notes
T4730D Unknown	none	1	1 creosote	Dpt	black	
T4731D Unknown	none		3 creosote	Dpt		
T4732D Unknown	none	1	3 creosote	50%sand/50 %Dpt	red	
T5384D Unknown	none			Dpt		
T5335D Unknown	none			Dpt/5%sand		
T5336D Unknown	none	3	3 creosote	50%sandy wash/59% Dpt	red	
T5337D Unknown	none		1 creosote	Dpt		Pulling station
T5389D Unknown	none			Dpt		
T5390D Unknown	none		4 creosote	50%Dpt/50% sandywash		
T5391D Unknown	none		1 ironwood;l creosote	Dpt;10% sandywash		
T5392D Unknown	none			Dpt/road		
T5393D Unknown	none		1ironwood; 60% creosote	sandywash	black	
T5399D Unknown	none		2 creosote	sandy/Dpt		
T5400D Unknown	none		2 creosote	50%Dpt;50% sandywash		
T5401D Unknown	none		1ironwood; 4 creosote	sandy		
T5402D Unknown	none	1	1 ocotillo; 3 creosote	crusted sand		
T5403D Known	none		1 ironwood	light Dpt Gravelly		
T5404D Known	none		1 ironwood;4 creosote	gravelly		
T5405D Known	none	1		gravelly		under transmission lines
T5406D Known	none	1	1 ironwood; 3 creosote	gravelly	red	

Pole No./Habitat	FTHL Scat	Other Lizard Scat	Vegetation	Soil Type	Ants	Notes
T5407D Known	none		5 creosote	gravelly/road		Hilly mounds
T5408D Known	none		4 ironwoods;3 creosote	sandy/road		
T5409D Known	none		1 ironwood; 1 creosote	gravelly/road		
T5410D Known	none		2 creosote; 1 ironwood	gravelly		
T5411D known	none		2 creosote; 2 cactus	gravelly/road		
T5412D Known	none		1 creosote	gravelly		
T5413D Known	none		3 creosote; 2 bushes	gravelly/road		
T5414 D Known	none		2 creosote; 1 paloverde;1 ironwood	gravelly		
T5415D Unknown	none		3 creosote	gravelly/Dpt		
T5416D Unknown	none		2 ironwood	gravelly/ rocky/sandy		
T5417D Unknown	none		2 ocotillo; 1 paloverde	Dpt		
T5418D Unknown	none			Dpt		
T5419D Unknown	none			Dpt		
T5420D Unknown	none		3 creosote	Dpt/sandy wash		
T5421D Unknown	none		2 ironwood; 5 creosote	Dpt/rocky/ sandywash		Access from Sidewinder
T5422D Unknown	none		2 ocotillo; 4 creosote	Dpt/rock		Access from Sidewinder
T5423D Unknown	none			Dpt		Access: east road- 25' both sides of pole

TABLE B - LIVE LIZARD SURVEYS

Pole No.	Live FTHL	Other Lizards	Vegetation	Soil Type	Notes
T5403D	none	2 zebra tails	1 creosote	Crusted sand	12 foot transects; 50 meter squares
T5412D	none	2 whiptails	10 creosote; 1 cactus	Gravelly sand with burrows	12 foot transects; 50 meter squares

TABLE C - ROAD SURVEYS

Road Surveyed	Miles from RR	Live FTHL	Vegetation	Soil Type	Miles of road surveyed
Sidewinder Rd.	0	none	various	various	4.6 (both sides)
East along transline	.6	none	sparce	dpt	1.8(both sides)
Sunshine/Stove Rd	1.0	none	creosote	dpt,sandy	.9 (both sides)
CocaCola Rd.	1.2	none	creosote, ironwood	dpt,sandy washes	.7 (both sides)
West to well	1.6	none	creosote	dpt, sand	.5 (both sides)
Barney Rd.	1.9	none	ocotillo,creosote ironwood	dpt, sandy washes	2.0 (borh aides)
Transmission line rd.	3.3	none	creosote,ocotillo ironwood,	dpt, sandy washes	.9 (bothsides)
North A471	4.2	none	creosote, ocotillo,ironwood	sandy	1. 1(both sides)
South A471	4.1	none	ocotillo,,creosote paloverde,iron wood	dpt,sandy wash	.6 (both sides)

TABLE D IID POLE PLACEMENT - SOUTH OF I-8

Area	FTHL Scat	Other Lizard scat	Vegetation	Soil Type	Ants	Notes
From rock burm to freeway fence	none	114	creosote, misc bushes	dpt, sandy	red & black	trashy

Conclusions: No FTHL scat or live Flat Tailed Horned Lizards were observed during this survey.

ATTACHMENTS

ATTACHMENT A

Guidelines for Scat Surveys

GUIDELINES FOR GENERAL RELATIVE ABUNDANCE SURVEYS OF FLAT-TAILED HORNED LIZARDS

1) Data must be collected between May 15 and August 15 (inclusive) using the attached data sheet.

2) Record to the nearest 0.1 mile the location of scat and horned lizards (whether desert or flat-tail). Count only scat which are composed of greater than 50% ant parts. Record the location of all such ant scat, whatever their size. Distinguish between scats less than or equal to 5.5 mm diameter and those greater than 5.5 mm diameter.

3) Each observer shall use a pedometer and compass to ensure proper distances and bearings. The compasses shall be set at the declination listed on the topographic map where the surveys are being done.

4) Postpone surveys of areas which have evidence of a recent heavy rainfall within the last two weeks. Postponing surveys after windy conditions is not neccessary.

5) No observer shall walk more than 2 transects in one day. This requirement prevents observer fatigue from affecting data quality and protects observers from heat stroke.

6) Each transect shall be triangular and 2.5 miles in length. The first leg shall be 0.9 miles long, the second and third legs shall be 0.8 miles long. The transect shall begin 0.1 miles from the section corner. Walk into the section at a 45° angle from the side of the section prior to beginning the transect. For example, if you are standing at the NE corner of a section, you would walk at a bearing of 225° for a distance of 0.1 miles into the section to be surveyed. This 0.1 mile stretch is not a part of the transect. For transects begun from the SE, SW and NW corners the angles of entry are 315°, 45° and 135°, respectively.

The angles and distances to be walked vary according to the corner from which the section is entered. These angles and distances are described below:

For transects begun near the SE section corner, the distances and angles to be walked are: 0.9 miles at 360° for the first leg, 0.8 miles at 236° for the second leg, 0.8 miles at 124° for the third leg.

For transects from the SW section corner, the specifications are: 0.9 miles at 360°; 0.8 miles at 124°; 0.8 miles at 236°.

For transects oriented from the NW section corner, the specifications are: 0.9 miles at 180°, 0.8 miles at 56° and 0.8 miles at 304°.

For transects oriented from the NE corner, the specifications are 0.9 miles at 180°, 0.8 miles at 304° and 0.8 miles at 56°.

If an impassable feature is encountered during the transect, such as a canal or interstate highway, you may alter these angles and distances so as to complete the survey. If this alteration is neccessary, record the modified survey triangle on a 7.5' topo and staple it to your data sheet.

7) The El Centro Office of the BLM shall be notified 48 hours prior to the beginning of surveys to allow personnel to ensure that surveys are performed in accordance with these guidelines.

8) The minimum performance time for walking a transect is 45 minutes, the maximum performance time is 75 minutes. Count only time spent looking for scat and lizards as performance time. Do not count time spent handling lizards, taking breaks, drinking water or doing any other activity as performance time. Time spent measuring scat or examining scat will be included in performance time.

9) To ensure your safety, we require the following:

a) Begin transects at dawn and drink a quart of water prior to starting transects.

b) Wear loose-fitting cotton clothing. We suggest wearing long pants, a long sleeved shirt and a wide-brimmed hat to reduce water loss. Shorts and short-sleeved shirts will allow greater water loss and sunburning.

c) Carry 1 gallon of cool water and a two-way radio or cellular phone.

d) Make sure someone from your firm knows where you are and when to expect your return. If you become lost, remain where you are and wait for help. Afternoon temperatures in the summer are usually lethal if you attempt to walk a long distance.

e) Carry a signaling device, such as a mirror.

f) When walking to remote transects, use pink or orange flagging tape to mark the route from your vehicle to the start of the transect.

10) Violation of any of the above stipulations will invalidate the data, necessitating repetition of the surveys.

11) Contact the El Centro Resource Office, if you have questions concerning these guidelines. 619-353-1060.

12) Any variance from these guidelines must be approved in writing in advance by the BLM.

ATTACHMENT B

FTHL Data Sheets for Scat Surveys

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

ATTACHMENT C

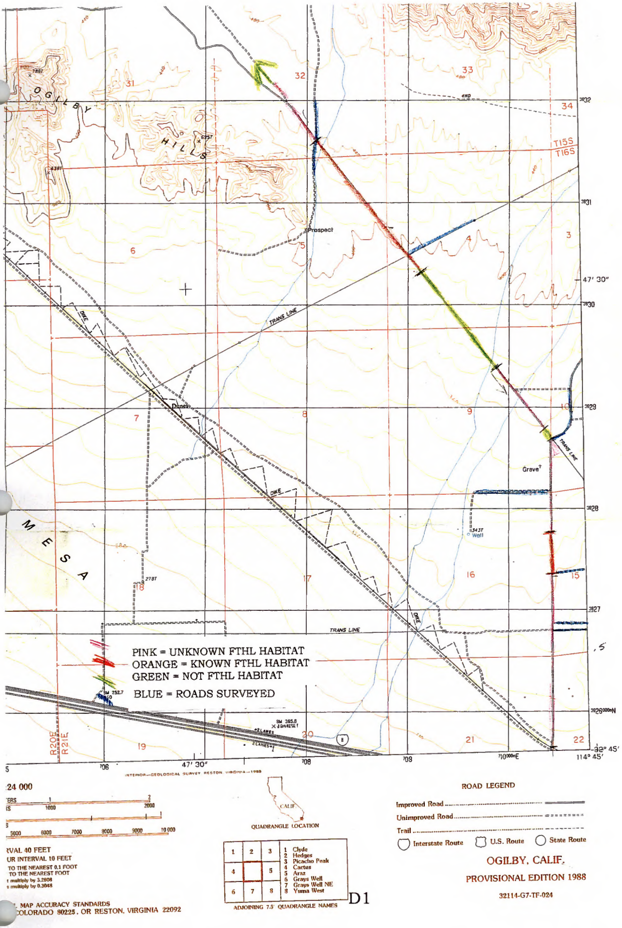
FTHL Data Sheets for Live Lizard Surveys

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

ATTACHMENT D

Ogilby Quadrangle - Map of Survey


PINK = UNKNOWN FTHL HABITAT
ORANGE = KNOWN FTHL HABITAT
GREEN = NOT FTHL HABITAT
BLUE = ROADS SURVEYED
OGILBY HILLS
MESA
Prospect
Dunes
Grave
Well
TRANS LINE
DIKE
T15S
T16S
R20E
R21E
47′ 30″
32° 45′
114° 45′
INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1988
1:24 000
INTERVAL 40 FEET
CONTOUR INTERVAL 10 FEET
TO THE NEAREST 0.1 FOOT
TO THE NEAREST FOOT
MAP ACCURACY STANDARDS
COLORADO 80225, OR RESTON, VIRGINIA 22092
CALIF
QUADRANGLE LOCATION
1 Clyde
2 Hedges
3 Picacho Peak
4 Cactus
5 Araz
6 Grays Well
7 Grays Well NE
8 Yuma West
ADJOINING 7.5′ QUADRANGLE NAMES
ROAD LEGEND
Improved Road
Unimproved Road
Trail
Interstate Route
U.S. Route
State Route
OGILBY, CALIF.
PROVISIONAL EDITION 1988
32114-G7-TF-024

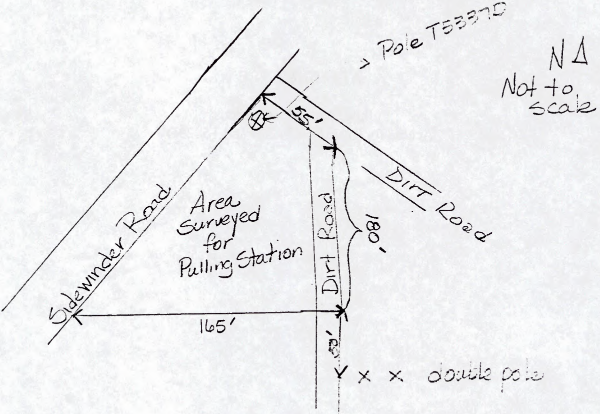
D1

This page intentionally left blank
for reproduction purposes.

ATTACHMENT E

Pulling Station Dimensions;
Access forT5421D, T5422D and T5423D

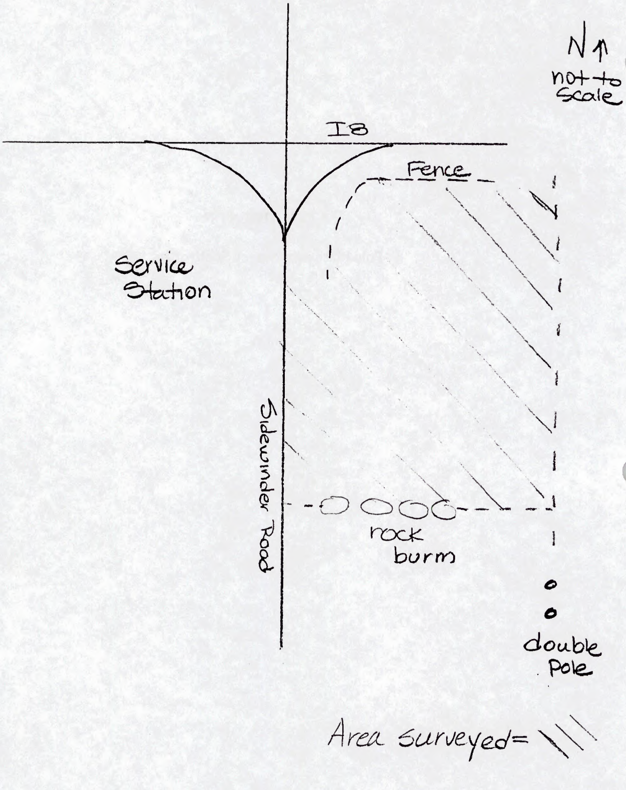
Diagram of Pulling Station - Pole T5337D



Access for Poles T5421D and T5422D will be from Sidewinder Road; Access for Pole T5423D will be from eastern access road; area surveyed from center of pole 25 feet on each side due east.

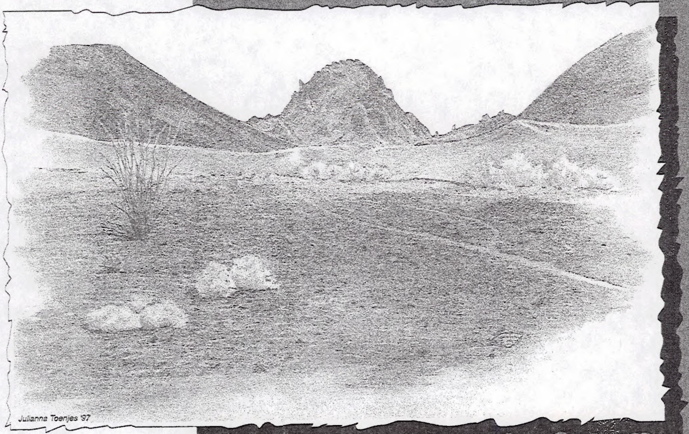
ATTACHMENT F

Pole Placement Survey South of I-8


N
not to scale
I8
Fence
Service Station
Sidewinder Road
rock burm
double Pole
Area surveyed =

APPENDIX L WHERE TRAILS CROSS: CULTURAL RESOURCES INVENTORY AND EVALUATION FOR THE IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA (OCTOBER 1997)[DRAFT]

WHERE TRAILS CROSS: CULTURAL RESOURCES INVENTORY AND EVALUATION FOR THE IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA



KEA Environmental

October 1997

Cover: Idealized view of Indian Pass and trail from CA-IMP-5067
Art by Julianne Toenjes
Design by John Brogan

DRAFT

WHERE TRAILS CROSS: CULTURAL RESOURCES INVENTORY AND EVALUATION FOR THE IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA

Submitted to:

Environmental Management Associates, Inc.
1698 Greenbriar Lane, Suite 210
Brea, California 92621-5919

Submitted by:

KEA Environmental, Inc.
1420 Kettner Boulevard, Suite 620
San Diego, California 92101
(619) 233-1454

Authors:

Andrew R. Pigniolo
Jackson Underwood
James H. Cleland

Contributors:

Rebecca Apple
Michael Baksh
Christy Dolan
Delman James
Tanya Wahoff
Jay von Werlhof
John Whitehouse

Acres: Approximately 1,625
U.S.G.S. Quadrangles: Grays Well NE, Hedges, Ogilby

October 1997

Key Words: Indian Pass, Imperial County, Imperial Mine, Quechan, Trails, Flaking Stations, Ceramics, Traditional Cultural Properties, Cultural Landscape, Settlement Patterns, Chert, Quartz, Geoglyphs.

This page intentionally left blank
for reproduction purposes.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS

Section **Page**

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

Figure **Page**

LIST OF FIGURES

Figure **Page**

LIST OF PLATES

EXECUTIVE SUMMARY

A cultural resource inventory and evaluation was conducted for resources within the area of potential affect (APE) of the Imperial Project (Project). The Project is a proposal by the Glamis Imperial Corporation to develop an open-pit, precious metal mining operation utilizing heap leach processes in eastern Imperial County, California. The Project area is located on public lands administered by the U.S. Bureau of Land Management (BLM), El Centro Resource Area Office, of the California Desert District. Fieldwork was conducted under Cultural Resource Use Permit #CA-97-01-020 and a Fieldwork Authorization from the El Centro Resources Area Office dated 6/13/97. Work was conducted in accordance with the National Historic Preservation Act (NHPA) and implementing regulations and guidelines.

Previous inventory and evaluation data identified a series of significant resources within the Project. In response to Native American concerns, the BLM required an additional inventory of the Project APE to ensure that the data were comprehensive and complete. The APE for the Project includes the Project mine and process area and a 500-foot buffer around this area, the access corridor and well area with 50- and 150-foot buffers, and a related transmission line corridor with a 100-foot buffer. An intensive inventory of the entire Project APE at 5-meter (m) transect intervals was conducted between June 17 and August 15, 1997. Representatives of the Quechan Tribe participated in the survey and provided important new ethnographic information at a series of meetings during the inventory and evaluation process.

The intensive inventory identified 88 cultural resource sites and 9 isolates within the Project APE. The mine and process area contains a diverse and widely distributed pattern of cultural features connected by low density lithic scatter. These features have been grouped into eight sites (CA-IMP-4970, CA-IMP-4971, CA-IMP-5061, CA-IMP-5067, CA-IMP-5594, CA-IMP-5526, CA-IMP-7408, and F-1792) and 16 prehistoric trails (CA-IMP-5010, CA-IMP-7388, F-4, F-298, F-745, F-940, F-1020, F-1336, F-1500, F-2142, F-2202, F-2282, F-2294, F-3024, F-4028, and F-4132) but can best be described as a portion of a larger cultural landscape. The remaining 64 sites are located in an ancillary area and along the transmission line. They represent a variety of resources including geoglyphs, historic and prehistoric trails, historic sites, pot drops, and flaking stations. Artifacts were not collected during the survey. Field notes from the inventory, photographs, and a copy of the technical report will be filed with the Southeastern Information Center at Imperial Valley College Museum.

All cultural resources were evaluated for eligibility for nomination to the National Register of Historic Places (National Register). Twenty-nine sites and nine isolates do not qualify as eligible for nomination to the National Register. Fifty-four archaeological sites are evaluated as eligible for nomination to the National Register under several criteria including A, B, and/or D. Five sites were indeterminate and will not be effected by the Project.

The evaluation also includes a traditional cultural property (TCP) assessment, which has resulted in the identification of the Indian Pass-Running Man area of traditional cultural concern (ATCC). Quechan representatives have indicated that this area was used for traditional religious and cultural educational purposes and is considered integral to the transmission of cultural knowledge. This resource is evaluated as eligible for the National Register under criteria A, C, and D and may be part of a larger TCP which includes other ATTCs linked by a trail network. Additional Native American consultation would be necessary to assess this possibility.

The report concludes that the Project would have a major adverse effect on the ATCC and on 54 archaeological sites evaluated as eligible for the National Register. Treatment options are discussed that would reduce this adverse effect, but residual impacts would still be significant. These include efforts to record the traditional cultural values in the ATCC, to contribute to Quechan cultural programs, and to protect portions of the ATCC that will remain after development of the project. Recommendations regarding data recovery are also made.

CHAPTER 1
INTRODUCTION

PROJECT INTRODUCTION AND BACKGROUND

The Imperial Project (Project) is a proposal by the Glamis Imperial Corporation to develop an open-pit, precious metal mining operation utilizing heap leach processes in eastern Imperial County, California (Figure 1-1). The Project area (Figure 1-2) is located on public lands administered by the U.S. Bureau of Land Management (BLM), El Centro Resource Area Office, California Desert District, the lead federal agency for the project. KEA Environmental, Inc. was retained under a third-party agreement to conduct a comprehensive cultural resource inventory and evaluation of the area of potential affect (APE) of the Project, and to prepare a treatment plan to address significant adverse effects to these resources. Inventory and evaluation work was conducted under Cultural Resource Use Permit #CA-97-01-020 and a Fieldwork Authorization from the El Centro Resources Area Office dated 6/13/97. Work was conducted in accordance with the National Historic Preservation Act (NHPA) and implementing regulations and guidelines.

The objectives of the current effort as stated in the scope of work were to:

- Ensure that previous cultural resource surveys of the Project area have identified all on-the-ground resources.

- Ensure that Native Americans are requested, and given the opportunity, to participate in the field surveys.

- Ensure that cultural resources are addressed in the overall context of a traditional cultural property within a cultural landscape.

- Ensure that adequate, accurate information exists on cultural resources within the area of potential effect (APE) and identified buffer areas to allow for possible manipulation of mining components to avoid cultural resources.

- Obtain a single, comprehensive, cultural resources report documenting cultural resources in the Project area; whether they will be affected by the Project and, if so, how; the significance of cultural resources in context of a traditional cultural property; evaluation for eligibility to the National Register of Historic Places; recommendations for mitigation and treatment.

The cultural resource inventory, overview, evaluation and treatment options were designed to meet these objectives.

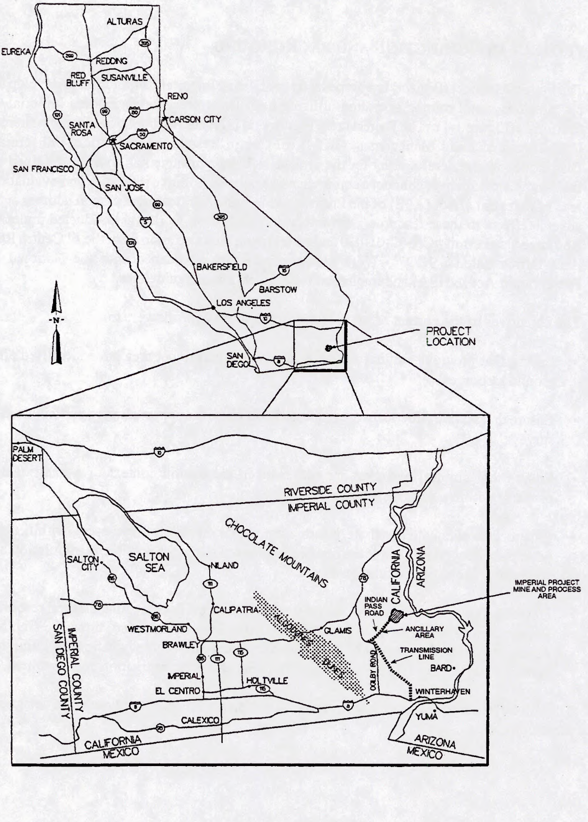


Figure 1-1. Regional Location

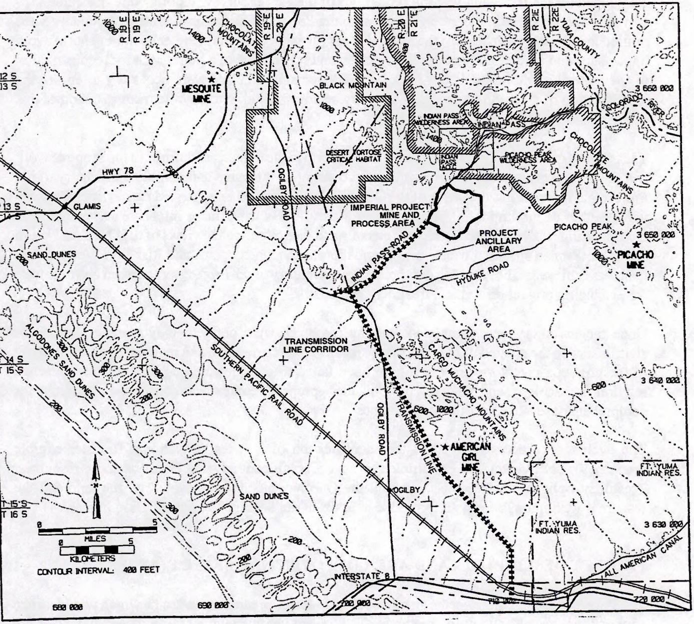


Figure 1-2. Project Location

Prior to the current work the Project was surveyed for cultural resources in three separate inventories. Inventories conducted by Schaefer and Pallette (1991) covered segments of the Project mine and process area; inventories by Schaefer and Schultze (1996) covered the majority of the Project mine and process area along with the Project ancillary area; and inventories by Schaefer and Victorino (1996) covered the transmission line corridor. The resurvey of these lands was requested by the BLM because (a) the Quechan Nation stated that the earlier surveys had "missed" many resources recognized by the tribe, and that interpretations of the earlier survey reports were inaccurate; (b) surveys of those areas immediately adjacent to the Project mine and process area boundary were desired to facilitate evaluation of the feasibility for relocation of certain Project components to avoid impacts to identified eligible cultural resources; and (c) surveys of a larger area for reconstruction of the Imperial Irrigation District (IID) 34.5 KV transmission line were necessary to ensure the identification of all cultural resources that may be adversely affected by the reconstruction of this transmission line.

The primary goal of the current inventory is to respond to the objectives defined in the scope of work and the comments on the previous work by providing an intensive and complete inventory of the Project that incorporates the views of the Quechan Nation and other interested parties, including Jay von Werlhof of the Imperial Valley College Museum. By using more intensive survey methods incorporating smaller (5-meter) survey intervals and incorporating the views of the Quechan Nation and other Yuman speaking tribes, the principal project archaeologists, and Mr. von Werlhof, this goal was achieved. The resulting comprehensive inventory of the Project served as an accurate base for evaluating project effects and treatment methods.

Once the inventory was completed and the resources were defined, they were evaluated for significance in the context of both a project-specific research design and a regional overview. Many of the previous inventories in the region have failed to consider the larger context of Quechan religion, archaeology, and history. Providing the appropriate context was considered imperative for comprehensive evaluation of these resources.

The evaluation process resulted in the identification of a series of National Register eligible properties. The Project was determined to have a significant adverse effect on these resources. Treatment options, designed to document the Quechan history represented by the land and the resources within the Project, are provided to assist in the Section 106 consultation process.

PROJECT DESCRIPTION AND AREA OF POTENTIAL AFFECT (APE)

The Proposed Action or Project is an open-pit, heap-leach, precious metal mine which would utilize conventional heap leach mining methods. The Project would include: mining gold and silver ore and waste rock at an average mining rate of 130,000 tons per day (up to a maximum mining rate of 200,000 tons per day) for up to 20 years; constructing and operating facilities to administer the operation and maintain all mining and related equipment; processing the ore and stockpiling the waste rock; developing and producing groundwater for use in processing operations and dust control; conducting mineral exploration activities; implementing environmental impact reduction measures; and implementing reclamation measures. The proposed Project has been designed to meet the anticipated permit requirements of the various federal, state, and local agencies which regulate mining in the area.

The proposed Project would consist of the following components:

- Three open pits, identified as the West Pit, East Pit, and Singer Pit;
- Two waste rock stockpiles, identified as the East Waste Rock Stockpile and the South Waste Rock Stockpile;
- Two soil stockpiles, identified as the West Soil Stockpile and the East Soil Stockpile;
- Five stream drainage diversion channels, identified as the West Pit West Diversion, the West Pit East Diversion, the Singer Pit East Diversion, the East Pit West Diversion, and the East Pit East Diversion;
- One administration office and equipment maintenance facility area;
- Ore processing facilities, including a lime bin, heap leach pad, and process solution ponds;
- One precious metal recovery plant and other related facilities;
- One electrical power substation;
- A system of roads and electrical distribution lines internal to the Project mine and process area which would connect the various facility components;

Specific Project components located within the Project ancillary area include:

- One groundwater well field, consisting of up to four production wells, designed to produce groundwater at a combined peak yield of approximately 1,000 gallons per minute (gpm) and combined peak yield of approximately 1,200 acre feet per year (afy);
- A buried water pipeline to convey the water from the groundwater well field to the Project mine and process area;
- An approximately 3.7-mile section of new 92/13.2kV transmission line; and
- Relocated portions of Indian Pass Road, including the permanent realignment of the intersection of Indian Pass Road and Ogilby Road and the temporary relocation of an approximately 6,000-foot portion of Indian Pass Road, which would be moved approximately 1,000 feet to the west of its current location to provide continuing public access to area northeast of the Project during the completion of Project activities.

Mining activities, performed 24 hours per day and seven days per week, would commence in 1998. Processing of ore on the leach pad would terminate around the year 2017, although reclamation activities would continue beyond this date as necessary.

As discussed throughout this document, the "Project area" consists of a "Project mine and process area" and a "Project ancillary area." The "rebuilt" utility-owned 92/34.5 kV transmission line is not discussed as part of the "Project area." It is, however, part of the "Project" and will be discussed here as the transmission line, or as the "rebuilt" or "overbuilt" 92/34.5 kV transmission line.

The APE for the Project includes the two major components of the Project area in addition to the transmission line. The Project mine and process area portion of the APE would contain all of the open pits, waste rock stockpiles, soil stockpiles, stream diversion channels, administration office and maintenance facility area, heap leach facility, precious metal recovery plant and other facilities, the electric substation, the temporarily realigned portion of Indian Pass Road, and internal roads and electrical distribution lines. To insure all potential affects were included in this area, the APE included an additional 500-foot buffer around the Project mine and process area. Figure 1-3 shows the Project mine and process portion of the APE and the buffer zone.

The "Project ancillary area" portion of the APE includes the groundwater production wells and buried water pipeline, the new 92/13.2kV transmission line, and the relocated portions of Indian Pass Road. The Project ancillary portion of the APE follows the current alignment of Indian Pass Road. The width of this area is variable, as shown on Figure 1-4. The APE includes a 50-foot buffer on the northwest side of Indian Pass Road where no major improvements are planned. At the junction of Indian Pass Road and Ogilby Road, where the intersection will be realigned, a 200 x 350-foot area was surveyed to address the intersection improvement. A 50-foot buffer was included around that area to address secondary affects. Southeast of Indian Pass Road, where the water line and new transmission are proposed, the area between the proposed transmission line and Indian Pass Road was surveyed. An additional 150-foot buffer southeast of the transmission line was included in the APE to address construction affects. The wells are also proposed for the area southeast of the transmission line. To address their affects, the 1-mile segment to the northeast along Indian Pass Road from the point where the existing 34.5 kV transmission line crosses Indian Pass Road was surveyed 500 feet south of the proposed transmission line.

The APE for the rebuilt 92/13.2kV transmission line was also variable in width. As shown on Figure 1-5, it includes minimally a 200-foot-wide corridor centered on the existing 34.5 kV transmission line. To address potential access roads, the area between the existing access road for the transmission line and the 34.5 kV transmission line itself was surveyed. Most of this area was within the 200-foot-wide corridor, but in some areas, the transmission line veered further from the road and up to 100 feet of additional area was covered. In addition to the corridor, "overbuilding" may require the replacement of one or two of the existing IID "A"-Line and WAPA 161kV transmission line poles. These poles may need to be replaced to allow for the greater height of the 92 kV line on either side of the places where the 34.5 kV transmission line passes under those transmission lines. To address transmission line intersection modifications, the APE included four additional survey areas. These include a 200-foot-wide corridor extension to the south side of Interstate 8, a 200-foot-wide corridor along the IID "A"-Line extending 100 feet beyond the poles on either side of the

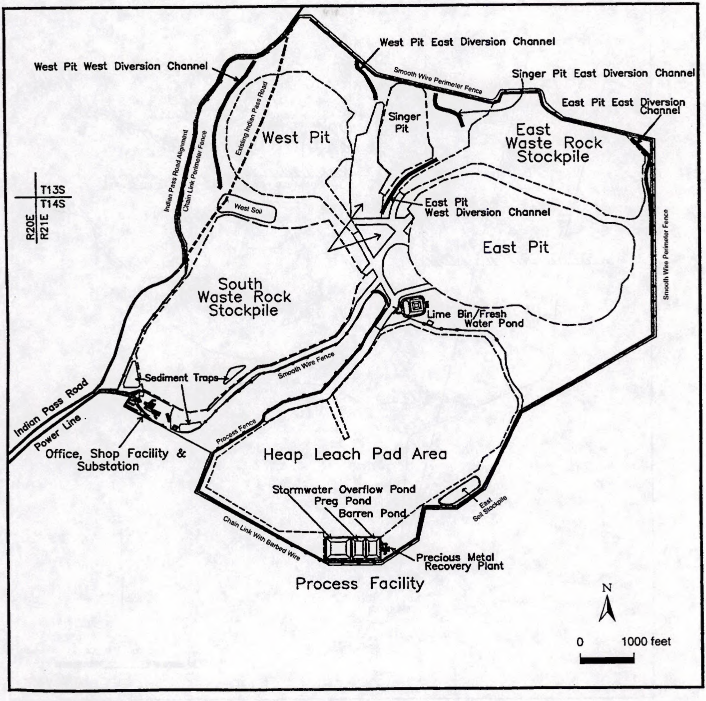


Figure 1-3. Mine and Process Area Facilities

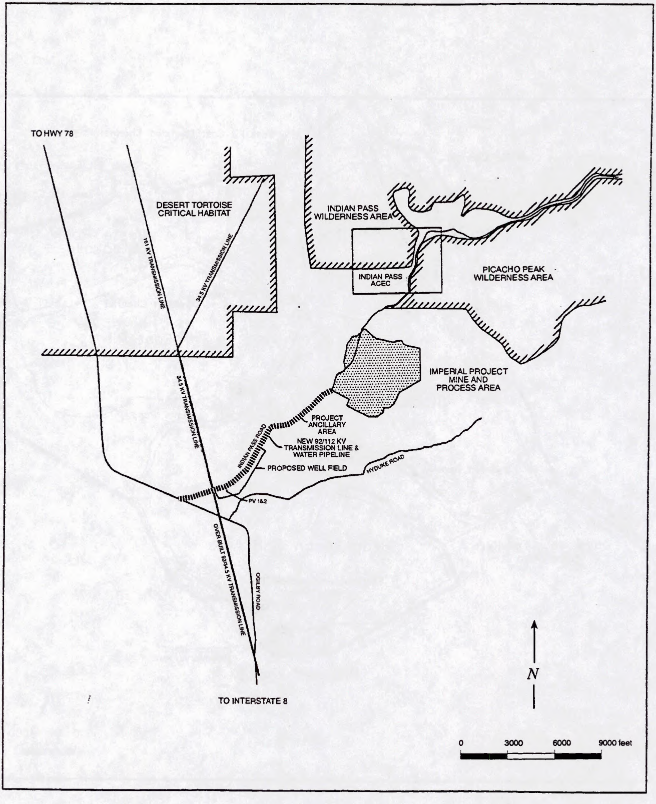


Figure 1-4. Project Ancillary Area

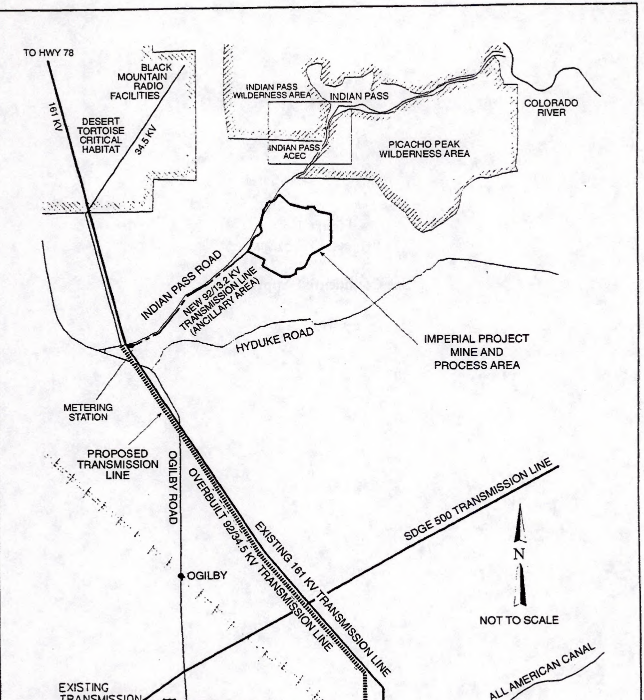


Figure 1-5. Transmission Lines

Figure 1-6
Project APE Maps

See Confidential Appendix

existing 34.5 kV transmission line, a 50-foot-wide corridor to address the placement of "H" frame towers for 400 feet on both sides of the 500 kV transmission line crossing, and a 200-foot-wide corridor along the WAPA 161kV transmission line extending 100 feet beyond the poles on either side of the proposed 92kV line crossing.

The APE for the entire Project is shown at USGS 7.5' quadrangle scale in Figure 1-6 (located in Appendix E). Although the APE for the three principal project components described above represent the potential extent of physical direct and indirect impacts from the project, secondary visual effects may also result from the Proposed Action. The APE for visual effects is defined here as the "Study Area" (Figure 1-7). The Study Area was also used to develop context for the project. It includes important features such as Indian Pass, Picacho Peak, the "Plug" and Black Mountain. Visual effects from and to these resources are also considered.

Additional survey work was conducted outside the Project APE to assess the potential for resource avoidance. This survey work is referred to here as the Transect Surveys and does not represent a part of the APE. The APE defined above is comprehensive and should reflect the areas affected by the Proposed Action.

PROJECT LOCATION

The Project is located in eastern Imperial County, California, approximately 45 miles northeast of El Centro, California and 20 miles northwest of Yuma, Arizona. The Project APE includes a total of 2,423 acres. This is made up of 2,000 acres associated with the Project mine and process area, 119 acres along the Project ancillary area, and 304 acres along the transmission line corridor.

The Project area is located within Sections 30, 31, 32,33, Township 13 South, Range 21 East, and Sections 4, 5, 6, 7, 8, and 9 Township 14 South Range 21 East, San Bernardino Baseline & Meridian (SBB&M), entirely on public lands administered by the BLM. The Project mine and process area is shown on the USGS Hedges 7.5' Quadrangle (Figure 1-6 in Appendix E). The Project ancillary area is located within Section 6, Township 14 South, Range 21 East and Sections 1, 11, 12, 14, 15, 22, and 21, Township 14 South, Range 20 East. It is also shown on the USGS Hedges 7.5' Quadrangle (Figure 1-6 in Appendix E).

The transmission line corridor includes portions of Sections 22, 26, 27, and 35, Township 14 South, Range 20 East; Sections 2, 11, 13, 14, and 24, Township 15 South, Range 20 East; Sections 19, 30, 31, 32, Township 15 South, Range 21 East; and Sections 4, 5, 9, 10, 15, 16, 21, 22, Township 16 South, Range 21 East. It is shown on the USGS Hedges, Ogilby, and Grays Well NE 7.5' Quadrangles (Figure 1-6 in Appendix E).

Access to the Project area is from Ogilby Road via Interstate 8 from the south, or from State Route 78 to the north. The Project mine and process area overlaps Imperial County-maintained Indian Pass Road, and is located approximately five miles northeast of the Indian Pass Road/Ogilby Road intersection.

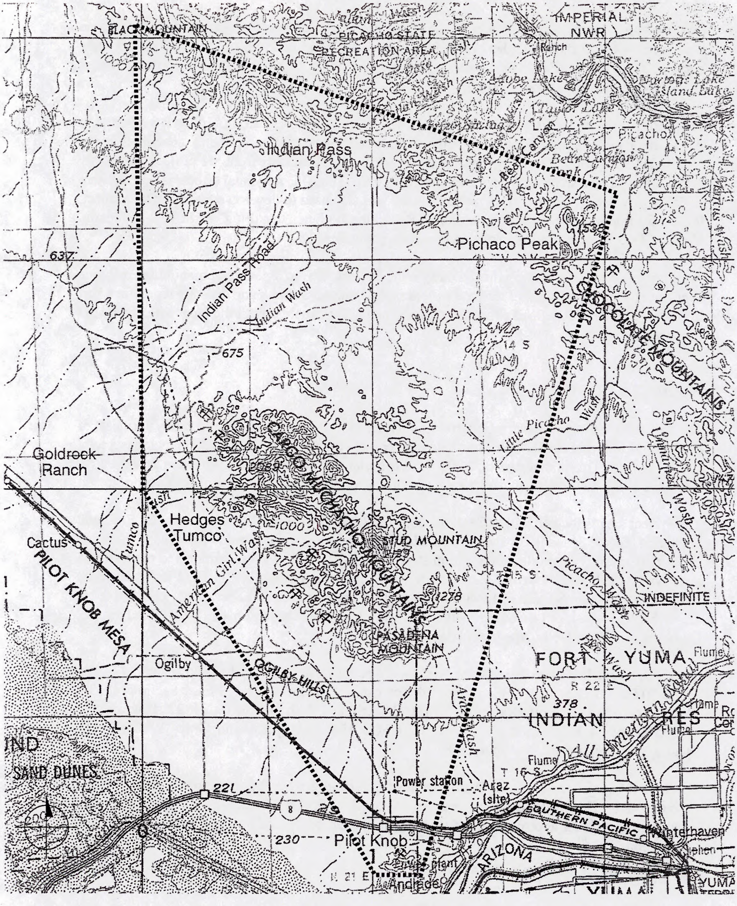


Figure 1-7. Study Area

The Project mine and process area boundary encompasses a broad, south- and west-facing, alluvial plain south of Indian Pass in the Chocolate Mountains, between the Cargo Muchacho Mountains, approximately four miles south and Peter Kane Mountain, approximately six miles north. The elevation over the Project mine and process area ranges from about 760 feet to 925 feet. The Project lies in the center of a mining district formed by the active Picacho Mine, Mesquite Mine, and American Girl Mine heap leach gold facilities, each located approximately 10 miles from the Project mine and process area.

PROJECT PERSONNEL AND ACKNOWLEDGMENTS

The KEA project team meets Federal qualifications and standards defined in 36 CFR 61. James H. Cleland, Ph.D. served as Project Manager and Principal Investigator. Andrew R. Pigniolo, M.A. served as Co-Principal Investigator and Field Director. Jackson Underwood, Ph.D. served as one of the principal authors and Field Crew Chief. Dr. Cleland, Mr. Pigniolo, and Dr. Underwood, are members of the Society of Professional Archaeologists (SOPA) and meet the requirements outlined in 36CFR61. Dr. Cleland holds a Ph.D. in Anthropology with an emphasis in Archaeology from the University of Virginia. Mr. Pigniolo has a M.A. degree in Anthropology from San Diego State University and Dr. Underwood holds a Ph.D. in Anthropology from the University of California, Los Angeles. Resumes of principal project personnel are included in Appendix A.

Principal contributors included Jay von Werlhof, M.A., of the Imperial Valley College Museum, who provided an important perspective during the survey effort and contributed to the overview, trail, and background discussions. Christy Dolan, M.A. served as Project Historian by conducting historic research and describing and evaluating the historical resources for the report. Ms. Dolan also coordinated the map and data production effort for the project. Mike Baksh, Ph.D. conducted interviews with knowledgeable Native Americans and summarized information related to the cultural resources within the Project and related concerns. Dr. Baksh's work is summarized in the report and provided in entirety as a confidential appendix. Delman James, B.A. served in the field as crew chief and drafted the methods section of the report. Tanya Wahoff, B.A. served both as GPS data collector and crew chief in the field and coordinated and helped write the discussions of previously recorded sites. Rebecca Apple, M.A. served as crew chief, directing the field work and writing the section on the transect surveys.

In addition to those that contributed directly to the text of the report are the many people who assisted in the field effort under often trying summer conditions. The field effort was directed by Andrew R. Pigniolo, M.A. Part- or full-time crew chiefs included Delman James, Jackson Underwood, Richard Bark, Tanya Wahoff, Rebecca Apple, Lori Lilburn, and John Whitehouse. Additional survey crew included Linda Therrien, Joe Mullen, Julianne Toenjes, Jim Toenjes, Stephanie Rose, Roy Pettus, Cheryl Bowden-Renna, Curt Duke, John Diettler, Serena Love, Kathryn Kallmes, and Kham Slater. Julianne Toenjes provided nearly all of the field illustrations and the cover art for this report. Jim Toenjes also assisted in the field illustrating effort. GPS data collectors included Lori Lilburn, Tanya Wahoff, Stephanie Rose, Linda Therrien, and John Whitehouse. Jay von Werlhof provided follow-up survey. Members of the Quechan tribe who played an important role in the survey effort included Mark Kelly and Vidal Townsend.

In addition to the personnel working directly on the Project, a variety of people provided information and support to the effort and deserve recognition. Steve Baumann of Glamis Imperial provided the funding that made this inventory and evaluation effort possible. Mr. Baumann should be acknowledged for providing the means to document an important part of Quechan history that is being slowly degraded by collectors and time.

BLM staff also played an important role in facilitating this effort. Particularly critical were the roles of Pat Weller, Dr. Joan Oxendine, Terry Reed, and Russell Kaldenberg.

Environmental Management Associates, Inc. (EMA) also helped to coordinate much of the project effort under the astute direction of Dr. Dwight Carey. EMA also provided the mapping for the project, and Joe DeStephano should be acknowledged for his efforts producing the final maps.

The project effort itself would have had little value without the efforts of the Quechan Nation and other interested Native American groups. These people not only showed their concern for their heritage but they brought life to the artifacts in the field. They provided observers during the field effort who helped identify and comment on the resources. The Quechan Cultural Committee, including Chairperson Pauline Owl, Eldred Millard, Pauline P. Jose, Willa Scott, Wally Antone, Barbara Antone, Preston Arroweed, Milton Jefferson, and Starla Cachora, provided their opinions on the significance and meaning of the resources identified. Lorey Cachora served as consultant to the Cultural Committee and, provided a large amount of valuable information on Quechan history and concerns. President Michael Jackson provided important Tribal perspectives and helped facilitate Native American participation in the new survey and the consultation process.

REPORT ORGANIZATION

This report is organized around the Archaeological Resource Management Report (ARMR) guidelines (Office of Historic Preservation 1989) and Section 106 of the National Historic Preservation Act (NHPA) to provide a complete and clear understanding of the inventory methods, results, evaluation, and treatment process. The document is organized into an introduction and three separate parts: context and inventory, evaluation, and treatment. Chapter 1 provides the introduction section of the report summarizing the Project and its location.

The first part of the report summarizes the context and inventory portion of the effort. Chapter 2 is a section on environmental context that provides background information on the natural environment as it relates to the available resources and other factors that might have affected human occupation of the area. The cultural context is provided in Chapter 3. This includes a chronology, a regional overview, and a discussion of previous research in the Project APE. Chapter 4 describes the methods and research design used during the cultural resource inventory. Chapter 5 summarizes and discusses the inventory results of the project. Site forms are included in Appendix F.

The second part of the report is focused on the significance and the proposed effects to the cultural resources identified during the inventory. Chapter 6 describes the evaluation research design and methods used to evaluate the resources. Chapter 7 presents the results of the cultural resource evaluation and summarizes the significant cultural resources within the APE.

The final part of the report addresses project effects and treatment. Chapter 8 is an evaluation of the project effects to the cultural resources within the APE and the significance of the effect. Appropriate treatment options for each effect are also presented. Chapter 9 discusses data recovery recommendations.

CHAPTER 2
ENVIRONMENTAL CONTEXT

INTRODUCTION

The Project area is located in the arid Colorado Desert approximately seven air miles southwest of the nearest bend of the Colorado River. Its environment has constrained the types of human uses of the area both historically and prehistorically. While hydrological and biotic resources are limited, the area did provide a source of toolstone to Native American groups. More important perhaps was the area's relationship to natural travel corridors. The Project mine and process area is just south of Indian Pass, which provides access between the river and the interior and facilitated movement north and south along the river corridor. The area also offers expansive views to the south and southeast, which may have been a factor contributing to religious uses of the area by Native American groups.

Twenty-five miles to the west of the Project area, the intermittent existence of Lake Cahuilla provided a rich lacustrine environment independent of the tight water budget of the Colorado Desert. In general, however, Native peoples were tightly tied to the resources of their local environment and processed these materials using specific and functional technologies. An understanding of the potential resources and constraints of the local environment is key to informed interpretations of prehistoric lifeways and cultural processes of the Lower Colorado area.

GEOMORPHOLOGY AND GEOLOGY

Landform and Geology

The Project area is located in a relatively flat portion of the Colorado Desert, south of the Chocolate Mountains and north and east of the Cargo Muchacho Mountains. The transmission line corridor passes directly west of the Cargo Muchacho Mountains. This region is located between the Colorado River Valley and the Salton Trough, which has in the past contained a freshwater lake known as Lake Cahuilla (Figure 2-1). The location of the Project area between these two major areas where water and human populations came together make it an important corridor for movement between them. One of the most important features of the local landscape is the proximity of the Project area to Indian Pass. A prominent gap in the Chocolate Mountains, Indian Pass acted as a funnel for movement through the area and the Project area itself. The abundant lithic materials for stone tool production, which are relatively unavailable along the Colorado River, have also helped make this a special place economically.

As noted above, the Project area also has religious significance. This is partly tied to its geographic relationship to other landscape features: Picacho Peak to the east, Black Mountain to the north, and a prominent small peak known as "the Plug" with a Solstice observation site to the northwest. All of these geographic features are significant to the Native American groups along the lower Colorado River.

The mountains surrounding the Project area provided the lithic materials that made this area so useful economically. The Cargo Muchacho Mountains consist of a variety of granitic rocks of Mesozoic age, primarily leucogranite in the north and quartz monzonite and quartz diorite in the southern mountains (Morton 1977). In the area of Tumco and American Girl Canyons are found the Tumco Formation of metasedimentary rocks thought to be of Precambrian age. Also along the western face of the Cargo Muchacho Mountains is the Vitrefrax Formation, also thought to be Precambrian, containing quartzite, quartz, and schist (Morton 1977:15-16).

The Indian Pass area and Black Mountain are generally volcanic in nature with some areas of Orocopia Schist. Clastic rocks dominated by basalt are located at the pass itself and down along the western edge of the Project area. Pliocene age basalt flows cap Black Mountain to the northwest and may have supplied much of the secondary basalt cobble material within the Project area.

The Project mine and process area is on a plain between these surrounding mountains (Plate 2-1). It consists primarily of alluvial fans and terraces deriving from the Chocolate Mountains to the north and east, and the Cargo Muchaco Mountains south and west of the Project area. Plate 2-2 provides an overview of the complex pattern of terraces and washes that make up the Project area. Darker areas of better-developed desert pavement indicate older terraces, which are often associated with an abundance of cultural material.

Elevations within the Project mine and process area range between 760 and 925 feet above sea level. The Project ancillary area and the transmission line corridor range from a low of 290 feet at the southern end to a high of 750 at the northern end of the Project ancillary area.

Terraces, Desert Pavement, and Desert Varnish

The terraces within the Project area are primarily composed of older alluvium and desert pavement areas thought to date to the late Pleistocene-early Holocene. These older terraces are dissected by active washes and unconsolidated, late Holocene alluvium (Morton 1977).

The surface of these terraces is dominated by larger coarse-grained basalt cobbles generally hand-sized. Between these cobbles is a smaller series of stones which include chert, milky quartz, and granitic rocks as major constituents. The abundance of these rock types varies between terrace deposits. Some areas contain an unusual combination of black basalt and nearly pure quartz (Plate 2-3), while other areas have larger components of chert. All the materials within the pavements in the Project mine and process area are subrounded, suggesting short distance transport from sources in the nearby mountains.

The terrace pavements in the western part of the Project ancillary area and along the transmission line corridor contained few cherts, making this area less useful for lithic prospecting. Quartz from igneous dikes in this generally granitic and metamorphic area was available along this corridor, which generally follows the west side of the Cargo Muchacho Mountains. At the southern end of the transmission line corridor the terraces were dramatically different. Although they were composed of well patinated material, the material was all well-rounded and small (approximately 3 cm diameter) suggesting long distance water transport. This terrace material appears to have been derived from Colorado River sediments rather than from the local mountains.

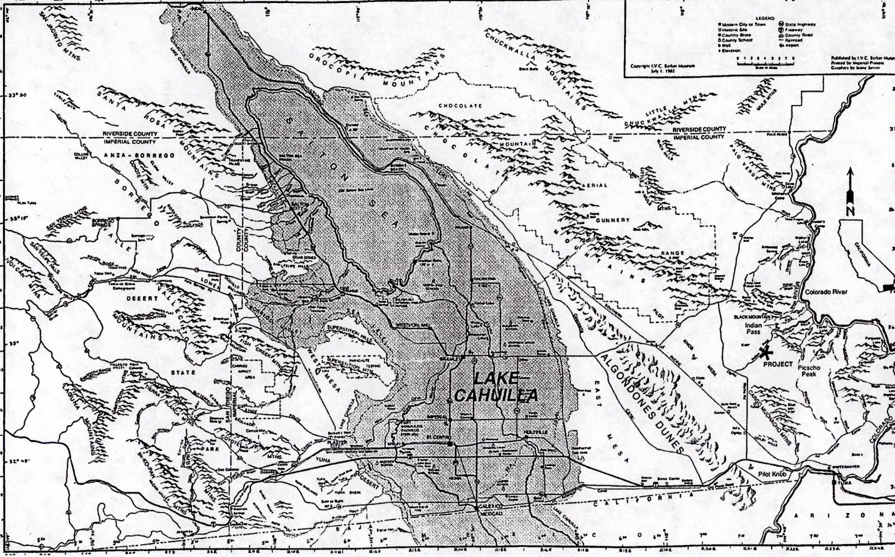


Figure 2-1. Regional Geography

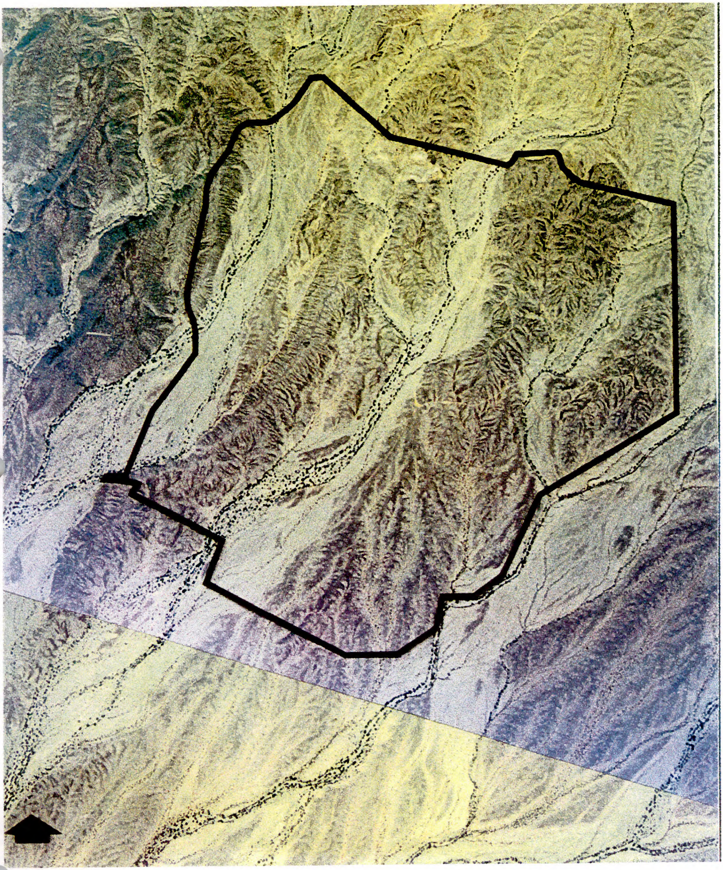


Plate 2-1. Aerial Photograph of Mine and Process Area

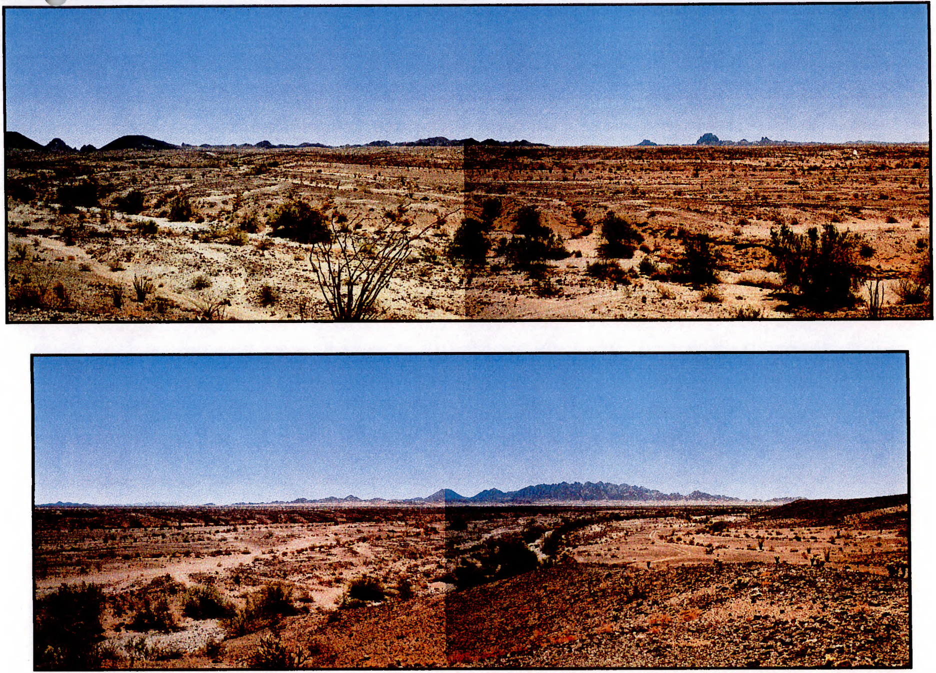


Plate 2-2. Overview of Project Mine and Process Area

Plate 2-3. Desert Pavement with Trail

One of the prominent geomorphic features of the Colorado desert is desert pavement. Desert pavement forms a pebble armor that protects the soil on these terraces from further erosion. It also discourages plant and animal life. There are two contrasting models to account for desert pavement formation: deflation and upward sorting. Until recently, most American archaeologists have subscribed to the soil deflation model. In this, pavements are thought to be formed primarily by a process of wind-induced soil deflation (Rogers 1966:39-43). As the wind action removes the silts and sands that compose the lighter soil fraction, the pebbles in the soil column gradually settle together to form a tight mosaic on the surface. This halts further deflation.

Malcolm Rogers conducted an experiment near the western shore of Lake Cahuilla to estimate the amount of soil that might have been removed in a typical desert pavement - soil deflation process (1966:39-43). He removed a one-yard-square section of pavement and counted the pebbles that composed the paving. The count was 178. Then he continued to excavate, screen, and count pebbles until he had obtained another 178 specimens. The depth he reached was 18 inches. He concluded that this is a reasonable estimate of the depth of deflation required to form this pavement based on the assumption that the soil column had a uniform amount of stones within the top few feet.

In this same area, Rogers noted what he defined as San Dieguito I and Yuman II picks in close proximity. The San Dieguito pick was sandblasted and was well incorporated into the desert pavement, while the Yuman pick was on the surface, still surrounded by lithic debitage generated in its manufacture (Rogers 1966:41). Rogers provides no measurements of the depth of the San Dieguito pick, but presumably, it would not have been visible if it had settled into the pavement more than a centimeter or two. Assuming that the pick was indeed San Dieguito, and that it dates to as far back as the posited beginning of the San Dieguito-Lake Mojave Period, ca. 10,000 years ago (Moratto et al. 1984:111-113; Warren and Crabtree 1986:182), it is reasonable to surmise that pavements in the Colorado Desert began to form by that time.

The contrasting model of desert pavement formation attempts to account for the fact that pavements exist above an essentially stone-free soil stratum. In this accretion model, stones are believed to be expelled upward from this clayey or silty substrate through cycles of wetting and drying. During the early pavement formation process, when individual rock components of the pavement are rougher, wind-blown silts are trapped in a soil accretion process. The rough rock creates mini-air turbulence, which causes silt to settle out of the wind-driven air column. This silt is washed down past the stones into the subsoil (Mabbutt 1965; 1979; Cooke 1970; Wells 1992). The soil accretion model is gaining acceptance among the archaeological community (Cleland et al 1993; Schneider 1997).

Older desert pavements are often darkly patinated and nearly devoid of plant life; they do in fact resemble a coffee brown colored, asphalt pavement. More recent pavements and more recently deposited artifacts are progressively less patinated. The dark patination seen on older desert pavements and on older artifacts incorporated into them is commonly known as desert varnish. Composed of wind-blown clay minerals, iron oxides, and manganese oxides, desert varnish is thought to be deposited by biological action (Dorn and Oberlander 1981; Laudermilk 1931; Perry and Adams 1978). Various bacteria, fungi, and algae do occur on and within the varnish layer. These organisms are thought to concentrate iron and manganese salts, which become oxidized through long exposure to sun. Over time, the exposed dorsal surfaces of desert rocks develop a deep coffee color while the ventral surfaces develop an orange-colored patina. This orange coating is similar to the desert varnish except that it is typically low in manganese oxides.

Relative dating of artifacts utilizing the degree of patination as a major factor has a long history in the archaeology of the Desert West (e.g., Campbell 1936; Campbell et al 1937; Hayden 1967, 1976; Rogers 1939, 1966; Davis 1978). However, there is evidence that desert varnish can develop at dramatically different rates and even over rather short periods of time (Davis 1966:136; Dorn and Oberlander 1981; Perry and Adams 1978). The rate of desert varnish formation may also vary between stones of different composition within the same desert pavement, rendering relative dating on the basis of patination rather problematic (Harry 1992). Recent attempts have been made to date desert varnish by means of AMS radiocarbon assays and by cation-ratios (Dorn 1983). These techniques are promising (Dorn 1983; Dorn and Oberlander 1981; Dorn et al. 1986, 1990), but also problematic (Harry 1992). Some years ago Emma Lou Davis nicely summed up the issue:

> Rates of patina formation seem to vary. A dark coating may be deposited in 25 years, or 2,500, or 25,000; or it may form and be dissolved a number of times. Patina is a clue to relative age, but one which must be used with judgment and caution (Davis 1966:136-137).

Lithic Resources

The varnished desert pavements within the Project area contain a variety of lithic materials that were important to the Native Americans for tool production. These materials derive from the nearby mountains and form an important part of the resource base for the area. The floodplain along the Colorado River, with a few exceptions, is relatively devoid of large rock for stone tool production, particularly those with a conchoidal fracture needed for flaked stone tools.

Chert

The Project area contains relatively abundant chert resources. This chert concentration attracts rockhounds to the area even today. These chert materials are often called cryptocrystalline silicates, chalcedony, agate, or jasper. The term "chert" will be used here as discussed by Leudtke (1992). Cherts within the Project area probably were formed in voids and veins within volcanic rocks and also as concentrates in some of the older metasedimentary rocks. The presence of a fossil snail in one piece of chert noted during fieldwork suggests that at least some of chert derives from these older metasedimentary rocks.

The chert within the Project area range in size from rare large chunks (approximately 50 cm) to small pebbles (approximately 1 cm). Most of the material was from four to eight centimeters in size. The chert is highly variable in color and texture. The most common form is translucent with various shades of brown. The next most common type was generally opaque and yellow to yellow-brown. The remainder of the cherts are variable ranging from white, to red, to black. These were nearly all translucent with good conchoidal fracture. Some were mottled in color, but clear examples of volcanic or hydrothermal cherts with botryoidal or "chalcedony rose" textures were very rare. Nearly absent also were examples with remnants of sedimentary layers. Chert represents the most frequently used lithic material in the Project area and was an important regional resource.

Quartz
Quartz was another important resource within the Project area. Most of the quartz is in the form of milky quartz, which is crystalline quartz with internal fractures and impurities producing a white color. This material was available throughout the Project area. Secondary materials probably derived from quartz veins within the nearby granitic and metamorphic rocks. A quartz dike within the transmission line corridor also appears to have represented a direct source of material. Quartz was used as both a source of flaked stone tool material and as an element in traditional Quechan religion it is thought to contain supernatural power.

In addition to the milky quartz, several natural quartz crystals are present within the Project mine and process area. These were often tinged slightly yellow. Native Americans revered such quartz crystals as a source of power, and several examples noted in the Project area may have been utilized for religious purposes.

Rhyolite and Quartzite
Another important flaked lithic material was rhyolite. This consisted of pink to red but occasionally brown and grey volcanic material. The material was moderately fine-grained and nearly always porphyritic. The source of the material is unclear, but it occurs as occasional cobbles within the float. Further analysis may show that this material is limited to particular terraces within the project.

Quartzite was relatively rare within the Project area but was also an important source of lithic material. Quartzite were usually grey or brown with very distinct "sugary" grains.

Fine-Grained Basalt
Fine-grained black basalt was also present within the Project area in subrounded cobbles. Although relatively rare within the desert pavements, where present, fine-grained basalt appears to have been extensively used. The material appears to derive from some of the flows in the Black Mountain area. In addition to having qualities suitable for making flaked stone tools, this material may also have been considered a source of power (von Werlhof personal communication 1997).

Groundstone Production Resources
The Project area contains large numbers of coarse-grained basalt cobbles. Many of these stones are large enough and suitable for groundstone production. Although some evidence of use was identified, this potential resource remained largely untapped. This may be due to the large groundstone quarries that have been identified along portions of the Colorado River and Gila River to the north and east. These focused quarries seem to have supplied most of the groundstone material needs, making dispersed sources of material such as the Project area less valuable. Lorey Cachora (Personal communication 1997) has mentioned the presence of a potential groundstone quarry on the east side of Indian Pass. This quarry may have supplied some of the groundstone needs for the region, as indicated by what appears to be a fragment of this material within the Project area.

WATER RESOURCES

The Colorado River

The distribution of water is of critical importance for human populations residing in arid environments like the study area (Bean 1972, 1978; Bean and Smith 1978; Benedict 1924; Lee 1979; Lawton and Bean 1968; Taylor 1964). The closest source of perennial water to the Project area is the Colorado River located approximately seven miles east. Indeed, the eastern Colorado Desert area is dominated by the Colorado River, one of the major river systems of North America. Native American populations utilizing the study area had their main settlements along the Colorado River, where permanent water was available. With headwaters in the Rocky Mountains, the Colorado River churns through the majestic recesses of the Grand Canyon before it becomes the border between southeastern California and southwestern Arizona. Here it slows and flows through broad floodplains flanked by rugged, barren mountains. A few miles below Yuma-Winterhaven, the river enters into its delta and forms a fan of braided channels leading to the present head of the Gulf of California some 60 miles south.

Prior to a period of extensive dam building beginning in the 1930s, the Colorado had a flood cycle typically beginning toward the end of April, with a maximum toward the end of June. This flood was highly variable from season to season both in terms of its timing and amount of water it contained. In wet years, the Colorado inundated vast areas in its lower reaches. According to Juan Bautista de Anza, traveling through the area in 1774, flood waters spread over a distance of half a league on from each bank (a league is about three miles). When Francisco Garces traveled down the Gila in August 1771, flood waters covered so vast an area that he was unable to recognize the confluence of the Gila with the Colorado (Forde 1931:107). Heintzelman provides some insight into conditions in the Yuma area prior to the dam building:

> The summer of 1851 there was no overflow here [at Fort Yuma, which was, in normal years, converted into an island by the filling of a wide slough to the west of the bluff] but a partial one below (Heintzelman 1857, cited in Forde 1931:108, brackets in original).

When the river was wild, it carried an immense silt load. An often heard aphorism referred to the Colorado as being "too thick to drink, too thin to plow (Wilson 1965, cited in Swanson and Altschul 1991:17). This mud was deposited in the floodplain and delta to form very rich riparian soils. This supported a dense vegetation along the river of importance to Native American inhabitants of the area. Native horticulture was also undertaken in these floodplain areas.

Historic occupation along the lower Colorado has dramatically altered the river and the adjacent land. A series of artificial lakes are formed behind dams all the way to the Rocky Mountains. The unpredictable floods no longer come. The raging, red river is now a placid, translucent green. The million tons of red-brown silt that gave the river its name are now gradually filling the array of reservoirs rather than enriching the floodplain farms of the Mojave and Quechan. A vast system of canals carries water to some of the most productive, technologically advanced agricultural operations in the world in the Yuma area and the adjacent Imperial Valley. Aqueducts stretch across the Colorado Desert to urban areas on the Pacific Coast. Many of the native cottonwoods and sycamores of the former floodplain have been chopped down to make way for the vast monoculture of agribusiness. The invasive tamarisk tree (*Tamarix* sp.) is spreading through the extant wild places of the floodplain and adjacent drainage.

Lake Cahuilla

Shifting of the Colorado River on its delta also created Lake Cahuilla in the Salton Trough to the west of the Project area. This was perhaps the most important hydrological feature in Holocene prehistory for the Lower Colorado area. Since it was fed by the Colorado River, with its origins high in the Rocky Mountains hundreds of miles away, Lake Cahuilla was largely unaffected by local precipitation rates. The lakebed is a trough that prior to the mid -Pleistocene was open to the Sea of Cortez. At some time prior to 37,000 years ago, a sill was created in the Colorado River delta, and flow was directed north into the Salton Trough. The first stand of Lake Cahuilla was followed by numerous cycles of desiccation and filling. There are thought to have been at least six separate lakestands during the Pleistocene. The early and middle Holocene record remains undocumented, but undoubtedly cycles of filling and desiccation continued through this time (Waters 1980, 1983).

On the basis of 31 radiocarbon dates from archaeological contexts, Wilke (1978) documents three Lake Cahuilla stands for the late Holocene: the first occurs between 100 B.C. and 600 A.D.; the second between 900 and 1250 A.D.; and the third between 1300 and 1500 A.D. Waters later (1983) obtained a series of nine radiocarbon dates derived directly from lakeshore strata containing Anodonta shell (freshwater mussels) and an additional five from archaeological hearths. His Lake Cahuilla chronology consists of four lakestands: the first from ca. 700 A.D. to 940 A.D.; the second between ca. 940 to 1210; the third from ca. 1210 to a partial recession at ca. 1430; and the last from ca. 1430 to 1540. Schaefer (1986, 1994) argued for the existence of another partial lakestand (up to sea level) based on excavations at Dunaway Road in western Imperial County. He suggested a date of 1516 to 1659 for this final filling of Lake Cahuilla based on radiocarbon data. He noted numerous bones of immature striped mullet in this excavation and inferred the presence of the freshwater lake. He also documented the existence of a map from ca. 1762 by John Rocque showing the combined Gila and Colorado Rivers flowing north into an inland sea (Schaefer 1994:73). Additional archaeological support of this final lakestand has recently been reported (Apple et al. 1997; Laylander 1994).

That there were numerous filling episodes is well accepted; however, the number of these lake stands and their dates remain somewhat controversial at this time. Similarly, it is accepted that Lake Cahuilla had an important influence on Native people during the Late Prehistoric; however, the ramifications of the various filling and desiccation episodes for populations in various parts of the Colorado Desert and beyond remain far from resolved. This remains an important topic for further research (Schaefer 1994:73).

Washes

The Project area itself does not contain any permanent sources of surface water. It is located in the Salton Sea Drainage Basin, a closed hydrologic basin in which all surface flows drain toward the Salton Sea. Intermittent surface washes that cross the Project area are blocked from reaching the Salton Sea by the Algondones Sand Dunes and either evaporate or infiltrate into wash bottoms.

Surface drainages within the Project area consist of a series of subparallel ephemeral washes that are fed by rain from infrequent winter storms and summer thunderstorms. Four primary washes flow into the Project mine and process area. Two of these washes conjoin within the Project area so that only three major washes exist within the Project mine and process area. Indian Pass Wash is one of these drainages which flows through the eastern portion of the Project area. Rains are rare occurrences in this area, but the three main washes attest to short periods of abundant flow. The presence of palo verde, ironwood, and smoke trees suggest that the water table may be rather high in some of these wash areas, but this appears to be ephemeral moisture. Groundwater studies within the Project area indicate consistent water levels are greater than 500 feet below the surface (EMA 1997).

Native American wells are documented for various places of the Colorado Desert. For example, a well is documented for the closely related Kamia of San Jacome, some 35 miles west-southwest of Pilot Knob (Forbes 1965:153, after the Garces journal of 1774). There are also ethnographically known wells at Xachupi or Indian Wells on the west bank of the New River about six miles north of the international border (Barker 1976:25). In the Southern California deserts, the best-known wells are the deep, walk-in wells of the Cahuilla of the northern Salton Trough (Bean 1972:30). There is no known evidence of wells in the Project area and, given the groundwater levels, they seem unlikely except to prolong collection of seasonal water.

Springs and Tanks

Beyond the seasonal washes, alternative sources of water are very limited. Within Project area itself, there are no known springs, seeps, or tanks but a few are scattered in the region. While tanks (rock depressions that hold water) are common in western Arizona they are relatively rare in the study area. One tank has been identified in Bear Wash near the Colorado River and others minor tanks may be present but none are large enough to have been mapped. Springs are also very rare and only a few are present in the Cargo Muchacho Mountains and areas along the Colorado River to the east. Seeps are reported near the Algodones Dunes approximately 12 miles west (EMA 1997), but the Project area and immediate vicinity are devoid of all but seasonal water, suggesting limits on the potential for long-term habitation within the area.

CLIMATE

Present Climate

Yuma is the nearest town to the Project area for which climatological data are available. It is the warmest town in Arizona, the sunniest in the nation, and one of the driest (Woznicki 1995:4). The mean low winter temperature is 44°F (6.7°C) and the mean summer high temperature is 104°F (40°C) Highs of 115°F are not uncommon, with a record high of 120°F (48.9°C). Temperatures in the Project area experienced during fieldwork of July and August 1997 were several degrees warmer than those recorded for Yuma: 120°F was not uncommon. Rainfall is infrequent, but not necessarily light when it occurs. An appreciable amount of the annual rainfall occurs in the summer in the form of torrential thunderstorms. These storms originate in northern Mexico as monsoons and drift north into the American Southwest and southern Great Basin. These storms often result in considerable runoff, flash floods, and erosion (Walker and Bufkin 1979:7). Rainfall averages about 1.3 inches (3.3 cm) in the winter and .8 inches (2.1 cm) in the summer (Schaefer 1986:15; Walker and Bufkin 1979:7). It is important to note that the rainfall is highly variable from year to year. For example, the total for 1904 was 1.43 inches, while in 1905 it was 11.41 inches (Forde 1931:90). The town of Goldrock, the closest location where data have been recorded, receives an annual average of 3.6 inches, more than twice that of Yuma, but still severely limited.

Climatic History

During the late Pleistocene Epoch, the Greater Southwest was dotted with mountain glaciers whose runoff created large lakes in the internally drained basins below. At these more moderate elevations, camel, sloth, horse, and mammoth grazed in grass-covered steppe. Pinon, juniper, and other conifers were found hundreds of meters downslope from their present locations (Spaulding 1990; Mehringer 1986; Van Devender 1990). At about 12,000 years ago, the glaciers, lakes, and streams began to dry up; the treeline began climbing upslope; and dramatic changes in flora and fauna took place. This general trend was not an even, gradual process; it was a time of dramatic climatic fluctuations.

The seminal model for the past climate in the American West was presented in a series of papers published by Ernst Antevs beginning in 1948. Antevs developed this model based on a variety of geological, glacial, and climatological data. Briefly, he visualized a three-part sequence of temperature and moisture changes beginning with the terminal Pleistocene. This first phase was termed the Anathermal (9,000-7,000 B.P.), characterized by cooler, more moist conditions than present. The subsequent Altithermal (7,000-4,000 B.P.), produced a hotter, drier regimen. With the final, Medithermal Phase (4,000 to the present), essentially modern conditions developed. For almost 50 years, the Antevs tripartite sequence has been the standard starting place for virtually all discussion of past climate for the West (Grayson 1993). The Antevs contribution has been more in generating research and reflection than in the accuracy of his model (Raven 1984:461). His scenario has been constantly refined and modified with the flow of further research facilitated by more sophisticated dating and other research techniques (Grayson 1993; Raven 1984).

While there has been no paleoecological research in the study area itself, a great deal can be inferred about the climate and vegetation from research conducted in nearby locations in California, the southern Great Basin, and Arizona. Some of the most informative of this research has been work on packrat middens (McGuire 1982). Packrats (*Neotoma* spp.) gather sticks, seeds and various other materials and build large aboveground nests, which they cement together with urine (McGuire 1982). It is thought that packrat midden material constitutes a representative sample of vegetation from about a 100-meter radius. When constructed in protected areas such as in rock crevices or under ledges, these packrat nests can survive for as long as 40,000 years. They constitute a valuable resource for reconstructing past plant life for the immediate vicinity (McGuire 1982; Van Devender 1977; Van Devender and Spaulding 1979; Wells 1976).

Packrat midden data from the Picacho Peak area, only about seven miles east of the Project area, suggests a terminal Pleistocene vegetation rather similar to today's Mojave Desert to the north. There is macrofossil evidence for Joshua tree, Whipple yucca, Mojave sage, and Black Brush. In fact, these data document the lowest elevation occurrences of Joshua tree (275 meters/902 feet), Whipple Yucca (285 meters/935 feet), and black brush (285 meters/935 feet) ever recorded to date

(Cole 1986). Notably, there was no evidence for a woodland community, which one might expect from an understanding of higher altitude and higher latitude vegetation from this period. Similarly, there is little evidence for the Lower Sonoran plant community found in the area today. Creosote bush is documented in the Picacho Mountains by 12,500 B.P. on their journey north (Van Devender 1990). By about 10,500 years ago, the dominant plants in the area were creosote bush, brittle bush, and pygmy cedar. These are still widespread along the lower Colorado River and the Salton Trough. However, plants typical of the Pleistocene for this area, Mojave sage and peachthorn wolfberry, are also found at this time. This suggests that at ca. 10,500, the area was in transition between the Pleistocene and modern plant regimes (Van Devender 1990). Creosote bush reached its current northern limit by about 5400 B.P. (Spaulding 1980). Individual plants respond to environmental change at their own pace and, because of that, community associations are constantly in flux, both in terms of membership and location. Essentially modern plant associations may have been in place in the Lower Colorado-Salton Trough area by about 9,000 B.P. (Van Devender 1990) or 8,000 B.P. (Thompson 1986:11).

Packrat midden data for the area allow some inferences to be made about the local climate of the terminal Pleistocene, the early and mid-Holocene. For example, the presence of Whipple yucca suggests that winters at this time were not particularly cold, since this plant has limited tolerance for freezing temperatures. The presence of Joshua trees, however, suggests at least 50 percent more precipitation than is now available in the area, (Van Devender 1990). While it is generally agreed that more mesic conditions of the Pleistocene gradually gave way to more xeric conditions during the early Holocene, the seasonal patterns of precipitation from pluvial to modern conditions remain poorly understood. Martin (1963) suggests that in the middle Holocene, there was increased summer precipitation. Similarly, Spaulding and Graumlich (1986) suggest more mesic transitional conditions resulted partly from intensified summer monsoons. Hot summer conditions are required for monsoon patterns to develop, which may be more applicable to portions of the middle Holocene, than to the early-middle Holocene transition. Van Devender (1990) argued against increased summer precipitation scenarios. Spaulding later suggested (1995) that the early Holocene may have been characterized by more tropical winter storms under conditions similar to modern El Ninos.

To summarize for the study area, one can suggest that during San Dieguito-Lake Mojave times, some Lower Sonoran vegetation had established itself, while some plants typical of more northern climes were still present (viz., Joshua tree). This suggests that there was more than 50 percent more rain, with more moderate summer temperatures. One can infer that now dry washes were a more dependable water sources for inhabitants of the area during this time, at least seasonally. Modern desert species were in place by 8,000 or 9,000 years ago, but one can envision many more grasses and annuals because of the generally more mesic conditions.

Recent research generally supports the Antevs model of increased aridity during the middle Holocene (his Altithermal), but has documented dramatic fluctuations in rainfall and temperature, rather than characterizing the period as unrelentingly hot and dry (Grayson 1993; Mehringer 1986; Spaulding 1991).

The climatic regimen for the middle Holocene in the California deserts appears rather complex. There is some evidence of a hot dry climate for this period from the Mojave Desert (Spaulding 1990). However, hotter conditions for the lower Colorado Desert may have resulted in increased monsoon conditions and this may have resulted in overall increased precipitation for the Lower Colorado area (Van Devender 1987, 1990). In the eastern portion of the study area at Picacho Peak, it appears that Mojave Desert vegetation (now found much further north) dominated until at least 4,800 B. P. with Lower Sonoran Desert plants such as ocotillo, ironwood, and white bursage arriving after that time (Apple et al. 1997:2-12). The middle Holocene between ca. 8,000 and 4,000 years ago, in the Great Basin (including the Mojave), is thought to have resulted in population declines and out-migrations (Bedwell 1973; Wallace 1962; Warren and Pavesic 1963:420-421). Climatic conditions and their influences on human groups in the Lower Colorado area are poorly understood at this time.

The late Holocene climate record reveals even more complexity than previous periods. There are three major climatic phenomena of considerable import to prehistoric populations of the Lower Colorado Desert: The Neoglacial (3,500 to 2,000 B.P.); the Medieval Climatic Anomaly (1150 to 600 B.P.); and the Little Ice Age (500 to 150 B.P.). These are also best viewed against a background of dramatic annual climatic variations, a situation that continues to this day in the arid American West.

The Neoglacial is a period of lower temperature and greater effective moisture thought to date from ca. 3,500 to 2,000 years ago. This event is documented and dated from various parts of the Mojave Desert; for example, on the basis of packrat data from the Little Granite Mountains, between Barstow and Death Valley (Spaulding 1995); from sediment cores from Soda and Silver Lakes east of Barstow (Wells et al. 1989; Enzel et al. 1992); from a lake stand deposit in Chronese Basin also east of Barstow (Drover 1979:154); and a peat formation at Ash Meadows (Mehringer and Warren 1976). It is likely that the Neoglacial influenced the climate of the Lower Colorado Desert, though it is not documented for our area. A reasonable working hypothesis is that this was a period of greater effective moisture in the Lower Colorado area (through reduced temperatures and, perhaps, increased winter precipitation) resulting in greater availability of surface water in areas away from the river and greater amounts of available plant foods for prehistoric populations.

The Medieval Climatic Anomaly is thought to date from about 1,150 to 600 B.P. It is also known as the Secondary Climatic Optimum, the Medieval Warm Period, and the Little Optimum. It is characterized by a highly variable climate punctuated by two extreme extended droughts (Stine 1994; York and Spaulding 1995, 1996). Data from the Sierra Nevada and the White Mountains of east-central California, suggest the existence of two epic droughts within this period: the first between A.D. 890 and 1100 and the second between A.D. 1210 and 1350 (Stine 1994). In the Mojave, a period of hot, dry conditions with an expansion of xeric plants is documented between ca. 800 and 1300 A.D.(Cole and Webb 1985). While water resources diminished elsewhere, Lake Cahuilla was full during this time. Lake Cahuilla is thought to have been an important refugium for populations displaced from other desert areas by more arid conditions (Schaefer 1994; Waters 1983; Wilke 1978; York and Spaulding 1995, 1996). However, population fluctuations associated with various iterations of Lake Cahuilla are only poorly understood at this time.

At about 600 years ago, the Medieval Climatic Anomaly was dramatically replaced by the Little Ice Age. As the name suggests, the Little Ice Age is characterized by cooler, moister conditions. Tree-ring data from the White Mountains suggest cooler conditions, as do the growth of glaciers in the Sierra Nevada. Packrat data from the Mojave Desert suggest both cooler and moister conditions

(Cole and Webb 1985; Hunter and McAuliffe 1994). Data for the Lower Colorado area are thus far lacking, but one might surmise cooler, but not necessarily moister conditions.

FLORAL AND FAUNAL RESOURCES

Flora

There are two basic habitats that are relevant to investigations of the study area because the people who used this area were mobile. One is the desert habitat of the Project area itself and the other is the habitat along the lower Colorado River. The native vegetation along the river is riparian and dependant on the seasonal flood cycles of the river. This vegetation was dominated by huge cottonwood (*Populus fremontii*) and sycamore (*Platanus racemosa*) trees. With their feet right in the water were willows (*Salix* sp.), arrowweed (*Pluchea sericea*), rushes (*Juncus* sp.), cattails (*Typha* sp.), and tules (*Scirpa* sp.). Out to a distance of a few hundred meters from the river, the vegetation was very dense. Another species of plant that was an important component of the drier parts of the floodplain was mesquite (*Prosopis glandulosa*). The two varieties of mesquite (screwbean and honey) were critical food components for the inhabitants along the river.

The Project area is made up of both desert riparian vegetation, also known as macrophyll woodland, and creosote scrub vegetation, also know as desert succulent scrub (Figure 2-2). The desert wash environments contain ironwood *(Olneya tesota*), palo verde (*Cercidium floridum*), cat's-claw (*Acacia greggii*), purple heather (*Krameria erecta*), desert lavender (*Hyptis emoryi*) and Anderson thornbush (*Lycium andersonii*). As indicated on Figure 2-2, this vegetation parallels the distribution of washes within the project. As the habitat with the most useful plant resources for food, it might be expected that human use of the area might focus on these washes, which also could serve as transportation corridors.

The arid hills and terraces of the Project area are dominated by creosote bush (*Larrea tridentata*), burrobush (*Ambrosia dumosa*), ocotillo (*Foaquieria splendens*), and brittlebush (*Encelia farinosa*). Cactus are sparsely distributed within the Project area and include Bigelow cholla (*Opuntia bigelovii*), cottontop cactus (*Echinocactus polycephalus*), beavertail cactus (*Opuntia basalaris*) diamond cactus (*Opuntia ramosissima*), and California barrel cactus (*Ferocactus cylindiceus*). The creosote bush scrub within the Project area is the dominant plant community of the Mojave and Colorado deserts.

Fauna

Similar to the vegetation, the fauna can be discussed in terms of species along the river and those within the Project area. Along the river, one finds large, varied populations of resident and migrating birds. Some of these contributed in a minor way to the diet of the Lower Colorado River tribes, notably geese (*Branta canadensis* and *Chen hyperborea*), duck (*Anas* sp.), dove (*Zenaida* sp. and *Columbina* sp.), and quail (*Callipepia* sp.) (Stokes 1996; de Williams 1983:104).

Important fish species include humpback sucker (*Xyrauchen texanus*) and Colorado squawfish (*Ptychocheilus lucius*). Fish were a primary protein source among the Lower Colorado River tribes (Kroeber 1925:737; Stewart 1983; Williams 1983) and were probably among the more important

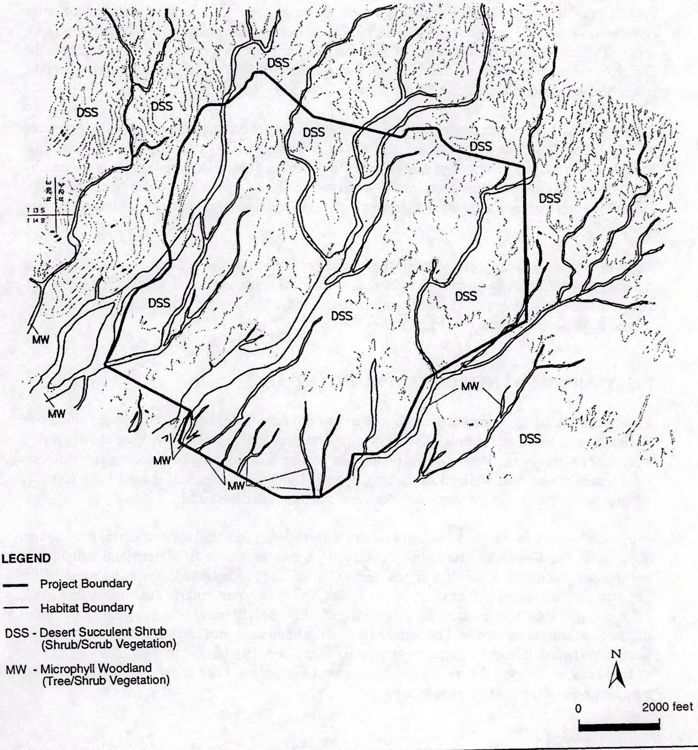


Figure 2-2. Vegetation and Habitat

resources available at Lake Cahuilla. Notable mammals include mule deer (*Odocoileus hemionus*), kit fox (*Vulpes macrotis*), gray fox (*Urocyon cineroargenteus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), ringtail cat (*Basariscus astutus*), badger (*Taxidea taxus*), skunk (*Mephitis* sp.) and beaver (*Castor canadensis*).

In the vicinity of the Project area away from the river, larger mammals included Sonoran pronghorn (*Antilocapra americana sonorensis*), mule deer (*Odocoileus hemionus*), mountain sheep (*Ovis canadensis*), mountain lion (*Felis concolor*) and jackrabbits (*Lepus californicus*). Throughout the Project area there are locally abundant rodent holes suggesting a large population of mice (*Peromyscus* sp. and *Perognathus* sp.), pack rats (*Neotoma* sp.), and kangaroo rats (*Dipodomys* sp.), many of which are nocturnal. Hunting of both small and large game was of minor importance to the Quechan and other river tribes (Bee 1983:86; Forde 1931:107; Stewart 1983:59), though deer, rats, mice, beaver, raccoon were occasionally taken.

Large mammals have been particularly affected by the changes brought about by Anglo-American society. The feral burro is now ubiquitous, while pronghorn is extinct; mountain sheep and mountain lion are rare. Burro sign was observed in the Project area, but no specimens were seen by field teams. Mule deer were occasionally observed in wash areas during fieldwork. Similarly, jackrabbits were occasionally encountered in both wash and arid terrace areas. A kit fox was also observed.

Reptiles were also an important part of the landscape. Desert tortoise (*Gopherus agassizii*) was noted during the inventory along with numerous species of lizards and one rattlesnake (*Crotilus* sp.). Desert tortoise was an important food source in parts of the Mojave and Colorado Deserts and also played an important role in oral tradition.

DISCUSSION AND ENVIRONMENTAL POTENTIAL

The discussion of environmental conditions above provides an important footing for studies of Native American use of the area. The Prehistoric Quechan and their ancestors were closely linked with their environment. Perhaps these people can best be seen as living in and using two different environments: one well-watered along the Colorado River floodplain and around Lake Cahuilla when it was present, and another water-deficient covering the desert itself.

While both areas faced the same hot and dry climate well into the earliest periods of human occupation, the Colorado River area provided a permanent source of water, land suitable for horticulture, abundant wild plant foods, and wildlife. This area lacked, however, some of the important lithic resources for making stone tools. The desert, particularly the Project area itself, offered important lithic resources for making flaked lithic tools in addition to supplemental sources of plant and animal resources. The combination of the lithic resources and a transportation corridor have helped make this area significant for its resources alone. In addition, the religious significance of the area goes beyond the resources of the natural environment and constitutes a portion of the complex web of the cultural environment.

CHAPTER 3
CULTURAL CONTEXT

INTRODUCTION

Native American history can be documented both as oral tradition and as an interpreted archaeological record. This chapter examines both ways to view the past: (1) using current interpretations of the archaeological record from the region to provide a chronological outline of the past and (2) providing an overview of the study area based on both archaeological and ethnographic information. Native American consultation was conducted to sum up the oral history and tradition of the region. This provided an important view into Quechan history and the cultural and religious significance of the Project and cultural features within it. This section provides a context for both a more complete understanding of the inventory results and an evaluation of significance.

CHRONOLOGY

Malpais Pattern (Early Man)

The term Malpais was first coined by Malcolm Rogers to refer to very early materials; he later dropped the term and reclassified these materials as San Dieguito I (Rogers 1939). The term was later resurrected by Julian Hayden to refer to assemblages of heavily varnished choppers, scrapers, and other core-based tools typically found on old desert pavement areas. Malpais materials are posited to predate the San Dieguito materials and some scholars argue for a date as old as 50,000 B.P. (e.g., Begole 1973, 1981; Childers 1974, 1977, 1980; Davis 1978; Davis, Brown and Nichols 1980; Hayden 1976; von Werlhof et al. 1977). Unfortunately, obtaining dates for these materials has proven very elusive and many scholars are quite skeptical of posited early occupations (e.g. Schaefer 1994).

A number of finds tentatively suggest some human occupation in the later portion of this posited period and prior to the following Lake Mojave-San Dieguito Period. Of note is the work conducted by Emma Lou Davis and her associates at China Lake in the central Mojave Desert. They surveyed and mapped the lakeshore, ultimately recording some 5,350 artifacts, almost 16,000 flakes and 900 fossil bones. She found artifacts associated with Pleistocene fauna, but only in a surface context. She obtained radiocarbon dates going back to 30,500 years (Davis and Panlaqui 1978), but none of these dates were directly and unequivocally linked to cultural materials (Moratto 1984). Other researchers have found materials that date back to 15,000 to 30,000 years ago on the coast and the Northern Channel Islands (e.g., Berger et al. 1971; Berger 1982; Greenwood 1972; Orr 1968; Snethkamp and Guthrie 1988), however, these too are not without problems. Some contain unequivocally cultural material, but have less than solid associations with dated material, while others are well dated, but their cultural origin is problematic. In sum, the existence of people in the Greater Southwest prior to the Paleoindian period still remains rather controversial at this time (Schaefer 1994).

Paleoindian Period

Fluted Point Tradition

The earliest part of the Paleoindian Period in the region is termed the Fluted Point Tradition. Fluted points have been well documented (Willig et al. 1988) and dated for the Rocky Mountain and Great Plains areas (Haury 1975; Hester 1972; Jennings 1978; McGuire and Schiffer 1982). Indeed, since the discovery of fluted points near Folsom, New Mexico in 1926 (Figgins 1927), fluted points have been found in every state and province of North America (Moratto 1984:79). In the Great Plains and Rocky Mountain regions, they are often associated with big game kill sites and have been interpreted to reflect a Big Game Hunting Tradition. However, in the Great Basin and California, their dating and economic significance is more problematic (Willig et al. 1989). Fluted points here are typically found along the shorelines of Pleistocene lakes, along fossil streams, and in passes connecting these kinds of places (Davis 1978; Fredrickson 1973; Riddell and Olsen 1969. Some researchers suggest that this reflects a lacustrine or riparian adaptation ancestral to, or a component of, the Western Pluvial Lakes Tradition that developed after ca. 12,000 B.P. The fluted-point assemblages in the Far West sometimes include artifact types found in the assemblages of the following period: flaked stone crescents, gravers, perforators, scrapers, and choppers (Moratto 1984:93).

San Dieguito-Lake Mojave Complexes

Our understanding of the later Paleoindian culture history in the region is largely based on the work of Malcolm Rogers at the San Diego Museum of Man. He conducted a number of surveys in the Colorado and Mojave Deserts of California in the 1930s and defined what he called the San Dieguito Complex or Tradition. Similar materials occurring in the Mojave Desert-southern Great Basin have been termed the Lake Mojave Complex (Bedwell 1973; Campbell et al. 1937; Warren 1967; Warren and Crabtree 1986:184). Sites dating to this period in the study area proper are not well documented, but many surface sites both east and west of the study area with similar technological aspects have been assigned to the San Dieguito complex (Pendleton 1984).

The San Dieguito-Lake Mojave Tradition is thought to have existed 12,000 to 7,000 years ago in this area during a time of greater effective moisture than the present (Warren and Crabtree 1986). Archeological materials from this period have been found around dry inland lakes, on old desert terrace deposits, at Ventana Cave in the vicinity of Tucson, and also near the California coast, where it was first documented at the Harris Site (Rogers et al. 1966; Warren 1966).

The assemblage consists of heavy percussion-flaked, core and flake-based tools: crescentics, domed and keeled choppers, planes, and scrapers. One also finds light-percussion flaked spokeshaves, flaked-stone crescentics, leaf-shaped projectile points, and the distinctive Lake Mojave and Silver Lake projectile points. Fluted points are also occasionally found on Lake Mojave-San Dieguito surface sites. Whether they represent a distinct cultural tradition (Davis 1969, 1978; Warren and Ranere 1968), a distinct function, or economic adaptation (Bedwell 1973; Hester 1973), or are best considered an integral part of the Lake Mojave-San Dieguito complex, remains problematic at this point. Milling equipment is apparently rare or absent (Warren and Crabtree 1986:184). Subsistence is generally thought to have been focused on highly ranked resources such as large mammals. This subsistence strategy during a time of more available water may have fostered a pattern of relatively high residential mobility.

Most materials from the Lake Mojave-San Dieguito complex in the California deserts are found along extinct Pleistocene-Early Holocene lakes or streams. This has spurred some scholars to suggest that it is a specialized, lacustrine-focused adaptation: a Western Pluvial Lakes Tradition (Bedwell 1973; Hester 1973). Others see it as generalized hunting-based adaptation in which lacustrine or riparian resources form only a portion of the seasonal round (Davis 1969, 1978; Warren 1967). Archaeological sites in and near our study area posited to belong to the Lake Mojave-San Dieguito Period consist primarily of trail complexes and cleared areas with few temporally diagnostic artifacts. The temporal placement of these materials in the desert is based primarily on degree of weathering and patination (Hayden 1976; McGuire 1982; Rogers 1939): a rather tenuous proposition. Other evidence occurs in the form of bifaces found below the high shoreline of Lake Cahuilla. Unfortunately these artifacts lack context and datable material (Apple et al 1997). Suffice it to say that for our area, the Lake Mojave-San Dieguito Period is poorly understood, and more research is required before much can be said with certainty about settlement, economic, and other basic cultural systems for this period.

Archaic Period

Pinto Complex

The Archaic period can be divided into two temporal complexes: the Pinto complex (7,000 to 4,000 B.P.) and the Amargosa complex (4,000 to 1,500 B.P.). During Pinto times, there is an apparent shift to a more generalized economy with increased emphasis on the exploitation of plant resources. The groundstone artifacts associated with this complex are typically thin slabs with smooth, highly polished surfaces, not the basin metates and manos typical of later times. Rogers, in fact, argued that these were not millingstones, but rather they were used to process fibrous leaves or skins (Rogers 1939:52-53). Projectile points consist of the distinctive Pinto series atlatl points made with crude, percussion technique. The assemblage also contains scrapers, knives, scraper-planes, and choppers. The mixed core-based tool assemblage of the Pinto complex may indicate a range of adaptations to a more diversified set of plant and animal resources brought about by a generalized desiccating trend in the West, punctuated by occasional more mesic times.

Amargosa Complex

The Amargosa complex, which is seen to have followed the Pinto complex in time, is characterized by the presence of fine, pressure-flaked Elko and Humboldt Series and Gypsum-type projectile points, leaf-shaped points, rectangular-based knives, flake scrapers, T-shaped drills, and occasional large scraper-planes, choppers, and hammerstones. Manos and basin metates became relatively common and the mortar and pestle were introduced late in this period (Warren 1984:416). The florescence of tool types and the addition of hard seed processing equipment suggests a more generalized and effective adaptation to desert conditions in the Greater Southwest. From the Grand Canyon area, southern Nevada, and the California deserts one finds pictographs of mountain sheep and rabbits and split-twig figurines suggesting a wide-spread hunting ritual complex from these times.

Cochise Complex

In nearby southern Arizona, the Archaic Period assemblages are called the Cochise complex, dating from as early as 9,000 B. C. to about A.D. 1 (Haury 1983:159; Sayles 1983:82, 114). In this very long period, three Cochise culture stages have been defined on the basis of technological changes and geological and radiocarbon dates: Sulphur Spring, Chiricahua, and San Pedro (Antevs 1983; Sayles 1983; Wasley and Sayles 1983). The Sulphur Spring stage is characterized by flat slab metates and small flat manos, pebble hammerstones and percussion-flaked, plano-convex knives, scrapers, and choppers. Projectile points are conspicuously absent. Chiricahua stage artifacts include shallow basin metates, small manos, both plano-convex and bifacial percussion-flaked tools and hammerstones, with relatively rare pressure-flaked projectile points. San Pedro stage materials are characterized by large, deep oval basin metates and larger manos. Mortars and pestles also appear. Flaked stone implements became much more frequent and pressure flaking became more important. Projectile points with rounded or flat bases and broad lateral notches are present. Storage and cooking pits are in evidence and pit houses appear (Thompson 1983).

At White Tanks, ca. 12 miles southeast of Blythe, both San Pedro series projectile points and points more typical of the Amargosa to the west (e.g., Elko series projectile points) have been found together (Schaefer 1992) leading some to suggest a cultural boundary. Archaic sites with dart points are rare in the Colorado River zone itself.

Patayan Period

The Patayan cultural pattern dates from approximately 1500 B.P (500 A.D.) to the Historic Period. It is characterized by marked changes economic and settlement systems. Paddle and anvil pottery was introduced, probably from Mexico by way of the Hohokam culture of the middle Gila River area (Schroeder 1975, 1979; Rogers 1945). A subsistence shift from hunting and gathering of desert and river resources to floodplain horticulture took place at this time. During this same period, the bow and arrow were also introduced at approximately A.D. 800. Burial practices also shifted from inhumations to cremations. Other culture traits generally associated with this period include increasingly elaborate kinship systems, rock art, including ground figures, and expanded trading networks (McGuire 1982).

Two different hypotheses have attempted to explain these new traits. Rogers (1945) proposed that these traits originated from Mexico, giving rise to both the Hohokam and Patayan traditions. An alternative view is that the Patayan is a regional variant of a distinct Hakatayan tradition, separate from the Hohokam (Schroeder 1979).

Preceramic and Chronology

A preceramic phase has been suggested in association with the introduction of Cottonwood Triangular Series projectile points (Rector et al. 1979; Rogers 1945:175; Warren 1984:401). However, this transitional phase has been rather difficult to identify in the Colorado Desert given the paucity of stratified sites and controlled excavation (Moriarty 1966; Schaefer 1992; Warren 1984). This non-ceramic Patayan phase has been demonstrated for the southern Great Basin-Mojave Desert at the Oro Grande site near Victorville (Rector et al. 1979) and, less convincingly, at Southcott Cave and Rustler Rockshelter (Donnan 1964). However, the applicability of these findings to the Lower Colorado area, and the existence of a pre-ceramic Paytayan in the area may be best viewed as a working hypothesis.

The first well-documented occupance of pottery on the lower Colorado River was at Willow Beach, on the Colorado River some 25 km below Hoover Dam. Intrusive Virgin Branch Basketmaker III, Verde Gray pottery and Cerbat Brownware Patayan pottery were noted here dated before A.D. 750 in association with arrow points similar to Rose Spring and Eastgate types. A local Lower Colorado ware, Pyramid Gray, shows up in deposits dated to A.D. 900 (Schroeder 1961). Cottonwood Triangular Series, Desert Side-Notched Series projectile points, and the characteristic buff and brown ware pottery evidently also appear at about A.D. 900 in the Colorado Desert. The Cottonwood Series apparently predates the Desert Side-Notched Series and probably the advent of pottery, and Tizon Brown Ware may predate Lower Colorado Buff Ware (Warren 1984:423).

Settlement

The settlement system of the early Patayan is characterized by small mobile groups living in dispersed seasonal settlements along the Colorado River floodplain. Numerous trail systems throughout the Colorado Desert suggest the growing importance of long and short distance travel for trading expeditions, religious activities, visiting, and warfare. Pot-drops and trail shrines attributed to the Patayan pattern can be found at sites along these routes, a number of which are located in our study area, most notably Rogers' site SDM-C-1, the Indian Pass Site.

The final desiccation cycles of Lake Cahuilla at perhaps 1650 A.D. (Schaefer 1994:84) is thought to have caused major population disruptions on both east and west sides of the Colorado Desert, large population shifts along the Lower Colorado River, and perhaps contributed to the persistent warfare that continued until 1857 along the Lower Colorado and Gila Rivers (Aschmann 1966:245; Castetter and Bell 1951:30; O'Connell 1971:180; Schaefer 1994:72-73; Stone 1981; Weide 1976:89; White 1974; Wilke 1974). However, the role of the desiccation cycles in these population perturbations is far from clear, and it remains an important topic for further research. By the time of the final desiccation, horticulture was well established along the Lower Colorado, and it is difficult to argue that population ever put pressure on potential farm land (Bee 1981:12; Castetter and Bell 1951 74-75).

Traditional Economy

Although the economy of the Lower Colorado tribes is often characterized as agricultural (e.g., Baksh 1994:18; Forde 1931:107), the agricultural technology was actually limited to digging stick and floodplain horticulture (Baksh 1994:18; Forde 1931 112; Kroeber 1925:736). Gathering wild plant resources actually contributed more to the native diet (Castetter and Bell 1951:238). While the economies of the various Lower Colorado tribes were very similar, their dependence upon horticulture (versus gathering wild plant resources) varied. The Cocopa are thought to have obtained only 30 percent of their aboriginal diet from horticulture, while the Mojave may have derived 50 percent of their foods from horticulture. The Quechan are thought to be between the two (Bee 1983:86; Castetter and Bell 1951:238). Domesticated plants included maize (mostly a white variety for making flour), tepari beans, squash, pumpkin, and gourds. Some grasses were also planted (Forde 1931:113-114). The Quechan diet also included honey mesquite and to a lesser degree, screwbean mesquite, palo verde, grasses and other wild plant foods. Overall, most researchers agree that wild foods were more important than crops and that mesquite was considered the most important food, more important than maize (Bee 1983:86; Castetter and Bell 1951:179-183; McGuire 1982:90).

However, this contrasts with the views that Father Font presented in the journal of his second expedition to California in 1775-1776, and the respective roles of wild plants versus crops is still a matter for some discussion and research.

> The crops raised by the Indians are wheat, maize, which they call Apache maize and which matures in a very short time, orimuni beans, tepari beans, cantaloupes, watermelons, and very large calabashes of which they make dried strips, which in Sinaloa they call bichicore, and seeds of grasses. With these things they have plenty to eat. They likewise gather a great quantity of tornillo and pechita [screw and mesquite beans], although this is more for variety than for necessity . . . (Font 1775-76 cited in Forde 1931:94-95)

Wheat, watermelon, garbanzo beans were important post-contact crops (Bee 1983:87).

Researchers agree that hunting formed only a minor part of the subsistence strategy. However, the reason for this is apparently a matter yet to be resolved. For instance, McGuire suggests, "Hunting was of relatively little importance because of a general scarcity of game along the lower Colorado" (1982:90). Bee takes a similar position, "The forbidding desert terrain immediately beyond the rivers' floodplains yielded little game for a relatively high labor output, so the productivity of growing or gathering plant foods was much greater" (1983:86). However, Forde (1931:91) states, "The game of this territory, although probably fairly abundant under aboriginal conditions, was limited in species and relatively unimportant in the native economy. Deer and antelope were sometimes to be found in the mesquite groves near the mesa and less frequently among the cottonwood close to the river." This passage of Forde appears credible, although he contradicts himself elsewhere:

> Since their country was largely arid, game, both large and small, was exceedingly scarce. A few deer might stray thorough the cottonwood groves along the river, rabbits burrowed in the sandy banks, but beyond these and the water birds of the Colorado, there was little to reward the hunter (1931:107).

While conducting archaeological research for this current project, deer were encountered by crews on a half dozen occasions. Deer were utilizing desert wash environments which are dominated by ironwood and palo verde in the Project area. Deer scat was frequently noted in these wash areas. Antelope are extinct in the Lower Colorado area, but the success of the ubiquitous burro may be taken as some index of the carrying capacity of this environment for tough, nimble grazing animals. All researchers apparently agree that large game was a minor component of the diet. However, our field observations suggest that levels of deer and antelope populations and their import to the Quechan diet should be considered a matter for further discussion.

Among the Quechan, few communal hunts were made. They hunted (and fought) with simple, unbacked bows and often used untipped arrows. The notion that Quechan arrows often lacked lithic projectile points and that hunting comprised a minor activity suggests that archaeologists should not expect to find many Late Prehistoric projectile points in our study area. The mountains around our study area are explicitly mentioned by Forde in his discussion of hunting.

> It was undertaken in winter; men went out alone or in small parties of three or four. Deer (akwa'k), antelope (mo'u'l), and more rarely mountain sheep (amo") were killed. The mountains to the north of Yuma, Castle Dome, Dome Rock, and Tugo were most frequently visited. Deer could also be taken in the valley (1931:118).

Small game was slightly more important than big game and occasionally rabbit drives were held utilizing nets. The curved throwing stick was utilized by the neighboring Mojave and desert Kumeyaay for taking small game, but was apparently absent among the Quechan (Forde 1931:118). Fish, caught in a variety of nets, traps, weirs, and basketry scoops, was the primary source of faunal food (Castetter and Bell 1951; Forde 1931; Stewart 1983). Aquatic birds were also taken using blunt arrows while birds were sitting. Primary avian resources were ducks and egrets (Forde 1931; McGuire 1982:90)

The degree to which the Quechan utilized desert resources away from the river is yet to be resolved. Most ethnographic accounts downplay the use of desert resources (Bee 1983; Forde 1931; McGuire 1982; Stewart 1983). Indeed, Forde (1931:102) cites Heintzelman, the U.S. Army captain who established Fort Yuma in 1853, as saying that the Quechan "never left the river." However, in the study area, there is an extensive system of trails linking desert areas with the river, Lake Cahuilla, and the Pacific Coast. Also in the study area, there are expansive desert pavement areas that are virtually covered with flaked lithic debris and numerous "sleeping circles" that may be the remains of temporary camps. These seem to testify to the import of these arid areas most likely beginning in the San Dieguito and peaking during the Late Prehistoric. These archaeological phenomena argue for a re-evaluation of the ethnographic record in this regard. It may be that, by the time diarists and early ethnographers arrived on the scene, traditional economic and settlement systems were already significantly disrupted and use of the desert had precipitously declined.

Political Organization

The Quechan lived in loose clusters of families, often termed rancherias. They recognized themselves as a single tribe, however. The Quechan recognized a series of patrilineal clan groups the importance and functions of which is not entirely clear. Forde was able to document in the late 1920s the existence of 23 (he called them sibs), though by that time some were extinct. Clan names were adopted as personal names only by females, even though clans were patrilineal. They had totemic associations (e.g., corn, frog, coyote, rattlesnake). The clans may have been ranked; the *Xavtca'ts kwatea'n* (sib associated with corn or moon) is frequently mentioned as premier sib. There is some suggestion that they may have separate ceremonial functions (Bee 1983). Clan membership does not seem to have been on the basis of rancheria membership despite the fact that residence was ideally patrilocal and clan affiliation was patrilineal. There is some suggestion that some Quechan clans may have originated in other Yuman groups (Bee 1983:92).

There appear to have been two parallel tribal leadership classes: the *Kwaxot* for civil affairs and the *Kwanami* for war. It is not known how clearcut this distinction was in precontact days or how formal was their status. Halpern, for example (cited in Bee 1983:92) feels that the *Kwaxot* was a man with prestige, spiritual power and informal influence, but far from a formal, tribal chief. Likewise, the *Kwanami* may have been more of an influential, skilled warrior rather than a tribal war chief. It may be that there was minimal formal tribal leadership and that some formal leadership in the post-contact period is a result of interaction with and machinations of Whites (Bee 1981).

> Font states specifically that the chieftainship was not hereditary among the Yuma... Font also makes the acute observation that the chiefs "rule and authority should not be understood as very vigorous for since the Indians are so free...sometimes they pay no attention to their chief even though he may give them orders" (Forde 1931:136 citing Pedro Font 1775)

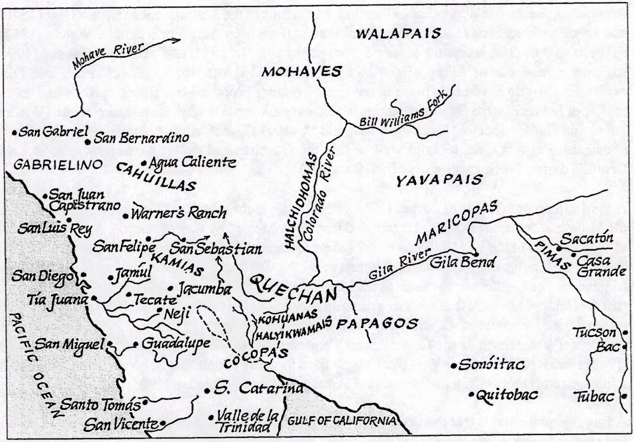
Each rancheria had one or more headmen (*pi'pa taza'n*). These included the more active and competent heads of village families. They met informally to discuss and decide public issues. Their authority came from public support and was circumscribed by public opinion of their competence. Part of their status was derived from having special types of dreams. Dreams were discussed by elders and appropriate ones elevated the social status of the dreamer. One apparently needed both dream power and practical ability to become a leader in traditional Quechan society (Bee 1983:92-3; Forde 1931:137).

Historic Period

Quechan and Other Yuman Groups

The first Spanish entrada into the Lower Colorado area began when Alarcón sailed up the river to about the Parker area in 1540 and Melchior Diaz marched from Sonora, Mexico to the confluence of the Colorado and Gila in the same year. At that time, a number of very closely related Native American groups were living along the Lower Colorado River (Kroeber 1925:782; McGuire 1982:68). The northernmost Lower Colorado peoples were the Mojave (also known as Amacavas, Soyopas, and Jamajabs) (Figure 3-1). Arguably the most populous of the Lower Colorado peoples, the Mojave are thought to have held an area from some 40 miles north of the present town of Needles south to below the Bill Williams Fork (Stewart 1983:55).

The Quechan, often in the past called the Yuma Indians (e.g. Kroeber 1925, Rogers 1936, 1945), lived traditionally at the confluence of the Colorado and the Gila Rivers. However, they were not noted there at the time of the Alarcón and Diaz expeditions. Writers with their expeditions made no mention of any group that could have been the Quechan (Forde 1931:98; Kroeber 1920:483). Likewise, the Quechan were not mentioned by Juan de Oñate, who marched to the Colorado River from New Mexico in 1605 (he would later become its first Governor). There is also no mention of the desert Kumeyaay (Kamia). At the Gila River (which he called the River of the Name of Jesus), Oñate found a non-Yuman people whom he called the Ozaras or Osera. Their identity is problematic. Kroeber suggests, "The most convincing explanation is that they were the Pima or Papago, or at least some Piman division, who then lived farther down the Gila than subsequently" (1920:483). At that time, the Matxalycadom (Halchidhoma or Alebdoma) lived below the Gila and were estimated by Oñate to have 8 villages, 160 houses, and a population of some 5,000 people. Next to the south were the Kohuana (Cohuana) with 9 villages and 5,000 inhabitants. Next were people thought to be the Halliquamallas and possibly the Halyikwamai living nearby. The last group living on the river and extending south to where the river becomes brackish were the Cocopa (Kroeber 1920:483).



After Forbes 1965:24

Figure 3-1. Historic View of the Quechan and Their Neighbors in the 18th Century

There are at least four plausible explanations of where the Quechan were at the time of Oñate's expedition.

> Oñate's failure to encounter the Yuman may be simply explained by the assumption that they were at that time living exclusively on the west bank where they have always been most numerous. Oñate did not cross the Colorado and it is expressly stated that the east bank people did not cross the river "because those on the other side were enemies although of the same nation" (Forde 1931:99, citing Zarate-Sameron in Bolton 1916:277)

Another explanation relates to Lake Cahuilla. At the time of the Alarcón, the Melchior Diaz (1540), and Oñate's expeditions (1605) Lake Cahuilla may have been full. For example, Waters (1983), suggests that the last lakestand occurred from about 1430 to 1540; and recently Schaefer (1994) suggests a final partial filling of the lake from about 1516 to 1659. The Alarcón and Diaz expeditions would have taken place at the end of Water's proposed last filling episode and in the middle of Schaefer's; the Oñate expedition would have taken place after the last lakestand of Waters, but within that of Schaefer. Since the timing and number of Lake Cahuilla lakestands is only poorly documented at this time, it could well be that the Quechan and desert Kumeyaay were at Lake Cahuilla during the Spanish visits of 1540 and 1605.

A third explanation is that of Forbes (1965:103-4), who argues that the Quechan were just south of the Mojave at the time of Oñate. He traveled from New Mexico by way of Jerome, Arizona, arriving at the Colorado at the Bill Williams Fork. Oñate first visited the Mojave in that area, then traveled south in their company past what is now known as the Chemehuevi Valley, where at the time, the Mojave also had settlements. South of the Mojave were the Bahacecha or Vacecha. Forbes argues that the Bahacechas were the Quechan primarily because, in the Oñate account, the Bahacechas were on very friendly relations with the Mojave, their language was very close to the Mojave, and their head chief was known as the Cohota, which corresponds to the Quechan term Kwoxot or coxot (Forbes 1965:103). Forbes argues that Oñate's term for these people, the Bahacecha, may have been a lineage term, Pa'vaxa's, transformed into Bahacechas by the Spanish (1965:104).

A fourth explanation is that the people the Spanish called the Halchidhoma were actually a part of the greater Quechan group and that the Spanish were actually giving groups of Quechan lineages different names (Lorey Cachora, personal communication, 1997).

To summarize, there are four alternative explanations regarding the whereabouts of the Quechan at the time of Oñate's 1605 expedition to the Colorado. The Quechan could have been (1) living on the west side of the river, which was not visited by Oñate; (2) living at Lake Cahuilla, which when full provided an attractive habitat; (3) living on the Colorado near present-day Blythe, but Oñate called them the Bahacechas; or (4) actually present, but just misnamed.

In 1701-1702, Kino visited the Colorado from the Gila south. At that time, he found the Matxalycadom (Halchidhoma) above, not below the confluence. The Quechan were in their traditional territory at the confluence, as well as up the Gila for some distance. Below the Quechan were the Halyikwamai; nearby and probably associated with them were the Kohuana. At the mouth of the Colorado were the Cocopa (Kroeber 1920:484).

> The chief changes in the century between Oñate and Kino are the following. The non-Yuman Ozara have disappeared from the Colorado. Their Place at the mouth of the Gila has been taken by the Yuma. The Halchidhoma have moved from below to above the Gila (Kroeber 1920:484)

In the 16th and 17th centuries, the Matxalycadom (Halchidhoma) territory centered around the present-day town of Parker (Kroeber 1920:478).

The Kohuana or Kahwan were at one time an important group, with nine villages during Oñate's time, but were frequently forced to relocate, presumably due to pressure from the Quechan and Mojave (Castetter and Bell 1951:35). They were called the Coana by Alarcón, the Cohuanna by Oñate, and the Cajuenche, by Garces. Alarcón puts the Kohuana near the delta just above the Halyikwamai when he visited in 1540. Oñate placed them just below the confluence of the Gila and Colorado during his entrada of 1604-1605, while Kino in 1701-1702 found them just above the confluence.

Below the Kohuana were the Halyikwanmai at the time of Alarcón (1540). These people were called the Quicama by Alarcón , the Halliquamalla by Oñate in 1605, and the Quiquima by Kino in 1700-1702 and by Garces in 1776 (Castetter and Bell 1951:35). They were a small group.

The Kamia, better known as the Kumeyaay, occupied a large territory including most of southern San Diego County, the southern Salton Sea and Imperial Valley to within perhaps 10 miles of the Colorado River. This territory also included most of northern Baja California beginning a few miles south of Ensenada (Forbes 1965).

The term Kamia was sometimes used to refer to just desert dwelling Kumeyaay. At times, the Kamia who mainly lived in the Imperial Valley, also lived near the southern border of Quechan territory on the west bank of the river near present-day Algodones. The term Kamia is a Lower Colorado variant of Kumeyaay. The Quechan call the coastal Kumeyaay *Kamya ahwe* or remote, foreign Kamia, while the Mojave call them *Kamia ahwe* or *Kamia ahkwe* (Luomala 1978:607-8)

The Cocopa were noted by Alarcón and Kino at the Gulf, and in 1774-1776, at the time of Garcés, they were still there. However, later they were located just south the Quechan settlement of *Xuksil* near Pilot Knob. They lived along the Colorado, and also lived along the New River and Hardy Rivers of the Colorado delta region south of the present international border. The Cocopa were at the time of Garcés, a large and prosperous people. They were allied with the Halchidhoma, Maricopa, and the Pima, against the two largest and most powerful of the Lower Colorado groups, the Quechan and Mojave.

The Quechan and Mojave had longstanding hostilities with the Matxalycadom (Halchidhoma) Maricopa-Cocopa-Pima. Indeed, warfare between the Mojave-Quechan alliance and the Matxalycadom (Halchidhoma) Maricopa-Cocopa-Pima alliance appears to have been virtually incessant (de Williams 1983; Bee 1983; Forde 1931; Steward 1983). It is thought to have escalated from 1540, the time of the first Spanish observations of the area:

> The most impressive evidence to indicate that warfare was not so pronounced in 1540 as in later times is the knowledge that the Lower Colorado was thickly settled with people who belonged to a number of different groups living rather close to each other (Forbes 1965:98).

The long-standing conflict between the Mojave-Quechan alliance and the Cocopa-Maricopa-Matxalycadom (Halchidhoma) was dominated by the Mojave-Quechan for many years. The raiding and pitched battles back and forth apparently caused or exacerbated extensive population shifts in the region at least over a period of some 300 years. Between 1827 and 1829, the Matxalycadom (Halchidhoma) pulled out of the Colorado River area under a major military offensive of the Mojave and Quechan. They moved first down to Mexico then up the Gila River to join their friends, the Maricopa. Two very small delta groups, the Halyikwama and Kavelchadom also left the river area under pressure from the Quechan and took up residence with the Maricopa, at about this same time (Forbes 1965:125; McGuire 1982:70; Stewart 1983a:1-2). Spier (1933) argues that the Kavelchadom first moved to the Gila between the Quechan and the Maricopa, and later moved from there to join the Maricopa. The Kohuana, another small delta group, joined the Maricopa in 1838 (McGuire 1982:70). The last battle in this conflict took place in 1857 when a large combined force of Quechan, Mojave, and Yavapai marched against the Maricopa (with their refugee friends the Matxalycadom (Halchidhoma), Kohuana, Halyikwamai, and Kavelchadom). The Maricopa, with their Pima allies soundly defeated the aggressors.

By 1774-1776, when Garces arrived at the river, the Quechan had horses which they obtained from Spanish in Sonora in exchange for women and children slaves. Ute and Pima also were enthusiastic participants in this lively slave trade. The Quechan used horses for mounts and modified their military tactics to incorporate a cavalry (McGuire 1982:69). They also used them for food and traded them to other groups, including back to the Spanish. The Mojave were raiding Spanish missions on the California coast to obtain horses by 1819 (Forbes 1965:133; McGuire 1982:69).

Early on, the Quechan seemed to enjoy trading with the Spanish and at first furnished the poorly prepared padres with food and other necessities. The hospitality turned to enmity as Frays Garces, Juan Diaz, and others attempted to fit by force the yoke of Christianity on the Quechan. On 17 July 1781, the Quechan Revolt began, and within a few days the priests and most of the Spanish soldiers and settlers were dead. The Spanish and their successors, the Mexicans, were never again able to control the Quechan (Forbes 1965).

The Maricopa-Pima alliance was generally friendly toward the Americans, while the Quechan-Mojave were uneasy with the changes engulfing them. At times they were openly hostile. By the mid-19th century Americans were exploring and settling all over the Greater Southwest, and Indian economies, populations, and cultural integrity were in decline. The Quechan and Mojave had frequent conflicts with Whites; their territory included major river crossings of settlers bound for California during the Gold Rush of 1849. In response, the U.S. Army founded Fort Yuma in 1852 after considerable armed conflict and other difficulties beginning with an abortive attempt to establish the fort in November 1850 (Forbes 1965:322). Fort Mojave was established in 1859 (Forbes 1965; McGuire 1982 70-71). It was this American military presence that ended the tradition of Lower Colorado warfare (McGuire 1982:70).

In 1865, congress established the Colorado River Indian Reservation (CRIT), near Parker and, with characteristic insensitivity to Native concerns, attempted to settle both Mojave and Chemehuevi there. They happened to be warring at the time. Many Mojave stayed in the Fort Mojave area to the north and, much later (between 1880 and 1910), this area became a reservation. The Chemehuevi left the CRIT in 1885 and settled in Chemehuevi Valley. This area later became the Chemehuevi Reservation. On 6 July 1883, a reservation was set aside for the Quechan on the east side of the River. This was unacceptable to the Quechan and they asked for the reservation to be moved to their traditional lands on the west of the River. The Yuma Reservation was established for the Quechan across the river from Yuma near Winterhaven, California by executive order on 8 March 1884. The reservation was originally 45,000 acres. In the late 19th and early 20th centuries, various allotment and amalgamation schemes were foisted upon the Quechan (e.g., the Dawes Severalty Act of 1887). In 1893, the Quechan were duped and coerced into signing an agreement reducing the reservation to only 8,000 acres in exchange for access to canal water for their farms and other services. This document is still a matter of contention because, Quechan argue, a very small percentage of Quechan actually signed it, because it was signed under duress, and because the government never provided the services agreed to (Bee 1981, 1883:94-95). This was part of a national policy that reduced Indian land in the U.S. from 132 million acres in 1887 to only 30 million in 1929 (Bee 1981:1893). A larger reservation was restored to the Quechan in 1978, but only encompassing some 25,000 acres (Figure 3-2).

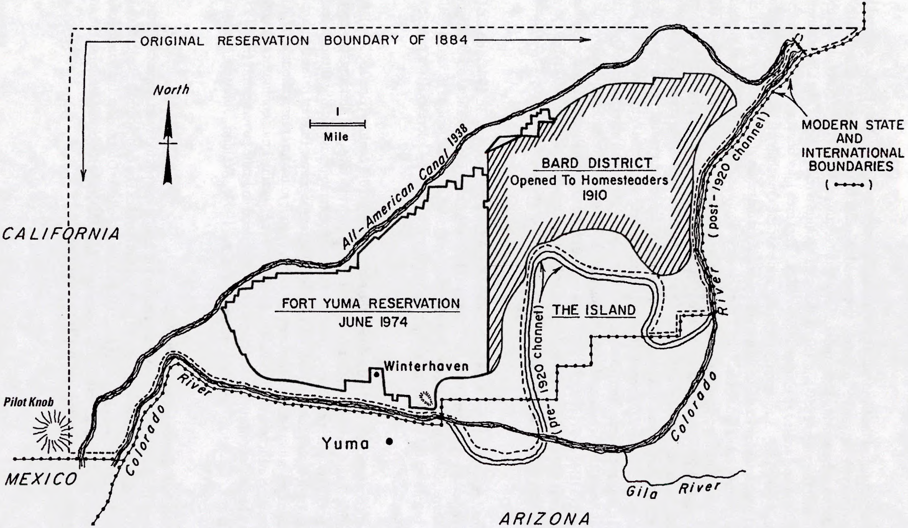
In 1917, two small reservations were set aside south of Yuma for the Cocopa. In 1945, the CRIT Tribal Council signed an agreement with the Bureau of Indian Affairs (BIA) to allow other Indians to be relocated there. Some 148 Hopi and Navajo families moved to CRIT, but in 1952 the CRIT Tribal Council rescinded the agreement, ending the immigration of non-Colorado River people to the Reservation.

After a period of economic and social decline in the early and mid-20th century (Bee 1983:96), the Yuma Reservation has a prosperous casino, which helps provide jobs and funding for social programs. Increasingly effective management of their agricultural lands, mainly through lease agreements with Anglos, also helps provide jobs and funding for programs. Interest in the traditional lifeways and languages is increasing; both reservations have active museum organizations and CRM programs. However conflict centered on land and water issues of various kinds continues as Yuman people point to a history of injustice in their dealings with federal and state governments (Bee 1981, 1983:95-97; Lorey Cachora, personal communication 1997; Weldon Johnson, personal communication 1997).

Spanish and Mexican Exploration (1539-1848)

The Spanish were the first Europeans to venture into the region known today as Imperial County. As early as 1539, the Spanish began to explore parts of California. The first Spanish explorer to set foot on Imperial Valley soil was Melchior Diaz (Henderson 1968:9). Diaz, under the command of Francisco Vasques de Coronado, traveled to the mouth of the Colorado River and explored the area to the west in present day Imperial Valley (Henderson 1968:9).

Figure 3-2. Changes in Quechan Land Holdings



Relative Amounts and Locations of Loss to Quechan Land Holdings, 1884-1974.

After Bee 1981:50

Spanish exploration for the next 200 years was intermittent in this area. Imperial Valley was considered remote and difficult to access and was not often visited. In 1767, the Jesuits were expelled from the Spanish Empire and the Franciscans took over the mission system. With the Spanish settlement of both San Diego and Monterey, and the threat of competition with Russia, the Spanish were anxious to find an overland route as an alternative to the oversea access they currently had. In 1775, Juan Bautista de Anza led an expedition from Tubac (near Tucson), Arizona across Imperial Valley and up to San Francisco (Lee 1968:41). His mission was to find an overland route that would prove safe and comfortable for settlers headed for San Francisco. Along with 240 men, women, and children, de Anza traveled the route from Arizona, through Imperial Valley, up to Santa Barbara, and on to San Francisco (Lee 1968:42).

Anza's expedition broke into several divisions and periodically met up along the way. Although most of the party made it to San Francisco, they encountered numerous obstacles along the way, including a snowstorm in the area presently known as the Anza-Borrego State Park. The following is Anza's account of the trek and the hardships that they faced in December 1775:

> At daybreak it was very windy, and the snow which had fallen the day and the night before was very hard from the freezing which had preceded, as a result of which six of our cattle and one mule died...The people were crippled by the storm...In spite of all their efforts to reach here yesterday, they were unable to do so, and on the way several persons were frozen, one of them so badly that in order to save his life, it was necessary to bundle him up for two hours between four fires (Lee 1968:43).

Despite the hardships, the trail was to be used by settlers traveling west through Yuma, Arizona from 1776 to 1781 (Norris and Carrico 1978:18). The trail through Yuma became known as the Yuma Crossing. As the town of Yuma grew, Spanish Padre Fransisco Tomas Garces established two missions: La Purisima Concepcion was on the Colorado River opposite Yuma, and San Pedro y San Pablo de Bicuner was located some four leagues downstream (Walker and Bufkin 1979:14). Use of the trail might have continued, but the Quechan revolt of 1781 resulted in the virtual abandonment of the Yuma Crossing and the Anza trail in favor of a northern route. Nevertheless, settlement had begun in the area and people were attempting to make a living. In 1781, the first mining boom began near the Spanish town of Potholes on the west side of the Colorado River, just above Yuma (Norris and Carrico 1978:38).

In the 1820s, Mexican soldiers and American settlers reopened the Anza route. It was used by the Mexicans as an intermittent mail route for several years. In addition to this, occasional trappers passed through the area on the route. During the Mexican-American War of 1846-1848, the route was utilized by the American military to transport supplies and troops. This, and other routes which would later be established through the Imperial Valley were used for many years to come.

Anglo-American Settlement (1849-Present)

Unlike the Spanish and Mexican period, during which explorers primarily passed through the desert of Imperial Valley, the Anglo-American period saw many attempts to develop and exploit the land. The first Americans to see Imperial Valley in large numbers were the gold seekers of the 1850s. The Americans had just obtained political control of the area through the Treaty of Guadalupe Hidalgo and established a military outpost in Yuma, Arizona in 1853. Yuma became the stopping point for many prospectors and the town experienced a population boom in the late 1840s and early 1850s. The expanding metropolitan areas demanded more food and an increasing number of cattle drives passed through Imperial Valley on their way from Texas to northern California (Woznicki 1995:42). The function of the trail had changed almost overnight from a military route to an emigrant path.

The majority of the travel through the area during this time was related to mining activities. Although the first railroad came through in the 1870s, it did not have a significant impact on land use at the time and it would be another 30 years before a branch line would actually service much of Imperial Valley (Norris and Carrico 1978:46; Henderson 1968:103). Early settlement of the area was also hampered by an improper land survey conducted by Government officials in 1856. Early settlers who tried to file for title to their land soon discovered that the survey was inadequate and listed far less land than was actually there (Henderson 1968:96). It took five years to straighten this out and, in the meantime, the settlers were unable to borrow money based on their property so they could not make improvements.

One of the biggest obstacles to permanent settlement of the Imperial Valley area was the lack of a secure water source. The first steps were taken to solve this problem when, in 1892, an engineer named Charles Robinson Rockwood was sent to Yuma by a Colorado company in order to explore the feasibility of diverting water from the Colorado River to Sonora, Mexico (Henderson 1968:15). He found it far more feasible to irrigate large portions of Imperial Valley, much of which was below sea level. Through his plan, he proposed to irrigate 1,250,000 acres in the "Salton Basin," which included the area bounded by the Mexican border, Indio, the San Jacinto Mountains, and Sand Hills. This is essentially the same area that the All-American Canal now serves. Unfortunately, the company that sponsored Rockwood was unable to raise the necessary capital and he was forced to try to raise his own funds. It was difficult to sell the idea, however, because of the expense involved in getting the water over the Pilot Knob area, which was above sea level (Henderson 1968:16). Finally, in 1900, the plan was realized with a few revisions. The water would be brought to Pilot Knob and then diverted to Mexico for a short while before coming back over the border. This way, the hills around Pilot Knob could be avoided.

The canal did not function without problems; severe flooding from 1905-1907 caused large blow-outs in the canal that created the Salton Sea. These had to be fixed at great expense. Despite difficulties, it helped establish an agricultural base in Imperial Valley that would not otherwise have existed. The canal served all of Imperial Valley until the creation of the All-American Canal in 1940 (Henderson 1968:18).

Because of the creation of the canals, Imperial Valley was able to develop as a farming community and the population increased. In 1900, the Imperial Land Company formed with the purpose of developing townsites in Imperial Valley (Henderson 1968:49). Imperial was the first town they platted (1901), and other towns such as Silsbee, Holtville, and Brawley followed in the next few years (Norris and Carrico 1978:57). This network of settlements soon led to the establishment of Imperial Valley as a separate California County. The area had previously been part of San Diego County but the inhabitants of the various towns began to complain of having to travel long distances to reach the county seat (Henderson 1968:85). In 1907, the county seat was placed in El Centro.

The railroad was still expanding at this time and small stations grew up along the tracks to service and provide water for stream engines. One such station at Ogilby in 1880, formed a junction point for those traveling to the mines in the Chocolate Mountains (Henderson 1968:104). Although these stations did not support many inhabitants (usually between two and ten) the sheer number of them (somewhere around 200) caused a significant impact on the landscape. With the advent of diesel locomotives in the post WWII era, these siding towns were abandoned.

Other transportation opportunities soon followed the railroad. Cars were in use, although not regularly, as early as 1910. A plank road was built from Imperial Valley to San Diego in 1913. One branch crossed the Algodones Sand Dunes and periodically had to be moved to accommodate the shifting dunes (Norris and Carrico 1978:72). A stage line began to take passengers to and from Imperial Valley by 1912 (Henderson 1968:96). The plank road was improved over the years and finally replaced by an asphalt road in 1926 (Henderson 1968:98). In 1927, a county airport was constructed in Imperial, although daily plane flights did not occur until 1943 (Henderson 1968:105). Roads continued to be built and improved all the way up to World War II.

Water conveyance systems were also improving. Irrigable areas were increasing and the construction of the Laguna Dam near Yuma, Arizona allowed the people in the area known as Bard Valley to practice large-scale agriculture (Norris and Carrico 1978:68). Construction of the All-American Canal between 1936 and 1940 put an end to the problems of flooding encountered by the Imperial Canal from the turn of the century. By the time World War II broke out, the desert area of Imperial Valley had gone from being infrequently visited by Anglo-Americans to being settled and farmed by them. World War II, however, put a halt to further developments in the desert for a while.

Historic Mining (1848-1950)

The first mining activity by Anglo-Americans occurred in Imperial Valley in the 1850s. The area had been mined on a small, individual basis by Mexican and Spanish miners previously, but without much impact to the area. An area of fairly intense mining activity was reportedly named for a group of Mexican boys who returned to their family's camp one evening loaded down with gold ore. These "muchachos cargados" or "loaded boys" reportedly gave the name to the Cargo Muchachos Mountains from which they came that day (Hector 1987:5). With the rush of the 1850s, mining quickly became the dominant factor in the desert economy, at least until the railroad arrived thirty years later (Norris and Carrico 1978:43). It was also the activity that probably had the greatest impact on the study area.

When the Anglo-Americans came into the area, they quickly resented the Mexican miners who were able to find ore more easily. This resentment grew until a Foreign Miners Tax in 1850 forced many Mexican and Spanish miners to return to their countries (Burney et al. 1993:5.4). The Cargo Muchacho mining district was first established in 1862 (Hector 1987:5). Until the 1870s, the prospecting was much like that of the Spanish and Mexican era, peripheral and superficial. Inhospitable conditions and lack of easy access to the area discouraged any large-scale mining. The most significant mining activity during this time was the Padre and Madre claims at the eastern edge of the Madre Valley (Burney et al. 1993:5.5).

The completion of the Southern Pacific Railroad in 1877, had a major influence on the course of mining activities in the area. In the 1880s, a railroad section headquarters was established at Ogilby. Peter Walters, a Swedish railroad employee stationed at Ogilby, discovered gold three miles north of the Padre and Madre claims (Hector 1978:6). His discovery prompted a rush to the area and numerous claims were filed over the next few years. Gold Rock Camp, the original camp formed from Walter's initial discovery, expanded in the 1890s. In 1894, its name was officially changed to Hedges after the company's vice-president (Norris and Carrico 1978:5.8).

Hedges grew until it contained two- to three-thousand inhabitants (Hector 1987:8). In the 1890s, several other strikes were also made. These were made even more profitable by the construction of stamp mills which avoided the high cost of shipping the ore to San Francisco for processing (Norris and Carrico 1978:5.6). A 20-stamp mill was installed at the Cargo Muchacho Mine in 1890 along with a 14-mile double pipeline which brought water from the Colorado River (Norris and Carrico 1978:5.7). New mines were being established constantly during this period. The first of the new mines was the Blossom Mine in 1890. Following that, in 1892, was the American Girl Mine, the largest of the mines in the southern Cargo Muchacho area (Hector 1987:9). The American Girl mine was very productive and, in 1898, the owners of the mine incorporated (Hector 1987:9). With incorporation came major expansion and, by 1899, members of the Board of Directors formed the American Boy Gold Mining Company and located the mine approximately one-quarter mile east of the American Girl Mine (Hector 1987:10). By the turn of the century, the American Girl Mine was the second largest in the Cargo Muchachos (after the Golden Cross Mines). The physical plant included a 12-mile pipeline from the Colorado River, a mill that could crush 100 tons a day, a cyanide plant, facilities for 50 employees, and a camp of about 20 buildings (Norris and Carrico 1978:5.7).

The various mines were productive but, by 1905, much of the easily accessible ore was exhausted and overextension of resources without adequate return forced several mines to shut down. Hedges quickly became a ghost town. During this period, many small companies and individual prospectors formed corporations, which made it possible for them to afford the expense of deep mining operations that had become necessary to make a profit (Norris and Carrico 1993:5.7). By 1909, several of the mines were reopened by these new corporations. Their endeavors were encouraged by the Government's newfound commitment to the gold standard and its call for new gold to increase the government reserve (Norris and Carrico 1978:5.7).

Despite the reopenings of several mines, including the American Girl Mine, between 1909 and 1930, not much activity occurred. A flurry of activity did occur between 1936 and 1940 that caused the development of a company town, called Obregon, to grow to 300 occupants and include a hospital, dining hall, and school (Hector 1987:11). After 1940, most mining on a large scale ceased but mining on a small scale has continued to the present day.

Military Activity (1942-1945)

Activity in the Imperial Valley changed focus during World War II when General George S. Patton, Jr. determined that the desert area stretching from California and Arizona's Mexican border up to the lower part of Nevada would provide the perfect training ground for troops participating in the Desert Warfare campaign in North Africa. In March of 1942, Patton and five aides flew over the area to discuss its suitability for such a training ground (Henley 1992:5). Patton later scouted the area on horseback and by jeep and decided that the best place for the headquarters of such an operation would be at Chiriaco Summit, not far from Palm Springs, and would be called Camp Young. What Patton liked about the area was that it was "...desolate and remote...large enough for any kind of training exercises..." (Patton Society Web Page 1997). The first troops arrived to the area within four days of the reconnaissance mission and they described the area as "the place God forgot" (Patton Society Web Page 1997). Initially, the area was called the Desert Training Center, but that was soon changed to the California-Arizona Maneuver Area (C-AMA) to reflect both the inclusion of support facilities in areas like San Bernardino and the fact that it was being used to train troops that weren't necessarily headed for desert warfare (Henley 1992:7). The training area eventually grew to encompass an area twice the size of Maryland and included Camp Young and ten divisional camps: Camp Coxcomb, Camp Iron Mountain, Camp Granite, Camp Essex, Camp Ibis, Camp Hyder, Camp Horn, Camp Laguna, Camp Pilot Knob, and Camp Bouse (Henley 1992:8) (Figure 3-3).

Patton found it an ideal training ground as he writes:

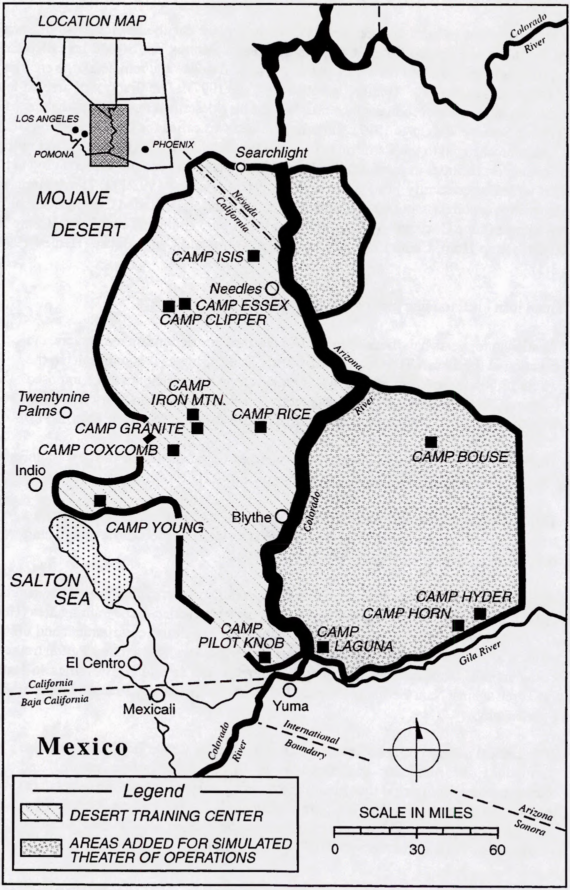
> To all who for years have been bedeviled by arbitrary restrictions on maneuvers, the situation at the Desert Training Center is truly as inspiring as it is unusual. In the whole 12,000,000 odd acres the only restrictions as to movement are those imposed by nature. Even so, these are more accurately deterrents rather than restrictions, for, with time and perspiration, you can go anywhere (Patton Society Web Page 1997).

Within a month of starting the program, the majority of the troops had arrived and new vehicles were arriving daily. The *Los Angeles Times* page 1 story on April 21, 1942 stated:

> This huge arid country of the cactus, the ocotillo, the sagebrush, juniper and smoke tree, the lizard and the tiny desert rat has come alive in the last few days, its age long desolation gone with a vengeance (Henley 1992:12).

In the beginning, the main troops that came into the training area were infantrymen and tankers of the Army Ground Forces. Later, an Air Support Command was added to the training area (Henley 1992:23). Training focused on conducting field maneuvers in a desert environment and effective use of artillery. Camps were sparse and designed to be removed without a trace. Patton trained the men for four months before he was called to Washington and sent to North Africa to lead the Operation Torch against Nazi Germany (Henley 1992:25). In his Cavalry Journal, he describes the training philosophy:

> The tactical mission of the force at the Desert Training Center has been to devise formations for marching and fighting which, while affording control and concentrated firepower, at the same time do not present lucrative air targets...(a) point about desert training that is alluring, particularly to artillery men, is the fact that one can open fire with live ammunition or drop bombs at any time...without endangering anyone (Patton Society Web Page 1997).



(After Henley 1989:9)

Figure 3-3. Desert Training Center Area

The men trained under conditions that were intended to simulate the African conditions. Patton would not allow his men more than one gallon of water per day and he notes that obesity was not a problem with these troops (Patton Society Web Page 1997).

Camp Pilot Knob was used by the 55th Infantry Division in 1943 (Meller 1946:41). The following is a description of conditions at Camp Pilot Knob:

> There was nothing permanent about it. It was fashioned out of a flat, barren desert tract...three thousand pyramidal tents were pitched and these housed company kitchens, administrative officers, and troops alike (Schultz 1949:33).

Schultz describes the training exercises and the extreme heat the troops had to endure. Small units were sent out on reconnaissance missions to get them used to the conditions. One such unit got lost and several men died of exposure before they found their way back (Schultz 1949:35).

Major General Alvan Gillem, Jr. took over command of the C-AMA after Patton left for Africa and within a year saw the areas population grow from 12,000 to 20,000 (Henley 1992:25). A series of commanders followed Gillem and trained the desert troops for combat in the successful North African Campaign. Major General Walton H. Walker was the primary officer with the responsibility of transforming the camps into a simulated theater of operations (Miller 1946:39). He accomplished this task well as his commanding officer remarked in a letter he wrote after visiting the facility: "I feel that the center... is an organized affair, as contrasted with the improvised, topsy-like array which you found on your arrival" (Miller 1946:40).

In May 1944, the government realized that the African campaign was winding down and that the desert trained troops were in demand elsewhere. Therefore, the desert training camps were closed and the troops were sent to fight in other parts of the war. By this time, one million troops had trained at C-AMA (Henley 1992:26).

After the camps were closed, they were dismantled and the land reverted back to either private or government ownership. In 1987, the Squibob Chapter of E. Clampus Vitus filled out the paperwork for Camp Pilot Knob to become California Registered Historical Landmark No. 985. In 1988, with the help of the Bureau of Land Management, the General George Patton Memorial Museum was opened at the entryway to what was once Camp Young.

Modern Land Use and Recent Mining Activity

New residents came to Imperial Valley in the 1950s to escape the crowded cities. They were able to live there comfortably due to the low price of federal land, effectiveness of air conditioning, and availability of swimming pools (Norris and Carrico 1978:106). Consequently the population of Imperial Valley grew from 112,500 in 1940 to 328,400 in 1960 (Norris and Carrico 1978:A-1). With the increase in population came an increase in recreational activities and it was during this time that off-road vehicle travel became popular, creating some of the impacts within the Project.

Mining and agriculture continued during this period. Mining was mostly on a large scale and agricultural pursuits were focused on the area just south of Indio.

Throughout the 1960s and 1970s, the desert area of Imperial Valley continued to grow in population. Interest in desert recreational activities has grown tremendously, prompting government regulations on previously unrestricted activities such as off-road vehicles and rock and fossil collecting (Norris and Carrico 1978:121). The completion of the last highway through the desert in the early 1970s encouraged the weekend visitor. The Project area is included in several rockhound books as a source of cherts and a purple rock called dumorturite, which can be polished. Recent rockhound activity has impacted the area and made distinguishing recent activity from prehistoric lithic reduction somewhat difficult.

Mining activities have also continued. Much of it has been small-scale and evidence of it can be seen throughout the desert landscape. Of the activities that have occurred in the desert since the 1940s, the mining activities have probably had the most significant impact to the area around the Cargo Muchacho Mountains. Much of that impact is still apparent today.

Little mining history exists for the Project itself. Some claims in the area may date to the 1950s, but the Project mine and process area was first prospected by Dick and Alice Singer in the 1970s (Personal Communication - Steve Baumann, Glamis Imperial 1997). Between 1982 and 1985, Gold Fields Mining Corporation conducted a regional exploration program in the Project which resulted in many of the small access roads and drill areas throughout the Project mine and process area (EMA 1997). Continued drilling after 1987 under Glamis Gold exploration, Inc. continued the development of roads and drill points in the area.

REGIONAL OVERVIEW

Introduction

The primary goal of this overview is to provide a context for interpreting our archaeological materials utilizing the direct historical approach. That involves beginning from what is known (the admittedly thin historic and ethnographic records), and proceeding toward an explanation of unknown (the meaning of the archaeological materials; Steward 1941, 1977).

An important first step in understanding the archaeology of the region is an understanding of the traditional Yuman world view. It is particularly important to understand the significance of spirit mountains, dreams, dream travel, and the trails linking sacred places, village sites and other places. Our discussion of the heritage resources of the area will begin with resources associated with religious activities.

Religion

The spiritual life among the Yuman peoples is dominated by a belief in a plural reality: one is the "normal" material existence, and the other is the spiritual-mystical existence. This spiritual level of reality is accessed by means of dreams, *icama* in Quechan (Bee 1982:49-50; Forbes 1965:63; Forde 1931: 201-204; Kroeber 1925:754). Dream travel, trails, and spirit mountains are significant parts of this spiritual life among contemporary Yuman peoples (Preston Arroweed, personal communication 1997; Lorey Cachora 1994:14; personal communication 1997; Weldon Johnson, personal communication, 1997).

Dreams

Dreams figure prominently in legend and song, in the pursuit of knowledge, and in the acquisition of good and bad luck. The dream experience or *icama*, is also the major source of power (*sumak*) (Bee 1982:49-50; Lorey Cachora 1994:14; personal communication 1997; Forbes 1965:63; Forde 1931: 201-202; Kroeber 1925:754; Weldon Johnson, personal communication, 1997). Dreaming in pursuit of knowledge and insight is somewhat analogous to prayer among other religious traditions, although no direct supplications to deities are made. Rather, dreaming is a way of directly accessing supernatural beings in order to obtain advice about ethical issues, morality, and the problems of everyday living (Preston Arroweed, personal communication 1997; Lorey Cachora 1994:14, personal communication 1997; Forde 1931:180-181). As Kroeber (1925:755) summarized it, for the closely-related Mohave:

> Dreams, then, are the foundation of Mohave life; and dreams throughout are cast in mythological mold. There is no people whose activities are more shaped by this psychic state, or what they believe to be such, and none whose civilization is so completely, so deliberately, reflected in their myths.

Among the Yuman peoples, dreams are tied closely to the natural and cultural landscape. Exact places and moments in time are related in dreams. Personal dreams parallel Yuman religious myth and legend in the sense that most are about journeys of spiritual discovery, often along trails leading to mountains of religious significance where important spirits reside. Kroeber (1925:754-755) points out:

> Myths are enormously long, and almost invariably relate the journey of either a single person, or of a pair of brothers with or without a following, beginning with their coming into existence and ending with their transformation into an animal or a landmark. This journey, which is sometimes described as occupying two or three days, but is really a timeless life history of the hero, is given with the greatest detail of itinerary; but incidents of true narrative interest are few, often irrelevant to the main thread of the story... But each locality reached, whether on the river, in the desert, or among distant mountains, is named, and its features are frequently described.

Elsewhere Kroeber continues:

> ...the Mohave in general admit frankly that they have learned much of their knowledge of songs and stories from their older relatives, and yet insist that they possess all this knowledge through dreams; and like the Yuma, every narrator is convinced that he was present at the ancient events he tells of. If these tribes could express themselves in our abstract terminology, they would probably say that the phenomena of dreams have an absolute reality, but that they exist in a dimension in which there is no time and in which there is no distinction between spiritual and material (1925:784).

In a similar vein, Forde describes the religious importance of dreaming among the Quechan:

> ...the true dream vision derives from *Kumastamxo* or from one of the ancestral spirits. It is an experience of tremendous significance, which at the same time conforms to a definite pattern. It usually involves a journey to the scene of the creation, or to one of the mountains which was visited by *Kukumat* or *Kumastamxo* (1931:201)

As described further below, *Kukumat* was the creator of all Yuman peoples and *Kumastamxo* was his son and spiritual successor.

Sacred, Spiritual Mountains

There are several mountains known to have Yuman spiritual significance near the study area: Pilot Knob *(Avi kwalal)* with its associated site of *Avi kwinur* (inscribed rock), located some 11 miles west of the present-day town of Yuma, and some 25 miles south of the Project area; Picacho Peak (*Avi milyket*, high rock one can see from a distance), located approximately 26 miles north of Yuma and some 9 miles east of our Project area. The most important sacred mountain to Yuman people is *Avikwaame*, also known as Spirit Mountain or Newberry Peak, where the origin of the Yuman world took place. *Avikwaame* is located some 30 miles north of Needles in traditional Mohave territory. (There are several different spellings of this mountain; the one we are using is based on the suggestion of Lorey Cachora, Quechan cultural resources consultant).

Pilot Knob *(Avi kwalal)* was the starting place for the traditional *Keruk* pilgrimage reenacting the death of the Yuman god *Kukumat* and the procession carrying his body back to *Avikwaame*. A major ceremonial stop on the pilgrimage was Picacho Peak (*Avi milyket*) near our Project area. Other places of spiritual importance are Tank Hill or Sierra Prieta *(Avi kwaxa*, cottonwood hill or peak) located within the town of Yuma (where the town water tanks are) some 30 miles southeast of our Project area (Bee 1982:50); Muggins Mountain some 23 miles east of Yuma; Castle Dome Peak some 38 miles east of Indian Pass; Monument Peak, a chimney rock in the Whipple Mountains, called *Avi haritat* in Quechan, located some 10 miles north of Parker, and Black Peak, southwest of the Buckskin Mountains located some five miles southeast of Parker called *Avi Suquilla* in Mohave (Lorey Cachora, personal communication, 1997; Weldon Johnson, personal communication, 1997).

The trails linking all these sacred mountains with each other and with various village areas are of particular spiritual significance. These trails were utilized for actual religious pilgrimages associated with the *Keruk* ceremony, the most important and deeply religious of all Yuman ceremonials, and they were also utilized for dream travel, an aspect of Yuman society that is difficult for Anglo-Americans to understand, but one of extreme importance for all Yuman peoples.

Keruk Ceremonies

The *Keruk* is a ritual held at irregular intervals to celebrate and perpetuate a ritual taught to the first men after the death of *Kukumat*, the creator of the world (Forde 1931:214). Modern *Keruk* ceremonies are believed to be a direct evolution of the original *Keruk* and while differences are acknowledged, there are some contrasting opinions about the details of the original ceremony and the extent to which modern ceremonies recreate the original. The aim, however, is to celebrate the creation of the world, the close relations between the spirit world, and the natural world, and the cremation of *Kukumat* (Forde 1931:214). The *Keruk* is also a memorial service for the recently deceased. The Yuman peoples: the Mojave, Halchidhoma, Quechan, Kamia, Cocopa, Maricopa and others trace their ancestry in various origin stories to a single event and a single place. There is some variation in their versions and in the way they celebrate the *Keruk*. This account of the traditional Quechan origin legend, and the *Keruk* is based largely upon the ethnography of Daryll Forde, of the University of California, Berkeley, who observed a Quechan *Keruk* in 1929 (1931:223). A number of Southern California Takic groups also celebrated their own versions of the *Keruk*, e.g., the Gabrieliño-Tongva, Cupeño, Serrano, Luiseño, and Kitanemuk (Altschul and Ezzo 1994:52).

All the Yuman peoples were created by the god *Kukumat* on the sacred mountain *Avikwaame*, located about 30 miles north of Needles, California (Forde 1931:214-244). After the death of *Kukumat*, his body was cremated and his house burned. His divine son, *Kumastamxo* sat quietly and listened while the people talked of their sad loss. Some of these early people were spirits, *pipa'tuats* ("people who have come to an end"). They were agents of *Kukumat* who had animal forms. They gave their names to the animals we know today so that all later peoples should respect the animals and keep them in mind. These *pipa'tuats*, or animal spirits, now live in the various mountains surrounding the Lower Colorado River area and give people power when they appear to them in dreams. This is one reason why mountains hold such special spiritual significance to the Quechan and other Yuman peoples. The *pipa'tuats* talked to *Kumastamxo* suggesting that they should mourn *Kukumat*, but *Kumastamxo* sat silently for many days (Forde 1931:214-244). Finally he told the *pipa'tuats*:

> I knew that you would have to sing and pray after the death of my father, the creator, for he has entrusted me to continue his work and I know all things. Unless you do this thing you will sicken with the illness of Kukimat. But I have waited until you received the power to have the ceremony (Forde 1931:215).

Kumastamxo was the creator of the ceremony, but he did not have to instruct the *Pipa'tuats* in how to conduct the ceremony: his knowledge and power flowed directly into them. The various *Pipa'tuats* (e.g. *maxwa'*, the Badger; *helto't*, the spider; *pamavit'ts*, the snake) performed tasks and interacted with each other and *Kumastamxo* to obtain the things they needed to create the proper ceremonial structures, to create the songs, and to hold the ceremony correctly.

The *Keruk* among the Quechan was apparently not an annual ritual, rather it was held as necessary to mourn the death of an important person or persons. The families of the deceased were the driving force behind the occasion. Typically several families would cooperate and share resources for holding the ceremony. In some years, it was held more than once; at other times one might not be held for several years. It could be held at any season, but more often after the harvest in the fall. The ceremony among the Quechan lasts four days; among other cultural groups it varies up to a week. The *Keruk* is also the occasion for relatives and friends from considerable distance to get together, exchange food, goods, and gossip, conduct courtship, arrange marriages, settle disputes, and so on. Often people from other tribes would be invited to attend, and personal and economic relationships were established and maintained. Altschul and Ezzo (1994:53), in reviewing the *Keruk* as conducted among southern California Yuman and Takic groups (e.g. the Gabrieliño, Luiseño, and Cahuilla) observed a number of cross-cultural similarities:

1. It is typically held in the autumn or winter.
2. It is sponsored by kinsmen of recently deceased.
3. A central structure is constructed forming the focus of the ceremonies
4. An elaborate, epic song cycle recounting the creation is sung.
5. The ceremony takes place over several days.
6. Elaborate dancing is part of the ceremony.
7. Bird feathers, particularly eagle feathers are used.
8. There is an intensive redistribution of food and goods.
9. Effigies of the dead are burned at the end of the ceremony.
10. Possessions of the dead are destroyed symbolically or actually.
11. The central structure is ritually burned.
12. Cooking and food preparation are done.
13. Visitors from far away and different cultures often attend.

Characteristics of Keruk Sites

When Forde attended a Quechan *Keruk* in September 1929, he drew a plan view of the *Keruk* ground, reproduced here as Figure 3-4. The *Keruk* that Forde witnessed took place in a clearing 250 yards square, in a dense, brushy area near the river (1931:224-5). This was evidently a medium-sized event attended by some 17 families, judging from the sketch map. Altschul and Ezzo (1994:54) redrew this sketch map, replacing the A-frame symbols signifying wickiups with circles representing the cleared circles that one would expect to find archaeologically in a desert pavement environment. As Forde points out, people make temporary camp at the site for several days; the ceremony itself lasts four days. The *Keruk* house at the ceremony attended by Forde in 1929 was called *keru'u'kva* (*Keruk* shelter) or *ava'laxan* (good shelter) by his Quechan consultants (1931:227). It was a rectangular structure of post and beam construction covered with brush.

> The building of the house begins in the early afternoon. The roof beams are first laid on the ground in the positions they will occupy in the finished structure. This affords a plan of the structure and indicates the position for the post holes. These post holes are dug with knives and sticks. Picks or shovels may not be used. Before the insertion of each pole, corn is sprinkled in the hole by the two corn women. The center posts are erected first, but the house is built complete, i.e., the successive additions of the mythological account are all erected at one time. The front center section of the roof is flat and about six feet high, but the back portion tilts sharply down the rear where the upright posts are only three feet high. With the dried brushwood, a dense thatch about one and a half feet thick is laid over further light poles on the roof frame and this completes the structure.
>
> In the evening, when the keruk house is finished, the leaders make long speeches recalling the solemnity of the occasion and the great benefits to be derived.
>
>> We shall all be better people, stronger to whip the enemy, living long in good health. We shall have everything new for our keruk. The house is now ready and all is well. Tomorrow we shall sing the songs and strengthen ourselves.

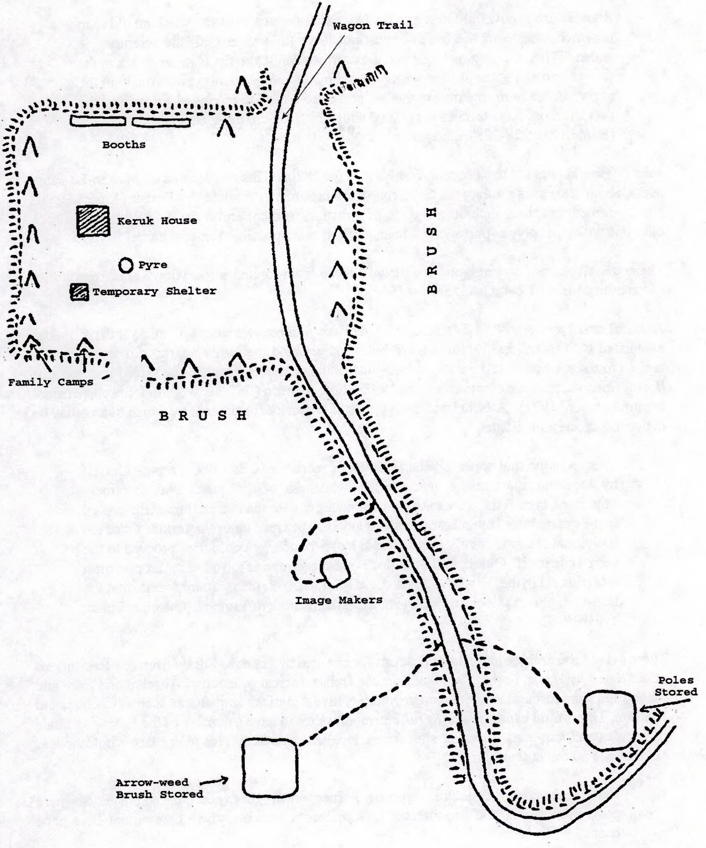


Figure 3-4. The *Keruk* Ground

After Forde 1931:224

> A small fire is now built between the two eastern center posts at which an old man is seated. He tends the fire and must not leave the shelter until the ceremony is ended. When the singing begins on the fourth evening, the fire is moved back to the far western end of the shelter, where the old man remains guarding it throughout the night. In the morning, during the last procession, his fire is moved forward to the east and from it the torches are ignited with which to burn the shelter and the images (Forde 1931:228-229).

John G. Bourke was led to a Mojave *Keruk* site in the 1880s. This was located on Mat-ho-ko-sabbi Mesa, about 100 yards south of the California-Nevada border. As related by Forbes (1965:67), this site contained intaglios, including figures of a man, a woman, and a child. Nearby were rock outcrops with petroglyphs portraying a man, a whirl, and a possible fish and horse.

These geoglyphs and petroglyphs are thought to be incorporated into major *Keruk* ceremonies (Altschul and Ezzo 1994:52-53; Forbes 1965:67).

Altschul and Ezzo (1994:53-54) note that there are numerous scatters of milky quartz shatter associated with intaglios. White is a symbol of power, and the milky quartz, it is thought, was broken to release power and purify an individual as he or she approached the sacred intaglio area (Lorey Cachora, personal communication, 1997; Boma Johnson 1985:37; Weldon Johnson, personal communication, 1997). Altschul and Ezzo (1994:55) describe the process by which quartz may be deposited at ceremonial sites:

> ... as an individual approached an intaglio or sacred area, he would prepare himself by breaking apart milky quartz. The whiteness of the quartz was extremely important, signifying a means of communicating with the supernatural. Embodied in the quartz were supernatural forces that would be freed upon shattering. Once the individual felt sufficiently purified by the experience, he could then proceed to the sacred site itself. Quartz shatter is also evident near one of the other anthropomorph intaglios at Blythe, as well as the horse at Pilot Knob. It is important to note that the horse intaglio is associated with vision quests by modern Yumans (Quechan Indian Tribe 1989).

There are several archaeological implications for our area that one may draw from the descriptions of the *Keruk* by Forde, Forbes, Bourke; from the archaeological research of Altschul and Ezzo and others; and from discussions with contemporary Native American consultants such as Cachora and Johnson. One would expect major *Keruk* ceremonial sites to have a number of the following kinds of features and materials. Smaller sites where local *Keruk* ceremonies took place would be less elaborate, with fewer features.

1. Because the central structure is typically burned, one might expect charred postholes where posts once stood, and fire-affected rock or hearth remains where ceremonial fires once burned..

2. Since elaborate dancing took place, one might expect amorphous tamped areas representing the "dance floor" area.

3. Because there was intensive redistribution of food and goods, and because families camped in the area for the duration of the ceremonies, some four days, one might expect a variety of artifacts representing the remains of cooking, eating and the exchange of material items.

4. Visitors from far away and from different cultures often attended *Keruk* ceremonies, so one might expect some exotic materials and artifact types.

5. As depicted on the sketch map of Forde, a number of cleared circles representing the remains of temporary family campsites should noted in the area.

6. Intaglios are associated with major *Keruk* ceremony sites. Additionally, the presence of intaglios should alert the archaeologist to the possible presence of other items in the area that might be characteristic of *Keruk* sites.

7. Scatters of milky quartz represent an attempt of spiritual leaders or pilgrims to obtain power or purification. These are often found on the approach toward intaglio sites near trails and around the perimeter of the sites.

Major Versus Local Ceremonial Sites

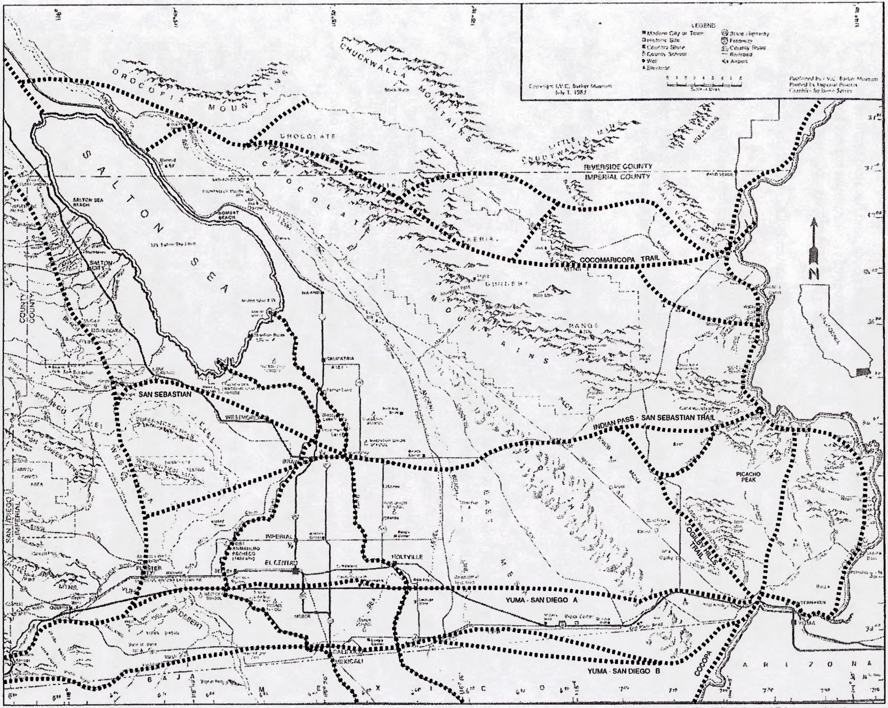
Altschul and Ezzo (1994:51) draw an interesting distinction between major and minor ceremonial centers with a focus on archaeological evidence that might be found in a desert environment.

> Major ceremonial centers along the Lower Colorado River are distinguished on the basis of the following characteristics: (1) The exhibit a large variety of ceremonial features, including intaglios; (2) they contain anthropomorphic intaglios and occasionally zoomorphic intaglios that are central features in the ceremonial layout; (3) major trail systems lead into and out of the localities; (4) their features represent elements of Yuman cosmology or important Yuman myths; (5) there is often evidence of temporary encampments in the form of clusters of cleared circles; and (6) in some cases, regional centers have been identified as important localities for major rituals such as the *Keruk*, or morning ceremony.

Examples of major ceremonial centers are Pilot Knob with 300 features, Ripley Geoglyph Complex with more than 500 features (Altschul and Ezzo 1994:52). Both major and minor ceremonial sites the way they define them, were used for the *Keruk* ceremony. Some participants in the *Keruk* began with a ceremony at Pilot Knob then undertook a pilgrimage to *Avikwaame* with ceremonials at Picacho Peak, Parker, and Blythe (Altschul and Ezzo 1994; Johnson 1985; Stone 1991; Woods 1986). The traditional *Keruk* trail is thought to run from Pilot Knob to *Avikwaame* (Altschul and Ezzo 1994; Boma Johnson 1985; Stone 1991; Woods 1986) (Figure 3-5, Table 3-1).

Local ceremonial centers, according to the Altschul and Ezzo model consist of isolated intaglios or those with only a small number of associated features (1994:57). Local ceremonial centers are often associated with a major trail. The example that Altschul and Ezzo provide is a site complex at Senator Wash (1994:61). This consists of fours sites. Two sites are located next to one another in this area separated by an ephemeral wash. One site has an area with 11 cleared circles, most likely wickiup bases, while the neighboring area contains a series of ceremonial features such as a rock

Figure 3-5. Major Trails



Approximate Locations based on Historic and Ethnographic Accounts

Table 3-1. Major Trails

Trail Name	Citations
Yuma Trail A	Bean 1972; Norris & Carrico 1978
Yuma Trail B	Almstead 1982; Gifford 1931; von Werlhof 1988;
Coco Maricopa	Davis 1961; Norris & Carrico 1978; Sample 1950; von Werlhof 1988;
Pilot Knob-Picacho	Norris & Carrico 1978
Indian Pass-San Sebastian	Casbier 1975 (in N&C); Gifford 1931; Norris & Carrico 1978; von Werlhof 1988
Ogilby Hills Trail	von Werlhof 1988

alignment with a D-shaped enclosure, suggesting a dance area; two rock cluster-geoglyphs. Another site nearby has 10 ceremonial features including dance paths and rock alignments. This is located on a terrace above the Colorado River. Sleeping circles are associated with all of these ceremonial sites. Dance areas are suggested by irregularly-shaped tamped areas. Song and dance were important features of the *Keruk*. Based on the ethnographic account of Forde (1931:221-244) discussed above, one would indeed expect, as a minimum, dance areas and cleared circles at any local ceremonial site.

Altschul and Ezzo argue that differences between major and local sites are in scale, not function. Major religious centers in our area, Pilot Knob and Picacho Peak for example, were of intertribal significance. Presumably the rites taking place there drew participants from some distance; visiting was a fundamental feature of *Keruk* ceremonies throughout Southern California. Local ceremonial centers, like the site complex at Senator Wash east of our study area, may have been stops for religious pilgrims on the trek from Pilot Knob to Spirit Mountain. Perhaps these were places where locals and pilgrims celebrated *Keruk* rituals together. Alternatively, local centers may have simply been utilized for community-based ceremonial and religious practice (Altschul and Ezzo 1994: 63).

Vision Quest and Prayer Circles

As pointed out above, an important aspect of Yuman spiritual life is dreaming. One archaeological manifestation of this are vision quest circles, vision circles, power circles, or prayer circles (Ezzo and Altschul 1993a:17, 1993b:114; Johnson 1985:37). These are rock rings typically ranging in size from about ½ meter to one meter in diameter: clearly too small to be considered "sleeping circles." They tend to be associated with trails and typically are found in clusters. Based on their work at Pilot Knob, Ezzo and Altschul suggest (1993b:114).

> As their name implies, these features most likely had ritual functions... Vision circles were places where individuals meditated or dreamed. Johnson (1985) has also used the term "power circle" to describe this feature. Based on ethnographic analogy, we hypothesize that vision circles were used in the following way. An individual would select a small, smooth cobble from close by and rub it as he/she sat or crouched in the vision circle .

Vision quest circles are quite numerous in and around our study area (see Results Section). Sometimes they have a cobble or small boulder in the center. Contemporary Quechan suggest that this serves as a focal point for the meditation-dreaming process (Lorey Cachora, personal communication 1997). Interestingly, Pendleton, in her work at nearby Picacho Basin, also found a number of these features, but did not relate them to traditional Quechan religious practice. She briefly entertained the thought they might be seed caches, hearths, or trail shrines, but concluded:

> We are left in the position of admitting that we have no idea what these features represent in terms of the archaeological record of the Picacho Basin. The most consistent associations are between the rock features and the mysterious Unknown A type seed. Precluding additional data which might shed some light on this issue, there is no definite evidence to support a claim that the rock features within our study area are cultural in origin (Pendleton 1986:192).

The circles in her sample ranged in size from 50 cm to 1.5 meters in diameter. She excavated a number of these features, but not surprisingly she found little in the archaeological record that could lead her to the correct interpretation of these materials. She did find what she called Unknown Type A seeds in some of them and some juniper twigs in another. In light of the ethnographically attested function of these features, it seems reasonable to suggest that seeds and juniper were used in a personal meditation ritual.

As pointed out above, vision quest circles are typically found in clusters. Contemporary Quechan suggest that spiritual leaders came to places like our study area with a small number of students. The spiritual leader would tell traditional legends, myths, and parables to help his or her students understand the connection between the material and spiritual realms. The students would be taught about the spiritual significance of the desert landscape and the mountains beyond. Part of the teaching and meditating took place at vision quest circles. Clusters of vision quest circles are analogous to classrooms where the spiritual leader and his or her students sat during this meditation-dreaming process (Lorey Cachora, personal communication 1997).

Geoglyphs

One of the hallmarks of Lower Colorado prehistory is the presence of geoglyphs. These are referred to by a number of terms, including ground figures, earth figures (B. Johnson 1985; n.d.), earthen art (von Werlhof 1987) and intaglios (e.g., Baksh 1994; Ezzo and Altschul 1993). Boma Johnson, a BLM archaeologist who has studied these phenomena extensively, has attempted to clarify the tangle of terms and refine them (1985:6-8). He argued against the use of the term intaglio because originally it referred to a process of engraving, carving or incising into a material. He points out that while some intaglios are made by scraping away the ground surface in a way that would be similar to an intaglio process, other images are created by other processes (e.g. by tamping or foot traffic on desert pavement, or by aligning or heaping rock or gravel). While Johnson's discussion is reasonable, the term intaglio appears well entrenched, and archaeologists appear unlikely to abandon the term for the one he prefers: geoglyph.

Johnson also draws a distinction between geoglyphs that are made intentionally and those which are by-products of dance or ritual (1985:7). He argues that intentionally created geoglyphs have considerable spiritual significance, while dance patterns are important only in terms of them having been places where dances were once held. He argues for the use of the term "earth figures" to include all types of desert pavement alterations. Under that umbrella term, he suggests using three major classifications: geoglyphs, rock alignments, and mounds. True intaglios, (to Johnson this means scraped figures, typically anthropo- or zoomorphs), dance paths and dance patterns are to be called geoglyphs in this scheme. Rock clusters and rock patterns are called rock alignments, and gravel mounds and rock mounds and cairns are subsumed under the term mounds.

For the purposes of his review, Johnson (1985:9) looked at an extensive area on both sides of the Colorado from north of Needles to Pilot Knob and east along the Gila River up to the Agua Caliente area (about 80 miles from Yuma) He offers an earth figure typology (Table 3-2), with the number of occurrences for each type (1985:9-10).

Table 3-2. Geoglyph Types (Johnson 1985)

Type	Occurrences
1. Anthropomorphic earth figures	57
2. Cleared circles	50
3. Dance patterns (circular paths)	49
4. Foot Trails	48
5. Gravel mounds	43
6. Dance Patterns (non-circular)	42
7. Rock alignments (non-circular)	40
8. Geometric earth figures	33
9. Zoomorphic earth figures	28
10. Rock cairns	22
11. Rock alignments (circular)	15
12. Dance staging areas	12
13. Gravel rings	7
14. Avenidas cleared areas	5
15. Power circles	5
16. Hopscotch areas	4

In this report, we shall use the term geoglyph to refer to zoomorphic and anthropomorphic earth figures, dance patterns and staging areas, gravel mounds, rock alignments, and anthromorphs (like the Running Man), and vision quest circles. Trails are not considered geoglyphs here and were discussed previously as were features typically associated with them, e.g. rock cairns, spirit breaks, etc. The function of cleared circles is not clear, and in fact there may be a number of different functions for them. At least some of them are sleeping places or wickiup pads; they are discussed below in the section on settlement systems.

Some of the types listed by Johnson are not found in the study area. For example, anthropomorphic and zoomorphic figures which play a prominent role in the *Keruk* ceremony, are not found here, but are located at Pilot Knob to the south (Ezzo and Altschul 1993b) and the Picacho Peak area to the east (Johnson 1985:67).

Gravel mounds are not recorded for the study area, but have been noted in a number of other places in the region. They vary from one to three meters in diameter. They are often associated with dance patterns or trails (Johnson 1985:11).

Rock figures consist of linear alignments, circular alignments, and complex alignments. Approximately half of the linear rock alignments noted by B. Johnson are associated with trails. He interprets these as being possible boundary markers (1985:12). One such alignment in our study area is a long linear alignment at the Running Man site (CA-IMP-2727). It may have been a boundary marker at one time between the *Matxalycadom* (Halchidhoma) and the Quechan (von Werlhof, personal communication, 1997). Other linear rock alignments have been associated with dance patterns, cleared areas, circular rock alignments, or cairns (B. Johnson 1985:12).

Circular rock alignments, excluding residential "sleeping circles," but including circular mounds, and concentric circles are often associated with trails, dance patterns or linear alignments.

Dance patterns, as reviewed by B. Johnson (1985:11), can be viewed as a number of types. The most common for the region is the circular path type. These vary widely in size from 90 meters in diameter to small "donuts" of less than 4 meters in diameter. Another type consists of linear paths, which often have turn-around areas at one or both ends. Turn-around areas sometimes have gravel mounds associated with them. Curvilinear dance patterns are, as the name suggests, a combination of various curved segments, taking a variety of shapes. Complex dance paths are a combination of various straight and curved path segments. Many of patterns of this type are associated with other features such as mounds, cleared areas, rock alignments, turn-arounds, anthro- or zoomorphs, etc. Circular patterns are known to occur southeast of the study area, at Pilot Knob, and Picacho Peak (B. Johnson 1985:14, 68).

A type of pattern not included in his typology but recognized by B. Johnson is the amorphous, cleared, tamped area, what he termed dance staging areas. These are thought to be also the result of dance or associated activities. Amorphous tamped and cleared areas have been noted at Pilot Knob (Ezzo and Altschul 1993b), at Senator Wash (some 18 miles southwest of our study area)(Ezzo and Altschul 1993c), and in the Picacho Basin, at CA-IMP-377 (Cooley 1986:3).

Most geoglyphs are generally thought to have been made by ancestors of the various Yuman peoples. Much of this complex has been linked with Yuman spirituality and ceremonial life, as discussed previously in the section on religion. However some geoglyphs in the Lower Colorado and the Greater Southwest appear to be associated with San Dieguito materials (Hayden 1981; B. Johnson 1985:14). Dating these materials directly has proven quite difficult. As mentioned previously, attempts have been made to date the patina or desert varnish by means of cation ratios and AMS radiocarbon techniques, primarily at rock art sites. This could be applied to geoglyph sites as well; however, recent research suggests that the rate of desert varnish formation may not be constant over time and space, so that there may be insurmountable problems in using it as the basis for absolute dates (Harry 1992). Most geoglyphs probably date to the last few hundred years (B. Johnson 1985:15; von Werlhof, personal communication, 1997).

The posited function of geoglyphs in the Lower Colorado area is thought to vary by type (Table 3-3). However, some types appear to have different functions in different contexts and the function of some is only poorly understood.

Table 3-3. Geoglyph Function

Type	Function
Anthropo- zoomorphic earth figures	Religious
Cleared circles	Residential
Dance patterns	Social, Ceremonial
Foot Trails	Trade and Religious
Gravel mounds	Dance, Ceremonial, Symbolic
Rock alignments	Symbolic, Religious
Geometric earth figures	Symbolic, Social, Ceremonial
Rock cairns	Trade, Spiritual
Rock alignments (circular)	Symbolic, Social, Ceremonial
Dance staging areas	Social, Ceremonial
Gravel rings	Symbolic, Social, Ceremonial
Power circles	Spiritual
Hopscotch areas	Unknown
Avenidas	Unknown

Rock Art

Rock art has been the subject of considerable research in California and the West, although, as is the case of geoglyphs, the ethnographic record is largely silent on this topic (Hedges 1973). Excellent descriptions and interpretations have been produced for the Coso Range east of the southern Sierra Nevada (Grant, Baird, and Pringle 1968), the central Sierra Nevada area (Payen 1966), and the Great Basin (Heizer and Baumhoff 1962). Rock art occurs with considerable frequency in the Lower Colorado River area, particularly in proximity to the river, but the area has not been systematically studied (Ken Hedges, personal communication, 1997; Hedges 1973, 1982).

Rock art is generally divided into two classes: petroglyphs (designs pecked or incised in stone) and pictographs (designs painted on stone). Stylistic areas have been defined for each of these techniques or classes e.g., the Great Basin, and the Southwest Coast, by Heizer and Baumhoff (1962), based on the pioneering work of Julian Steward (1929). The Lower Colorado region is traditionally placed within the Great Basin stylistic sphere (Clewlow 1978: 620; Hedges 1973: 14-15; Heizer and Baumhoff 1962). Two subdivisions within the Great Basin petroglyph style area are typically recognized: Great Basin Representational and Great Basin Abstract. However, recent research has cast some doubt on the validity of the rock art typologies in general and that of Heizer and Baumhoff in particular (e.g. Crotty 1979; Rector 1976; Hedges 1982, 1996). As Hedges points out (personal communication 1997), when the sites upon which the typology is based are examined closely, there is little of the consistency portrayed by Heizer and Baumhoff, and considerable intra-site variability and regional contradiction.

Hedges and others (e.g. Schaafsma 1980) now view the southern California-northern Baja area for the late period as exhibiting a Yuman or Patayan style, for both painted and pecked elements. This late-prehistoric Patayan style has an abstract and a representational variant, and these contain elements of the Great Basin abstract and representational styles of Heizer and Baumhoff. This is a broader, looser grouping than the earlier Colorado Desert Representation Style of Hedges (1973:16-18), based upon a better appreciation of the complexity of rock art in the region and a reluctance to ignore this variability. This Patayan style, both pictographs and petroglyphs, is distinct from the rock art of the Mojave Desert-Great Basin.

Hedges recognizes an earlier Western Archaic style, composed primarily of abstract, non-representational elements. This underlies and forms the basis for later rock art manifestations in Sonora, Chihuahua, west Texas, southern and eastern New Mexico, western Arizona, Nevada Puebloan, Fremont, Hohokam, Lower Gila River Patayan, and Southern California Patayan. He also recognizes the possibility that some of this Western Archaic style may predate the Archaic Period and be from the Paleoindian period (personal communication, 1997). Schaafsma (1980) summarizes the Western Archaic rock art tradition:

> The oldest and most widespread rock art configuration in the Southwest attributable to the Western Archaic consists of elemental abstract designs, both curvilinear and rectilinear, similar or even identical to those found in the Great Basin of western Utah, Nevada, and eastern California. Its broad distribution and its relationship to the ancient substratum of archaic art in the Great Basin are evidence of an antiquity possibly greater than that hypothesized by Heizer and Baumhoff (1962). I believe that this general style is the material manifestation of an interrelated ideographic system formerly shared throughout by hunting-and-gathering groups in the Archaic.

Stylistic classification is now in a state of flux, but the trend in the West is toward defining a type based on elements present at a particular site (a type site) as is the practice in the study of ceramics. Thus, stylistic elements can be explicitly discussed over time and space without suppressing the complexity and variability existing in rock art (Ken Hedges, personal communication, 1997).

In the study area there are a few examples of "conventional" pecked petroglyphs, primarily composed of abstract design elements (Figures 3-6 and 3-7). However, the Indian Pass area is well known for its extensive examples of the Great Basin scratched style petroglyphs.

Malcolm Rogers is thought to have been the first to record the existence of Great Basin scratched style (Stoney 1994:34), although his notes were not published until Waters (1982b) wrote up a small excavation that Rogers conducted at Indian Pass in 1925 (Figure 3-8). The first published description of this style was provided, however, by Albert Schroeder (1952:60, also see Waters 1982a:278). Stoney (1994) inventoried some 40 sites with the scratched style petroglyphs, mostly in southeastern California southern Nevada, Utah, and northern Arizona (Figure 3-9). Stoney (1994:34) notes that scratched glyphs are very widespread in the western United States.

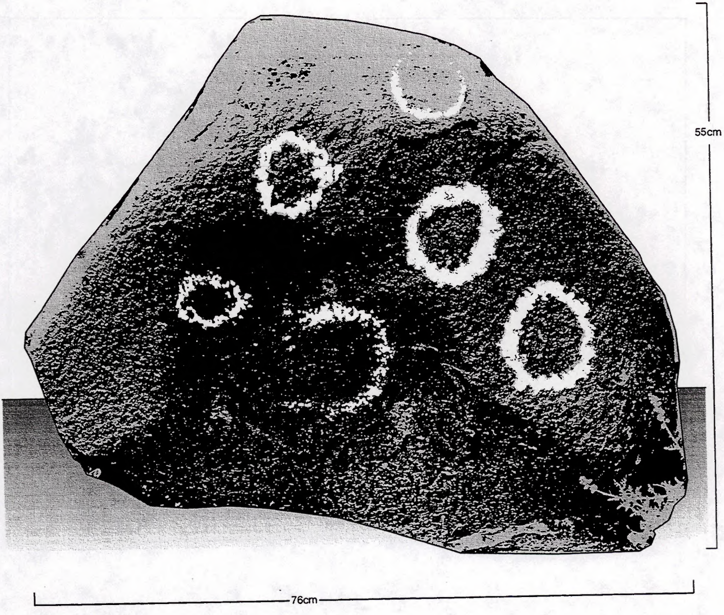


Figure 3-6. Abstract Petroglyph From Near Indian Pass (CA-IMP-201)

Figure 3-7. Abstract Petroglyphs From the Plug Site (CA-IMP-1139)

After Photographs by Ed Collins

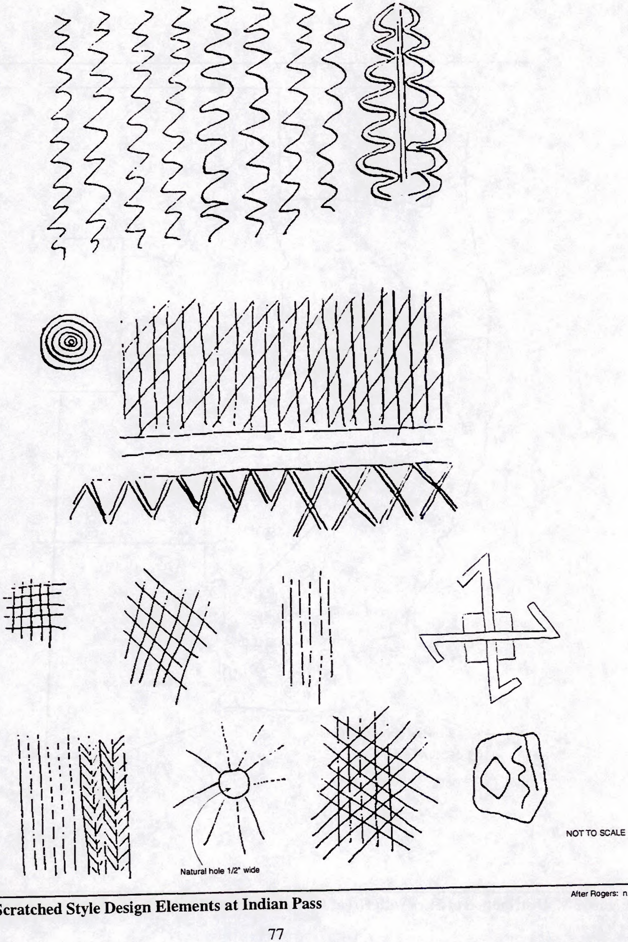


Figure 3-8. Scratched Style Design Elements at Indian Pass

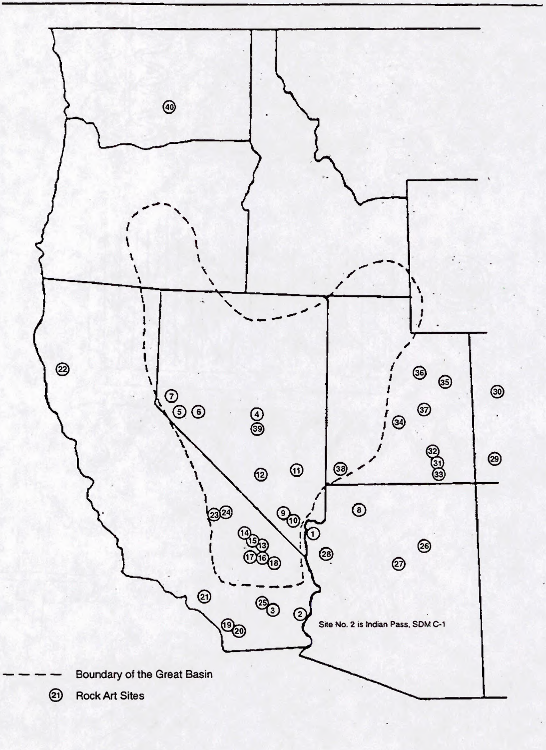


Figure 3-9. Distribution of Sites with Great Basin Scratched Rock Art

After Stoney 1994

Hedges (1982b:17; 1973:19) also points out that this type of glyph is easily overlooked or misinterpreted as modern graffiti; more careful and systematic examination may reveal a higher frequency and broader distribution of this type of glyph.

The Great Basin Scratched petroglyph style consists of lightly scratched glyphs, usually with crosshatching. The scratching appears to be made with one stroke of a sharp instrument, like a flake. Most recorded examples are on hard, dark igneous rocks, though some examples are noted on sandstone in Arizona and Utah (Hedges 1973:19; Stoney 1994:36). The examples from Indian Pass match this description for the scratched style. The scratches themselves are very fine, perhaps a millimeter wide, and average about a centimeter apart. The elements in the Indian Pass area are typically parallel lines or cross hatches forming diamond or square shapes on small boulders or large cobbles. Other design elements include a sunburst around a natural hole in a cobble, fretting, parallel wavy lines, concentric circles, a circle composed of numerous short lines, scratches in random directions, and a swastika (Rogers n.d.).

As outlined above in the discussion of petroglyphs, dating of rock art in general is fraught with difficulty, but generally these scratched style elements are thought to originate in a Patayan, post-500 A.D. time frame (Hedges 1973:19; Heizer and Baumhoff 1962:234; Stoney 1994:41). For the Indian Pass site, Rogers had some contrasting ideas relating to the dating of this scratching, left in his unpublished notes. The reader will recall that he excavated a number of shrines at this site (SDM-C-1) in 1925, published by Michael Waters in 1982.

> All shrines from top to bottom but especially in the rims contained incised lava blocks. Although some of this work might have been done by the first pottery people, some of the buried blocks had "desert varnish" over the incisions and must have been done by pre-pottery people. The designs are peculiar to the immediate vicinity and have only have been found in the south end of the Chocolate Mts... At the head of Hogue's Wash on a divide is a faint evidence of an old trail coming up from the Colorado and going on west to a big basin north of Black Mesa. On this divide is a small cobble shrine badly scattered by erosion. A few of the cobbles carry the same fine line petroglyphs as are found at [SDM]-C-1 (Rogers n.d.).

The meaning of these scratched style petroglyphs is problematic. In some settings, scratched glyphs are superimposed on other design elements, as if to somehow nullify or reduce the efficacy of them (Heizer and Baumhoff 1962). An example of this along the Lower Colorado River is at the Palo Verde Petroglyph Site (CA-IMP-268), some 21 miles north of Indian Pass near the river. In some places, like the Indian Pass site, scratched glyphs are incorporated into trail shrines, perhaps as a way of increasing the importance and power of the shrine (Hedges 1973:19). Some scratchings may consist of tally marks, particularly those found in trail settings, like Indian Pass (Davis et al. 1965).

Pictographs have also been recorded in the study area, in Indian Pass Wash (CA-IMP-205) (Figure 3-10). These are executed in red ocher. Most elements could be placed within the Patayan Representational Style defined by Hedges 1982b; a few elements are abstract. These are thought to date as far back as perhaps 850 A.D., the date Rogers posited for the onset of the Yuman cultural sequence (Hedges 1973:18; Rogers 1945). Pictographs of this style are often associated with trails and it is possible that they may have been, like trail shrines, offerings in the hope of safe passage (Hedges 1973:16). Like the anthropomorphic and zoomorphic figures in Yuman geoglyphs and intaglios, the figures in pictographs may represent mythological events and spirit beings. They may be the artistic representations of dreamed experience created by persons with spiritual power (Hedges 1973:13). Among the neighboring and closely related Cocopa, pictographs were associated with the nasal septum piercing ceremony, a boys' puberty ceremony (Hedges 1973:13).

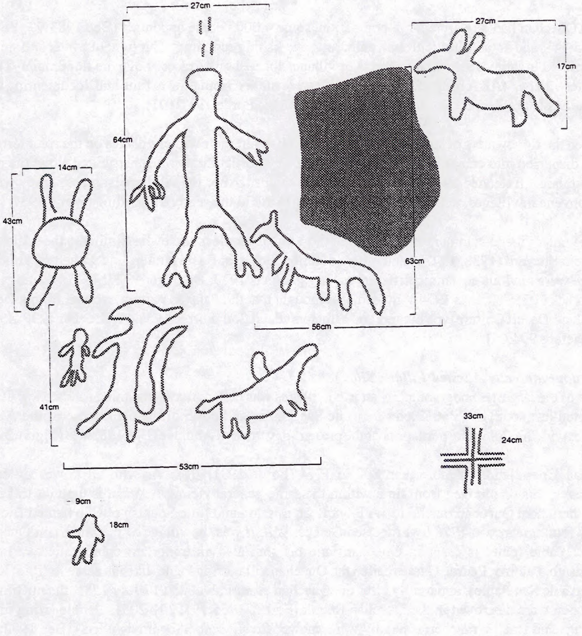
To summarize, the stylistic classification of rock art in the Lower Colorado is in a state of flux and awaits refinement based on further research (Ken Hedges, personal communication, 1997). Although it is known that pictographs and particularly petroglyphs are plentiful in the region, very little of it has been systematically surveyed nor have known rock art sites been documented in sufficient detail. Dating of these sites remains problematic. The function of rock art in traditional Quechan society is not known, but it may be associated with the dream quest, ceremonials, or shamanism.

The "Plug Site"

A single example of what might be a solar observatory site has been recorded about four and one-half miles west of Indian Pass. The "Plug Site" consists of a tall volcanic plug surrounded by an area of basalt boulders, cobbles, and desert pavement. Site CA-IMP-1139 was first recorded in 1977 by Guido Bianchi of the Imperial Valley College Museum as a petroglyph panel. When it was resurveyed in 1988, two small rockshelters and a rock ring were noted. Still later, a second smaller locus of petroglyphs was recorded. Karen and Ed Collins of Imperial Valley College made a visit to the site in early October 1995 and realized that some elements in the rock art panels might be associated with a solar solstice or equinox alignment. This began a series of visits in mid-December 1995, March 1996, June 1996, and October 1996 to make solar observations.

> As the sun continued to rise, it became apparent that the sunlight was forming a "V" or large shaft of light that cut into the disappearing morning shadow. This shaft of sunlight progressed in a easterly direction toward the rock ring. As the "V" continued down the east- facing slope, of the west bank to the wash, it became apparent that the point on the "V" was headed for the center of the rock ring. The "V" passed through the center of the rock ring and continued east Collins and Collins 1996:5).

In addition to documenting the existence of solar alignments elements in the rock art, they were also able to record ten previously unrecorded petroglyph panels on basalt boulders on a terrace on the east side of the wash. Some of these elements have re-patinated and are probably quite old (Collins and Collins 1996). Since the evidence of an Archaic Period is rare for the Lower Colorado area, these re-patinated elements may date to the Paleoindian Period (see Figure 3-7). Some of the numerous rock art panels at the CA-IMP-1139 have been sketched and photographed, but none have been



Pictographs painted with Red Ochre.

After Sketch by H. Barton on Site Form for CA-IMP-205

Figure 3-10. Pictographs from Indian Pass Wash

documented in detail to professional standards. Likewise, comprehensive, detailed drawings, measurements, and photo-documentation of the solar alignments have yet to be undertaken (Collins and Collins 1996).

Settlement System

The Quechan had a relative large population, some 4,000 people at contact (Bee 1983:97; Forbes 1965:343) and a stable horticultural, gathering, and fishing economy. Throughout winter and spring, they lived in large, seasonal rancherias or villages located on terraces above the floodplain. These winter villages (AKA residential base camps) were moved from time to time and documenting their locations is problematic at this time (Bee 1982:40-44; Forde 1931:101).

When the floodwaters of spring receded, the Quechan left their winter villages on the river terraces and dispersed into camps near their two to three acre horticultural plots distributed along the river floodplain. Extended families resided in these camps. After the fall harvest season, they would reconvene in villages on terraces above the river to avoid the seasonal flooding (Forde 1931:101).

The winter village-summer camp pattern of the Yuman people is somewhat similar to the settlement pattern Steward (1938, 1977b) and others describe for Great Basin hunters and gatherers, although there were obvious economic differences (e.g., Aikens 1970; Bettinger 1977; 1985; Jennings and Norbeck 1955; Thomas 1974). Indeed, it is thought that the Patayan pattern evolved from a Desert Archaic-Desert Culture type hunters and gatherers adaptation (Forbes 1965:41; Kroeber 1939: 45-50; Schaefer 1994:65).

Ethnographically Attested Village Sites

One of the largest ethnographically attested villages was called *Xuksil* (meaning sandstone). It was located just south of Pilot Knob (Cerro de San Pablo) and north of the confluence of the Alamo River with the Colorado, perhaps near the present-day town of Andrade (Bee 1982:41) (Figure 3-11).

It had a population of more than 800 in 1774 (Forde 1931:101). As with all Lower Colorado villages, this one moved from time within the same general vicinity. *Xuksil* is thought to be the southernmost Quechan rancheria. A Franciscan mission and little Spanish pueblo named Bicuñer was found nearby in 1776 by Francisco Garcés. *Xuksil* was the village of the important Quechan chief Pablo (chief is *cozot* in Quechan) and his son, also an important chief, called variously Ygnacio, Pablo or Pedro. Garcés called the Quechan village San Pablo, like his name for Pilot Knob (Cerro de San Pablo), apparently after the Quechan *cozot* Pablo. On 17 July 1781, the pueblo and mission were destroyed in the Quechan Revolt (Forbes 1965:191, 201-205). People living in this village and smaller rancherias nearby were known *Kavely cadom* (south dwellers) (Bee 1982:42).

Another large village near our study area was named *Amay* and located near where Araz Wash flows into the Colorado a few miles west of present-day Winterhaven and east and a little north *Xuksil*.

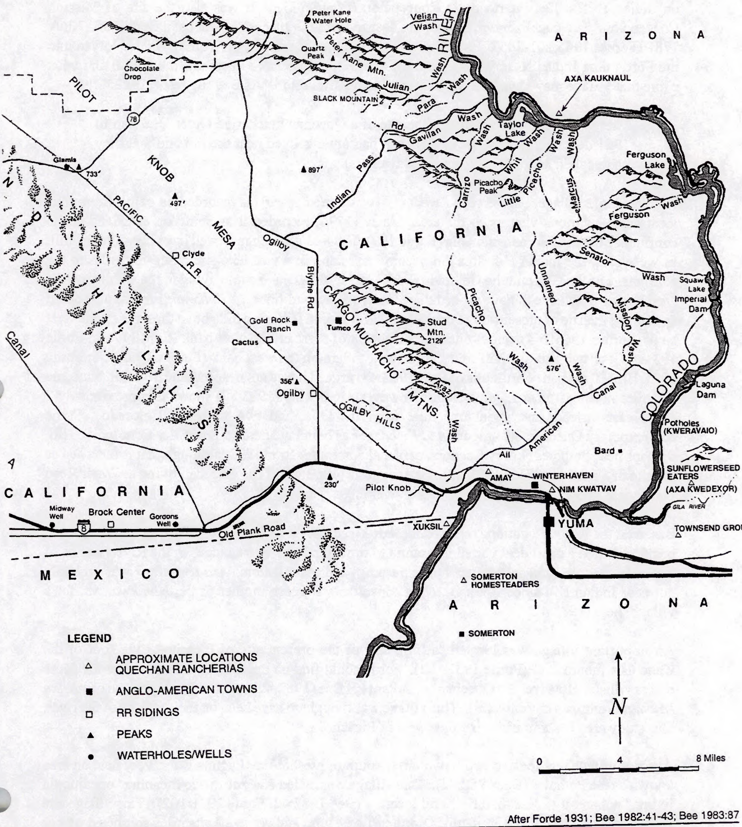


Figure 3-11. Late 19th Century Settlements

Nim kwatavav (two men fishing on each side of the river) was a village thought to be located on or near what is now known as Indian Hill, and the hill directly across River near Yuma, now spanned by a railroad bridge (Bee 1982:42). The main Spanish pueblo on the Lower Colorado was founded on Indian Hill, called Puerto de la Concépcion (Font 1775). It was also the site of Mission Concépcion. The pueblo and mission were destroyed in the successful Quechan Revolt of 17 July 1781 (Forbes 1965:201-205). Later Indian Hill became the site of Fort Yuma, which evolved into the Fort Yuma Indian Reservation. The existence of a Quechan village on Indian Hill and what name that village may have had is a matter of some discussion. As Bee suggests (1982:42)

> ...it is not clear whether it was the site of a Quechan rancheria. Older Quechan in 1961 declared that groups of Quechan had always lived near the hill and that they were called *Matxaly cadom* (north dwellers).

Another large village, named *Axa Kwedexor* (water reed place) is recorded as being in various locations by various visitors to the area. Anza (1774) recorded it as being on an island at the confluence of the Colorado and Gila (Forde 1931:100-101), which may well have been Indian Hill. In wet years, the Indian Hill area did become an island in a vast lake stretching for miles at the confluence of the Gila and the Colorado (Forde 1931:100-101). People living in the vicinity on the west bank would have to have moved there under those conditions. *Axa Kwedexor* was also noted as being at the site of present-day Fort Yuma (AKA Indian Hill) on a hill above the river on the west bank (Forbes 1965:164), about one mile northeast of there on the west bank (Font 1775 in Forde 1931:100) or two and one half miles northeast of there on the west bank (Forbes 1965:158; Forde 1931:101). Quechan consultants of Bee (1982:43) argued it was not near Indian Hill at all, but some 15 miles northeast near Laguna Dam. However, Bee's map (1983:87) shows it approximately 7 miles east instead, and about one mile from the Gila, and two from the Colorado. Some contemporary Quechan also report *Axa Kwedexor* as being upstream a few miles from Indian Hill, perhaps near Potholes (Lorey Cachora, personal communication 1997) although that is recorded as the site of *Kweravaio* (Bee 1982:42). Bee suggests (1982:43), "The Quechan living at Water Reed Place were known as *akít kwemác* ("sunflower [seed?] eaters")."

Based on the various locations reported for *Axa Kwedexor,* it seems reasonable to conclude that the position varied a great deal varied from time to time in response to changes in the River, deaths of important people (and subsequent house burning) and other factors. *Axa Kwedexor* was probably not near Indian Hill since Bee's Quechan consultants suggest another name, *Nim kwatava,* for a village there (1983:42).

An important village was located "a little east of the present site of Picacho at the foot of the Chocolate mountains" (Forde 1931:102). Forde could find no one who could remember the name of this village. However the Quechan consultants of Bee (1982:42) apparently suggest the name *Axa kauknaul* (humped cottonwood). This village was thought to have been on the east side of the river. Our study area is about nine air-miles west of Picacho.

A major village was located about two miles south of present-day Laguna Dam, very near an area known as the Potholes (Bee 1982:42). This village was called *Kwerav ava'io* meaning "pneumonia living," apparently a less than healthful location (Bee 1982:42; Forde 1931:102). This village site would be approximately 13 air-miles northeast of Yuma and some 20 air-miles southeast of our study area. According to Bee (1982:42), these people were also known as *mataxaly cadom* or north dwellers.

Avi Kwotapai was located on the west side of the river between the present-day towns of Blythe and Palo Verde. The term *Avi* in the name means mountain; there is no gloss for *Kwotapai.* Between 1850 and 1880 some 50 families lived there under the leadership of a man called *Akies Har Ar* (Bee 1982:43).

Xenu mala vax (meaning big lake) was located on the east side of the river in the vicinity of present-day Ehrenberg, Arizona (across the river from Blythe). Apparently, this village shifted at times from the Ehrenberg area to the Cibola area some 20 miles south of Ehrenberg (Cibola is about 21 air-miles north-north-east of Indian Pass; Ehrenberg-Blythe is about twice that.) In the 1850-1880 period, some 60 families lived at this village under the leadership of *Xo mar va atch* also known as Captain Tom (Bee 1982:43).

Avi vatai (Big Rock or Big Mountain) is a village located in the area of La Paz, Arizona, some six miles or so northeast of the Blythe-Ehrenberg area. This settlement is thought to have been established quite early in the Quechan occupation of the Lower Colorado River area, before the Spanish entrada into the area and well before the Halchidhoma and Kohuan occupation of this area during the 18th century. There are geoglyphs associated with this village site that apparently relate to origin legends of the Quechan (Bee 1982:43)

The problem of documenting winter village locations may never be satisfactorily resolved because for one thing, villages had numerous exact locations over time. A village is typically thought of as some collection of dwellings and features that exist or existed at some fixed place. In the case of the Quechan, however, the village was a collection of composite families who lived together and moved, more or less as a unit, from place to place within a constantly changing floodplain-riparian terrace environment. The annual flood of the Colorado constantly changed the gardening areas, eroding some, burying others under tons of silt. This undoubtedly changed the desirability of potential village sites, camp sites, and garden plots from time to time. The Quechan also were very serious about not wanting to be reminded of friends and family who have passed away, so they burned the houses and possessions of the dead (Bee 1982, 1983: Forde 1931). This probably also contributed to the movement of villages from time to time. The various Yuman peoples also changed territory in a very dynamic cultural landscape, as previously discussed.

Because of the Yuman pattern of frequently moving their villages, the likelihood of finding deep, stratified archaeological village sites is low. But upland village sites should be archaeologically visible and distinguishable from upland temporary camps. Summer floodplain camps and village sites located on lower terraces have probably been swept away or buried by the restless river. Further archaeological survey and controlled excavation can certainly shed light on village location issues. Indeed archaeological research is probably the only promising avenue for those who want to know more about traditional Quechan settlement systems.

Structure Types

Houses at winter villages were substantial earth-covered structures, four to eight meters square with gable roofs. They were called *ava'cope't* (Forde 1931:120). Construction consisted of heavy post and beam framing covered with arroweed thatch. Three walls and the roof was buried in sand, so that from the back they looked like small sand hills. The floors were earthen, and were excavated 50 to 100 cm below grade. These structures housed several extended families during inclement weather.

Most living activities took place under large, open ramadas. These were typically square or rectangular flat-roofed shades supported on the sides and corners with heavy posts. Roofs were covered with arrowweed. These ramadas were called *ava'metkya'.* A semi-circular, roofless brush windbreak called an *ava' tsoxw'er* is also reported. In settlements along the river, this consisted of arrowweed stems about a meter high tied to stakes driven into the ground (Forde 1931:123). Presumably these would also be constructed at temporary desert habitation sites utilizing locally available plant materials.

Summer houses were domed brush structures, circular in plan and "rarely more than three paces in diameter: (Forde 1931:122). Common among Native people of various cultural traditions in the Great Basin and the Southwest, these are often termed wickiups (Arkush 1987). While the ethnographic record attests to their use in summer camps associated with riparian horticultural plots, one can assume that wickiups and roofless brush windbrakes were utilized in desert temporary camps as well. In desert pavement areas, these wickiups and windbreaks should show up archaeologically as cleared circles (Ezzo and Altschul 1993:16-17, 34-35).

While there is some information on the Quechan life along the river, the ethnographic record is largely silent regarding their use of the desert. The main ethnographic and ethnohistoric works on the Quechan, Forbes 1965 and Forde 1931, scarcely mention the desert at all. However, because of the large number of archaeological sites in the desert away from the river, it is largely accepted that the desert was of some significance in subsistence, settlement and other cultural systems (McGuire 1982:219). Progress on these issues and the relationship between river terrace winter villages, summer floodplain camps and temporary desert camps has been hampered by the lack of controlled excavation in the area. For example, no river terrace winter village sites have been excavated on the Lower Colorado (McGuire 1982:219).

There is no ethnographic or historical data to suggest the presence of village sites within the study area. Likewise, there have been no rancheria or village archaeological sites located in the desert in our area. The tethered nomadism model of Taylor (1964) would suggest that rancherias would be located only near dependable water resources. There are such villages in the Lower Colorado Desert, located at springs or wells (e.g. San Sabastian), but no such resources are available in our area. Therefore, one would expect only temporary camps in the local archaeological record. Archaeologists use as a working hypothesis, the notion that the desert was visited at virtually all seasons to utilize different plant, animal, and lithic resources (Pendleton 1986:61), but because of the paucity of research in the area, this has yet to be demonstrated and documented (Table 3-4). The people who utilized our area in the Patayan and Historic periods probably resided in villages relatively nearby, most likely *Axa Kauknaul.*

Table 3-4. Yuman Annual Subsistence Cycle (after Castetter and Bell 1951:145; McGuire 1982:89)

Natural Cycle	Month	Agriculture	Plants	Animals	Comments
Budding of cottonwood	February		Agave harvest		Time of relative inactivity
Budding of willow and mesquite	March	Clear new land for planting		Greatest dependence on hunting; little fishing	
Spring planting	April	Early planting, clear old fields for planting	Wild rice harvest	Hunting and fishing	Planting done now if early flood occurs
Month of wild berries	May			Taking of river and ocean fish	
River reaches its peak	June	Planting		Taking of stranded fish when river recedes	Usual time for river flood, food in short supply
Mesquite beans ripen	July		Gather mesquite pods and pigweed greens	River fish taken	
Hoeing time	August		Screwbean pods gathered	River fish taken	
Green corn ripens	September	Green corn harvested	Pinon nuts collected and greens gathered	River fish taken	
Harvest month	October	Mature corn, beans and squash harvested		Rabbits and birds taken	Lots of dancing and celebrating
Frost month	November			Rabbits and birds taken	Building of winter homes
Middle of winter	December			Rabbits and birds taken	Relative inactivity
Dried cane month	January February			Rabbits and birds taken	Food supply scarce

Cleared Circles - Temporary Campsites

Understanding the archaeological manifestations of temporary camps for our Project area is far from straightforward. Among the more common archaeological features in our area are cleared circles or sleeping circles. These are typically interpreted to be the archaeological remains of a wickiup, a windbreak, or a place cleared of rocks where someone once spent the night (Begole 1973, 1974; Hayden 1965, 1967, 1976; Rogers 1938; Tuohy 1984). Rogers noted that cleared circles in the Lower Colorado area resemble those associated with ethnographically known brush windbreaks from Baja California (Rogers 1938:8; Tuohy 1984). There are two basic types of cleared circles. One has a boulder ring around its perimeter, and the other does not. Rogers (1966:47) interpreted the two types to be coeval and dating from San Dieguito times, though he also noted Late Prehistoric ones as well. Hayden (1976) suggested the rock-ringed circles were more recent in the Sierra Pinacate of Sonora, Mexico. The rock-ringed type is the more typical around the shore of Lake Cahuilla, which is a Late Prehistoric phenomenon, of course. The relative dating of these types is an open question at this time.

There appear to be regional differences as well. Some nine miles east of our Project area, at Picacho Basin, Pendleton (1982) found some 210 cleared areas in a survey-data recovery project she conducted there. Of these, only about 2% were rock outlined, while some 16% had a mound or berm outlining them. In our study area, there are virtually no rock ringed type cleared circles that appear to date to the Patayan Period. There are some very degraded rock specimens that appear to be from a San Dieguito time frame. Berm-lined cleared circles are not known for our area and they are rare or not recorded for areas other than the Picacho area. For example, Rogers does not mention them in his summary of cleared circle types based on surveys of the deserts of northern Baja California, eastern Alta California, western Nevada, and southern Arizona (1966:43-47).

Another issue with regard to cleared circles is the problem of identifying them in the field. There is some discussion of the characteristics of cleared areas among desert archaeologists, but this takes place informally, rarely in writing. A notable exception is found in Pendleton (1986:173-178).

Some cleared circles are quite clearly cultural, while others are amorphous, indistinct, and problematic (Pendleton 1986:173-175). Rogers points out that one must be quite perceptive and have the benefit of low angle, morning or evening light to discern some of them.

> The non-boulder-rimmed sleeping circles, trails, and some ceremonials are so much a part of present land forms that many are observable only under the most favorable lighting, a crosslight just after dawn or just before sunset (Rogers 1966:43).

Since archaeological survey is never limited to those times, it is highly likely that many of these more indistinct features are missed. Likewise, archaeologists unfamiliar with the subtleties of desert sites and features may not recognize them; there are some field archaeologists who simply dismiss features as non-cultural unless they are obvious, textbook-perfect specimens.

On the other hand, undoubtedly, some naturally occurring features are being recorded as cultural. As Rogers pointed out, in many cases it is difficult to tell the difference:

> There are hundreds of apparent circles and ceremonial lines of such an indefinite nature that it is impossible to determine whether they are man-made or due to natural erosion (1966:43).

Some areas on desert pavements do resemble cleared areas, but are probably the result of pooling of water after thunderstorms (Pendleton 1986:175). In our experience, these areas do indeed sometimes appear to be compacted by foot traffic. However, it is often possible to see drainage patterns that hint at a natural origin for the cleared, compacted area.

Another pseudo-cleared circle type is caused by the interaction of wind and the ubiquitous creosote bush. Soil is deposited at the base of creosote bushes as dust freed from wind by turbulence created by the branches of the bush. When the bush itself dies and disappears, the soil is sometimes left and dispersed. This process often leaves a circular area that appears to have been cleared of pavement down to the silty substrate. Actually, it is an aeolian deposit on top of the pavement. A careful student of desert archaeology can discern the difference, especially if he or she conducts a small subsurface probe around the perimeter of the problematic feature.

Because of the indistinct nature of some cleared circles and other desert archaeological features, one must make evaluations on the basis of education and experience and one's attitude toward error. A false positive error can be rectified by further research and future improvements in technique and technology. A false negative (failing to record a problematic, questionable resource) may result in a potential resource being destroyed. In terms of managing cultural resources, it would seem preferable to err on the side of over recording problematic potential resources rather than losing them forever.

The interpretation of cleared circles as wickiup pads or sleeping circles, i.e. structural remains of a temporary camp is also rather problematic. Typically, cleared circles have very few or no artifacts or domestic features associated with them (e.g., Begole 1974, 1980; Carrico and Quillan 1982; Pendleton 1986:62, 173-177; Rogers 1939, 1966:45). If cleared circles are wickiup pads, windbreak foundations, or sleeping circles, then they represent the remains of a temporary camp. While temporary camps exhibit much less assemblage complexity and variety than a village (Bettinger 1979, 1991; Grayson 1993; Thomas 1983), one would expect some artifacts that reflect food processing and other domestic activities, e.g., resharpening flakes, utilized flakes, groundstone. One would also expect Late Prehistoric Period temporary camp sites to contain at least some pottery. Likewise, one might expect some evidence of resource extraction activities, e.g., early stage reduction flakes at camp sites near quarry areas (Pendleton 1986:62).

On the other hand, if the camps were utilized while people gathered the locally plentiful pods of palo verde and ironwood, for example, then no archaeologically visible artifacts from that activity would be expected. Palo verde and ironwood may have been gathered here, then processed back at villages or camps along the river. Alternatively, if people processed these particular foods on site, the tools they utilized would probably have been large wooden mortars and pestles (Kroeber 1925:737). These would not be preserved in the archaeological record.

In a similar vein, one might also expect hearths or fire affected rock scatters (degraded hearths) to be present at temporary camps, but if the camps were used briefly in summer, a hearth may not have been necessary (Pendleton 1986:74). Likewise, it is ethnographically attested that resource exploitation parties, particularly all-male hunting parties, travel very lightly and leave scant evidence of their passing (Aschmann 1959; Gould 1968; Lee 1979; Yellen 1977). This suggests that for our study area, cleared circle complexes without associated artifacts or features may have served a different function from the cleared circles and other camp sites that do have associated flakes and other artifacts. It may not be reasonable to expect many artifacts to be associated with temporary camps if they were utilized only briefly or by people who were traveling very light. As Pendleton (1986:62) suggests, temporary camps that were occupied for a single, brief episode will be nearly invisible archaeologically.

To summarize our model, a Patayan or Historic Period archaeological deposit would be more likely to represent the remains of a temporary camp if it exhibits some or most of these attributes. Cleared circles without any of these attributes may still represent the remains of a campsite, but one that was only briefly occupied, or occupied by a party traveling with very little baggage. Such cleared circle complexes may have functioned differently in the local settlement system than campsites with associated artifacts. The presence of some of the following attributes certainly strengthens the interpretation of a collection of cleared circles as a temporary camp.

A village (residential base camp) would have these attributes as well, but such a site would be larger and have much more artifact density and assemblage complexity (Bettinger 1979, 1991; Grayson 1993; Thomas 1983). There are no such sites within our study area.

Temporary camps in our area may have functioned in a number of ways in the local settlement system: It can be presumed that they all were temporary satellites supporting villages along the Lower Colorado River; the nearest known village was *Asa kunaul.* Some of the temporary camps in the study area may have functioned as places from which to gather plant resources, primarily pods of the palo verde and ironwood, or grass seeds. Mesquite, the most favored wild plant food among the Quechan, is not found in our study area and grasses, another important resource, are not plentiful. However, the near ubiquity of flaked stone debris in our Project area suggests that the area was heavily utilized as a lithic procurement area; some temporary camps must have been associated with lithic procurement activities. The large number of small geoglyphs suggests that some camps may be associated with local ceremonies or shamanistic activities. The numerous spirit circles and shrines in the study area suggests that some more solitary sleeping circles probably functioned as places where a shaman or a select few spiritual leaders spent the night while they dreamed, worshiped and studied.

Trails and Exchange

Upon first glance, one might think trails are a straightforward cultural item of little complexity. This is far from the actual case. Trails in the desert are footpaths that link various places of importance to prehistoric inhabitants. Trails are an important adaptation to this rocky, hot, harsh environment. They figure prominently in the settlement, subsistence, and exchange systems. But they also have spiritual significance to the various Yuman peoples as well. The physical characteristics of trails and how they functioned in various cultural systems of the prehistoric inhabitants of the area will be explored here.

Exchange

There has been considerable archaeological and ethnographic research on the subject of trails and exchange (e.g. Davis 1961; Heizer 1978; Johnson 1985; Rogers 1941, 1966, n.d.; Sample 1950; Woods 1982, 1986). Exchange between the Pacific Coast and the Great Basin and pueblos of the Southwest has considerable antiquity, and of course, it took place over trails.

> Shell beads are the most anciently documented trade item, the evidence being the occurrence at Leonard Rockshelter, Pershing County, Nevada, of a string of about 50 large, spire-ground *Olivella biplacata* beads dating from about 6,600 B.C. whose source was the central California coast. Implied by the presence of a complete string of Olivella beads some 250 miles from their source are intervening peoples who passed these items on by intertribal trade (Heizer 1978:691)

Exchange and mobility for the Yuman people is well documented (Davis 1961; Forde 1931; Forbes 1965; Harwell and Kelly 1983; Kroeber 1925; Sample 1950; Stewart 1983) . For example, Forde (1931:105-106) documents "sporadic traffic with the western Pueblos" particularly with the Zuni and Hopis. He goes on to say:

> Within the river territory, however, the Yuma and the other tribes traveled freely and over long distances. Bands of "Yumas" and "Cocomaricopas" journeyed down to the gulf to meet Kino and his party. War parties would travel for days with very little food, covering over a hundred miles to fight a battle; and in modern times Trippel claimed that the messengers and trailers were expert runners who could cover sixty to seventy-five miles a day when necessary (Forde 1931:106).

Forbes (1965:109) summarized the extensive exchange along the Lower Colorado in the following way:

> The Colorado River Tribes were involved in widespread trading activities at the time of Oñate's visit. From the western coast they were obtaining shells, "which they make into squares...which are very sightly." The shells were large and "shining" and may well have been abalone shells. The natives were also obtaining "coral" from the Gulf of California. All along the river the Indian women had coral, which was gathered by one particular group of Indians who sold it to the others. These "Coral Coast" Indians are identified as part of the Ozaras (Ootams) by one chronicler...The Indians of the Colorado were in contact with the natives of the mountains to the west, for Oñate found acorns among the Ozaras which they had obtained from the latter area. In the 1800s, the Kamias of the Imperial Valley-Colorado River region were obtaining acorns from the mountain Kamias to the west. It was said to be a three-day journey from the river to Jacumba, in the mountains.

Based on a number of ethnographic accounts, James Davis provided a list of items that were traded to and from the Quechan (1961:45). This list, which is presented in Table 3-5, will give the reader a rough idea of the kinds of things that traveled over the trail system of the Lower Colorado. It is obvious that many of these products were bulky, heavy or otherwise difficult to transport in any quantity (e.g. maize, beans, melons, acorns, buckskin). The list can be considered in no way a complete account of commerce among the Quechan.

Trail Attributes

Trails were always single file. They link places of importance to people like resource procurement areas, settlements, and ceremonial sites. Prehistoric human trails are sometimes mistaken for big game trails, and vice versa. The fact that human trails link places of importance to people is one way to distinguish human trails from animal trails in the desert. Burros and deer are common along the lower Colorado River, and both often utilize prehistoric trails. The fact that one finds burro or deer sign on a trail does not rule out the possibility that it was previously used by prehistoric populations,. Prehistoric trails tend to be about 35 cm wide, though they range from 20 to 50 cm (von Werlhof 1987:13). Burro and deer trails tend to be narrower (they have smaller feet). Human trails also have artifacts and trail features along them. If one follows a desert trail, some evidence of human activity should be encountered within a half mile or so if it was indeed used by humans.

Table 3-5. Quechan Trade (after Davis [1961])

Group	Product
Quechan Exports	
Western Yavapai	Glass trade beads, dried pumpkin, maize, beans, melons
Cahuilla	Gourd rattles
Kamia	Tobacco
Kumeyaay	Gourd seeds
Quechan Imports	
Western Yavapai	Rabbit-skin blankets, baskets, buckskin, other skins, mescal, finished skin dresses
Mojave	Gourds, eagle feathers
Pima	Martynia pods used in basketry
The Northeast	Buckskin
Kumeyaay	Acorns.

Prehistoric Indian trails tend to avoid proceeding in a straight line; they tend to curve and weave their way over the landscape as if dancing with friendly spirits or dodging evil ones. Historic Anglo-American trails, in contrast, hew to the straight line of efficiency (von Werlhof 1987:13).

Archaeologically visible trails in the lower Colorado area tend to be through desert pavement or stable alluvial areas. They typically disappear when they drop into a wash, since the soil in a wash gets churned and redeposited after every major thunderstorm. Washes in the desert are often used as jeep trails as well, which also tends to destroy whatever archaeological evidence that might have otherwise survived. However, washes were indeed utilized as prehistoric travel corridors and one sometimes sees intermittent trail segments on hills and terraces paralleling washes. A trail may drop into a wash for a while, then climb out, then drop back in, then out, and so on. Of course, it would be visible only where it runs through geologically stable areas.

One occasionally finds a trail placed low on the edge of a drainage. It is thought that these low-lying trails and wash trails may have been utilized prehistorically by warriors attempting to travel undetected through enemy territory or by non-combatants trying to avoid hostile warriors (Weldon Johnson, personal communication, 1997). In our study area, most detectable prehistoric trails are on the shoulders and tops of ridge systems, relatively stable alluvial fans, and other upland areas. These areas typically have better footing and less vegetation to tangle with than washes; they are easier places to walk.

Trail Construction

Trails appear to be created primarily by repeated use (von Werlhof 1987:13). The recurring use tamps down the desert pavement, discourages plant growth, and creates a visible path that can be followed the next time out. Sometimes, however, one finds evidence of heavy labor in trail construction. For example, the Indian Pass Trail, located within our study area, passes through a pavement that has numerous basalt boulders embedded in it. Hundreds of heavy rocks some weighing up to perhaps 100 pounds were moved to make a clear path through this boulder field (Rogers 1966:23-24; von Werlhof 1987:13). The Trail of Dreams or Mojave War Trail, a north-south route running through our study area, also crosses areas of boulder fields and shows evidence of strenuous labor in its creation. According to recent testimony from a Native American consultant associated with this project, sometimes trails may be created by dragging a log over rough ground to make a mark for others to follow (Lorey Cachora, personal communication, 1997).

Major Trail Systems

The term trail is often used to describe major trail systems across the desert, but in reality, the singular trail across the countryside is rare. Generally, there were trail systems consisting of a network of alternative routes connecting important places. Alternative paths came together to form one or very few routes in passes or near springs or waterholes (Davis 1961:10), after which they would again split and fan out over the more open terrain. While the term trail will be used here, it generally refers to a system of alternative routes.

Forbes (1965:109) suggests that there was a major trade route from the Palo Verde Valley, on the Colorado some 17 miles southwest of Blythe, to the Los Angeles basin. This basic route evolved into U.S. Route 66 and then present-day Interstate 40. It is called here the Cocomaricopa Trail (see Figure 3-12). The Bahacecha, or Vacecha tribe in the account of Oñate (1605), which Forbes (1965:103) argues were the Quechan, evidently carried on a fairly brisk trade with the Pacific Coast that included what appears to be an account of a steatite bowl from Catalina Island (Forbes 1965:109). Quechan myths also tell tales of Catalina Island (Lorey Cachora, personal communication, 1997). Captain Otata of the Bahacecha, suggested that they made it from Palo Verde Valley, to what appears to be the Long Beach-San Pedro area in five days. There were major Gabrieliño-Tongva villages in this area with close ties to Catalina Island. Garcés writing in 1774 found the Halchidhomas in the Palo Verde area; they also traded with the Pacific coast, and said the trip took four days (Forbes 1965:109).

There was also a major east-west trade trail system, called the Yuma Trail, over which the Quechan traded with the Kumeyaay of Imperial Valley and San Diego. This same basic route is now known as Interstate 8. A number of trail segments have been recorded in and around the study area. Malcolm Rogers (n.d.) conducted extensive trail research in the region beginning in 1925. He left notes and sketch maps suggesting a number of trail locations that relate to our area (Figure 3-12). Jay von Werlhof, of the Imperial Valley College Museum has also conducted considerable trail research in the Lower Colorado region over the years. Also, with the advent of environmental mandates of the 1960s and 1970s, contract archaeologists have been increasingly active in the region. This has resulted in the recordation of a number of local trail segments (Figure 3-13). Many of the trails recorded in our area are apparently secondary trails linking temporary camps, resource areas, and so on, while others are portions of primary trail systems such as the Trail of Dreams (Mojave War Trail) and the Indian Pass-San Sebastian Trail. More research will be necessary to determine the destinations of trail segments that have been recorded thus far and their relationships with regional trail systems.

In addition to the importance of trails for trade, travel, and communication, among the Yuman peoples of the Lower Colorado, trails have a religious and spiritual significance that can scarcely be overemphasized. As discussed above, dreaming is a major source of power and insight among

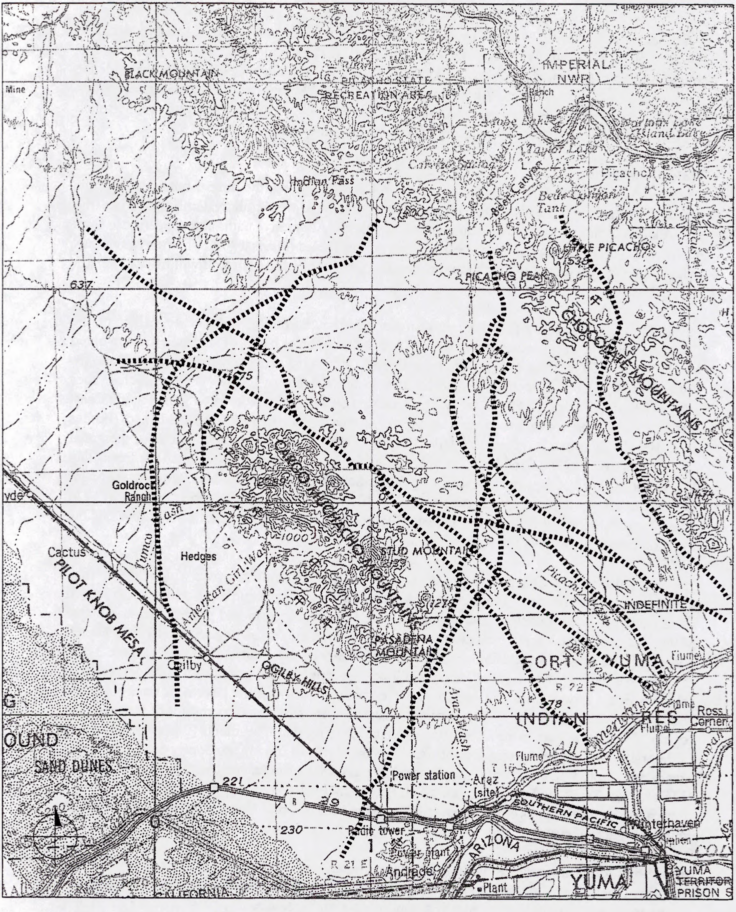


Figure 3-12. Trail Map by Malcolm J. Rogers (Date Unknown)

After Pendleton 1986:181

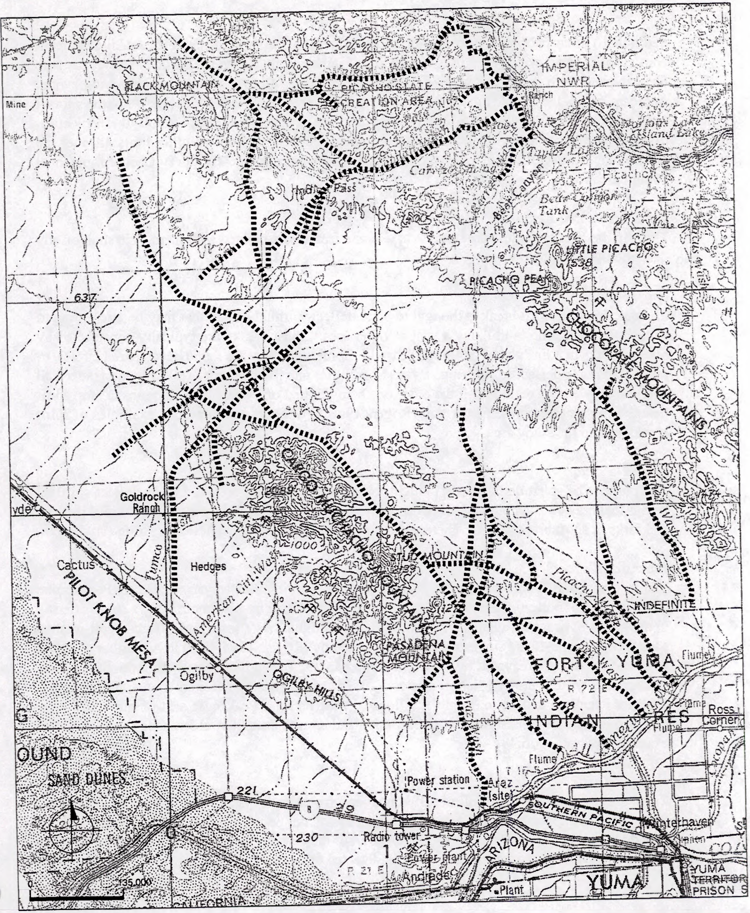


Figure 3-13. Previously Recorded Prehistoric Trails

Based on Archeological Survey Maps, IVC Museum traditional Yuman peoples. An important recurring theme of the spiritually significant kind of dream consists of dream travel over trails to mountains of spiritual significance. This dream travel can take one back and forth in time, as well as along traditional trails all over Yuman territory and beyond. In dream travel, the people have direct access to the events of creation, which also involves travel over traditional trails. This is primarily a mythical pilgrimage from Pilot Knob to *Avikwaame*. There are other creation stories and other mythical journeys that utilize other trails all over the Greater Southwest (Preston Arroweed, personal communication 1997; Lorey Cachora, personal communication).

Trail Associated Features

Trails in the Yuman culture area tend to have some features associated with them. We shall briefly describe the types below.

Spirit Breaks

The purpose of a spirit break is thought to be to deflect spiritual beings that may be attempting to follow someone who is utilizing a trail or other area. Spirit breaks are typically constructed by placing rocks in a line across or alongside trails. Sometimes they are found near cleared circles, or other features to deflect spirit beings away. Sometimes one finds a spirit break where an older trail is crossed by a later period trail; the older one being closed off with a line of stones to stop spirit beings from getting on the newer trail (Rogers 1966:51). There are numerous examples of spirit breaks within the study area.

Spirit Deflectors

The purpose of spirit deflectors is thought to be similar to spirit breaks, i.e., to deflect spiritual beings that may be attempting to follow someone utilizing the trail. They are characterized by dead end forks or short branch trails. There are numerous examples of spirit deflectors in the study area.

Cairns or Shrines

These consist of piles of small rocks. In shrines utilized during the Patayan or Historic Periods one also finds bits of pottery. They were created by travelers passing by who contributed a small offering in the hopes of assuring against sickness, injury, or fatigue. As attested by Quechan consultants, each traveler deposited a single stone as they passed by (Rogers 1966:49-51). A number of cairns were recorded and excavated by Malcolm Rogers in 1925 in Indian Pass, within our study area. These were written up by Michael Waters (1982d) on the basis of Rogers' notes and sketches. Another excellent and large example, is located near Picacho Peak, just east of our study area. Sometimes shrines consist of pebbles cast upon and around a small boulder, as is the case in this example (Rogers 1966:48).

Parallel Trails

There are places where two trails of different ages run alongside one another. This is interpreted by Rogers to have spiritual significance, in the sense that later people (presumably Quechan or some Yuman people) being reluctant to walk in the trail of the dead (Rogers 1966:51). This has not been identified in the study area, but may exist undetected or in unsurveyed areas.

Temporal-Cultural Context
Placing trails into temporal and cultural context is difficult. The more recent prehistoric examples often have pottery associated with them or with cairns on or near the trails. This enables the researcher to date these trails to some degree and to assign them a cultural affiliation as well. However, as Rogers points out, this is not without difficulties:

> Those which have potsherds on their margins are not difficult to assign culturally because of the characteristic Yuman ceramic types present. This does not preclude the possibility, however, that the Yumans in some instances used the trails of more ancient peoples (Rogers 1966:47).

Additionally, the chronology of Lower Colorado river ceramic types remains open to question. Trails segments utilized exclusively in pre-pottery days often lack any kind of temporal indicator other than the degree of weathering and desert varnish. As discussed previously, there are considerable difficulties with using these as temporal indicators (Davis 1966; Harry 1992). Unfortunately, weathering and patination are often the only characteristics available to the archaeologist. As previously pointed out, there is ongoing discussion about older assemblages for the Colorado Desert. They too are viewed as problematic (e.g., Schaefer 1994; Weide 1976) because they are defined in the desert primarily on the basis of weathering and patination, not controlled excavation (e.g., Davis and Panlaqui 1978; Hayden 1976; Rogers 1939). Therefore, even when tool types thought to be of San Dieguito or Malpais age are noted on a well-patinated trail, the assignment of that temporal period is best viewed as a good working hypothesis, rather than an empirically demonstrated fact.

Most of the trails recorded within the study area are thought to date to the Late Prehistoric; the primary exception is what Rogers called the Pre-Colombian trail, the most northerly of several leading into Indian Pass from the west. There are other, smaller trail segments that may also date to the San Dieguito Period. Further research and synthesis will be required to sort out the temporal placement and cultural context of the extensive system of trails along the Lower Colorado.

Technology

The technology of the prehistoric people who occupied the study area is another important aspect of their culture. Major categories of technology are discussed below.

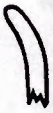
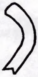
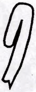
Ceramics
Using the Rogers-Waters model (Waters 1982), ceramics appear in the archaeological record of the Lower Colorado with the Patayan I at approximately 1,200 B.P. Patayan I wares appear to be primarily limited to the Colorado River vicinity. Pottery of the Lower Colorado is all made by coiling and thinned and smoothed with the paddle and anvil technique. Some small pieces are modeled. Sedimentary (riverine) clays are utilized. Firing is done in an oxidizing atmospheres and usually pieces are well-fired and much harder than nearby Tizon Brown or Paiute Brown wares (Waters 1982a, 1982b).

Five Patayan I Period types of Lower Colorado Buffware are defined (700 to 1000 A.D.) based primarily on surface treatments, jar rim form, and vessel form, with paste and temper given secondary consideration (Waters 1982a:281). These are known as Colorado Beige, Colorado Red-on-beige, Colorado Red, Black Mesa Buff, and Black Mesa Red-on-buff. The Black Mesa types were originally defined from materials recovered by Rogers at Indian Pass (Waters 1982:558-559). The basic types are Colorado Beige and Black Mesa Buff. Colorado Red is Colorado Beige with a burnished red slip. At the Indian Pass Site (SDM-C-1), Rogers excavated two pit shrines containing the remains of 70 to 100 Patayan I vessels, mostly Black Mesa Buff. Santa Cruz Red-on-buff, a Hohokam Colonial Period type dating from 700 to 900 A.D. was associated with the Paytayan I materials. This site was instrumental in Rogers initial definition of Lower Colorado Ware and what are now known as Patayan I types, particularly the Black Mesa types (Waters 1982a:281-287) (Figure 3-14).

The Patayan II phase coincides with the creation of Lake Cahuilla by a shift in the course of Colorado River. The lake covered much of Imperial Valley from about 950 to 1500 A.D. (Wilke 1978). This phase is characterized by the discontinuation of some vessel forms and ceramic traits: direct chimney necks on jars, the Colorado Shoulder, burnishing, red clay slip, rim notching, punctate and incised decoration, lug and loop handles. New ceramic traits include recurved rims, stucco finish, an increase in fine-lined geometric designs and new vessel forms (Rogers 1945:188, Waters 1982a:287). Five types of Lower Colorado Buffware are defined for this period: Tumco Buff from our study area, Parker Buff and Topoc Buff from Lower Colorado areas well north of our study area, Palomas Buff from along the Gila River, and Salton Buff, associated with the 12 m shoreline of Lake Cahuilla (Waters 1982:287). These had red-on-buff decorated equivalents. Patayan II ceramics are dated primarily as a result of their association as intrusives in Hohokam sites (Waters 1982a:290) (Figure 3-15).

The last phase, Patayan III, began around 1500 A.D. as Lake Cahuilla began its final recession (Rogers 1945; Wilke 1978). Colorado Buff became the predominant pottery type (not to be confused with Lower Colorado Buff Ware), both in the desert and along the river during this time. Parker Buff and Palomas Buff and their decorated equivalents continued to be made well into historic times (Waters 1982a:290-91). Colorado Buff and Colorado Red-on-buff have been noted at the San Diego Presidio (1769-1837 A.D.) and vessels exist in collections at the San Diego Museum of Man made in the late 19th and early 20th centuries (Figure 3-16).

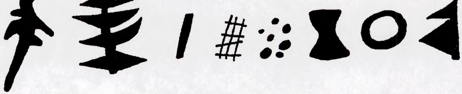
Forde (1931:123-4) documented Quechan pottery making during his fieldwork in 1928-29. Little pottery was being made at that time, but he was able to elicit information from Quechan women who recalled pottery making from the time of their youth (mid-19th century). During this period, the number of pottery types had declined. They made ollas, or water jugs *(kwil'lyo)*, from 18 inches to 2 feet tall. *Kwil'lyo* (ollas) of two kinds were made. A carrying olla *(axa'nyamopa'iv)*, which had a narrow and strongly flared neck, and a heavily built storage olla (*halyose'v*). The latter was as tall as 2 ½ feet and nearly 2 feet in diameter (Forde 1931:124). A spherical cooking bowl *(tu'ckin)* was made, that measured from 8 inches to 1 ½ feet tall; a serving bowl (*kwiski'*) from about 9 inches to 1 foot high, an oval roasting dish *(kate'l)*; and a dipper (*kamotu*), used for serving (Forde 1931:123) (Figure 3-17). A very large bowl (*Kate'lhakem*), with a shape similar to the *kwiski'* was made to ferry goods and children across the river. This was typically four feet across (Forde 1931:123).

1. Direct rim, rounded lip 
2. Direct rim, roughly flattened lip (lipped) 
3. Slight recurved rim, rounded lip 
4. Recurved rim, roughly flattened lip (lipped) 
5. Recurved rim, finely finished flattened lip 
6. Reinforced rim band 

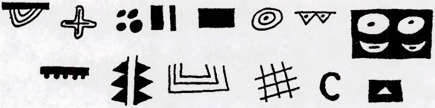
Patayan I	=	Shapes 1, 2, and 3
Patayan II	=	Shapes 3, 4, and 5
Patayan III	=	Shapes 4, 5, and 6

After Waters 1982a:282

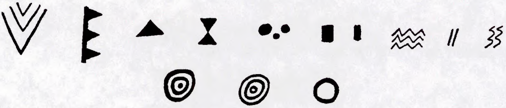
Figure 3-14. Lowland Patayan Pottery Rim Forms



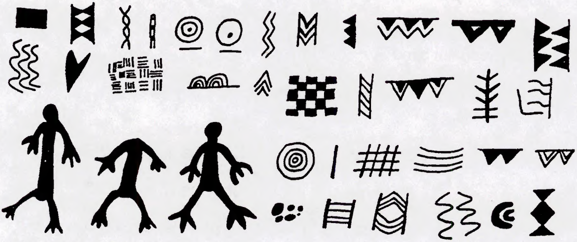
Black Mesa Red-on-buff design elements



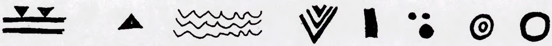
Colorado Red-on-beige design elements



Salton Red-on-buff design elements



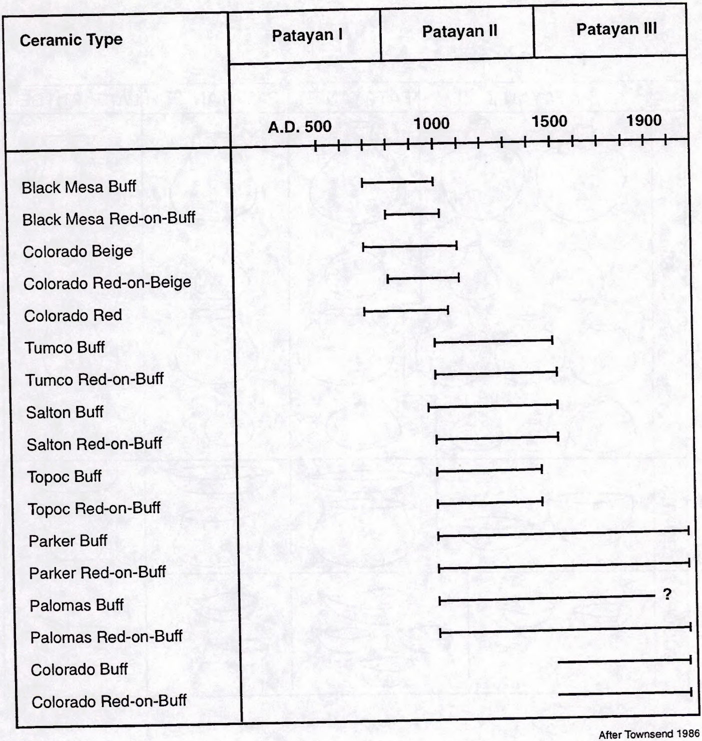
Tumco Red-on-buff design elements



Palomas Red-on-buff design elements

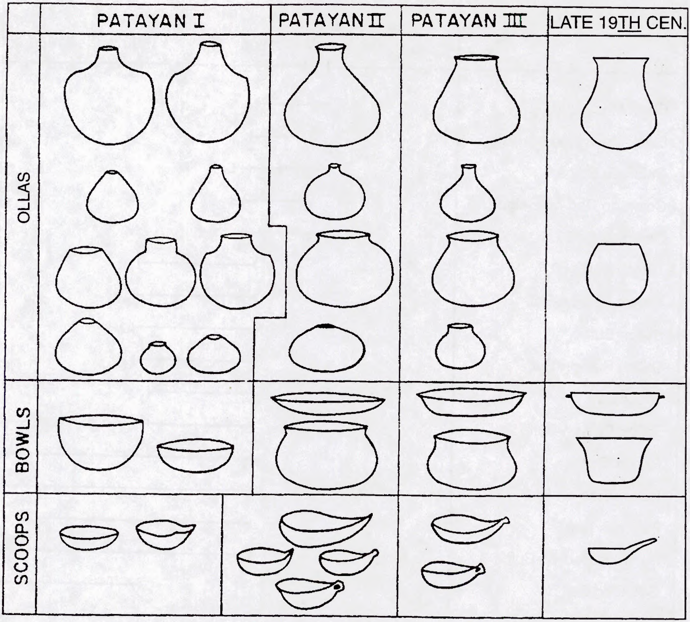
Not to Scale

Figure 3-15. Design Elements of Decorated Patayan Pottery Types of the Indian Pass Area After Waters 1982b



After Townsend 1986

Figure 3-16. Proposed Dates for Patayan Pottery Types



After Forde 1931:123; Rogers 1945; Waters 1982a:282

Figure 3-17. Common Vessel Forms of the Lowland Patayan Ceramic Tradition

Forde describes pottery making techniques of the day (1931:124):

> Red clay from the mesa was soaked in water and mixed with finely ground decomposed granite from an outcrop to the north of Yuma. The damp mixture was wrapped in willow bark or rags and buried a few days. The pot was built up by coiling, using a rounded pebble anvil, *kwilazai* and a curved paddle of mesquite wood *kwiskokye*, after which it was sun-dried for a day. Lugs, but not handles were made. Black and red paints were sometimes applied with a bark brush. The paint frequently covered the entire outer surface of the pot. Mrs. Roosevelt remembered seeing geometrical designs in two colors (Black and dark Red), but never made any herself.

In a recent archaeological review, Schaefer (1992b) notes that Patayan II and III buff ware types are now known to be more widely distributed than previously thought. Both Tumco Buff (Patayan II) and Colorado Buff (the Patayan III type) are now well documented for the west shore of Lake Cahuilla, as well as their original locations along the Lower Colorado in our study area. The vast majority of ceramics noted in our study area were Tumco Buff Ware (Patayan II) and Hedges Buff Ware (Patayan III). Hedges Buff ware is a very recently defined ware first documented by Schaefer (1992b) based on work Hedges-Tumco area just south of our study area. This is a very late Patayan III type. It is distinguished from Tumco Buff by crushed sherd temper; Tumco Buff has clay fragment temper (Waters 1982:562). Vessel shapes of Hedges Buff are influenced by Anglo-American and Mexican culture. Indeed, some of it may have been produced for sale to Anglos and Mexicans, as was the case for Parker Buff in the Fort Mojave area (Schaefer 1994b:87). Tumco Red-on-buff is the decorated elaboration of Tumco Buff, first documented by Rogers from the Palo Verde area north of our study area, and south of Blythe (Waters 1982:563). It is characterized by a thick bright red ochre paint setting well into the paste. While Waters suggests Tumco Buff was discontinued at around 1500 A.D., Schaefer (1994:84) cites radiocarbon data to suggest that it continued to be made until about 1700. He further suggests extending Patayan II to that date. The differences between Hedges and Tumco Buff are quite subtle, and in fact, the separation of the two is a matter of some discussion at this time.

Waters (1982d:574-6) provided some limited data on pottery sherd counts from the collections of Malcolm Rogers for our study area. The reader will recall that Rogers made extensive collections, now housed in the San Diego Museum of Man (and elsewhere), which remain largely unanalyzed and unpublished (a notable exception is the work of Waters 1982a, b, c, and d). For site SDM-C-1, the Indian Pass site, Waters described the results of Rogers' test excavation of several shrines:

> All shrines contained Patayan I pottery types and a few shrines contained sherds of Santa Cruz Red-on-buff. Patayan II pottery types occurred on the surface, indicating a later use of the shrines. Shrines 1 and 2 contained a combined total of 70 to 100 Patayan I vessels or parts of vessels, and Shrines 3, 4, 5, and 6 had a combined total of about 35... Together, Shrines 1 and 2 contained sherds from 70 to 100 Patayan I vessels, mostly Black Mesa Buff, with lessor amounts of Colorado Beige and still fewer examples of Black Mesa Red-on-buff and Colorado Red. A few intrusive sherds of Santa Cruz Red-on-buff, and some shell, bone, and stone artifacts were also recovered (Waters 1982c:533,534).

Santa Cruz Red-on-buff is a Hohokam Colonial Period ware dating from 700 to 900 A.D. This site was instrumental in Rogers initial definition of Lower Colorado Ware and what are now known as Patayan I types, particularly the Black Mesa types (Waters 1982a:281-287).

Black Mesa Red-on-buff is the earliest of the local decorated wares. Like Black Mesa Buff, it is made of poorly prepared sedimentary (riverine) clays with no temper. Unpulverized clay particles occur in the finer, processed clay paste and act somewhat like temper. Decorations in both Black Mesa Buff and Red-on-buff include rim notching, and a minor amount of punctuate, incised, and thumbnail patterns on the necks of jars. Black Mesa Red-on-buff painted decorations are crude and probably applied with the fingers. Paint consists of a thick, fugitive, dull-red ocher resulting in a range of color from maroon to bright red in well-oxidized specimens (Waters 1982:558-559).

Site SDM-C-1N is the trail that heads north from the Running Man Site southwest of the Project area, through what Rogers called Black Mesa Pass (just southeast of what the USGS calls Black Mountain), through Quartz Peak Pass (southeast of that peak) and on through broken terrain to the River.

> When it goes through Quartz Peak Pass, there is a small trail shrine greatly disturbed by erosion. Besides the usual cobbles and dirt, the shrines contain nothing but Yuman I and a few Yuman II sherds. The saddle in the pass is very narrow and the approaches steep. Consequently much broken pottery of a accidental nature has slid down both sides. This is a typical resting place common to all trails which climb over steep divides (Rogers site form SDM-C-1/ C-1N, p.2).

Waters (1982:577) notes that Rogers found a minimum of 103 vessels along this trail segment including the following pottery types: Black Mesa Buff, Black Mesa Red-on-buff, Colorado Beige, Colorado Red-on-beige, Colorado Red, and Tumco Red-on-buff.

Site SDM-C-43 is located about three quarters of a mile southeast of Indian Pass, along what Rogers calls Black Mesa Wash, probably what appears as Indian Wash on the USGS Quartz Peak 7.5 minute map. This is within our study area, and about two miles north of the Project area. Rogers describes this site, on the SDM-C-1 site form, as follows:

> ... a large resting area (SDM-C-43) on a mesa margin. Very many ollas were broken here, so many in fact that it may indicate a surface sacrificial area. At SDM-C-43-B two miles south of the pass on the margin of Black Mesa Wash is another concentration area of broken pots mostly of Second Period age which probably indicates a camp area for gathering ironwood and palo verde beans The Yumas even in late historic time occasionally visited this area on food gathering trips.

SDM-C-43 yielded the following sherd counts from the Rogers collections at the Museum of Man: Black Mesa Buff 37; Colorado Beige 67; Colorado Red 12; Tumco Buff 110 (some with stucco finish); Salton Buff 4 (some with stucco finish); Tizon Brown Ware 2.

Sites SDM-C-84 and SDM-C-70A, are part of a trail complex that goes from Midway Pass to the Yuma area that Rogers called the Mojave War Trail; the Quechan now call this the Trail of Dreams.

This trail begins in the Yuma area, passes east of the Cargo Muchacho Mountains, through the Running Man Site, across Indian Pass Road, and passes west of Black Mountain to the north of the study area. Waters (1982:577) lumps this with SDM-C-70E, which goes from Pilot Knob to Indian Pass west of the Cargo Muchachos, and SDM-C-70D/C-86 that goes from Pilot Knob to Picacho (the *Keruk* Trail). Rogers noted a minimum total of 137 broken vessels for these trails, all of which are in or near our study area (Waters 1982:577). The following pottery types and wares were recorded as being present, but no percentages or totals by type are available. Black Mesa Buff, Colorado Beige, Colorado Red-on-beige, Tumco Buff (some with stucco finish), Tumco Red-on-buff (some with stucco finish), Parker Buff (some with stucco finish), Topoc Buff (some with stucco finish), Salton Buff (some with stucco finish), Salton Red-on-buff (some with stucco finish), Colorado Buff (some with stucco finish), Tizon Brown Ware, and Hohokam buffware.

Site SDM-C-83 is also part of a trail complex that goes near the Project area and crosses the transmission line corridor. It is documented in Rogers' notes as a 17 mile trail from the dunes near Pilot Knob passing along the north side of the Cargo Muchacho Mountains where it is superimposed upon what Rogers called the "Mohave War Trail," known to the contemporary Quechan as the Trail of Dreams (Preston Arroweed, personal communication, 1997; Lorey Cachora, personal communication 1997). Northwest of the Cargo Muchachos, the trail bends west and crosses Ogilby Road at the junction of Indian Wash and Ogilby Road. From there it heads west toward Lake Cahuilla. Rogers noted a minimum of 242 broken vessels along this trail (Waters 1982:577). The following pottery types and wares were noted: Black Mesa Buff, Colorado Beige, Colorado Red-on-beige, Colorado Red, Tumco Buff (some with stucco finish), Tumco Red-on-buff (some with stucco finish), Salton Buff (some with stucco finish), Salton Red-on-buff (some with stucco finish), and Colorado Buff.

Salton Red-on-buff is a Patayan II type similar to the Salton Buff. The latter is thought to date from about 950 to 1500 A.D., while the Red-on-buff apparently occurs at about 1000 A.D. Both are characterized by occasional inclusions of freshwater mollusk shell, with well-rounded coarse to fine beach sand temper. Decorations of the Red-on-buff type are made with both finger and brush techniques; paint was red ochre or limonite base mixed with a fixative (Waters 1982:564-565)

Colorado Red-on-beige, another decorated type noted by Rogers in our area, is a Patayan I pottery dating from about 800 to 1050 A.D. Our study area marks the approximate southern edge of its distribution. Colorado Beige and Red-on-beige are characterized by its distinctive beige color, soft, friable nature, and abundant temper of rounded quartz, feldspars, lithic grains with some mica. Colorado Red-on-beige is the most common decorated Patayan I pottery type. Decoration consists of thick geometric and occasional zoomorphic elements possibly drawn utilizing finger techniques. Burnishing was typically applied after painting. A thick red paint of iron oxide is used.

In a data recovery effort conducted by Pendleton (1986) at Picacho Peak some nine miles east of our Project area, a small amount of pottery was recovered. Types included Tumco Buff, Salton Buff, Colorado Beige, and Black Mesa Buff.

Recent survey research within the Project area has resulted in the documentation of four Lower Colorado Buff Ware potdrops, but the type/variety were not determined (e.g. Schaefer and Schultze 1996:34). This has been a relatively common practice for survey level research. Schaefer and

Victorino 1996) noted Palomas Buff and Palomas Red-on-buff within the transmission line corridor. The distribution of this type is centered on the middle Gila River around the Dome Mountains and Agua Caliente and has previously been thought to be confined entirely to Arizona (Waters 1982c:568). Schaefer and Victorino did not describe the process by which they arrived at their pottery type conclusions; it is possible that Palomas Buff and Palomas Red-on-buff have been improperly identified for our study area.

Palomas Red-on-buff belongs to the Paytayan II and III periods, dating from ca. 1000 to post 1900 (Waters 1982c:568-69). Like Palomas Buff, it is characterized by inclusions of fine mica and abundant temper of medium grains of rounded white feldspars and quartz. It often rather soft, and often has a friable fracture. Surface color is most often grey but varies to tan. These types have recurved rims with flattened lips; reinforced rim bands appear in the Patayan III period. The decorated type is characterized by a ochre paint producing a dull red color. Brushwork is typically poorly executed.

From the above discussion of the work of Rogers in the study area beginning in 1925, it is apparent that the study area once had very numerous pots, pot drops and extensive sherd scatters. The portion of the study area that has been subject to archaeological survey reveals much less pottery now. Large amounts of ceramic materials (and other archaeological materials) have probably been picked up by rockhounds, ORV enthusiasts, prospectors, and others who frequent the area. It is important to realize that samples of ceramics selected now will not necessarily reflect prehistoric populations of ceramics for the area. Fortunately, Rogers collected extensively from the area. Although the provenance he provides is quite poor by today's standards, it is still possible to use these collections to advantage, as Waters has done (1982a, b, c, and d). It is reasonable to believe that his sample is more representative of what was on the ground prehistorically than what remains in the area now. Also, there are numerous whole pots, restored pots, and large sherds in the collections which may help researchers further refine the Rogers-Waters typology in terms of vessel shapes and related issues.

Flaked Stone

Due to their technological importance to Native Americans and their durability, flaked stone materials comprise the most common class of artifacts in most archaeological assemblages throughout the Desert West, including the Project area. Very little was recorded ethnographically regarding flaked stone production and use, primarily because most stone tool use was replaced early in the Spanish colonial period. As a consequence, archaeological methods are the major source of information regarding this important aspect of Native American culture. Recent archaeological research has focused attention on the utility of flaked stone to provide information on a relatively broad suite of cultural behaviors. Generally, this has included (1) technological analysis of stone tool acquisition and production, especially in relation to how this behavior reflects organization of work groups, settlement/mobility patterns, and craft specialization; (2) functional analysis of tools and assemblage composition to address issue of prehistoric subsistence behavior and site function; (3) diachronic analysis of raw material acquisition to investigate changes in territorial range and mobility; and (4) morphological-temporal classification for dating purposes.

Tools, Technology, and Chronology

Archaeological projectile point typologies based on morphological features have been shown to be reliable indicators of rough temporal placement of assemblages (e.g., Thomas 1981; Thomas and Bettinger 1976), although some controversy exists as to how other factors, such as, reuse affect the usefulness of these typologies (Flennikin and Wilke 1989). Projectile points, however, are quite rare in the study area for at least two reasons. One is that the Quechan often did not use projectile points on arrows:

> Their arrows, propelled from simple, unbacked bows, had relatively weak penetrating power, made weaker when used (as they often were) without points (Bee 1983:89).

The other issue is that the study area has been subject to extensive visits by artifact collectors, off-road-vehicle users, prospectors, and rockhounds. All kinds of formal tools, including projectile points, and ceramic sherds are likely to have been picked up selectively by these people.

With the exception of the early tool component discussed below, formal tools of all types are rare in the Project area. Utilized flakes may be present in some quantities, but distinguishing use wear from naturally occurring edge attrition is problematic (Bamforth 1988; Bamforth et al 1990; Greiser and Sheets 1979; Sampson 1982). Field identification of use wear is a hazardous enterprise at best (Young and Bamforth 1990), since it has been demonstrated that one must experiment with local lithic types to see how local rock fractures and how use damages edges or creates polish. Also, it is generally accepted that edge wear analysis of surface materials is fraught with difficulties (Keeley 1980; Tringham et al. 1974). Arguments for the presence of utilized flake tools based upon field survey should therefore be accepted with great caution. It would be much more reasonable to conduct the necessary experiments and then examine, under high power magnification, archaeological tools or flakes posited to have been utilized prehistorically. To the degree that it could be demonstrated that informal flaked stone tools dominate the assemblage, this would have implications regarding settlement and mobility patterns. Some research suggest that groups with high residential mobility tend toward highly curated, formal, multifunctional tools such as bifaces (Kelly 1988). Conversely, work groups traveling relatively short distances from residential villages may be expected to utilize less formal, "expedient" tools, especially when suitable raw material is locally available. Such expectations must be tempered, however, by a clear understanding of the "lithic landscape," which also affects lithic technology organization (Adrevsky 1994). This model arguing for a definitive relationship between formal tools and settlement system has yet to be demonstrated for our area.

Lithic tool manufacturing waste comprises the vast majority of artifacts within the study area. In related research in the Picacho Basin several miles east of the study area, Pendleton (1986) demonstrated statistically a number of widely accepted, common-sense understandings about the distribution of chipping stations and flaked lithic materials. She noted that the frequency of a particular lithic raw material decreases as one gets farther from the source (1986:92-3). This is sometimes known as a gravity model. In the case of the Picacho Basin, she noted that quartz outcrops occur in the Cargo Muchacho Mountains, and that quartz lithic scatters and chipping stations increased in frequency as she approached the Cargo Muchacho Mountains. Likewise, she observed increased frequencies of basalt chipping stations as she approached the Chocolate Mountains, named for the dark brown colored basalt found there. She also ran several linear regression analyses and discovered that lithic debris increased in two directions: (1) as one approached the river, where all permanent settlements were, and (2), as one approached the lithic source-quarry areas, in this case, the east slope of the Cargo Muchacho Mountains (1986:96). Studies like these could be productively applied in our study to determine if the frequency of chipping circles and lithic scatters changes with regard to distance from the Chocolate Mountains or the Cargo Muchacho Mountains.

Pendleton (1986:108) also deals with the difficulties of identifying prehistoric quartz chipping stations in her work in the Picacho Basin; the same situation holds true for the Project area, and for all lithic material types, not just quartz:

> One of the problems with the analysis of the quartz chipping stations is that it was extremely difficult to determine whether the feature is prehistoric. Many of the quartz chipping stations appeared fresh; several appear smashed, and fine powder adheres to the surface of the debitage. Through a series of interviews conducted with local rockhounds in Yuma and El Centro, we discovered that the Picacho Basin is a favored rock collecting locale, as well as being a famous gold mining area. We eliminated several chipping stations which were identified by rock hounds, but we were left with an uneasy feeling about the quantity of quartz debris.

In her work in the Picacho Basin, Pendleton also noted the occasional presence of what appeared to be anvil stones. In her area, these appear to be associated with basalt quarries and initial reduction of large basalt cobbles from which large pestles were made presumably for the processing of mesquite, ironwood, or palo verde pods. There are numerous embedded cobbles and small boulders in the Imperial Project area that are pecked and probably related to lithic reduction. Within our study area, these pecked stones often appear associated with chipping stations and lithic scatters of chert, rhyolite, and other materials.

Anvil stones can be employed in direct percussion, indirect percussion, and bipolar reduction. No focused research on lithic technology issues, anvil stones and chipping stations has been conducted in the Project area to determine lithic techniques employed or what role the anvil stones played, if any.

Early Lithic Tools

The presence of early lithic tools still remains an unresolved issue in the Project area for many researchers. Von Werlhof (1984) has identified early tools during inventory work within the Project area, but Schaefer and Schultze (1996) and Schaefer and Pallette (1991) noted the absence of most tools and did not identify this category of artifact during their inventory work.

As mentioned in the chronology sections, there are some serious differences of opinion with regard to the archaeological manifestations and the posited dates relating to early time periods (Schaefer 1994). Some of the more dramatic early, pre-Paleoindian dates have been revised (e.g., the Yuha and Truckhaven inhumations [Taylor et al. 1985]). Controversy over early human occupations in the California deserts remains, and much of it revolves around lithic tools, toolkits, and technology issues. On one side are the researchers with extensive amounts of desert field work who believe that there are numerous early human cultural manifestations in the California Deserts, usually referred to as Malpais and San Dieguito, Phases I, II, and III. Their conclusions are based on perceived differences in assemblage technology, morphology, weathering, and patina (e.g. Begole 1973, 1981; Childers 1977, 1980; Hayden 1987; Minshall 1976; Moriarty 1987; Rogers 1966; and von Werlhof, personal communication, 1997) and a basic premise that focuses on cultural versus natural geologic explanations. On the other side are those who are highly skeptical of cultural and temporal conclusions not based on more rigorous data, like radiocarbon dating (e.g., Pendleton 1986; Schaefer 1994) and whose premise focuses on natural geological explanations over cultural explanations for unclear data. Many archaeologists have become skeptical of the Malpais (early man, pre-projectile point) period, and find the posited distinctions between the San Dieguito Period phases difficult to distinguish. However, most appear to accept the concept of the Paleoindian Period (e.g. Schaefer 1994; Warren 1966, 1967; however, see Gallegos 1987).

Begole (1973:36) presents a brief discussion of the Malpais toolkit (Figure 3-18) based on his work in the Anza-Borrego Desert State Park. Almost all Malpais materials are highly weathered and patinated core or cobble-based tools made of vesicular basalt:

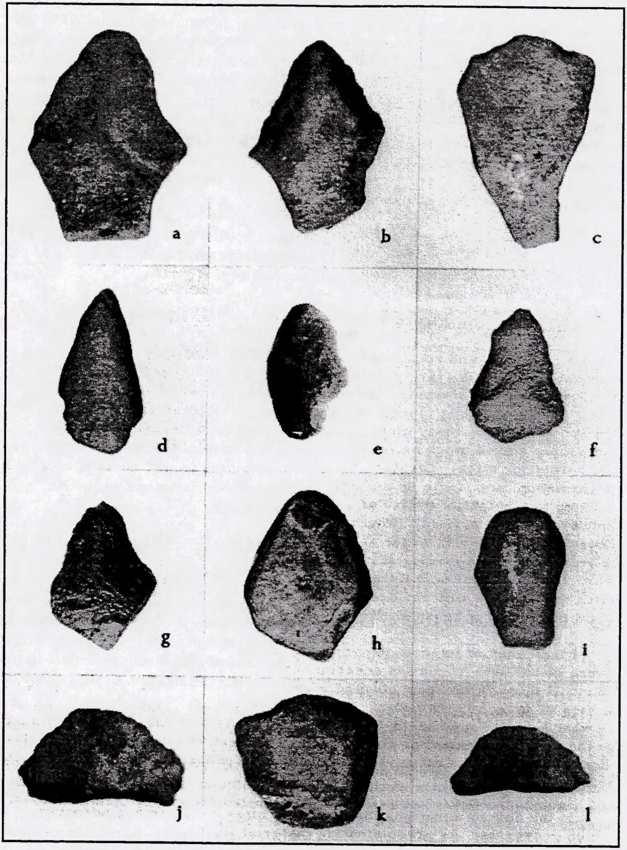
> In assembling a possible Malpais tool kit, I have considered only material that was found either at the edge of or in the cleared circles. The general forms emerging have been ostensively of vesicular basalt... They include picks with shanks...; end scraper with shank...; spear-shaped tool with indentations (for hafting?)...; pick with large flake removed (for hafting or hand hold?)...; picks...; heart-shaped tool with right edge sharpened...; end scraper with shank...; crescent "cabbage choppers", shaped similar to present day metal cabbage choppers...; and cleaver, shaped like a single bladed axe... Occasionally three or four of these tools are found together on the edge of a circle. No hammerstones can be identified with any surety, nor have any adjacent large flat stones ever shown traces of having been hammered upon. One portable and several buried anvil stones have been noted.

Because of the high degree of weathering, technological and functional analyses of proposed Malpais tools are virtually impossible.

The San Dieguito I tool assemblage consists primarily of crude, hard hammer percussion flaked materials (Figure 3-19). Like the posited Malpais industry, heavy duty core tools dominate the collections from this period. Cores consist of amorphous, multidirectional types, and prepared platform types, somewhat hemispherical in shape with a relatively flat striking platforms. Rogers divided the San Dieguito culture area into geographical aspects, our area is in his central aspect.

> Amorphous cores have flakes removed from a number of faces, and no pattern can be discerned. Such workshop evidence has been found on nearly every San Dieguito I site in the Central Aspect (Rogers 1966:24, 156).

Crude, thick, core-based bifaces are also frequently found (Rogers 1966:157). Hemispherically shaped planes and scrapers (horsehoof planes) are also typical. There are also various choppers, scrapers, and hafted mauls made from cobbles with few flakes removed. Some flake tools exist, including teshoa flake knives. Teshoa is a Ute term for a cutting tool made by striking a flake from a rounded cobble (Rogers 1966:156). Quartzite, porphyry (felsite) and basalt were commonly used in San Dieguito I, and materials from this period are highly patinated (Begole 1973:39).



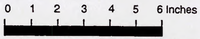
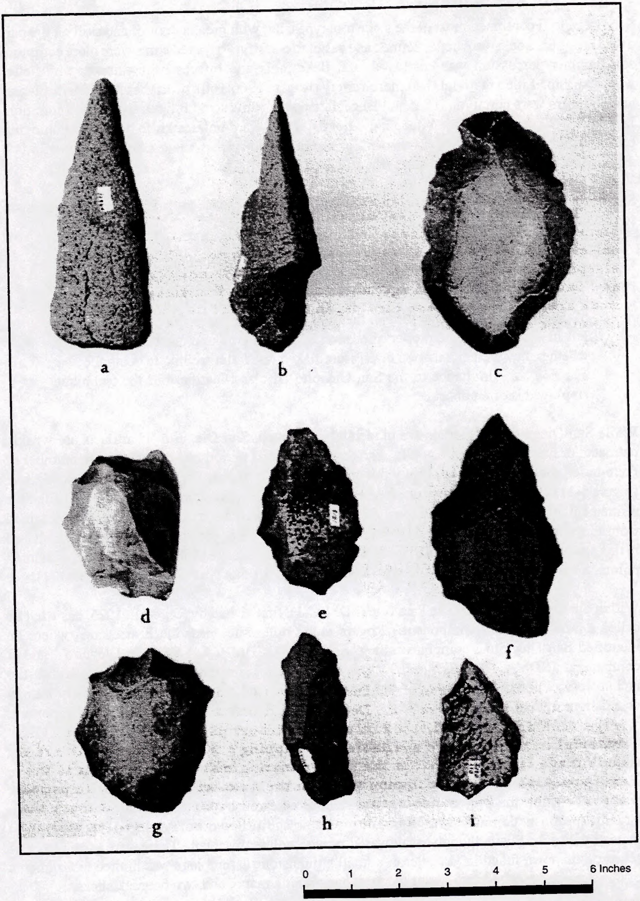


Figure 3-18. Malpais Tools

After Begole 1973:40



After Begold 1973:40

Figure 3-19. San Dieguito I Tools

San Dieguito II continued most of the same tool types, but with greater control and skill on the part of the knapper. Tools were better defined and easier to classify. Prepared cores were more common, soft hammer percussion was employed, and flake tools and bifaces were thinner, with better workmanship. Lithic materials had more variety (Rogers 1966:160). Core-based scrapers, planes, and choppers were common. Leaf and lanceolate points-knives and bifaces were more common. In Figure 3-20, a, b, and c are biface knife-points; d and e are uniface knife-points; f is an ovoid biface; g is a left-handed side scraper-knife; h is an end scraper; i is a side-end scraper; j is a discoidal scraper; k is a reamer; and l is a drill (Begole 1973:44).

San Dieguito III is a continued refinement of San Dieguito II; stone tools from the two phases are somewhat difficult to distinguish, as Rogers points out (1966:87):

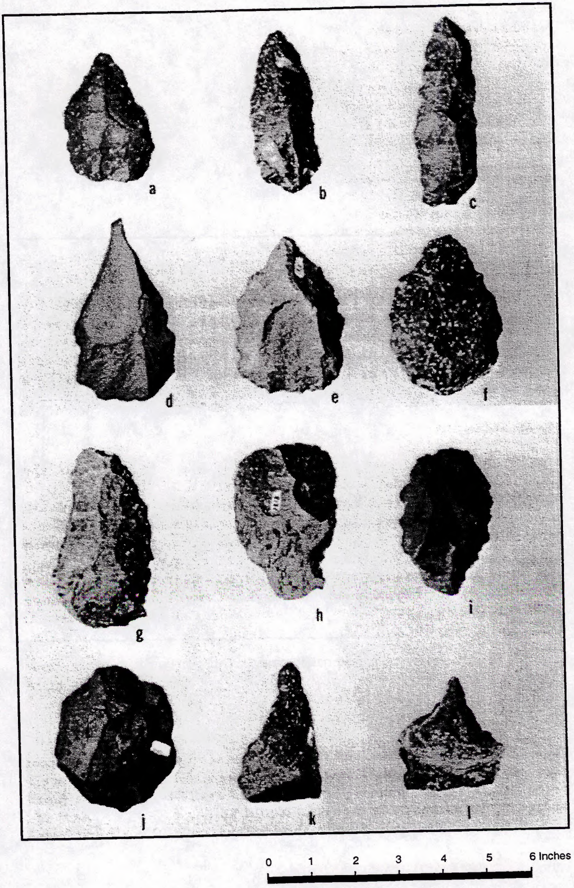
> ...there exists a considerable residue of a transitional nature which makes it difficult to assign a specific type of artifact either to the second or third phase. Many items carry an intermediate degree of alteration, and since a deep or thin patination is one of the criteria for the separation of the tools of the two phases, the classifier is often left in doubt. For the proper allocation of these items one must also determine whether they were percussion or pressure flaked, the latter technique being the *sine qua non* for admittance to the San Dieguito III classification, but the technique employed is often obscure.

While San Dieguito II materials are moderately patinated, San Dieguito III artifacts are weakly patinated or have no patination at all. The San Dieguito III period had a much greater number of flake-based tool types, and the heavy duty core tool types of San Dieguito I and II became rare (Figure 3-21). Bifaces continue from the San Dieguito I phase, but finer of form, with considerable refinement in flaking technique. Jasper, chert and obsidian were used and these were often obtained from some distance (Rogers 1966:61). Rogers places a number of projectile points and knife shapes in this phase including ovoid, leaf-shaped, leaf-shaped bipoint, Lake Mojave, Silver Lake, and fluted points. Cresentics are also a distinctive San Dieguito III artifact type (Rogers 1966:168-171).

Within our study area, the Indian Pass Site (SDM-C-1), first visited by Rogers in 1925, has what he called a San Dieguito I component. Rogers found other sites near the Project area where he identified San Dieguito I components (e.g. SDM-C-70, SDM-C-86) and San Dieguito I and II components (SDM-C-43). While the phases of San Dieguito remain controversial within the archaeological community, some of the more respected and active researchers of early human occupations of the Lower Colorado Desert continue to find these distinctions useful and important.

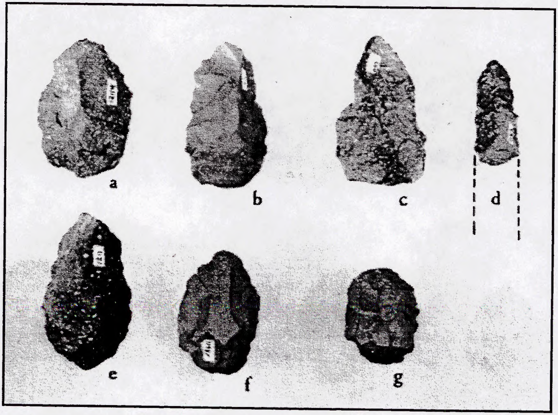
Groundstone

Groundstone has been recorded only rarely for the study area. Of the groundstone specimens known, most are made of basalt available in the nearby Chocolate Mountains. One possible bedrock slick was noted within the project area during previous research by Schaefer and Schultze (1996). Granitic specimens dominated the groundstone assemblage in the work of Pendleton (1986:142-145) in nearby Picacho Basin, though basalt was almost as well represented. There were a few pieces of schist of unknown function. Pendleton's small groundstone assemblage was limited to fragments of three granitic metates, two basalt metates, one granitic mano, and two bedrock slicks.



After Begole 1973:43

Figure 3-20. San Dieguito II Tools



Possible San Dieguito III tools, material porphyry except **g** of basalt. **a** and **b**, scraper knives; **c**, knife/point; **d**, lanceolate blunt point, broken; **e**, scraper/knife; **f**, ovoid scraper/ knife; **g**, small plane

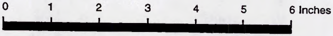


Figure 3-21. San Dieguito III Tools

After Begole 1973:46

Pendleton (1986:147-167) also noted a basalt quarry area composed of several sites where a number of large basalt pestle or two-handed mano blanks were recovered; their average length is 29.1 cm (Pendleton 1986, Table 31, after p. 160). These sites were in the Chocolate Mountains quite near the River. Besides these pestle preforms and associated flakes, the site assemblage included heavy spherical hammerstones, heavy angular hammerstones, and small spherical pecking stones. Spherical hammerstones were rare and tended to be associated with decortication and early-stage shaping. As mentioned above, a number of cobble anvil stones were also detected. These consist of cobbles naturally embedded in the desert floor, which exhibit some evidence of pecking or crushing (Pendleton 1986:151, 156). Pendleton does not mention the bipolar lithic reduction technique, presumably because she saw no evidence for it. However, she and her research team explored direct and indirect percussion technique issues in some length.

To this end, replicative lithic experiments were conducted by Richard A. Cerutti. He attempted manufacture of replicas by direct percussion and indirect percussion using stone punches. Cerutti (1986:172) concluded from these experiments that direct percussion using a heavy, angular hammerstone is the more efficient technique, and probably the one used prehistorically.

As pointed out above, very little groundstone has been recovered within the Project area. However, there may be groundstone quarry sites like those recorded by Pendleton (1986:147-167) in unsurveyed areas toward the Chocolate Mountains in the northeast portion of our area. Lorey Cachora, Quechan cultural resources consultant, suggested that may indeed be the case (personal communication 1997). Millingstone quarries along the Lower Colorado have only recently become defined and recorded beginning with the work of Pendleton (1986) and Bruce Huckell (1986). Subsequently, a number of millingstone quarry areas have been investigated, and considerable light has been shed on manufacturing techniques (e.g. Schneider 1993a, 1993b), but study of this industry is still in its early stages.

While metates and manos are associated with grass and other hard seed processing, large wooden mortars and pestles are typically associated with processing of mesquite and similar foods like palo verde and ironwood (Kroeber 1925:736-7). However, both the Mojave (Bourke 1889:177; Kroeber 1925:736) and the Quechan (Forde 1931:116) are known to have also utilized large stone pestles with wooden mortars for processing these foods. The large basalt pestle blanks discovered by Pendleton (1986) may relate to the plentiful palo verde and ironwood resources in wash environments like those of the Project area as well as to the mesquite found closer to the Colorado River.

Conclusion

Several themes emerge from this integrated review of the ethnographic and archaeological materials for the Indian Pass study area. A very important issue, underappreciated in the archaeological community, is the unique role of dreams in the Yuman religious system and how that relates to trails and associated features. Dreams figure prominently in legend and song, in the pursuit of knowledge, and power (*sumak*) (Bee 1982:49-50; Lorey Cachora 1994:14; personal communication 1997; Forbes 1965:63; Forde 1931: 201-202; Kroeber 1925:754; Weldon Johnson, personal communication, 1997). Among the Yuman peoples, dreams are tied closely to the natural and cultural landscape. In dream, people typically travel along trails leading to mountains of religious significance where important spirits reside (Kroeber 1925:754-755). Trail systems linking major ceremonial centers (e.g., Picacho Peak, Pilot Knob, and *Avikwaame* [Newberry Peak]) with each other and with habitation areas are understood to have important religious significance. These trail systems were used for actual religious pilgrimages between major ceremonial centers, local ceremonial centers, and villages as part of the *Keruk* ceremony as well as spiritually significant dream travel. Some of these trails also figure prominently in ancient origin myths and other traditional religious parables of pan-Yuman peoples. The religious and spiritual significance of trails, added to the well-recognized importance of desert trails for trade and travel, provides a portrait of trail patterns as an extremely significant heritage resource. This is a resource that has sometimes been poorly understood, underesteemed, and poorly protected in the past.

Another theme to recently emerge from ethnographic and archaeological research in the region is the religious significance of geoglyphs and their association with the *Keruk* ceremonial cycle. Based on ethnographic materials of Forde (1931) and Bourke (in Forbes 1965), Altschul and Ezzo (1994) reconstructed what major and local Keruk ceremonial sites should look like archaeologically. In arid environments away from the river, the archaeological attributes of these sites may include the presence of anthropomorphic, zoomorphic, and abstract intaglios or geoglyphs; dance circles; winding, amorphous dance path and staging areas; cleared circles; and white quartz scatters.

The spiritual significance of white quartz among Yuman peoples has also not been widely recognized. White quartz scatters are typically found along trails that approach intaglios. White quartz is thought to contain power and purification properties. As an individual approached an intaglio site or other sacred area, he or she would shatter some milky quartz, freeing spiritual forces. Purified and empowered by releasing the spiritual energy of the hard, white rock, the person could then proceed to the sacred site itself (Altschul and Ezzo 1994:55). A reasonable working hypothesis, then, is that white quartz scatters in the Yuman area, particularly those in association with geoglyph or other sacred sites, may have spiritual significance rather than being chipping stations. The presence of quartz scatters should alert the archaeologist to the possibility that the area itself may have spiritual significance or that there may be geoglyphs in the area. On the other hand, quartz was in fact used for tool stone, so quartz scatters should be looked at carefully regarding technological issues relating to tool manufacture.

Another archaeological manifestation of the spiritual life of Yuman peoples is the vision quest circle. These are typically rock rings between one-half and one meter in diameter. Some of them have a cobble in the center: a focus stone. These small rock rings are identified ethnographically as a place for the practice of meditation or dreaming. Vision quest circles are often encountered in small clusters, suggesting use in teaching. This may constitute archaeological evidence of a spiritual leader and a small group of students studying and meditating together. Contemporary Quechan consultants suggest this is typically how traditional knowledge is transmitted (Preston Arroweed, personal communication, 1997; Lorey Cachora, personal communication, 1997). The spiritual and religious significance of vision quest circles has not been widely recognized in the archaeological community.

Finally, the existence of scratched-style petroglyphs concentrated in the Indian Pass area, abstract and figurative petroglyphs at the Plug Site, and abstract and figurative pictographs in Indian Pass Wash also argue for the spiritual significance of the general area. The interpretation of these rock art elements is problematic, but generally they are thought to have ritual, ceremonial, and/or religious significance. None of these sites have been documented in detail. The Plug Site may also be a solar observatory site, but more detailed research is required to confirm this. An observatory site would also have spiritual significance.

The local settlement system is also poorly understood. There are numerous cleared circles recorded for the area, but identifying cleared circles and other cleared areas in the field is the subject of some debate, as any seasoned field archaeologist will attest (see Pendleton 1986: 175; Rogers 1966:43). The interpretation of cleared circles as wickiup pads or sleeping circles, i.e. structural remains of a temporary camp, is rather problematic as well. In addition to cleared circles, one might expect a temporary camp in the desert to exhibit some small assemblage reflecting domestic activities. However, the research literature suggests that cleared circles have very few or no artifacts or domestic features associated with them (e.g., Begole 1974, 1980; Carrico and Quillan 1982; Marmaduke and Dosh 1994:146, 150; Pendleton 1986:62, 173-177; Rogers 1939, 1966:45). However, within our study area, a records search at IVC Museum revealed some 35 sites with cleared circles. Of these, 25 (i.e. 71 percent) had associated artifacts and one (3 percent) had rock rings.

With regard to the function of posited temporary camps in the study area, Rogers refers to the Quechan utilizing the Indian Pass area for harvesting palo verde and ironwood pods in late historic times. Likewise, there is considerable archaeological evidence of prehistoric lithic resource procurement and prospecting in the study area. Also, as mentioned above, there are also numerous small geoglyphs, alignments, vision quest circles, and shaman hearths. The associations, if any, between cleared circle sites and temporary camps and these resource and spiritual areas are poorly understood at this time. Also poorly understood is the relationship between the study area and the presumed rancheria-village areas along the river. Season of use is similarly unclear. One might presume that summer temperatures of 120 degrees Fahrenheit might dramatically reduce the appeal of the area, but the mid-summer is precisely when ironwood and palo verde pods are harvested. Lithics and religious teaching can take place any time of year, of course.

The ceramics of the Lower Colorado region are also only poorly understood at this time. Numerous ceramics have been recorded and collected from the study area, and many specimens are in the collections of Rogers at the San Diego Museum of Man. In fact, the reigning ceramic typology, that of Waters (1982a, c, and d), was an evolution of the Rogers typology. This was partly defined on the basis of materials from the Indian Pass cairn excavations and trail collections in the study area. Subsequently, however, the area seems to have suffered considerable collecting of ceramic materials by rockhounds, and others. The definition of ceramic types is an ongoing process, and the area can still contribute information about the attributes, distribution, and definition of ceramic types. This can be accomplished by examination of new materials collected from the field and by looking at previously collected materials.

During the Spanish and Mexican Period (1539-1848), the area was visited intermittently by explorers and miners. Some settlement occurred in the surrounding area but nothing within the project area itself. The area remained relatively untouched until Anglo-Americans began mining activities there. They began to exploit the resources of the area as early as 1850, but it was not until the railroad arrived in the late 1870s that large-scale mining began to occur. Mining towns, such as

Tumco/Hedges, began to spring up. The construction of a canal system at the turn of the century allowed the mining operations to process the ore on site. Many operations bought stamp mills and increased both their productivity and their profit.

After the turn of the century, the area continued to be mined intermittently. The mines were mostly reworked with much less productivity. Activity in the desert changed focus for a brief time during World War II. General George S. Patton, Jr. determined that the desert area stretching from California and Arizona's Mexican border up to the lower part of Nevada would provide the perfect training ground for troops participating in the Desert Warfare campaign in Africa. In March of 1942, the area was officially designated for the task. It was called the Desert Training Center and, later, the California-Arizona Maneuver Area (C-AMA). The training area eventually grew to encompass an area twice the size of Maryland and included Camp Young and ten divisional camps. In the beginning, the main troops that came into the training area were infantrymen and tankers of the Army Ground Forces. Later, an Air Support Command was added to the training area (Henley 1992:23). Training focused on conducting field maneuvers in a desert environment and effective use of artillery. Camps were sparse and designed to be removed without a trace. A total of one million troops trained until the camps were shut down and dismantled in May 1944.

Since the 1940s, the primary activities in the Imperial Valley area have been mining and agriculture. Agricultural practices have been primarily confined to the middle to western portions of the county, while mining has taken place to the east. Much of this mining has been on a small scale and there are numerous indications of mining claims throughout the landscape. Some recreational activities, such as camping and use of off-road vehicles, has also occurred. None of this activity has had a significant impact upon the landscape.

ETHNOGRAPHIC CONTEXT AND NATIVE AMERICAN CONSULTATION

Introduction

The goals of the Native American consultation study conducted by Dr. Baksh were to aid in the identification of contemporary Native American concerns and values associated with the Project area; document current Native American knowledge about the function and/or interpretation of available resources; record the meaning and significance of resources to Native Americans today; and identify mitigation measures that Native Americans feel would be appropriate to minimize impacts to sensitive cultural resources. The addition of this perspective is an important part of research and development of context. The complete text of the consultation study is provided as Appendix C, but portions have been excerpted here to provide a complete context for the project.

Quechan Consultation

Consultation with the members of the Quechan Cultural committee were conducted on a variety of occasions and provided important information on the Project. The complete description of consultation is provided in Appendix C. Many of the feelings about the Project were summarized when Dr. Baksh met with Mr. Lorey Cachora and Mrs. Linda Cachora at the office of Tierra Environmental Services in San Diego on March 28, 1997. The following excerpts were condensed from transcribed notes of taped discussions with Mr. Cachora and are included here to provide a complete context for the project.

On Quechan Knowledge:

> It is important to keep a lot of information to one's self, or to share it only with certain individuals. That is why sometimes I ask you to turn off the recorder when we are talking, and to keep certain things to yourself. I don't even tell my own people a lot of things. Sometimes I suspect that people criticize me, including those from other tribes, for sharing information. But sometimes it is important to do this, especially if it will help protect our culture.
>
> The Chemgold people do not share our culture, knowledge, or Native American values. If they did, they would not be proposing to mine that area. And even a lot of our own people don't understand these things. You would have to be training with the Tribe for a long time to learn many things. You would have to become a Quechan to learn a lot, which would take 10 years or so of living with us and studying. Even some Quechans have tried and lost patience. You can't see the spirit world unless you go through the proper training -- learning to fast and learning to hallucinate through dreams. Some people hallucinate through jimsom weed and other drugs, but that is kind of a shortcut to the natural way of hallucinating through dreams.

On Quechan Traditional Territory:

> Our people came to this area from Newberry Mountain (*Avikwaame*), where our ancestors lived for thousands of years. Before that they moved all around, after originally coming from the north. After migrating to this area, our traditional territory extended west past El Centro to the base of the mountains towards San Diego and east into Arizona. It also extended north up to Blythe and south into Mexico. With settlement of this territory, sites such as lithic scatters and petroglyphs developed throughout the entire area. But the main part of our area, and the most important religious area, is the area along the Colorado River. This area is where our ancestors stayed, this is where they healed themselves, and this is where their dreams came true. This area is part of me, it belongs to me. It is this area, in the shape of a small box, that I would like to see protected. This area should be protected, in the way that the area of the Grand Canyon is protected. Is that asking the impossible? This is our life we are talking about.

On Pilot Knob and Picacho Peak:

> After settling in this area, our people consisted of South Dwellers and North Dwellers. The South Dwellers went to Pilot Knob (*Avikwalal*) for food and substance, or when they needed to increase their power or were feeling distressed. The North Dwellers went to Picacho Peak for the same reasons. The Sunflower Eaters in the Arizona side used Muggins Peak. The areas in between were used to

go into another world. Pilot Knob was an extremely sacred place. Even other Tribes were allowed to use it. Our people often migrated from Pilot Knob to *Avikwaame* to worship and obtain power.

On The Importance Of The Project Area:

That area proposed for the Project mine is real important to us today -- we still use the area. It is a strong area; people feel it and will sometimes go there without even realizing it or knowing why. I could tell you several examples of people who have been drawn out to that area, and then their lives improved afterwards. We can't lose the sites out there or have that area destroyed. The sites in the Project area are of the highest possible religious importance to us, particularly for travel. Too many areas like that have already been destroyed and, whenever another sacred area is destroyed, Native Americans are destroyed. Maybe not necessarily physically as seen by others, but inside.

The sites in that area tie in with something that is bigger in the long run. As I've said before, the whole area along the Colorado River is sacred. But this is not reflected in all the individual archaeology and anthropology studies that have been done over the years. Someone has to look at all those studies and review them all together. If this could by done, others would also come to the conclusion that this is an extremely important area.

We have already sacrificed other areas but at least most of those were away from the important trails. We already knew that this was an important area and were shocked when we learned that they wanted to have a project in the Indian Pass area. When told about the project being planned in this area, I said, "Oh no, here we go again." I participated in the survey, but even I was surprised at the large number of important sites out there and at the amount of destruction that was being planned. There are so many sites out there that I know some were missed by the survey.

We thought the federal government took over that property to protect it, but they don't always do a good job at that. Some people in the government simply do not respect Native American values. The government should look at the area like a church, which is a superior place with superior value and should not be destroyed. If the government doesn't consider religion important, then there is definitely something wrong.

On Dreams:

Everything has to happen through dreams. Dreams are the main way to obtain knowledge and power to make it through the various phases of life. Dreams are for learning songs, learning to become a medicine man, and learning to become an orator. In the past, the old people used to come to Pilot Knob, and they used that same trail that passes through the Project area to get to Newberry Mountain or *Avikwaame*.

Today, if you are lucky and strong enough, you go to sleep and you see that trail in your dream. That Pilot Knob trail to *Avikwaame* is there because I have seen it. And when you take that trail in your dream, you can do some fantastic things -- you can get to Newberry Mountain in seconds and do whatever you want. The ancestors said that if you ever destroy that trail, we would not be able to get to that place if we want to in our dreams. Of course, now we can get there by car, but that is not the same as traveling by dreams. Traveling by dreams is key for obtaining traditional knowledge and power and practicing our religious beliefs.

On Trails:

There are two trails in this area that our ancestors followed to reach *Avikwaame*. One was used when our people traveled north from Pilot Knob -- this trail passes through the Project area. Another trail travels more closely along the river, and passes through Picacho. We recently took the trail through Picacho to Ward Valley. The trail through the Project area is the "Trail of Dreams." The one that we took through Picacho is the "Medicine Trail." If the Trail of Dream was to be physically damaged, it would affect our ability to dream in the future.

There is also an important east-west trail in the Project area, and in fact that trail goes west all the way to the ocean. A lot of materials from other tribal areas are found in our area because of trading with other groups; sometimes things were dropped and today they can be found along the trails. In any case, that area is situated at a "crossroads" and is like a major intersection that served the important function of facilitating regional exchange along the Colorado River. The north-south and east-west trails that cross at the Running Man site make this an extremely important place.

A lot of the trail through Picacho has been destroyed. But we know that the trail in the Project area still exists. We need the ability to keep going back to the old ways. We still think about the old ways and use them to live in today's world. That's why we say no to the Project -- don't touch that area! It's our only avenue to *Avikwaame* now.

On "The Trail Of Dreams" And "The Running Man Site":

The Trail of Dreams passes right through the Project site, and the site that is called the Running Man site is directly tied into this trail. Although I have said that the Running Man is recent, there is a reason for its importance. My father and other people of his generation went to the area of the Running Man site to use this area for spiritual and religious practices; I believe they made the Running Man geoglyph for an important reason. My father told me that he went to this area to learn and sing his songs. He told me that it is a powerful area and said that there is an important trail passing through there.

At the Running Man site one could run along the trail and, at the spot of the rock alignment, could jump and pass through a "window." This was a way of passing into another world, I guess you could call it. This would be done, again, through dreaming.

On Small Rock Circles:

A circle is a form of power. When you see those small circles near the trails, you could sleep there or rest or do whatever you wish to do. Those circles are "power sources." They go hand in hand with the trail. You could use the circles both to find the trail if traveling in the area and to get power while already traveling along the trail, whether the travel be by foot or by dream. There used to be a feather within each circle, but now they've blown away. People traveling along the trail would stop at a power source and could make the feather dance in that circle. All those circles, and others that extend to Pilot Knob, were made by a single powerful medicine man, probably with two or three student assistants training to become medicine men. Like the trail, destruction of the circles in the Project area would represent an obstacle in terms of getting from Pilot Knob to *Avikwaame*, both by foot and by dream.

On Life Phases and Final Resting Places:

There are seven phases of life, as there are seven Yuman Tribes, although some powerful individuals can reach an eighth. The first phase was when we came down from the north to *Avikwaame*, and the second was when we migrated from *Avikwaame* to this area. Today we're in the third phase of life; the fourth is when you die; the fifth is when you see the trail; the sixth is when you're at the intersection; and the seventh is when you're home at your final resting place. In the past, some powerful people like singers, orators, and medicine men went to an eighth stage of life, which is what we now call heaven. I'm now in my third phase; when I die it will be up to me to find the fifth. Migrations to *Avikwaame* are important for these phases, and I believe our people are about to migrate to *Avikwaame* again.

All Quechan have a final resting place to go after they die. Each one's place is given to them by the spirits ahead of time. My final resting place is somewhere in Arizona. The Project area is a strong area. We have to keep areas like that protected because I believe it is the final resting place for some ancestors, and it may eventually be for some who are living today. If someone today was to pass on and go there for their final resting place and find it destroyed, it would be like hitting a wall.

Discussion and Conclusions

Comprehensive efforts were made to identify current Native American concerns about the proposed mining project and to document knowledge about the function and/or interpretation of specific cultural resources in the project area. A major explanation discussed by the Quechan that accounts for the extreme importance that they attribute to the cultural resources in the project area is related to the trail system. Specifically, it was explained that the north-south trail segments passing through the project site are part of the trail linking Pilot Knob with Spirit Mountain, the two single most important places in Quechan religious mythology and beliefs. According to the Quechan, this trail previously served the important function of accommodating their ancestors' regular return to worship at Spirit Mountain, the place of origin for all Yuman tribes. The Quechan feel that trails, and particularly the trail linking Pilot Knob with Spirit Mountain, were at least as important for spiritual and religious reasons as they were for actual travel.

The Quechan explained on several occasions that the Running Man site is intimately connected with the trail system. For example, the large rock alignment at this site represented a "window to another time." Their ancestors would sometimes run along the trail at this location and jump over the alignment, and thereby go back to the past or "pass into another dimension." The Running Man geoglyph was said to be made by one of the informant's fathers and a friend of his father, who used the site for spiritual purposes. Although the Running Man site would not be directly impacted by the proposed project, tribal members feel that views of the horizon, including those of Picacho Peak and the Indian Pass area, would be significantly impacted by the construction of stockpiles. Disruption of current views of the skyline would effectively prevent any future religious use of this site which, from the tribe's perspective, would be detrimental to their religious beliefs and practices.

The Quechan also explained that many of the other sites in the project area (as well as beyond the project area) were directly associated with the Spirit Mountain/Pilot Knob trail. For example, the "power circles" were used by travelers along the trail, both during actual travel and dream travel, to pray and obtain power to assist with the journey. The larger cleared circles, in turn, were used to rest along the way.

A principal concern of the Quechan about the proposed project is that it would significantly jeopardize their present and future ability to travel along this trail, both in a physical sense during dreams. Although they have not used the area since their father's generation, they want to use it in the future. As an example of current use of traditional resources, a contingent from the tribe recently traveled by foot along a major trail from Yuma to Ward Valley.

Another principal concern offered by some Quechan tribal members is that the project vicinity is a "strong" area and likely is the final resting place for their ancestors. At least one individual speculated that the area has also likely been designated by the spirits as the final resting place for Quechan who are still living. The specific concern is that impacts from the proposed project would severely disturb those who seek to rest at this location during their final phase of life.

Another major important reason that the Quechan are intensely opposed to disturbance of the project area is that it represents a critical learning and teaching center. Although the project area has not been used extensively in the recent past, tribal members want to use the area in the future and feel that they can learn much about spiritual matters and their history by visiting the area. The project area was defined as one of four key "teaching areas," where religious leaders and others can study, learn, and subsequently teach the younger generation aspects of religion and history that are critical for cultural survival.

One interpretation of the cultural resources in the project area, offered by at least some tribal members, is that these archaeological sites reflect a major village site at this location. This interpretation, however, is not supported by the ethnohistoric literature. Rather, the ethnohistoric literature clearly demonstrates that Quechan villages, or rancherias, were located along flood plains of the Colorado and Gila Rivers where water was permanently available and where agriculture and fishing were extensively pursued. Although there is no question that the project area was used extensively, based upon the vast quantities of lithic artifacts alone, the ethnohistoric literature supports the archaeological interpretation that the area was used primarily for hunting and collecting activities and for activities associated with travel.

PREVIOUS PROJECT RESEARCH

In order to evaluate previous survey efforts within the Project area, it is necessary to understand at the outset that materials and features there tend to blend in optically with the surrounding matrix. KEA's survey, as well as previous work, reveals that there is a high density of flaking stations, ceramic scatters, and often indistinct cultural features. These loci are surrounded by a nearly continuous low density lithic scatter that results in part from lithic material testing and acquisition. An additional difficulty has been created by the activities of rockhounds, who have left numerous broken rocks that cannot be readily distinguished at the typical survey level from prehistoric debitage.

Previous survey efforts fall into four general categories: exploratory research, impact specific inventories, initial project inventories, and summary inventories. Each of these categories is discussed below.

Exploratory Research

The first archaeological work within the Project APE was conducted by Malcolm Rogers of the San Diego Museum of Man in the 1920 through the 1940s. This work included the first exploration and identification of prehistoric sites in this part of the state. Because the archaeology was unexplored, much of this work was focused on developing cultural chronologies and defining artifact types.

Within the Project itself, Rogers focused his studies on prehistoric trails. Because mapping and collection was at a general scale, it is not possible to determine which artifacts were actually collected from the Project area. As noted above, many whole or reconstructable pots were collected from such trail sites as SDM-C-1. However, this site is located both within and outside of the Project area. Rogers did record the Running Man Site (CA-IMP-2727) which is within the Project APE. This site is an important area where two trails cross and, as described more thoroughly in Chapter 4, includes rock alignments and other items of religious significance.

Impact Specific Inventories

The next class of inventory work, associated with initial drilling and testing to define the mine, consists of a series of studies within the Project mine and process area to address impacts of these operations. Included are various surveys and letter reports conducted by Pat Welch of the BLM, reports by Gallegos and Pigniolo (1987, 1989) as consultants to the mining companies, and letter reports by Pat Weller of the BLM. These inventories can be characterized as impact-specific in that they were surveys of specific access roads and drill points and incorporated very little in the way of context and background. The goal of these programs was avoidance. Road alignments and drill points were adjusted to avoid specific flaking stations and pot drops. Where significance was assessed, these features were generally not considered National Register eligible.

The scope of these surveys was impact-specific and narrow. For the most part, the background distribution of flakes was ignored or not recognized, trails were followed only short distances, and only features such as flaking stations, pot drops, and trails were recorded. These surveys resulted in the identification of a series of small sites and isolates within the Project area. Some of these were recorded and others were limited to descriptions within letter reports. Methods were relatively intense, but because the survey areas were largely linear and small, the bigger picture of cultural resources was not considered.

Initial Project Inventories

The next category of cultural resource inventories within the Project APE were somewhat larger in scale, but again their methodology did not allow for an accurate description of cultural resources within the APE. Inventories in this category include both those for the Project mine and process area and the transmission line. Previous studies included in this category include Quillen (1982), von Werlhof (1984a 1984b, and 1987), Schaefer and Pallette (1991). These inventories covered larger areas of the Project or the Project as it was at the time.

Surveys were generally in linear transects using 20-meter intervals or greater. Some of these inventories attempted to integrate regional context but lacked formal research designs. Some larger sites were identified and trails are identified and expanded, but many of the inventories, particularly that of Schaefer and Pallette (1991), continued to record only individual flaking stations as sites. The background scatter was ignored where it was recognized because it was perceived as difficult to incorporate into the site/isolate framework. In other areas, the interval of the survey left the background scatter unrecognized. Where evaluations were conducted, they usually concluded that flaking stations were not significant, but this conclusion can be questioned due to the absence of an evaluation of context.

Summary Inventories

The final set of surveys of the Project were conducted in 1995 and 1996. They include a survey of most of the Project mine and process area and Project ancillary area by Schaefer and Schultze (1996) and a survey of the transmission line by Schaefer and Victorino (1996). Although these surveys were intended to be comprehensive, the use of 20-meter intervals in areas of desert pavement and abundant resources failed to result in a complete inventory of the area. Although the reports considered context to some extent during the evaluation phase neither included research designs and detailed examinations of context and previous research were absent. These inventories did however begin to identify the connecting background scatter. Some of the identified features were clustered into large sites connected by low density scatter. The survey interval, however, failed to provide a sufficiently intensive coverage for a complete inventory due to the difficulty of identifying cultural resources on complex desert pavement surfaces. The addition of initial levels of Native American input and consideration of context during the evaluation stage resulted in the evaluation of many of these sites as significant.

Discussion of Trends in Methodology and Results

The above grouping of previous work within the Project APE can provide an indication of trends within previous investigations. Changes in methodology and consideration of context are clearly related to changes in results as summarized on Table 3-6. Exploration of the area included an examination of only high potential site areas and resulted in the identification of only major sites and trails. Impact-specific inventories were intensive but narrow and lacked a larger view and context. They resulted in the identification of individual features, but not the larger patterns and scatter. Initial project inventories included larger areas, but still were hampered by transect intervals that did not meet the difficulties of working on this type of desert pavement. Some larger sites were identified but the scatter remained unrecognized or ignored. Finally, the summary inventories were still limited by inappropriate intervals. Because of the larger area covered, however, some background scatter was identified and lumping of individual features occurred. It is important to note that each succeeding inventory identified more cultural resources within the project. This is primarily due to improvements in methodology and consideration of context.

Table 3-6. Inventory Trends

Previous Inventory Type	Methods	Context	Results
Exploratory Research	Examination of High Potential Areas	Initial stage of development	Only major sites in region identified
Impact Specific Inventories	Close interval survey of small areas	Little consideration of context	Individual features and some isolates identified, connecting background scatter unrecognized
Initial Area Inventories	Generally 20-m or greater survey intervals	Some consideration although no formal research designs	Some larger sites identified most are still looked upon as isolated features and background scatter largely ignored or unrecognized.
Summary Inventories	Still 20-m survey interval	Some consideration although no formal research designs	Some background scatter recognized and grouping of smaller sites occurs. Other features and scatter missed due to interval.

Not only are the trends in methodology and context consideration directly linked with results, they are also directly linked with significance. Impact-specific inventories and initial project inventories generally considered features in isolation and most of the sites were considered not significant. The summary inventories began to incorporate more context resulting in evaluations of many of the sites as significant. Understanding the previous research trends within the Project can help design more appropriate methods and a research design that considers broader context to provide a complete inventory and evaluation of the project.

SUMMARY

The context provided in this chapter and Chapter 2 provides a footing for the development of appropriate field methods and a research design. It should be clear from the above discussions that potentially significant cultural resources have been previously identified within the Project. In a regional context they are also significant, particularly when Native American context is considered.

CHAPTER 4
INVENTORY METHODS AND RESEARCH DESIGN

After determining that additional inventory was necessary, the BLM El Centro Resource Area developed a scope of work that included (1) additional background research to establish a context for inventory and evaluation and (2) additional field survey. A key goal was to increase the level of Native American involvement. In this chapter we first describe the background research undertaken to provide the necessary context and then present the research design for the fieldwork.

CONTEXT RESEARCH METHODS

The first objective of the research process was to provide a complete context and background from which to design an appropriate field strategy and evaluative framework. That context was divided into natural and cultural settings and is provided in Chapters 2 and 3. A variety of methods were used and resources consulted to gather the data necessary for complete context development.

Records Search and Prehistoric Research

Research was conducted at a variety of libraries and repositories. Data collection on previously recorded sites within the Project area and the larger study area was conducted through the Southeastern Information Center at Imperial Valley College Museum. Record searches conducted for the 1995 and 1996 surveys of the Project were obtained from ASM Affiliates and were updated at the Southeastern Information Center by KEA personnel. When problems and questions with some of the Information Center data were identified, Karen Collins of IVCM rechecked their data, which resolved these issues. She provided a corrected map of the current data for the area. The current record search data were then compared to information provided in earlier reports to reconstruct the sequence of site designations, including determining which previously recorded sites had been lumped together in more recent designations. Working with Ms. Collins and Jay von Werlhof at the Southeastern Information Center, a literature search of all reports within the study area and other significant references in the region was conducted. Additionally, all trails within the study area were mapped on USGS 7.5' topographic maps.

Mr. von Werlhof also made an important contribution as a consultant. Not only did he share field notes of class surveys and volunteer fieldwork in the region, but he provided maps of trails within the study area. He has done an extensive amount of work in the region, and his shared his knowledge on trails and geoglyphs is incorporated into this section.

Another important source of data were Malcolm Rogers' notes, which are on file at the San Diego Museum of Man. These provided insight into his work in the area, which formed the foundation for much of the later models of cultural history and ceramic typology.

Extensive published sources were also examined. The literature from the Southeastern Information Center, books and articles from the San Diego State University library, and publications in the libraries of KEA staff provided the basis for the annotated bibliography for the region, which is included as Appendix B.

Ethnographic Research Methods

The goals of the Native American consultation study conducted by Dr. Baksh were to aid in the identification of contemporary Native American concerns and values associated with the Project area; document current Native American knowledge about the function and/or interpretation of available resources; record the significance of resources to Native Americans today; and identify mitigation measures that Native Americans feel would be appropriate to minimize impacts to sensitive cultural resources.

The complete report of the Native American consultation conducted to date for the Imperial Project is provided in Appendix C. It is intended to assist the U.S. Bureau of Land Management (BLM) with its planning responsibilities pursuant to Section 106 of the National Historic Preservation Act. Dr. Michael Baksh met with the Cultural Committee of the Quechan Indian Tribe from December 12, 1996 through March 28, 1997, in his initial data gathering phase. Subsequently, a series of meetings were held with Tribal representatives during the summer of 1997. Other sources of information that have been taken into account include the ethnohistoric literature, the cultural resources reports prepared for the project, comments received from the Quechan Indian Tribe on the November 1996 Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR), and testimony provided by members of the Quechan Indian Tribe during two public hearings held by the BLM.

Historical Research

To develop the historical research context, a variety of repositories were visited. Historical information of the WWII period activity within the Project was obtained from the San Diego Public Library and the Squibob Chapter of E. Clampus Vitus. A management plan for the desert training centers was obtained from the El Centro office of the Bureau of Land Management. Records on previously recorded historic sites were obtained from the Southeastern Information Center at the Imperial Valley College Museum.

The Museum of Man, the University of California San Diego, the Pioneer Museum, and San Diego State University were all visited with the purpose of obtaining historic maps of the area.

Research pertaining specifically to the military history of the area was obtained from the National Archives in Washington, D. C. and E. Clampus Vitus. Eugene Chamberlin of the Squibob Chapter of E. Clampus Vitus was contacted because he was the historian of the chapter at the time that Camp Pilot Knob was listed as a California Historical Landmark. He provided all of the information that he had collected on the Desert Training Centers for this research.

INVENTORY RESEARCH DESIGN

Introduction and Resource Expectations

All levels of archaeological research require choices as to what data is collected and recorded. A research design is used to guide these choices so that specific research goals can be met. Although research designs are critical during the testing, evaluation, and data recovery phases of archaeological research, they are also important during the inventory process in focusing recording efforts.

Based on the previous survey work within the Project APE, a large variety of cultural resources were expected. The abundance of flaking stations, and their sometimes problematic nature when confused with rockhound activity, was recognized in earlier efforts. Also, it was clear in the record of previous research that site boundaries, site definition, and accurate site location changed with each survey. Military use was also recognized in the Project and the mining districts of Hedges and the American Girl Mine near the transmission line corridor have been important topics of research in recent years. During his research in the area, Jay von Werlhof also identified numerous early tools that were not described in later surveys, raising another research topic.

The goal of the inventory, and thus the field methods, was to accurately identify and describe the cultural resources within the Project APE. Using the issues identified during studies of context and previous research the research design provided below focused the inventory recording strategy on data needed to address important research topics.

Effect of Methodology on Interpretation

As discussed in Chapter 3, there are clear research relationships among field methods, consideration of context, results, and significance determinations. Since the goal of the current inventory was to ensure an accurate and complete survey using appropriate methods, testing the effects of methods on results and significance determinations was seen as an important topic of research at the inventory level. As will be discussed further below, to assess the effect of methodology on interpretation, closer interval survey transects were used and consideration of the full context (including Native American values) was made. Using these differences from earlier methods, we can assess their affect on results and interpretation. This can be an important contribution to a determination of appropriate methods for future inventories and survey requirements in similar environments.

Site Definition and Boundaries

As discussed in Chapter 3, previous inventories initially identified individual features as sites. However, changes in methodology, and administrative policies have led to more lumping of features into larger, complex sites. Site definition and site boundaries have changed with each new recording. Because the presence of large areas of low-density scatter were recognized before the inventory began, lumping was anticipated. This was particularly true in light of stronger enforcement by the Information Center of the 50-meter rule for artifacts. That rule states that where artifacts are within 50 meters of each other, they should be included within the same site.

By creating large sites linked by low-density scatters, problems in management, recording, and treatment result. Within southern California, this issue of low-density background scatter has been a difficult one in a variety of areas particularly in areas of prehistoric lithic procurement. When recording and mapping large site areas, it becomes more difficult to record detail on individual features within these sites. Often features would be recorded and tested in more detail if they were identified as individual sites and the low-density scatter was ignored. With testing and data recovery requirements often blindly linked to site size and percentages of site area, recognition of scatter as large sites often leads to unrealistic and inappropriate testing and data recovery costs.

One goal of the inventory effort was to record and identify sites for what they are. This would be irrespective of whether they are traditional sites representing discrete concentrations of artifacts or individual features spread out on the landscape and all related to the larger landscape by trails and large areas of low-density lithic scatter. Recognition of these differences in site type are important to carry through to the evaluation and treatment phases of the effort.

Settlement Pattern

Another important research topic identified in the overview sections of Chapter 3 deals with settlement within the Project area. Comments on the draft EIS raised a question as to whether this area was used for extensive and possibly permanent habitation possibly in the form of a village or whether its use was more temporary and dispersed. Another important issue related to settlement pattern was whether the Project mine and process area represented a unique concentration of cultural material or whether the same density of features occurs in the surrounding areas. This is not only relevant to identifying prehistoric patterns of settlement, but also relevant to the possibility of refining the Project design to avoid features. Eight survey transects outside the Project APE were used to look at the larger patterns of settlement. During the inventory, efforts were made to identify any indicators of permanent habitation such as midden soils or extremely high densities of surface artifacts. GPS mapping of individual features allowed for an examination of land use and settlement patterns within the Project area.

Prehistoric Flaking Station Identification

Another research topic that has been identified by previous research in the area was the difficulty of separating recent rockhound activity from prehistoric tool production. Efforts to set up criteria to address this issue have been made in the past (Quillen 1982), but accurate identification of the prehistoric component is critical to resource recording. Many of the previous investigations appear to have used inconsistent criteria. A unified approach is necessary for accurate recording, although technological research beyond the inventory level may be required in some cases.

Early Tool Assemblages

Malcolm Rogers' early work in the region indicated the potential for early tools in the area, although many of the resources in the area appear to be Patayan in age. Jay von Werlhof's work in the area has also identified a series of early tools within the Project APE and suggested this was an important and often overlooked component of the region. Other researchers, such as Schaefer and Schultze

(1996), did not recognize many of these early component tools as such and did not record this type of data. This contrasting previous work suggests that the presence and nature of early tool assemblages within the Project is an important aspect of the investigation that can be addressed, at least in part, at the inventory level. Only by recording a sample of these tools and describing their distribution can we address deeper issues of their meaning and cultural nature.

Extent of Military Use

As indicated in Chapter 3, the activities of the Desert Training Center are included within the study area. Features related to this activity have also been recorded within the Project APE. Although a concerted effort was previously made to map many of these features within the main portion of the military camp in the Project mine and process area (Schaefer and Schultze 1996), previous background research and survey efforts failed to identify Camp Pilot Knob within the transmission line APE. Outside of Camp Pilot Knob, documentation on the location of temporary military camps is nearly absent, and the need to determine the full extent of military use within the Project APE was indicated by the background research. Recording of all features such as tent pads, rock features, roads, and bomb craters within the APE that could potentially be associated with WWII military activity was seen as a critical means of assessing the extent of this activity in the Project.

Mining History and Features

The long and extensive history of mining in and around the Cargo Muchacho Mountains is another important research topic that can be addressed to help focus the inventory efforts. Although the mining history within the Project mine and process area appears to be relatively recent, the transmission line passes near some of the major historic mines and settlements in the region. These settlements include Tumco/Hedges and Obregon. The relationship of features within the Project area to these mines and mining towns is another important topic of research at the inventory level. Many of the resources within the Project may be secondary deposits downstream from these historic townsites. Another important issue to consider is the relationship of historic trails and prospects to the larger mines.

FIELD METHODS

The field methodology for the cultural resources survey for the Imperial Project was designed to meet the goals of Section 106 of the NHPA and its mandate for a complete and accurate inventory and also to address the research topics identified as important using the previous research and overview context. The methods described below were designed with the objectives of being both complete and focused on important topics. Because surface survey results were also to be used for NRHP evaluations and treatment planning, a premium was put on accurate recording and mapping.

Constraints

As indicated in Chapter 3, the Imperial Project and previous work related to it provide an excellent view of how methodology can shape the recorded perceptions of the archaeological record. A combination of factors make this area challenging for inventory work, accentuating the effects of varying survey methodology.

One of the most important factors affecting survey results is the desert pavement that covers most of the Project area. The complex patterning of the gravels and the generally dark nature of the patinated rocks often make artifact location difficult. The effect of scanning through numerous fragments of rock at once, combined with the rock patination that covers both artifacts and non-artifacts alike, makes many cultural materials difficult to identify at first glance or even after relatively close inspection. One can be standing directly above an artifact and have difficulty visually discerning it from the complex background pattern. Morning and evening shadows make the patterns even more difficult.

The nature of the sites themselves also make them difficult to identify. Most of the sites, or site elements, are small flaking stations (1 to 2 sq m) that do not stand out from the background material. In other areas of the Colorado Desert, such as East and West Mesa, rock can be sparse. From a distance, temporary camps can stand out visually as areas having larger fire-affected rock and stone tools. In contrast, most of the desert pavement sites in the Project area, unless they represent stone features or cleared circles, do not stand out at a distance.

Rockhound reduction can contrast with the pavement, but most of the older patinated flaking stations blend in with the pavement at a distance. Because artifacts are similar in color and size to background materials, flaking stations or pottery scatters are difficult to spot. A 1-meter optimal zone directly in front of each surveyor, and two meters on either side of that, is probably the survey transect width where most material could be located. Beyond this width, features and larger, more contrasting flaking stations would be observed, but most flaking stations and ceramic scatters would be missed. As will be discussed below, 5-meter transect intervals were used to address this constraint.

Another constraint in desert environments is heat, which can distract attention from the task of surveying to physical discomfort and needs. Although the inventory was conducted during summer and temperatures were extreme, this constraint was addressed in several ways. First, crew members with experience and known ability to deal with desert conditions were selected for the inventory. All crew carried water during the survey and took breaks for cold water at the end of transects. Misters and a small battery-operated fan were also used to make the crew comfortable enough to remain focused on the inventory effort.

An advantage of working in the desert is the absence of nearly all vegetation, which often acts as a serious survey constraint in forests, grasslands, and chaparral. Surface visibility within the Project APE was close to 100 percent. This, and the absence of alluvial soils or aeolian deposits of sand or silt that might bury cultural material, allowed for a complete inventory of the Project APE. Because the constraints of visibility and temperature discussed above were addressed, and surface cover was not a constraint, the current inventory was intensive and complete.

Survey Methods

The cultural resource survey for the Chemgold project was completed between June 16 and August 15, 1997. Field crew for the inventory are listed in Chapter 1. To address the issue of summer heat, crews began work about 5:30 a.m. and finished between 2:00 and 2:30 p.m. For safety reasons, each crew was near a vehicle with extra water and a walkie talkie, and a cell phone was located in at least one of the field vehicles.

Work began with the relocation of previously recorded sites within the Project mine and process area. Key features and landmarks that were previously identified were relocated and marked for later recording during the survey phase. This portion of the field effort lasted approximately five working days, and it provided an assessment of the adequacy of the previous inventories and indicated the need for methodological change.

To address the need for a complete inventory of the project, the constraints of working in this desert pavement environment, and the research topic on the effect of research methodology to inventory results, it soon became apparent that a modification of the 20-meter interval defined in the Scope of Work would be necessary. In coordination with the BLM, the methodology was modified to use 5-meter intervals. To provide consistency and completeness, the entire field survey (with the exception of the Transect Survey, see below) was conducted using 5-meter intervals between individuals.

Transects were usually conducted in lines rather than by contour. Survey crews varied in size from three to eight individuals. Outside transects were marked with flagging to demarcate areas previously surveyed. Flagging was removed from the adjacent transect upon the return trip. Areas were surveyed in large blocks, using roads and topographic features to more easily delineate areas to be covered.

Before Native American observers were available, work was confined to previously recorded site boundaries to ensure that Native American observers would be present when new resources were identified so their input could be included during recording. Once they were available and assigned to the project, a Native American observer accompanied each crew.

To address the research issue of early tools and to ensure that all difficult to recognize feature types were identified, Jay von Werlhof was brought on to the project as a consultant. He conducted an intuitive follow-up survey behind the main survey crews. Using his extensive experience in the region, he helped to identify and describe the early tool component and difficult-to-identify geoglyphs and rock features.

Initially, all tools, including early tools, and cores were marked and identified for later recordation. When it became apparent that the number of possible early tools was overwhelming and that complete recording of this resource type was not necessary to address the research topic, a sampling approach was developed. This approach included using the areas where 100 percent recording was conducted as a database from which to extrapolate. The areas with 100 percent recording were largely within CA-IMP-4970 and CA-IMP-2727. To examine variation in these tools in other parts of the project, Mr. von Werlhof took notes on the distribution and variation within seven geographic areas. These notes, in conjunction with the 100 percent recording data set, provide a good indication of the nature of this type of assemblage within the Project.

A Transect Survey outside the Project APE was initiated during the third week of the project. This part of the survey helped to address the research issue of settlement pattern and also address the potential for impact avoidance outside the Project APE. The Transect Surveys consisted of (a total of 16 transects, placed in sets of two parallel transects, 1,000 meters long, placed approximately 500 meters apart. These were oriented in the eight cardinal directions (north, northeast, east, etc.) perpendicularly around the buffer zone for the Project mine and process area (Figure 4-1). These transects were identified as T-1 and T-2, with the point of origin (i.e. NE T-1). Each transect was surveyed by a two person archaeological survey team walking at 20-meter intervals. Features were identified and marked for GPS mapping, but were not recorded as sites, since the narrow linear nature of the transects could not place these features into their appropriate site context.

The inventory of the Project ancillary area was initiated during the fifth week. Survey transects were conducted parallel to Indian Pass Road and the work was completed in segments moving from east to west. All buffer zones for the Project ancillary area were covered during the inventory using 5-meter intervals.

Survey of the transmission line corridor began during the sixth week of fieldwork. The entire APE including the buffer area was included in this inventory. This area was surveyed in a similar manner to the Project ancillary area, with the survey transects paralleling the powerline. The survey began in the north and moved south. During all portions of the survey, all cultural features and some topographic features were marked with color pinflags by the survey crews for later recording.

Recording

Field recordation consisted of five related efforts: Global Positioning System (GPS) mapping, feature recording, field illustration, field photography, and site form preparation. GPS mapping and feature recording were usually conducted simultaneously by two crew members. One crew member using a Spectrum submeter GPS pack would walk up to each pinflagged feature and record its UTM coordinates. These coordinates were downloaded daily for postprocessing and any necessary editing.

At the same time that GPS data was being recorded, another crew member would record the major characteristics of the feature on a field form. These data include site, type, material and color, count, patination, and other comments specific to each feature. Codes were used for feature types and categories of features. A complete list of these codes in included in Appendix D. This field data was later entered into the GPS database and the complete database of feature information is included in Appendix D.

In order to provide more detail of specific features and types of artifacts, one or more illustrators drew features and examples of artifacts in the field. Illustrations were mainly focused on features of potential religious or symbolic significance, but artifact examples such as rim sherds, painted pottery, bifaces, and examples of some tools were included. Complex portions of some sites were also drawn, as were some features such as pot drops to show their relationship to trails.

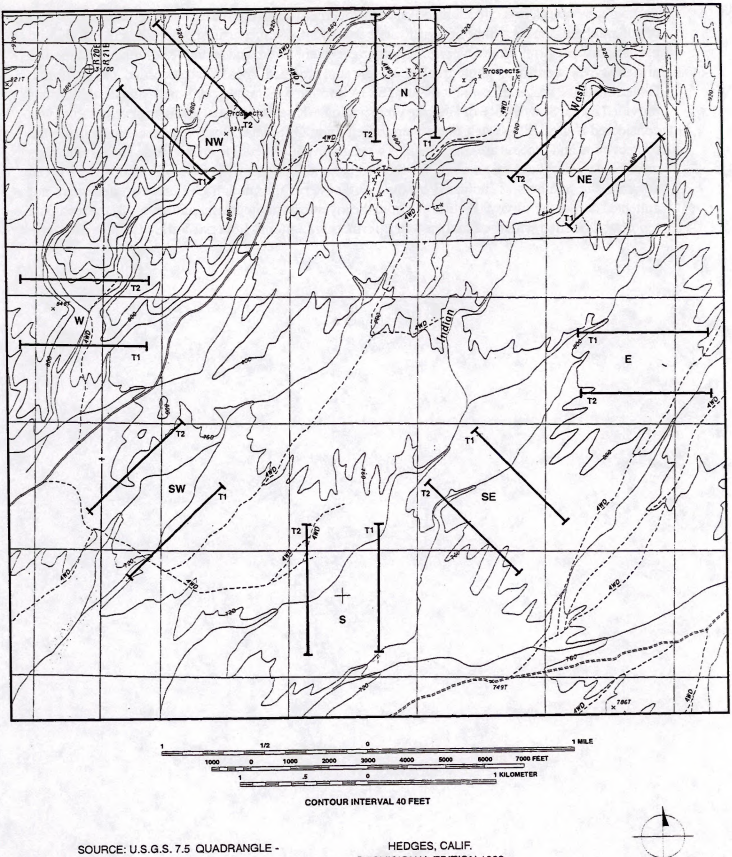


Figure 4-1. Transect Survey

Photography was also an important tool used to document features. With few exceptions, all features of potential religious or symbolic significance were photographed using color print, color slide, and black-and-white print film. Overview photographs were taken, and examples of other features and artifact types were also photographed. New and updated sites were recorded on California Department of Parks and Recreation Forms 523A through F. Sites were defined using the definitions provided by the State Office of Historic Preservation. Three associated artifacts or any feature was considered a site. Site sketch maps were based upon GPS data. For those resources outside the Project mine and process area sketch maps were given added detail from the field. Larger site maps were made using base maps made for the Project and GPS data. Trails within sites were given separate site numbers as indicated by the Southeastern Information Center. Artifacts were not collected during the survey. Field notes from the inventory, photographs, and a copy of the technical report will be filed with the Southeastern Information Center at Imperial Valley College Museum.

CHAPTER 5
INVENTORY RESULTS

INTRODUCTION

Records searches conducted for this project resulted in the identification of 128 previously recorded archaeological sites and 21 isolated artifacts within the Project APE. These cultural resources are described in Table 5-1. The majority of the previously recorded cultural resources (101 sites, 17 isolates) are located in the Project mine and process area, while 8 sites are included in the Project ancillary area, and 19 sites and four isolated artifacts are located along the transmission line corridor.

The intensive cultural resource inventory conducted by KEA resulted in the identification of 88 sites and nine isolates within the Project APE (Table 5-2; Figure 5-1 in Appendix E). The reduction in number of sites over those previously recorded results from the lumping of sites within the Project mine and process area in accordance with California site recordation guidelines. Despite the reduced number of sites, KEA's surveys resulted in a dramatic increase in the number of identified features within the Project mine and process area, an increase in the total site area there, and an increase in the number of sites recorded along the transmission line. Virtually the entire Project mine and process area is now encompassed within seven expansive sites.

Sites recorded include a variety of both prehistoric and historic features. The large sites within the Project mine and process area are comprised of abundant features linked by a low density lithic scatter. Feature types there suggest a variety of cultural behavior, both utilitarian and symbolic-religious, and Quechan concerns suggest that a traditional cultural property (TCP) may exist in the Project area. The inventory was successful in not only documenting the resources within the APE, but also in addressing the research topics identified for the inventory phase of work.

The cultural resource inventory for the Project applied consistent intensive survey methods to the entire APE. This resulted in the identification of a large number of additional cultural features. The feature types used during recording are provided in Appendix D. Major feature types identified during the survey are described as follows:

- Cleared Circle: A circular place in desert pavement which has been cleared of cobbles and large pebbles. These are sometimes called sleeping circles, but they rarely show signs of domestic refuse. Cleared circles may have been places where people once slept out, or where wickiups once stood. They tend to be about two or three meters in diameter. Cleared circles that have rocks aligned around the perimeter are typically called rock rings.

- Flaking Station: Three or more flakes of the same material type within a two meter area.

- Lithic Scatter: A distinct concentration of flakes of two or more material types.

- Pecked Rock: A cobble or boulder with evidence of pecking. Some pecked rocks are thought to have been an anvil stones for lithic reduction activities.

Table 5-1. Previously Recorded Sites

Previous Trinomial (CA-IMP-)	Field Number	Earlier Trinomial (CA-IMP-)	Site Type	Site Description	Area (M²)	Previous NR Evaluation
Mine and Process Area						
4970H*			Historic rock features, lithics	Three historic rock alignments, lithics	1,178	rec. Testing
4971			Lithic scatter	Chert lithic scatter	3	
4972			Lithic scatter	Chert lithic scatter: 10+ cores, 50+ flakes		
4973			Lithic scatter	Five chert flakes	7	
4974			Lithic scatter	Six chert flakes	7	
4975			Lithic scatter	Four chert flakes	3	
4976			Lithic scatter	Four chert flakes	3	
5034	38		Rock rings, lithic scatter	Two rock rings, 27 chert flakes, one chert scraper		
5037	'23'		Trail, cleared circles, lithics	Trail segment, two cleared circles, ten chert flakes, one chert core, one chert scraper, one chert chopper	12,576	
5061*	K-5, K-1, K-2-H, I-K-2		Rock rings, cleared circles, rock figure, game blind, intaglio, flaking stations, historic cleared area	Four rock rings, 60+ large and 37+ small cleared areas, one female rock figure, one possible rock turtle, one game blind, one possible intaglio, historic cleared area with "1869" in rocks, 13+ flaking stations: 34 cores, 39 core fragments, 766 flakes, two core/scrapers, 21 scrapers, two end scrapers, one flake scraper, one chopper/scraper, two scraper/blades, one blade, two drills, one hammer, two broken tools	206,145	
5063	Pritchett, B, C		Cleared circle, rock ring, power station, spirit break, ceramic, core, mining prospects	One cleared circle, one rock ring, one quartz power station, one spirit break, one ceramic sherd, one chert core, four prospects, military vehicle tracks	11,775	
5067 (update)	CG-40		Trail, pot drop, flaking stations, historic rock alignment	Segment of original Indian Pass trail, parallels Indian Pass road with one spur trending E-W. Three sherds of Hedges Buffware, 3 flaking stations: 70+ chert flakes, 10+ rhyolite flakes	50,000	E
5130	'D'		Rock alignment, cleared area, possible hunting blind	One rock alignment (possible spirit break), one cleared semi-circle, one possible hunting blind	39	
5138	KW-1		Petroglyphs, trail	Petroglyphs on small boulder, 150 m trail segment	750	
5380	RW-1		Trail	Segment of Indian Pass trail, 70 m in length	70	
5494	IP-31		Flaking station	One chert flaking station: two cores, three flakes; heavily patinated	3	NE
5495-I	R-4		Isolate	One chert core, one chert flake		
5496	R-5		Lithic scatter	Five chert flakes	6	
5497	R-6		Lithic scatter	Small chert lithic scatter: two flakes, two angular waste	1	

Table 5-1. Previously Recorded Sites (Continued)

Previous Trinomial (CA-IMP-)	Field Number	Earlier Trinomial (CA-IMP-)	Site Type	Site Description	Area (M²)	Previous NR Evaluation
5498 (update)	CG-4		Flaking stations, lithic scatter	Twelve flaking stations: four chert cores, 59 chert flakes, two quartz cores, 37 quartz flakes, one rhyolite preform, 1 chert unifacial tool; moderate patination	34,305	
	R-8	5499-I	Isolated flakes	Two chert flakes; two colors chert		
	R-9	5500	Lithic scatter	Small chert lithic scatter: two flakes, two angular waste	1	
5501-I	R-10		Isolated flake	One chert flake		
5502	R-11		Flaking station	One chert flaking station: one core fragment, three flakes, three angular waste		
5503-I	R-12		Isolated flake	One chert flake		
5504	R-13		Flaking station	One chert flaking station: one core, five flakes, one angular waste	1	
5505	R-14		Flaking station	One chert flaking station: one core, one flake, one angular waste	1	
5506	R-15		Lithic scatter	One small lithic scatter: three flakes, three angular waste; two colors chert	2	
5507	R-16		Flaking station	One chert flaking station: three core fragments, three flakes, six angular waste	2	
5519	KW-11		Lithic scatter	Small lithic scatter: two flakes, one biface	1	
5520	KW-12		Lithic scatter	Small lithic scatter: one chert core, one chert tool, 45 debitage	6	
5521-I	KW-13		Isolated flake	One chert flake		
5522	KW-14/ RW-14		Flaking station, cleared area	One chert flaking station: three flakes; one possible cleared area	3,533	E
5523-I	RW-17		Isolated core	One chert core		
5524-I	RW-18		Isolated flake	One chert flake		
5525-I	RW-19		Isolated flake	One chert flake		
5526-I	KW-20		Isolated flake	One chert flake		
5527	KW-21		Lithic scatter	One small chert lithic scatter: one flake, one unifacial scraper, one biface	2	
5528-I	RW-22		Isolated tool	One chert unifacial knife (collected)		
5529	KW-23/ RW-23		Cleared circles, trail, lithic scatter	Two cleared circles, one trail segment of undetermined length, one small chert lithic scatter: one core, one spokeshave (collected), one unifacial knife (collected), eight flakes.	1,460	E
	CG-86				482,775	
5530*	CG-84			One chert flaking station: one core, 110 flakes; heavy patination	4	E
	feat-6					
	feat-7			Two chert flaking stations: three cores, six flakes		
	feat-9			Two chert flaking stations: two cores, 13 flakes, all stages of patination present	1,036	
	feat-10			Three chert flaking stations: three cores, 34 flakes, one rhyolite primary flake; all stages of patination present	1,800	
	feat-11			One rhyolite flaking station: one core, three flakes, 10 + chert flakes	168	
	feat-12		Flaking station	One chert flaking station: nine flakes; light patination	4	
	feat-13		Lithic scatter	10+ chert flakes; moderate patination	36	

Table 5-1. Previously Recorded Sites (Continued)

Previous Trinomial (CA-IMP-)	Field Number	Earlier Trinomial (CA-IMP-)	Site Type	Site Description	Area (M²)	Previous NR Evaluation
5530 (cont.)	feat-49/H		Historic World War II camp, flaking stations	26 semi-circular and circular rock rings, four rock rectangles, 38 rock cairns, four rock walls, two pits, one can dump, tin cans, seven flaking stations: one core, 70+ flakes	285,000	NE
	feat-56		Flaking stations	Three chert flaking stations: one core, four core fragments, 11 flakes	960	
	feat-57		Flaking stations, historic rock alignment	Two flaking stations: one chert test core, three chert flakes, 60+ rhyolite flakes; English letters formed in rocks at base of cairn, no longer legible.	195	
	feat-58		Flaking stations	Two flaking stations: three rhyolite cores, 25 flakes, one milky quartz core, 60 flakes	800	
	feat-59		Flaking stations	Two chert flaking stations: one test core, 40+ flakes	800	
	feat-60		Flaking station	One chert flaking station: five test cores, 30+ flakes	16	
	feat-61		Flaking stations	Five chert flaking stations: two cores, 45+ flakes	1,591	
	feat-62		Flaking stations	Two flaking stations: one chert core, one chert test core, six flakes, one rhyolite core, seven flakes	940	
	feat-65		Flaking stations	12 flaking stations: 200+ chert flakes, seven chert test cores, one rhyolite core, 10 rhyolite flakes	17,250	
	feat-66		Trails	Two segments of same trail, each 30 m long, separated by 140 m @ 330 degrees		
	feat-67		Flaking station	One chert flaking station: two test cores, 50+ flakes	4	
	feat-68		Flaking station	One flaking station: one test core, 10 flakes	4	
	feat-69		Flaking station, lithic scatter	One chert flaking station: one core, three flakes	4	
	feat-70		Lithic scatter	One concentration of 20+ chert flakes	9	
	feat-71		Flaking station	One chert flaking station: one core, eight flakes	4	
	feat-72		Flaking station, tool blank	One chert flaking station: two cores, 100+ flakes, one chert hammerstone, one rhyolite biface blank	50	
		4974	Lithic scatter	Six chert flakes		
	KW-12	5520	Lithic scatter	Lithic scatter: 45 flakes, one chert core, one chert uniface knife	5	
	KW-13	5521-I	Isolated flake	One chert flake, patinated		
	RW-24	5530-I	Isolated tool	One chert chopper (collected)		
5531-I	RW-26		Isolated flakes	Two chert flakes; two colors of chert		
5532-I	RW-28		Isolated tool	One chert utilized flake (collected)		
5533	RW-29		Flaking station	One chert flaking station: 18 flakes, one basalt anvil	1	
5534	RW-30		Flaking station	One chert flaking station: 40 flakes; two colors of chert	3	
5535-I	RW-34		Isolated tool	One chert end scraper (collected)		
5536-I	RW-35		Isolated tool	One chert end scraper (collected)		
5537	RW-36		Flaking station	One chert flaking station: one core, seven flakes	1	
5538	RW-37		Flaking station	One chert flaking station: one unifacial knife, four flakes	1	
5539-I	KW-38/ RW-38		Isolated tools	Two chert unifacial knives (collected)		

Table 5-1. Previously Recorded Sites (Continued)

Previous Trinomial (CA-IMP-)	Field Number	Earlier Trinomial (CA-IMP-)	Site Type	Site Description	Area (M²)	Previous NR Evaluation
5540	IP-26		Flaking stations	Two chert flaking stations: two cores, 18 flakes; moderately patinated	10	NE
5541-I	RW-40		Isolated tool, core	One chert chopper, one chert core		NE
5542	RW-41		Lithic scatter	One lithic scatter: one core, 45+ flakes; two colors of chert	306	NE
5543-I	RW-42		Isolated flake	One chert flake		
6295-I			Isolated tools	Two chert spokeshaves		NE
6568	IP-2		Lithic scatter	Concentration of eight rhyolite flakes	3	NE
6569	IP-3		Flaking stations	Two flaking stations: one chert core, 20+ chert angular waste, two chert flakes, six rhyolite flakes (two different colors), one rhyolite core, four flakes.	118	NE
6570	IP-4		Flaking stations	Two flaking stations: 14 chert flakes, seven rhyolite core fragments, 12 rhyolite flakes	118	NE
6571	IP-5		Flaking stations	Two flaking stations: one rhyolite core, five rhyolite flakes, seven chert core fragments, eight chert angular waste, five chert flakes	236	NE
6572	IP-6		Flaking stations, lithic scatter	Lithic scatter: 25+ core fragments, 50+ flakes of rhyolite and chert; includes two or three flaking stations. Modern cairn noted.	1,963	NE
6573	IP-7		Flaking stations	Several flaking stations: 100+ chert angular waste and flakes, three rhyolite flakes	10	NE
6574	IP-8		Flaking station	One chert flaking station: three flakes, three angular waste	1	NE
6575	IP-9		Flaking station	One chert flaking station: two core fragments, four flakes, including one possible utilized flake	2	NE
6576	IP-10		Flaking stations	Two flaking stations: one rhyolite core fragment, 46 rhyolite flakes, two chert cores, eight chert flakes	20	NE
6577	IP-11		Flaking station	One chert flaking station: two core fragments, 31 flakes; heavily patinated	33	NE
6578	IP-12		Flaking station	One chert flaking station: two core fragments, nine flakes. One additional flake of different colored chert	2	NE
6579	IP-13		Flaking station	One chert flaking station: one core, five flakes	2	NE
6580	IP-14		Flaking station	One chert flaking station: 10 flakes	12	NE
6581	IP-15		Flaking stations, trail	Three flaking stations: one chert core, three chert core fragments, 30 chert flakes, one rhyolite core, nine rhyolite flakes; heavily patinated. 60 m trail segment runs north-south	7,850	NE
6582	IP-16		Flaking station	One chert flaking station: three core fragments, 30+ flakes	2	NE
6583	IP-17		Flaking station	One chert flaking station: one test core, two core fragments, three flakes, two angular waste	2	NE
6584	IP-18		Flaking station	One chert flaking station: three cores, two core fragments, 15 flakes; two colors of chert, one quartz uniface	3	NE
6585	IP-19		Flaking station	One chert flaking station: one core, eight flakes; moderate patination	5	NE
6586	IP-20		Flaking station	One chert flaking station: one core, three core fragments, 15 flakes; heavy patination	25	NE
6587	IP-21		Flaking station	One flaking station: one rhyolite core, two chert core fragments, two chert flakes	1	NE
6588	IP-22		Flaking stations	Three flaking stations: two chert cores, two chert core fragments, 22 chert flakes, one rhyolite flakes	100	NE
6589	IP-23		Flaking station	One chert flaking station: one core, seven flakes; moderate patination	3	NE
6590	IP-24		Flaking station	One chert flaking station: 15 flakes	2	NE
6591	IP-25		Flaking stations	Two chert flaking stations: one core, one test core, seven flakes; two colors of chert	12	NE

Table 5-1. Previously Recorded Sites (Continued)

Previous Trinomial (CA-IMP-)	Field Number	Earlier Trinomial (CA-IMP-)	Site Type	Site Description	Area (M²)	Previous NR Evaluation
6592	IP-27		Flaking station	One chert flaking station: one core, two core fragments, 12 flakes	79	NE
6593	IP-28		Flaking stations	Two chert flaking stations: one core, one test core, three core fragments, 23 flakes; two colors chert	98	NE
6594	IP-29		Flaking stations	Two chert flaking stations: one core, two test cores, 24 flakes, one possible utilized flake, one domed scraper; heavily patinated	314	NE
6595	IP-30		Flaking station	One chert flaking station: five flakes; heavily patinated and weathered	2	NE
6596	IP-32		Flaking station	One flaking station: one chert test core, two chert cores, 12 chert flakes, one rhyolite core, four rhyolite flakes; two colors of chert	79	NE
6597	IP-33		Flaking station, lithic scatter	One flaking station: one chert core, 15 chert flakes, one rhyolite core, two rhyolite flakes; two of colors chert. Low-density lithic scatter		NE
6598	IP-34		Ceramic scatter	One ceramic scatter: 61 Tumco Buff sherds; recurved rim sherds; burnished exteriors	3	NE
7377	CG-1		Flaking station	One flaking station: five rhyolite flakes, three chert flakes	107	NE
7378	CG-14		Flaking station	One chert flaking station: one core, 22 flakes	198	E
7379	CG-15		Cleared circles, flaking stations	Two cleared circles, two chert flaking stations: six core fragments, 17 flakes	567	E
7380	CG-16		Flaking stations	Two chert flaking stations: two cores, seven flakes; light patination	1,143	E
7381*	CG-17		Lithic scatter, historic cairn	20+ chert flakes, heavily patinated, rock cairn with east-west alignment of rocks on either side - miner's claim	57	E
7382	CG-19		Flaking stations, lithic scatter, possible milling feature.	One possible milling slick on volcanic boulder, five chert flaking stations: six cores, 46 flakes, one chert retouched flake	4,430	E
7383	CG-26		Flaking stations	Four flaking stations: five cores, 50+ flakes	27,083	E
7384	CG-27		Flaking stations	Three flaking stations: one chert core, 16 flakes	8,831	E
7385	CG-28		Flaking stations	One chert flaking station: three cores, 100+ flakes	3	E
7386	CG-31		Flaking stations	Four chert flaking stations: four cores, 70+ flakes	3,297	E
7387	CG-33		Flaking station	One rhyolite flaking station: two core fragments, four flakes	9	E
7388	CG-34		Trail	East-west trending trail of undetermined length		E
7389	CG-35		Flaking stations	Three chert flaking stations: two cores, 40+ flakes	1,884	E
7390	CG-36		Flaking stations	Eight flaking stations: six chert cores, three test cores, 100+ chert flakes, one rhyolite core, four flakes	4,327	E
7391	CG-37		Flaking stations	Five chert flaking stations: two cores, one test core, 40+ flakes	3,366	E
7392	CG-38		Flaking stations	Two chert flaking stations: one core, 12 flakes	9,539	E
7393	CG-39		Rock ring/Geoglyph	One rock encircled rock alignment, indicating south, 60 cm diameter	3	E
7394	CG-41		Flaking station	One rhyolite flaking station: 50+ flakes	7	E
7395/H*	CG-42/H		Historic camp	One rectangular rock alignment, two rock circular alignments, camp fire pits, and historic debris	1,236	NE
7396	CG-43		Flaking stations	Two chert flaking stations: 15 flakes, one test core	28	E
7397	CG-44		Rock ring	80 cm diameter rock ring encircling embedded volcanic cobble	.5	E

Table 5-1. Previously Recorded Sites (Continued)

Previous Trinomial (CA-IMP-)	Field Number	Earlier Trinomial (CA-IMP-)	Site Type	Site Description	Area (M²)	Previous NR Evaluation
7398	CG-45		Flaking stations, cairns	Three chert flaking stations: 20+ flakes, onc possible rock ring, one phallic rock cairn, two cairns	5,299	NE
7399	CG-46		Rock rings, flaking stations	Two rock circles, slightly cleared inside, each 2.8 m diameter. Two chert flaking stations: one core, 30+ flakes	314	E
7400	CG-47		Flaking stations	Two flaking stations: 10 chert flakes, one basalt core, 20 flakes; heavily patinated	816	E
7401	CG-48		Flaking stations	Five chert flaking stations: two cores, 40+ flakes	5,633	E
7402	CG-50		Flaking station	One chert flaking station: one core, seven flakes	7	E
7403	CG-51		Lithic scatter	Concentration of chert lithics one core, 26 flakes, three test cores	314	E
7404	CG-52		Flaking stations	Two chert flaking stations: four cores, four core fragments, 40+ flakes	204	E
7405	CG-53		Flaking stations	Four flaking stations: one chert core, 50+ chert flakes, five rhyolite flakes	1,963	E
7406	CG-54		Flaking stations	Two chert flaking stations: two test cores, 20+ flakes, one rhyolite test core	800	E
7407	CG-55		Rock ring	One rock ring 1.5 m in diameter, embedded in desert pavement	3	NE
7408	CG-63		Cleared circles, lithic scatter	Four cleared circles (each 2 m. diameter), 12 chert flakes	769	NE
7409	CG-64		Trail	Trail segment approx. 1 km long, running from major wash to major wash at 150 degrees	244	E
7415	CG-85		Flaking stations	Two flaking stations: one chert core, eight flakes	448	E
	feat-20					
	feat-21		Flaking station	One rhyolite flaking station: 35 flakes	108	
	feat-22		Flaking station	One chert flaking station: nine flakes	48	
	feat-23		Flaking stations	12 chert flaking stations: five cores, 200+ flakes. One rhyolite flaking station: 1 core, 2 test cores, 100+ flakes, 1 rhyolite core, 2 flakes	11,600	
	feat-24		Trail, flaking stations	One 38 m long trail segment, two chert flaking stations: two test cores, 18 flakes	38	
	feat-25		Flaking station	One chert flaking station: one core, 13 flakes		
	feat-32		Flaking stations	Two chert flaking stations: one core, four core fragments, 60+ flakes; all stages of patination	100	
Ancillary Area						
2727 (update)	CG-78, 79,82		Trails, temporary camp, ceremonial site	Two intersecting trails, two rock alignments, "Running Man" geoglyph, trail shrine, seven flaking stations, ceramic and lithic scatter		
5359T	RW-1		Trail, spirit breaks, rock rings, cleared circles, ceramic scatters, lithic scatters	Trail, spirit breaks, rock rings, cleared circles, ceramic scatters and lithic scatters adjacent to trail	11,094	
5360T (update)	CG-77		Trail, flaking station	One trail segment crossing Indian Pass road, 110 m in length @ 165 degrees, one white quartzite flaking station: 100+ flakes, one cobble volcanic anvil	4,400	E

Table 5-1. Previously Recorded Sites (Continued)

Previous Trinomial (CA-IMP-)	Field Number	Earlier Trinomial (CA-IMP-)	Site Type	Site Description	Area (M²)	Previous NR Evaluation
5360T	RW-1		Trail, ceramic scatters, lithic scatters	Trail segment which runs 7315 m at 148 degrees, ceramic scatters and lithic scatters adjacent to trail	14,630	
7410	CG-74		Pot drop	One potdrop of 23 sherds, including 1 rimsherd		
7411	CG-75		Flaking station	One flaking station: one test core, 10+ flakes; both quartz and chert		
7412	CG-76		Trail, trail shrine	One trail segment 10 m long at 110 degrees	79	E
7413	CG-80		Pot drop, flaking station	One milky quartz flaking station: 25+ flakes, five sherds prehistoric ceramic	236	E
7414	CG-81		Flaking station	One basalt flaking station: 20+ flakes		
Transmission Line Corridor						
1467T			Trail	A 140 m trail segment	330	
1469T			Trail	A 60 m trail segment	60	
1471T		1723	Trail	A 210 m trail segment	210	
2878		3574	Geoglyphs, lithic scatter, pot drops	Three geoglyphs, a sparse lithic scatter, three pot drops: 111 sherds	14,169+	
3297/H		6134	Trail, ceramic scatters	A trail segment of undetermined length, six ceramic scatters		
4131			Cleared circles, geoglyph, flaking station, ceramic scatter	Two cleared circles, one geoglyph, one ceramic scatter of 75+ sherds , one quartz flaking station: one core fragment, five flakes	9,106	
4419H*			Trash scatter	Historic can and glass scatter	2,355	
5397H*	E		Historic mine	Hill mined for kayanite, two timber loading platforms	70,650	
6661			Geoglyphs, cleared circle, rock alignment, shamans' hearth, lithics	Two geoglyphs: one cleared circle with wavy lines above and below, one anthropomorphic design. One small cleared circle, one shaman's hearth, one small (four quartz rocks) rock alignment, one chert utilized flake, one chert scraper	636	
7191-I	WBK I.O. 94		Isolated tool	One chert retouched flake		
7203H-I	WBK I.O. 107		Isolated ceramic	One historic porcelain bowl base		
7204H-I*	WBK I.O. 109		Isolated glass insulator	One aqua glass insulator		
7269/H*	WBK 76		Trail, geoglyph, hearth, historic trash dump	A 30 m trail segment, a possible geoglyph, a possible hearth, historic can and bottle dump	5,593	
7272T	WBK 81	1720 1468	Trail	A 110 m trail segment	35	

Table 5-1. Previously Recorded Sites (Continued)

Previous Trinomial (CA-IMP-)	Field Number	Earlier Trinomial (CA-IMP-)	Site Type	Site Description	Area (M²)	Previous NR Evaluation
7273/H*	WBK 82		Trails, historic rock feature	Three trail segments (measuring about 130 m, 160 m, and 170 m), and a historic rock feature forming "R.A."	6,280	
7274T	WBK 83		Trail	A trail segment of undetermined length	150+	
7275T	WBK 84	1723 1471	Trail	A trail segment of undetermined length	62+	
7276T	WBK 85		Trail, geoglyph, pot drop	A 350+ m trail segment, a possible geoglyph, one pot drop: 40 bowl sherds, including two rim sherds	21,195+	
7339	WBK 166		Ceramic scatter	A ceramic scatter of Palomas Red-on-buff sherds from two vessels	3	
7340	WBK 167		Lithic scatter	One small chert lithic scatter: seven flakes	3	
	96-1		Isolated flake	One chert flake		
	96-2		Rock ring	One rock ring, 3 m diameter	78	
	96-3		Geoglyph	One "J"-shaped geoglyph	12	

KEY:
Recommended National Register Evaluation
E = potentially National Register eligible
NE = not potentially National Register eligible
* = includes historic features or artifacts

Table 5-2. Summary of Cultural Resources

Resource Number	Description	Size (M2)
Mine and Process Area (N = 24 Sites, 1 Isolate)		
CA-IMP-4970	Multi-component	1,878,670
CA-IMP-4971	Multi-component	589,650
CA-IMP-5010	Prehistoric trail	
CA-IMP-5061	Multi-component	282,740
CA-IMP-5067	Multi-component	352,000
CA-IMP-5494	Multi-component	583,160
CA-IMP-5526	Multi-component	2,283,160
CA-IMP-7388	Prehistoric trail	65
CA-IMP-7408	Multi-component	172,000
F-4	Prehistoric trail	
F-298	Prehistoric trail	
F-745	Prehistoric trail	
F-940	Prehistoric trail	
F-1020	Prehistoric trail	
F-1336	Prehistoric trail	
F-1500	Prehistoric trail	
F-1792	Flaking station	
F-2142	Prehistoric trail	
F-2202	Prehistoric trail	
F-2282	Prehistoric trail	
F-2294	Prehistoric trail	
F-3024	Prehistoric trail	
F-4028	Prehistoric trail	
F-4132	Prehistoric trail	
F-4018	Isolated metate	--
Ancillary Area (N = 18 Sites, 2 Isolates)		
CA-IMP-2727	Multi-component (Running Man site)	
CA-IMP-5359	Prehistoric trail	
CA-IMP-5360	Prehistoric trail	
CA-IMP-6661	Ring geoglyph, possible anthropomorph	1,880
AA-1	Lithic scatter, historic component	13,660
AA-2	Lithic scatter	3,850
AA-3	Lithic scatter	11,390
F-3147	Flaking station	3
F-3167	Shaman's hearth	0.2
F-3169	Flaking station	2.3
TL-1	Recent rock ring encircling a cairn	216
TL-2	Lithic scatter	10,000
TL-3	Ring geoglyph	7
TL-4	Ceramic scatter	7
TL-5	Ring geoglyphs	14,450
TL-42	Ring geoglyphs	630
TL-43	Lithic scatter	0.8
TL-44	Ceramic scatter	3
TLI-1	Isolated pecked rock	--
TLI-8	Isolated WWII era flashlight part	--
Transmission Line Corridor (N = 46 Sites, 6 Isolates)		
CA-IMP-1469	Prehistoric trail	1,415
CA-IMP-1471	Possible prehistoric trail	23

Table 5-2. Summary of Cultural Resources (Continued)

Resource Number	Description	Size (M2)
CA-IMP-2878	Two large geoglyphs, ring geoglyphs	18,380
CA-IMP-3297	Prehistoric ceramic scatter, mining era refuse	21,200
CA-IMP-4131	Ceramic scatter, geoglyph, WWII era component	38,800
CA-IMP-7269	Probable prehistoric trail, mining era component	3,300
CA-IMP-7272	Prehistoric trail	23
CA-IMP-7273	Historic campsite, with rock alignment	470
CA-IMP-7274	Probable Historic trail, historic component	400
CA-IMP-7275	Probable historic trail, historic component	4,000
CA-IMP-7276	Ring geoglyph, ring geoglyph, ceramic scatter	4,712
CA-IMP-7339	Ceramic scatter, not relocated	3
CA-IMP-7340	Lithic scatter	7
TL-6	Recent rock ring encircling a cairn	3
TL-7	Non-Quechan rock alignment	0.3
TL-8	Ceramic scatter	3
TL-9	WWII era refuse scatter	188
TL-10	Three ring geoglyphs	8.8
TL-11	Ring geoglyph with stone in center	0.3
TL-12	WWII era refuse scatter	470
TL-13	Three trails, probably historic	--
TL-14	Seven possible WWII era foxholes	5,490
TL-15	Ring geoglyph	0.07
TL-16	Three ring geoglyphs	47
TL-17	Possible geoglyph	13
TL-18	Ceramic scatter	0.8
TL-19	WWII era refuse scatter	78
TL-20	Refuse scatter, mining and WWII era components	177
TL-21	Mining era refuse scatter	78
TL-22	Historic trail network	200
TL-23	Buried historic water pipeline	
TL-24	Possible historic trail	19
TL-25	Lithic quarry	31
TL-26	Two ring geoglyphs	16
TL-27	WWII era refuse scatter	12
TL-28	Refuse scatter, mining and WWII era components	23
TL-29	WWII era refuse scatter	20
TL-30	Lithic scatter	19
TL-31	WWII era refuse scatter	314
TL-32, TL-33, TL-34, TL-35	Camp Pilot Knob, two sets of three cleared circles, three ring geoglyphs	4,919,745
TL-36	Prehistoric trail	45
TL-37	Prehistoric trail	26
TL-38	Prehistoric trail	21
TL-39	Road to Tumco/Hedges	470
TL-40	Prehistoric trails	--
TL-41	Prehistoric trail	28
TLI-2	Isolated hammerstone	--
TLI-3	Isolated historic brake shoes	--
TLI-4	Isolated historic Ford radiator	--
TLI-5	Isolated historic universal joint	--
TLI-6	Isolated historic ironstone plate	--
TLI-7	Isolated WWII era dry cell battery	--

- Pot Drop: A scatter of ceramic sherds from one vessel with no other associated artifacts.

- Geoglyph: Any abstract or figurative design made on the ground surface. This includes figures made by scraping or tamping the earth (intaglios), aligning rocks or gravel, or piling up rocks or gravel. This does not include cleared circles or rock rings that have a residential rather than artistic or spiritual function. It does include dance circles or other dance patterns.

- Shaman's Hearth: A miniature hearth thought to be associated with vision quest activities of shamans, spiritual leaders or others seeking spiritual experience. These shamans hearths are composed of a ring of rocks and are typically 30-60 cm in diameter. The small fires in these hearths are part of the traditional Quechan meditation-dreaming process.

- Spirit Break: The purpose of a spirit break is thought to be to stop spiritual beings that may be attempting to follow someone who is utilizing a trail or other area. Spirit breaks are typically constructed by placing rocks in a line across or alongside a trail.

- Trail Shrine. These consist of piles of small rocks; they vary widely in size and some contain thousands of rocks. In shrines of the Protohistoric or Historic Periods pottery is also present. Shrines are thought to have been created by travelers who deposited a small offering at the shrine in the hopes of assuring against sickness, injury, or fatigue.

- Trail Marker: These consist of a stack of small stones used to mark a trail. For example, a trail marker might be placed where a trail enters and leaves a wash or other area where the correct route is difficult to discern. These are also known as cairns or ducks. There are prehistoric, historic, and modern trail markers, and sometimes they are difficult to tell apart.

- Vision Quest Circle: These are typically rock rings between ½ and one meter in diameter. Some of them have a cobble in the center: a focus stone. These small rock rings are identified ethnographically as a place for the practice of meditation or dreaming. Vision quest circles are often encountered in small clusters, suggesting use by a spiritual leader and a small group of students studying and meditating together.

- Prehistoric Quartz Smash: This refers to an area where quartz was broken apart to release its spiritual power. These are often found near geoglyph sites or trails leading to such sites.

MINE AND PROCESS AREA

Previously Recorded Sites

The majority of the previously recorded archaeological sites within the mine and process area are prehistoric (n=94), with only one historic site, and six sites with both prehistoric and historic components. Flaking stations are the dominant previously recorded site type; 56 consist of one or more flaking stations. The remaining 38 prehistoric sites include 15 lithic scatters, four lithic scatters with flaking stations (including one with possible milling), one lithic scatter with four cleared circles, one cleared circle with an associated flaking station, one site with two cleared circles and two flaking stations, one ceramic scatter, and one site with both flaking stations and rock cairns. Six trail segments were recorded, including two with associated flaking stations and one with petroglyphs consisting of a scratched rock. Of the five previously recorded sites with rock rings, one includes a flaking station, and one a lithic scatter. Three of the cultural resources include three or more feature types: two sites which each contain a trail segment, a lithic scatter, and cleared circles, and a site which includes a rock alignment, cleared area, and a hunting blind.

Six of the sites which contain multiple features have both prehistoric and historic components: CA-IMP-5061 was recorded as including rock rings, cleared circles, a geoglyph, flaking stations, a possible game blind, and a historic cleared area. CA-IMP-5063 includes a cleared circle, a rock ring, one quartz power station, a spirit break, a ceramic sherd, lithics, mining prospects, and vehicle tracks, including some from military vehicles. CA-IMP-5067 was recorded as including a trail segment, a pot drop, flaking stations, and a historic rock alignment. Previous surveyors found CA-IMP-5530 to contain mostly lithic scatters and flaking stations, although a trail segment, and a historic WWII camp were also recorded. Previously recorded site CA-IMP-4970/H consists of three historic rock alignments, and lithics. CA-IMP-7381 includes a lithic scatter and a historic mining claim. Only one historic site was recorded: CA-IMP-7395, a historic camp which contains rectangular and circular rock alignments, camp fire pits, and historic debris.

Twelve of the previously recorded isolates include single artifacts: seven flakes, one core, one unifacial knife, one utilized flake, and two end scrapers. The remaining five isolates each include two items: two unifacial knives, two spokeshaves, a chopper and a core, two flakes, a core, and a flake. All of the isolates are of chert material.

KEA Survey Results

The KEA inventory resulted in the identification of 24 sites and one isolated artifact within the Project mine and process area. As noted in Chapter 4, KEA's site boundaries conform to the criteria recommended by OHP. Trails are recorded as separate sites, even when they are encompasses within a larger deposit of cultural material, and site boundaries are drawn to include areas where three or more artifacts were noted within 50 m of each other. As a result of this approach, previously recorded sites in the Project mine and process area were often lumped into new larger sties. At the request of the Southeast California Information Center, each new lumped site has been given the lowest of the previously recorded site numbers that it now encompasses. Most of the KEA sites are trails or trail segments, but seven sites are large multicomponent resources grouped on the basis of low density lithic scatters. Table 5-3 shows the relationships between the currently recorded sites and previously recorded sites in the Project mine and process area. These multicomponent sites contained a variety of prehistoric features which are summarized on Table 5-4. Historic features were also typically found at these sites, and they are summarized by site on Table 5-5. Each of the cultural resources identified within the Project mine and process area are described below.

CA-IMP-4970

Site CA-IMP-4970 is one of the largest multicomponent sites within the Project. This site includes a variety of prehistoric artifacts and features, including lithic and ceramic scatters, flaking stations,

Table 5-3. Current and Previously Recorded Site Designations

Trinomial (CA-IMP-)	Previous Site Designations (CA-IMP-)
4970	4972, 4975, 4976, 5506, 5507, 5519, 5520, 5522A, 5523, 5524, 5530, 6568, 6569, 6570, 6571, 6572, 6573, 7379, 7383, 7384, 7385, 7395/H
4971	4973, 4974, 5497, 5498, 5500, 5501, 5502, 5503, 5504, 5505, 5521, 5522B, 5525
5061	5138, 7387
5067	5380, 7389, 7394, 7407
5494	5495, 5496, 5539, 5540, 5541, 5542, 6592, 6593, 6596, 7399, 7400, 7401
5526	5527, 5528, 5529, 5530, 5531, 5532, 5533, 5534, 5535, 5536, 5537, 5538, 6574, 6575, 6576, 6577, 6578, 6579, 6580, 6581, 6582, 6583, 6584, 6585, 6586, 6587, 6588, 6589, 6590, 6591, 7377, 7378, 7380, 7381, 7382, 7386, 7390, 7391, 7392, 7393, 7396, 7397, 7402, 7403, 7404, 7405, 7406, 7415
7388	7388
7408	7408

Table 5-4. Prehistoric Features within Project Mine and Process Area

	Prehistoric Trail	Prehistoric*																					Ceremonial*												Early Tools*				
Resource Number (CA-IMP-)	PT	B	CC	C	FS	GS	H	LS	M	MT	PP	PR	PD	P	PS	PRC	PRS	PRF	PRR	SR	T	Subtotal	G	L	K	PG	PC	PRA	PRC	SH	SPB	VO	O	Subtotal	TS	ET	FS	Subtotal	Total
4970		6	15	129	425	4	8	89	2			143	4	2			3		4	5	147	986	6		2		3	1	3	5	2	3		25	1	95		96	1107
4971			1		122	1	1	6				15										146	2										1	3	1			1	150
5010	8																					0												0				0	8
5061			12	1	11	2						1				1			1	4	1	34										1		1	6			6	41
5067		2	5	12	74	3	4			1	1	34	27	49	14					9	4	239				1					1	1	2	5		1		1	245
5494			1	1	49	1		5											3			60		1								1		2				0	62
5526			7	4	437	2	2	49				15	14	3				2	7		11	553	2				6	2			2	1		13		8	1	9	575
7388	4											2										2												0				0	6
7408			4	16	8			5					11	16	1				1	1	13	76									4	3		7		9		9	92
F-4	10																					0												0				0	10
F-298	6																					0												0				0	6
F-745	1																					0												0				0	1
F-940	1																					0												0				0	1
F-1020	1																					0												0				0	1
F-1336	1				1																	1												0				0	2
F-1500	5																					0												0				0	5
F-1792					1																	1												0				0	1
F-2142	1																					0												0				0	1
F-2202	1																					0												0				0	1
F-2282	1																					0												0				0	1
F-2294	1																					0												0				0	1
F-3024	7																					0												0				0	7
F-4028	2																					0												0				0	2
F-4132	4																					0												0				0	4
Totals	54	8	45	163	1128	13	15	154	2	1	1	210	56	70	15	1	3	2	16	19	176	2098	10	1	2	1	9	3	3	5	9	10	3	56	8	113	1	122	2330

* See Appendix D for feature code key.

Table 5-5. Historic Features within Project Mine and Process Area

Resource Number**	Resource Type* BC	CNS	CS	CA	HA	HP	HRF	RS	HRA	HRC	RLP	RRECT	HRR	RSC	RW	Total
CA-IMP-4970	33	3		3	73	1	3	14	1	62	1	11	15	28	7	225
CA-IMP-4971					1											1
CA-IMP-5010																0
CA-IMP-5061	2				1		1							1		5
CA-IMP-5067	4	1	1		8		1		1	1		1				18
CA-IMP-5494																0
CA-IMP-5526	9				1		3									13
CA-IMP-7388																0
CA-IMP-7408	5	1			13	1			1							21
Total	53	5	1	3	97	2	8	14	3	63	1	12	15	29	7	312

* See legend in Appendix D for code key.

**Table only includes sites with historic features.

cleared circles, and a variety of features of potential symbolic or religious significance. It extends over 2990 m north/south and 800 m east/west, and the features are connected by a low density lithic scatter. Much of the site was previously described as CA-IMP-5530 but the directive of the Southeastern Information Center to renumber resources with the lowest previously recorded site number resulted in a redesignation of this area. The site is dominated by a large desert pavement covered ridge and this feature somewhat unifies the site (Figure 5-3 in Appendix E).

Prehistoric Features

The site area encompasses four trails that have been recorded as separate sites within this same geographic area. These include trails F-298, F-745, F-940, and F-1020. These seem to represent at least two trail systems one crossing the ridgeline at an angle from the northwest to the southeast and the other following the ridgeline south and southwest.

The site contains a variety of both prehistoric and historic features, and these are generally concentrated along the higher ridgeline and it's slopes. One concentration of prehistoric features is in the southern part of the site (Figure 5-4). Although no prehistoric trails could be identified in this area, it contains a variety of material such as ceramics that seem to be associated with trails elsewhere. The presence of roads along most of the ridgeline may have destroyed evidence of older trails, perhaps including a continuation of trail F-745.

The concentration of features in the southern portion of the site includes three cleared circles, a pot drop, a geoglyph, and a shaman's hearth (Figure 5-4). Another two pot drops are in the vicinity of this area suggesting a concentration of prehistoric activity here. The majority of CA-IMP-4970 consists of scattered flaking stations.

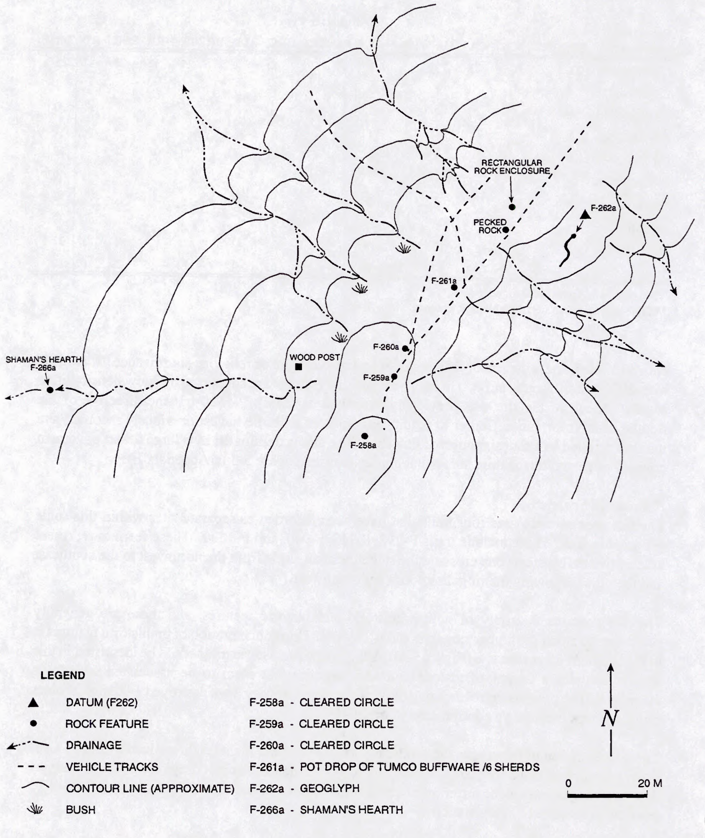


Figure 5-4. Site CA-IMP-4970, (F-258a - F-262a, and F-266a)

The geoglyph was identified by Jay von Werlhof as a serpent-like figure similar to others he had seen in the region (Figure 5-5). The "head" consists of fine unpatinated gravel while the linear part of the tail is more cleared. This may have resulted from the piling of unpatinated gravel in one area and the scraping away of gravel in other areas. The proximity of this feature to the others supports it's cultural assignment as does the presence of a nearby water rounded cobble hammerstone. While it is possible that natural causes, such as animal burrows and trails, may have created this feature, Jay von Werlhof expressed confidence as to the cultural nature of this feature based on his experience with similar features elsewhere.

An example of a shaman's hearth (Figure 5-6) is located near the concentration of features. It represents a small circle of stones in a minor drainage area. No charcoal or any cultural material were noted in association.

Other concentrations of prehistoric features within this site were more subtle. Figure 5-3 suggests several concentrations of flaking stations, and many of these may be related to the availability of material. This site included the greatest number of flaking stations (N=425) within the project, suggesting that lithic procurement was the major activity in this area. Lithic scatters (N=89) were also very common. Debitage density throughout the site area was highly variable. It ranged from approximately one per square meter to approximately one per 500 square meters. Pecked rocks, which appear to be associated with lithic reduction, were also fairly common at the site (N=143). These features were only recorded if patination was present, but others appear to be recent. These features were often associated with concentrations of lithic reduction. One cluster of three cleared circles also exists in the eastern portion of the site in an area with very few lithics.

Religious or symbolic features include a variety of types including six geoglyphs, two quartz crystals, two prayer circles, one prehistoric rock alignment, five shaman's hearths, and three vision quest circles. All of these features represent an important component of this resource. Most of the geoglyphs were the "ring" type that was common throughout the project area.

Prehistoric features also included a double rock ring feature with a small cairn (Figure 5-7). This feature was in the vicinity of historic activity but appears to represent a prehistoric resource based on patination and embeddness. Ceramics within the site were limited to four pot drops and two isolated pot sherds. Figure 5-8 shows the diagnostic rim sherds from the site. Both represent Tumco Buff jars of very different form.

Well formed lithic tools were relatively rare at the site, as is biface technology throughout the project area. This suggests that if a Paleoindian component is present, biface production similar to that at the Harris Site and the Lake Mojave sites was not an important element. Only one biface preform that fit the Paleoindian period type was identified during the project (Figure 5-9). This artifact was made from rhyolite material characteristic of San Dieguito bifaces. No other true bifaces of this type were identified within the site. The five other bifaces listed in Table 5-4 represent bifacial cores that were probably used to produce flakes rather than representing bifacial tools.

With the aid of Jay von Werlhof, a large possible early tool component was identified at this site. A total of 95 early tools and several tool scatters were recorded within the site. This probably represents only a third of the early tools within the area because recording of this category was halted

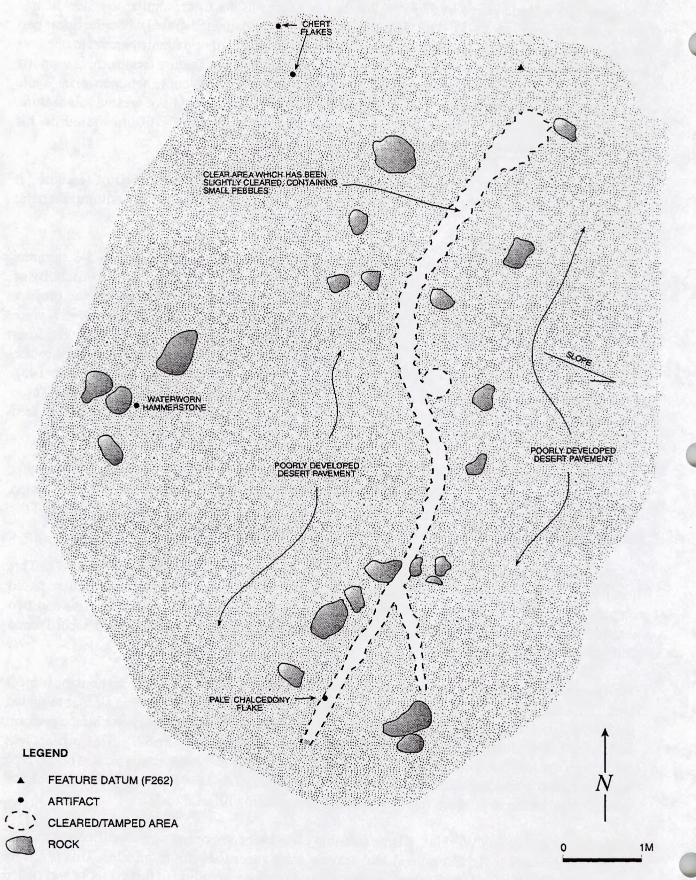


Figure 5-5. Site CA-IMP-4970, Geoglyph (F-262a)

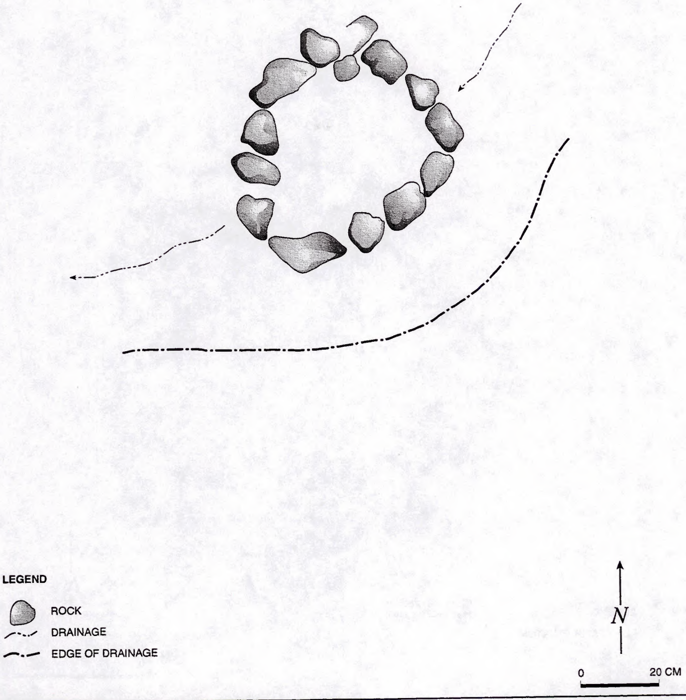


Figure 5-6. Site CA-IMP-4970, Shaman's Hearth (F-266a)

Figure 5-7. Site CA-IMP-4970, Double Rock Rings with Rock Cairn (F-379)

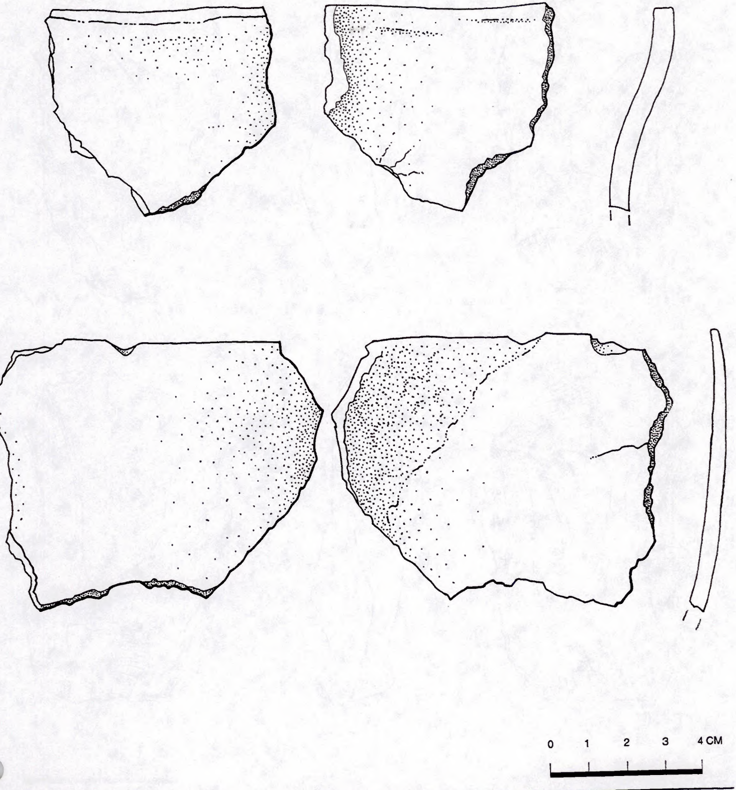


Figure 5-8. Site CA-IMP-4970, Ceramics (F-261 and F-348)

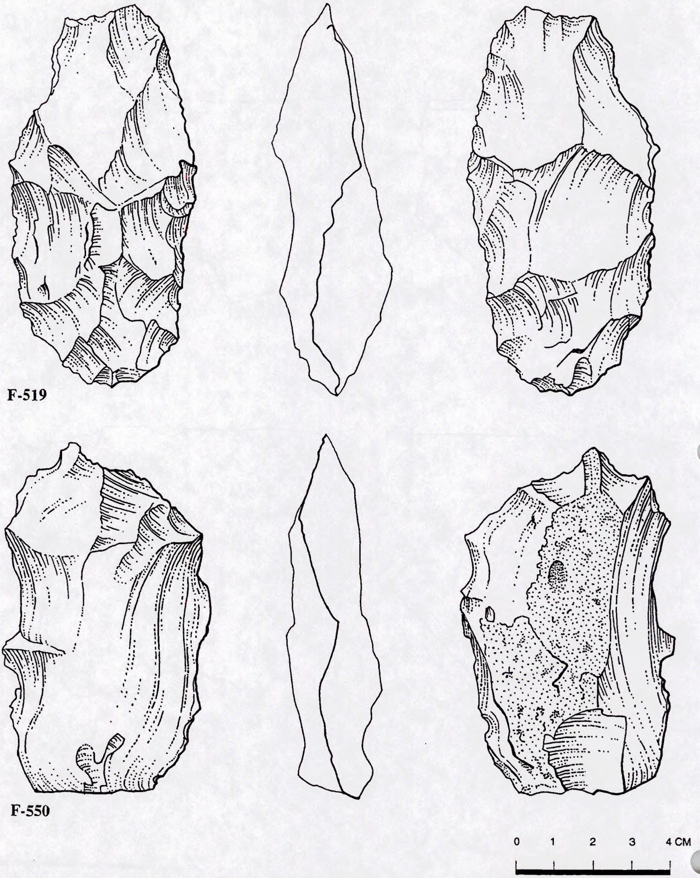


Figure 5-9. Site CA-IMP-4970, Biface Preform and Tool (F-519 and F-550)

during the survey of this site due to the abundance of this tool type. Figure 5-9 shows an example of a possible San Dieguito tool identified by Jay von Werlhof.

Historic Component
The historic component is a WWII training camp with associated rock features, roads, and artifact scatters dominated by cans. This site encompasses a historic component that appears to have functioned as a bivouac that was part of the Desert Training Center activities of World War II. The most common features at this site are rock semi-circles, rock cairns, rock rectangles, rock rings, and bomb craters. There are also cleared areas, rock walls, anomalous rock features, and a rock lined pit. Rock semi-circles, rectangles, rings, and cairns may have been used for gun placements and firing shelters. They are generally three to four courses tall and one to two courses thick. Bomb craters often contained pieces of shrapnel. Cleared areas were most likely used for sleeping areas. Numerous historic artifacts and trash scatters exist at this site. Most of these scatters consist of World War II ration cans and range from tobacco tins to cocoa, coffee, vegetable, and meat cans (Plate 5-1a).

For ease of discussion, the site will be broken down into three parts: the northern part, the central part, and the southern part. The arbitrary dividing lines for these will be the 3651300 m and the 3650550 m Northing UTMs.

The northern portion of the site contains a bomb crater, a cleared area which is lined with gravel, a rock semi-circle, a rock cairn, two rock rings, and two rock rectangles. There are also six historic artifacts in the area that are mostly composed of ration cans. One of the rock rings and the two rock rectangles are clustered on a knoll just south of Indian Pass Road. They are slightly different than most of the rock features on the rest of the site. One of the rock rectangles (F-300) is rather large (approximately 2.5 x 3.5 meters) and appears to have been the outline of a tent pad. It has a single course alignment of rocks inside the perimeter that serves to divide the tent area into two "rooms" (Plate 5-1b). There are also rocks lining the entrance on the open east side of the rectangle. The other rock rectangle is slightly more amorphous and lies to the east of the first. It looks more like a rounded rectangle and it has much higher walls. Its opening is on the west side and the is flanked by a circular pattern of rocks on either side. This may also have served as living quarters although it would have been far more cramped than the other rectangle. Between the two rectangles lies a sinuous rock ring. It is shaped somewhat like a figure eight and the rocks lining it are piled two to three courses high. There are berms on the east end and the rocks here become less regularly placed. It is less clear what this feature was used for although it could have been used as a shelter of some kind.

The central portion of the site contains 14 bomb craters, one cleared area, two rock semi-circles, and approximately four historic artifacts including ration cans, shrapnel, and metal ammunition clips which read "G1W-M9-2".

The southern portion of the site contains by far the most concentrated historic features. It lies on a ridge that commands a good view of the surrounding terrain (Figure 5-10). A road runs through the central portion of the site. The site may have been used to train soldiers how to defend against attack. It contains 18 bomb craters, 13 rock rings, eight rock rectangles, two pits (one of which is rock lined), 61 rock cairns, 26 rock semi-circles, seven rock walls, five anomalous rock features, and

Plate 5-1a. Site CA-IMP-4970, Ration Can (F-234)

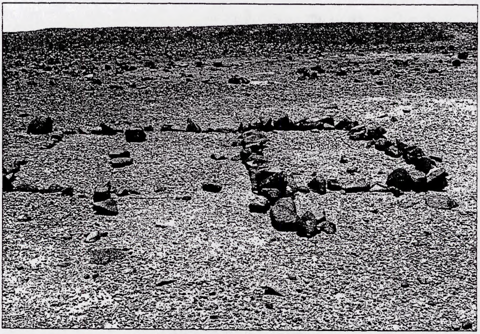


Plate 5-1b. Site CA-IMP-4970, Historic Rock Foundation (F-300)

Figure 5-10
Site CA-IMP-4970, Overview of Military Camp

See Confidential Appendix

over 70 artifact scatters. The majority of the rock cairns are lined up in a northwest/southeast direction and form two staggered lines along a west facing slope (Figure 5-11). It is possible that these lines were used as firing lines since the westernmost line would have been lower down the slope than the easternmost line. The southern end of this portion of the site had several tent stakes and was somewhat flatter than the rest of the area. This is most likely the sleeping area. Several artifact scatters were found, many of which appeared to be dumping areas, and consisted of ration cans similar to those in the central and northern parts of this site, and various wooden and metal items. These items included shrapnel, nails, and parts of wooden crates.

Most of the rock rectangles measured approximately six feet by three feet and were composed of rocks that were two to three courses high and one to two courses thick (Figure 5-12; F-163). While some of them had walls that formed perfect right angles, others had rounded corners and sinuous sides. These may have been used as protection for more numerous men firing in several directions. In contrast, there were several rock walls that six feet long and had small walls coming off the six foot line at right angles (Figure 5-12; F-228). These measured approximately one and one-half feet. These features look like they would only protect only one or two people and they could only fire in one direction.

There were several variations on rock rings at this site (Figure 5-13; F-249). Some rings appeared to be lining pits that may have been made by bombs. It is unclear what their function may have been as the stones lining them appear to have been placed there after the bomb blast occurred. Other rock rings were more elaborate, measuring approximately six feet across (Figure 5-13; F-226). These were composed of rocks piled two to three courses high and one to two courses thick. Some of these features had occasional ration cans in or around them. These may have served the same function as the rock rectangles.

CA-IMP-4971

This site is primarily a large lithic scatter with discrete flaking stations and a moderate density debitage scatter. One cleared circle, groundstone, and two geoglyphs were also noted. The site is located on a large ridge area in the north central portion of the Project mine and process area (Figure 5-14 in Appendix E). The site is approximately 1500 m north/south by 500 m east/west and is bounded by washes on three sides. The presence of a subsurface deposit is unlikely in this desert pavement terrain.

The site is dominated by lithic procurement and reduction activity. A total of 122 flaking stations and six lithic scatters were identified within the site area along with 15 pecked rocks. The area contains some evidence of rockhound activity but not as great an impact as areas closer to Indian Pass Road. The absence of trails within this site may be associated with the low occurrence of features other than flaking stations.

As with CA-IMP-4970, a variety of possible early tools resources were identified in this site area by Jay von Werlhof. The site has only one historic item in it. It is an unidentified circular threaded metal object that is approximately three inches in diameter and 1.5 inches deep. The center has a perforation of about one inch diameter. Since it is unidentified, it is difficult to assign a time period to it.

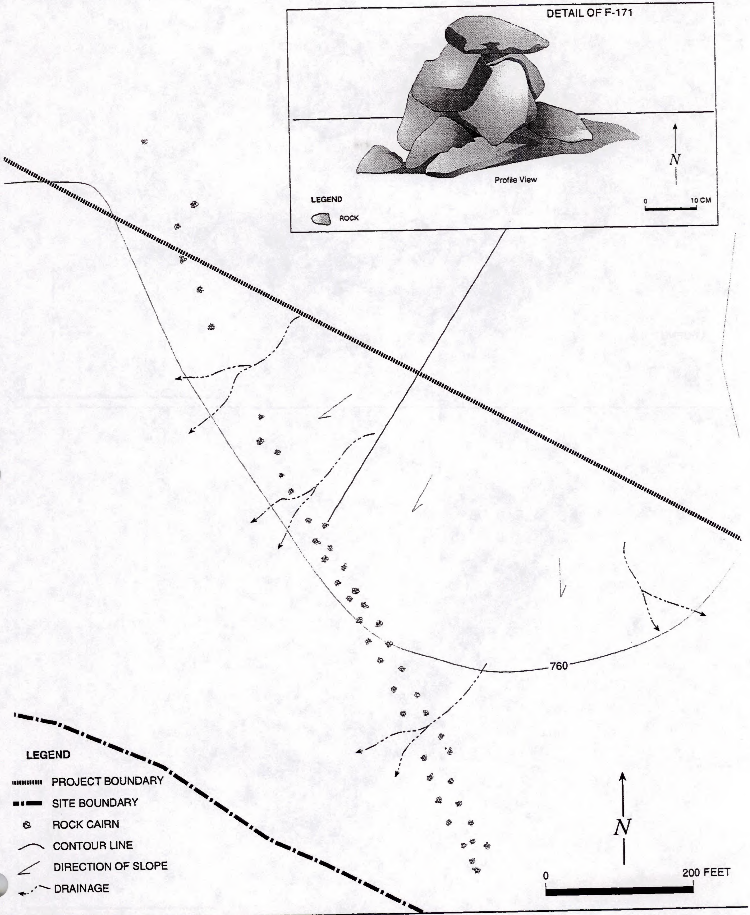


Figure 5-11. Site CA-IMP-4970, Historic Rock Cairn Alignment

Figure 5-12. Site CA-IMP-4970, Historic Rock Features (F-163 and F-228)

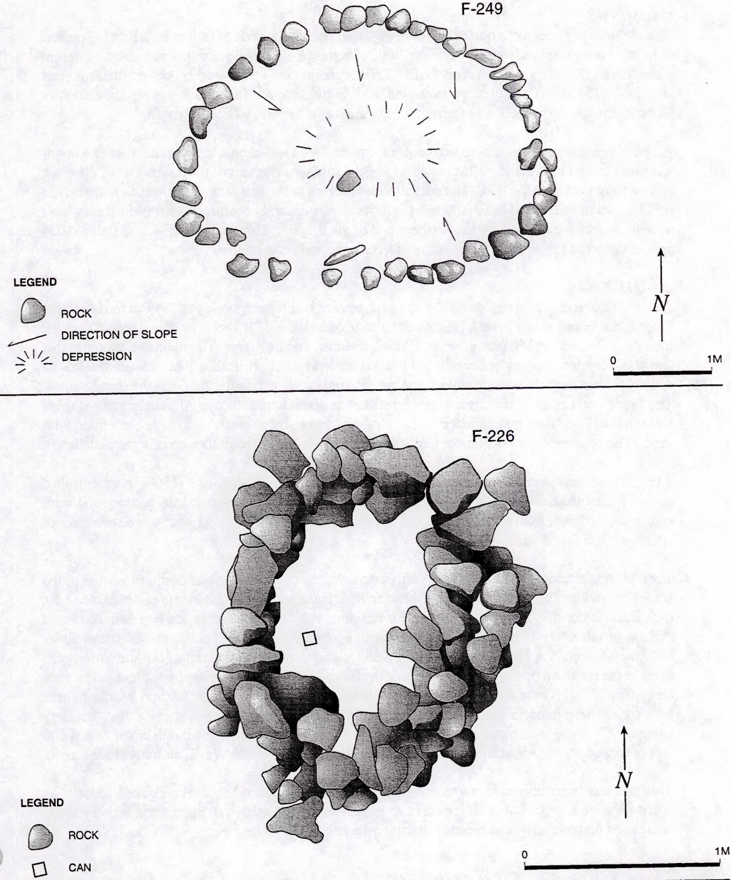


Figure 5-13. Site CA-IMP-4970, Historic Rock Rings (F-226 and F-249)

CA-IMP-5010

This includes segments of a northeast-southwest trail on the west side of Indian Pass Road. Portions of the trail have been obscured by erosion, but this series of eight trail segments appears to represent a single trail (Figure 5-15 in Appendix E). Trail segments are within portions of multicomponent site CA-IMP-5067. Ceramics, groundstone, and flaking stations in that site appear to be directly associated with the trail. Trail segments range in size from 10 to 625 m in length.

All but the northern and southern segments of this trail are located on a low terrace west of a major wash and Indian Pass Road. What appears to be the southern segment of the trail is east of the wash and may connect with F-3024. The northern end crosses to the east side of the wash. It appears to parallel Indian Pass Road before merging into its alignment and becoming destroyed. It may have once joined with trail F-4 near the northern end of the Project. This trail, trail F-4, and trail F-3024 appear to be the major trails through the Project mine and process area.

CA-IMP-5061

This multicomponent site is located on the high terrace and terrace slope at the western side of the Project mine and process area (Figure 5-16 in Appendix E). It includes a variety of features including cleared circles, groundstone, flaking stations, and debitage. The debitage scatter at this site was very low density reflecting the limited amount of chert in this area. It was the lowest density within any site area. Early tools were also nearly absent, particularly on the terrace slope. The 12 cleared circles in the site may not be related to prehistoric activity. Although many of these were well defined they may reflect either natural features or bomb craters that have been filled with sand. The later explanation is more likely and could be tested through the use of a metal detector.

This site contains several trail segments that were recorded separately as F-1500. As mentioned below in the discussion of this resource, many of these trails may reflect animal activity and were somewhat different from clearly prehistoric trails. These trails also lack any associated ceramics or artifacts often found with major trails.

The historic features in this site are primarily concentrated in the middle and northern portion of the site. The northern portion contains two historic rock features and a single bomb crater. One of the rock features consists of a rock semi-circle three courses high and the other is a less defined pile of rocks approximately 25 cm wide. The historic component in the central portion of the site includes two bomb craters. A single bomb crater is also located in the southern part of the site. Along the ridge in the southern portion of the site is a collection of white quartz that has been arranged to form the letters "AC." These are approximately six feet in length. According to Jay von Werlhof, these letters may be related to the World War II activities in the area and could stand for "Artillery Company." There are no associated artifacts to confirm this, but there is a bomb crater within 100 feet of these letters. All of these items appear to be related to World War II activities in the area.

This site has been impacted by recent rockhound activity and many rocks stacked loosely on boulders were noted. These all appeared to be recent and not related to prehistoric activity in the area based on patination and recent battering on some of the rocks.

CA-IMP-5067

This site appears to largely represent cultural material associated with two major prehistoric trail systems in the area (Figure 5-17 in Appendix E). These trails CA-IMP-5010 and F-4 are discussed separately but should be considered in association with this site because most of the cultural material appears to be patterned along these trails. The site itself includes both historic and prehistoric components.

The prehistoric component of the site includes ceramics, groundstone, flaking stations, debitage and features such as a scratched petroglyph and trail related rock features. As with the historic component most of these features were concentrated in the northern portion of the site (Figure 5-18). Figure 5-18 shows the relationship between many of these features and the trail junction at the northen end of the site. This trail junction appears to represent an area of concentrated activity, possibly a temporary camp. There are also a number of religious or symbolic features that appear to be directly associated with the trail system. Figure 5-19 shows what appears to be a spirit break along the northern portion of the trail. This feature had an associated pot drop. The abundance of ceramics in this area of the site suggests that at least some of the ceramics were related to purposeful breaking to mark the trail junction.

Another trail junction marker noted further south consisted of a very heavily patinated piece of groundstone and two associated rocks on the east side of a trail fork. As shown in Figure 5-20, this junction was also associated with several large pot drops. It is interesting to note that all of the markers and associated concentrations of material are at the northern forks in these trails. The southern forks to not show any special marking or associated activities. This may reflect a boundary phenomenon.

Another special item at a trail junction was a scratched petroglyph (Figure 5-21). This item was relatively small and well patinated. It shows a very similar pattern to many of those at the Indian Pass Site and may even have been brought in from there, although it could have easily been made on the site. Other scratched rocks were present in the site but most of these were problematic.

Figure 5-22 shows another example of scratching but this may have been created by a tire or tank tread passing over the rock. These rocks were poorly patinated, although some was present, and less patterned. One Quechan consultant thought one example of this scratching was the result of using a rock as a base for cutting with a knife.

Ceramics were an important component of this site. A variety of types were present, but they were dominated by Tumco Buff. One example of stucco finished ceramic was present in the northern portion of the site and a Colorado Buff vessel with red lines was also present in this area (Figure 5-23). Two large sherds of this vessel were found together. Several other sherds that probably were part of this vessel were scattered up to 20 m away suggesting that these sherds may have been purposefully scattered. Several rim sherds were present at this site. Figure 5-24 provides an example of one of the jar rims. Many of the pot drops within the site can be reconstructed to determine vessel form. General vessel types included both jars and shallow bowls. Several sherds

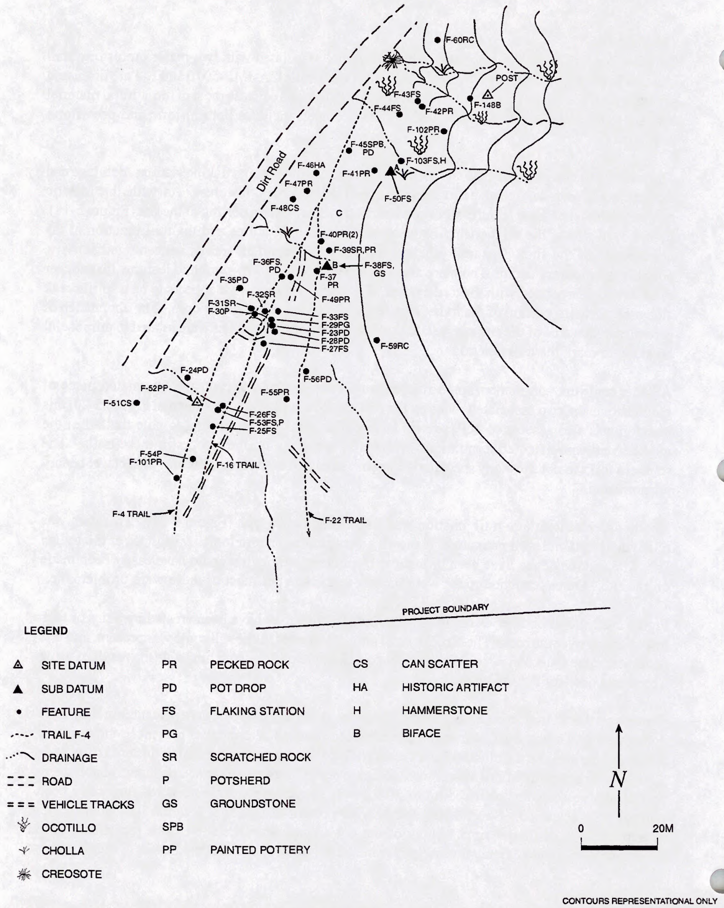


Figure 5-18. Site CA-IMP-5067, North End Concentration

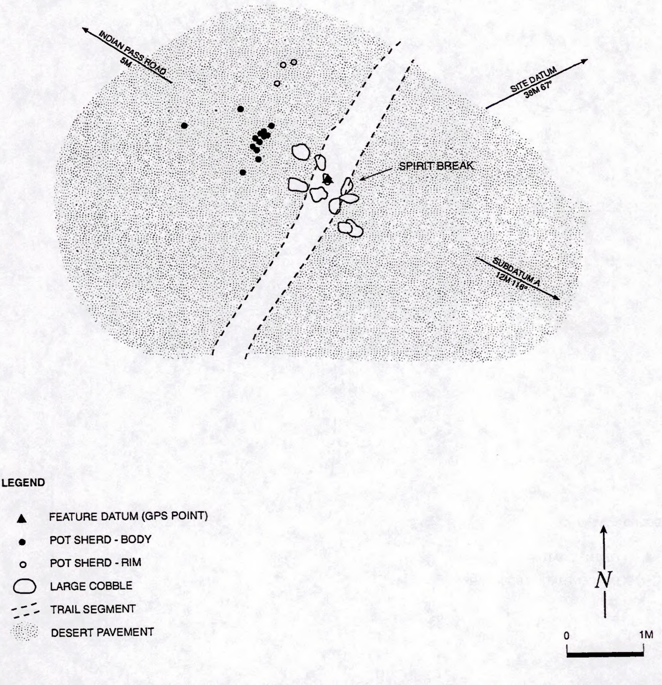


Figure 5-19. Site CA-IMP-5067, Spirit Break and Pot Drop along Trail F-4 (F-45)

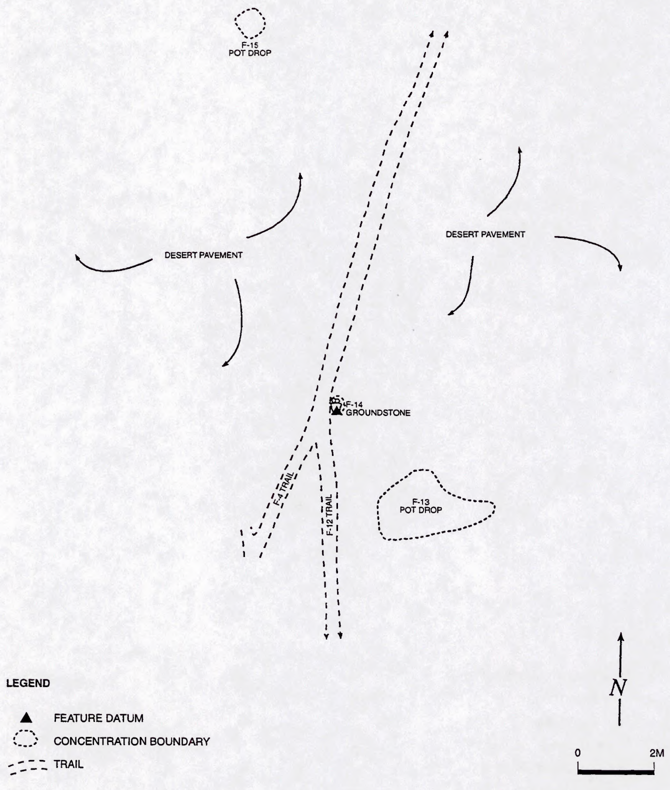


Figure 5-20. Site CA-IMP-5067, Trail Marker and Related Pot Drops along Trail F-4

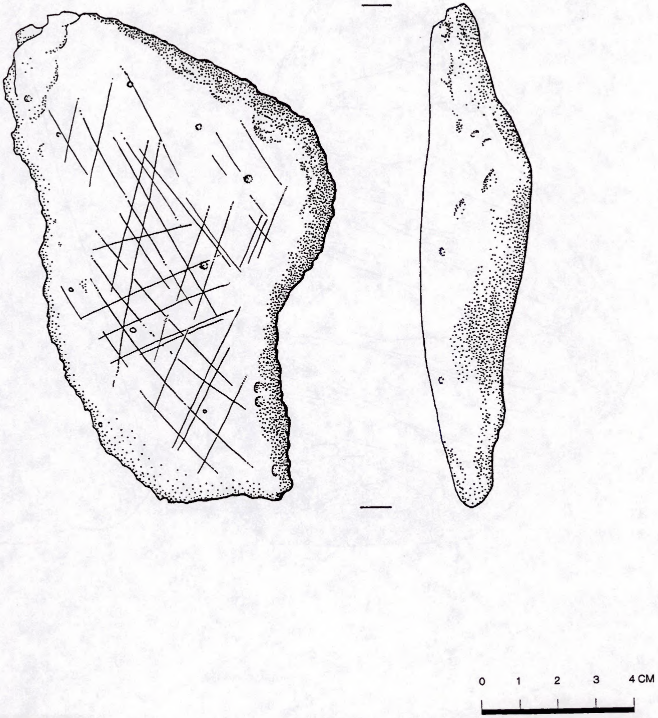


Figure 5-21. Site CA-IMP-5067, Scratched Petroglyph (F-29)

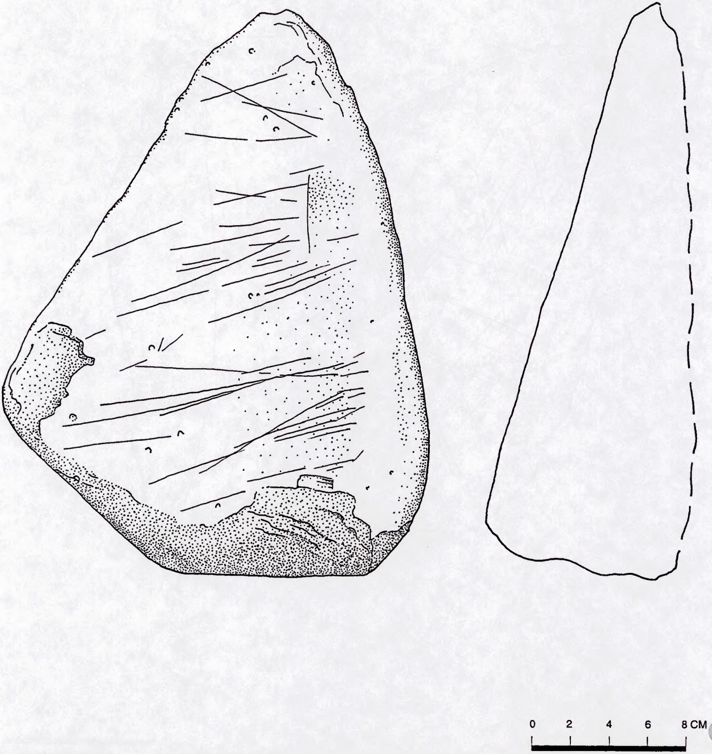


Figure 5-22. Site CA-IMP-5067, Scratched Rock (F-1410)

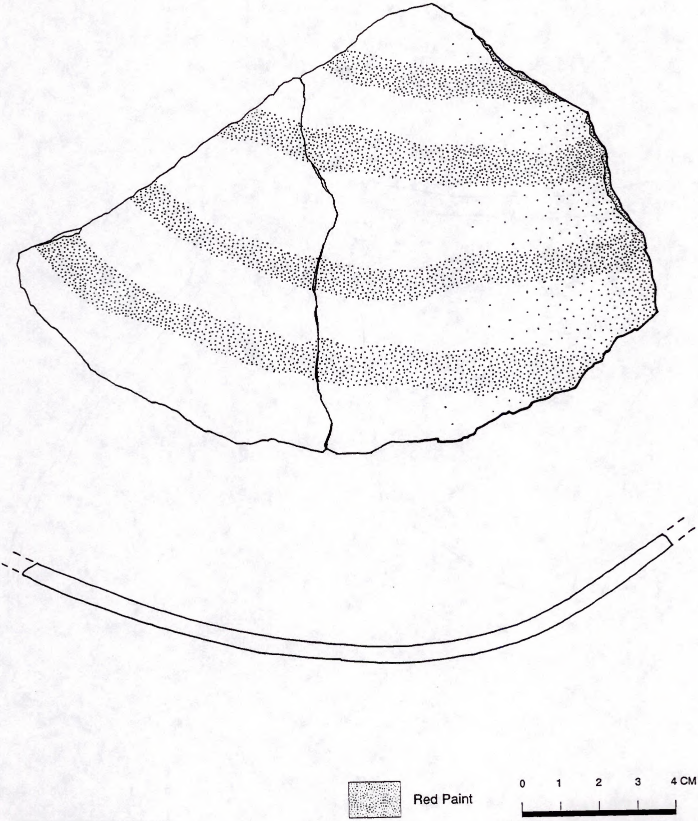


Figure 5-23. Site CA-IMP-5067, Red on Buff Ceramic Sherd (F-1640A)

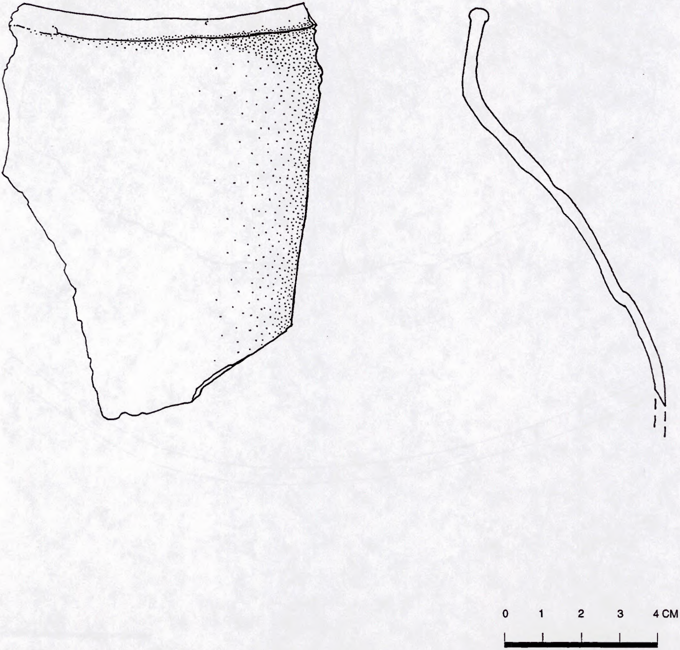


Figure 5-24. Site CA-IMP-5067, Rim Sherd (F-11)

of Tizon Brown ware were also found, and this material may have been imported from the desert mountain areas to the east. The distance to sources in the west is greater and therefore less likely to have been the source.

Groundstone at CA-IMP-5067 included two metates and a pestle preform. The pestle preform was an early stage example of shaping. An elongated local basalt cobble was bifacially flaked along its length in an attempt to further shape the artifact. It appears to have broken during manufacture and was discarded although the flakes were not in direct association with the preform.

The second piece of groundstone was a thin flat slab of granitic schist that was used as a unifacial metate on one face. The final metate (Figure 5-25) was represented by four fragments. This metate was well shaped and was made of non-local material. A knowledge Quechan felt that the material may have come from a quarry on the far side of Indian Pass. The metate is a good example of a tool that was semi-portable and appears to have been carried along the trail.

Flaked lithic tools were relatively rare at this site although Jay von Werlhof noted the presence of an early tool component in this area. Two bifacial tools were noted within the site. One of these tools is somewhat crudely shaped (Figure 5-26). This was probably not used as a projectile but as a cutting tool. The second biface from the site (Figure 5-26) appears to represent a flake-based Cottonwood triangular projectile point made from brown chert. The flake was minimally retouched to produce the projectile point and most of the flake remains intact. Other than ceramics, this was the only other artifact diagnostic of the Patayan Period within the project.

The historic component includes several historic features and can scatters, all in the northern half of the site. The southern part of the northern half of the site contains most of the features while can scatters are primarily in the northernmost part. Among the historic features are a bomb crater with a linear alignment of rocks on the edge, a group of about 50 rocks with a can and bottle cap associated, and a rectangular grouping of rocks (Figure 5-27). Most of these appear to be related to World War II activities in the area.

CA-IMP-5494

This site is a large lithic scatter with discrete flaking stations and a moderate density scatter of debitage. It is approximately 1350 m north/south by 550 m east/west in size. Three rock rings and a cleared circle were also noted but historic material was absent. This site is located on the eastern side of the Project mine and process area and is bounded on the west, north, and south by major washes (Figure 5-28 in Appendix E). On the east, the site is bounded by an 50 m gap in low density lithic scatter and flaking stations. The lithic scatter density is much lower in this area, as is the density of flaking stations. The northern portion of the site almost completely lacks the low density lithic scatter of other sites. The density of flakes in this area is less than one per 5000 m^2. This area appears to have less chert abundant naturally than in some other sites. Possible early tools were also noted to be less abundant in this area during the survey.

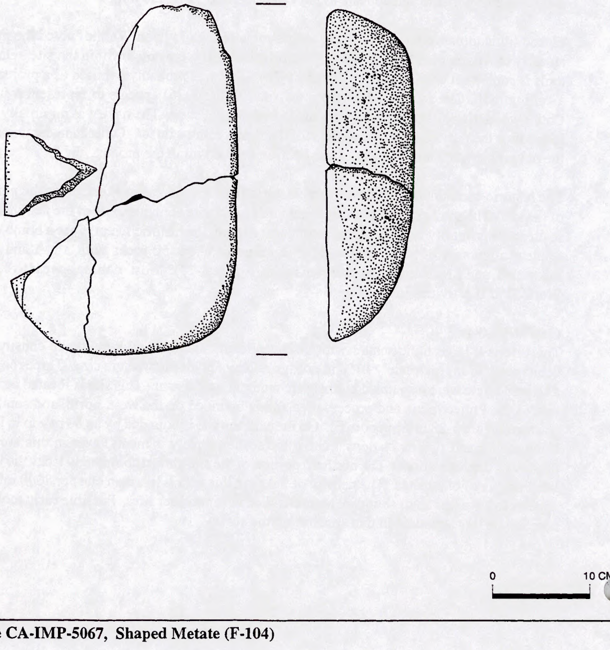
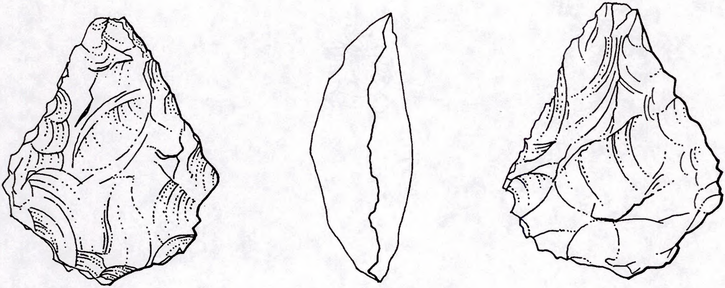
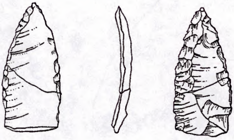


Figure 5-25. Site CA-IMP-5067, Shaped Metate (F-104)



F-148



F-1481

Figure 5-26. Site CA-IMP-5067, Bifaces (F-148 and F-1481)

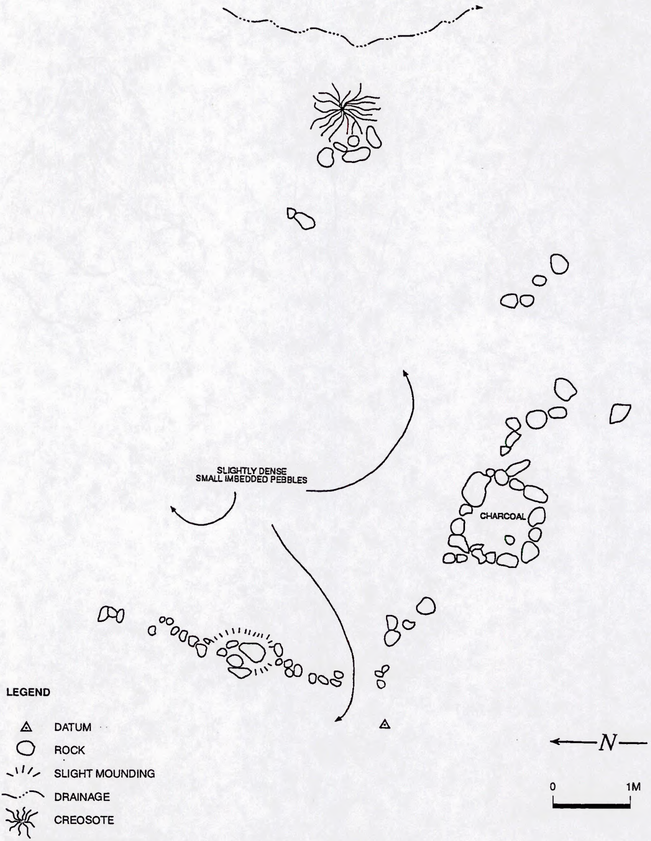


Figure 5-27. Site CA-IMP-5067, Historic Rock Feature (F-3)

This site lacks the diversity of feature types that are present in many of the other large sites, and trails are not located within this site area. The three rock rings in this site appear to be prehistoric and represent good examples. Plate 5-2 shows two of these features with well developed desert pavement of the interior. This site also includes the previously recorded possible *Lingum*. This feature had fallen but was relocated during the survey. With the exception of drill points and roads, this area appears largely undisturbed. Rockhound activity is much lower than sites to the west probably reflecting both the distance from Indian Pass Road and the lower density of chert.

CA-IMP-5526

This is the largest site within the Project mine and process area and although it includes several historic features most of the site is prehistoric. It includes several north/south ridgelines and large areas of terrace bounded by major washes to the east and west (Figure 5-29 in Appendix E). Cultural material may continue to both the north and south. Trails F-2142, F-2202, F-2282, F-2294, F-4028, and F-4132 pass through this site area, and some of the artifacts within the site are probably associated with these.

The prehistoric component is dominated by flaking stations and the low density lithic scatter characteristic of the area. Similar to the other sites in the region chert is the major lithic material. Flaking stations and lithic scatter density seem to parallel each other and often are also directly related to resource abundance. Early tools were also present in this area and parallel the more dispersed nature of the flaking stations and material. As shown on Figure 5-29 (Appendix E), most of the flaking stations are evenly dispersed throughout the site although they are slightly more dense in the south and sparse on the northern end of the site.

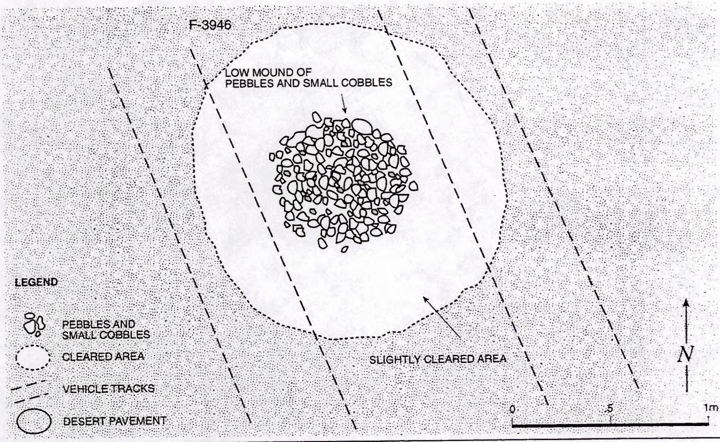
A variety of ceremonial features is present at the site including two geoglyphs, six prayer circles, two rock alignments, two spirit breaks, and one vision quest circle. Figure 5-30 provides an example of one of the vision quest circles. This feature was seen as particularly important by Native American observer Mark Kelly who burned tobacco in this area during the survey. Near this feature is a small gravel mound (Figure 5-30). This feature is unusual and represents an area of desert pavement gravel that has been scraped into a mound.

On the southwestern side of the site there is a flat open plain. Several ceramic scatters including one large one were identified in this area, although no trails were identified. Desert pavement is not well developed in this area and a trail could easily have been obscured through time. The large scatter represents a jar and may be completely reconstructable (Figure 5-31).

Another interesting ceramic feature is a polychrome ceramic scatter located in the northern part of the site. This pottery is southwestern in design and appears to have been manufactured in the coil and scape method rather than the paddle and anvil method of the Patayan (Figure 5-32, Plate 5-3). Polychrome wares in the southwest are usually late (circa 1400s) in age. Because this sherd could not be readily typed, it may represent an intrusive item. However, it could also suggest continued Native American use through relatively recent times.

Plate 5-2. Site CA-IMP-5494, Prehistoric Rock Rings

Plate 5-3. Site CA-IMP-5526, Polychrome Ceramic



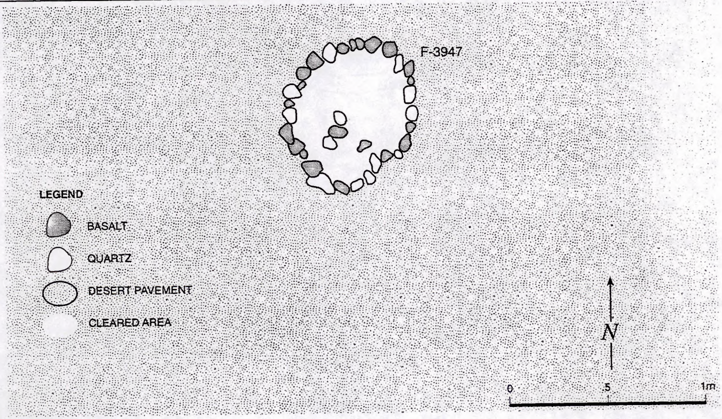


Figure 5-30. Site CA-IMP-5526, Vision Quest and Gravel Mound (F-3946 and F-3947)

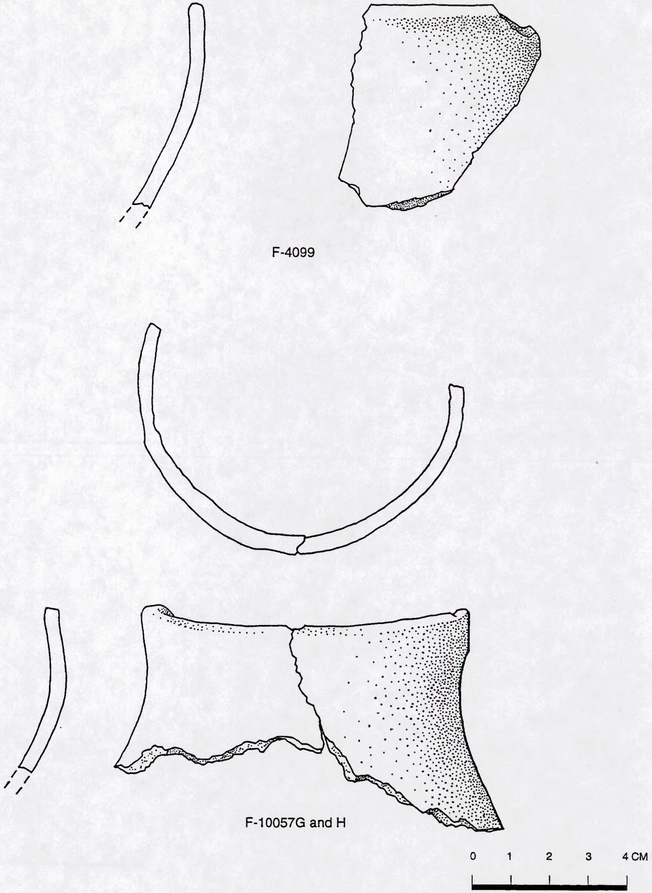


Figure 5-31. Site CA-IMP-5526, Ceramic Neck (F-4099, F-10057G and F-10057H)

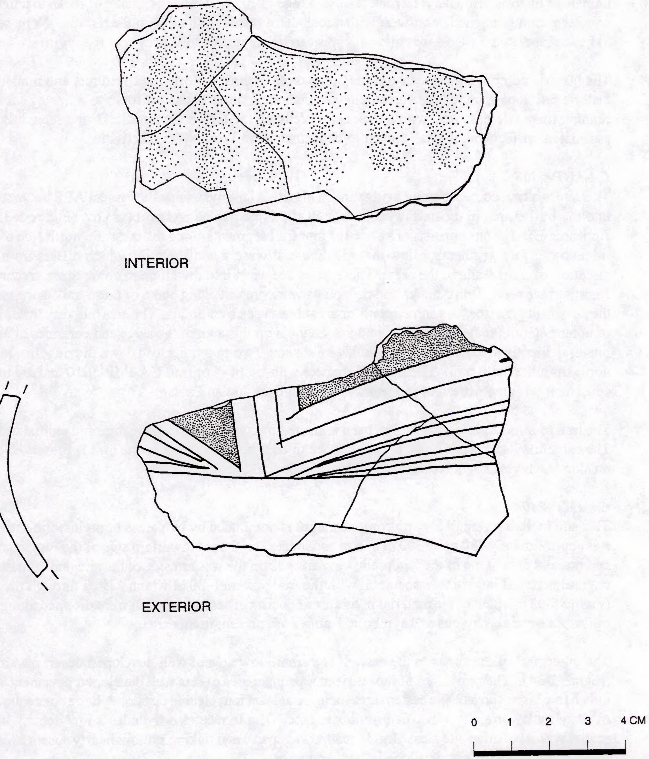


Figure 5-32. CA-IMP-5526, Polychrome Ceramic Fragment (F-2148)

Although roads do cross the area and drill points are relatively abundant in the northern portion of the site, the area generally has good integrity. Rockhound activity is present but the majority of this area is undisturbed and retains prehistoric features with good integrity.

The historic component of this site consists of nine bomb craters, three historic rock features, and numerous historic artifacts. The rock features range from an anomalous cluster of rocks to a line of cobbles running magnetic east/west with a rock cairn breaking the line in the middle. None seem to have associated artifacts, but they all appear to be connected to World War II activities.

The historic component consists of nine bomb craters, three historic rock features, and numerous historic artifacts. The rock features range from an anomalous cluster of rocks to a line of cobbles running magnetic east/west with a rock cairn breaking the line in the middle. None seem to have associated artifacts but they all appear to be connected to World War II activities.

CA-IMP-7388

This site is a trail complex along a ridgeline. This site is largely outside the Project APE but extends into the buffer area in the northwest portion of the Project mine and process area (Figure 5-33 in Appendix E). The site consists of a series of four trail segments along the crest and north side of the ridgeline. Two segments follow the ridgeline east/west, a configuration which differs from the direction of most trails in the area. These trails are worn into the slope in some areas creating a slight terrace area. Burro tracks and droppings were present along some of these trails suggesting the possibility that they are animal trails or are at least used by animals. The area has very little chert or other potential material for producing stone tools on this area of the ridge and ceramics or other material directly associated with the trail were absent. Two spur trails lead down the ridgeline to the north from the main trail. These could connect with trail F-4 or trail CA-IMP-5010 and are more consistent with the pattern of movement radiating from Indian Pass.

The trail retains fair integrity but has been impacted by roads along the ridgeline and animal traffic. The ridgeline itself is not made of highly developed desert pavement so the trail is preserved best on slopes where a slight terrace was formed by the trail use.

CA-IMP-7408

This site includes a small historic component but is dominated by two areas of prehistoric activity. It is approximately 730 m by 300 m in size and located on the southwestern side of the Project mine and process area. One of the two prehistoric areas is on the western side of the site and consists of cultural material largely in association with the trail system F-3024 which passes through the site (Figure 5-33). Much of the material in this area consists of ceramics which were dropped along the trails, but several religious and symbolic features are present in this area.

The other part of the site is to the east. It is a small, low area of well developed desert pavement (Figure 5-34). The remainder of the site is in a younger area of less well developed pavement with only a few higher areas. The eastern area includes at least four cleared circles. A large concentration of early tools were also identified on this terrace. The terrace also includes a low density lithic scatter typical of other site areas. Lithic scatter was sparse and flaking stations nearly absent in other parts of the site with less developed desert pavement.

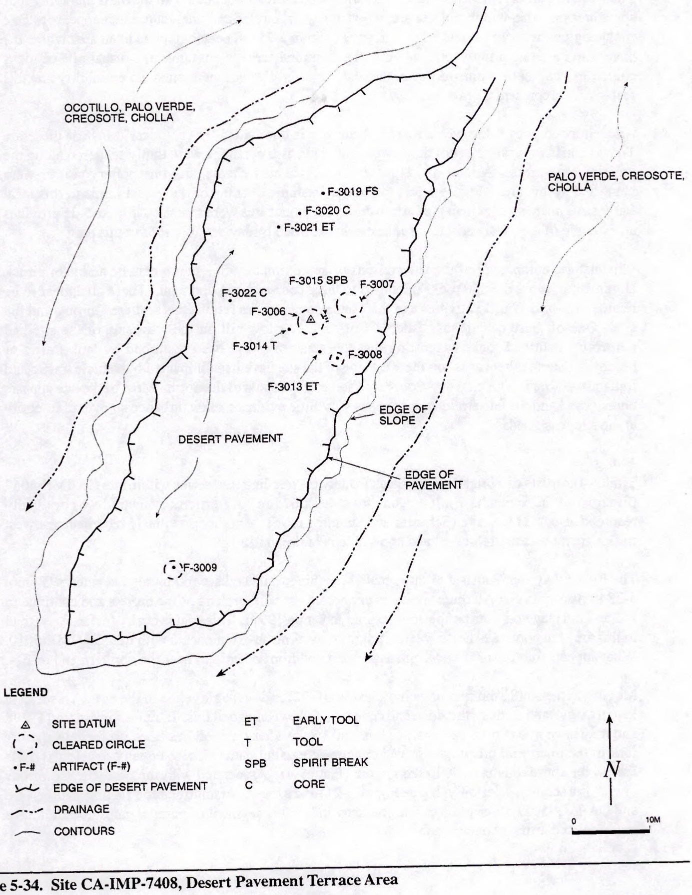


Figure 5-34. Site CA-IMP-7408, Desert Pavement Terrace Area

The western portion of the site includes a variety of features associated with the trails including four spirit breaks. Also within the site are two vision quest circles and one feature that appears to be a ring geoglyph with an associated rock feature (Figure 5-35). The geoglyph is in an area where the pavement has started to develop again in the disturbed area. It contains an unusual pile of rocks similar to a cairn along one portion of the ring. Jay von Werlhof mentioned the possibility that this feature may represent a grave marker.

As mentioned above, the western area of the site is dominated by ceramics. Most of these are Tumco Buff. Several large pot drops were noted but also ceramics were thinly scattered along the trail in some areas. A total of 11 pot drops, 16 isolated sherds, and one pottery scatter were identified in this area. Figure 5-36 provides an example of some of the vessel forms in this area. Early tools in areas other than the eastern desert pavement area were sparse but Figure 5-37 provides an example of a typical early tool spokeshave identified by Jay von Werlhof in this area.

This historic component of the site consists of approximately five bomb craters, an historic rock alignment of more than 50 rocks piled two to three courses high, and a pit. These all appear to be related to World War II activities and there are also numerous ration cans scattered throughout the site. One of these cans reads "Salerno Coffee." The low hill on the west side of the site had numerous disturbed rocks suggesting that the area may have been disturbed by tank traffic or bombing. Some others areas on the west side of the site have been impacted by vehicle traffic and Indian Pass Road. This may have obscured some of the trails to the north. Most of the site appears undisturbed and the eastern terrace area has very little evidence of disturbance so overall integrity at the site was good.

F-4

Trail F-4 consists of a branching northeast/southwest trending trail series within site CA-IMP-5067 (Figure 5-38 in Appendix E). It extends for at least 675 m. A portion of this trail was originally recorded as part of that site (Schaefer and Schultze 1996). Another previously recorded east/west trail segment was not relocated and appears to be a tire mark.

The F-4 trail system consists of three main branching trails and several parallel segments (Figure 5-38 in Appendix E). All three appear to connect at the northern end of the project and continue to Indian Pass (Jay von Werlhof personal communication 1997). This trial is cut by Indian Pass Road in this area but continues north, where it may at one time have connected with trail CA-IMP-5010. What appears to be a spirit break and associated pot drop are present near the northern end of F-4.

Moving to the south, the first branch of the trail (F-22) is down a ridgeline to the east. This trail is lost in a wash at the end of the ridge and cannot be followed beyond this. It trends toward trail F-298 and may have at one time been part of this trail. Soon after this trail branches off there is another fork in the main trail creating two well developed parallel paths. These equally developed trails extend for approximately 140 m then rejoin (Plate 5-4). Associated with the northern end of this branch is a scratched petroglyph (see Figure 5-21) and a cluster of potdrops and flaking stations (see site CA-IMP-5067 description). The southern end of this segment of parallel paths does not have an associated artifact concentration.

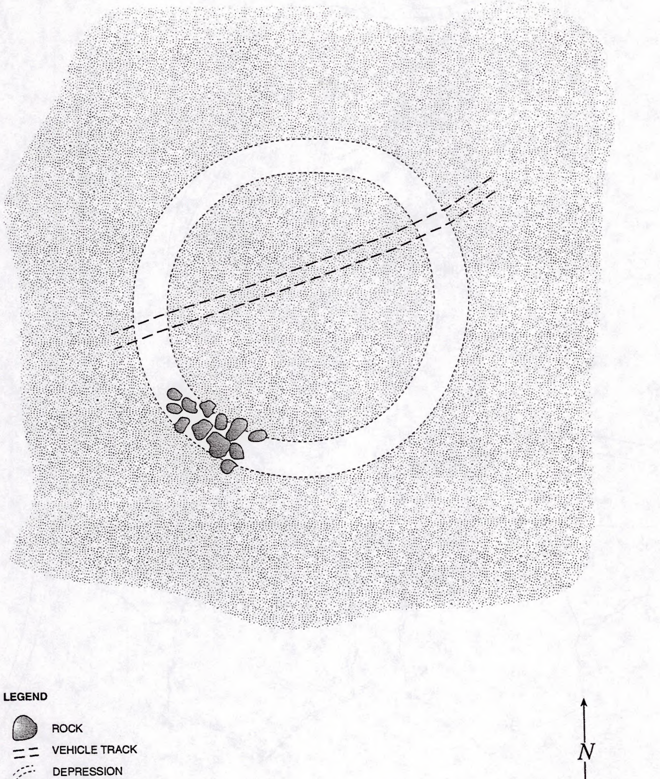


Figure 5-35. Site CA-IMP-7408, Ring Geoglyph (F-3023)

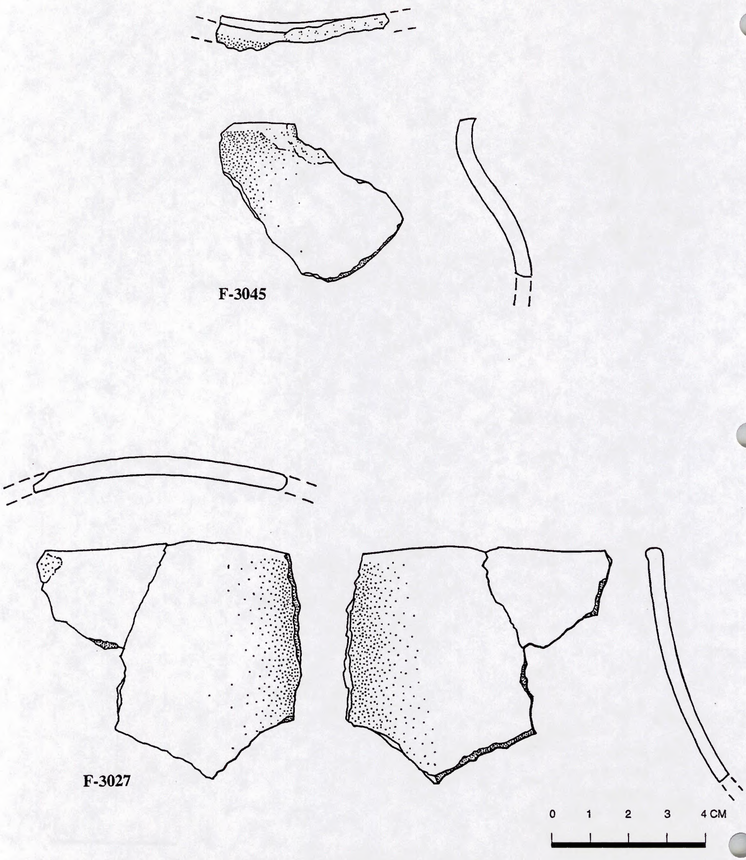


Figure 5-36. Site CA-IMP-7408, Ceramics (F-3027 and F-3045)

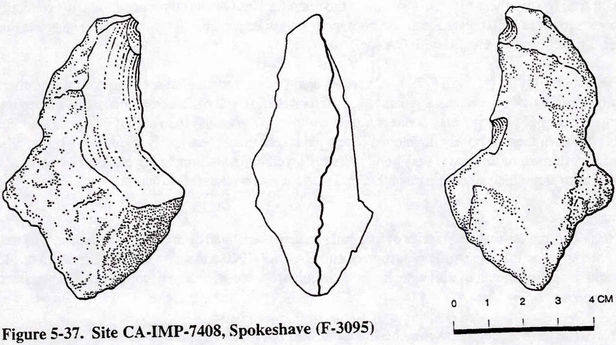


Figure 5-37. Site CA-IMP-7408, Spokeshave (F-3095)

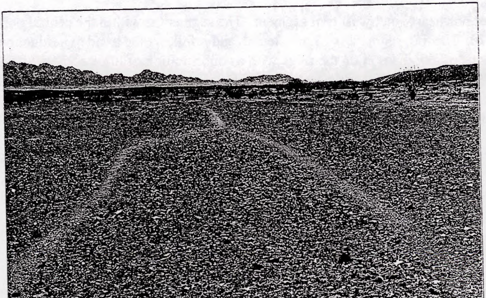


Plate 5-4. Site CA-IMP-5067, Split trails (F-4)

Just south of this area, a trail (segments F-5, F-1636, F-1406, F-1407, F-1408) branches from the main trail toward the west. This parallels the main trail and is slightly more faint. It eventually appears to cross Indian Pass Road and goes up to a wash edge. This directional trend suggests that this trail segment connected with CA-IMP-5010.

The main trail (F-4, F-5 part, F-7, F-12) breaks again twice into parallel segments. At the northern end of the first of these is what appears to be a trail marker of well patinated groundstone and several large pot drops. This trail may connect further south with the trail system at F-3064 or F-1336. The area between these is poorly developed desert pavement that is less likely to preserve trails. The integrity of most of this site is very good with trails well defined. Some tank tracks are present and tire tracks along the southern part of this trail make it less well defined there.

F-298

This is a northwest-southeast series of five trail segments separated by areas of disturbance. The trail segments are within the northern portion of site CA-IMP-4970 and range in length from 15 to 115 m and the entire stretch of trail extends for approximately 465 m before becoming lost in the desert pavement.

This series of trail segments may be linked to trail F-4. They appear to form a linear trail that follows, then crosses a ridge of rocky well developed pavement. To the south this trail may be related to trail F-4132, but the connection of these trails is only speculation based on geography. The relationship of the small segment that crosses the main alignment of F-298 is unclear. Integrity of this trail is fair, but drilling roads and backdirt have eliminated this trail in some areas.

F-745

This is a short northeast-southwest trail segment. The segment is within the central portion of site CA-IMP-4970. The trail segment is 73 m in length and it follows the trend of a ridgeline. It passes on the west side of a high knoll on the ridge with a concentration of lithic activity. The trail itself is fairly faint and may represent animal activity. No artifacts were directly associated with the trail, but no evidence of recent animal activity was present either. The integrity of the area is good, although a fair amount of rockhound activity is present in the area.

F-940

This is a short east-west trail segment. The segment is within the northern portion of site CA-IMP-4970. The segment is approximately 15 m in length. It may be associated with F-1020 just to the north because it is along the same ridgeline, but the angle and direction suggest that it may not directly related. Integrity in the area is good.

F-1020

This site is a short northwest-southeast trending trail segment. The segment crosses the northern portion of site CA-IMP-4970. The segment is small and only extends for 28 meters before it is lost. The trail generally trends along a ridgeline and may be related to F-940 and F-745 to the south. No artifacts were associated with this feature and integrity in the area was good.

F-1336
This is a short northwest-southeast trending trail segment. The segment crosses a portion of site CA-IMP-5067. The segment extends for approximately 60 meters before it is lost. Its angle and direction make it unclear as to how this segments relates to F-4 and other nearby trails. It is in an area of poorly developed desert pavement, and drilling activity has reduced the integrity of this area to fair.

F-1500
This site is a series of five trail segments. They are oriented north-south and would be connected except for areas of natural disturbance. The trail segments are within a portion of site CA-IMP-5061 and range in length from 18 to 250 meters.

F-1792
This site is a flaking station with a core and two flakes. It is approximately 3 by 3 m in size and the presence of depth is unlikely in this desert pavement environment. Artifacts include one red chert core and two flakes. The area is relatively undisturbed but rockhound activity is present in the region.

F-2142
This is a short north-south trail segment following the crest of a ridgeline. The trail is within the southern portion of site CA-IMP-5526. The trail segment extends for approximately 90 m before becoming lost in the desert pavement. This trail may be related to F-2202, F-2282, and F-2294 which generally follow the same ridgeline.

F-2202
This is a short northeast-southwest trail segment. The trail is within the southern portion of site CA-IMP-5526. The trail segment extends for approximately 20 m before becoming lost in the desert pavement. This trail may be related to F-2142, F-2282, and F-2294 which generally follow the same ridgeline.

F-2282
This is a short northeast-southwest trail segment. The trail crosses the southern portion of site CA-IMP-5526. The trail segment extends for approximately 15 m before becoming lost in the desert pavement. It is the most northerly in a series of four segments along this ridgeline. It may be related to these other segments which include F-2142, F-2202, and F-2294.

F-2294
This is a short northeast-southwest trail segment. The trail crosses the southern portion of site CA-IMP-5528. The trail segment extends for approximately 20 m before becoming lost in the desert pavement. This trail may be related to F-2142, F-2202, and F-2282, which generally follow the same ridgeline.

F-3024
This includes a series of a northeast-southwest trail segments. There are as many as three parallel trail segments in many areas. Portions of the trail have been obscured by erosion and the pavement

in much of the area is not well developed. The trail segments are within site CA-IMP-7408. Most of the artifacts within this portion of CA-IMP-7408, particularly the ceramics, are probably associated with the trail. Ceramic distribution directly parallels the trail corridors. Trail segments range from 12 to 430 m in length and are well defined in some areas. These trails may be related to either CA-IMP-5010 and/or F-4.

F-4028

This is a roughly north-south trail segment in the southern portion of the Project mine and process area within the southern portion of site CA-IMP-5526. Portions of the trail are obscured by erosion, but the segment extends for approximately 2740 m. It follows a small ridgeline of more developed desert pavement. This trail may be associated with a slightly higher density of lithic scatters in the area. It may be a branch from F-4132, or it could be a trail which has not been preserved to the north, where desert pavements are less well preserved.

F-4132

These are north-south trail segments with a long northwest-southeast section within site CA-IMP-5526. The segments are separated by areas of road disturbance and range from 45 to 295 m in length. The F-4135 segment may represent a branch from the main trail to the southwest.

The main stretches of this trail as a whole are very well defined but have been impacted by a road which follows the trail route. To the north this trail enters an area of poorly developed desert pavement. To the south both trail ends are lost in small washes. The original trail may have followed these washes and has been washed away.

F-4018

This is an isolated fragment of a shaped portable basalt metate. It was located in a wash area with no associated artifacts and may represent a secondary deposit.

Indian Pass-Running Man Traditional Cultural Property

The Quechan tribe has expressed strong cultural concerns for the vicinity of the Project mine and process area, and the archaeological surveys have revealed a high frequency of cultural features of religious or symbolic significance. In view of this, a cultural resource district has been defined that encompasses the Project mine and process area but also extends as far north as Indian Pass and south into the Project ancillary area. This district is described further in Chapter 7, where it is evaluated as a traditional cultural property.

ANCILLARY AREA

Previously Recorded Sites

All eight previously recorded sites within the access corridor and well areas are prehistoric. The archaeological sites include one trail segment with a trail shrine, two flaking stations, one pot drop, and one site with a pot drop and a flaking station. Three additional previously recorded sites include multiple features: CA-IMP-2727 contains two intersecting trails, two rock alignments, the "Running Man" geoglyph, a trail shrine, flaking stations, and ceramic and lithic scatters. CA-IMP-5359T includes a trail segment, spirit breaks, rock rings, cleared circles, and ceramic and lithic scatters, and CA-IMP-5360T includes a trail segment, a flaking station, and ceramic and lithic scatters.

Three small bone fragments were discovered near the project area in April, 1997 by Karen Collins of Imperial Valley College while conducting an archaeological training class on site recording

(Personal Communication, Patricia Weller, Bureau of Land Management, El Centro Resource Area, November, 1997). This training session was totally independent from the proposed mining project. The fragments were collected by the BLM for identification (human/non-human) by a forensic anthropologist. Dr. Madeleine Hinkes, Ph.D. identified the fragments as human bone, sex and race unable to be determined. She stated that the bone exhibited characteristics of burning at a temperature in excess of 1200 degrees F, which is entirely consistent with modern cremation.

California law (Health and Safety Code Section 7054(a)) makes it illegal to dispose of cremated remains by any means other than: 1) internment in a cemetery; 2) burial at sea; or 3) kept in a home, church or religious shrine. Notwithstanding this law, during the public comment period for the November, 1996 Draft EIS/EIR, members of the general public stated that they had personal knowledge of non-Indian cremains being scattered in the area. The cremated bone fragments found at the site are consistent with being deposited by one of these individuals.

KEA Survey Results

KEA's survey resulted in the recordation of 18 sites. These are described below.

CA-IMP-2727

This site is known as the Running Man Site for a geoglyph within the site area. It is located on several well developed desert pavement terraces east of Indian Pass Road. The site was originally recorded by Rogers in the 1920s and is a very important resource in terms of Native American values. As indicated in Chapter 3, the Quechan feel this site is of particular importance to their cultural traditions.

The site itself is very similar to other large sites in the Project mine and process area. It consists of a low density lithic scatter connecting numerous features (Figure 5-39 in Appendix E). Many of the features are flaking stations typical of other sites in the region. Although chert is very common within the site, quartz flaking stations are very abundant suggesting an association between this rock with perceived power and a site which is seen by Native Americans to have spiritual significance.

A major part of the significance of this site appears to be related to the two trails that pass through this resource. Trails CA-IMP-5359 and CA-IMP-5360 are both major trail routes that cross within the central area of the site. They have associated rock features and potdrops. Three other trail segments pass through the site (Figure 5-39 in Appendix E). These trail segments are for the most part less distinct than the main trails and may represent branches that interconnect with the main trails. Because they do not extend beyond the site boundaries, these trail segments were included as part of site CA-IMP-2727.

The major feature for which the site is known is the Running Man geoglyph (Figure 5-40). This geoglyph is located on the northern corner of the two major trails that run through the site. It is a rock on rock geoglyph of a person running. Rocks are oriented so that the long axes of each stone are parallel forming a wider rock pattern than if the stones were aligned for maximum length. Jay von Werlhof suggested that this was a characteristic of Native American geoglyphs as opposed to Anglo-American work which would tend to maximize length.

The figure is oriented with the head toward the south and facing east towards the sunrise. Schaefer and Schultze (1996) noted that no caliche occurred on the top of the rocks although some was present on the sides. They also noted that the stones were not well embedded in the pavement although they are well patinated. Comparison with Rogers notes and photographs of the site in 1939

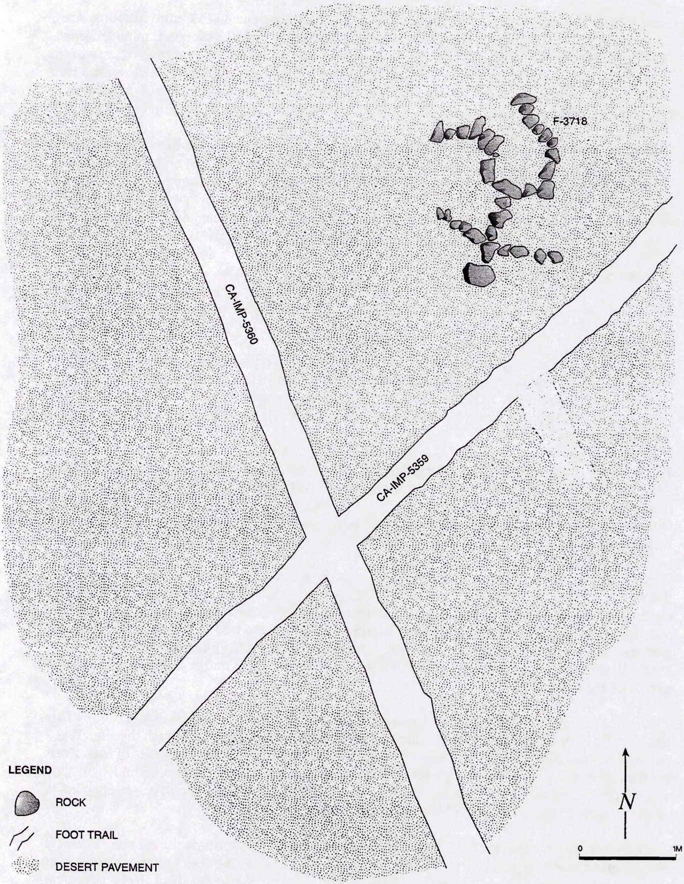


Figure 5-40. Site CA-IMP-2727, Running Man at Trail Intersection (F-3718)

suggested that this feature was not present at that time (Schaefer and Schultze 1996). They suggested that this feature was historic in age.

Lorey Cachora (see Chapter 3) suggested that the Running Man Geoglyph was directly tied to the Trail of Dreams (CA-IMP-5360). He suggested that the feature may have been made by his father or someone of his generation and that it shows continuity of use and significance of this site from prehistoric time to the present. He suggested that his father and people from that generation went to the area of the Running Man site to use it for spiritual and religious practices and that the area and the trail were very powerful.

Two rock alignments are also important parts of the Running Man site and all these features may be related through use. Northeast of the Running Man feature itself and west of the Blackmesa Trail (CA-IMP-5359) is the smaller of the two rock alignments at the site (Figure 5-41). This feature is approximately 2 meters long and is oriented north northwest to south southeast. The feature is made up of 15 well patinated stones. This feature was recorded by Rogers and rocks are fairly well embedded in the desert pavement. No specific ethnographic use for this features has been described. It includes two pieces of quartz but other associated artifacts are absent from this feature

The second rock alignment at the site is much larger measuring 36 m in length (Figure 5-42). This feature is perpendicular to the Blackmesa Trail which passes through a portion of the alignment. The alignments and the trail are clearly associated, and Lorey Cachora (see Chapter 3) suggested that the feature was used in dream travel. He indicated that "...one could run along the trail and, at the spot of the rock alignment, could jump and pass through a window." This was a way of crossing into another world and could also be done through dream travel.

As indicated in Figure 5-42 this feature is clearly related to the trail. Where the trail crosses the alignment there are two ground stones on each side of the trail. The associated manos are also present. The purpose of these grinding implements is unclear, but they do not appear to represent domestic use and are probably ceremonial elements of the feature. In addition to these grinding stones the alignment contains an overturned metate which has a larger grinding surface more typical of domestic use. Extending within the alignment and the trail is a ceramic scatter probably associated with more than one pot drop. Other sherds probably have been collected by Rogers and these may represent what was left from once larger ceramic scatters.

Another element of the rock alignment is a scratched petroglyph (Figure 5-42). This petroglyph is scratched on a small oval cobble and is similar in style to others within the Indian Pass area (Figure 5-43). It consists of a series of scratched lines with a few cross lines on end forming diagonals. This petroglyph and the other elements within the alignment suggest that it is an important ceremonial feature.

Moving northwest along the Blackmesa Trail from the large rock alignment one would come to a small fork in the trail where it splits for approximately 10 m before merging again. At the southern end of this split trail segment is a pile of stones and dirt (Figure 5-44). This may represent a prehistoric cairn similar to another cairn nearby but its location at the trail fork and the presence of several ceramic sherds, including two that were well embedded in the soil, suggests that this feature may represent a trail shrine similar to those described by Rogers at the Indian Pass area. Rogers described a trail shrine in this area and labeled it S-1 on his map of the site (Figure 5-45). This appears to be the same feature shown in Figure 5-44.

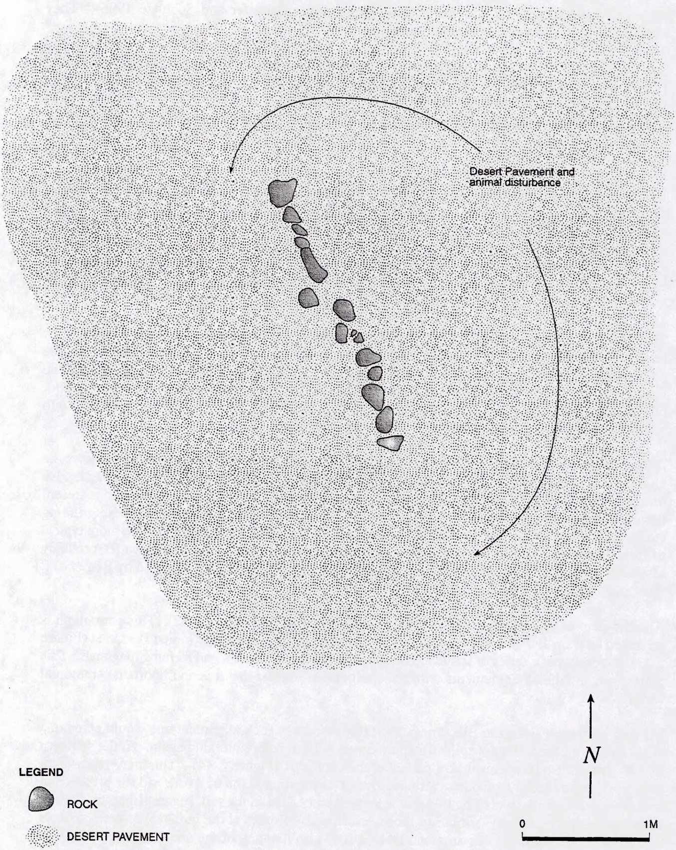


Figure 5-41. Site CA-IMP-2727, Small Rock Alignment (F-3722)

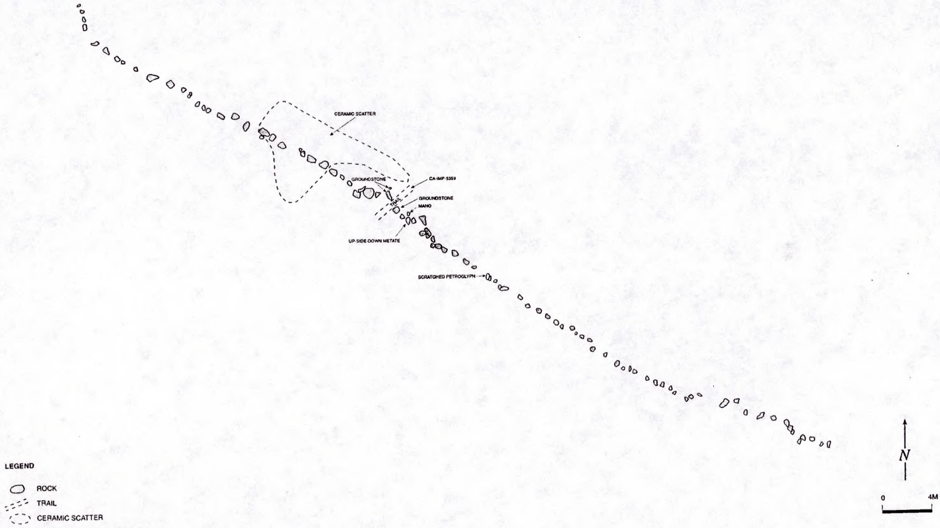


Figure 5-42. Site CA-IMP-2727, Rock Alignment (F-3741)

Figure 5-43. Site CA-IMP-2727, Scratched Petroglyph

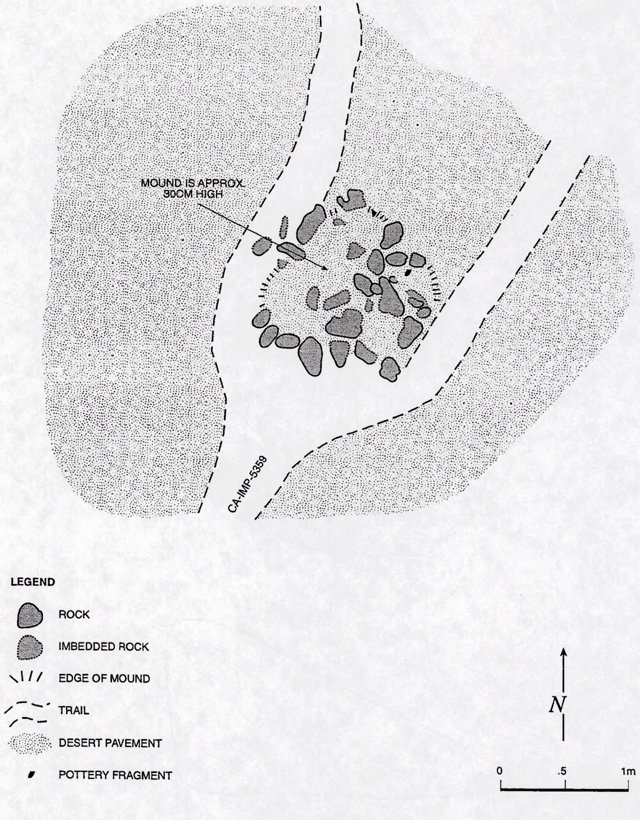
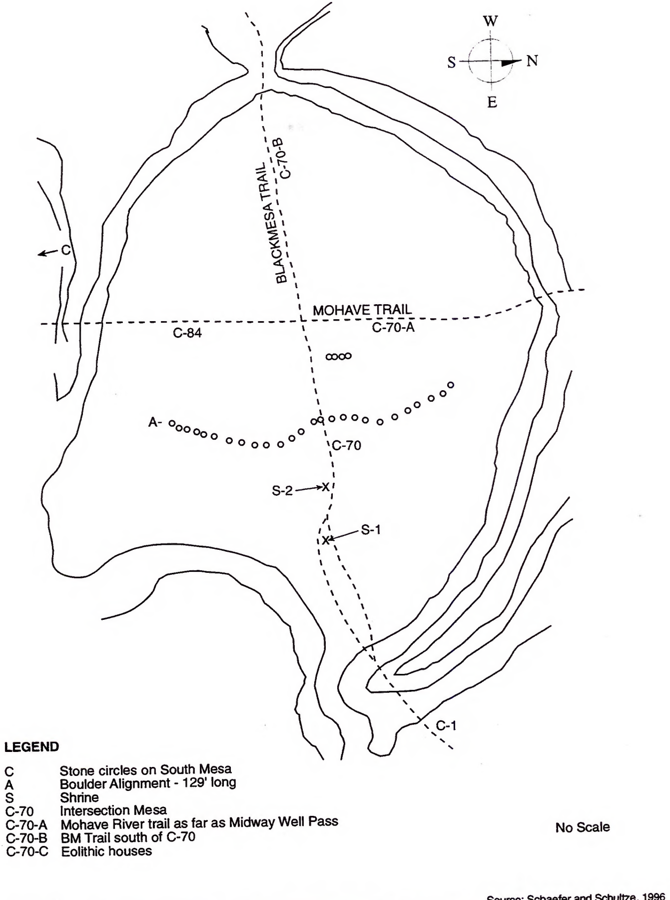


Figure 5-44. Site CA-IMP-2727, Trail Shrine along CA-IMP-5359



Source: Schaefer and Schultze, 1996

Figure 5-45. Malcom Rogers' 1939 map of CA-IMP-2727 (San Diego Museum of Man)

The Schaefer and Schultze (1996) survey identified a second shrine or rock cairn several meters south (Plate 5-5). This appears to be the feature shown as S-2 on Rogers sketch map of the area. The ASM survey noted that this cairn (ASM's Feature 7) has caliche on the upper surfaces of many of the rocks suggesting more recent placement. The possibility exists that this has been modified but it appears that this feature represents S-2 on Rogers map.

Plate 5-5. Roger's Trail Shrine (S-2)

Schaefer and Schultze(1996) discuss in detail the work by Rogers at this site. His sketch map shown as Figure 5-45 indicates that most of his effort was focused on the high terrace area where the two major trails pass through the site. Schaefer and Schultze(1996) suggest that Rogers recorded all the major rock features in this area and the absence of any notes on the Running Man geoglyph suggests that it was not present at the time Rogers recorded the area in the late 1930s and early 1940s. Rogers did not specifically map the area north of the two shrines and the trail split. As shown on Figure 5-45 his map stops where the split trail comes back together. Karen Collins of the Imperial Valley College Museum noted a series of trail markers on the lower terrace north of this split trail. These trail markers appear old and are partially embedded (Figure 5-46). Caliche is not present on the upper portions of these trail markers also suggesting that they are fairly old. The trail markers themselves consist of a series of six pairs of three rocks placed on each side of the Blackmesa Trail. The rocks are generally oriented in a somewhat triangular form with long axes oriented away from the center point (Figure 5-46). Although these features are readily visible once noted, they are not obvious given the amount or cobble size rocks in the area. The appear old given weathering characteristics. It is difficult to determine whether or not these features were present during Rogers early work at the site and just missed. Whether or not they are of prehistoric age, they are clearly associated with the Blackmesa Trail, are probably Native American in origin, and are associated with the significance of the site overall.

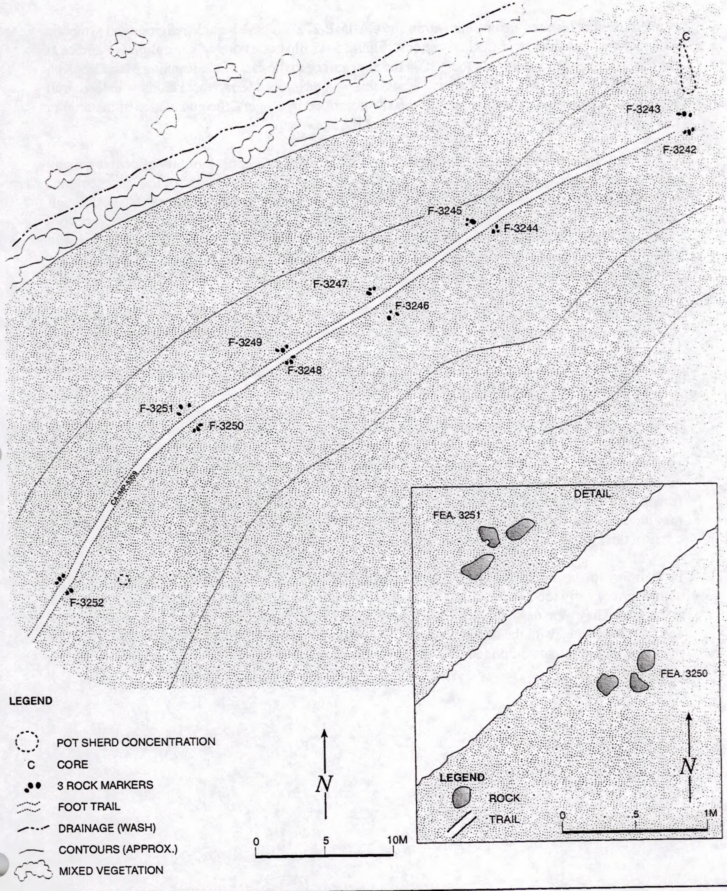


Figure 5-46. Site CA-IMP-2727, Trail Segment and Associated Features

Numerous other features are present within site CA-IMP-2727. These include religious and symbolic rock features, potdrops, and flaking stations. Figure 5-47 illustrates one of several prayer circles at the site. These other features are located on the high terrace to the east of the Running Man Geoglyph and the trail crossing. They are scattered across this well developed terrace area along with three trail segments. Although not the main area of the site described by Rogers, the abundance of material in this area suggests that it was an important part of the site.

The terrace in this area contains numerous large cobbles with a finer background of pebbles, many of which are quartz. In several areas the gravels appear to be tamped and most of the larger cobbles removed. These areas do not represent clearly defined circles and are fairly amorphous. Although these areas could represent habitation or activity areas, Jay von Werlhof felt these were probably natural features. In the denser cobble areas several circles were perceived in the cobble patterns (Figure 5-48). These circles appear to be beyond the natural random pattern and represent some modification of the area . The are small and roughly a meter in diameter. Their purpose is unknown.

Another feature in this part of the site is a series of letters beginning with the letter "J" that have been spelled out on the pavement with quartz rocks. This feature is clearly recent or historic in nature.

Another feature that is somewhat similar in manufacture is a rectangular quartz feature (Figure 5-49). This feature is made from small quartz stones similar to the letters. Some soil staining is present on some of the rocks suggesting that they have been move in the not to distant past. Algae is well developed on the undersides of these rocks however, suggesting that they have some time depth. Jay von Werlhof originally interpreted this feature as recent in age. Although this is not near the trail junction, it seems likely that Rogers would have observed this feature during his recording of the site because of its size and contrasting color. Mark Kelly, the Native American observer felt that this feature was important and it reminded him of the pattern of a *Karuk* ceremony. He suggested that it may have been an area where human remains were burned, but further research would be required to confirm this.

In addition to the numerous rock features within the site, Jay von Werlhof identified a large component of early tools in this area. Table 5-6 indicates the large number of early tools identified at this site. They were most abundant in the areas away from the main trail intersection and geoglyphs and were associated with the abundant chert material on the well developed desert pavements. This represent an important component of the site for future research.

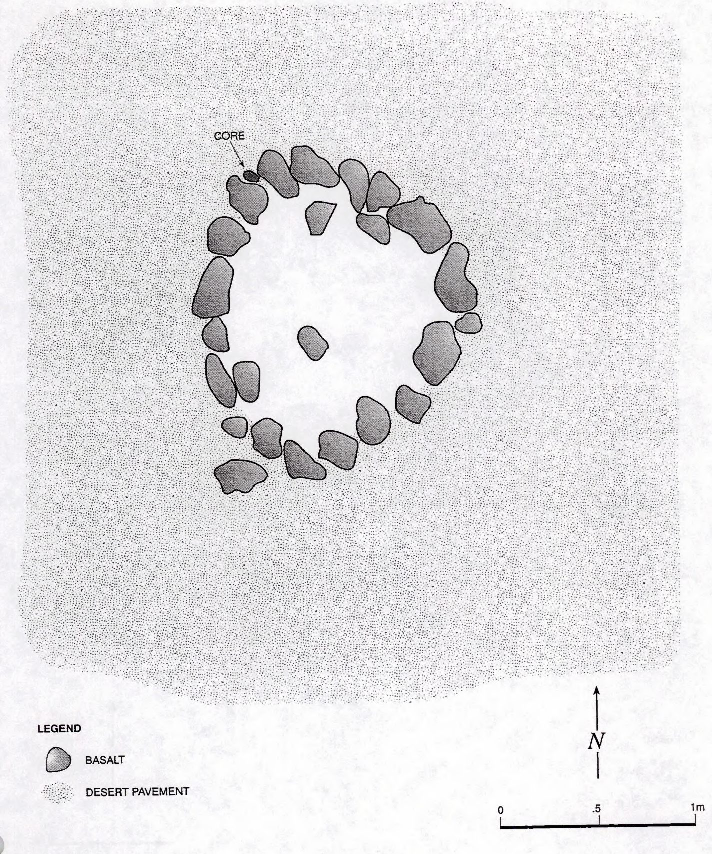


Figure 5-47. Site CA-IMP-2727, Prayer Circle (F-3300)

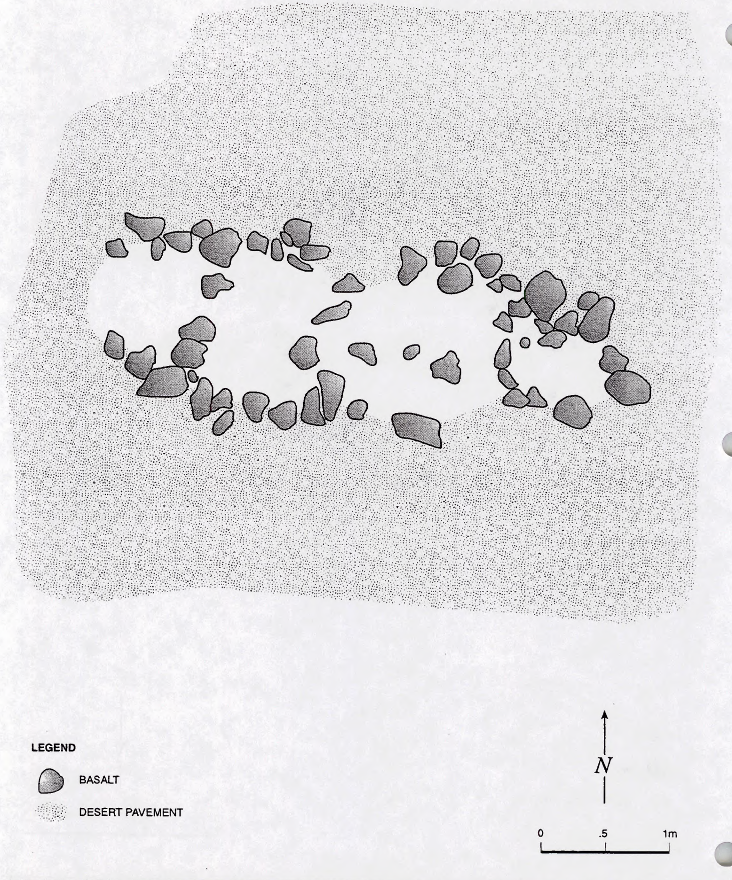


Figure 5-48. Site CA-IMP-2727, Rock Feature (F-3176)

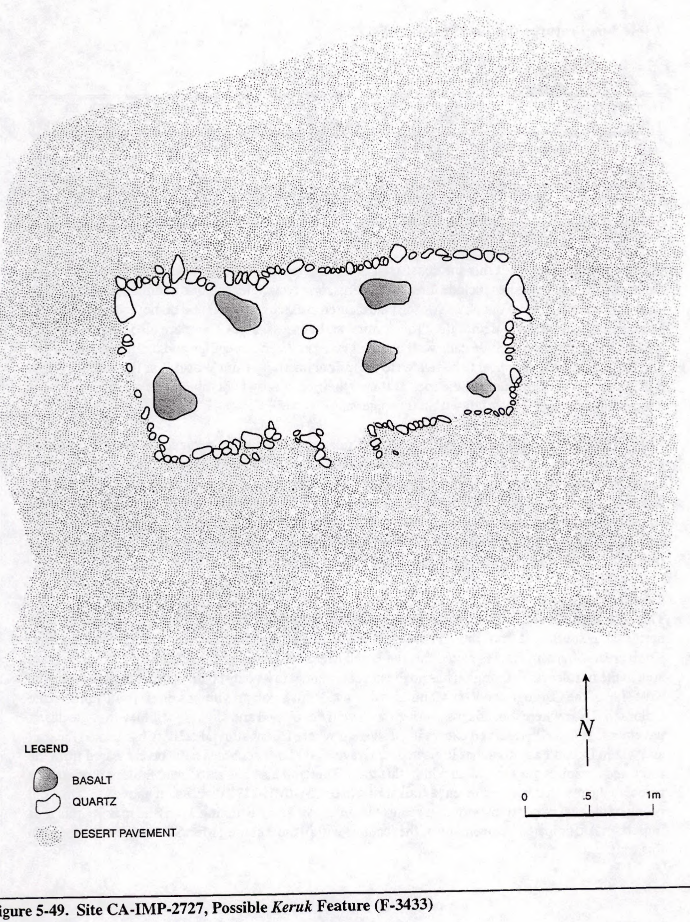


Figure 5-49. Site CA-IMP-2727, Possible *Keruk* Feature (F-3433)

Table 5-6. Features Within Site CA-IMP-2727

	Prehistoric Trails	Prehistoric																
Feature Type*	PT	CC	C	FS	GS	GFS	H	LS	M	MT	PR	PD	P	PS	PRF	PRR	SR	T
Total	3	1	45	273	3	4	6	20	2	3	35	19	9	1	1	2	1	44

	Historic								Ceremonial						Early Tools		
Feature Type*	BC	CA	FR	HA	HRF	HRA	RW	RRECT	PC	PRA	PRC	SH	SPB	VQ	ET	ETSB	FS
Total	1	5	4	2	2	2	1	2	2	9	1	1	1	2	257	6	1

* See appendix D for feature code key.

The historic component of this site consists of one bomb crater, five cleared areas, four historic rock features. The rock features include three alignments, one rectangle, and one anomalous feature with a can that has a key wind opening. Most of the cleared areas are circular and do not look like the tent pad clearings in the sites within the Project mine and process area. There are also several historic artifact scatters which include cans with church key or key wind openings and a military magazine. Some of these features appear to be related to the military activity from World War II training. While it is not easy to assign a date to the rock features, their proximity to bomb craters and World War II era cans indicates that they fall within this date range as well.

Although this site is being impacted by visitors related to the current project, its integrity remains good. Trail areas near Indian Pass Road are less distinct due to foot traffic and the desert pavement at the base of the Running Man Geoglyph has been largely obliterated. Although Rogers, and probably others, have collected ceramics from the site many features remain. Our ability to relocate all the features mapped by Rogers suggests that integrity is good overall and that the record of the site remains. The area shows some but relatively little evidence of rockhound activity and areas away from the trail intersection show well preserved desert pavement.

CA-IMP-5359

This site number refers to a major prehistoric and possibly ethnohistoric trail. This trail runs northeast to southwest from Indian Pass and the trail systems along the Colorado River to the Pilot Knob area. Malcolm Rogers called this the Black Mesa trail because it leads toward this important area in the northeast. Although it has not been documented in its entirety, it appears to pass along the west side of the Cargo Muchacho Mountains down to Pilot Knob providing a direct route north to the Colorado River where it bends west. The trail is well developed and clearly visible within the desert pavement. It is well preserved except in wash areas where recent alluvial activity has erased the trail and where Indian Pass Road has impacted it. Gravels and larger cobbles have been cleared from the route and ceramics are associated within this trail. This trail also has associated trail markers and an associated cairn that may represent a trail shrine (See CA-IMP-2727 discussion above.). This trail is one of the two major transportation routes that intersect at the Running Man Site making this area important As indicated below many of the features within the Running Man Site area associated with this trail.

CA-IMP-5360

This site was named the Mojave War Trail by Malcolm Rogers, presumably based on ethnographic information. This trail has been more recently called the Trail of Dreams and has particular significance for Quechan religion and dream travel (see Chapter 3). This trail also passes through the Running Man Site and crosses CA-IMP-5359 at an angle within several feet of the Running Man Geoglyph. Only small amounts of ceramics have been identified along the part of the trail within the Project. No rock features such as those along CA-IMP-5359 have been identified. This trail is similar to CA-IMP-5359 and is well defined through the Running Man Site. It is temporarily lost in a wash area to the north and continues across a wash to the south of the Running Man Site. The trail runs from the Palo Verde area south. After it crosses through the Running Man Site it passes along the east side of the Cargo Muchacho Mountains to Yuma. Both CA-IMP-5359 and CA-IMP-5360 represent very important transportation corridors.

It as been impacted by Indian Pass Road and recent foot traffic associated with visits of groups of people to the Running Man Site. On some slopes this trail is represented by erosional drainages due to its age, but overall this trail shows very good integrity.

CA-IMP-6661

This site was originally recorded in 1991 by Wilcox and others as "Two geoglyphs, one a cleared circle ring with wavy lines above and below, one an anthropomorph design; a small cleared circle; a shaman's hearth; a white quartz four rock alignment [sic]; and associated lithics." During the current survey, all features with the exception of the shaman's hearth were relocated and an additional geoglyph was discovered, in the vicinity of the others. The site is approximately 80 m northwest/southeast by 30 m northeast/southwest. To the east of the geoglyphs there is a low density lithic scatter and two flaking stations.

F-10268 was originally recorded as the cleared circle ring with wavy lines directly above and below. This area has been impacted by vehicle traffic, and the feature does not contrast very sharply with the surrounding pavement so the relocation of elements was difficult. Figure 5-50 shows those elements that were relocated. KEA's recording is somewhat different from the original illustration. Different light conditions may reveal additional elements, and Figure 5-50 shows elements below the ring.

The previously recorded anthropomorph design (F-10270) is illustrated in Figure 5-51. It was relocated as previously recorded, bisected by two tire tracks. Jay von Werlhof stated that this feature may represent one of the two hero twins of Quechan mythology because of the lack of a second arm element. As indicated by Figure 5-51, the ends of the line elements are not abrupt and the true nature of this feature may be open to interpretation.

F-10271 represents a feature that was not previously identified at this site (Figure 5-52). This feature has been excavated into the desert pavement approximately 10 cm creating a slight berm around the feature. The feature is more than three meters in length and is sinuous and somewhat irregular. Its function is unknown. The previously recorded small cleared circle was relocated southwest of the anthropomorph geoglyph.

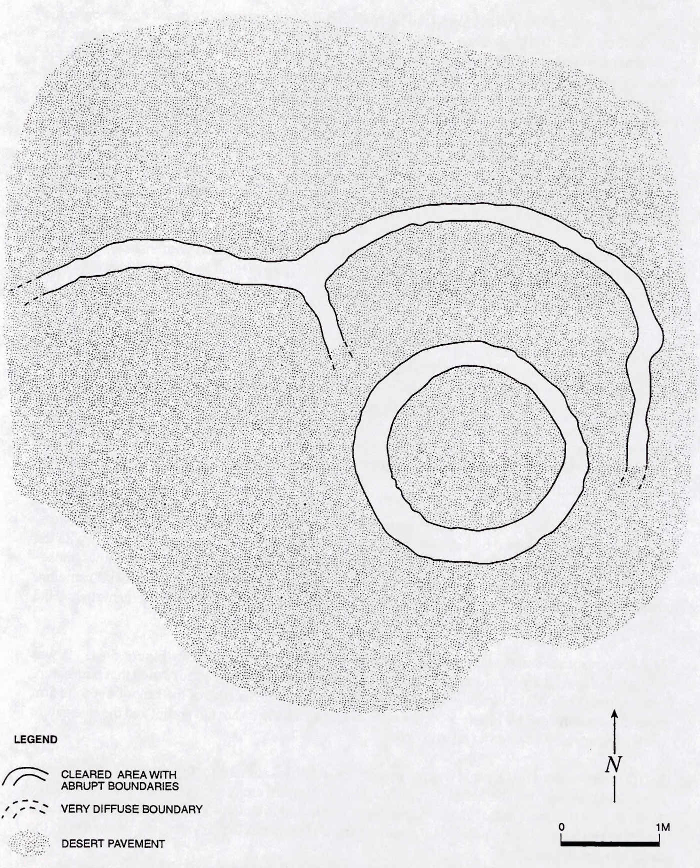


Figure 5-50. Site CA-IMP-6661, Geoglyph (F-10268)

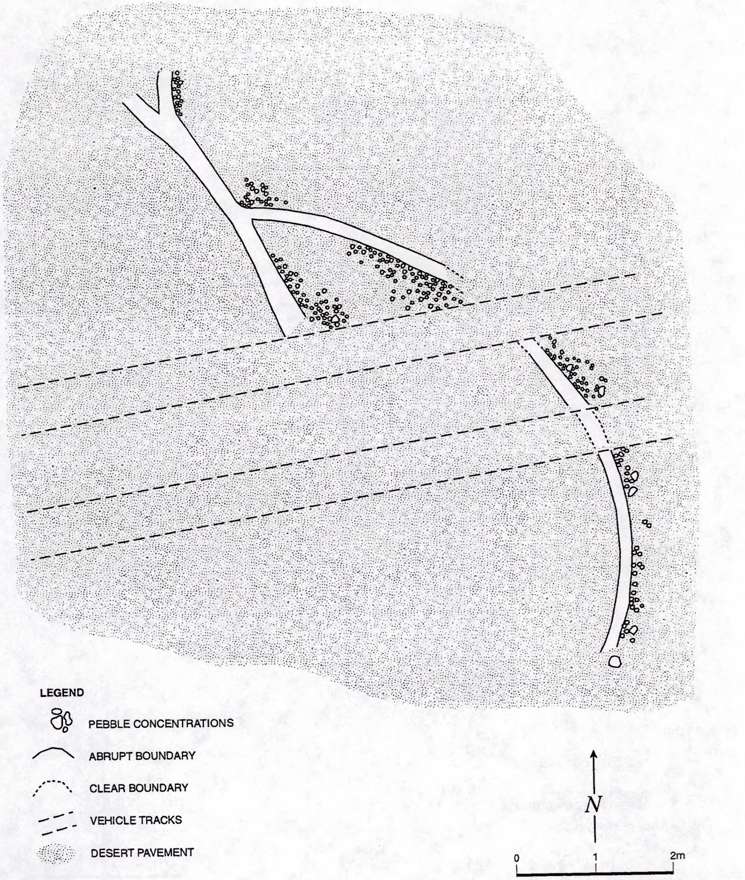


Figure 5-51. Site CA-IMP-6661, "Anthropomorphic" Geoglyph (F-10270)

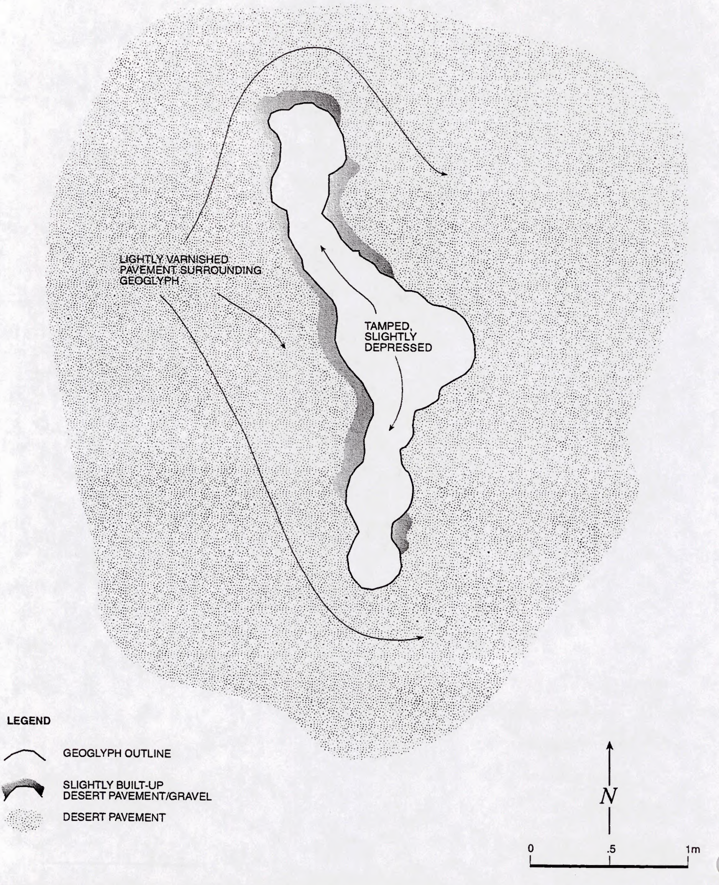


Figure 5-52. Site CA-IMP-6661, Irregular Geoglyph (F-10271)

Mark Kelly, one of the Native American observers, and Jay von Werlhof felt these features represented an outstanding ceremonial site. The site is adjacent to Indian Pass Road and has been heavily impacted by modern vehicle tracks. The geoglyph previously described as an anthropomorph was directly impacted by tire tracks. Despite the disturbances, the site retains overall integrity.

AA-1
This site is a moderate density scatter of flaked lithics including tools, discrete flaking stations with cores and debitage. Also noted were an historic bomb crater, a "V" shaped rock feature, cairn, and tin cans. The site was not identified during earlier surveys and is approximately 120m east/west by 145 m north/south. Site depth is unlikely due to the desert pavement environment. Prehistoric features include two quartz and one chert flaking station.

Observed artifacts include one basalt core/tool with one worked edge; one retouched chert flake; and debitage of chert, rhyolite and quartz. Discrete flaking stations consist of 62 quartz flakes with a unifacial core; 32 quartz flakes with a unifacial core; and nine chert flakes. Site integrity is fair with minor impacts from off-road vehicles, rockhounds, and mining activities.

The historic component of this site consists of two cans and lids that are probably ration cans, a V-shaped rock alignment of about 20 rocks, a bomb crater with shrapnel, and a partially collapsed rock cairn and can with a church key opening. These all appear to be related to World War II activities in the area.

AA-2
This site is a moderate density scatter of flaked lithics with discrete flaking stations with cores and debitage. Also noted were recent rock features. The site was not previously recorded and extends approximately 70 m east/west by 70 m north/south. Depth is unlikely in this area of desert pavement. Features include three quartz and two chert flaking stations. Artifacts within the flaking stations include 60+ gray quartz flakes; 15 quartz flakes with a core; three brown chert flakes; and two gray/tan flakes with a core fragment. A recent fire ring and a rock feature in the shape of a peace sign were also noted. Site integrity is fair with minor impacts from off-road vehicles, rockhounds, and mining activities.

AA-3
This site is a moderate density scatter of flaked lithics with discrete flaking stations. Artifacts include tools, debitage, and pecked rock/anvils. Also noted was a Tumco Buff rim sherd. The site was not previously recorded and is approximately 145 m east/west by 100 m north/south. Depth is unlikely in this area of desert pavement. Features include one rhyolite and four quartz flaking stations.

Observed artifacts include one quartz hammerstone, and one rhyolite bifacially retouched tool. Discrete flaking stations consist of 100+ quartz flakes; 50+ quartz flakes; 22 quartz flakes; and 15 rhyolite flakes. A Tumco Buff rim sherd was recorded in the northwest corner of the site. Two pecked rocks/anvils were also identified. Both were heavily patinated basalt. Site integrity is fair with minor impacts from off-road vehicles, rockhounds, and mining activities.

F-3147
This site is a flaking station consisting of 51 rhyolite and three additional chert flakes. The site covers an area less than two by two meters in size and was not previously recorded. Depth is unlikely in this

area of desert pavement. The site includes the single flaking station of red rhyolite and three additional red/white chert flakes. Site integrity is fair with minor impacts from off-road vehicles, rockhounds, and mining activities.

F-3167

This site consists of a shaman's hearth constructed using 12 rocks of both quartz and volcanic material. The circular hearth measures 50 cm in diameter. Depth is unlikely and no charcoal or associated artifacts were observed. Site integrity was good although this feature was fairly close to Indian Pass Road.

F-3169

This site is a flaking station consisting of 12 gray/white chert flakes. The site is approximately 2 m by 1.5 m in size and consists of a single flaking station. Site integrity is good with minor impacts from off-road vehicles, rockhounds, and mining activities.

TL-1

The site consists of a rock alignment, a trail, rock ring with cairn inside, and a flake. The site is approximately 55 m northeast/southwest by 5 m southeast/northwest and depth is unlikely given the desert pavement environment.

The rock alignment (F-10257C) is south of Indian Pass Road and north of a small wash. This feature is made from cobbles of basalt, granite, quartzite, and quartz. It is 1.5 meters long and points to a trail starting at the edge of the desert pavement, 40 meters away. The alignment has a stack of stones near its midpoint, four tiers high (Figure 5-53).

The trail (F-10257B) is 25 cm wide, and tamped into the developing pavement. It winds 15 meters southeast up slope to a rock ring with a cairn inside. The rock ring (F-10257A) is just over one meter in diameter and is constructed of approximately 20 basalt stones. It also includes an equal number of smaller quartz stones. The cairn in the center of the ring is two tiers high, and contains approximately 10 stones.

These features appear to be of recent origin because the rock alignment is in a fairly recent wash area and the stones within the rock ring are not imbedded in the pavement. The features appear to have been carefully made but their function is unknown. During the field effort it was speculated that this may represent "new age" practices in the area. This site, therefore may or may not reflect modern Quechan usage of this area. One chalcedony flake is located on the interior of the rock ring. This stone was probably chosen for placement within the feature for its attractive appearance, and not because it is a prehistoric artifact. The site appears undisturbed and integrity is good.

TL-2

This site consists of four separate loci with no intervening lithic scatter. The overall site extends over an area 150 m northeast/southwest by 85 m southeast/northwest and the presence of a subsurface deposit is unlikely, given the desert pavement environment. Features include two flaking stations,

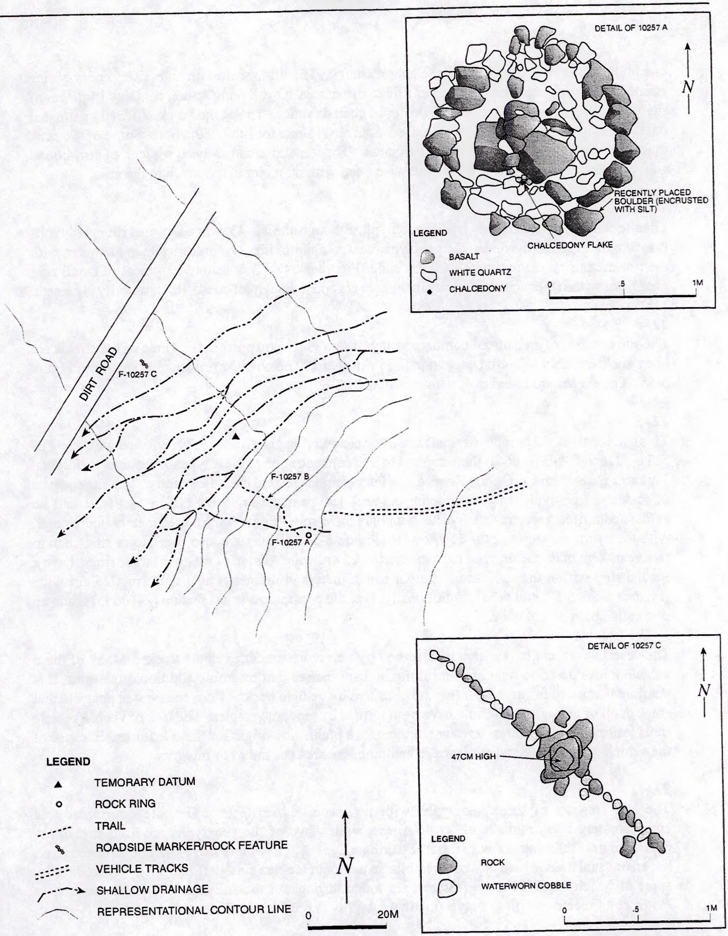


Figure 5-53. Site TL-1 Sketch Map

one lithic scatter, and one isolated pecked rock/anvil. The lithic scatter includes 50+ pieces of fine grained basalt debitage distributed over a three meter area. One flaking station contains 14 pieces of rhyolite lithic debris, the other has 17 pieces of chert debitage. The pecked rock is heavily patinated basalt. It is large enough to have been used as an anvil stone for lithic reduction. Some of the peck marks appear modern but others are patinated. The general area has been a focus of rockhound activity for some time. Integrity is otherwise good with no major disturbance in the area.

TL-3

The site consists of an isolated circular geoglyph, although site TL-43 with additional ring geoglyphs is approximately 125 m south. The geoglyph measures approximately three meters in diameter, with the rim measuring approximately 20 cm wide (Figure 5-54). This feature is typical of small ring geoglyphs within the region. Integrity in the area is good although off-road vehicle activity is present.

TL-4

The site consists of an isolated compact scatter of four Buffware potsherds. Three of the sherds are body sherds, with the fourth being an incised rim sherd. The notched rim sherd is shown in Figure 5-55. The sherds are found over a three meter area.

TL-5

This site consists of a number of small and large cleared ring geoglyphs. When viewed with site TL-3, TL-43, and CA-IMP-6661, there appears to be a concentration of these types of features in the area. This area is also close to Ogilby Road, and winter campers tend to use it frequently. The site consists of scattered geoglyph features covering an area 150 m north/south by 115 m east/west and no associated artifacts are present. Features include three small rings, two to three meters in diameter, with their rims measuring 50 - 60 cm wide (Figure 5-56). There are also four larger rings, ten to twelve meters in diameter, with rims measuring 25 cm wide. Three of the four larger rings have a second ring within them, measuring eight to ten meters in diameter, also with rims 25 cm wide (Figures 5-56, 5-57, and 5-58). Additionally, this site possesses a spiral feature (F-10605) made up of a coiled path 30 cm wide.

The desert pavement in this area is disturbed by numerous modern vehicle tracks. Many of these vehicle tracks describe tight arcs, resulting in disturbances that resemble additional features. It is possible that more features exist that are obscured by vehicle tracks. Conversely, it is possible that some or all of these features could have been formed by modern vehicles. The lack of visible vehicle trails leading to the features, however, argues for a prehistoric origin for these features. Because of the vehicle disturbance and evidence of camping, the area has only fair integrity.

TL-42

The site consists of three geoglyphs with no associated artifacts. The site covers an area approximately 20 m north/south by 40 m east/west. Two of the geoglyphs are rings measuring approximately three meters, with rims measuring roughly 30 cm wide (Plate 5-6). The third geoglyph has an unusual double loop design resembling a pair of pince-nez glasses (Plate 5-7). Vehicle tracks, some of which resemble these features, are found throughout the site area. The area also shows evidence of recent camping, suggesting that integrity is only fair in this area.

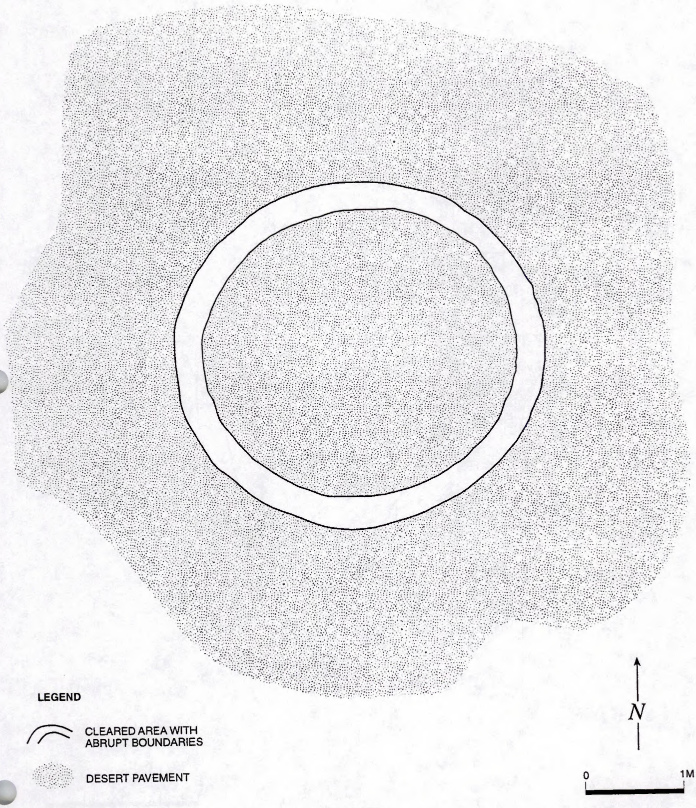


Figure 5-54. Site TL-3, Ring Geoglyph (F-10265)

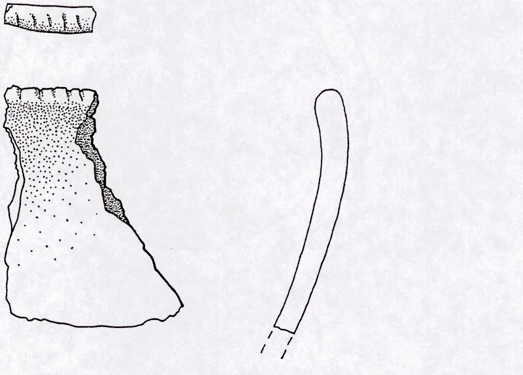


Figure 5-55. TL-4, Incised Rim Sherd (F-10267)

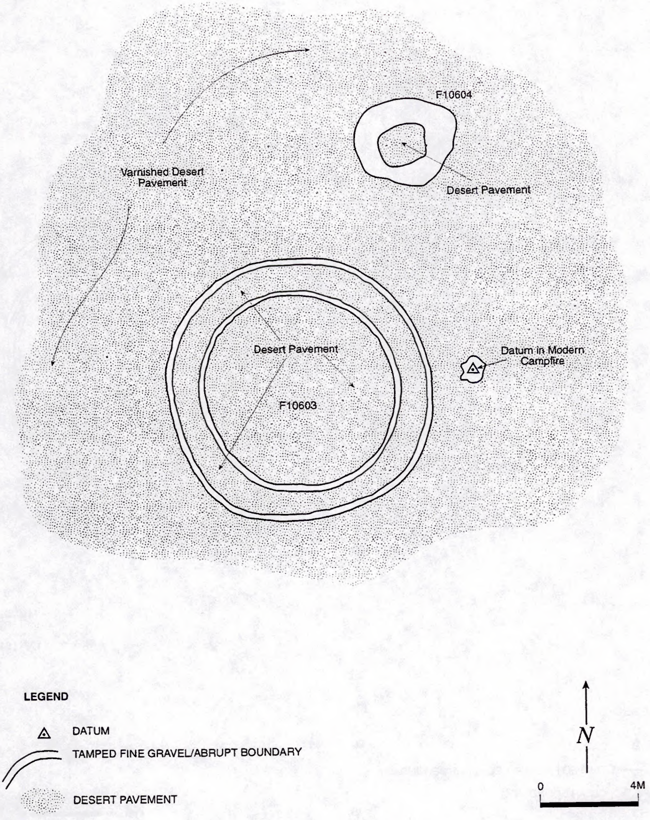


Figure 5-56. Site TL-5, Geoglyphs (F-10603 and F-10604)

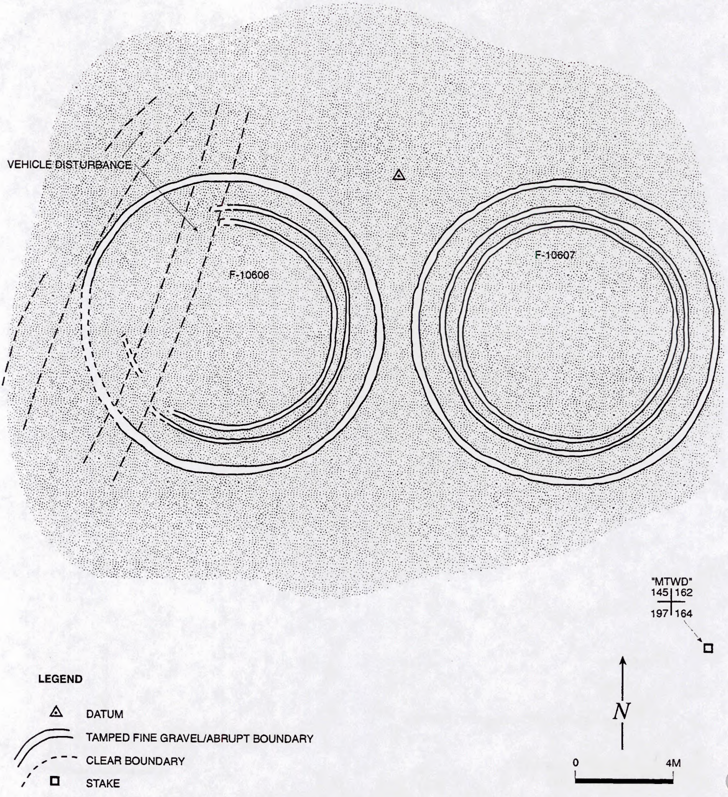


Figure 5-57. Site TL-5, Two Ring Geoglyphs (F-10606 and F-10607)

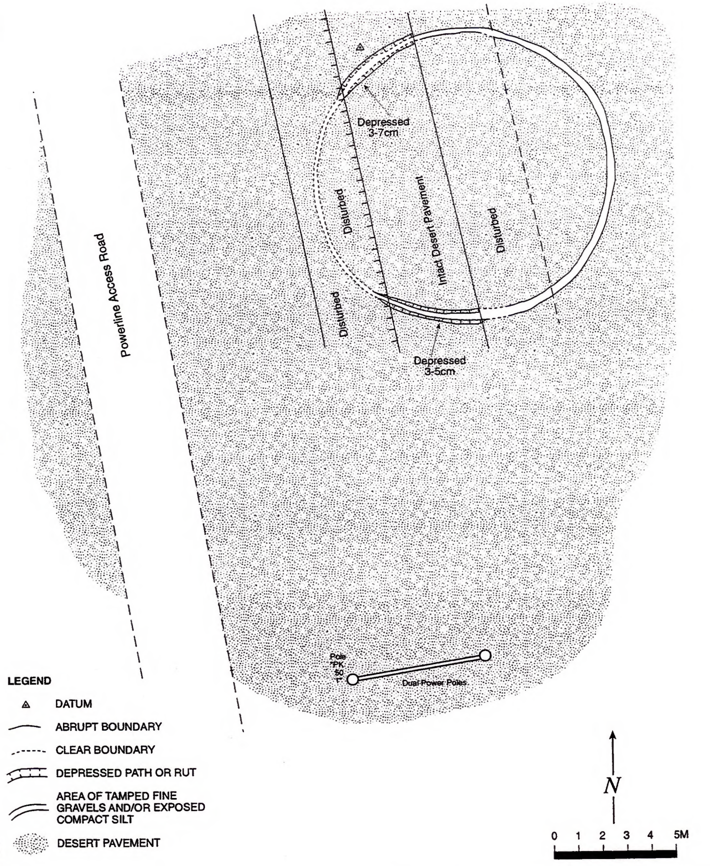


Figure 5-58. Site TL-5, Geoglyph and Disturbance (F-10608)

Plate 5-6. Site TL-42, Ring Geoglyph (F-4091)

Plate 5-7. Site TL-42, Geoglyph with Spirals (F-4093)

TL-43
This site consists of an isolated flaking station with four red chert flakes. It is in an area of poorly developed desert pavement. The flakes are lightly patinated and are spread over a 1 x 1 meter area. Although some rockhound activity is present in the vicinity, it is otherwise undisturbed and integrity is good.

TL-44
This site consists of a Tumco Buff pot drop. The feature is a small, discrete scatter of sherds from a single Tumco buff pot. The pot drop forms a dense scatter of ceramic material approximately two meters in diameter. There are a total of 20 sherds present, including three recurved rim sherds. The site is located near a large wash and evidence of recent camping in the area is abundant indicating integrity is only fair.

Isolates

TLI-1
This is a single pecked rock. The stone is basalt, heavily patinated, and large enough to have been used as an anvil stone for lithic reduction. The peck marks, concentrated in the middle portion of the stone, are considerably less patinated than the rest of the stone. It is difficult to tell whether the peck marks only extended partially into the thick patination layer, or patination has re-formed over the peck marks, or both. The general area has been a focus of rock collector activity for some time, and it is possible that the peck marks are of recent origin.

TLI-8
The artifact is the head end of a World War II vintage right-angle flashlight.

TRANSMISSION LINE CORRIDOR

Previously Recorded Sites

The previously identified sites within the transmission line corridor include 15 prehistoric sites, two historic sites, and two sites which include both prehistoric and historic components. The prehistoric sites recorded include seven trails, one of which has associated ceramic scatters, a trail segment with an associated pot drop and a geoglyph, one lithic scatter, one ceramic scatter of Palomas Red-on-buff, one rock ring, and one "J"-shaped geoglyph. Three additional sites contain multiple prehistoric features: CA-IMP-2878 includes three geoglyphs, a sparse lithic scatter, and three pot drops, CA-IMP-6661 contains two geoglyphs, one small cleared circle, one shaman's hearth, a small quartz rock alignment, and lithics, while two cleared circles, one geoglyph, one ceramic scatter, and a flaking station were noted at CA-IMP-4131.

The two previously recorded historic sites in the transmission line corridor include a trash scatter, and a historic mine with loading platforms. The two sites which have both prehistoric and historic components are CA-IMP-7269 with a trail segment, a possible geoglyph, a possible hearth, and a historic can and bottle dump. CA-IMP-7273T/H includes three trail segments and a historic rock feature which possibly forms the letters "R.A.". The four isolated artifacts are a chert flake, a chert retouched flake, a porcelain bowl base, and an aqua glass insulator.

KEA Survey Results

The current inventory identified 46 sites and six isolates within the transmission line corridor. Each of these resources is described below.

CA-IMP-1469
This site was previously recorded by Miller in 1977. It consists of a north/northwest, south/southeast trending prehistoric trail. It is approximately 30 cm wide and extends for approximately 60 m. The trail appears from its configuration to be prehistoric, but no prehistoric materials were found in association. No mining activity was present in the vicinity. The trail segment is divided by a wash and the segment was bounded at both ends but may continue further additional terraces in both directions. No historic or prehistoric artifacts were found associated with this site. The area is moderately disturbed by pole line associated activity.

CA-IMP-1471
This site was also originally recorded by Miller in 1977. It consists of a east west trending trail segment, approximately 30 cm wide. The trail is distinguishable for over 100 meters. No artifacts were found in association with this site. The area is moderately disturbed by pole line associated activity. KEA could not ascertain, based on the current survey results, whether this site is historic or prehistoric in age.

CA-IMP-2878
This site was originally recorded in 1978 by Pritchett as an intaglio located on the east side of Sidewinder Road. It included lithic material and two cleared circles in association. In 1994, Curtis and others recorded the presence of three small ceramic scatters within the site boundaries. An additional geoglyph and two areas of ceramics were identified during the current survey, enlarging the site area. The sites area extends 180 m north/south by 130 m east/west and the presence of depth is unlikely.

The previously recorded geoglyph area, located on the east side of the road, consists of a series small depressions connected by a winding and sometimes looping cleared path-like element (Plate 5-8, Figure 5-59). The ceramics in this area were relocated as previously recorded and include two areas of Tumco Buff and one pot drop of Colorado Beige. A quartz crystal that appears to have some signs of edge damage was also identified within the area surrounded by the geoglyph (Figure 5-60). It was also discovered during the course of this survey that what had previously been recorded as "trench disturbance" running through this geoglyph is a portion of the buried historic water pipeline that runs through the area and is recorded as TL-23.

A possible cleared spiral was noted south of the geoglyph in an area of heavy disturbance. Previously noted concentrations of quartz were relocated on the periphery of the site, and these were thought by Jay von Werlhof to be examples of quartz smashes to release power before entering the ceremonial site.

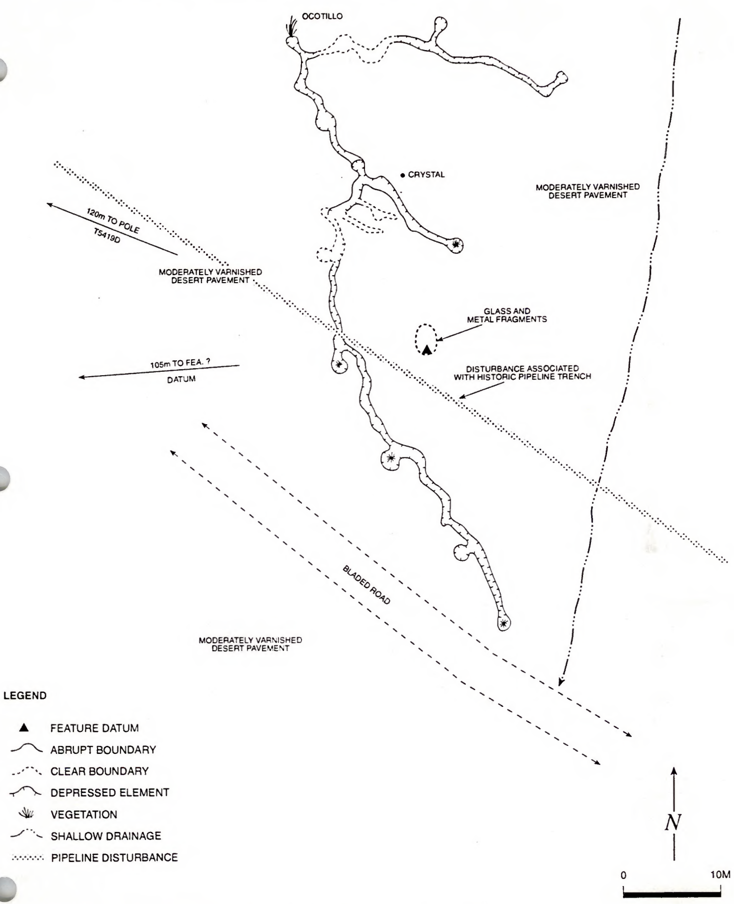


Figure 5-59. Site CA-IMP-2878, East Portion of Ogilby Hills Geoglyph

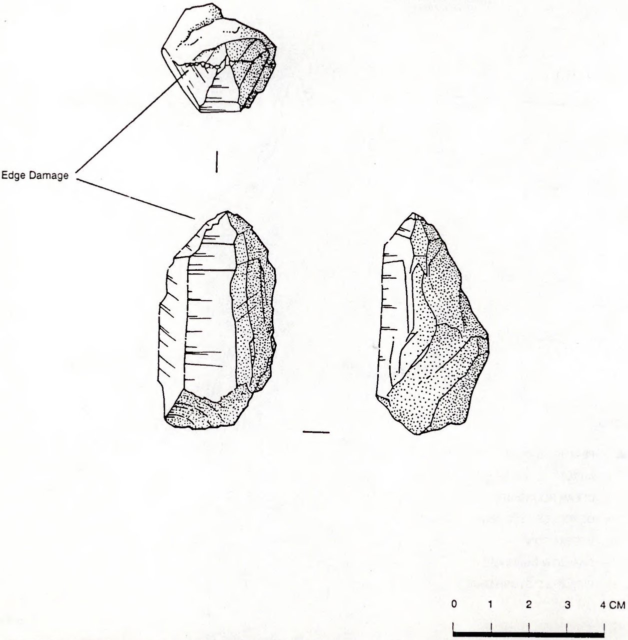


Figure 5-60. Site CA-IMP-2878, Quartz Crystal

Plate 5-8. Site CA-IMP-2878, Geoglyph

The previously unrecorded geoglyph on the west side of Sidewinder Road is generally similar to the previously recorded feature (Figure 5-61). The small depressions are connected by elements more branching than path-like. A previously recorded ceramic scatter of Colorado Beige was identified on the edge of this geoglyph and an isolated burnished Colorado Beige body sherd was identified near the center of the geoglyph. A north/west south/east trail segment was located southwest of the geoglyph area. It is typical of prehistoric trails and extends for approximately 60 m.

CA-IMP-3297

This site was originally recorded by Elling and others in 1988 as a trail and three Tumco Buff sherds. The site was updated by Victorino in 1996 with the addition of a second trail and five additional ceramic scatters. The current survey relocated the previously recorded features and identified two additional trail segments and six additional pot drops and three isolated sherds. The site extends over an area 300 m north/south by 90 m east/west. Depth is unlikely.

This resource is a fairly complex site emblematic of the reuse of old routes that we see throughout the project area. Because the Southeastern Information Center required separate recording of linear features what was originally recorded as a single site, CA-IMP-3297, has been divided into three separate sites. CA-IMP-3297 is updated to refer only to the non-trail elements. The four trail segments recorded during the current effort are now TL-40 and the historic road is TL-39. The artifacts associated with CA-IMP-3297 include 12 ceramic scatters and 3 isolated sherds. Types include Salton and Tumco Buff. Most of these features appear associated with TL-40.

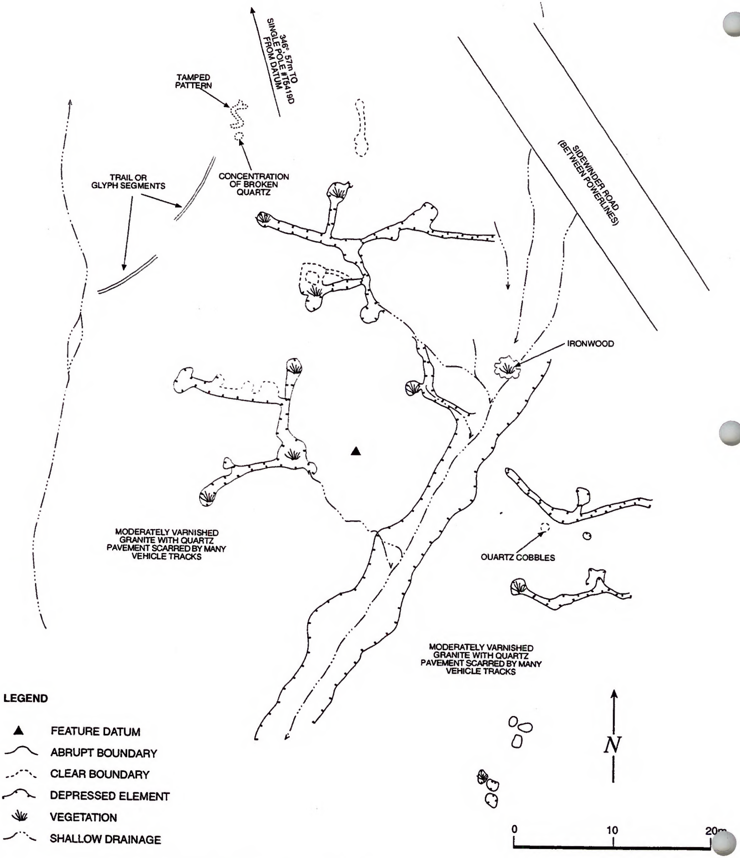


Figure 5-61. Site CA-IMP-2878, West Portion of Ogilby Hills Geoglyph

Historic artifacts include glass fragments colored brown, aqua, green, clear, and sun-purpled. Vessels include a clear pumpkin seed flask and a green glass champagne bottle. Cans in association with the road include an oyster can, a coffee can, key-opened potted meat cans, hole-in-top cans, and a canteen. The historic artifacts appear to be primarily in association with the historic road TL-39. This site is located near the closest approach of the project area to Hedges, and has previously been mapped as part of the Hedges complex but it was excluded during the final mapping and evaluation of the site as a National Register District (Burney et al. 1993).

CA-IMP-4131

This site was originally recorded in 1994 by Moreno and others as "a geoglyph, two cleared circles, one quartz flaking station, and a ceramic concentration." The current survey showed no definite signs of flaking at the quartz feature, leaving open the possibility that what was believed to be a flaking station is a "quartz smash" associated with the geoglyph. The site is approximately 380 m north/south by 130 m east/west.

The previously recorded ceramic concentration is only a few meters south of dual-pole PK 51-8, and directly under the electric wires. A total of 285 sherds were counted, from a minimum of two vessels. The sherds are a thin walled buffware, with no rim sherds evident. All of the sherds are very small.

A second, smaller ceramic concentration is located at the geoglyph. J. Moreno noted one sherd in this area and identified it as Palomas Buff.

The geoglyph was previously described as being 16 meters long on an east/west axis ending in a cleared circle at the western edge. During the current survey, a number of similar north/south trending features were noted and mapped (Figure 5-62).

The prior site forms for this site mentioned disturbance from off-road vehicle use. One even noted "numerous jeep trails." During the current survey, these "disturbances" were recognized as a World War II era campsite superimposing much of the site area. There are numerous tent clearings, set up in a style that Jay von Werlhof, who served in the army in the early 40's, says is consistent with the military. Small amounts of World War II vintage refuse are present, including metal cans, and a total of six cot springs. Due to the presence of vehicle tracks in the area of the geoglyph, the prehistoric origin of this feature is problematic.

CA-IMP-7269

CA-IMP-7269 was originally recorded in 1994 by Curtis and others as a historic dump, with a trail segment and a possible geoglyph. The site covers and area approximately 60 m north/south by 70 m east/west and depth is unlikely based on the desert pavement conditions in the area. The possible geoglyph was recorded as an overlapping loop design. B. Johnson suggested that the possible geoglyph was historic. This feature is likely the imprint left from a canvas or fabric water-hose, flexing or leaking slowly onto the desert pavement based on the patterning and relationship to a nearby waterline.

The trail segment was relocated and is approximately 30 cm wide, and curves in a manner characteristic of prehistoric trails over its 25 meter length.

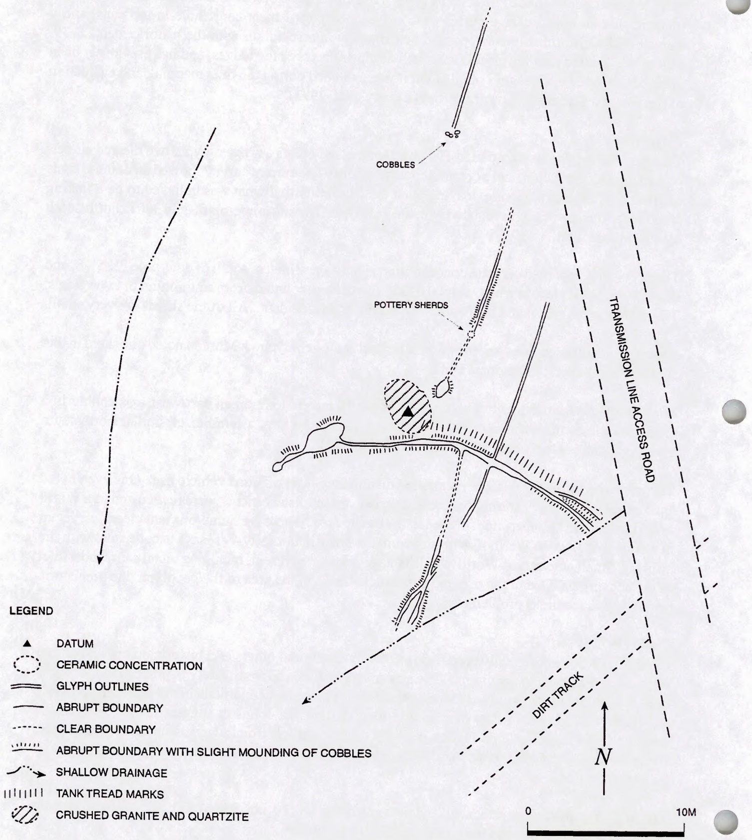


Figure 5-62. Site CA-IMP-4131, Possible Geoglyph (F-10308)

A large proportion of the historic refuse at this site appears to have been collected into four piles. Most of the cans on this site are of the hole-in-cap variety, and show visible lead seams. The visible lead-soldered seam is characteristic of cans manufactured before 1905. The glass bottles on the site are mostly hand-finished. Manganese glass bottles are present.

Sun-purpled, or manganese glass first appeared in the 1880's. The addition of manganese to a molten glass mixture resulted in glass that was clearer than regular glass of the same purity. Over time, however, exposure to ultraviolet radiation caused the glass to undergo a photochromic reaction, and permanently turn a distinctive shade of purple. The chief producer of manganese during this time was Germany. At the onset of World War I, manganese exports to North America ceased, forcing glass producers to turn to other methods to clarify their product. Articles made of manganese glass can therefore confidently be ascribed to the period between 1880 and World War I.

CA-IMP-7272
This site, originally recorded by Moreno and others in 1994, consists of an east/west trending prehistoric trail, approximately 30 cm wide. The trail was relocated during the current survey and is distinguishable for over 100 meters. It was impacted by two bladed roads and it terminates in disturbance in disturbance at Ogilby Road.

CA-IMP-7273
This site was originally recorded by Moreno and others in 1994. Their site form described the site as three trail segments with no associated artifacts, as well as a historic component thought to be related to the nearby Hedges townsite. Under instructions from the Southeast Information Center, the current survey has divided the trails from the historic or recent features to allow for separate and individual discussion of the trail features. The three trails are currently designated TL-36, TL-37, and TL-38.

The historic component of this site consists of a rock alignment, three rectangular tent pads, and a hearth. This area is approximately 20 m northwest/southeast by 30 m northeast/southwest. The rock alignment is made up of small stones lined up to form two letters on the desert pavement. The first letter has been disturbed and is indecipherable. The second letter is clearly an "A." Many of the stones have become lightly imbedded into the desert pavement. The tent pads are located a few meters northeast of the initials, with the hearth situated immediately west of the northernmost pad. The hearth has a large amount of modern refuse in it, including charcoal, a Pepsi can, an oil filter, and pallet nails. In summary, the historic component may largely be recent.

CA-IMP-7274
CA-IMP-7274 consists of a northeast southwest trending historic trail, approximately 30 cm wide. This trail, first recorded by Moreno and others in 1994 as extending for over 1600 meters, was believed to be associated with the town of Hedges. During the current survey, a stretch of over 300 meters of trail was mapped. The trail segment terminated at minor washes. The trail probably continues beyond the APE toward Hedges and based on the straightness and orientation toward Hedges this trail appears to be historic. No historic or prehistoric artifacts were noted in association.

Located to the north of the trail are four rectilinear cleared areas, measuring approximately 2 m x .75 meters. These are modern or historic tent pads with no associated artifacts. Adjacent to these areas is a 2 meter diameter cleared circle, formed on the desert pavement. This feature may or may not be recent. A basalt stone has recently been placed into the center of the circle.

CA-IMP-7275

This site consists of a probable historic trail, approximately 30 cm wide. The trail trends north northeast to south southwest, and is distinguishable for approximately 150 meters. Although this trail appears identical in width and route to known prehistoric trails, there is a broken sun-purpled bottle just to the west of the trail suggesting that it might be historic. The trail also trends toward Hedges supporting its assignment as historic. This trail was originally recorded by Moreno and others in 1994.

There is an additional feature in the vicinity of this trail. Located by the side of an old dual-track road is a pile of over one hundred rounded, highly patinated, small cobbles. No known source of small, rounded stones is located in the vicinity, and the reason for this feature is unknown. No prehistoric artifacts were associated with the trail.

CA-IMP-7276

This site was originally recorded by Moreno and others as a prehistoric trail segment in association with a geoglyph and a ceramic scatter. The trail extends for over 100 meters east/west, crossing a number of small washes in the process. A four meter diameter ring geoglyph is located near the north edge of the site, while a total of eight tamped circles are located on both sides of the trail (Plate 5-9, Figures 5-63 and 5-64). The circles measure from 60 cm to 75 cm in diameter, and are tamped into the desert pavement. The site extends over a 100 m area northeast/southwest by 60 m northwest/southeast. Depth is unlikely due to the desert pavement environment.

Plate 5-9. Site CA-IMP-7276, Geoglyph

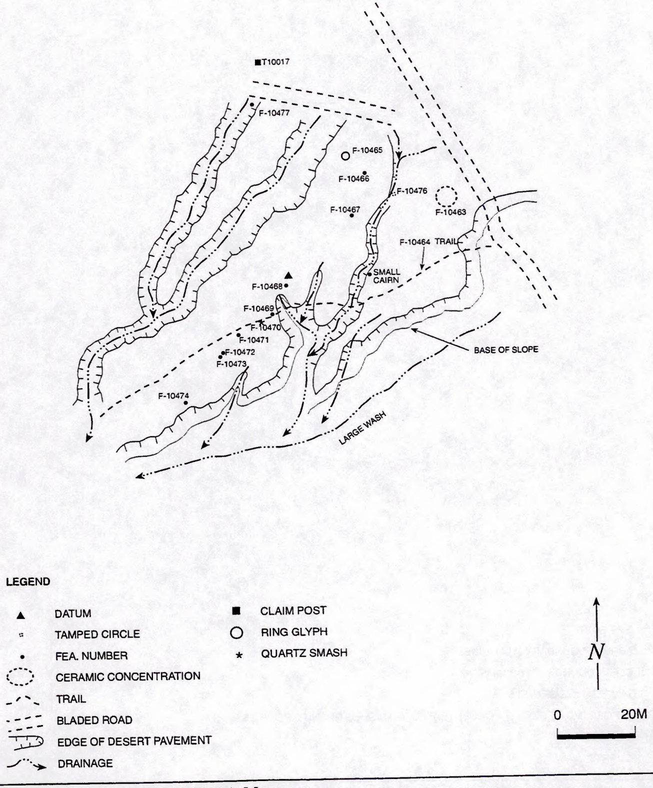


Figure 5-63. Site CA-IMP-7276, Sketch Map

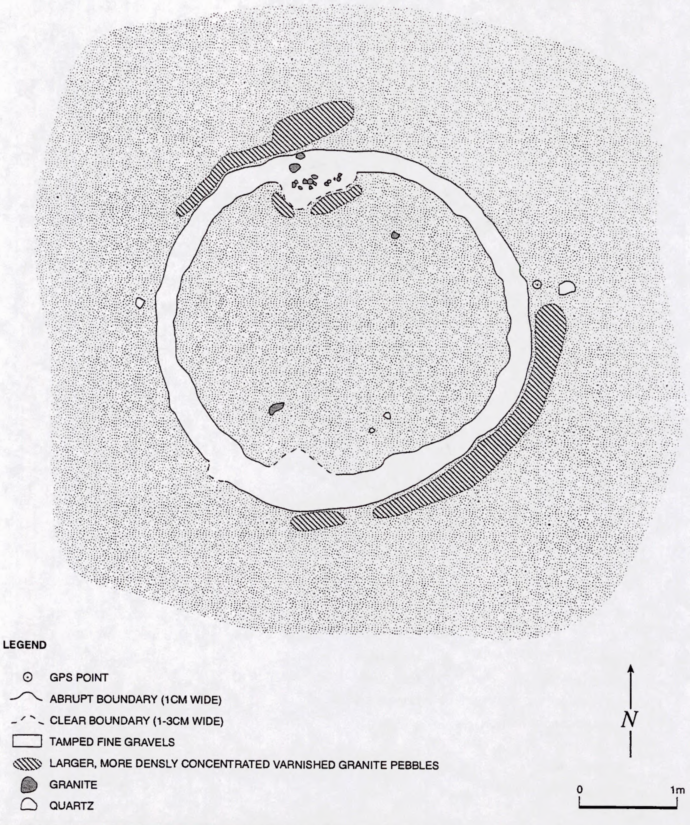


Figure 5-64. Site CA-IMP-7276, Ring Geoglyph (F-10465)

A second ceramic scatter was identified during the current survey. The majority of the ceramics on the site have not been typed, but one rim fragment was previously identified as Palomas Red-on-buff (Figure 5-65). Under instructions from the Southeast Information Center, the current survey has divided the trail from the rest of the site to allow for separate and individual discussion of the trail features. The trail is currently designated TL-41. Despite the proximity to the transmission line road the abundance of large ceramic fragments suggests that integrity is good.

CA-IMP-7339
This site was recorded by Moreno in 1994 as a 2 by 2 m ceramic scatter. An initial relocation attempt at 1 m intervals failed to relocate this resource within the APE. The intensive survey at 5 m intervals also failed to relocate this resource. A third attempt a 1 m intervals was also made, but again no ceramic resources were located within the APE. It is suggested that this resource was mismapped and is outside the current project APE.

CA-IMP-7340
Site CA-IMP-7340 was originally recorded by Moreno in 1994 as "seven pieces of chert angular debris," scattered over an area measuring three by three meters. Despite an intensive survey similar to that conducted at CA-IMP-7339, this resource was not relocated within the APE.

TL-6
This site was originally discovered by ASM during their 1996 survey of the project area. Although a completed site form for this site appears in the appendix of Schaefer and Victorino's 1996 report, the Southeast Information Center has no record of the site and has not assigned the site an official trinomial. Therefore, this site has been recorded as a new site.

The site consists of a rock ring, composed of basalt and granite, with a small cairn in the center. The ring is granite on the southern side, and basalt on the other. The ring is approximately two meters in diameter, and is composed of 18 cobble sized stones. In the center of the ring is a small cluster of five stones, which appear to be a collapsed cairn. All of the stones are lightly embedded into the sand and gravel that form the soil in the site vicinity.

No artifacts were noted during this survey. On his original site form for this site, Ken Victorino reports finding aluminum foil remnants within the ring suggesting a recent origin for the feature.

The scale on the sketch map drawn for Schaefer and Victorino is incorrect. The actual size of the ring is approximately two meters in diameter, and it is composed of cobble sized stones. This feature was thought by Jay von Werlhof to represent possible "new age" use of the area and does not appear to be prehistoric due to a lack of embeddedness and its location in a sandy wash area.

TL-7
The site consists of an alignment of 19 stones, divided into 4 clusters. The clusters are aligned in roughly an east/west direction. The stones are graduated in size, with the largest stones in the westernmost cluster, and the smallest pebbles in the easternmost cluster. This feature could be associated with mining era activities in this region, as it does not match known prehistoric feature

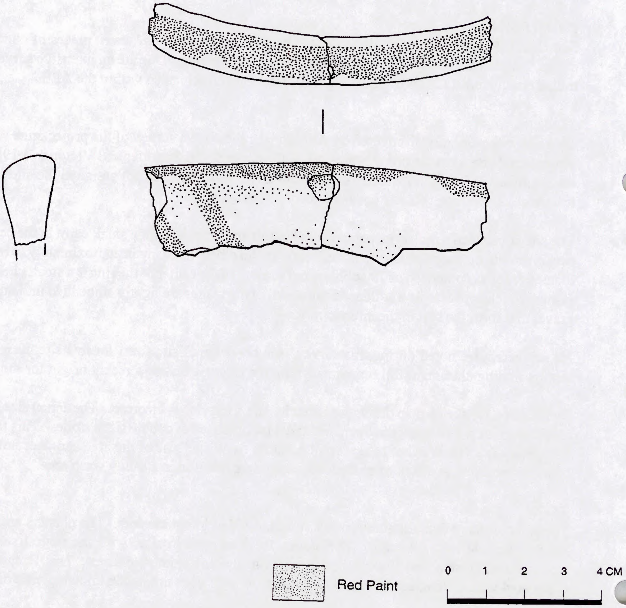


Figure 5-65. Site CA-IMP-7276, Painted Rim Sherd (F-10463)

types. This site measures under one meter in diameter. Integrity in the area was good with few recent impacts.

TL-8

The site consists of a pot drop from a single vessel. The pot drop forms a dense scatter of ceramic material approximately two meters in diameter. There are roughly 25 sherds present, including three large rim sherds. The vessel appears to be a shallow buffware bowl, probably Tumco Buff (Figure 5-66). Integrity in the area was good with little disturbance noted.

TL-9

This site consists of a diffuse historic can scatter approximately 12 m north/south by 20 m east/west. This site is located in a wash and may be a secondary deposit. A total of eight cans were observed: three hole-in-top cans, two cylindrical dry storage cans, one church-key opened beverage can, one sanitary can, and one can fragment of unknown type.

Based on the lack of visible lead seams, the hole-in-top cans date to after 1905. Hole-in-top cans are scarce after 1960. The artifact with the narrowest range of dates is the church-key opened beverage can. First introduced in 1935, they first became common in a military context during World War II, but were quickly displaced by the introduction of the pull-tab beverage can after 1962. On the whole, this can assemblage is characteristic of the World War II period, and is therefore probably associated with the training activities here in the early 1940's.

TL-10

The site consists of a triangular cluster of three small cleared circles. The circles, created by tamping, measure between 70 and 80 cm in diameter and the site as a whole is 4 by 2 m in size. One track of a dual-track road cuts across one of the circles. While the relationship between the circle and the road track cannot be stated for certain, it appears that the circle was made after the creation of the road.

If the circles superimpose the dual track road, this would be evidence that possible ceremonial usage of the area extended well into the twentieth century.

TL-11

The site consists of an approximately 60 cm diameter tamped circle, with a large granitic cobble in the center. The circle lies in an area of well-formed pavement, and the cobble is well embedded into the pavement. It is unclear whether the circle was cleared first, with the cobble placed in the center afterward, or if the circle was cleared around a cobble left in place. The integrity of the area is good with little evidence of disturbance.

TL-12

This resource consists of a diffuse refuse scatter in a large wash. This area appears to be a secondary deposit that is approximately 20 m north/south by 30 m east/west. Metal artifacts include sanitary cans, church-key opened flat top beverage cans, tobacco tins, rectangular potted meat cans, and a bucket. Glass artifacts include a screw top jar, a broken green bottle, and a Clorox bottle.

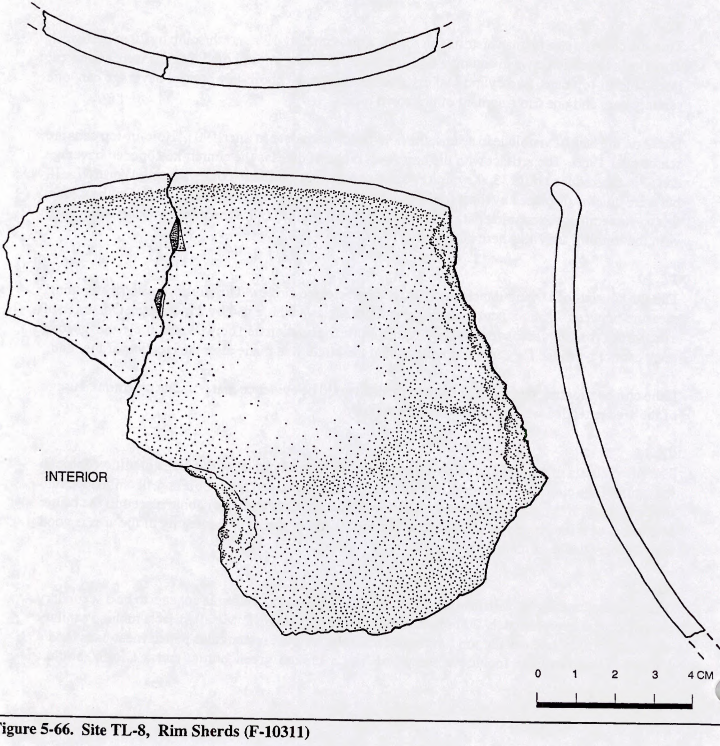


Figure 5-66. Site TL-8, Rim Sherds (F-10311)

Additionally, a possible mustard jar and a possible ceramic creamer were found. Modern disturbance is also found in the area.

Based on the lack of visible lead seams, the cans date to after 1905. The artifact with the narrowest range of dates is the church-key opened flat top beverage can. First introduced in 1935, they first became common in a military context during World War II, but were quickly displaced by the introduction of the pull-tab beverage can in 1962. On the whole, this can assemblage is characteristic of the World War II period, and is therefore probably associated with the training activities here in the early 1940's. Site integrity is fair due to secondary nature of the deposit and the modern disturbance in the area.

TL-13
The site consists of three trail segments tamped into the desert pavement covering the hills. One of the trails curves around the flank of a hill before joining with a second trail heading over a saddle between two hills. The third trail parallels the maintenance road, running along the flank of a small hill. These trails are in an area of historic and modern mining activity, and are probably associated with the early mining activity. The trails are approximately 30 cm wide and it may extend well outside the project APE. The trails were recorded as a single site because they were interrelated. Site integrity is good and the trails are generally undisturbed.

TL-14
This site consists of seven rectangular possible foxholes, measuring approximately 2 m long, 1 m wide, and between 30 and 50 cm deep. No associated artifacts, including bullets, were present. The site as a whole is approximately 152 m northwest/southeast by 46 m northeast/southwest. The exterior of each foxhole is rimmed with the material taken from the center. All of the seven foxholes are oriented in the same direction but are placed irregularly along the APE. Integrity in this area of the project was good.

TL-15
A single, 30 cm diameter circle tamped into the desert pavement. No artifacts were found in association, but site TL-16, an additional 3 cleared circles, is located less than 100 meters to the southeast. Integrity in this area of the project was good.

TL-16
This site consists of a cluster of three 40 cm diameter circles tamped into the desert pavement. No artifacts were found in association, but sites TL-15 and TL-17 are both in the immediate vicinity. The site measures 10 m east/west by 6 m north/south.

TL-17
This resource consists of a possible geoglyph just over 50 meters southeast from TL-16. The geoglyph, only 10 cm wide, stretches 10 meters east/west, ending in an oval tamped area measuring 75 cm x 1.1 m. The area of the geoglyph is highly disturbed by mine borings and integrity is only fair. The unusual narrowness of this geoglyph renders this feature problematic.

TL-18

This site consists of a scatter of four very weathered buffware sherds with mica and sand used as temper. These sherds are possibly Salton Buff, but these sherds have slipped exteriors suggesting they may be Colorado Beige. This pot drop measures less than one meter in diameter. Integrity in the area was good.

TL-19

This site is a small can scatter in a wash. It may represent a secondary deposit. A total of eight cans were observed, scattered over a 10 x 10 meter area. Four of the cans are of the hole-in-top type, while the other four were sufficiently buried in the sand of the wash that their typology is unknown.

Based on the lack of visible lead seams, the hole-in-top cans date to after 1905. Hole-in-top cans are scarce after 1960. The probably secondary nature of this deposit suggests that integrity is limited.

TL-20

This site is another diffuse can scatter. This site extends over a 15 x 15 meter area. Six cans were observed at this site. One is a lead-seamed hole-in-top, two are dairy hole-in-top, one is a key-opened potted meat can, and two are sanitary cans. Also present is what appears to be a gas tank in two pieces.

The hole-in-top can was used for dairy products, for either evaporated or condensed milk. Prior to 1905, hole-in-top cans had visible lead seams. After 1960, hole-in-top cans are scarce. The key-opened potted meat can, and the two sanitary cans, date to between 1905 and the present. Integrity in the area was generally good.

TL-21

This site consists of a scatter of broken glass over a 10 x 10 meter area. A total of nine vessels appear to be present. One bottle is sun-purpled, from a 3 piece mold. Two bottles are of dark green glass, and 6 are of aqua glass.

Sun-purpled, or manganese glass first appeared in the 1880's. The addition of manganese to a molten glass mixture resulted in glass that was clearer than regular glass of the same purity. Over time, however, exposure to ultraviolet radiation caused the glass to undergo a photochromic reaction, and permanently turn a distinctive shade of purple. The chief producer of manganese during this time was Germany. At the onset of World War I, manganese exports to North America ceased, forcing glass producers to turn to other methods to clarify their product. Articles made of manganese glass can therefore confidently be ascribed to the period between 1880 and World War I. Integrity in the area was generally good.

TL-22

The site consists of a number of trail segments, either flanking or running over the small hill complex to the west of the Cargo Muchachos. The observed trails run along the east side of the hills, but may continue on the west side of the hills, which were outside of the project area. The trails are probably related to mining adits in the area. The trail segments show a fair amount of braiding, with lighter paths cutting from one trail to the next (Plate 5-10). In addition to the trails, a large rock feature is present. This is an alignment of over 160 stones, probably from an adjacent mining pit. The trails were included as one sites because they were clearly associated with each other. The site including the trails and associated features is approximately 1200 m northwest/southeast by 50 m northeast/southwest.

Plate 5-10. TL-22, Trails

The historic artifacts include one metal flask labeled "Apple Blossom Talc" and measuring 8" x 3" x 1.5 ", and three bottles with white paint and corrugated shoulders labeled "Circle A Beverages...bottled in Brawley, Calif", as well as a Pepsi bottle. There was one prehistoric artifact present, a retouched flake with two modified edges and some tumbling.

TL-23

This site consists of an old water pipeline. Small segments of a buried water pipe are visible for over a mile, exactly paralleling the current Blythe - Pilot Knob electric transmission line. Because of the length and intermittent nature of this resource, portions of this feature also lie within sites TL-22, CA-IMP-7269, and CA-IMP-2878, and lie adjacent to site TL-24. Originally buried in a shallow trench, portions of the pipeline are eroding out, and can be traced over short distances.

At one point along the pipeline route, where the pipeline crosses a small arroyo, the remnants of what appears to be a trestle can be seen. The trestle consists of a pair of six inch by eight inch posts, emerging vertically from the sand at the bottom of the arroyo.

Several references were found to pipelines that were built by miners to bring water from the Colorado River to their mines. The earliest was the 14-mile pipeline that ran from the Yuma area to Hedges in 1890 (Norris and Carrico 1978:5.7). The second was a 12-mile pipeline that went to the American Girl Mine at the turn of the century (Norris and Carrico 1978:5.7). The final reference to a pipeline was a reference to the replacement around 1910 of the old Hedges lines. These were originally two, six inch pipes and they are thought to have been replaced with an eight inch line (Burney 1993:5.26). The pipeline itself has rusted badly and collapsed. The alignment has been impacted by roads and natural erosion and integrity is fair.

TL-24
This site consists of a north/west to south/east trail, approximately 30 cm wide. It is basically parallel to the transmission line, and parallel to the historic water pipe (TL-23). The trail is distinguishable for over 80 meters. No artifacts were found in association with this feature. The trail may be associated with the water pipeline. It has been severely impacted by grading for the transmission line and my have extending over a much larger area.

TL-25
This site consists of a quartz quarry. Hundreds of quartz fragments (possible angular waste) and a minimum of ten flakes are found in an area measuring five by eight meters, at the south side of a quartz outcrop. The outcrop is one of several quartz dikes in the immediate vicinity. This is the only outcrop with signs of purposeful lithic reduction. A quartzite hammerstone showing extensive battering was also identified at this feature. Several of the nearby outcrops have been graded during construction of the transmission line and Sidewinder road but this outcrop appears undisturbed and integrity is good.

TL-26
This site consists of two cleared circular areas. These cleared areas in the desert pavement are adjacent to modern drilling activity. They are oval in shape and measure two by three meters and three by four meters, respectively. The site area is 5 m northwest/southeast by 4 m northeast/southwest. No artifacts were associated with these features and their age and function is problematic. The recent drilling disturbance in the area leaves the integrity of these features only fair.

TL-27
This site is a diffuse historic can scatter in a small wash. It consists of seven cans in an area measuring three by five meters. Four are hole-in-top cans, one is a key opened potted meat can, and two are sanitary cans. The hole-in-top cans do not have visible lead seams.

The hole-in-top can was used for dairy products, for either evaporated or condensed milk. Prior to 1905, hole-in-top cans had visible lead seams. After 1960, hole-in-top cans are scarce. The key opened potted meat can, and the two sanitary cans, date to between 1905 and the present. The deposit is probably secondary and the integrity of the site is poor.

TL-28
This site is another historic can scatter. A total of nine cans were observed at this site, which measures three by ten meters. Three are sanitary cans, three are hole-in-top cans, one is a hole-in-cap

can, one is a church-key opened beverage can, and one is a potted meat can. The site appears to be WWII era in age and integrity in this area was fair.

TL-29
This site is also a historic can scatter. It includes a total of five cans in an area which measures five by five meters. Four are sanitary cans, and one is an embossed oil can. The oil can is one quart in capacity, and is embossed with "MOTOR OIL SAE 40." Site integrity in this area of the transmission line was fair.

TL-30
The site is a flaking station of fifteen yellow-brown rhyolite flakes on a well-formed desert pavement. Patination was moderate. The flaking station measures four meters by six meters. Integrity in this areas of well developed desert pavement was high. Good quality rhyolite was relatively infrequent in the gravels along this part of the transmission line.

TL-31
The site consists of a concrete foundation with an associated historic refuse scatter. A well worn two track road paralleling Sidewinder road was also present in the area and this had a cleared rectangle in it similar to a tent pad. The foundation measures approximately 12 x 20 feet, and is oriented with the long axis NE-SW. The cement has been mixed with local, rounded pebbles to form the concrete mix. The refuse scatter appears to be associated with the foundation and appears to represent domestic refuse. It consists chiefly of amber and clear bottle glass, with at least four vessels present. Also present are ironstone pottery, glazed crockery, bone, and some building materials. The refuse scatter was concentrated in a wash to the northwest and measures 20 x 20 meters. Site integrity appears to be very good with little evidence of disturbance. This site may be associated with nearby Camp Pilot Knob but was recorded separately because it is separated by more than 50 m from the main concentration of features that are known to be part of Camp Pilot Knob.

TL-32, TL-33, TL-34, TL-35
This site is the location of Camp Pilot Knob which was part of the desert training effort during WWII. It also includes a series of prehistoric features located in the same geographic area.

The prehistoric features are concentrated in two clusters. One cluster consists of three ring geoglyphs in an area of well-formed desert pavement. The rings measure two to three meters in diameter, with the entire cluster measuring 9 by 9 meters (Figure 5-67). The center geoglyph has been disturbed by a small excavation, possibly by pothunters.

The second cluster of prehistoric features is a series of two sets three cleared circles. These are between 50 and 60 cm in diameter and are also on a well-formed desert pavement. Both sets are within an area measuring 7 by 8 m in extent.

Camp Pilot Knob was one of General George S. Patton's training camps during World War II. Visible features include areas of desert pavement where grids of tent pads can be seen, with cleared areas, paths, and roads in between (Figure 5-68). These grids of tents often consist of eight or ten contiguous tents, arrayed in two rows of four or five tents each (Plate 5-11a). Also found in the desert

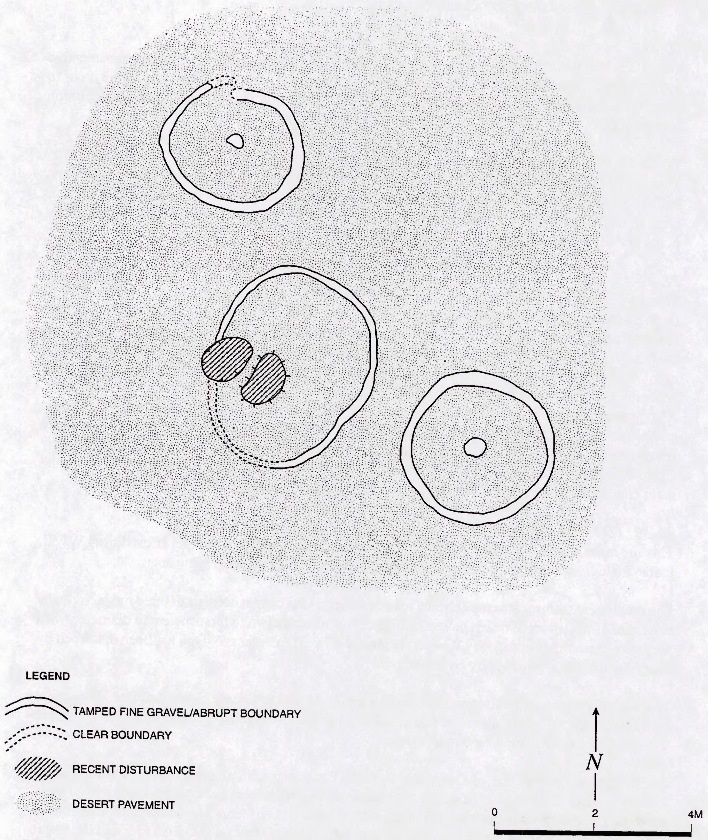


Figure 5-67. Site TL-35, Ring Geoglyphs (F-10525, F-10526 and F-10527)

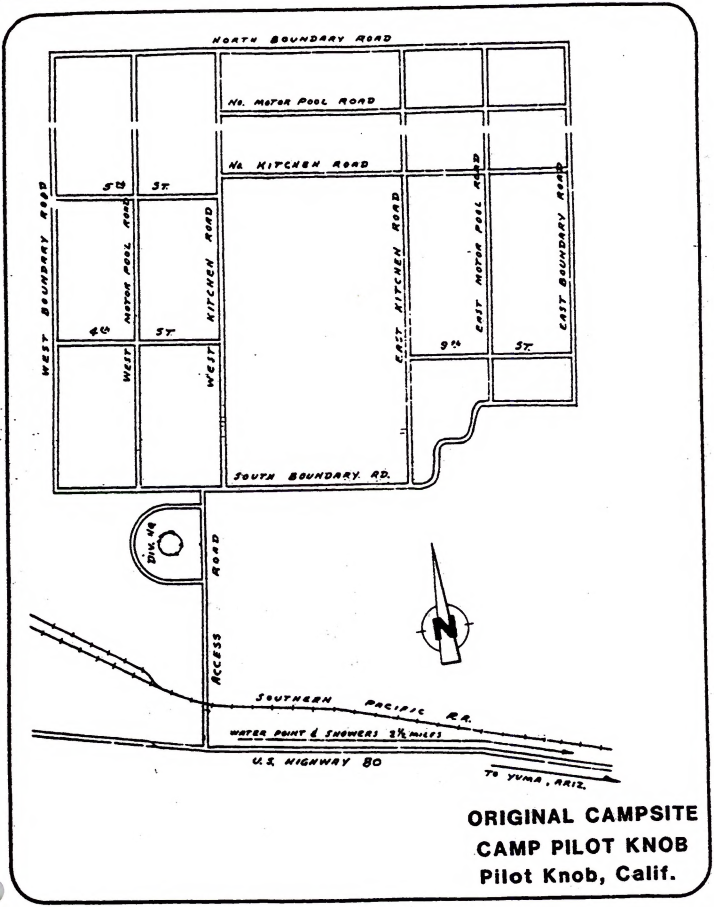


Figure 5-68. Site TL-35, Camp Pilot Knob Plan

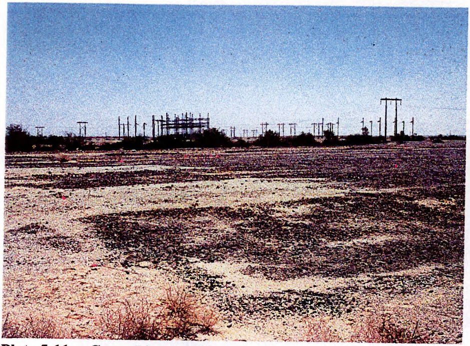


Plate 5-11a. Camp Pilot Knob tent grids

Plate 5-11b. Camp Pilot Knob tent grids of small stones

pavement, as well as the non-pavement areas, are grids of small stones (Plate 5-11b), forming borders for tents or temporary structures now gone. Small scatters of World War II era refuse are found in the washes crossing the site. In areas which have been graded after the war, occasional small artifacts such as razor blades and batteries can be seen. Tent stakes are occasionally found in association with the tent pads. A historical monument for Camp Pilot Knob is located near the south end of the site.

Dozens, perhaps hundreds, of tent pads are still visible. Dozens of stone outlines showing structure borders. Numerous cleared areas, probably representing marshaling points, motor pools, parade grounds, etc. Trails, paths and roads run through the site, many of which are of World War II vintage, based on their relationships with the tent grids and cleared areas. Numerous rock piles and excavations of unknown purpose.

While the military were clearly conscientious about removing refuse from the site area, assorted World War II vintage cans and bottles can be found in the washes that cross the site. Wooden tent pegs are often found in association with the tent pads, and can occasionally be found *in situ*. A light scatter of single edge razor blades, cork-lined bottle caps, batteries, and other easily misplaced items such as waterproof match containers and tobacco tins covers the site, including the disturbed areas.

Sidewinder Road cuts a wide swath through the site. A number of private, unimproved roads criss-cross the site area. A modern grave, indicated on the U.S.G.S. maps and clearly visible in the fields, overlays the site. A number of residences in the area lie within probable site boundaries.

Camp Pilot Knob was a unit of the Desert Training Center, formed during World War II to provide a very large training ground for troops to develop and learn desert warfare strategies. The camp reached its peak in 1943, when the 85th Infantry Division, and two squadrons of the 11th (Mechanized) cavalry were stationed there.

Despite disturbances and the fragile nature of the resource, large portions of the layout of Camp Pilot Knob are still visible and mappable. Occasionally, patterns in the desert pavement even show what areas in and around the tents received the most use, and where items of furniture, such as cots and stoves, were located. Camp Pilot Knob served as a vital part of America's World War II effort.

The California Department of Parks and Recreation monument at the site reads:

> Site of Camp Pilot Knob
>
> Camp Pilot Knob was a unit of the Desert Training Center, established by General George S. Patton, Jr., to prepare American troops for battle during World War II. It was the largest military training ground ever to exist. At the peak of activity here at Pilot Knob, June-December 1943, the 85th Infantry Division, and the 36th and 44th Reconnaissance Squadrons of the 11th (Mechanized) Cavalry trained for roles in the liberation of Europe, 1944-45.
> California Registered Historical Landmark No. 985
> Plaque placed by the State Department of Parks and Recreation with the Bureau of Land Management and Squibob Chapter, E Clampus Vitus, November 10, 1990.

Figure 5-69 shows the remaining roads associated with this camp.

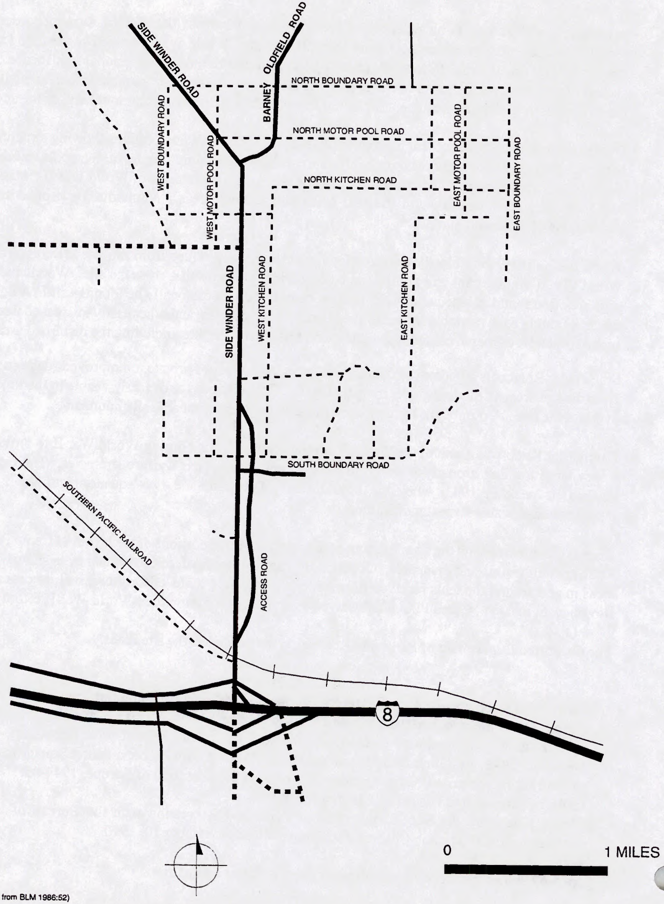


Figure 5-69. Camp Pilot Knob Remaining Streets

After DeLorme Mapping Co.:127

TL-36
This trail is one of the three prehistoric trails previously associated with CA-IMP-7273. The trail is approximately 30 cm wide, trends east/west, and is visible for over 150 meters. The trail probably extends beyond this area but natural geographic features and disturbance, such as washes and Ogilby Road were used to define this trail segment. Near the eastern end of this trail segment, the trail is crossed by trail TL-37, which trends northwest/southeast. TL-36 has previously been recorded as doubling back in a hairpin turn and becoming TL-38. This connection between these two trails was not perceived by the current survey crew, but it was outside the segments mapped during our inventory. The area has fair integrity with the recent features (CA-IMP-7273), the pole line road, and Ogilby Road as disturbance.

TL-37
This is the second of three prehistoric trails previously recorded as a part of CA-IMP-7273. This trail is approximately 30 cm wide, and tamped into the desert pavement. This segment is visible for over 100 meters. The trail trends northwest/southeast and crosses trail TL-38 near the center of its run. It also crosses TL-36 near its southeastern end, beyond the area mapped. All three trails in this area extend well beyond the APE and are mapped as segments. The area has fair integrity with the recent features (CA-IMP-7273), the pole line road, and Ogilby Road as disturbance.

TL-38
This is the third prehistoric trail previously recorded in association with CA-IMP-7273. Like the other trails in this area, this trail is approximately 30 cm wide, and tamped into the desert pavement. The trail runs west northwest/east northeast, and is distinguishable for almost 100 meters. TL-38 has previously been recorded as doubling back in a hairpin turn and becoming TL-36. This connection between these two trails was not perceived by the current survey crew, but it was outside the segments mapped during our inventory. The area has fair integrity with the recent features (CA-IMP-7273), the pole line road, and Ogilby Road as disturbance.

TL-39
This is an old dual track road passing through CA-IMP-3297. The road is the main north/south road that leads from Ogilby to the townsite of Tumco/Hedges. It is associated with historic refuse and manganese glass which is recorded as part of CA-IMP-3297. This road appears on several historic maps. It is shown on the 1953 edition of the USGS Ogilby 15' quadrangle surveyed in 1948. It is also shown on the 1936 Blackburn Map of Imperial County. The road continues beyond the project APE. Within the National Register eligible Hedges/Tumco Historic Townsite District. The integrity of this section of the road is very good. To the west, the road has been cut by the transmission line road and associated grading.

TL-40
TL-40 is the trail complex within CA-IMP-3297. There are a minimum of three trails cutting across and intersecting at this site. All of these appear to be prehistoric and have associated prehistoric ceramics. These prehistoric trails are approximately 30 cm in width and wind slightly. The longest of these trails extends for over 200 meters north/south. A second trail crosses the first, running 50 meters northwest/southeast. Additionally, there are two short trail segments running north/south to

the east of the first two. These two short segments may be parts of the same trail but are separated by impacts. Overall integrity is fair because of transmission line impacts.

TL-41
This site consists of the prehistoric trail running through CA-IMP-7276. The trail extends for over 100 meters east/west. It crosses a number of small washes which define this segment of the trail. The trail runs near the south edge of a desert pavement area, immediately to the north of a large wash. The integrity of the trail is high and traces can be seen in the bottoms of many of the small washes. It is the only trail in this portion of the project with this type of integrity.

Isolates

CA-IMP-7191-I
This isolated chert flake-based scraper was first recorded by Curtis in 1994. After the intensive survey and an additional effort to relocate this isolate, it was not found within the APE.

96-I-1
This isolated chert flake was first recorded by Giacomini in 1996. Despite an intensive, one meter transect survey of the recorded isolate location, this artifact was not relocated within the APE during the current survey.

TLI-2
This isolate is a quartzite hammerstone, with four battered edges.

TLI-3
These appear to be brake shoes to a pre-World War II vehicle.

TLI-4
This resource consists of the radiator to a pre-World War II Ford. The "Ford" insignia is embossed on the upper tank.

TLI-5
This artifact is an old universal joint that appears to have the same weathering as the known pre-WWII vehicle parts in the area. It is part of a road vehicle's drive train.

TLI-6
This is a broken ironstone dinner plate that appears to date before WWI in age based on the style of maker's mark. The maker's mark on the back reads "S. AHRENFELDT LIMOGES FOR THE KNUTSFORD G.S. HOLMES PROPr."

TLI-7
This is a dry-cell battery, possibly to a field radio. It appears to date to the WWII era. The battery measures 2.5" x 3" x 6".

TRANSECT SURVEY

Transect Survey Results

Introduction

Nine of the 16 1-km long transects surveyed outside the Project mine and processing area contain archaeological features. The remaining seven survey corridors were found to lack cultural material that met the minimum criteria for feature documentation. For example, single flakes and/or cores were noted on most of the transects, but these fell below the threshold for reporting. Features encountered during the transect survey include flaking stations (FS), lithic scatters (LS), prehistoric trails (PT), a prehistoric rock ring (PRR), cleared circles (CC), and a geoplyph (G). In addition, the location of tools (T) and pecked rocks (PR) were noted and mapped.

Features

Table 5-7 provides the results of the transect survey while Table 5-8 summarizes the results of the transect survey work by transect and feature. Flaking stations (N=10) were the most frequently encountered type of feature, accounting for 37% of the cultural locales. The flaking stations typically contained between 4 and 20 flakes/debitage. A core or core fragment was present in over half of these features. Prehistoric trails (N=5) and lithic scatters (N=5) were the next most common cultural elements, each comprising 18.5% of the identified features.

Table 5-7. Transect Feature Description

Transect Orientation	Transect Number	Feature Number	Description
North (0°)	1	F-10014	Flaking station (chert)
		F-10016	Flaking station (chert)
		F-10017	Flaking station (chert), pecked rock (basalt)
		F-10018	Lithic scatter (chert), pecked rock (basalt)
		F-10019	Lithic scatter (chert), hammerstone
	2	F-10008	Prehistoric trail segment (out of transect)
		F-10010	Flaking station (quartz)
		F-10011	Flaking station (chert)
		F-10012	Pecked rock (basalt)
		F-10013	Lithic scatter (chert)
Northeast (45°)	2	F-10020	Flaking station (chert)
Southeast (135°)	1	F-10006	Cleared circle (45 cm dia. with embedded quartz cobble)
		F-10007	Cleared circle (1.5 m dia. with shrapnel)
South (180°)	1	F-10002	Tool (chert)
	2	F-10003	Flaking station (chert)
		F-10004	Core (chert, unifacial)
		F-10005A-I	Prehistoric trail segment with possible spirit break
Southwest (225°)	1	F-10001	Geoglyph (65 cm dia., out of transect)
West (270°)	1	F-10028	Rock ring
		F-10029	Flaking station (chert)
		F-10030	Flaking station (chert)
Northwest (315°)	1	F-10021	Flaking station (chert)
		F-10022	Lithic scatter (chert)
		F-10024	Prehistoric trail segment (out of transect)
	2	F-10025	Lithic scatter (chert)
		F-10026	Prehistoric trail segment
		F-10027	Prehistoric trail segment

Table 5-8. Transect Survey Results

Transect Orientation	Transect Number	Feature Count FS	LS	PR	PT	PRR	CC	G	T	Total
North (0°)	1	3	2	-	-	-	-	-	-	5
	2	2	1	1	1*	-	-	-	-	5
Northeast (45°)	1	-	-	-	-	-	-	-	-	0
	2	1	-	-	-	-	-	-	-	1
East (90°)	1	-	-	-	-	-	-	-	-	0
	2	-	-	-	-	-	-	-	-	0
Southeast (135°)	1	-	-	-	-	-	1/1*	-	-	2
	2	-	-	-	-	-	-	-	-	0
South (180°)	1	-	-	-	-	-	-	-	1	1
	2	1	-	-	1	-	-	-	1	3
Southwest (225°)	1	-	-	-	-	-	-	1*	-	1
	2	-	-	-	-	-	-	-	-	0
West (270°)	1	2	-	-	-	1	-	-	-	3
	2	-	-	-	-	-	-	-	-	0
Northwest (315°)	1	1	1	-	1*	-	-	-	-	3
	2	-	1	-	2	-	-	-	-	3
Total		10	5	1	5	1	2	1	2	27

* This feature is outside of transect survey corridor, but was observed from the transect and was mapped during the mapping effort.

The types and frequency of features varied somewhat by geographic area and proximity to Indian Pass. Table 5-9 provides a summary of the major types of terrain crossed by the transects and the number of features encountered. The western and northwestern transects traverse the most rugged terrain encountered on the survey. While less rocky, the Northeast Transect 1 also crosses a series of relatively steep, dissected ridges. The more eastern and southern of the transects are generally characterized by flatter topography. Washes were present, but tend to be shallower than in the north and west. Despite the topographic relief, the greatest numbers of features were found along the northern and northwestern survey corridors, which are within 5 km of Indian Pass. These four transects contain almost 60% of the features identified during the transect investigations. The inventory for this area includes flaking stations, lithic scatters, trails, and pecked rocks. In addition to the features documented in this area, several cleared circles and flaking stations were also noted near the northwestern portion of Transect 1 (Northwest 315°), but these were categorized as non-prehistoric by the recording team.

A lower level of prehistoric activity is reflected in the transects to the northeast and east. Only one feature, a flaking station, was reported along these four transects. The number of features increases somewhat as one moves to the south, but more notably the type of features are different from those encountered in the north. In the vicinity of the southeastern, southern, and southwestern transects a total of seven features were identified. Only one of these was a flaking station. The other cultural elements in this area include two tools, a trail, two cleared circles, and a geoglyph. The northernmost of the western transects, which crosses mostly steep terrain and two major washes, contained no cultural features. The more southerly of the two western transects include some less rugged terrain. Two flaking stations and the only rock ring found during the transect survey were located on this transect.

Table 5-9. Transect Terrain and Feature Count

Transect Orientation	Transect Number	Terrain	Feature Count
Within 5 km of Indian Pass			
North (0°)	1	Wash/low hills	5
	2	Wash/low hills	5
Northeast (45°)	1	Dissected ridges	0
	2	Wash/low hills	1
Northwest (315°)	1	Wash/rocky ridge/low hills	3
	2	Wash/ridge/low hills	3
More than 5 km from Indian Pass			
East (90°)	1	Wash/valley floor	0
	2	Wash/valley floor	0
Southeast (135°)	1	Wash/valley floor	2
	2	Wash/valley floor	0
South (180°)	1	Wash/valley floor	1
	2	Wash/valley floor	3
Southwest (225°)	1	Valley floor	1
	2	Valley floor	0
West (270°)	1	Wash/rocky ridge/plateau	3
	2	Wash/rocky ridge/low hills	0

Previously Recorded Sites

A review of the records search indicates that some of the resources identified during the transect survey are previously recorded. These features are correlated with the appropriate trinomials in Table 5-10.

Table 5-10. Previously Recorded Resources Along the Survey Transects

Transect Orientation	Transect Number	Feature	Permanent Trinomial
North (0°)	1	Flaking station, pecked rock	CA-IMP-5066
North (0°)	2	Trail	CA-IMP-5060T
Northwest (315°)	2	Trail	CA-IMP-5359T

Discussion

The purpose of the transect survey was to provide comparative data on the frequency and types of cultural resources within areas immediately adjacent to the Project. An initial review of the results suggested that there is generally greater feature density inside the Project area than along the survey transects. In order to make a more direct comparison, a hypothetical 1-km long transect was extended into the Project area on the same bearing as four of the Transect 1 alignments (in each of the four cardinal directions). This in effect provided an extension of the survey transects into the Project area. The results of this comparison are provided in Table 5-11.

Table 5-11. Features Along 1-km Transects Inside and Outside the Project Area

Transect Orientation	Transect Number	Number of Prehistoric Features Inside Project Area*	Outside Project Area
North (0°)	1	3	5
East (90°)	1	5	0
South (180°)	1	6	1
West (270°)	1	13	3
Total		27	9

* extrapolated transects

As indicated in Table 5-11, the overall feature count was higher inside the Project area compared to the survey transect results. Only the extension of the northern transect proved less productive. This may be the result of the (hypothetical) transect's location in the more eastern extent of the Project area, an area characterized by relatively fewer features both inside and outside the Project limits. Not unexpectedly, the greatest number of features were encountered in the western portion of the Project, along the main transportation route associated with Indian Pass. In this area, three times the number of features were identified inside the project limits as compared to the survey transect.

The overall range of features (i.e., flaking stations, lithic scatters, tools, trails, etc.) encountered in the Project area as a whole and along the survey transects was similar. Flaking stations were the predominant feature both inside and outside the Project limits. One noticeable difference in the two inventories was the absence of ceramics outside the project. This may simply reflect sampling error. By comparison, geoglyphs, cleared circles, and rock rings were not reflected in the inventory along the extrapolated transects inside the Project area, but these features are known to occur elsewhere in the Project area. The relative rarity of such features and the small size of the sample can probably account for their under-representation in the comparison.

In sum, the cultural inventory both inside and outside the Project limits is dominated by flaking stations, but includes a range of features such as trails, geoglyphs, rock rings, lithic scatters, and cleared circles. The total number of features varies spatially, with an apparent focus on the transportation corridor associated with Indian Pass along the western part of the study area. While features similar to those found in the Project area are present outside the Project limits, the density of features is considerably greater inside the western extent of the Project.

Extrapolated transects inside the project showed a greater density of material within the Project APE then outside the APE to the east, south, and west. Only to the north, where the transects cross the corridor from Indian Pass more directly was the artifact density outside the project APE greater. This suggests that redesign to the east, south, and west would reduce the number of cultural features impacted while redesign to the north would increase impacts to cultural resources.

DISCUSSION

At the survey level, a research design serves to guide the data collection effort and the interpretation of the identified resources. This section is a summary of the inventory results focused on the research design topics.

Effect of Methodology on Interpretation

As indicated in Chapter 3, there appears to have been a strong relationship among previous survey field methods, consideration of context, results, and significance determinations. As indicated in Table 5-12, the current field inventory identified a much greater number of cultural resource features than previous surveys. This dramatic difference in results can be seen in almost every feature category. Not quantified in the table is the greater extent of low density lithic scatter also identified during the current survey.

Table 5-12. Summary of Previously and Currently Recorded Cultural Resources

	Previously Recorded Resources				Currently Recorded Resources			
Resource Type	Mine and Process Area	Ancillary Area	Transmission Line Corridor	Total	Mine and Process Area	Ancillary Area	Transmission Line Corridor	Total
Prehistoric Trail (Segments)	11	6	12	29	54	6	15	75
Bomb Crater				0	53	2		55
Cans				0	5	1	10	16
Can Scatter	2			2				0
Historic Ceramic Scatter				0	1			1
Historic Concrete Foundation				0			1	1
Historic Cleared Area	1			1	3	5	48	56
Historic Fire Ring	2+			2	37	5	3	45
Historic Artifact			2	2	97	3	40	140
Historic Petroglyph				0				0
Historic Pit	2			2	2		1	3
Historic Road				0				0
Historic Rock Feature	1		1	2	8	2	79	89
Historic Trail				0			22	22
Mining Prospect	4		10+	14			1	1
Historic Refuse Scatter	1		2	3	14		17	31
Historic Rock Alignments	4			4	3	3	5	11
Historic Rock Cairn	39			39	63			63
Historic Rock lined pit	1			1	1		7	8
Historic Rock Rectangle	5			5	12	2	4	18
Historic Rock Ring	16			16	15			15
Historic Rock Semicircle	13			13	29			29
Historic Rock Wall	4			4	7	1		8
Biface	3			3	8			8
Bone				0				0
Cleared Circle	109+	2+	3	114	45	2	34	81
Core	340+		1	341	163	451		614
Flaking Station	221+	11+	1	233	1,128	292	2	1422

Table 5-12. Summary of Previously and Currently Recorded Cultural Resources (Continued)

Resource Type	Previously Recorded Resources: Mine and Process Area	Ancillary Area	Transmission Line Corridor	Total	Currently Recorded Resources: Mine and Process Area	Ancillary Area	Transmission Line Corridor	Total
Groundstone	1			1	13	3		16
Groundstone Flaking Station				0		4		4
Hammerstone	2			2	15	7	1	23
Lithic Scatter	31	5+	2	38	154	21		175
Lithic Quarry				0			1	1
Mano				0	2	2		4
Metate				0	1	3		4
Painted Pottery				0	1			1
Pecked Rock		1		1	210	38		248
Pot Drop	1	2	4	7	56	21	9	86
Pot Sherd	1			1	70	10	6	86
Pottery Scatter	1	5+	2	8	15	1	12	28
Prehistoric Rock Cairn	2			2	1			1
Prehistoric Rock Semicircle				0	3			3
Prehistoric Rock Feature	2			2	2	1		3
Prehistoric Artifact	6		6	12		2		2
Rock Hearth			1	1				0
Prehistoric Rock Ring	9	2+	1	12	16	2		18
Scratched Rock				0	19	1		20
Shell				0				0
Tool	57+		3	60	176	47	5	228
Tool Scatter				0	1			1
Geoglyphs	3	1	8	12	10	16	5	31
Human Bone				0				0
Lingam	1			1	1			1
Crystal				0	2			2
Petroglyph	1			1	1			1
Prayer Circle				0	9	3	1	13
Prehistoric Rock Alignment	1	2	1	4	3	9		12
Prehistoric Rock Cairn				0	3	1		4
Shaman's Hearth			1	1	5	2		7
Spirit Break	1	2+		3	9	1		10
Trail Marker				0		12		12
Trail Shrine		2		2				0
Vision Quest				0	10	2	3	15
Prehistoric Quartz Smash	1			1	3			3
Tool Scatter				0	102			102
Early Tool				0	18	257		275
Early Tool Site Boundary				0		6		6
Early Tool Flaking Station				0	1	1		2
Total	900	41	61	1002	2680	1248	332	4260

As indicated in Chapter 4, the desert pavement environment can be a difficult one in which to identify surface artifacts because of color relationships and the amount of "noise" created by gravels and cobbles. Most of the earlier surveys of the area were conducted in 20 m intervals and often with serious time constraints. The goal of the current inventory was completeness and accuracy. A shift in methodological approach to 5m survey transects is seen as the major reason for such dramatic differences in survey results. Factors such as crew experience and knowledge may also have had some effect.

While the direct relationship between survey methods and survey results seems clear, it should be noted that the results are not merely different in quantity of artifacts but also in site boundaries and interpretation. As noted above site boundaries are dramatically different from those previously recorded. This is due to both the larger number and the greater distribution of features than had previously been recorded. Areas of poorly developed desert pavement in the western portion of the project previously were thought to be devoid of features. The close interval survey in this area resulted in the identification of trails, ceremonial features, and ceramics. Identification of these features in environments previously thought to be sterile was one of the dramatic differences in survey results due to differences in methodology.

Another dramatic difference that affected site boundaries was the identification of much more extensive areas of low density lithic scatter. As indicated in Chapter 3, the progressive identification of lithic scatter over time resulted in some site lumping during the Schaefer and Schultze (1996) survey. The current survey resulted in the identification of even larger areas of low density scatter. This in turn resulted in additional site lumping and dramatic differences in site boundaries. These differences in site boundaries will also have implications for management. If this survey had been conducted before any exploration drilling of the area in the 1980s was conducted, then numerous impacts to trails, site areas, and features would have been avoided or required mitigation.

Such dramatic differences in results surely affect archaeological interpretation. For example, Schaefer and Schultze (1996) were not able to see a relationship between ceramics and trails because most of these features had been missed and they were working only with a very limited sample of what was really there. The results of the current survey showed a clear spatial relationship between trails and ceramics. And, this association has interpretive implications, suggesting that ceramics in the Project area were either accidentally dropped during transportation activities or purposefully left for symbolic reasons. They were probably not deposited as a result of domestic habitation. The current survey was also able to show greater use of the area for ceremonial use, and the greater importance of the area as a transportation corridor was indicated by the identification of a more complete trail system in the western portion of the project.

The consideration of context was also an important factor related to site identification and definition. Not only was the large site of Camp Pilot Knob with its numerous associated features missed during two previous inventories because of a lack of background research, but the interpretation of the whole Project mine and process area is affected by the consideration of context. The transect surveys determined that there appears to be a real concentration of cultural material within the Project mine and process area and that this concentration appears to be part of a larger pattern extending from Indian Pass to the Running Man site. Context from oral history clearly attested to the great significance and importance of this area to the Quechan.

Finally, all these relationships add up to differences in significance determinations. Early previous work considered flaking stations in isolation and recommended them as not significant. More recent work began to consider more context and interpreted much of the area as significant (Schaefer and Schultze 1996). The current effort as will be discussed below used the broader context provided by oral history and regional overview studies, in conjunction with differences in survey results to define an area of traditional cultural concern which probably qualifies as eligible for the National Register as a traditional cultural property.

The dramatic differences in survey results due to differences in methodology suggest that methodological procedures for future work in the area may need to be revised to reflect these differences in results. The use of closer survey interval resulted in dramatic differences in interpretation, site boundaries, and significance. Context consideration also had an important effect on interpretation and significance. The differences in survey results, interpretation, and significance between the current and previous survey warrant further use of these methods in similar environments when the goal of a complete and through survey is desired.

Site Definition and Boundaries

As mentioned above, the KEA inventory both expanded the areas where features were located and expanded the extent of low density lithic scatter identified. As a result, site boundaries dramatically expanded (Figure 5-70 in map pocket).

The definition of site boundaries in expansive areas of low density scatter is a difficult one. Is it better to record as a site the entire geographic distribution of low density or restrict site boundaries to more manageable areas of higher density? In the current study, the former approach was selected for use for several reasons. First this definition was required by the Southeastern Information Center for site recording, second the inclusion of large areas with low density scatter between features or concentrations of features was seen as the best way of describing the nature of the archaeological record in the area. Finally, the traditional cultural significant of the area dictated a broad site boundary approach.

Another difficult issue in terms of site boundaries is the recordation of trails. The Southeastern Information Center instructed KEA to record these trails as separate entities because trails can extend for miles and cross through multiple site areas. This approach was used in this project unless segments were very small and did not appear to extend beyond the site.

The problem with recording trails as separate entities is it separates the trails from associated features and evidence of activity. Although, trails and ceramics are clearly associated, this will not be reflected in how these resources are recorded, analysis of the area must grapple with relating numerous related sites to each other.

Site boundaries related to trails are also incompletely defined in terms of ends. What were recorded during the project were trail segments. Many of these appeared to align into specific trails while others are more difficult to assess in relation to each other. Some may require careful walkover to trace them out and others may require low level aerial mapping. Trail segments beyond the Project boundaries were not traced and most of these trails extend beyond the APE.

Settlement Pattern

The Project cultural resource inventory and the transect survey served to assess the settlement pattern in a large region west and south of Indian Pass. The survey of the Project mine and process area identified several important patterns. The main pattern was one of a transportation corridor along Indian Pass Road. This transportation corridor was reflected by the presence of the majority of trails in this area and the concentration of ceramics and trail related features along this corridor. Outside of this corridor, trails are much more dispersed and lack associated material. They do show an overall pattern radiating from Indian Pass with only some of the trails with a questionable cultural association going perpendicular to this general trend (Figure 5-70 in map pocket).

The distribution of lithic reduction related features is very widespread (Figure 5-70 in map pocket). As suggested in the background section (Chapter 2), the general absence of appropriate lithic material along the Colorado River may have been one of the forces driving much of the lithic reduction activity in the area. Lithic reduction appears to parallel the resource base in many respects but also trends toward a greater abundance in the western portion of the project were the transportation corridor is located. This suggests that the overall pattern is one of heavy prehistoric use of the transportation corridor and where this overlaps with important lithic resources a corresponding high frequency of lithic reduction.

The distribution of features of religious-symbolic significance somewhat parallels the trails system because many of these were features such as spirit breaks are directly related to the trails. The remainder of these features appear to be widely distributed throughout the Project mine and process area without any clear pattern (Figure 5-70 in map pocket). There is a slight concentration of these features along the ridgeline east of the major transportation corridor suggesting a possible association although the features in the far eastern portion of the project would contradict this association.

Another major pattern seen in the distribution of features and the types of sites is the general absence of major habitation evidence. This appears consistent with the larger settlement pattern in the region as indicated by the overview (Chapter 3). Actual village locations are focused on water sources such as the Colorado River. Settlement within the Project mine and process area appears to have been relatively short term and dispersed. Clusters of cleared circles and rock rings range from isolated features to groups of four. The absence of greater congregations of house features and association with large amounts of cultural material suggests that these features represent temporary camps. These features are distributed throughout the Project mine and process area and are not particularly associated with the trail system.

The transect surveys served to support the hypothesis that Native American activity was focused along the trail system and drops gradually away from this corridor. Transects to the east of the project lacked cultural material suggesting a drop off which is somewhat apparent when examining the distribution of features (Figure 5-70 in map pocket). Both the transects and the survey area data suggest a wide corridor of focused activity emanating from Indian Pass and roughly following Indian Pass Road.

Prehistoric Flaking Station Identification

Flaking stations represent the most abundant archaeological feature within the Project APE and are particularly abundant within the Project mine and process area. Previous research in the area has established some of the difficulties of distinguishing these features from the abundant rockhound activity in the area. The current project attempted to use consistent criteria for flaking station identification. These criteria included any level of patination, embeddedness, and reduction strategy. Patination was the most definitive criteria used.

Several of the survey crew felt that even using the patination criteria some rockhound activity may have been recorded. White impact crush marks on patinated pieces suggested the possibility that they were more recent. Sometimes elements of technology such as crude testing and association with dumorturite (a rock favored by rockhounds) contrasted with the patination evidence. Sometimes the reverse was true and reduction strategies were felt to indicate a prehistoric flaking station without patination. The patination criteria was used for recording purposes however. This contrasted with some of the earlier recording in the area and some previously recorded features were not recorded during this inventory because they were felt to be recent.

The pattern of overall flaking station distribution parallels the distribution of other features in the area. As shown on Figure 5-71 (map pocket) flaking stations appear to be concentrated near the trail corridor. It must be noted that this is also near Indian Pass Road which provided access to most of the rockhounds in the area.

The flaking station data collected during the survey reflects the most accurate and objective database possible, but the difficulty of determining the age of flaking stations leaves these features somewhat problematic. Flaking station dispersion has been one means used to assess the age of flaking stations in the Mojave desert (Bamforth 1992), but again there is no objective means of testing this data. Rockhounds and prehistoric Native Americans shared many of the same lithic reduction goals but advances in experimental archaeology have shown important uses for replicative technological analysis. By using replicative analysis in a testable manner, resolving some of the ambiguity in this data set could be possible.

Early Tool Assemblages

The early tool assemblage category represents one of the most problematic issues in the study area. This assemblage of tools was not identified by Schaefer and Schultze (1996) and many archaeologists do not accept these items as cultural artifacts. Another faction of archaeologists, led locally by Jay von Werlhof, who has extensive experience in the area, feels this is a critical component of archaeological sites in the area and that whole categories of early site components are lost by ignoring this database.

The distribution of possible early tools and tools is shown on Figure 5-72 (map pocket). As indicated in the methods section, this category of material was not recorded throughout the entire project area but only from sample areas focusing on the western side of the project. The distribution of early tools appears to pattern the distribution of flaking stations and lithic materials. The distinction between tools and early tools on Figure 5-72 (map pocket) is gray. Those on the tool end of the scale represent more patterned reduction but clear use-wear was not established on any of the tools. Jay von Werlhof identified many important categories of tools such as spokeshaves within the Project. Several rare tool categories were also identified, suggesting that the area represents an important resource for examining these types of tools. Most of these tools reflect minor flaking or nibbling of chert edges, and "retouched" flakes represent by far the largest category of these tools.

As with the flaking stations in the project area the early tools represent an important issue for further research. On the one hand they could represent a huge early component of activity in the area, not reflected by formal tools such as bifaces and projectile points. On the other hand, they may represent natural phenomena and indicate little early prehistoric use of this area. This issue is critical to resolve with future research in the area. Careful sampling, geological comparison, and replicative analysis may help resolve this issue in the future.

Extent of Military Use

Large portions of the project area have been altered by activities associated with the World War II Desert Training Camps. Evidence of training activities appears in the form of rock cairns, rock features, ration cans, cleared tent pads, shrapnel, and bomb craters. In the mine and process area, five sites contain evidence of World War II activity. Most of this is in the form of rock features, bomb craters and ration cans. Most of these features (particularly the bomb craters) are disbursed and seem to represent either single or short-term use.

One site, Site CA-IMP-4970, contains a larger number and variety of features concentrated in a relatively small area. It looks like it may have been a bivouac area. The numerous trash dumps and rock features indicate that the area was used for several days. This seems to be the main maneuver area in the mine and process area (Figure 5-73 in map pocket). It appears to represent a secondary camp with Pilot Knob as the main base camp in the region. It differs from Camp Pilot Knob in many ways. Although Camp Pilot knob has some rock features and a line of cairn-like features it is largely made up of tent pad clearings and associated refuse. The CA-IMP-4970 area is largely made up of rock features that may represent gun emplacements. The CA-IMP-4970 site appears to represent an area of active training and use of weapons where Camp Pilot Knob appears to represent a staging area or encampment in itself. An examination of the distribution of military material within the Project mine and process area suggests that CA-IMP-4970 represent the major encampment for this area and that bomb craters generally radiate out from this area.

Evidence of World War II activity continues within the ancillary area in two sites. It is in the form of rock features, ration cans, bomb craters, and occasional cleared areas that were most likely tent pads. There is also an isolate that is a World War II vintage flashlight. The features in this area are less frequent than those in the Project mine and process area, and probably represent a third type of military activity area limited to a small group conducting field operations.

Along the transmission line corridor, ten sites contain these features related World War II activities. The majority of these features are trash scatters (some of which exist in washes) but there are also tent pads, and fox holes. No bomb craters were noted in this area although there may be some outside the corridor. Like the features in the ancillary area these represent short-term activities and probably the smaller or third level of military camp.

The exception to this is a single site in the southern end of the transmission line, TL-35. This site contains the remains of one of the main Desert Training Camps, Camp Pilot Knob. This camp was most active in 1943 and evidence of its existence can be seen in the form of rock features, tent pads, and trash dumps.

Since Camp Pilot Knob is the only major camp in close proximity to the World War II era features in the project area, it is likely that all of the features are associated with activities that were based at Camp Pilot Knob. These areas most likely represent training sessions involving men that were stationed at Camp Pilot Knob. Since the camp was used most heavily during 1943, most of these features probably occurred during that year as well.

Mining History

Evidence of mining activities within the project area is less frequent than evidence of World War II activities. It seems that most of the major mining activities occurred outside the Project APE. The only evidence of mining activities in both the mine and process and the ancillary area appears to be less than 45 years of age and is represented by scattered mining claim rock cairns.

The transmission line corridor contains recent rock cairns like those in the main area but it also contains evidence of historic mining. This evidence can be found in eleven sites along the corridor. It consists of historic refuse, roads, segments of a water pipe, and trails which lead to adits. The trails do not appear to have a connection to the larger mining areas. Very few artifacts appear along them, making it difficult to assess their age. Most of these trails are part of a network that leads to several adits. Since it is difficult to assign a time period, it is not known whether these trails represent a single miner or several miners over a long period of time.

Some evidence exists of the large-scale mining such as that at Tumco/Hedges just outside the project area. The main indication of this is a portion of a road that leads to Tumco/Hedges. The northern portion of this road was recorded as part of a previous study of Tumco/Hedges but was not considered part of the designated district (Burney 1993).

A number of historic refuse scatters exist along the transmission line corridor. They mainly consist of cans and sun-purpled glass. Most of them were found in dry washes, indicating that they are a secondary deposit. They appear to have originated in the areas of Tumco/Hedges and Obregon. Since they are redeposited, they have lost most of their context.

An historic water pipe runs through a portion of the transmission line corridor. It appears in at least three places within the APE and most likely continues outside the project area. Archival sources indicate that it leads to either Tumco/Hedges or the American Girl Mine.

In summary, the majority of the mining-era features occur in the transmission line corridor. Some of it represents small-scale activities but most of it provides a peripheral indication of large-scale mining that was occurring outside the project area.

SUMMARY OF RESULTS

The survey identified a variety of cultural resources within the Project APE. These resources are dominated by evidence of prehistoric activity but also include historic resources. The inventory primarily served to complete the resource identification phase for the project. It accomplished this by using more appropriate inventory methods in conjunction with a thorough consideration of context including Native American input.

The inventory provided an evaluation of previous and appropriate methodology for the area. This indicated that 5 m interval surveys are needed in areas of desert pavement to completely identify small features such as pot drops and flaking stations. The inventory methods also expanded areas of low density scatter making site boundary definition an important issue. Site boundaries were defined based on the distribution of cultural material and geographic features. Trails were identified as separate sites where they were likely to extend beyond the boundary of a single site.

CHAPTER 6
EVALUATION RESEARCH DESIGN AND METHODS

Chapter 6 presents a research design for the evaluation of the significance of the cultural resources in the Project area. First, the general methods for evaluation dictated by regulatory considerations are discussed. Then, the NRHP criteria are discussed specifically in relationship to the Project area. Finally, regional research goals are presented to help focus the evaluations.

EVALUATION METHODS

In accordance with 36 CFR 800, the BLM is required to determine whether the sites that could be affected by the Project qualify as eligible for nomination to the NRHP. To assist in meeting this requirement, BLM prepared a scope of work for the cultural resource survey that required the contractor (KEA) to evaluate the NRHP eligibility of the sites recorded. Due the nature of Native American concerns, the scope paid particular attention to the need to evaluate the potential of a traditional cultural property (TCP) in accordance with National Register Bulletin 38 (Parker and King 1992).

In meeting this scope, KEA undertook detailed surface inspection and recordation of the identified sites and coordinated closely with members of Quechan tribe who participated in the survey and recordation. We also worked closely with the Project cultural anthropologist, Dr. Michael Baksh in collecting data relevant to the possible TCP.

While no subsurface excavation was conducted in conjunction with the archaeological evaluations, the vast majority of the sites were found on desert pavement surfaces, where little or no subsurface deposition is expected. Therefore, the assemblage of materials visible on the surface yields an adequate characterization of the informational content of the sites as well as the sites' potential in regard to NRHP criteria A, B, and C, when taken in conjunction with the ethnographic and ethnohistoric information compiled in Chapter 3 and in Dr. Baksh's report.

The evaluation undertaken in the current report differs from the typical archaeological evaluation of prehistoric sites because of the attention paid to all four NRHP criteria. Most often archaeological sites are evaluated for their informational content (Criterion D) and either explicitly or implicitly fail to meet the other criteria. In the present case, however, particular attention is paid to the sites' potential under Criteria A and C in particular. In applying these criteria we have followed the guidance provided in National Register Bulletin 38, which deals with the kinds of resources that we generally encountered in the Project area.

RESEARCH DESIGN

Theoretical Orientation

Most of the archaeological research carried on in the California deserts over the past two decades has been directed under a materialist research paradigm. Primary attention has been paid to issues of prehistoric economy such as reconstructing Native American subsistence systems, technology, and settlement patterns and relating these to changes in the biotic and physical environment (see McGuire and Schiffer 1982; Schaefer 1994; Warren 1986). Without dismissing the importance of these issues, we believe that the nature of the resources present in the Project area and the strength of Native American concerns for these resources necessitates a broadening of this research paradigm.

The Project area contains numerous archaeological manifestations of behavior that was primarily religious or symbolic in nature. While radical materialists claim that such behavior is largely determined by material conditions (see Harris 1968), the post-processualist critique (e.g. Conkey 1989; Hodder 1982; Leone 1982) has argued that reductionist arguments fail to account satisfactorily for the rich variety of symbolic behavior that occurs both ethnographically and archaeologically. While a wide variety of post-processualist research strategies have been offered, they concur that more attention needs to be paid to "the cultural *meanings* [emphasis in original] of material objects, and to the interplay between the symbol systems and the artifacts created by past human groups" (Watson and Fotiadis 1990: 614).

One of the difficulties for symbolic archaeology has been finding ways to validate the inferred cultural meanings of material things. This problem may never be solved adequately for the very distant past. However, in the present case there is a demonstrable cultural continuity of religious and symbolic lore from the Patayan period through the present. While we do not discount the probability that symbolic meanings have evolved significantly during this time in response to changed social and material conditions, we believe that the testimony of modern Quechan with respect to the religious meaning of certain archaeological features is critical to the full understanding of the significance of these things. Archaeological and Native American perspectives may complement or contradict each other; regardless, a dynamic interplay between these perspectives is necessary and will result in a less ethnocentric understanding of Native American history (McGuire 1992). In sum, our approach will be to address research issues that stem from both the processual and the post-processual paradigms, with particular attention paid to issues raised by the Quechan tribe.

Research Topics and Data Requirements

The cultural overview (Chapter 3) and inventory results (Chapter 5) suggest a series of eight research topics relevant to the evaluation of resource significance: Religion and Symbolism; Prehistoric Trails - Their, Economic, Religious and Chronological Significance; Ceramic Typology; Lithic Procurement and Technology; Early Lithic Tools; Settlement Patterns and Mobility; Desert Training Military Activity; and Mining Activity. Each of these topics is discussed below, leading to the identification of fourteen sets of related research questions and associated data requirements.

The ability of sites within the APE to contribute to these research topics is relevant to their NRHP eligibility on Criterion D. Several of these topics are also relevant to Criteria A and C in that they help establish the context to identifying which events should be considered significant and which types of structures or objects may be representative of a style or period of use.

Religion and Symbolism

As noted above, the Project area has been identified as being of high religious concern to the Quechan tribe. Archaeological survey results confirm the presence of numerous cultural features that probably had a religious function. Because of this sensitivity, the evaluation of significance must address the nature of religious activities evidenced in the Project area and must consider how the archaeological materials present may have functioned within traditional Quechan belief systems. Because of the study area's diversity of cultural materials with symbolic meanings, it may have an unusually high potential to address belief systems archaeologically.

Question Set 1 - What is the nature of religious activities practiced in the Project area, and how are these activities manifested archaeologically? How recently have these activities been practiced, and do the Quechan intend to continue these practices in the future? How critical are these practices to cultural continuity; are they integral to the community in the sense described by Parker and King (1992)?

The overview presented in Chapter 3 reviews a variety of Quechan religious activities. Broad topics included:

- The importance of dreaming as a way to communicate with the spiritual world and the relationship of dream travel to trails;
- The importance of several key sacred mountains;
- The importance of the *keruk* ceremony, and the relationship of intaglios to this ceremony;
- Rock art as a symbolic manifestation of religious beliefs and/or practices;
- The contrast between major and local ceremonial centers (Altschul and Ezzo 1994);
- The role of vision quests; and,
- Religious education and the cultural transmission of sacred knowledge.

In order to evaluate the significance of the cultural resources in the project area under the NRHP criteria, especially Criteria A, B and C (Parker and King 1992), we will need to examine a broad array of data sources to identify religious practices in the Project area. The ethnographic literature describes selected aspects of Quechan religious behavior through the 1920s (e.g. Forde 1931), and modern Quechan can provide testimony regarding traditional lore and current and planned religious activities. With regard to both the ethnographic literature and current ethnography, however, it should be understood that there are cultural limitations imposed. In accordance with traditional practice, the Quechan are reticent to reveal many specifics regarding traditional religion. Cultural resource specialists must take this into account in evaluating the data provided. The available data cannot be considered complete but rather understood as information which is considered by Quechan consultants to be unavoidably necessary to reveal in order to communicate their concerns.

Archaeological data can supplement the testimony of the ethnographic record about religious activities and perhaps add a longer temporal dimension than can be achieved through ethnographic methods. Chapter 3 (above) discussed potential archaeological correlates of various religious activities. A major *keruk* site, for example, would normally be located in an area that could support the food and water needs of several family camps for several days. Thus, habitation debris might be expected, especially if the site were to have been repeatedly used. It should also be located near a major trail. There should be evidence of a burnt structure, including the subsurface stubs of burnt posts, and an itaglio might be associated with a *keruk* site.

While the *keruk* ceremony is very much a social function, much of Quechan traditional religious behavior is solitary, including the quest for spiritual knowledge and power through dreaming or the vision quest. Archaeological manifestations of this behavior include small rock circles often called prayer circles or power circles, but termed herein vision quest circles. Some cleared circles may also be involved with vision quests as might tamped rings and small dance floors. The breaking of white quartz might also be associated with such activities. Because some areas are considered particularly strong in spiritual power, we should expect to find diffuse clusters of features associated with generations of solitary religious behavior.

Although the spiritual quest is largely solitary, the Quechan have stated that experienced religious leaders train pupils in the ways of the quest. Thus, clusters of cleared areas might represent "classrooms" where a religious leader conducted spiritual training (Cachora, personal communication, 1997). In such a case the features might be more tightly clustered and patterned, as opposed to more diffuse clusters resulting from repeated solitary activities.

The distribution of ceramic scatters must also be considered in the context of potential symbolic behavior. Rogers (1966; see also Waters 1982) reported finding whole and (purposefully?) broken pots in trail shrines. Such pots might be considered offerings to the spiritual world. Alternatively, personal belongings are destroyed at death, and some ceramic scatters could represent this behavior. While archaeologists normally refer to small ceramic scatters as "pot drops," suggesting accidental breakage, the possibility that some subset of these scatters might represent purposeful symbolic behavior should be considered in light of this Rogers' findings and the ethnographic evidence. We would suggest that an increased frequency of "pot drops" in association with other evidence of symbolic religious behavior would help to demonstrate this connection.

Question Set 2 - What is the distribution of rock art in the Project area? Does all rock art in the area conform to the Great Basin scratched style or are other types represented? How does the occurrence of rock art correspond spatially to evidence of social or solitary religious activities? Is there any evidence regarding the relative chronology of the glyphs?

A major concentration of the scratched petroglyph style is found at Indian Pass, just 5.6 km (3.5 miles) north of the Project mine and process area, but pecked abstract elements and painted naturalistic pictographs have been reported from the Indian Pass vicinity and nearby Picacho basin sites. Elsewhere, scratched glyphs have been reported superimposed on other styles, suggesting that they are later in time and perhaps placed to nullify the earlier panels (Heizer and Baumhoff 1962). The association of the scratched petroglyphs with Indian Pass is quite strong spatially and suggests that the spot was chosen at least in part because of its relationship to this major travel corridor. But, given the symbolic importance of dream travel in Quechan culture, we cannot be sure if the association is with physical travel (suggesting a trail marker or ethnic boundary type of function) or with dream travel. Rogers (n.d.) recorded numerous examples of the scratched style from Indian Pass, but no systematic recordation has been attempted, and little information on comparative glyph motifs and frequencies in relative to other scratched glyph sites exists. Such a study would likely yield new information on the chronology, function and cultural meanings of this style.

The function of rock art in general within prehistoric cultural systems is not well understood. Numerous interpretations have been forwarded, including associations with hunting magic, shamanistic vision quests, territorial demarcation, and astronomical observations. We believe, given the wide variety in rock glyph styles, that multiple functions across time and space are probable. Since the written ethnographic record is largely silent regarding rock art in the desert west, archaeological data forms a major avenue of research. However, the possibility that ethnographic information on the Indian Pass petroglyphs could be obtained from modern Quechan should not be dismissed without further investigations.

In addition to seeking additional ethnographic data, studying the relationship of the Indian Pass petroglyphs to trails, trail shrines, geoglyphs, vision quest circles, quartz smashes, and other features of symbolic meaning would be useful. A study that (1) closely examined the spatial distribution of these elements for evidence of symbolic association or exclusion, (2) compared symbolic content and glyph design similarities and differences, and (3) integrated these findings with the ethnographic information about belief systems would greatly enhance current knowledge about Native American belief systems and their archaeological expressions. This would be useful to the Quechan in cultural heritage education as well as to archaeologist in their endeavors to understand the archaeological record.

Prehistoric Trails - Their Economic, Religious and Chronological Significance

The numerous trail segments recorded in the Project area may be useful in addressing a broad suite of research issues due to their varied roles - they were utilized for mundane settlement and subsistence activities, served as avenues for interregional trade and exchange and as paths followed by raiders and warriors, and were symbolically associated with dream travel. Additionally, Rogers believed that parallel trail segments resulted from abandonments and relocations and thus can serve as chronological clues for seriating ceramic types, if it can be shown that different ware types are associated with different trail segments (see Waters 1982).

Question Set 3 - Can extant trail segments be related to ethnographically recorded named trails? If so, do the Quechan place special significance on certain trails? Do trail segments identified as *ethnographically significant exhibit higher concentrations of such symbolic cultural features as vision quest circles, geoglyphs, quartz smashes, and (possibly) pot drops?*

Perusal of Figures 3-5, 3-12 and 3-13 (above) will show that the reconstruction of trail systems is not necessarily straightforward. The general trails map produced by the Imperial Valley College Museum from ethnographic and historical sources (Fig. 3-5) does not correspond in some substantial ways to archaeologically recorded trails (Fig. 3-13). For example, the Ogilby Hills trail (Fig. 3-5) southwest of the Cargo Muchaco Mountains is not recorded archaeologically; instead, an archaeological trail runs on the northeast side of those mountains. Similarly, many trails recorded by Rogers in the 1920s and 30s are mapped somewhat differently today or no longer exist.

Not reproduced in this volume is a trail map maintained by the Quechan Tribe for educational purposes. The Quechan in recent ethnographic interviews mention some named trails that are not recorded elsewhere. It is clear that they refer in some cases to extant trail segments and to trails that have been given other names by previous researchers. For example, the trail referred to in recent ethnographic interviews as the "Trail of Dreams," which passes through the Project area may be the same trail referred to by Rogers (1966) and others (e.g. Schaefer and Schultze 1996) as the "Mojave War Trail." In recent years the Quechan have been actively utilizing existing trail segments for foot travel across the desert as part of a cultural revitalization movement. Quechan consultants have stated that the "Trail of Dreams" is particularly sensitive culturally.

The destinations of trail segments can sometimes be ascertained by following them out beyond washouts and other areas of poor preservation. Low level aerial photography has the potential to facilitate connecting trail segments separated by disturbances and correlating parallel segments. Ethnographic field visits, in conjunction with aerial mapping, could help determine trail segments that clearly have special cultural or religious significance. Archaeological recordation of associated pot drops and cultural features with symbolic meaning would be useful in further identifying and assessing cultural significance under the NRHP criteria.

Question Set 4 - Can a trail seriation similar to that proposed by Rogers (1966) and Waters (1982) be worked out?

Archaeological recording of trail segments, trail breaks, and associated ceramic scatters (pot drops) could help verify Rogers' and subsequently Waters' trail/ceramic chronology. Aerial mapping techniques could improve the reconstruction of trail systems over what Rogers had to work with. Additionally, more detailed mapping of the relationship of pot drops to trail segments would be useful in verifying Rogers' original work in view of the fact that Rogers mapped site locations at a very general scale. Finally, modern petrographic techniques could better quantify paste and temper characteristics that are used in ware-type determinations. The latter might be useful in the investigation of regional exchange patterns as well as chronological placement of ceramic types.

Question Set 5 - Is there evidence of the use of trails for trade? If so, can exchange networks be reconstructed?

Typically, the economic use of trails for exchange is not well represented in the archaeological record. Exchange goods would not be expected to enter the archaeological record on a regular basis along trails. Perhaps the exception would be the accidental breakage of ceramics. Rogers did find some exotic pottery types in the Indian Pass area. Reexamining his collections and comparing those to extant frequencies in the Project area would provide useful information on the context of exotic wares. Assessing whether exotic types were accidentally broken during trade forays as opposed to having been purposefully deposited for symbolic purposes would be relevant to the trade issue. Petrographic analysis of paste and temper may identify variability or uniformity in the manufacturing location of more common ware types, and this would have relevance for the reconstruction of exchange relationships.

Ceramic Typology

As indicated in Chapter 3 there are many unresolved issues related to ceramic typology within the Lower Colorado River. A long standing disagreement between the Rogers-Waters camp and the Schroeder camp in Arizona is some indication of the problems with the typologies, but as additional data that does not fit the Waters typology accumulates, it has become clear that some level of revision is necessary. The separate examination of cultural and geological attributes may be one way to address these problems, but the existing database also requires reexamination using more quantifiable techniques than those used in the previous typologies. Patterning of ceramics in relation to trails and other features may be another way to address the issues of type. New types of ceramics such as Hedges Buff require more testing before they can be accepted as both a chronological and geographic marker. Relevant research questions for the Project are identified below.

Question Set 6a - How do the ceramics in the area fit the Waters' typology and compare with Rogers' early work in the area? Are the type expectations of the Waters typology met in the project? What types from outside the project area are present? Were the majority of ceramics being made locally or along the river? How well does the Waters typology work in an area where it was initially defined?

Schroeder (1961) and Malcolm Rogers developed similar but incompatible ceramic typologies for the Lower Colorado River area. Rogers used data from trails and shrines in the Indian Pass area to formulate much of his typology. Although Rogers' methods were sophisticated for the time, there is little quantitative analysis of ceramic characteristics and many sherds, particularly body sherds, were classified using more intuitive methods.

Waters (1982) built on the strengths of Rogers' typology and attempted to emphasize the cultural elements of vessel form. Waters used Rogers data to formalize and describe a typology for Lower Colorado Buffware. Schroeder considered Waters' typology inaccurate and attempted to block its publication, suggesting a lack of expert consensus on the issue.

Although the typology itself emphasized cultural elements such as rim form, the practical application required use primarily on body sherds, and as a result paste and temper attributes have come to dominated the application of Waters' typology. Abrupt shifts in type attribution by Waters himself (Phillips 1982) resulted in divergent type assignments. Application of Waters typology on the west side of Lake Cahuilla has proved to be problematic and does not indicate that the typology works as a geographic or chronological tool.

Quantative analysis of a partially reconstructable ceramic assemblage in conjunction with sound theoretical analysis are the ways in which this issue can be addressed. Reconstructable vessels or portions of vessels would allow for an analysis of vessel form. A large sample would allow for quantative comparison. Petrographic analysis would allow for a quantative description of paste and temper characteristics.

Question Set 6b - Can trails in this portion of the Colorado Desert be successfully dated using ceramics? Can braided trails be seriated in this way? How successful is the chronological application of Waters' typology? Can Lower Colorado Buffware ceramics be used for relative dating?

Malcolm Rogers used relative dating as a major tool for developing his ceramic chronology because radiocarbon dating was not available at the time. He also applied his ceramic typology to trails as a means of dating these features. He used both the distribution of ceramics along trails and the types of ceramics found in trail shrines as means of dating trails.

Trails are an important aspect of the archaeological record that have been considered to range in age from the Paleoindian Period through historic time but because they represent pathways with no associated organic materials that can be radiocarbon dated their age can only be determined though relative dating. The presence of ceramics along many of the trails within the Project mine and process area provides the potential for testing this aspect of relative dating for trails. Not only are ceramics relatively abundant along some of these trails but the tendency for patterning of ceramic type along trails was also noted.

Question Set 6c - Is the Tumco/Hedges distinction real and useful? Is color contrast among clay inclusion a reflection of sherd temper or firing differences? Is the distribution of sherd tempered ceramics limited to the ethnohistoric period and associated changes in vessel form?

Schaefer (1994) built on Waters' typology by adding several types. The type relevant to the project is Hedges Buff. This type is similar to Tumco Buff with the exception that it has been assigned to the ethnohistoric period and associated with culturally transitional vessel forms. It also has sherd temper distinguished by contrasting clay inclusion color and sometimes by sherd edges. The type is based on research at the mining town of Hedges in the Cargo Muchacho Mountains near our Project APE. Although similar ceramics were seen in historic sites in Yuma, the authors think it is important to consider the cultural and paste/temper elements separately.

Ceramics from the Salton Sea Test Base on the west side of Lake Cahuilla show contrasting inclusion color with no indication of vessel form modification related to historic contact. Also, samples with some areas of contrasting inclusions and some areas without suggest that the color contrast may be more of a reflection of firing practices than anything else. The reality of this type and the link between ethnohistoric vessel forms and paste/temper characteristics is in question. The Project data sample from near the Cargo Muchacho Mountains can be important for assessing this issue because of its proximity to the "type site" for these ceramics and because it appears to be dominated by prehistoric period activity. During the inventory, Tumco and Hedges Buff were combined for description. This combined type was the most abundant ceramic type in the Project area.

Petrographic analysis of these ceramics can determine the extent of sherd verses clay temper. Firing tests can also be used to determine the relationship between these materials and color contrast. Other inclusions within the ceramics can lead to a better understanding of exactly where these sherds were made. Vessel form can also be examined though the use of partially reconstructable vessels to look for evidence of acculturation.

Lithic Procurement and Technology

Although lithic procurement from secondary cobble material has been identified throughout large areas of the eastern Colorado Desert, including the Project area, the implications of this pattern and related technology have not been fully explored. The relationship between these procurement areas and the Colorado River valley is an important topic. The large amounts of low density lithic procurement do not appear associated with corresponding amounts of temporary habitation and use that would explain their function. Thus, production of tool blanks for use elsewhere may be indicated.

The lithic technology of the area is also poorly understood. Although some analysis of technology has been conducted on the Arizona side of the river (Slaughter et al. 1992) and some groundstone reduction replication has occurred in relation to pecked rocks (Pendleton 1986) there still remains a large information gap on the actual production goals of the prehistoric Native Americans in this area and techniques used to reach that goal. Ambiguity still exists between many lithic scatters in the Project area and older rockhound activity as discussed in Chapters 4 and 5 (above).

Question Set 7 - Was lithic procurement in the Project area largely conducted to supply toolstone to habitation sites located along the Colorado River? Alternatively, is there evidence of more than one lithic procurement strategy, which might indicate separate temporal components - an earlier one related to more mobile preagricultural groups and a second associated with Patayan settlements within the foraging radius of the Project area?

Due to the dearth of dated Archaic sites in the Colorado Desert and the absence of habitation debris mentioned above, the tacit assumption is often made that lithic resource areas in the desert uplands near the Colorado River primarily supplied toolstone to Patayan settlements there. However, elsewhere in the arid west, *major* lithic sources generally saw a reduction in use during the Late prehistoric (Cleland et al. 1990; Delacorte et al. 1997; Elston et al. ; Hildebrandt and Gilreath 1988). Although the causes of this general reduction are not well understood, several key factors may have played a role: (1) increased social circumscription may have resulted in the reduction of subsistence territories, making travel to major lithic sources more costly, (2) reduced mobility may have decreased the value of curated tools and increased the tendency to use expedient tools, which could be manufactured from readily available debitage left in prime settlement locations by earlier occupants, (3) concurrently, the introduction of the bow and arrow may have reduced the need for large bifaces, and (4) widespread droughts at the middle-late transition may have resulted in a general population decrease and a consequent decrease in demand for raw materials.

Because of the well known difficulty of dating *lesser* lithic resource areas, such as the ones in the Project area, we do not yet know whether a parallel reduction in exploitation occurred in such areas. If social circumscription and reduced mobility were the primary causes, and reduced tool size and population decline relatively minor factors, then lesser quality sources near settlement areas may well have seen an increase in use, particularly in the acquisition of materials suitable for expedient tools. The inability to date securely the flaking stations in the Project area will make a definitive answer to this question difficult. However, technological attributes of the assemblages can provide a reasonably solid assessment as to whether biface reduction occurred within the Project area. Additionally, mobile groups retooling in an area typically discard worn-out tools. Such indicators, when placed within a regional database, could help to provide chronological clues, as well as a reconstruction of lithic technology. Thus, a rigorous technological investigation in the project area could go beyond the mere reconstruction of tool manufacturing processes and yield implications regarding prehistoric settlement and mobility systems.

Question Set 8 - Can differential patination within the Project area be identified? If so, is this a reliable indicator of relative chronology?

Demonstrating the utility of patination as a relative dating tools within a relatively confined and homogeneous locale, such as the Project mine and process area, would have obvious implications in addressing the previous Question Set. Assuming that substantial variability in patination exists, comparing patination within and between single episode flaking stations would be a relatively rigorous test of the chronological utility of this phenomenon.

Early Lithic Tools

Early lithic tools remain a unresolved issue within the Project area and within the wider region of southern California. The types of artifacts identified by von Werlhof during the current inventory were not identified by earlier surveyors (Schaefer and Schultze 1996; Schaefer and Pallette 1991) and many researchers doubt that these items are cultural in origin. Because this remains a unresolved issue in the region, it is important to address this issue and not to ignore one camp or the other based on philosophical differences. Although the scope of this Project cannot address the entirety of this issue, aspects relevant to the interpretation of the Project area can be addressed. The goal is to address these issues in an objective manner by searching for cultural and natural patterns and comparing the two. Because the Project area contains uncontested cultural assemblages as well as controversial early tools, comparisons of the two assemblages could help resolve some of the issues.

Question Set 9 - Is most of the edge flaking identified during the survey culturally or naturally patterned? Does edge damage on early lithic tools differ significantly from edge damage on later period tool-sized debitage flakes? Is the distribution of early identified lithic tools patterned in relation to terrace age and gravel and material types? How do the early lithic tools relate to the lithic production technologies and goals of the flaking stations and debitage in the area?

The early lithic tools identified in the Project area often are flake-like in morphology with heavily patinated dorsal and ventral surfaces and less patinated edge damage. Flake-like attributes and edge damage can be caused by tumbling, but current surfaces are stable. A geomorphological analysis of the desert pavement terraces could help in dating the formation of stable surfaces and would be relevant to the issue of whether tumbling could account for the initial formation of the flake-like specimens or the subsequent edge-damage. By comparing the nature of edge damage on early tools and later debitage, an assessment could be made as to whether the similar causes could account for both. A comparison of clast size and morphology of identified early lithic tools and naturally occurring gravels of the pavement surfaces would also be useful in address their cultural vs. natural origin.

A technological examination of the identified early tool assemblage would be useful. Paleolithic technologies are reasonably well described on a world-wide basis. The technological attributes of the Project area assemblage could be compared to these known technologies and an assessment made regarding similarities and differences. This analysis should reveal whether the early tool assemblage makes sense from a technological standpoint.

Settlement Patterns and Mobility

The particular concentration of cultural material within the Project APE appears to be related to the correspondence of abundant lithic resources, the funneling of a major transportation system through Indian Pass and the Project, and a religious/educational importance to the area. These three elements have led to a focus of activity within the project. Most ethnographic work for the Quechan has focused on the Colorado River area and very little is known about areas away from the river. Much of the time these areas were perceived of a marginal or supplementary to the Colorado River valley itself. Projects in the region have tended to view their areas in isolation and the relationship between the desert environment and the river environment remains a very important issue. Related to this issue is the trail network in the area. Accurate mapping for many of the trails outside the project area is absent and the resolution of where many of the smaller trails within the Project go is unknown.

Question Set 10 - How do the cultural resources within the Project area relate to the major occupations along the Colorado River in terms of resource use and settlement. On the continuum between foragers and collectors, where did the Quechan stand and how was the Project area used? Is there evidence for change in mobility strategies over time?

If a group with a forager-type mobility system were to have utilized the Project area, there should be some evidence of a residential camp in the vicinity. Foragers move the entire residential group to resource areas and stay until the resource is depleted or until another resource of greater utility becomes available (Bettinger 1991; Binford 1981). Collectors on the other hand send out work parties from logistically located residential bases. Often the transition from a foraging strategy to a collecting strategy results in the reduction of the number of residential camps, especially in marginal resource areas. The Project mine and process area is within, but perhaps close to the edge of, the resource procurement zone (foraging radius) of possible residential bases along the Colorado River. As a consequence, a collector-type strategy would not necessarily be expected to result in evidence of habitation associated with resource exploitation. Accordingly, the absence of evidence of residential camps in the Project area would be consistent with a collector-type system, while the presence of residential camps would be consistent with a forager-type system.

Ethnographic evidence would suggest that a collector-type strategy should be anticipated for the Patayan period. Resources were strongly clustered along the river, including horticultural land, and semi-permanent residential bases were established near the river. Food storage was probably important. The construction of trails to facilitate rapid movement implies the kinds of investment that would be expected from logistically organized groups rather than from foragers. Earlier groups particularly Paleoindian groups may well have practiced a much more active form of residential mobility. Evidence from throughout the desert west suggests a Paleoindian pattern of frequent residential moves within very expansive group territories (Apple, et al. 1997; Delacorte, et al. 1997; Kelly and Todd 1988). The Archaic period in the Colorado Desert is too poorly known to predict the type of mobility system that might be expected.

Question Set 11 - Can the suggestion by the Quechan that the Project area was utilized residentially be confirmed?

One of the issues raised by the Quechan regarding the earlier surveys was a concern that habitation sites were overlooked or misinterpreted. Schaefer and Schultze (1996) subsequently examined Rogers' field notes at the San Diego Museum of Man and concluded that his references to a habitation area refers to a different locale. Since cleared circles are sometimes taken as evidence of residences, the Quechan concern may stem in part from the presence of these features within the Project area. Chapter 3 reviewed the conflicting interpretations of this feature type. Many cleared circles have been found with no archaeological manifestations of domestic activities (Pendleton 1986) - i.e., no fire affected rock, no associated artifacts, and no lithic debitage - while others appear to have been too small to function as domestic space. Nonetheless, the potential that some cleared circles served as habitation areas cannot be dismissed *a priori*. All cultural features and associated artifact assemblages in the Project area will need to be considered in determining whether there is any evidence for habitation (residential, domestic) sites.

Desert Training Military Activity

Remnants of the World War II desert training activities can be found throughout the desert area stretching from California and Arizona's Mexican border up to southern Nevada. Military and mining activities in the area are probably the two most influential historic activities on the landscape. Although the Patton Museum at Chiriaco Summit has collected some information on the camps, there has been no systematic collection of information and several questions remain. The World War II generation is aging. Soon it will be too late to gather oral histories about camp life in what was the most ambitious military training program in U.S. history.

Question Set 12 - What were the day-to-day activities occurring at a base camp like Camp Pilot Knob? How was Camp Pilot Knob arranged? How many troops stayed there at one time?

As one of the main camping areas, Camp Pilot Knob probably functioned as an area where basic training began for the troops. Activities there were probably focused organizational activities and logistics, as well as on preparing troops for maneuvers in other parts of the desert. Historic maps suggest that the camp was most likely divided into specific use areas. There is evidence of many tent pads which perhaps number in the hundreds. The size of the tent pads should vary according to their function. Recordation of extant features could provide many details that are missing from existing historical maps.

Written records could provide some information on these issues. If the journals of commanding officers survived, these would answer some questions. Interviews with members of the 85th Infantry Division and the 36th and 44th Reconnaissance Squadrons of the 11th Cavalry could provide some answers. Some oral histories have already been collected and these could also provide answers.

Archival research at the National Archives could answer some of these questions, but some information about the Desert Training activities was discarded by the military in the years following WWII. Accounts relating to the chain of command and the presence of various divisions presumably still exists. Some of this was located for the present study, but a more extensive search could yield a more complete picture. Especially useful would be historical photographs - camp overviews, aerial photographs, images of daily life, and shots of desert training activities.

Question Set 13 - How did activities in this portion of the desert differ from those surrounding the other camps such as Camp Young? Could the difference in activities be determined by observing alterations to the landscape?

Several of the other camps from the Desert Training activities have been preserved (e.g., Camp Young, Camp Iron Mountain, and Camp Coxcomb). These camps housed different divisions than those at Camp Pilot Knob and presumably conducted different training sessions. There are certainly differences in the way these camps were laid out and there may be differences in the ways they altered the landscape around them.

More in depth archival work on each of the camps would provide more detail on how the camps differ from each other. A field visit to some of the areas would yield information on alterations to the landscape and how this changes depending on the activity taking place.

Mining Activity

Evidence of mining activity is widespread in the vicinity of the Project area. Mining activities these have occurred in this area over the last 150 years and have continued to the present day. Physical evidence observed in the Project area itself is limited to trails leading to adits and associated refuse dumps. Numerous large historic mining operations can be seen in the area surrounding the Project (e.g., Hedges, American Girl Mine). Some of the items found along the transmission line portion of the Project area are thought to relate to these larger mines. While studies have been done on some of the mining operations in the area (Burney et al. 1993, Hector 1987), the information represents large-scale mining activities. Small-scale operations such as those adjacent to the Project transmission line, have been little studied.

Question Set 14 - Are the historic trails in the Project area associated with significant events in regional history or could they yield important information regarding historic mining activities?

Archival information could help establish the historical associations of these trails - their approximate age and possibly the identity of mining claim holder. Recording of the trails may exhaust their research potential.

CHAPTER 7
CULTURAL RESOURCE EVALUATION

Chapter 7 evaluates the sites recorded in the Project area in accordance with the NRHP criteria of eligibility. As noted in Chapter 6 (above), these evaluations are made on the basis of the surface inventory results - no surface collection or subsurface testing has been done. As a consequence, representative collections have not been made at most sites. Partially because of the absence of representative collections, we have found that most sites do contain materials that could be useful in addressing regional research questions and are thus eligible for the NRHP.

In the sections that follow, we address first the evaluation of potential traditional cultural properties. We then evaluate prehistoric archaeological sites and components, including those in the district, individually. Finally, we evaluate the historic sites and components.

POTENTIAL TRADITIONAL CULTURAL PROPERTIES

Quechan tribe comments on the November 1996 DEIS and on the supporting cultural resource reports (e.g. Schaefer and Schultze 1996) stated that the tribe has strong cultural concerns regarding the Project. This suggested the potential presence of one or more traditional cultural properties (TCPs) in the Project area and, accordingly, the BLM scope required that a TCP evaluation be undertaken.

The National Park Service defines a TCP as a district, site, building, structure, or object that is "eligible for inclusion in the National Register because of its association with the cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1992: 1). Specific cited examples include:

- a location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world ...

- a location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice ... (Parker and King 1992:1).

Due to the high level of Native American concern, Dr. Michael Baksh, a cultural anthropologist with Tierra Environmental Services, was retained in December 1996 to conduct Native American consultation to:

- Identify contemporary Native American concerns and values associated with the Project area;

- Document current Native American knowledge about the function and/or interpretation of available resources;

- Record the meaning and significance of resources to Native Americans today; and,

- Identify mitigation measures that Native Americans feel would be appropriate to minimize impacts to sensitive cultural resources (Baksh 1997:3).

Dr. Baksh conducted ethnographic interviews, participated in meetings with knowledgeable tribal members, undertook an ethnohistoric literature review, and made field visits with tribal members. During the summer of 1997, KEA's cultural resource staff participated in the Native American consultation in coordination with Dr. Baksh and the BLM. In addition to meeting with the Quechan cultural committee and knowledgeable tribal members, KEA conducted field tours for tribal and agency representatives and worked closely with the Quechan representatives who participated in the cultural resource survey. Baksh's (1997) report (Appendix C), KEA's notes regarding Native American consultation, and the ethnographic and ethnohistoric information in overview material presented in Chapter 3 (above) form the basis of this TCP evaluation. This work conforms to guidelines provided by the National Park Service in *National Register Bulletin* 38 (Parker and King 1992).

As will be discussed below, ethnographic information gathered to date indicates that the Quechan have concerns for a series of areas of high traditional cultural significance, linked by a network of travel corridors (Native American trails). The corridors are also of traditional cultural concern. Ethnographic information gathered to date may be insufficient to clearly indicate whether there should be an evaluation of one very large TCP encompassing this entire complex or separate evaluations of components of this complex. Because of this uncertainty, BLM has requested that this draft report leave open for now the ultimate boundaries of the TCP. Instead, we will describe and evaluate an area of traditional cultural concern (ATCC) that is in the Project vicinity. At the same time we will address the potential of the Project to affect the larger complex that includes the present ATCC and potentially other ATCCs and linking trail systems.

Indian Pass-Running Man ATCC

The Quechan tribe has stated on numerous occasions that the Project is located within an area of traditional cultural significance (Baksh 1997; Cachora 1997; Jackson 1997; Owl 1997). In order to adequately describe the ATCC, we will first summarize the values expressed by Quechan tribal members regarding the area and then relate those values to extant features, including archaeological materials and landscape elements. Native American values center around four topic areas which, from the traditional Quechan perspective, are interrelated:

- Trails and their relationship to traditional religious beliefs and practices;

- The Running Man geoglyph;

- The traditional quest for spiritual knowledge and power; and,

- Cultural transmission of traditional knowledge and practices.

Each of these topics is discussed below. Then a physical description of the area and its boundaries is offered.

The Religious Significance of Trails

One of the special qualities of the ATCC is that it is a confluence of trails. Beyond their economic importance, trails have clear religious significance in Quechan tradition. The Quechan have stated that trails served to connect all major religious sites into a single complex through which they can trace their history as a people. Traditionally, the Quechan and other Yuman groups trace their creation to the sacred mountain *Avikwaame* north of Needles, California (see Baksh 1994). Some trails were originally created in mythological time as the Creator (positive force) and the Blind Old Man (negative force) traveled throughout the Greater Southwest. The migrations of the Yuman peoples are believed to have recapitulated these travels and were in a sense predetermined by them.

One of the most important of the trails with religious significance, known to modern Quechan as the Trail of Dreams (or the *Keruk* Trail) passes through the Project area on its way from *Avikwlal* (Pilot Knob), a highly significant sacred place, to *Avikwaame*. The Quechan say that knowledgeable religious practitioners can visit *Avikwaame* in their dreams and in doing so they travel along the Trail of Dreams through the project area.

The importance of dreaming in traditional Quechan culture is well established in the ethnographic and ethnohistoric literature (Forbes 1965; Forde 1931). Dreams were seen as a source of knowledge and power. The Quechan believe that a person can learn his history and his destiny through dreaming, and that dreams can help solve practical problems in life. Religious practitioners in particular strove for spiritual knowledge through dreaming. Ethnographic accounts and modern Quechan suggest that political as well as religious leaders were chosen at least in part on the basis of dream experiences. Trails are believed to be of critical importance to dreamers in navigating through the spiritual world.

The Quechan have said that *Avikwaame* can be visited via another trail as well as the Trail of Dreams. That trail, the Medicine Trail, passes east of the Cargo Muchachos, closer to the Colorado River than the Trail of Dreams. The two merge near Blythe at a major geoglyph site north of the project area and continue together to *Avikwaame*. Beliefs regarding the specific symbolic relationships between these two trails have not been clearly documented in the ethnographic literature. Information regarding these relationships may be available in the oral tradition, however, and could possibly be obtained through additional consultation. The Medicine Trail has not been a focus of the present investigations as it is outside the Project area.

The Running Man Geoglyph

This geoglyph (a component of archaeological site CA-IMP-2727) is a unique anthropomorphic construction, consisting of basalt boulders arranged on a desert pavement surface to evoke the image of a human figure in full stride. The geoglyph is situated near the conjunction of two major prehistoric trails and just south of a major spirit break (rock alignment crossing the trail). The figure appears to be running in the general direction of the spirit break, and a knowledgeable Quechan tribal member stated his belief that this was the intent of the builders of the geoglyph. He also stated that this arrangement has religious significance. Several other archaeological features appear to be associated with this complex, including trail markers, pot drops, and shattered quartz. These types of features have been associated in the ethnographic and archaeological literature with religious practices. Rogers noted that trail shrines included both whole and broken pots and collected many specimens from the Indian Pass area. Milky quartz is associated with the concepts of purity and power, and the Quechan have stated the breaking of quartz served religious purposes. Broken quartz concentrations are associated with major intaglios of high religious significance along the Colorado River (Altschul and Ezzo 1994).

Malcolm Rogers visited this site in 1925, 1939, 1941, and 1942, recording the trails and spirit break but not the Running Man geoglyph (see Baksh 1997; Schaefer and Schultze 1996). Quechan tribal members have stated their belief that the geoglyph was made by traditional religious practitioners in the 1940s and that these practitioners used the area for religious purposes (Baksh 1997: 15). Thus, the ethnographic and archaeological information indicate that the site has a long and continuing history of religious use by the Quechan and their ancestors. Rogers reported a predominance of Patayan I ceramics from trail shrines in the Indian Pass area (see Waters 1982). This would suggest religious observances dating to as early as 1200 years ago. The Running Man attests to recent religious use, and the Quechan have stated their intent to use the area in the future for religious purposes.

The Traditional Quest for Knowledge and Power

Some Quechan tribal members have stated that the ATCC is "strong" and likely the resting place of the spirits (not necessarily the physical remains) of some of their ancestors. According to modern Quechan tribal members, persons seeking to understand the nature of their world had to train sequentially in four areas. The ATCC was the first of those four areas. Knowledge gained there is considered essential to gaining knowledge at the subsequent areas. It is connected in particular to the education of orators. In addition to the presence of the trails and geoglyph, physical characteristics of the Project area cited as important in contributing to the area's special power in this regard are a sense of solitude and the expansive views, particularly in the direction of Picacho Peak and Picacho Basin. The Quechan say that there are times at dawn when lighting and ground fog conditions viewed from the ATCC combine to create a phenomenon of special importance.

Cultural Education

The Quechan have expressed the desire to be able to use the ATCC in the future not only for religious observances, but also for teaching traditional culture to new generations. As stated above, it is considered the first place a person must go in order to learn the true nature of the world and to gain direction in life. The area is considered critical for seeing the "positive" side of things and countering the "negative." The Quechan believe that traditional cultural practitioners need to bring students to the area in order for them to properly understand traditional lore. As such, the ATCC is considered essential to the transmission of traditional cultural heritage.

ATCC Boundaries

The ATCC is located within a series of pavemented, dissected alluvial terraces that lie in an expansive basin between the Chocolate Mountains to the north and the Cargo Muchachos to the south. As a consequence, the ATCC is not clearly delimited by first-order landscape features. The Quechan have stated that they view their entire traditional territory as a continuum and that the ATCC is linked inextricably with this territory in general and through the trail system to other specific areas of particular significance. Thus, definition of TCP boundaries in conformance with National Register principles is challenging. On the one hand, the overarching Quechan concern for the relationship of *Avikwlal*, the Trail of Dreams, and *Avikwaame* should not be minimized. On the other, the special concerns for the vicinity of the Project area should not be overlooked. We focus first on the latter issue and then address concerns for the larger complex.

In consultation with KEA and Tierra cultural resource personnel, knowledgeable Quechan tribal members have agreed on ATCC boundaries for the Project vicinity that conform to National Register standards. Additional Native American consultation is recommended to validate these boundaries, including consultation with the Tribal Cultural Committee.

It is important to note that the Quechan have stated that there is a name for the ATCC in their language. While they have held this name confidential, the existence of a place-name implies that the area *is* conceived of as a specific place with physical manifestations. A place-name does not typically imply clear boundaries in traditional lore, however. For National Register purposes, the Quechan have agreed that the place can be defined by a combination of first and second order landscape features and the archaeological manifestations of traditional Quechan practices (Figure 7-1).

One of the clearest associations of the ATCC is with Indian Pass and the complex of Native American trails leading to it. As noted in Chapter 3, there is a complex of scratched petroglyphs at Indian Pass that has been recognized by the BLM as an Area of Critical Environmental Concern (ACEC) due to its cultural significance. These scratched petroglyphs imply a culturally recognized place. According to one knowledgeable Quechan consultant, the petroglyphs convey the meaning, "This is a known place. You are welcome." Northeast of the petroglyphs lies the drainage divide at Indian Pass which forms a natural boundary at the northeastern extent of the ATCC.

The other prominent association of the ATCC is with the Running Man complex (CA-IMP-2727) to the southwest. Beyond this site, the frequency of archaeological materials associated with traditional Native American practices drops dramatically. This includes intact trail segments, ceramic scatters ("pot drops"), cleared circles, rock features, broken quartz concentrations, and flaking stations. In view of this, knowledgeable Quechan tribal members have agreed that the Running Man complex forms the southwestern limit of the ATCC. In view of the prominence of Indian Pass and the Running Man, the Quechan consultants have agreed the area should be designated as the "Indian Pass-Running Man area" for National Register purposes.

Between the Running Man and Indian Pass the desert pavements are dissected by northeast-southwest trending desert washes emanating from the southern Chocolate Mountains in the Indian Pass area. This has resulted in northeast-southwest trending pavemented terraces, along which lies a complex of Native American trails. The northwest and southeast boundaries of the ATCC have been drawn to encompass known extant trails along this terrace system. The southeastern boundary generally follows branches of Indian Wash, while the northwestern boundaries follow a previously

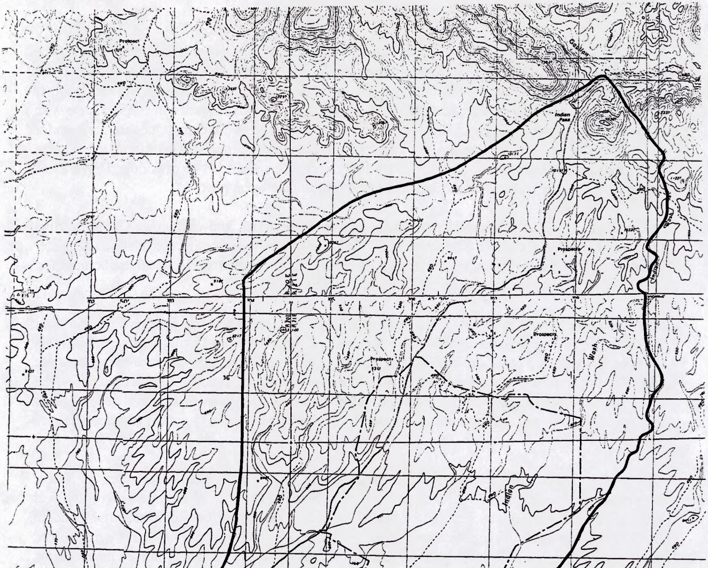


Figure 7-1. Area of Traditional Cultural Concern

recorded trail from Indian Pass until it disappears in a wash. The boundary then follows the wash to the Running Man site. KEA's transect surveys, reported in Chapter 5 (above) demonstrate that these boundaries encompass an unusually high density of cultural material of both practical and symbolic significance. The frequency of cultural features drops off significantly along the transects as one moves from the heart of the ATCC outward.

Type of Property and Relationship to Archaeological Sites
The Indian Pass-Running Man ATCC is best conceived of as an area of cultural significance to Native Americans that also encompasses numerous archaeological sites which they value in their own right. From a National Register perspective, then, the ATCC is evaluated as a district. It contains a concentration of linked sites and objects (features such as the Running Man geoglyph and spirit breaks qualify as objects under the National Register guidelines), comprising a culturally significant entity. The sites are important in defining the district, but the values of the district transcend the values of the individual sites. The whole is far greater that the sum of its parts. Because the landscape elements of the district are also important, all of the area within the district boundaries is considered a contributing part of the property.

We have evaluated the significance of the archaeological sites in the Project area both independently and in the context of the district. Table 7-1 presents the archaeological sites that fall within the ATCC boundaries. Certain sites (e.g. CA-IMP-2727 and trail sites) were key to defining the boundaries of the ATCC while other sites contribute to the value of ATCC as a whole. Two sites appear to KEA to lack values that contribute meaningfully to the ATCC.

National Register Evaluation of the Indian Pass-Running Man ATCC

The evaluation of the Indian Pass-Running Man ATCC follows the three-step process advocated by Parker and King (1992: 9-12). Step 1, defining the property type, has been addressed above. The ATCC clearly fits the definition of a district. Steps 2 and 3 are presented below, followed by a discussion of the period of significance.

Integrity
According to Parker and King (1992:10), to meet the integrity criteria, a property must have an integral relationship with traditional cultural practices and beliefs, and the condition of the property must not have been altered to the extent that the property has lost its significance within traditional practices and beliefs. The integrity of the Indian Pass-Running Man ATCC in relationship to traditional belief systems is clear. The Quechan have stated that certain key elements of learning traditional cultural knowledge can only be obtained at the ATCC. This uniqueness is confirmed by the presence of a unique combination of cultural objects, including geoglyphs, trails, and petroglyphs.

The integrity of the condition of the ATCC is demonstrated by the presence in good condition of numerous archaeological features that have religious and cultural significance to the Quechan. The Quechan have indicated that a sense of solitude and view sheds from the ATCC are important components of its utility in traditional cultural practices. The sense of solitude is still present in the district despite the presence of Indian Pass Road. This road sees very little traffic during much of

Table 7-1. Archaeological Sites in the Indian Pass - Running Man ATCC

Site Number	Site Type	Contributing	In Project Area
CA-IMP-192	Prehistoric Trail	Yes	No
CA-IMP-1811	Prehistoric Trail	Yes	No
CA-IMP-1812	Fire Ring		No
CA-IMP-1813	Lithic Scatter	Yes	No
CA-IMP-1814	Lithic Scatter	Yes	No
CA-IMP-2727	Multi-component	Yes	Yes
CA-IMP-2728	Ceramic Scatter	Yes	No
CA-IMP-4121	Lithic Scatter	Yes	No
CA-IMP-4970	Multi-component	Yes	Yes
CA-IMP-4972	Lithic Scatter	Yes	Yes
CA-IMP-4973	Lithic Scatter	Yes	Yes
CA-IMP-4974	Lithic Scatter	Yes	Yes
CA-IMP-4975	Lithic Scatter	Yes	Yes
CA-IMP-4976	Lithic Scatter	Yes	Yes
CA-IMP-5010	Multi-component	Yes	Yes
CA-IMP-5015	Lithic Scatter, Rock Rings	Yes	No
CA-IMP-5034	Lithic Scatter, Rock Rings	Yes	No
CA-IMP-5035	Prehistoric Trail	Yes	No
CA-IMP-5036	Prehistoric Trail	Yes	No
CA-IMP-5038	Prehistoric Trail	Yes	No
CA-IMP-5039	Lithic Scatter	Yes	No
CA-IMP-5040	Lithic Scatter	Yes	No
CA-IMP-5041	Lithic Scatter	Yes	No
CA-IMP-5059	Lithic Scatter	Yes	No
CA-IMP-5060	Prehistoric Trail	Yes	No
CA-IMP-5061	Prehistoric Trail	Yes	Yes
CA-IMP-5062	Lithic Scatter	Yes	No
CA-IMP-5063	Multi-component	Yes	No
CA-IMP-5064	Lithic Scatter	Yes	No
CA-IMP-5065	Lithic Scatter, Geoglyph	Yes	No
CA-IMP-5066	Lithic Scatter	Yes	No
CA-IMP-5067	Multi-component	Yes	Yes
CA-IMP-5068	Prehistoric Trail	Yes	No
CA-IMP-5069	Geoglyphs, Lithic Scatter	Yes	No
CA-IMP-5070	Lithic Scatter	Yes	No
CA-IMP-5104	Prehistoric Trail	Yes	No
CA-IMP-5359	Prehistoric Trail (Trail of Dreams?)	Yes	Yes
CA-IMP-5360	Prehistoric Trail (Trail of Dreams?), Flaking Station	Yes	Yes
CA-IMP-5361	Lithic Scatter	Yes	No
CA-IMP-5362	Lithic Scatter	Yes	No
CA-IMP-5363	Prayer Circle	Yes	No

Table 7-1. Archaeological Sites in the Indian Pass - Running Man ATCC (Continued)

Site Number	Site Type	Contributing	In Project Area
CA-IMP-5372	Lithic Scatter	Yes	No
CA-IMP-5373	Lithic Scatter	Yes	No
CA-IMP-5374	Ceramics Scatter	?	No
CA-IMP-5380	Trail		Yes
CA-IMP-5492	Flaking Station	Yes	No
CA-IMP-5493	Multi-component	Yes	Yes
CA-IMP-5494A,B	Flaking Station	Yes	Yes
CA-IMP-5495-I	Isolated Core/Flake	No	Yes
CA-IMP-5496	Lithic Scatter	Yes	Yes
CA-IMP-5497	Lithic Scatter	Yes	Yes
CA-IMP-5498-I	Isolated Flake	No	Yes
CA-IMP-5500	Lithic Scatter	Yes	Yes
CA-IMP-5501-I	Isolated Flake	No	Yes
CA-IMP-5502	Flaking Station	Yes	Yes
CA-IMP-5503-I	Isolated Flake	No	Yes
CA-IMP-5504	Flaking Station	Yes	Yes
CA-IMP-5505	Flaking Station	Yes	Yes
CA-IMP-5506	Lithic Scatter	Yes	Yes
CA-IMP-5507	Flaking Station	Yes	Yes
CA-IMP-5519	Lithic Scatter	Yes	Yes
CA-IMP-5520	Lithic Scatter	Yes	Yes
CA-IMP-5521-I	Isolated Flake	No	Yes
CA-IMP-5522A	Flaking Station	Yes	Yes
CA-IMP-5522B	Cleared Circle	Yes	Yes
CA-IMP-5524-I	Isolated Flake	No	Yes
CA-IMP-5525-I	Isolated Flake	No	Yes
CA-IMP-5526-I	Isolated Flake	No	Yes
CA-IMP-5527	Lithic Scatter	Yes	Yes
CA-IMP-5528	Multi-component	Yes	Yes
CA-IMP-5529	Cleared Circle, Trail, Lithic Scatter	Yes	Yes
CA-IMP-5530	Multicomponent	Yes	Yes
CA-IMP-5531-I	Isolated Flakes	No	Yes
CA-IMP-5532-I	Isolated Tool	No	Yes
CA-IMP-5533	Flaking Station	Yes	Yes
CA-IMP-5534	Flaking Station	Yes	Yes
CA-IMP-5535-I	Isolated Tool	No	Yes
CA-IMP-5536-I	Isolated Tool	No	Yes
CA-IMP-5537	Lithic Scatter	Yes	Yes
CA-IMP-5539-I	Isolated Tools	No	Yes
CA-IMP-5540	Flaking Stations	Yes	Yes
CA-IMP-5541-I	Isolated Took, Core	No	Yes
CA-IMP-5542	Lithic Scatter	Yes	No
CA-IMP-5543-I	Isolated Core	No	No

Table 7-1. Archaeological Sites in the Indian Pass - Running Man ATCC (Continued)

Site Number	Site Type	Contributing	In Project Area
CA-IMP-5544	Cleared Circles	Yes	No
CA-IMP-5545	Lithic Scatter	Yes	No
CA-IMP-5546	Lithic Scatter	Yes	No
CA-IMP-5547	Lithic Scatter	Yes	No
CA-IMP-5548	Lithic Scatter	Yes	No
CA-IMP-5549	Lithic Scatter	Yes	No
CA-IMP-5550	Lithic Scatter	Yes	No
CA-IMP-5551	Lithic Scatter	Yes	No
CA-IMP-5552	Lithic Scatter	Yes	No
CA-IMP-6665	Lithic Scatter, Rock Rings	Yes	No
CA-IMP-6666	Petroglyphs	Yes	No
CA-IMP-6674	Prehistoric Trail	Yes	No
CA-IMP-7377	Flaking Station	Yes	Yes
CA-IMP-7378	Flaking Station	Yes	Yes
CA-IMP-7379	Cleared Circles, Flaking Stations	Yes	Yes
CA-IMP-7380	Flaking Stations	Yes	Yes
CA-IMP-7381	Lithic Scatter, Historic Rock Cairn	Yes	Yes
CA-IMP-7382	Lithic Scatter, Milling	Yes	Yes
CA-IMP-7383	Flaking Stations	Yes	Yes
CA-IMP-7384	Flaking Stations	Yes	Yes
CA-IMP-7386	Flaking Stations	Yes	Yes
CA-IMP-7387	Flaking Stations	Yes	Yes
CA-IMP-7388	Prehistoric Trail	Yes	Yes
CA-IMP-7389	Flaking Stations	Yes	Yes
CA-IMP-7390	Flaking Stations	Yes	Yes
CA-IMP-7391	Flaking Stations	Yes	Yes
CA-IMP-7392	Flaking Stations	Yes	Yes
CA-IMP-7393	Rock Ring, Geoglyph	Yes	Yes
CA-IMP-7394	Flaking Station	Yes	Yes
CA-IMP-7395	Historic Camp	No	Yes
CA-IMP-7396	Flaking Stations	Yes	Yes
CA-IMP-7397	Rock Ring	Yes	Yes
CA-IMP-7398	Flaking Stations, Rock Cairns	Yes	Yes
CA-IMP-7399	Rock Rings, Flaking Stations	Yes	Yes
CA-IMP-7400	Flaking Stations	Yes	Yes
CA-IMP-7401	Flaking Stations	Yes	Yes
CA-IMP-7402	Flaking Station	Yes	Yes
CA-IMP-7403	Lithic Scatter	Yes	Yes
CA-IMP-7404	Flaking Stations	Yes	Yes
CA-IMP-7405	Flaking Stations	Yes	Yes
CA-IMP-7406	Flaking Stations	Yes	Yes

Table 7-1. Archaeological Sites in the Indian Pass - Running Man ATCC (Continued)

Site Number	Site Type	Contributing	In Project Area
CA-IMP-7407	Rock Ring	Yes	Yes
CA-IMP-7408	Multi-component	Yes	Yes
CA-IMP-7415	Flaking Stations, Trail	Yes	Yes
AA-1	Lithic Scatter, Historic Component	Yes	Yes
AA-2	Lithic Scatter	Yes	Yes
AA-3	Lithic Scatter	Yes	Yes
C-1	Prehistoric Trail	Yes	No
C-1-N	Prehistoric Trail	Yes	No
F-298	Prehistoric Trail	Yes	Yes
F-745	Prehistoric Trail	Yes	Yes
F-940	Prehistoric Trail	Yes	Yes
F-1020	Prehistoric Trail	Yes	Yes
F-1336	Prehistoric Trail	Yes	Yes
F-1500	Prehistoric Trail	Yes	Yes
F-1792	Lithic Scatter	Yes	Yes
F-2142	Prehistoric Trail	Yes	Yes
F-2202	Prehistoric Trail	Yes	Yes
F-2282	Prehistoric Trail	Yes	Yes
F-2294	Prehistoric Trail	Yes	Yes
F-3024	Prehistoric Trail	Yes	Yes
F-3147	Flaking Station	Yes	Yes
F-3167	Shaman's Hearth	Yes	Yes
F-3169	Flaking Station	Yes	Yes
F-4018	Isolated Metate	No	Yes
F-4028	Prehistoric Trail	Yes	Yes
F-4132	Prehistoric Trail	Yes	Yes
TL-1	Historic	No	Yes
TL-2	Lithic Scatter	Yes	Yes

the year and is not visible from much of the ATCC. Other than the road, there is little to disturb the sense of solitude. Views are expansive and reveal no prominent modern features. The Quechan have stated that in its current condition the ATCC can and will be utilized for traditional cultural practices.

Significance

The Indian Pass-Running Man ATCC is evaluated as eligible for the National Register under criteria A, C and D. Criterion B is not considered applicable because, to date, ethnographic research has not revealed the names of people or mythological beings (see Parker and King 1992) of importance to the Quechan who are closely associated with the ATCC. The builders of the Running Man geoglyph were perhaps important leaders, but we do not have sufficient information to evaluate their importance in Quechan history or the importance of their association with the geoglyph. It is possible that Criterion B could apply if more ethnographic research were able to clarify these relationships.

Criterion A - Association with Events
The Indian Pass-Running Man ATCC is the location of a broad pattern of religious and cultural events in Quechan history. Historically, the Quechan came here to seek religious insight and learn cultural lore. The site is considered essential to events involving the transmission of cultural knowledge. The association of these events with the place is clearly demonstrated by archaeological features as well as by Quechan oral tradition.

Criterion C1 - Embodiment of Distinctive Characteristics
The ATCC contains a high concentration of distinctive Native American built objects, including geoglyphs, petroglyphs and trails. The Running Man geoglyph is a unique construction, and the complex of features there spans both the prehistoric and the historic period, indicating continuity of Native American tradition. The petroglyphs at Indian Pass are the greatest known concentration of glyphs in this scratched style, which has been reported at only a very few other sites in the Colorado Desert.

Criterion D - Important Information
Archaeologically, the district contains materials that can contribute important information to the regional research questions outlined in Chapter 5. This aspect of significance is considered elsewhere in this report. Beyond this, the Quechan believe that the ATCC is capable of yielding important information on their history and of revealing traditional knowledge. Rather than through scientific study, this information would be acquired by cultural leaders and students through the practice of traditional ceremonies. This information can only be revealed in the ATCC, and it is considered of fundamental importance in cultural education.

Period of Significance
Parker and King (1992:18) suggest that the period during which a ATCC has been used is the most important factor in assessing the period of significance. Trail shrines recorded by Rogers in the Indian Pass area contained Patayan I ceramic wares. This suggests religious use of the area could extend back to 1,200 BP. The Quechan state that religious use occurred during the 1940s, and this appears to be confirmed by the archaeological data. It appears likely that the religious use of the area has occurred for many hundreds of years. The Quechan would like to continue religious use. In view of this, the period of significance would extend from Patayan I times through the present.

The Trail of Dreams

As mentioned above, the Trail of Dreams is a Native American trail that connects two highly significant Quechan sacred places, *Avikwlal* (Pilot Knob) and *Avikwaame* (Newberry Mountain), a straight line distance of approximately 270 km (170 mi). A second trail, called by the Quechan the Medicine Trail, also connects these two places. The two trails follow different routes from Pilot Knob to Blythe, where they merge at a distance of about 96 km (60 mi) north of Pilot Knob. According to Quechan consultants, the junction of the two trails is marked by a major geoglyph complex. From this junction a single route leads to *Avikwaame*.

The significance of *Avikwaame* and *Avikwlal* have been well documented (see Chapter 3). *Avikwaame* is believed by the Quechan to be the place where the Creator first emerged and where all Yuman groups originated. This site has been determined by the National Park Service to be eligible for the NRHP as a TCP. *Avikwlal* is connected with the origin of the Quechan and was a location of the *keruk* ceremony. It has been designated by BLM as an ACEC in recognition of its special traditional significance (Welch 1982).

The exact routes of the Trail of Dreams and the Medicine Trail have not been ascertained in the field or on topographic maps. The Quechan maintain a schematic map of the routes and have stated that the Trail of Dreams passes through the Indian Pass-Running Man ATCC. They have not indicated that the Project would affect the Medicine Trail, the route of which is well to the east.

Two major trails converge at the Running Man site. Rogers called one of the these the Blackmesa Trail (CA-IMP-5359), which according to Jay von Werlhof runs from Pilot Knob to Indian Pass. This trail crosses the major spirit break at the Running Man site and proceeds to Indian Pass. The other trail, called by Rogers the Mojave Trail (or Mojave War Trail, CA-IMP-5360), runs from Yuma to Palo Verde (near Blythe) according to von Werlhof (personal communication, 1997). It crosses the Chocolate Mountains near State Route 78 and does not intersect the Project mine and process area at all. The Quechan have stated that the trail that proceeds northeast from the Running Man toward Indian Pass is the Trail of Dreams. Thus, at this location the Trail of Dreams would correspond to CA-IMP-5359 (aka the Blackmesa Trail). However, in the Project mine and process area, the Quechan have indicated that the Trail of Dreams corresponds to the trail recorded by KEA as F-4. The recorded location of CA-IMP-5359 in this vicinity is to the west of the Project area. Thus, there is not a one-to-one correspondence between the Quechan Trail of Dreams and archaeologically designated trails.

The situation is complicated by the fact that portions of the trail system have been destroyed by the construction of Indian Pass Road and by erosion, and numerous trail segments head in the general direction of Indian Pass. Clearly, more work is necessary in relating Quechan trails to extant trail segments and topographic features. The Quechan have stated that they could assist in doing this in the field.

The Trail of Dreams is important to the Quechan as a travel corridor from *Avikwlal* and *Avikwaame*. This would include both physical travel and spiritual travel through dreams. They have also said that the Trail of Dreams is a "strong" or powerful place in a spiritual sense. It is now considered stronger than the Medicine Trail, which is lost some of its power due to modern impacts. In another context, the Quechan stated that one of the other routes to *Avikwaame* has been cut-off by modern development. This may refer to the Medicine Trail. The Quechan believe that development of the Project mine and process area might similarly cut-off travel along the Trail of Dreams. This is an especially strong concern because the Trail of Dreams may be the last remaining route from *Avikwlal* to *Avikwaame*. In this regard additional fieldwork would be useful in clarifying the relationship of the physical route of the Trail of Dreams to Project area.

In view of Native American concerns, the Trail of Dreams should be considered to be an ATCC. The portion of the Trail of Dreams that runs through the Indian Pass-Running Man ATCC is clearly eligible for the NRHP as a contributing element. However, current evidence is not sufficient to assess the eligibility of the entire trail in accordance with National Register Bulletin 38. One problem is boundary definition. TCP evaluation requires that a physical place be specified. At present we are not able to do this with certainty other than to say that it passes through the Indian Pass-Running Man ATCC and through the Project mine and process area. The Quechan maintain a schematic map of the Trail of Dreams and state that they can assist in identifying this trail in the field. However, current information is not sufficiently detailed outside of the Project area to specify a physical place in accordance with NRHP standards. Another possible issue is integrity. Regardless of its actual route, numerous modern intrusions have probably disturbed the Trail of Dreams; clarification needs to be sought regarding how these intrusions have affected its traditional cultural values.

Because the NRHP eligibility of the Trail of Dreams outside of the Indian Pass-Running Man ATCC has not been resolved, it would be prudent to assume for purposes of the assessment of effects that the trail does qualify as eligible for the NRHP as a TCP. We have taken this concern into account in evaluation of the Indian Pass-Running Man ATCC and as discussed below we consider traditional cultural concerns in addressing the eligibility of other Native American trails and related features found in the Project ancillary area and along the transmission line. Since the Quechan have not raised any concerns for impacts of the Project to the Trail of Dreams outside of the Indian Pass-Running Man ATCC, it seems reasonable to conclude that this approach is adequate. The Quechan *have* expressed concerns for archaeological sites outside of this ATCC, however, and this concern is considered in addressing the significance of those sites.

The lack of clear information on the precise route of the Trail of Dreams is a function of two factors. First, the present investigations focused attention on the Project area and did not aggressively pursue detailed data relevant to other portions of the trail system. Second, the Quechan will only release sensitive cultural information when necessary to protect resources (Baksh 1997). But, as noted above, locational issues could probably be resolved through further consultation and field inspections.

PREHISTORIC SITES EVALUATED AS ELIGIBLE

The 66 prehistoric sites within the project APE as a whole fall into several general categories for purposes of NRHP evaluation: large multicomponent sites, trails, geoglyphs, ceramic scatters, a quarry, a shaman's hearth, lithic scatters and flaking stations, and questionable sites. With the exception of the final category, sites within each class are sufficiently similar that they represent a consistent set of potential NRHP values. Accordingly, the evaluations are organized around each site class. Sites evaluated as eligible for the NRHP are presented first, followed by sites evaluated as ineligible. The prehistoric sites generally exhibited good integrity due to their relatively isolated desert setting, and none were disqualified on that basis. Table 7-2 summarizes the results of the evaluation process.

Table 7-2. Summary of Archaeological Sites

Resource Number	Description	National Register Evaluation (Significance/Criteria)
Mine and Process Area (N = 24 Sites, 1 Isolate)		
CA-IMP-4970	Multi-component	Eligible/A, C, D
CA-IMP-4971	Multi-component	Eligible/A, C, D
CA-IMP-5010	Prehistoric trail	Eligible/C, D
CA-IMP-5061	Multi-component	Eligible/A, D
CA-IMP-5067	Multi-component	Eligible/A, D
CA-IMP-5494	Multi-component	Eligible/D
CA-IMP-5526	Multi-component	Eligible/A, C, D
CA-IMP-7388	Prehistoric trail	Eligible/D
CA-IMP-7408	Multi-component	Eligible/A, D
F-4	Prehistoric trail	Eligible/C, D
F-298	Prehistoric trail	Eligible/C, D
F-745	Prehistoric trail	Eligible/D
F-940	Prehistoric trail	Eligible/D
F-1020	Prehistoric trail	Eligible/D
F-1336	Prehistoric trail	Eligible/D
F-1500	Prehistoric trail	Eligible/C, D
F-1792	Flaking station	Not Eligible
F-2142	Prehistoric trail	Eligible/D
F-2202	Prehistoric trail	Eligible/D
F-2282	Prehistoric trail	Eligible/D
F-2294	Prehistoric trail	Eligible/D
F-3024	Prehistoric trail	Eligible/C, D
F-4028	Prehistoric trail	Eligible/C, D
F-4132	Prehistoric trail	Eligible/C, D
F-4018	Isolated metate	Not Eligible
Ancillary Area (N = 18 Sites, 2 Isolates)		
CA-IMP-2727	Multi-component (Running Man site)	Eligible/A, C, D
CA-IMP-5359	Prehistoric trail	Eligible/C, D
CA-IMP-5360	Prehistoric trail	Eligible/C, D
CA-IMP-6661	Ring geoglyph, possible anthropomorph	Eligible/C, D
AA-1	Lithic scatter, historic component	Not Eligible
AA-2	Lithic scatter	Not Eligible
AA-3	Lithic scatter	Not Eligible
F-3147	Flaking station	Not Eligible
F-3167	Shaman's hearth	Eligible/Contributing to ATCC
F-3169	Flaking station	Not Eligible
TL-1	Recent rock ring encircling a cairn	Not Eligible
TL-2	Lithic scatter	Not Eligible
TL-3	Ring geoglyph	Eligible/C, D
TL-4	Ceramic scatter	Eligible/D
TL-5	Ring geoglyphs	Eligible/C, D
TL-42	Ring geoglyphs	Eligible/C, D
TL-43	Lithic scatter	Not Eligible
TL-44	Ceramic scatter	Eligible/D

Table 7-2. Summary of Archaeological Sites (Continued)

Resource Number	Description	National Register Evaluation (Significance/Criteria)
TLI-1	Isolated pecked rock	Not Eligible
TLI-8	Isolated WWII era flashlight part	Not Eligible
Transmission Line Corridor (N = 46 Sites, 6 Isolates)		
CA-IMP-1469	Prehistoric trail	Eligible/D
CA-IMP-1471	Possible prehistoric trail	Indeterminate
CA-IMP-2878	Two large geoglyphs, ring geoglyphs	Eligible/C, D
CA-IMP-3297	Prehistoric ceramic scatter, mining era refuse	Eligible/D
CA-IMP-4131	Ceramic scatter, geoglyph, WWII era component	Eligible/C, D
CA-IMP-7269	Probable prehistoric trail, mining era component	Eligible/D
CA-IMP-7272	Prehistoric trail	Eligible/D
CA-IMP-7273	Historic campsite, with rock alignment	Not Eligible
CA-IMP-7274	Probable historic trail, historic component	Indeterminate
CA-IMP-7275	Probable historic trail, historic component	Indeterminate
CA-IMP-7276	Ring geoglyph, ring geoglyph, ceramic scatter	Eligible/C, D
CA-IMP-7339	Ceramic scatter, not relocated	Not Eligible
CA-IMP-7340	Lithic scatter	Not Eligible
TL-6	Recent rock ring encircling a cairn	Not Eligible
TL-7	Rock alignment, possibly mining-related	Not Eligible
TL-8	Ceramic scatter	Eligible/D
TL-9	WWII era refuse scatter	Not Eligible
TL-10	Three ring geoglyphs	Eligible/C, D
TL-11	Ring geoglyph with stone in center	Eligible/C, D
TL-12	WWII era refuse scatter	Not Eligible
TL-13	Three trails, probably historic	Not Eligible
TL-14	Seven possible WWII era foxholes	Not Eligible
TL-15	Ring geoglyph	Eligible/C, D
TL-16	Three ring geoglyphs	Eligible/C, D
TL-17	Possible geoglyph	Not Eligible
TL-18	Ceramic scatter	Eligible/D
TL-19	WWII era refuse scatter	Not Eligible
TL-20	Refuse scatter, mining and WWII era components	Not Eligible
TL-21	Mining era refuse scatter	Not Eligible
TL-22	Historic trail network	Not Eligible
TL-23	Buried historic water pipeline	Indeterminate
TL-24	Possible historic trail	Indeterminate
TL-25	Lithic quarry	Eligible/D
TL-26	Two ring geoglyphs	Eligible/C, D
TL-27	WWII era refuse scatter	Not Eligible
TL-28	Refuse scatter, mining and WWII era components	Not Eligible
TL-29	WWII era refuse scatter	Not Eligible
TL-30	Lithic scatter	Not Eligible
TL-31	WWII era refuse scatter	Not Eligible
TL-32, TL-33, TL-34, TL-35	Camp Pilot Knob, two sets of three cleared circles, three ring geoglyphs	Eligible/A, D
TL-36	Prehistoric trail	Eligible/D
TL-37	Prehistoric trail	Eligible/D

Table 7-2. Summary of Archaeological Sites (Continued)

Resource Number	Description	National Register Evaluation (Significance/Criteria)
TL-38	Prehistoric trail	Eligible/D
TL-39	Road to Tumco/Hedges	Eligible/D
TL-40	Prehistoric trails	Eligible/C, D
TL-41	Prehistoric trail	Eligible/C, D
TLI-2	Isolated hammerstone	Not Eligible
TLI-3	Isolated historic brake shoes	Not Eligible
TLI-4	Isolated historic Ford radiator	Not Eligible
TLI-5	Isolated historic universal joint	Not Eligible
TLI-6	Isolated historic ironstone plate	Not Eligible
TLI-7	Isolated WWII era dry cell battery	Not Eligible

Multicomponent Sites

Eight large sites in the Project mine and process area and the Project ancillary area (CA-IMP-2727, CA-IMP-4970) fall into this category. All of these lie within the Indian Pass-Running Man ATCC and have been evaluated as eligible for the NRHP as part of that district. Each also meets the NRHP criteria individually.

All contain a large number of flaking stations and at least several of the following feature types (see Table 7-3): ceramic scatters, trails, geoglyphs, pecked rocks, shamans' hearths, cleared circles, spirit breaks, trail markers, vision quest circles, miscellaneous rock features, and quartz smashes. This gives each of these sites a potential to address many, if not all of the eleven prehistoric research questions presented in Chapter 6 (above), and therefore, each of the multicomponent sites is evaluated as eligible for the NRHP under Criterion D. Table 7-3 summarizes how the data sets found at the multicomponent sites can help address regional research questions.

Six multicomponent sites (CA-IMP-2727, CA-IMP-4970, CA-IMP-4971, CA-IMP-5067, CA-IMP-5526, and CA-IMP-7408) also meet Criterion A individually, based on the occurrence of a larger number of features symbolic of religious activities or specific resources noted as being of heritage concern by the Quechan tribe, such as trail segments that appear to be components of the Trail of Dreams. As noted in the ATCC evaluation, ethnographic information indicates that the Quechan came to this area repeatedly to perform important religious activities. The archaeological evidence suggests that the special religious significance of these sites extends back to Patayan I times and continued at least through the 1940s.

Similarly, four multicomponent sites (CA-IMP-2727, CA-IMP-4970, CA-IMP-4971, and CA-IMP-5526) meet Criterion C individually, based on the presence of geoglyphs. These are excellent examples of a distinctive group of Native American built objects. Site CA-IMP-2727 (the Running Man site) in particular demonstrates continuity of Native American ground art style from the prehistoric period through the recent past.

Table 7-3. Informational Values at Multicomponent Sites

Question Set	Applicable Data Set	Sites Where Present (CA-IMP-)
1. Religious activities	Geoglyphs, shamans hearths, cleared circles, trail breaks, vision quest circles, and quartz smashes represent a wide variety of symbolic behavior and associated belief systems. The potential symbolic associations of "pot drops" could be investigated via a spatial analysis amongst these features, trails, and the feature types listed above.	2727, 4970, 4971, 5067, 5526, 7408
2. Rock art	Two confirmed examples of scratched petroglyphs have been found at the multicomponent sites within the project area.	2727, 5067
3. Ethnographic trails and religious beliefs	The Quechan have identified the Trail of Dreams in the Project area. A wide variety of the archaeological remains of religious symbolic behavior is present in the vicinity of several trail segments. Ethnographic field visits may help to better identify particular trail segments. Spatial analysis of trail segments and symbolic features will help identifying trails of special significance.	2727
4. Trail seriation	Numerous spatial associations of trail segments and pot drops exist. Collection and typing of ceramics would provide new information on trail seriation.	5067, 5526, 7408
5. Trails and exchange	Typological identification and petrographic analysis of pot drops will add information on regional exchange.	5067, 5526, 7408
6. Ceramic typology	Ceramics can be compared to Rogers' original collections, Waters' reanalysis, and more recent collections. Refitting and petrographic analysis can identify significant variability within and between types.	5067, 5526, 7408
7. Lithic procurement	Thousands of flaking stations provide information on lithic production activities. Technological analysis of a sample of these would yield a reconstruction of production goals. Presence or absence of exhausted tools of exotic materials would be relevant to question of retooling.	All
8. Differential patination	Thousands of flaking stations provide opportunity to measure variability in patination within and between single episode flaking events.	All
9. Early lithic tools	Collection of samples of early lithic tools and comparing their lithic technology, material types, and edge damage to collections from the flaking stations will help resolve whether the former specimens can be shown to be cultural in origin.	All
10. Mobility strategies	Assemblage composition, including tools, debitage, fire-affected rock, and cultural features, will reflect the presence of residential camps and investment in logistical planning; presence of exotic lithic materials would help determine territorial range.	All
11. Residential uses	Assemblage composition and features will reflect the presence or absence of residential uses.	All

Prehistoric Trails

A total of 26 prehistoric trails were recorded in the project area. In addition, three trails of uncertain date may also be prehistoric. Sixteen prehistoric trails are within the Indian Pass-Running Man ATCC and have been evaluated as eligible for the NRHP as part of that district. These are also evaluated as individually eligible for reasons outlined below. Ten trail sites were found in the Project ancillary area and along the transmission line.

Prehistoric trail segments in the Project area are generally well worn into the desert pavement and are quite distinct visually. Pot drops are often associated with trail segments, and some segments are associated with trail markers, trail breaks, and possibly other items of symbolic significance. Rogers (1966) reported trail shrines in the Project vicinity, and two that he recorded can still be identified at the Running Man site. Some of the associated ceramic scatters may be remnants of once more impressive shrines, a possibility that might be demonstrated through the typological analysis and refitting of extant sherds. The presence of multiple vessels in discrete, non-residential assemblages would argue for the purposeful placement of the pots, perhaps for symbolic as opposed to utilitarian purposes.

Chapter 6 identified three research question sets focused on trails. Question Set 3 addresses the identification of ethnographically recorded trails, the reconstruction of prehistoric interaction networks, and the religious significance of trails. All prehistoric trail segments in the Project area can contribute information relevant to this question. The transmission line corridor may follow the general route of the Trail of Dreams, and some trail segments may either form part of this trail or intersect it. By following-out the segments in the field, archaeologists will probably be able to determine their destinations and thus reconstruct the interaction network, particularly as it relates to the Trail of Dreams. Recordation would also help in ethnographic interpretation. Recordation of associated features and built objects, such as trail breaks, trail markers, trail shrines, quartz smashes, cleared circles, and vision quest circles provides information on religious significance.

Question Set 4 addresses verifying and enhancing the Rogers' (1966) trail seriation (see also Waters 1982). Several trails in the Project area are associated with pot drops and ceramic scatters and can provide useful information on this issue. Question Set 5 concerns the relationship of trails and trade. Due to poor preservation of perishable materials, most information regarding trade is probably lost. However, ceramic types and sourcing of temper and paste could provide useful information on trade and/or other forms of regional interaction.

Because of their ability to address these research issues, all prehistoric trail sites in the Project area have been assessed as eligible for the NRHP under Criterion D. Trail sites associated with the Trail of Dreams and/or those with particularly good integrity are evaluated as eligible also under Criteria A and/or C. These are distinctive examples of Native American construction and are considered important in heritage preservation by the Quechan tribe. The three trails of uncertain date (historic vs. prehistoric) have been not been evaluated with regard to eligibility as insufficient information exists on which to base an assessment. Table 7-4 summarizes our prehistoric trail site evaluations.

Table 7-4. NRHP Evaluations of Prehistoric Trail Sites

Site Number	Eligibility Evaluation/Criteria	Comments
CA-IMP-1469	Eligible/D	No artifacts or features
CA-IMP-5010	Eligible/C, D	Crosses CA-IMP-5067, ceramics, groundstone, flaking stations near trail
CA-IMP-5359	Eligible/A, C, D	Trail of Dreams?, crosses CA-IMP-2727, trail markers, shrines, scratched petroglyph, ceramics, rock alignments, flaking stations, groundstone near trail
CA-IMP-5360	Eligible/A, C, D	Mojave Trail? Crosses CA-IMP-2727, ceramics, rock alignments, flaking stations near trail
CA-IMP-7269	Eligible/D	No artifacts or features
CA-IMP-7272	Eligible/D	No artifacts or features
CA-IMP-7388	Eligible/D	Pecked rocks near trail
F-1020	Eligible/D	Crosses CA-IMP-4970, no artifacts or features
F-1336	Eligible/D	Crosses CA-IMP-5067, no artifacts or features
F-1500	Eligible/C, D	Crosses CA-IMP-5061, no artifacts or features
F-2142	Eligible/D	Crosses CA-IMP-5526, no artifacts or features
F-2202	Eligible/D	Crosses CA-IMP-5526, no artifacts or features
F-2282	Eligible/D	Crosses CA-IMP-4428, no artifacts or features
F-2294	Eligible/D	Crosses CA-IMP-5526, no artifacts or features
F-298	Eligible/C, D	Crosses CA-IMP-4970, no artifacts or features
F-3024	Eligible/C, D	Crosses CA-IMP-7408, ceramics, trail markers, spirit breaks, flaking stations near trail
F-4	Eligible/C, D	Crosses CA-IMP-5067, ceramics groundstone, flaking stations, trail markers, spirit breaks, scratched petroglyphs near trail
F-4028	Eligible/C, D	Crosses CA-IMP-5526, no artifacts or features
F-4132	Eligible/C, D	Crosses CA-IMP-5526, ceramics
F-745	Eligible/D	Crosses CA-IMP-4970, no artifacts or features
F-940	Eligible/D	Crosses CA-IMP-4970, no artifacts or features
TL-36	Eligible/D	Part of CA-IMP-7273, no artifacts or features
TL-37	Eligible/D	Part of CA-IMP-7273, no artifacts or features
TL-38	Eligible/D	Part of CA-IMP-7273, no artifacts or features
TL-40	Eligible/C, D	Crosses CA-IMP-3297, ceramics
TL-41	Eligible/C, D	Crosses CA-IMP-7276, geoglyphs and ceramics near trail

Geoglyph Sites

Twelve geoglyph sites and one possible geoglyph site have been recorded in the Project ancillary area and along the transmission line. These are in addition to geoglyphs recorded within the multicomponent sites in the Project mine and process area. Nearly without exception, the geoglyphs are circular constructions that have been tamped into desert pavement surfaces. Most are small from less than 1 m to 4 m in diameter. Several include concentric rings, but most are restricted to a single circle. The circular geoglyphs recorded by KEA would probably be classed as "dance patterns" under the terminology suggested by B. Johnson (1985); however, their small size suggests that some other function might be implied. Most geoglyph sites lack associated cultural material but, nonetheless, appear to be of prehistoric cultural origin. At least one was associated with a prehistoric ceramic scatter. A possible anthropomorphic tamped glyph has been reported at CA-IMP-6661 by previous investigators in addition to a circular geoglyph, but KEA's recording suggests that feature may not be of cultural origin.

The lack of associated cultural material at most sites makes estimating geoglyph age difficult and reduces the potential for traditional archaeological research approaches. Nonetheless, because these sites appear to represent symbolic cultural behavior that is otherwise poorly preserved in the archaeological record, these sites do have substantial research potential. They are relevant to addressing Question Set 1 regarding the reconstruction of religious behavior. In this regard additional ethnographic research among the Quechan, including field visits to a sample of these sites would likely provide additional information about attached cultural meanings. Surface reconnaissance in the vicinity of these seemingly isolated features would be useful in broadening the search for cultural associations. Particular attention should be paid to potential associations between the spatial distribution of circular geoglyphs and prehistoric trails (see Question Set 3).

In view of this research potential, the geoglyph sites are evaluated as eligible for the NRHP under Criterion D. These sites are also eligible under Criterion C inasmuch as they embody distinctive characteristics of a type of Native American built object. Geoglyphs are relatively rare on the landscape and are considered to be culturally significant by the Quechan tribe as representatives of their traditional religion. The repetitive small circle motif suggests a distinguishable entity in the Project area that may be associated with the Trail of Dreams. One possible geoglyph site (TL-17) has been evaluated as ineligible for the NRHP. The cultural origin of this atypical feature cannot be confirmed, and no ethnographic information relevant to it has been found. Without confirmation of cultural origin or specific Native American concerns, this site does not meet the NRHP criteria.

Shaman's Hearth

A single, isolated shaman's hearth (F-3167) was found in the Project ancillary area. This site is within the Indian Pass-Running Man ATCC and, as an archaeological manifestation of traditional religious activities, it contributes to the significance of that NRHP-eligible district. This small feature would probably not be individually eligible, however.

Ceramic Scatters

Seven ceramic scatters were recorded in the Project ancillary area and along the transmission line. In addition, one previously recorded ceramic scatter could not be relocated and is probably mismapped. One site recorded as a ceramic scatter (CA-IMP-4131) also contains a circular geoglyph. Typically, ceramic scatters in the Project area are small sites with a limited number of sherds, presumably representing a portion of or a single vessel. With such a limited artifact inventory, ceramic scatters in the desert have often been dismissed as not significant. However, we believe that the ceramic scatters in the Project area deserve additional management consideration because they do contain useful (if limited) information from a regional research perspective.

As noted in the Overview (Chapter 3), Rogers' work on trail seriation (including, prominently, the Indian Pass area) formed the basis of the currently utilized ceramic sequence for the Lower Colorado River area. This sequence, as revised by Waters (1982a), while still useful, is in need of verification and refinement (see Question Sets 4 and 6). Additional collections from Rogers' sites in the Project area would be useful in providing better geographic provenience than he typically recorded. Comparison of these wares with Rogers' and Waters' type collections could then be conducted, including petrographic identification of paste and temper characteristics (see Question Set 6). Combining modern collections with a reexamination of museum collections would enhance the value of both data sources. Petrographic analysis would also contribute to the reconstruction of prehistoric exchange relationships (Question Set 5). Thus, despite their limitations, ceramic scatters in the Project area can contribute to at least three important regional research issues. These data could be relatively easily retrieved through surface collection and mapping.

In view of this research potential the six ceramic scatters in the Project area have been evaluated as eligible for the NRHP under Criterion D. Site CA-IMP-4131, which is the ceramic scatter that also contains a geoglyph, is evaluated as eligible under Criterion C as well for reasons discussed for the other geoglyph sites. The mapped location of the ceramic scatter that could not be relocated is evaluated as ineligible for the NRHP. If this site could be relocated and mapped properly, it might qualify as eligible. However, it is not within the Project area.

Flaked Stone Quarry

A single quartz quarry (TL-25) was recorded on the transmission line. Although this small site's artifact inventory appears on surface examination to be limited, KEA did observe definite indicators of prehistoric usage. As noted in the research design (Chapter 6), quartz reduction served symbolic as well as utilitarian functions during the Patayan period and possibly earlier. Our initial impression is that this quartz quarry was probably utilitarian in function, but this would need to be confirmed by more detailed technological analysis. The site differs from other lithic reduction sites in the Project vicinity, which utilized surface cobbles and boulders. This is the only site recorded that utilized a bedrock source.

TL-25 can contribute information useful in addressing two specific regional question sets as presented in Chapter 6. First, it can contribute to the resolution of whether lithic procurement in the project area was conducted primarily to supply habitation areas, presumably along the Colorado River (Question Set 7). A technological analysis of the debitage would permit an assessment of the production goals of the quarriers. If the creation of usable blanks was the primary goal, long-distance transport might be implied, as this technique seems to have been the most common practice at numerous major quarry sites in the desert west. Alternatively, if local utilization was intended, reduction would be expected to be carried to a more finished state.

The site could also help in assessing the mobility strategy of groups utilizing the quarry. As noted in the discussion of Question Set 10, residentially mobile groups utilizing a source might be expected to discard worn out tools as they acquired new materials. The absence of discards might help support the notion that this site was exploited by logistically organized work groups.

A final research potential at TL-25 would be to compare the technology of quartz reduction at a quarry to quartz smashes (symbolic) and utilitarian quartz reduction at desert pavement sources. One would suspect that reduction techniques would differ substantially among these activities, with perhaps less difference among the utilitarian desert pavement reduction and the bedrock quarry production. Explicit technological comparisons among these site types should help to confirm interpretations regarding site functions.

Because TL-25 can contribute to addressing regional research issues, it is evaluated as eligible for the NRHP under Criterion D. It does not appear to meet any of the other criteria.

PREHISTORIC SITES EVALUATED AS NOT ELIGIBLE

A total of 11 prehistoric sites are evaluated as not meeting any of the NRHP criteria. These are discussed under two groupings: lithic scatters/flaking stations and sites of questionable cultural origin.

Lithic Scatters and Flaking Stations

Nine flaking stations and lithic scatters were recorded in the Project ancillary area and along the transmission line. Typically these are relatively sparse scatters of lithic debitage with no other associated artifacts. Beyond the recording already done, these sites do not have substantial research value. Question Set 7, which addresses lithic procurement, would be best addressed by the highly concentrated lithic scatters and flaking stations in the large multicomponent sites that clearly do meet the NRHP criteria. The small, more isolated sites probably represent chance occurrences that do not form a distinct pattern that could be ascertained through further analysis. The inability to securely date such deposits would also severely limit their research utility. Thus, these sites do not meet NRHP Criterion D. KEA's research has revealed no evidence that these sites were associated with significant events or persons and such associations would be nearly impossible to demonstrate. These sites are not distinctive representatives of type or style and do not have high aesthetic value. Accordingly, Criteria A, B and C are not met either.

Questionable Sites

Two other sites have been evaluated as not eligible. One is the location of the ceramic scatter (CA-IMP-7339) that could not be relocated and the other is the possible geoglyph that may not be of cultural origin. Both of these sites were discussed above. Neither meets the NRHP criteria.

HISTORIC SITE EVALUATED AS ELIGIBLE

The area encompassed by Camp Pilot Knob (Site TL-35) is evaluated as significant under the NRHP criteria. The site was part of the network of camps that housed troops at General George S. Patton's Desert Training Center. From these camps, trainees were sent out to other parts of the desert to train and practice maneuvers for the North African campaign in World War II. As one of the main camps used in this training, it has a strong association with the Desert Training Center, the largest military training facility of its time, and made a significant contribution to the success of Patton's North African campaign. In view of this, Camp Pilot Knob is significant under Criterion A.

In order to be significant under Criterion B, Camp Pilot Knob would have to be associated with persons significant in the country's past. While General Patton established the Desert Training Center, he was only personally in command for the first few months of the operation in 1942. There are conflicting views on the specific details of when Camp Pilot Knob was first active, but most agree that the peak of activity was not until 1943 (Chamberlin 1990:18), by which time Patton was in North Africa. Patton was probably not heavily involved in the activities at Camp Pilot Knob and there is no indication that he was ever physically present at this camp. Therefore, the camp is not considered significant under Criterion B.

In order to satisfy the requirements of significance under Criterion C, Camp Pilot Knob would have to exhibit distinctive characteristics, represent the work of a master, possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction. Most of the features at Camp Pilot Knob can also be found at other camps, such as Camp Young and Camp Coxcomb, where they are in somewhat better condition. These camps also have features, such as a contour map and stone chapel, that Camp Pilot Knob lacks (BLM 1986:26-31). Because better examples exist of the Camp Pilot Knob features, it can not be considered significant under Criterion C.

Criterion D requires that the resource be able to contribute to information important in prehistory or history. According to a report by E. Clampus Vitus, much of the written information about the establishment, operation, and disassembly of World War II training camps was considered non-historical and was discarded (Chamberlin 1990:18). Archaeological evidence of camps like Camp Pilot Knob may be the best information we have from which to interpret the activities that took place. Oral histories combined with archaeological investigations may yield new information about the operations at camps such as this. Because of its potential to yield further information, Camp Pilot Knob is considered significant under Criterion D.

HISTORIC SITES EVALUATED AS NOT ELIGIBLE

A total of 33 sites contain historic components. Thirteen of these are dual-component sites that also include prehistoric artifacts. There are also six isolates that represent historic artifacts. With the exception of TL-35 (Camp Pilot Knob) all of the dual-component sites that are recommended eligible were done so based upon the significance of the prehistoric materials, not the historic. Most of the historic components fell into two categories; those related to World War II desert training activities, and those related to the mining of the area.

Evidence of World War II desert training activities occurred throughout the project area. This evidence ranged from bomb craters and rock features that represented short-term maneuver training and bivouac activities, to tent pads, rock features, and ration cans representing a long-term camping area (represented by Camp Pilot Knob). The bivouac and maneuver training areas were generally composed of bomb craters, various rock features most likely used for gun placements, occasional tent pads, and trash scatters (mainly ration cans). Beyond their association with World War II desert training activities, most of these cannot be connected to specific events or persons. Integrity for some of these areas is also an issue as some of them have evidence of other activities in the area. Even in areas such as the southern end of site CA-IMP-4970, where integrity is relatively good, the short-term use and the lack of direct association to specific activities limits the information potential these areas are likely to yield. The fact that similar sites exist throughout the Colorado desert indicates that these resources are not unique and most likely not the best examples of this type of resource (Orrell 1991:34). Therefore, none of the short-term maneuver or bivouac sites/components are considered eligible for nomination to the National Register of Historic Places.

While there is evidence of recent mining claim activities throughout the Project area, evidence of historic mining was limited to the transmission line corridor. Historic mining-related sites include historic trails leading to adits, portions of roads leading to Tumco/Hedges, trash scatters, and a buried water pipeline. None of these resources are associated with the lives of persons significant in our past. None of them seem to exhibit distinctive characteristics that have not been noted elsewhere. Most of the trash scatters lack significant integrity since they are either in washes that have redeposited the materials or they are discrete dumps not readily associated with a particular event. The historic trails generally have no artifacts associated with them, making it difficult to determine their dates of use or who was using them. They are unlikely to yield further information. For these reasons, none of the trash scatters or historic trails were found eligible for nomination to the National Register.

The only resources which may possibly be tied to specific events that have made significant contributions to the broad patterns of our history are the road to Tumco/Hedges (TL-39) and the water pipeline segment, which may have led to either Tumco/Hedges or the American Girl Mine (TL-23). Both of these may have associations with sites that have been found eligible for nomination to the National Register and may themselves be eligible. Due to the restricted size of the survey corridor, however, only small segments of these resources were explored, and further archival and archaeological work would need to be done to fully determine their significance. Therefore, these have been classified as indeterminate as regards their eligibility to the National Register. Both of these can be avoided during construction.

CHAPTER 8
PROJECT EFFECTS AND TREATMENT

This chapter assesses the effects of the Project on historic properties (cultural resources that are determined eligible for the NRHP). It presumes that the BLM and SHPO will concur on the NRHP eligibility evaluations presented in the previous chapter. First, the Criteria of Effect and Adverse Effect are presented. Then, the effects of each Project component - mine and process area, ancillary area, and transmission line - are assessed in relation to these criteria. Possible treatment options directly follow each assessment of effect.

We conclude that the Project will have an adverse effect to historic properties, including most notably the Indian Pass-Running Man ATCC and the Trail of Dreams ATCC. In recognition of these effects, we understand that BLM plans to execute a Memorandum of Agreement with the SHPO and the ACHP under 36 CFR 800.5(e)(4). This MOA will specify how the adverse effect will be taken into account and what treatment measures will be taken to reduce the adverse effects. BLM is in consultation with the Quechan Tribe and with SHPO regarding approaches to treatment as this report is being written. Consequently, the treatment measures discussed below are offered potential approaches that should be considered in developing the MOA.

It should be noted that Glamis Imperial has already modified the Project to reduce impacts. These measures include reducing the height of the waste rock stock pile to reduce the visual intrusion and reconfiguration of Project components within the mine and process area to avoid some of the features of religious and symbolic significance. Unfortunately, however, there are direct conflicts between the location of the ore body and the location of some of the important features, and the intrusion of a mining operation of this magnitude cannot avoid adverse effects.

CRITERIA OF EFFECT

36 CFR 800.9 provides the following criteria of effect and adverse effect:

(a) **An undertaking has an effect** on a historic property when the undertaking may alter characteristics of the property that may qualify the property for inclusion in the National Register. For the purpose of determining effect, alteration to features of a property's location, setting, or use may be relevant depending on a property's significant characteristics and should be considered.

(b) **An undertaking is considered to have an adverse effect** when the effect on a historic property may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects on historic properties include, but are not limited to:

(1) Physical destruction, damage, or alteration of all or part of the property;
(2) Isolation of the property from or alteration of the character of the property's setting when that character contributes to the property's qualification for the National Register;

(3) Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;
(4) Neglect of a property resulting in its deterioration or destruction; and
(5) Transfer, lease, or sale of the property.

(c) **Effects of an undertaking that would otherwise be found to be adverse** may be considered as being not adverse for the purpose of these regulations:

(1) When the historic property is of value only for its potential contribution to archaeological, historical, or architectural research, and when such value can be substantially preserved through the conduct of appropriate research, and such research is conducted in accordance with applicable professional standards and guidelines;

(2) When the undertaking is limited to the rehabilitation of buildings and structures and is conducted in a manner that preserves the historical and architectural value of affected historic property through conformance with the Secretary's "Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings"; or

(3) When the undertaking is limited to the transfer, lease, or sale of a historic property, and adequate restrictions or conditions are included to ensure preservation of the property's significant historic features.

In the present case, physical destruction and damage, alteration of the property's setting, and introduction of visual and audible elements are the primary concerns as discussed more fully below.

PROJECT MINE AND PROCESS AREA

The Project mine and process area will have a major adverse effect to the Indian Pass-Running Man ATCC, to the archaeological sites that are contributing elements to that district, and to the Trail of Dreams. Effects to the ATCCs are presented first, followed by a discussion of effects to individual archaeological sites.

Indian Pass-Running Man ATCC and the Trail of Dreams

Effects

The Project mine and process area will physically disturb about 2,000 acres in the central-eastern sector of the ATCC, approximately 15% of the total ATCC area. It would not physically disturb either the concentration of petroglyphs at Indian Pass or the religious-symbolic features at the Running Man site. However, it would disturb a high concentration of archaeological features of potential religious-symbolic significance. The transect surveys revealed that the frequency of trail segments, geoglyphs, and prehistoric rock features declines to the west, north and east of the Project mine and process area. Only to the south, in the direction of the Running Man geoglyph, is the frequency of these types of features equivalent. The ore body conflicts directly with a major northeast-southwest trending trail with associated pot drops and prehistoric rock features. The

Quechan have identified this trail segment as part of the Trail of Dreams, which is of religious significance to the Tribe.

The Quechan have stated their belief that development of the Project mine and process area will cut-off their ability to travel physically and in dreams along the Trail of Dreams to their creation spot at *Avikwaame.* Ability to travel along this trail is considered essential to traditional Quechan beliefs regarding the quest for spiritual knowledge and power and to the understanding of their cultural history and traditional lore.

The Quechan have stated, and the archaeological evidence confirms, that traditional practioners came physically to the ATCC in order to pursue spiritual knowledge. The sense of solitude and panoramic views offered by the ATCC in its present condition are considered essential to this function. The Quechan believe that the presence of a mine operation and, later, abandoned waste rock stockpiles, would destroy their ability to undertake this traditional religious practice. They have said that traditional practioners came to this location as recently as the 1940s and that they plan to do so in the future.

Another important Quechan concern has to do with education and the maintenance of their cultural tradition. The Quechan have said that the ATCC is critical to educating new generations in traditional lore. It is the first of four key learning areas to which an initiate must come to learn about the spiritual world and the true nature of the physical world. If they could not come here to learn first, they would not be able to learn the lessons of the succeeding three locations. Thus, the Quechan have stated that the development of the Project mine and processing area would have a "devastating" effect on cultural education and continuity.

Avoidance of Effects
Glamis Imperial Corporation has reduced the visual intrusion of the Project into the ATCC by lowering the height of the waste rock stockpile (originally proposed to be 400 feet) to 300 feet. Nonetheless, the Quechan have stated that the Project would still represent a significant visual intrusion into the qualities that give the ATCC its traditional significance.

In addition, Glamis Imperial Corporation has reconfigured its engineering design to avoid several features of religious-symbolic significance. In the south-central sector of the mine and process area, two features have been pedestaled: F3946 (a geoglyph) and F3947 (a prayer circle). At the southwestern edge of the mine and process area, a major trail complex and two concentrations of features have been avoided by reducing the Project area. This includes trail segments, three spirit breaks, two vision quest circles, and several pot drops.

While these efforts reduce the impacts, the Project mine and process area will still have a major adverse effect on the ATCC.

Treatment Options
The Quechan have stated that only complete avoidance will adequately reduce the adverse effect. They have said that the Mining Act of 1872 should be repealed because it does not allow for adequate consideration of traditional religious practices. They will remain opposed to the project regardless of what mitigation measures, short of avoidance, are proposed.

However, if the Project proceeds, there are some measures that might lessen the impact through the enhancement of Quechan heritage preservation programs. The overall goal would be to preserve Quechan history and make it accessible and useful to current and future members of the Quechan tribe. At the request of the BLM, each of these potential treatment measures is tied to a specific project-related effect. As Section 106 consultation regarding effect and treatment is ongoing, treatments discussed below are offered as options to be considered during that process.

Effect 1 - The Project mine and process area will physically disturb features of religious-symbolic significance within the Indian Pass-Running Man ATCC.

Treatment Option 1 - Extant cultural features in the ATCC should be avoided to the extent possible. KEA's GPS data base should be provided to Glamis Imperial to determine whether additional features can be avoided.

Treatment Option 2 - A professional archaeologist should flag or fence avoided features near construction areas prior to initial site preparation. Environmental inspectors should monitor avoidance. Flags outside of the perimeter fence should be removed immediately after construction of that fence.

Treatment Option 3 - An archaeological data recovery program (conforming to the recommendations in Chapter 9) should be implemented and should include a description and analysis of the features and artifacts that would be destroyed by the project and a technical archaeological report.

Effect 2 - The Project mine and process area will physically disturb significant Native American trails and will cut-off the ability of the Quechan to travel physically and spiritually along the Trail of Dreams.

Treatment Option 4 - In consultation with the Quechan, extant trails in the Indian Pass-Running Man ATCC should be field mapped and their significance to Native Americans ascertained. Low level aerial photography and video photography should be used to document trails that will be destroyed. It appears from present information that certain trail corridors through the ATCC west of the mine and process area can be preserved, including routes to *Avikwaame*. Preserved segments with high Native American sensitivity should be nominated to the NRHP and a preservation plan prepared and adopted by BLM.

Effect 3- The Project mine and process area will inhibit the Quechan's ability to conduct traditional religious activities at the Indian Pass-Running Man ATCC. In addition to physical disturbance, visual and aural intrusions into the ATCC will conflict with traditional practices.

Treatment Option 5 - In accordance with the current mine plan, the height of spoils piles should be restricted to 300 feet.

Treatment Option 6 - The BLM should continue consultation with the Quechan to ensure continued access to the ATCC during Project implementation and after Project closure.

Effect 4 - The Project mine and process area will inhibit or destroy the Quechan's ability to use the Indian Pass-Running Man ATCC for traditional cultural education programs.

Treatment Option 7 - Provide for a cultural educational program which would include (a) a professional-quality video documentary of the ATCC prior to disturbance; (b) a full or part-time teaching/curatorial position for a Quechan tribal member for a period of three to five years; (c) preconstruction cultural educational classes in the ATCC; and (d) a comprehensive report documenting Quechan history and prehistory written in part or in its entirety by the Quechan.

Treatment Option 8 - Delay or phase construction activities to allow the Quechan the opportunity to conduct traditional cultural education in the ATCC prior to their loss of this resource.

Treatment Option 9 - A non-technical report should be written based on the archaeological and ethnographic studies written for the Quechan tribe, addressing the part of Quechan history that would be destroyed by the mine.

Treatment Option 10 - Provide for the expansion of the Quechan Museum and curation of artifacts from the Project in this facility.

Effect 5 - The Project mine and process area will have a cumulative adverse effect on traditional cultural sites in Quechan territory.

Treatment Option 11 - The Indian Pass-Running Man ATCC, the Trail of Dreams, Pilot Knob, Muggins Peak, and the Picacho Basin should be nominated to the NRHP as traditional cultural properties.

Treatment Option 12 - A recording and protection program for the concentration of scratched petroglyphs at Indian Pass should be implemented.

Treatment Option 13 - Consultation should be initiated with the Quechan to identify a site of traditional concern that could be acquired and protected.

The BLM should proceed with consultation with the Project proponent and with the Quechan Tribe to determine which options are desirable and economically feasible. The agreed upon options should then be included in the proposed MOA. These options were discussed on a preliminary basis with representatives of the Quechan on September 9, 1997. KEA recommends that Glamis Imperial Corporation be brought into the discussion and that Glamis Imperial Corporation agree to provide funding for the selected measures.

Archaeological Sites

Effects

Table 8-1 summarizes project effects to significant archaeological sites inventoried at the Project mine and process area. Affected portions of sites in this area would be subject to disturbance through excavation, heavy equipment operation, and burial. Impact levels are defined as follows:

> None - Site avoided or no elements that contribute to the site's eligibility would be effected.
>
> Low - Less than 10% of the site would be impacted and no features of religious-symbolic significance would be effected.

Table 8-1. Effects on Archaeological Sites in the Project Mine and Process Area

Site Number (CA-IMP-)	Project Component	Adverse Effect	Impact Level
Multicomponent			
4970	West Pit, South Waste Rock Stockpile	yes	high
4971	Singer Pit, East Waste Rock Stockpile	yes	high
5061	Indian Pass Road realignment, West Pit	yes	low
5067	West Pit, West Soil Stockpile	yes	high
5494	East Pit	yes	moderate
5526	East Pit, East Waste Rock Stockpile, Heap Leach Pad Area	yes	high
7408	West Waste Rock Stockpile	yes	moderate
Trails			
5010	West Pit	yes	high
7388	None	no	avoided
F-4	West Pit	yes	moderate
F-298	West Pit	yes	high
F-745	South. Waste Rock Stock Pile	yes	high
F-940	West Pit	yes	high
F-1020	West Pit	yes	high
F-1336	West Pit	yes	high
F-1500	None	no	avoided
F-2142	East Pit	yes	high
F-2202	East Pit	yes	high
F-2282	None	no	avoided
F-2294	East Pit	yes	high
F-3024	None	no	avoided
F-4028	Heap Leach Pad Area	yes	high
F-4132	Heap Leach Pad Area	yes	high

Moderate - 10 to 50% of the site would be impacted including elements that contribute to the site's eligibility.

High - Over 50% of the site would be impacted including elements that contribute to the site's eligibility.

As can be seen from Table 8-1, all of the multicomponent sites in the mine and process area would be adversely affected. At most of these the impact is rated high, but the impact would be low at one site and moderate at two. In addition, 12 Native American trails would be adversely affected. Historic period features related to military and mining activities in the mine and process area have been evaluated as not contributing to the NRHP eligibility of any of the sites or to the district.

Avoidance of Effects
Glamis Imperial's efforts to avoid significant archaeological features to date are discussed under the ATCC (above). Additional avoidance may be possible at the edges of project facilities. KEA's GPS locations should be provided to Glamis Imperial's engineering department to determine whether additional features could be saved.

Treatment Options
Adverse effects to archaeological sites include data loss and disturbance of historic context. Several of the sites are evaluated as eligible under criteria A and/or C in addition to criterion D. Data loss can be reduced by the implementation of a data recovery plan (see Chapter 9). Implementation of some or all of the treatment options discussed for the ATCC (above) would be appropriate to reduce the adverse effects to archaeological sites eligible under criteria A and C.

Effect 6 - The Project mine and process area will physically disturb all or parts of seven multicomponent and 12 trail sites. This will result in data loss and the destruction of historic context.

Treatments Options 1 and 2 - See above.

Treatment Option 14 - An archaeological data recovery program in accordance with the recommendations provided in Chapter 9 should be implemented at sites that cannot be avoided.

Treatment Option 15 - Implementation of some or all of the treatment options discussed for the ATCC (above) would be appropriate to reduce the adverse effects to archaeological sites eligible under criteria A and C.

PROJECT ANCILLARY AREA

The Project Ancillary Area crosses southern sector of the Indian Pass-Running Man ATCC. In addition, ten archaeological sites in this portion of the APE have been evaluated as eligible for the NRHP (see Table 7-2).

Indian Pass-Running Man ATCC

Effects
The proposed new transmission line corridor runs about 200 m northwest of the Running Man geoglyph complex. This would add a new visual element to the ATCC during the 20 year mine operation period that is out of character with its National Register values. In addition, increased traffic would adversely affect the solitude of the place during operation. Another concern is the water pipeline, which is presently planned to run through CA-IMP-2727, where it would cross two trails. These intrusions, while significant, are probably dwarfed by the visual and aural intrusion of the mine and process area, which is only 1 km northeast of the Running Man complex.

Avoidance of Effects
Direct impacts to archaeological features of potential religious-symbolic significance should be avoided by citing of all ancillary facilities. Avoidance of visual and aural effects to traditional cultural values would not be possible if the Project proceeds.

Treatment Options

Treatment measures should be similar to those specified for the Project mine and process area.

Effect 7 - Construction of ancillary facilities will physically disturb and add out-of-character visual and aural intrusions into the Indian Pass-Running Man ATCC.

Treatment Options 4, 6, 7, 8 and 9 - See above.

Effect 8 - Significant archaeological sites could be physically disturbed by construction.

Treatment Option 16 - No ground disturbance should be allowed within features that contribute to the significance of the Indian Pass-Running Man ATCC. In site CA-IMP-2727, the water pipeline should be rerouted to the area already disturbed by Indian Pass Road; alternatively, boring could be utilized to avoid impacts to contributing features. All NRHP eligible archaeological sites outside of the ATCC should be avoided. Flagging and monitoring should be done in accordance with Treatment 2 (above).

Archaeological Sites

Effects
The ancillary area passes through multicomponent site CA-IMP-2727, which includes the Running Man geoglyph complex. This site and six other trail or geoglyph sites have been evaluated as eligible for the NRHP under criteria A or C. Construction of ancillary facilities will cause an adverse effect to these sites values under those criteria A and C by diminishing the historic setting.

Avoidance of Effects
Direct impacts to features that contribute to the sites' eligibility under NRHP criteria A, C and D should be avoided in the citing of poles, wells, and utility lines.

Treatment Options
Treatment options for the archaeological sites in the Project ancillary should be the same as those discussed for the ATCC in the ancillary area (see above).

PROJECT TRANSMISSION LINE

Twenty-two sites in the APE of the Project transmission line have been evaluated as eligible for the NRHP under at least one of the criteria and half of these under two criteria (see Table 7-2). In addition five sites have not been evaluated due to insufficient evidence. One of these sites, Camp Pilot Knob is quite large and cannot be avoided completely. The rest of the eligible sites and the indeterminate sites can be avoided.

Construction of the Project transmission line will involve the removal of an existing wood pole line and the installation of new taller poles and reconductoring. In existing access road runs along the existing transmission line and would be used without upgrading during Project-related construction activities.

Camp Pilot Knob (CA-IMP-)

Effects
This site is several miles in length and consequently has already been impacted by the existing transmission line and access road. The new line would not significantly alter the existing historic setting of the site. Through most of the site, the existing line is immediately adjacent to a well-graded county road. Direct ground disturbance would be minimal and would not result in any data loss. With proper precautions (see below) the NRHP values of this site would not be adversely affected by construction of the Project transmission line.

Treatment Options
Effect 9 - Construction activities could disturb features that contribute to the NRHP-eligibility of Camp Pilot Knob.

> Treatment Option 17 - Prior to construction, a professional historical archaeologist should flag all features in the vicinity of existing poles that contribute to the NRHP eligibility of Camp Pilot Knob. Periodic archaeological monitoring should be conducted to ensure avoidance. In case of accidental damage, BLM should consult with SHPO regarding an appropriate mitigation program. Oral history and archival research should be considered along with archaeological data recovery in case of such an eventuality.
>
> Treatment Option 18 - If adverse effects cannot be avoided, an interpretive display should be developed to supplement the E Clampus Vitus sign that already exists on-site. This display should address the relationship of Camp Pilot Knob to the overall Desert Training Center operations and include historical photos of the camp during its period of significance.

Other Archaeological Sites

Because of the existing transmission line, project construction will not alter the existing historic setting of any of the other significant sites. Ground disturbance at all features that contribute to the NRHP values of eligible sites should be avoided.

Effect 10 - Construction of the transmission line could inadvertently disturb a significant archaeological site.

Treatment Option 19 - All NRHP eligible sites should be flagged for avoidance of direct impacts prior to construction of the transmission line. Avoidance of flagged archaeological sites should be part of the overall environmental monitoring program for the Project. In addition, periodic monitoring by a professional archaeologist and Quechan representative should be conducted to ensure avoidance. In case of accidental damage, BLM should consult with SHPO regarding an appropriate mitigation program. Oral history archival research, and ethnographic research should be considered as appropriate along with archaeological data recovery in case of such an eventuality.

CHAPTER 9
DATA RECOVERY RECOMMENDATIONS

If the Project proceeds, one of the mitigation measures should be archaeological data recovery. The enhanced recordation of surface features, the recovery of some of the artifacts, and the analysis and reporting of these data will reduce the loss of informational values at historic properties that would be affected. It would also help to address in a small way part of the cultural heritage loss that would be suffered by the Quechan. Any archaeological data recovery should, if at all possible, be coordinated closely with the Quechan cultural committee and should seek to address specific questions and concerns put forward by Quechan representatives.

KEA recommends that a research design be developed by the group that will actually conduct the data recovery. This will permit that group to develop a personal understanding of Quechan concerns and maximize the potential for fruitful interchange between the archaeologists and Native Americans. Such an interchange would be critical to optimizing the success of the data recovery effort. The data recovery team should include a cultural anthropologist with regional experience to facilitate and encourage interaction between Native American and archaeological perspectives.

The present chapter is intended to provide ideas that might be useful in the data recovery program based on KEA's experience in the survey and evaluation. Seven topics are addressed: geoarchaeology, features of religious-symbolic significance, prehistoric trails, ceramics, flaking stations, reporting and curation. This is not offered as a complete list of potential research objectives/approaches but rather as a guide to future researchers based on our experience.

GEOARCHAEOLOGY

A geoscience specialist (or specialists) with previous experience with desert pavements should be included in the data recovery effort. Appropriate goals would be to:

- Closely examine and describe the pavements in the Project area, focusing on the mine and process area, but also including inspection of the ancillary area and transmission line.
- Describe landscape processes relevant to the formation and preservation of prehistoric cultural materials.
- Explore methods of dating the formation of the surfaces.
- Examine and comment on the differential patina both on natural pavements and on archaeological materials.
- Explore methods of relative dating of archaeological features - e.g. embededness, mineral and biotic deposits, and landscape processes.

- Comment on potential natural causes for enigmatic features, possible early tools, and edge damage.

- Assess potential for subsurface cultural materials (e.g. through entrainment during pavement accretion).

- Provide a reconstruction of environmental history of the Project mine and process area during the terminal Pleistocene and Holocene based on recent published sources and a survey of the vicinity for useful paleoenvironmental proxies (e.g. fossil packrat middens).

The geoarchaeological investigation should be initiated prior to the archaeological fieldwork in order to maximize the benefits of geosciences input in formulating and executing the field strategy and should continue throughout the investigation. The usefulness of mechanical trenching prior to construction should be considered in assessing landscape formation processes.

FEATURES OF RELIGIOUS-SYMBOLIC SIGNIFICANCE

Features of religious-symbolic significance (geoglyphs, vision quest circles, trail shrines, shaman's hearths, etc.) that cannot be avoided should be recorded through photogrametry in order to create accurate recordation in three dimensions. This recordation should be in accordance with Historic American Buildings Survey (HABS) standards for archival documentation. Archivally stable copies of all documentation should be provided to the Quechan tribe for use in their cultural preservation program. Scaled line drawings should be made of selected features for publication and display purposes. These can probably be made from the photogrametric data.

PREHISTORIC TRAILS

All prehistoric trails that cannot be avoided should be followed out to the extent possible through archaeological survey and mapped at 7.5' scale. The survey area should include at least 20 m on either side of the trail surveyed at 5 m intervals to record associated features. If possible these should be recorded as components of the trail on the site record. The utility of low level aerial reconnaissance should be investigated for surveying and recording trail systems. Selected trail segments should be recorded photogrametrically in accordance to standards discussed above.

Special attention should be paid to evidence of trail seriation. Relevant data would include purposeful trail closures, trail markers, relative chronology of associated materials, and ground surface conditions at trail junctions. Associated ceramics should be carefully typed in the field by a knowledgeable specialist, and surface sampling should be done for laboratory analysis.

CERAMIC SCATTERS AND POT DROPS

Ceramic scatters are relatively rare but abundant enough to provide useful information. All ceramics that cannot be avoided should be surface collected. A sample of desert pavement surfaces beneath ceramic scatters should be excavated to examine subsurface conditions.

Ceramic analysis should include typological classification in accordance with regional typologies, vessel form assessment, description and illustration of surface treatments, refitting, MNI evaluation, and petrographic identification of paste and temper characteristics. In addition, Rogers' museum collections from the Indian Pass vicinity and related trail systems should be carefully investigated and compared and contrasted with the Project collections in terms of typology, vessel form, association (e.g. trail shrines, pot drops, habitation area), surface treatment, and paste and temper. Petrographic analysis of museum samples should be considered.

FLAKING STATIONS

Hundreds of flaking stations and small lithic scatters have been recorded in the mine and process area. Each has been mapped accurately using a sub-meter GPS instrument, and notes have been taken regarding the content of each. These data should form a solid basis for the development and implementation of a sampling plan for data recovery. KEA recommends that a sample of these features be selected for complete surface recovery and that shallow subsurface excavations be conducted at some of the selected features. The sampling design should consider: material type, count, presence/absence of cores, and proximity to trails. Important goals of the analysis would be:

1. Technological description.
2. Removal from consideration of debris created by modern rock hounds.
3. Refitting to determine products removed from the site.
4. Site functional analysis and assessment of associated mobility pattern.
5. Identification of non-utilitarian quartz smashes and utilitarian quartz tool reduction.
6. Assessment of the association of lithic reduction with possible early tool assemblage.
7. Assessment of the quality of available materials and comparison to other sources within the catchment of sites on the Colorado River.

In order to meet these goals laboratory procedures would need to include technological analysis, refitting, and replicative experiments.

CURATION

Materials and supporting documentation will be curated in an archivally stable condition. Curation at the Quechan Museum should be preferred. If necessary, assistance should be provided to the Quechan in meeting Federal standards for curation.

REPORTING

The technical report should be regional in scope, clearly tying the data recovery results to Quechan belief systems, Quechan cultural history, and regional archaeological research problems. In addition, a non-technical report useful to the Quechan in their cultural heritage programs should be prepared that summarizes and integrates the ethnographic and archaeological information on the Project area.

REFERENCES CITED

Aikens, C. Melvin

1970 Hogup Cave. University of Utah, Anthropological Papers, 93. University of Utah Press, Salt Lake City.

Almstedt, Ruth F.

1982 The Kumeyaay and Iipay. In Clyde M. Woods (ed.), The APS/SDG&E *Interconnection Project, Miguel to the Colorado River and Miguel to Mission Tap: Identification and Evaluation of Native American Cultural Resources.* Document on file with San Diego Gas & Electric Company, pp. 6-21.

Altschul, Jeffery H. and Joseph A. Ezzo

1994 The Expression of Ceremonial Space Along the Lower Colorado River. In Joseph A Ezzo (ed.) Recent Research Along the Lower Colorado River. *Statistical Research Technical Series* No. 51, Tucson, pp. 51-68.

Andrefsky, William Jr.

1994 Raw-Material Availability and the Organization of Technology. *American Antiquity* 59(1):21-34.

Antevs, Ernst

1948 The Great Basin, with Emphasis on Glacial and Post Glacial Times. *University of Utah Bulletin* 38(20):168-191.

1952 Arroyo-Cutting and Filling. *The Journal of Geology* 60:375-385.

1962 Late Quaternary Climates in Arizona. *American Antiquity* 28:193-198.

1983 Geological Dating. In E. B. Sayles (ed.), The Cochise Cultural Sequence in Southeastern Arizona. *Anthropological Papers of the University of Arizona* 42:26-43.

Anza

1774 The San Francisco Colony: Dairies of Anza, Font, and Eixarch, and Narratives by Palóu and Moraga. (Anza's California Expeditions, v.5).

Apple, Rebecca McCorkle, A. York, A. Pigniolo, J.H. Cleland, S. Van Wormer

1997 Archaeological Survey and Evaluation Program for the Salton Sea Test Base Imperial County, California. Prepared for U.S. Department of the Navy, Southwest Division.

Arkush, Brooke S.

1987 Historic Northern Paiute Winter Houses in Mono Basin, California. *Journal of California and Great Basin Anthropology* 9(2):174-187.

Aschmann, Homer

1959 The Central Desert of Baja California: Demography and Ecology. *Ibero-Americana* 42.

1966 The Head of the Colorado Delta. In S. R. Eyre and G.R.J. Jones (eds.), *Geography as Human Ecology,* St. Martin's Press, New York, pp. 231-263.

Baksh, Michael

1994 Ethnographic and Ethnohistoric Insights into the Quen Sabe Intaglios. In Joseph A. Ezzo (ed.) Recent Research Along the Lower Colorado River: Proceedings from a Symposium Presented at the 59th Annual Meeting of the Society for American Archaeology, Anaheim, California, April 1994. *Statistical Research Technical Series* No. 51, Tucson, pp. 15-48.

1997 Native American Consultation for the Chemgold Imperial Project. Document on file with Bureau of Land Management, El Centro, and Tierra Environmental Services, San Diego.

Bamforth, D.

1988 Investigating Microwear Polishes with Blind Tests: The Institute Results in Context. *Journal of Archaeological Science* 15:11-23.

1992 Quarries in Context: A Regional Perspective on Lithic Procurement. In *Stone Tool Procurement, Production, and Distribution in California Prehistory*, edited by Jeanne E. Arnold, pp. 131-156. Perspectives in California Archaeology vol 2. Institute of Archaeology, University of California, Los Angeles.

Bamforth, D., G. Burns, and C. Woodman

1990 Ambiguous Use Traces and Blind Test Results: New Data. *Journal of Archaeological Science* 17:417-430.

Barker, James P.

1976 Ethnographic Sketch of the Yuha Desert Region. In Philip J. Wilke (ed.) *Background to Prehistory of the Yuha Desert Region.* Ballena Press, Ramona, California.

Bean, Lowell J.

1972 *Mukat's People: The Cahuilla Indians of Southern California.* University of California Press, Berkeley.

1978 Cahuilla. In Robert F. Heizer (volume editor), *Handbook of North American Indians,* Volume 8, California, Smithsonian Institution, Washington D.C., pp. 575-587.

Bean, Lowell J. and Charles R. Smith

1978 Serrano. In Robert F. Heizer (volume editor), *Handbook of North American Indians,* Volume 8, California, Smithsonian Institution, Washington D.C., pp. 570-574.

Bedwell, S. F.
1973 *Fort Rock Basin: Prehistory and Environment.* Eugene: University of Oregon Books.

Bee, Robert L.
1981 *Crosscurrents Along the Colorado: The Impact of Government Policy on the Quechan Indians.* University of Arizona Press, Tucson.

1982 The Quechan. In Clyde M. Woods (ed.), *The APS/SDG&E Interconnection Project, Miguel to the Colorado River and Miguel to Mission Tap: Identification and Evaluation of Native American Cultural Resources.* Document on file with San Diego Gas & Electric Company, pp. 34-55.

1983 The Quechan. In Alfonso Ortiz (ed.), *Handbook of North American Indians,* Vol. 10, Southwest. Smithsonian Institution, Washington, D.C., pp. 86-98.

Begole, Robert S.
1973 An Archaeological Survey in the Anza-Borrego Desert State Park: 1972 Preliminary Report. *Pacific Coast Archaeological Society Quarterly* 9(2):27-55.

1974 Archaeological Phenomena in the California Desert. *Pacific Coast Archaeological Society Quarterly* 10(2):41-70.

1981 1978-1980 Investigations in the Anza-Borrego Desert State Park. *Pacific Coast Archaeological Society Quarterly* 17(4):1-38.

Benedict, Ruth
1924 A Brief Sketch of Serrano Culture. *American Anthropologist* 26:368-369.

Berger, Reiner, R. Protsch, R. Reynolds, Charles Rozaire, and James R. Sackett
1971 New Radiocarbon Dates Based on Bone Collagen of California Paleoindians. *Contributions of the University of California (Berkeley) Archaeological Research Facility* 12:43-49

Berger, Reiner
1982 The Wooley Mammoth Site, Santa Rosa Island, California. In J. E. Ericson, R. E. Taylor, and R. E. Berger (eds.), Peopling of the New World. *Ballena Press Anthropological Papers* 23: 163-170.

Bettinger, Robert L.
1977 Aboriginal Human Ecology in Owens Valley: Prehistoric Changes in the Great Basin. *American Antiquity* 42:3-17.

1978 Alternative Adaptive Strategies in the Prehistoric Great Basin. *Journal of Anthropological Research* 34(1):27-46.

1979 Multivariate Statistical Analysis of a Regional Subsistence-Settlement Model for Owens Valley, Eastern California. *American Antiquity* 44(3):455-470.

1985 Native Life in Desert California: The Great Basin and Its Aboriginal Inhabitants. *Masterkey* 59(203):42-50.

1991 *Hunter-Gatherers: Archaeological and Evolutionary Theory.* Plenum Press. New York.

Binford, Lewis R.
1981 *Bones: Ancient Men and Modern Myths.* Academic Press, New York.

Bolton, Herbert E.
1916 *Spanish Exploration in the Southwest, 1543-1709.* Scribner's, New York.

1931 The San Francisco Colony: Dairies of Anza, Font, and Eixarch, and Narratives by Palóu and Moraga. (Anza's California Expeditions, v.5). University of California Press.

Bourke, John G.
1889 Notes on the Cosmogony and Theogony of the Mohave Indians of the Rio Colorado, Arizona. *Journal of American Forklore* 2:169-189.

Bureau of Land Management (BLM)
1986 Desert Training Center, California-Arizona Maneuver Area Interpretive Plan. United States Department of the Interior, Bureau of Land Management, California Desert District.

Burney, Michael S., Stephen R. Van Wormer, Claudia B. Hemphill (ed.)
1993 The Results of Historical Research, Oral History, Inventory, and Limited Test Excavations Undertaken at the Hedges/Tumco Historic Townsite, Oro Cruz Operation, Southwestern Cargo Muchacho Mountains, Imperial County, California. Report prepared by Burney and Associates for P.M. DeDycker and Associates, Inc. June 15, 1993.

Cachora, Lorey
1994 The Spirit Life of Yuman-Speaking Peoples: Lower Colorado River Between Arizona and California. In Joseph A. Ezzo (ed.), Recent Research Along the Lower Colorado River, *Statistical Research Technical Series* No. 51, Tucson, Arizona, pp. 13-14.

1997 Letter to Terry Reed, Bureau of Land Management, El Centro, California.

Campbell, E. W. C.
1936 Archaeological Problems in the Southern California Deserts. *American Antiquity* 1(4):295-300.

Campbell E. W. C., W. H. Campbell, E. Antevs, C. E. Amsden, J. A. Barbieri, and F. D. Bode

1937 The Archaeology of Pleistocene Lake Mohave. Los Angeles: *Southwest Museum Papers* 11.

Carrico, Richard L. and Dennis K. Quillan

1982 *Cultural Resource Inventory and National Register Assessment of the Southern California Edison Palo Verde to Devers Transmission Line Corridor.* Document on file with Southern California Edison, Rosemead, California.

Castetter, Edward F. and Willis H. Bell

1951 Yuman Indian Agriculture: Primitive Subsistence on the Lower Colorado and Gila Rivers. University of New Mexico Press.

Cerutti, R. A.

1986 Basalt Stone-Knapping Experiments. In Loriann Pendleton (ed.) *The Archaeology of the Picacho Basin, Southeast California,* pp. 167-172. Report on file with San Diego Gas and Electric.

Chamberlin, Eugene K.

1990 *Camp Pilot Knob*. Squibob Chapter, E. Clampus Vitus, Campout #56, Camp Pilot Knob, Imperial County California. Manuscript on file, ASM Affiliates, San Diego.

Childers, W. Morlin

1974 Preliminary Report on the Yuha Burial, California. *Anthropological Journal of Canada* 1(1):2-9.

1977 Ridge-Back Tools of the Colorado Desert. *American Antiquity* 42(2):242-248.

1980 Evidence of Early Man Exposed at Yuha Pinto Wash. *American Antiquity* 45(2):297-307.

Cleland, Jamie H., Rebecca M. Apple, and Andrew L. York

1993 *Kern River Gas Transmission Company Kern River Pipeline Cultural Resource Data Recovery Report, California.* Document on file with Dames and Moore, San Diego.

Cleland, Jamie H., Rebecca M. Apple, Andrew L. York, and Elena Nilsson

1990 Sugarloaf Mountain in Prehistory: Archaeological Testing and Data Recovery for the Exploratory Drilling Program II and the Unit No. 1 Project. Report submitted to the Los Angeles Department of Water and Power. Dames and Moore, San Diego.

Clewlow, C. William

1978 Prehistoric Rock Art. In Robert F. Heizer (volume editor), *Handbook of North American Indians,* Volume 8, California, Smithsonian Institution, Washington D.C., pp. 619-625.

Cole, K. L.
1986 The Lower Colorado River Valley: A Pleistocene Desert. *Quaternary Research* 25(3):392-400.

Cole, K. L. and R. H. Webb
1985 Late Holocene Vegetation Changes in Greenwater Valley, Mojave Desert, California. *Quaternary Research* 23:227-235.

Collins, G. Edward and Karen McNitt Collins
1996 *New Findings at Site CA-IMP-1139.* Paper presented at the San Diego Museum of Man Rock Art Symposium, San Diego

Colton, Harold S.
1953 Potsherds. *Museum of Northern Arizona Bulletin 25.*

Colton, Harold S. and Lyndon L. Hargrave
1937 Handbook of Northern Arizona Pottery Wares. *Museum of Northern Arizona Bulletin* 19.

Conkey, Margaret W.
1989 The Structural Analysis of Paleolithic Art. In *Archaeological Thought in America*, edited by C.C. Lamberg-Karlovsky, pp. 135-154. Cambridge University Press, New York.

Cooke, R. U.
1970 Stone Pavements in Deserts. *Annals of the Association of American Geographers* No. 60, pp. 560-577.

Cooley, Theodore
1986 Appendix A Prehistoric Site Narratives. In the Archaeology of Picacho Basin, Southeast California by Lorann Pendleton. Prepared for SDG&E, San Diego. Prepared by Worth Environmental Services.

Crotty, H. K.
1979 Rock Art of the Modoc Territory. *American Indian Rock Art* 5:22-3. American Rock Art Research Association, El Toro.

Davis, Emma Lou
1966 New Prospects for Dating Ancient Man. In M. J. Rogers, H. M. Wormington, E. L. Davis, and C. W. Brott, *Ancient Hunters of the Far West.* Copley Press, San Diego, pp 125-138.

1969 The Western Lithic Co-Tradition. In Emma Lou Davis, C. W. Brott, and David L. Weide (eds.) The Western Lithic Co-Tradition. *San Diego Museum Papers* 6, pp. 11-78.

Davis, Emma Lou (ed.)
1978 The Ancient Californians: Rancholabrean Hunters of the Mojave Lakes Country. *Natural History Museum of Los Angeles County, Science Series* 29.

Davis, Emma Lou and Carol Palanqui
1978 Chapters 1-5 in Emma Lou Davis (ed.) The Ancient Californians: Rancholabrean Hunters of the Mojave Lakes Country. *Natural History Museum of Los Angeles County, Science Series* 29.

Davis, Emma Lou, Cathryn H. Brown, and Jacqueline Nichols
1980 *Evaluation of Early Human Activities and Remains in the Colorado Desert.* Document on file with the Great Basin Foundation, San Diego, and BLM, Riverside.

Davis, Emma Lou, Delbert True, and Gene Sterud
1965 Engraved Rocks Beside a Trail: Imperial County. *University of California (Los Angeles) Archaeological Survey Annual Report* No. 7, pp.323-332.

Davis, James T.
1961 Trade routes and Economic Exchange Among the Indians of California. *University of California (Berkeley) Archaeological Survey Report* No. 54.

de Williams, Anita Alvarez
1983 Cocopa. In Alfonso Ortiz (ed.), *Handbook of North American Indians,* Vol. 10, Southwest. Smithsonian Institution, Washington, D.C., pp. 99-113.

Delacorte, Michael G.
1997 Report on Archaeological Data Recovery Investigations for the Tuscarora Pipeline Project from Malin, Oregon to Tracy, Nevada. Volume III: South Forke Valley and Madeline Plains. Report prepared for Tuscarora Gas Transmission Company. Far Western Anthropological Research Group, Inc. Davis, California.

Delorme Mapping Company
1990 Southern and Central California Atlas Gazetteer, page 127.

Donnan, C.B.
1964 A suggested culture sequence for the Providence Mountains (eastern Mojave Desert). *University of California, Los Angeles, Archaeological Survey Annual Report.* 1963-1964:1-26.

Dorn, Ronald I.
1983 Cation-Ratio Dating: A New rock Varnish Age Determination Technique. *Quaternary Research* 20:49-73.

Dorn Ronald I. and T. M. Oberlander
1981 The Microbial Origin of Desert Varnish. *Science* 213:1245-1247.

Dorn, R. I., D. B. Bamforth, T. A. Cahill, J. C. Dohrenwend, B. D. Turin, D. J. Donahue, A. J. Jull, M. E. Macko, E. B. Weil, D.S. Whitley, and T. H. Zabel

1986 Cation-Ratio and Accelerator Radiocarbon Dating of Rock Varnish on Mojave Artifacts and Landforms. *Science* 231:830-33.

Dorn, R. I., T. A. Cahill, R. E. Eldred, T. E. Gill, B. Kusko, A. J. Bach, and D. L. Elliot-Fisk

1990 Dating Rock Varnishes by the Cation-Ration Method with PIXE, ICP, and the Electron Microprobe. *International Journal of PIXE* 1:157-195.

Drover, C.E.

1979 The Late Prehistoric Human Ecology of the Northern Mohave Sink, San Bernardino County, California. Unpublished Ph.D. dissertation, University of California, Riverside.

Elston, Robert G.

1990 A Cost-Benefit Model of Lithic Assemblage Variability. In *The Archaeology of James Creek Shelter*, edited by Robert G. Elston and Elizabeth E. Budy, pp. 153-163. University of Utah Anthropological Papers 115.

Elston, Robert G. and C. Raven (editors)

1992 *Archaeological Investigations at Tosawihi, A Great Basin Quarry*. Report submitted to the United States Department of the Interior, Bureau of Land Management, Elko Resource Area.

Environmental Management Associates, Inc. (EMA)

1997 Imperial project, Imperial County California. Draft Environmental Impact Statement/Environmental Impact Report

Enzel, Yehouda, W. J. Brown, R. Y. Anderson, L. D. McFadden, and S. G. Wells

1992 Short-Duration Holocene Lakes in the Mojave River Drainage Basin, Southern California. *Quaternary Research* 38:60-73.

Euler, Robert C.

1966 Southern Paiute Ethnohistory, *Anthropological Papers* 78, Department of Anthropology, University of Utah, Salt Lake City.

Ezzo, Joseph A. and Jeffery H. Altschul

1993a Synthetic Themes, in Joseph A. Ezzo, and Jeffery H. Altschul (eds.) Glyphs and Quarries of the Lower Colorado River Valley, *Statistical Research Technical Series* No. 44, pp. 12-23.

1993b An Archaeological Survey of Pilot Knob, Imperial County, California. A Class III Cultural Resources Survey and Evaluation. In Joseph A. Ezzo, and Jeffery H. Altschul (eds.) Glyphs and Quarries of the Lower Colorado River Valley, *Statistical Research Technical Series* No. 44, Part 4.

Figgins, J. D.
1927 The Antiquity of Man in America. *Natural History* 27(3):229-39

Flenniken, J. Jeffery and Philip J. Wilke
1989 Typology, Technology, and Chronology of Great Basin Dart Points. *American Anthropologist* 91(1):149-158.

Font, Pedro
1775 The Colorado Yumans in 1775. In Bolton, Herbert E. (ed.) *Font's Complete Diary,* 1931. Reprinted in Robert F. Heizer and M. A. Whipple (eds.) *The California Indians: A Source Book,* Second Edition, University of California Press, Berkeley, pp. 247-254.

Forbes, Jack D.
1965 *Warriors of the Colorada: The Yumas of the Quechan Nation and Their Neighbors.* University of Oklahoma Press, Norman.

Forde, Daryll C.
1931 Ethnography of the Yuma Indians. *University of California (Berkeley) Publications in American Archaeology and Ethnology* 28(4):83-278.

Fredrickson, Dave L.
1973 *Early Cultures of the North Coast Ranges,* California. Ph.D. dissertation, Department of Anthropology, University of California, Davis.

Fredrickson, Dave L. and J. Grossman
1977 A San Dieguito Component a Buena Vista Lake, California. *Journal of California Anthropology* 4(2):173-190.

Gallegos, Dennis
1987 A Review and Synthesis of Environmental and Cultural Material for the Batiquitos Lagoon Region. In Dennis Gallegos (volume ed.), San Dieguito-La Jolla: Chronology and Controversy, *San Diego County Archaeological Society Research Papers* No. 1, pp. 23-34..

Gould, Richard A.
1968 Living Archaeology: The Ngatatjara of Western Australia. *Southwestern Journal of Anthropology* 24(2):101-122.

Grant, Campbell, James W. Baird, and J. Kenneth Pringle
1968 Rock Drawings of the Coso Range, Inyo County, California. *Maturango Museum Publications* No. 4, China Lake, California.

Grayson, Donald K.
1993 *The Desert's Past: A Natural Prehistory of the Great Basin.* Smithsonian Institution Press, Washington, D. C.

Greenwood, Roberta S.
1972 9000 Years of Prehistory at Diablo Canyon. *San Luis Obispo County Archaeological Society Occasional Papers 7.*

1978 *Archaeological Survey and Investigation, Channel Islands National Monument.* Document on file with the National Park Service, Denver.

Greiser, Sally T., and Payson D. Sheets
1979 Raw Materials as a Functional Variable in Use-wear Studies. In *Lithic Use-wear Analysis*, edited by Brian Hayden, pp. 289-296. Academic Press, New York.

Gumerman, George J.
1970 Black Mesa; Survey and Excavation in Northeastern Arizona, 1968. *Prescott College Studies in Anthropology* No. 2.

Harris, Marvin
1968 *The Rise of Anthropological Theory.* Thomas Crowell Company, New York.

Harry, Karen G.
1992 Lithic Procurement and Rock Varnish Dating: Investigations at CA-KER-140, a Small Quarry in the Western Mojave Desert. *Statistical Research Technical Series* No. 36, Tucson.

Harwell, Henry O. and Marsha C. S. Kelly
1983 The Maricopa. In Alfonso Ortiz (ed.), *Handbook of North American Indians,* Vol. 10, Southwest. Smithsonian Institution, Washington, D.C., pp. 71-85.

Haury, Emil W.
1975 *The Stratigraphy and Archaeology of Ventana Cave.* University of Arizona Press, Tucson.

1983 Concluding Remarks. In E. B. Sayles (ed.), The Cochise Cultural Sequence in Southeastern Arizona. *Anthropological Papers of the University of Arizona* 42:158-166.

Hayden, Julian
1965 Fragile-Pattern Areas. *American Antiquity* 31:272-276.

1967 A Summary Prehistory and History of the Sierra Pinacate, Sonora. *American Antiquity* 32:335-344.

1976 Pre-Altithermal Archaeology in the Sierra Pinacate, Sonora, Mexico. *American Antiquity* 41:274-289.

1981 Ground Figures of the Sierra Pinacate, Sonora, Mexico, pp. 1-11. Unpublished Report on file at the BLM, Yuma District Office.

1987 Notes on the Apparent Course of San Dieguito Development. In Dennis Gallegos (volume ed.), San Dieguito-La Jolla: Chronology and Controversy, *San Diego County Archaeological Society Research Papers* No. 1, pp. 45-50.

Hector, Susan M.

1987 Archaeological Survey and Resource Assessment of the American Girl Mine Project, American Girl Canyon Project Area, Imperial County, California. Report prepared by RECON for Steffen Robertson and Kirsten, Consulting Engineers. October 6, 1987.

Hedges, Ken

1973 Rock Art in Southern California. *Pacific Coast Archaeological Society Quarterly* 9(4):1-28.

1982a The Petroglyphs of Riv-1383. In Richard L. Carrico, Dennis K. Quillen, and Dennis R. Gallegos (eds.), *Cultural Resource Inventory and National Register Assessment of the Southern California Edison Palo Verde to Devers Transmission Line Corridor (California Portion),* Appendix B. Document on file with Southern California Edison, Rosemead, California.

1982b Great Basin Rock Art Styles: A Revisionist View. American Indian Rock Art 7,8:205-211. *American Rock Art Research Association,* El Toro.

1996 Regional Rock Art Styles. In Andrew L. York, Robin E. McMullen, Paula de Lespinasse, and W. Geoffrey Spaulding (eds.) *Rock Art Sites on the Nellis Range Complex, Nellis Air Force Base, Nevada.* Document on file at Nellis Air Force Base, Las Vegas, Nevada.

Heizer, Robert F.

1978 Trade and Trails. In Robert F. Heizer (ed.), *Handbook of North American Indians,* Vol. 8, California. Smithsonian Institution, Washington, D.C., pp. 690-693.

Heizer, Robert F. and Martin A. Baumhoff

1962 *Prehistoric Rock Art of Nevada and Eastern California.* University of California Press, Berkeley.

1978 *Prehistoric Rock Art of Nevada and Eastern California.* University of California Press, Berkeley.

Henderson, Tracey

1968 *Imperial Valley.* Neyenesch Printers, Inc. San Diego, California.

Henley, Brigadier General David C.
1989 *The Land That God Forgot: The Saga of General George Pattons Desert Training Camps*. Western American History Series (Revised 1992). Western Military History Association.

1992 *"The Land that God Forgot..." The Saga of General George Patton's Desert Training Camps*. The Western Military History Association.

Hester, J. J.
1972 *Blackwater Locality Number 1: A Stratified Early Man Site in Eastern New Mexico.* Fort Burgwin Research Center, Rancho de Taos, NM.

Hester, Thomas R.
1973 Chronological Ordering of Great Basin Prehistory. *University of California Archaeological Research Facility Contributions* 17, Berkeley.

Hildebrandt, William R. and Amy S. Gilreath
1988 Survey and Evaluation of Cultural Resources on a Portion of the Navy/CLJV Contract (Residual Navy 2) Lands within the Coso KGRA, Inyo County, California. Report prepared for California Energy Company, Inc. Far Western Anthropological Research Group, Davis. On file at South Coastal Information Center, San Diego State University, San Diego, California.

Hodder, Ian
1982 *The Archaeology of Mind.* Cambridge University Press.

Huckell, B. B.
1986 A Ground Stone Implement Quarry on the Lower Colorado River, Northwestern Arizona. *Bureau of Land Management Cultural Resources Series Monograph* No. 3. Phoenix.

Hunter, Kimberly L. and Joseph R. McAuliffe
1994 Elevational Shifts of Coleogyne Ramossissima in the Mojave Desert During the Little Ice Age. *Quaternary Research* 42:216-221.

Jackson Sr., Mike
1997 Letter to Terry Reed, Bureau of Land Management, El Centro, California.

Jennings, Jesse D.
1978 Origins. In J. D. Jennings (ed.), *Ancient Native Americans.* Freeman, San Francisco, pp. 1-41,

Jennings, Jesse D. and Edward Norbeck
1955 Great Basin Prehistory: A Review. *American Antiquity* 20:226-239.

Johnson, Boma
1985 *Earth Figures of the Lower Colorado and Gila River Deserts: A Functional Analysis.* Arizona Archaeological Society, Phoenix.

Keeley, L. H.
1980 *Experimental Determination of Stone Tool Uses.* University of Chicago Press, Chicago.

Kelly, Robert L.
1988 The Three Sides of a Biface. *American Antiquity* 53(4):717-734.

Kelly, Robert L. and Lawrence C. Todd
1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53(2):231-244.

Kroeber, A. L.
1920 Yuman Tribes of the Lower Colorado. *University of California (Berkeley) Publications in American Archaeology and Ethnology* 16(8):475-485.

1925 *Handbook of the Indians of California.* Dover Publications, New York.

1939 Cultural and Natural Areas of Native North America, *University of California (Berkeley) Publications in American Archaeology and Ethnology* 38.

Laudermilk, J. D.
1931 On the Origin of Desert Varnish. *American Journal of Science,* 5th Series, 21:51-66

Lawton, Harry W.
1978 History and Ethnohistory of the Yuha Desert (1769-1865). In Philip J. Wilke (ed.) Background to Prehistory of the Yuha Desert. *Ballena Press Anthropological Papers* 5:43-72

Lawton, Harry W. and Lowell J. Bean
1968 A Preliminary Reconstruction of Aboriginal Agricultural Technology Among the Cahuilla. *The Indian Historian* 1(5):18-24, 29.

Laylander, Don
1994 Phase III Data Recovery at the Elmore Site (CA-IMP-6427) Imperial County California, 11-IMP-86, P.M. 33.6/43.2, 11221-194860, 11221-100710. Caltrans District 11, San Diego.

Lee, Richard B.
1979 *The Dobe !Kung.* Holt, Rinehart, and Winston, New York.

Lee, W. Storrs
1968 *California: A Literary Chronicle.* Funk & Wagnalls, New York.

Leone, Mark P.
1982 Some Opinions about Recovering Mind. *American Antiquity* 47(4):742-760.

Luedtke, B.E.
1992 The Nature of Chert (p.5-9) and Mechanical Properties (p.79-87). In *An Archaeologist's Guide to Chert and Flint.* ART 7. Institute of Archaeology, UCLA.

Mabbutt, J. A.
1965 Stone Distribution in a Stony Tableland Soil. *Australian Journal of Soil Research* No. 4, pp. 131-142.

1979 Pavements and Patterned Ground in the Australian Stony Deserts. Festschrift fur Wolfgagn Meckelein. *Stuttgarter Geographische Studien, Geographisches Institut der Universitat Stuttgart, Band 93* pp. 107-123.

Marmaduke, William S. and Steven G. Dosh
1994 *The Cultural Evolutionary Context of "Sleeping Circle" Sites in the Lower Colorado River Basin.* Document on file with U.S. Army, Yuma Proving Ground, and Northland Research, Flagstaff.

Martin, Paul S.
1963 *The Last 10,000 Years.* University of Arizona Press, Tucson.

McGuire, Randall H.
1982 Environmental Background. In Randall H. McGuire and Michael B. Schiffer (eds) *Hohokam and Patayan: Prehistory of Southwestern Arizona.* Academic Press, New York, pp. 13-56.

1992 Archaeology and the First Americans. *American Anthropologist* 94(4):816-836.

Mehringer, P.J.
1986 Prehistoric Environments. In *Great Basin*, edited by W.L. D'Azevedo, pp. 31-50. Handbook of North American Indians Vol. 11, Smithsonian Institution, Washington, D.C.

Mehringer, P.J., and Claude Warren
1976 Marsh, Dune, and Archaeological Chronology, Ash Meadows, Amargosa Desert, Nevada. In *Holocene Environmental Change in the Great Basin*, edited by R. Elston. Nevada Archaeological Survey Research Papers 6, 120-150.

Meller, Sidney L.
1946 *The Army Ground Forces: The Desert Training Center and CAMA, Study No. 15.* Historical Section - Army Ground Forces.

Minshall, H.L.
1976 The Broken Stones. Copley Press, San Diego.

Moratto, Michael J.
1984 *California Archaeology.* Academic Press, New York

Moriarty, James R. III
1966 Cultural Phase Divisions Suggested by Typological Change Coordinated with Stratigraphically Controlled Radiocarbon Dating in San Diego. *Anthropological Journal of Canada* 4(4):20-30.

1987 A Separate Origins Theory for Two Early Man Cultures in California. In Dennis Gallegos (volume ed.), San Dieguito-La Jolla: Chronology and Controversy, *San Diego County Archaeological Society Research Papers,* No. 1, pp. 51-62.

Morton, Paul K.
1977 Geology and mineral Resources of Imperial County, California. *County Report 7, California Division of Mines and Geology, Sacramento.*

Norris, Frank and Richard L. Carrico
1978 A History of Land Use in the California Desert Conservation Area. Report prepared for Desert Planning Staff, Bureau of Land Management by WESTEC Services, Inc.

O'Connell, James F.
1971 Recent Prehistoric Environments in Interior Southern California. *University of California (Los Angeles) Archaeological Survey Annual Report* 13:173-184.

Office of Historic Preservation
1989 Archaeological Resource Management Reports (ARMR): Recommended Contents and Format. Department of Parks and Recreation, Office of Historic Preservation, Sacramento, California.

Orr, P. C.
1968 *Prehistory of Santa Rosa Island.* Santa Barbara Museum of Natural History.

Orrell, F.L.
1991 Recent Military Operations in the Anza-Borrego Desert State Park (A Preliminary Study of Such Activity from 1941-1959).

Owen, Roger C.

1959 Semi-Sedentary "Nomads" in Baja California. *University of California (Los Angeles) Archaeological Survey Annual Report*

Owl, Pauline

1997 Letter to Pat Weller, Bureau of Land Management, El Centro, California.

Panlaqui, Carol, and David Whitley

n.d. Rock Drawings of the Coso Range: A Brief Summary of Facts about the Coso Petroglyphs. Pamphlet produced by the Maturango Museum, China Lake Naval Weapons Station, China Lake, California.

Parker, Patricia L. and Thomas F. King

1992 Guidelines for Evaluating and Documenting Traditional Cultural Properties. *National Register Bulletin 38*. United States Department of the Interior, National Park Services, Interagency Resources Division. Washington, D.C.

Patton Society Web Page

1997 http://www.yorktown.com/patton/chiriaco/index.html

Payen, Louis A.

1966 *Prehistoric Rock Art in the Northern Sierra Nevada, California.* M.A. Thesis, Department of Anthropology, Sacramento State College, Sacramento, California.

Pendleton, Lorann S.A.

1984 Lithic Use-wear Analysis. In *The Archaeology of Hidden Cave, Nevada*, edited by David Hurst Thomas. Anthropological Papers of the American Museum of Natural History.

1986 Archaeological Investigations in the Picacho Basin. Southwest Powerlink Project - Sand Hills to the Colorado River Segment. Report prepared for San Diego Gas & Electric. Report prepared by Wirth Environmental Services.

Pendleton, Lorann S.A., Alvin R. McLane, and David Hurst Thomas

1982 *Cultural Resource Overview of Western Nevada*. Bureau of Land Management Carson City District, Cultural Resource Series, No. 5.

Perry, R. S. and J. B. Adams

1978 Desert Varnish: Evidence for Cyclic Deposition of Manganese. *Nature* 276:489-491.

Phillips, Roxana

1982 Archaeological Data Recovery Program: Northern Portion of IT Corporation Imperial Valley Site. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.

Pourade, Richard F.
1966 Part I, Forward, A Journey into Man's Past. In M. J. Rogers, H. M. Wormington, E. L. Davis, and C. W. Brott, *Ancient Hunters of the Far West.* Copley Press, San Diego, pp 2-20.

Quechan Indian Tribe
1989 Quechan Tribal Resolution and Statement of Position Concerning All-American Canal in Relation to Pilot Knob. Yuma Indian Reservation. Yuma.

Quillen, Dennis
1982 *Cultural Resource Inventory of Gold Fields Mining Corporation's Indian Rose Mining Prospect, Imperial County, California.* WESTEC Services, San Diego.

Raven, Christopher
1984 Northeastern California. In Michael J. Moratto, (ed.) *California Archaeology.* Academic Press, New York, pp.431-470.

Rector, Carol
1976 The Function of East Mojave Rock Art. *American Indian Rock Art* 3:151-156. American Rock Art Research Association, Whittier.

1979 *Archaeological Studies at Oro Grande, Mojave Desert, California.* Riverside: Report to the Victor Valley Wastewater Reclamation Authority.

Riddell, Francis A. and W. H. Olsen
1969 An Early Man Site in the San Joaquin Valley. *American Antiquity* 34(2):121-130.

Rogers, Malcolm J.
1936 Yuman Pottery Making. *San Diego Museum of Man Papers* No. 2

1939 Early Lithic Industries of the Lower Basin of the Colorado River and Adjacent Desert Areas. *San Diego Museum of Man Papers* No. 3.

1941 Aboriginal Culture Relations Between Southern California and the Southwest. *San Diego Museum of Man Bulletin* 5:1-6.

1945 Outline of Yuman Prehistory. *Southwestern Journal of Anthropology* 1:167-198.

1966 San Dieguito I in the Central Aspect. In M. J. Rogers, H. M. Wormington, E. L. Davis, and C. W. Brott, *Ancient Hunters of the Far West.* Copley Press, San Diego, pp 37-58.

n.d. Fieldnotes, Colorado Desert Region. On file at the San Diego Museum of Man.

Sample, L. L.

1950 Trade and Trails in Aboriginal California. *University of California (Berkeley) Archaeological Survey Reports* 8:1-30.

Sampson, Michael P.

1982 *A Test of Edge Angle and Usewear Analyses: Experiments in Butchering.* Unpublished Master's Thesis, Department of Anthropology, Washington State University, Pullman.

Sayles, E.B.

1983 *The Cochise Cultural Sequence in Southeastern Arizona.* Anthropological Papers of the University of Arizona No. 42. Tucson.

Schaafsma, Polly

1980 *Indian Rock Art of the Southwest.* School of American Research, Santa Fe, and University of New Mexico Press, Albuquerque.

Schaefer, Jerry

1986 Present Environment. In Lorann Pendleton (ed.), *Archaeological Investigations in the Picacho Basin.* Document on file with Dames & Moore, San Diego and San Diego Gas & Electric Company.

1992 Ceramic Vessels, Figurines, Pipes, and Disks from Tahquitz Canyon. Paper presented at the 26th Annual Meeting of the Society of California Archaeology, Pasadena.

1994 Stuff of Creation: Recent Approaches to Ceramics Analysis in the Colorado Desert. In Joseph A. Ezzo (ed.) Recent Research Along the Lower Colorado River: Proceedings from a Symposium Presented at the 59th Annual Meeting of the Society for American Archaeology, Anaheim, California, April 1994. *Statistical Research Technical Series* No. 51, Tucson, pp. 81-100.

1994b The Stuff of Creation: Recent Approaches to Ceramics Analysis in the Colorado Desert. In *Recent Research Along the Lower Colorado River.* Edited by Joseph A. Ezzo, pp. 81-100. Statistical Research Technical Series No. 51. Tucson.

Schaefer, Jerry, and Drew Pallette

1991 *Cultural Resource Survey and Assessment of the Bema Indian Rose Project Area.* Document on file at Brian F. Mooney Associates, San Diego, and Imperial Valley College, Barker Museum.

Schaefer, Jerry and Carol Schultze

1996 *Culture Resources of Indian Pass: An Inventory and Evaluation for the Imperial Project, Imperial County, California,* Vol 1. Document on file at Chemgold, Inc., Winterhaven California and ASM Affiliates, Inc. Encinitas.

Schaefer, Jerry and Ken Victorino

1996 *Supplemental Culture Resources Inventory and Evaluation of the Power Supply Route for the Imperial Project, Imperial County, California,* Vol 1. Document on file at Chemgold, Inc., Winterhaven California and ASM Affiliates, Inc. Encinitas.

Schneider, Joan S.

1993a *Milling Implement Quarrying and Production in Eastern California and Western Arizona: A Behavioral Perspective.* Ph.D. dissertation, Department of Anthropology, University of California, Riverside.

1993b Antelope Hill: A Cultural Resources Inventory and Inquiry into Prehistoric Milling Implement Quarrying and Production Behaviors Along the Lower Gila River, Yuma County, Arizona. In J. A. Ezzo and J. H. Altschul (eds.) Glyphs and Quarries of the Lower Colorado River Valley, *Statistical Research Technical Series* No. 44, Tucson.

Schroeder, A. H.

1952 A Brief Survey of the Lower Colorado River From Davis Dam to the International Border. Bureau of Reclamation, Boulder City, Arizona.

1961 The Archaeological Excavations at Willow Beach, Arizona. *University of Utah Anthropological Papers* 50.

1975 The Hohokam, Sinagua, and the Hakataya. *Occasional Paper* 3. An Imperial Valley College Museum Society Publication, El Centro.

1979 Prehistory: Hakataya. In *Southwest*, pp. 100-107, edited by Alfonso Ortiz. Handbook of North American Indians, Vol. 9., William G. Sturtevant, General Editor. Smithsonian Institution, Washington, D.C.

Schultz, Paul L.

1949 *The 85th Infantry Division in World War II.* Infantry Journal Press, Washington.

Slaughter, Mark C., Lee Fratt, Kirk Anderson, Richard V.N. Ahlstrom

1992 Making and Using Stone Artifacts: A Context for Evaluating Lithic Sites in Arizona.

Snethkamp, Pandora E. and Dan Guthrie

1988 *The Early Holocene Occupations of Daisy Cave, San Miguel Island, California.* Paper presented, Society for California Archaeology Annual Meeting.

Spaulding, W. G.

1980 *The Presettlement Vegetation of the California Desert.* Document on file with the Bureau of Land Management, Riverside, California.

1990 Vegetational and Climatic Development of the Mojave Desert: The Last Glacial Maximum to the present. In *Packrat Middens: The Last 40,000 Years of Biotic*

Change, edited by J. L. Betancourt, P. S. Martin, and T. R. Van Devender, pp. 166-199. University of Arizona Press, Tucson.

1991 A Middle Holocene Vegetation Record from the Mojave Desert and Its Paleoclimatic Significance. *Quaternary Research* 35:427-437.

1995 Environmental Change, Ecosystem Responses, and the Late Quaternary Development of the Mojave Desert. In David W. Steadman and Jim I Mead (eds), Late Quaternary Environments and Deep History: A Triute to Paul S. Martin. *The Mammoth Site of Hot Springs, South Dakota, Inc. Scientific Papers,* Vol 3. Hot Springs, South Dakota.

Spaulding, W. G., and L. J. Graumlich

1986 The Last Pluvial Climatic Episodes in the Deserts of Southwestern North America. *Nature* 320:441-444.

Spier, Leslie

1933 *Yuman Tribes of the Gila River*. University of Chicago Press.

Steward, Julian H.

1929 Petroglyphs of California and Adjoining States. *University of California (Berkeley) Publications in American Archaeology and Ethnology* 24(2):47-238.

1938 Basin-Plateau Aboriginal Sociopolitical Groups. Smithsonian Institution, *Bureau of American Ethnology Bulletin* 120.

1941 Culture Elemnt Distributions XII, Nevada Shoshoni. *University of California (Berkeley) Anthropological Records* 4:209-259.

1977a The Direct Historical Approach to Archaeology. In Julian H. Steward, Jane C. Steward, and Robert F. Murphy (eds.). *Evolution and Ecology: Essays on Social Transformation by Julian H. Steward.* University of Illinois Press, Urbana, pp. 217-239.

1977b The Foundations of Basin-Plateau Shoshonean Society. In Julian H. Steward, Jane C. Steward, and Robert F. Murphy (eds.), *Evolution and Ecology: Essays on Social Transformation by Julian H. Steward.* University of Illinois Press, Urbana, pp. 366-406.

Stewart, Kenneth M.

1983a Yumans: Introduction. In Alfonso Ortiz (ed.), *Handbook of North American Indians,* Vol. 10, Southwest. Smithsonian Institution, Washington, D.C., pp. 1-3.

1983b Mohave. In Alfonso Ortiz (ed.), *Handbook of North American Indians,* Vol. 10, Southwest. Smithsonian Institution, Washington, D.C., pp. 55-70.

Stine, Scott

1994 Extreme and Persistent Drought in California and Patagonia During Medieval Time. *Nature* 369:546-549.

Stokes, Donald and Lillian

1996 *Stokes Field Guide to Birds, Western Region.* Little, Brown and Company, Boston.

Stone, Connie L.

1981 Economy and Warfare Along the Lower Colorado River. In David R. Wilcox and Bruce Masse (eds.) The Protohistoric Period in the North American Southwest, A.D. 1450-1700, *Anthropological Research Papers* No. 24, Arizona State University, Tempe, pp. 183-197.

1991 *The Linear Oasis: Managing Cultural Resources Along the Lower Colorado River.* U.S. Bureau of Land Management Cultural Resource Series No. 6. Phoenix.

Stoney, Stephen A.

1994 Rock Art in the Great Basin: The Scratched Style Mystery Reexamined: Is It Illusion or Reality? *Pacific Coast Archaeological Society Quarterly* 30(4):33-54.

Swanson, Mark T. and Jeffrey H. Altschul

1991 *Cultural Resources Investigations at the Yuma Quartermaster Depot.* Statistical Resource, Inc. Technical Report 21. Statistical Research, Inc. Tucson.

Taylor, Walter W.

1964 Tethered Nomadism and Water Territoriality: An Hypothesis. Congreso Internacional de Americanistas, *Actas Memorias,* 2:197-203, Mexico, D. F.

Taylor, R.E., L.A. Payen, C.A. Prior, P.J. Slota, Jr. R. Gillespie, J.A.J. Growlett, and R.E.M. Hedges, A.J.T. Jull, T.H. Zabel, D.J. Donahue, and R.Berger

1985 Major Revisions in the Pleistocene Age Assignments for North American Human Skeletons by C-14 Accelerator Mass Spectrometry: None Older Than 11,000 C-14 years B.P. *American Antiquity* 50(1):136-140.

Thomas, David H.

1974 An Archaeological Perspective on Shoshonean Bands. *American Anthropologist* 76:11-23.

1981 How to Classify the Projectile Points of the Monitor Valley, Nevada. *Journal of California and Great Basin Anthropology* 3:7-43.

1983 The Archaeology of Monitor Valley 1. Epistemology. *Anthropological Papers of the American Museum of Natural History* 58(1):1-194.

Thomas, David H. and Robert L. Bettinger

1976 Prehistoric Pinon Ecotone Settlements of the Upper Reese River Valley, Central Nevada. *Anthropological Papers of the American Museum of Natural History* 53(3):263-366.

Thompson, Raymond H.

1983 Introduction. In E. B. Sayles (ed.), The Cochise Cultural Sequence in Southeastern Arizona. *The Archaeology of the Picacho Basin, Southeast California,* pp. 167-172. Report on file with San Diego Gas and Electric.

Thompson, Robert S.

1986 Past Environment. In The Archaeology of Picacho Basin, Southeast California.

Townsend, Janet E.

1986a Ceramic Scatters. In *the Archaeology of the Picacho Basin, Southeast California*, by Lorann Pendleton, pp. 193-200. Wirth Environmental Services, San Diego.

Tringham, R., G. Cooper, G. Odell, B. Voytek, and A. Whitman

1974 Experimentation in the Formation of Edge Damage: a New Approach to Lithic Analysis. *Journal of Field Archaeology* 1:171-196.

Tuohy, Donald R.

1984 On Sleeping Circles in Baja California... And Elsewhere. *Pacific Coast Archaeological Society Quarterly* 20(1):37-49.

Van Devender, Thomas R.

1977 Comment on: Macro Fossil Analysis of Woodrat (Neotoma) Middens as a Key to the Quaternary Vegetational History of Arid North America, by P. V. Wells. *Quaternary Research* 8:236-237.

1987 Holocene Vegetation and Climate in the Puerto Blanco Mountains, Southwestern Arizona. *Quaternary Research* 27:51-72.

1990 Late Quaternary Vegetation and Climate of the Sonoran Desert, United States and Mexico. In Julio L. Betancourt, Thomas R. Van Devender, and Paul S. Martin (eds), *Packrat Middens: The Last 40,000 Years of Biotic Change.* University of Arizona Press, pp. 134-165.

Van Devender, Thomas R. and W. Geoffrey Spaulding

1979 Development of Vegetation and Climate in the Southwestern United States. *Science* 294:701-710.

von Werlhof, Jay

1984a *Archaeological Investigations of the Gold Fields Mesquite District.* Report prepared by the Imperial Valley College Museum for Gold Fields Mining Company, Inc.

1984b *Archaeological Examinations of the Mesquite District northwest.* Report prepared by the Imperial Valley College Museum for the Gold Fields Mining Company, Inc.

1984c *Archaeological Investigations of Gold Fields Indian Pass Project Area.* Report prepared by the Imperial Valley College Museum for Gold Fields Mining Company, Inc.

1987 *Spirits of the Earth, A Study of Earthern Art in the North American Deserts, Volume I: The North Desert.* Imperial Valley College Museum, El Centro, California.

von Werlhof, Jay, Sherilee von Werlhof, Morlin Childers, Howard Pritchett, Lorraine Prichett, Ray Avels, and George Collins

1977 *Archaeological Survey of the Yuha Basin.* Document on file with Imperial Valley College, Barker Museum, El Centro, California.

Walker, Henry P. and Don Bufkin

1979 *Historical Atlas of Arizona.* University of Oklahoma Press, Norman, Oklahoma.

Wallace, William J.

1962 Prehistoric Cultural Development in the Southern California Deserts. *American Antiquity* 20(2):112-123.

Warren, Claude N.

1966 The San Dieguito type Site: M. J. Rogers' 1938 Excavation on the San Dieguito River. *San Diego Museum of Man Papers* 5:1-39.

1967 The San Dieguito Complex: A Review and Hypothesis. *American Antiquity* 32(2):168-185.

1984 The Desert Region. In Michael J. Moratto (ed.) *California Archaeology.* Academic Press, pp. 339-430.

1986 *The Research Overview, Volume Two, Fort Irwin Historic Preservation Plan.* National Park Service, Western Region, San Francisco.

Warren, Claude N. and Robert H. Crabtree

1986 Prehistory of the Southwestern Area. In Warren L. D'Azevedo (ed.), *Handbook of North American Indians,* Vol. 11, Great Basin. Smithsonian Institution, Washington, D.C., pp. 183-193.

Warren, Claude N. and A.J. Ranere

1968 Outside Danger Cave: A View of Early Man in the Great Basin. *Eastern New Mexico University Contributions in Anthropology* 1(4):6-18.

Warren, Claude N. and M. G. Pavesic

1963 Shell Midden Analysis of Site SDi-603 and Ecological Implications for Cultural Development of Batiquitos Lagoon, San Diego County. *University of California (Los Angeles) Archaeological Survey Annual Report* pp. 17-26

Warren, Claude N. and D. L. True

1961 The San Dieguito Complex and It's Place in California Prehistory. *University of California (Los Angeles) Archaeological Survey Annual Report* 1960-1961:246-338.

Wasley, William W. and E. B. Sayles

1983 Radiocarbon Dating. In E. B. Sayles (ed.), The Cochise Cultural Sequence in Southeastern Arizona. *Anthropological Papers of the University of Arizona* 42:44-57.

Waters, Michael R.

1980 *Lake Cahuilla: Late Quaternary Lacustrine History of the Salton Trough, California.* Master's thesis, Department of Geosciences, University of Arizona.

1982a The Lowland Patayan Ceramic Tradition. In Randall H. McGuire and Michael B. Schiffer (eds) *Hohokam and Patayan: Prehistory of Southwestern Arizona.* Academic Press, New York, pp. 275-297.

1982b The Lowland Patayan Ceramic Typology. In Randall H. McGuire and Michael B. Schiffer (eds) *Hohokam and Patayan: Prehistory of Southwestern Arizona.* Academic Press, New York, pp. 537-570.

1982c Trail Shrines at Site SDM C-1. In Randall H. McGuire and Michael B. Schiffer (eds) *Hohokam and Patayan: Prehistory of Southwestern Arizona.* Academic Press, New York, pp. 533-536.

1982d Ceramic Data From Lowland Patayan Sites. In Randall H. McGuire and Michael B. Schiffer (eds) *Hohokam and Patayan: Prehistory of Southwestern Arizona.* Academic Press, New York, pp. 571-580.

1983 Late Holocene Lacustrine Chronology and Archaeology of Ancient Lake Cahuilla. *Quaternary Research* 19:373-387.

Watson, Patty Jo and Michael Fotiadis

1990 The Razors' Edge: Symbolic - Structuralist Archaeology and the Expansion of Archaeological Inference. *American Anthropologist* 92(3):613-629.

Weide, Margaret L.

1976 A Cultural Sequence for the Yuha Desert. In Philip J. Wilke (ed.) *Background to Prehistory of the Yuha Desert Region.* Ballena Press, Ramona, California, pp. 81-94..

Wells, Philip V.

1976 Macro Fossil Analysis of Woodrat (Neotoma) Middens as a Key to the Quaternary Vegetational History of Arid North America. *Quaternary Research* 6:223-248.

Wells, Stephen G.

1992 *Desert Pavement Landscapes: Theories of Formation and New Surface Exposure Dating Techniques.* Special Lecture, Sixth Annual Mojave Desert Quaternary Research Symposium, San Bernardino County Museum, Redlands, California.

Wells, S.G., R.Y. Anderson, L.D. McFadden, W.J. Brown, Y.Enzel, and J.L. Miossec

1989 *Late Quaternary Paleohydrology of the Eastern Mojave River Drainage, Southern California: Quantitative Assessment of the Late Quaternary Hydrologic Cycle in Large Arid Watersheds.* New Mexico Water Resources Research Institute Report No. 242. Las Cruces, New Mexico.

White, Christopher

1974 Lower Colorado River Area Aboriginal Warfare and Allied Dynamics. In Lowell J. Bean and Thomas F. King (eds.) *?Antap, California Political and Economic Organization, Ballena Press,* Ramona, California, pp. 111-136.

Wilke, P. J.

1974 Settlement and Subsistence at Perris Reservoir: A Summary of Archaeological Investigations. In: Perris Reservoir Archaeology: Late Prehistoric Demographic Change in Southeastern California, James F. O'Connell, Philip J. Wilke, Thomas F. King, and Carol L. Mix, eds., pp.20-30. Sacramento: Department of Parks and Recreation.

1978 Late Prehistoric Human Ecology at Lake Cahuilla, Coachella Valley, California. *Contributions of the University of California (Berkeley) Archaeological Research Facility* 38.

Willig, Judith A., C. Melvin Aikens, and John L. Fagan (editors)

1988 *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface.* Nevada State Museum Anthropological Papers 21. Carson City.

Woods, Clyde M.

1982 *APS/SDG&E Interconnection Project, Miguel to the Colorado River and Miguel to Mission Tap: Identification and Evaluation of Native American Cultural Resources.* Document on file with San Diego Gas & Electric Company.

1986 *The Archaeology of Creation: Native American Ethnology of Cultural Resources at Pilot Knob.* Wirth Environmental Services, San Diego.

Woznicki, Robert M.A., M.A., Ph. D.

1995 *The History of Yuma and the Territorial Prison*, Self Published.

Yellen, John E.
1977 *Archaeological Approaches to the Present: Models for Reconstructing the Past.* Academic Press, New York.

York, Andrew, and W. Geoffrey Spaulding
1995 Late Holocene Environment and Culture in the Central Mojave Desert. Paper presented at the Annual Meeting of the Society for California Archaeology, Eureka, California.

1996 Late Holocene Environment and Human Settlement of the Mojave Desert. Paper presented at the Annual Meetings of the Society for American Archaeology, New Orleans, Louisiana.

Young, D. and D. Bamforth
1990 On the Macroscopic Identification of Used Flakes. *American Antiquity* 55:403-409.

APPENDIX A

RESUMES

Andrew Pigniolo, M.A.
Senior Archaeologist

K·E·A Environmental

Summary

Experience in conducting cultural resource Investigations for a wide variety of projects

Knowledge of CEQA/NEPA requirements

Employment History

KEA Environmental, Inc.
San Diego, CA
1994-present, Senior Archaeologist

Ogden Environmental and Energy Services, Inc./ERC Environmental and Energy Services, Inc./ WESTEC Services, Inc.
San Diego, CA
1985-1994, Project Archaeologist

Cultural Resource Management Center, San Diego State University
San Diego, CA
1982-1985, Reports Archivist

Archaeological Consultant
1980-1985, Archaeologist

Education

M.A., Anthropology
San Diego State University, 1992

B.A., Anthropology
San Diego State University, 1985

Certifications

Society of Professional Archaeologists (SOPA): Field Research, 1992-present

Certified Archaeology Consultant, County of San Diego

Bureau of Land Management Certification - California

Professional Affiliations

Society for Archaeological Sciences
Society for California Archaeology
Society for American Archaeology
Pacific Coast Archaeological Society
San Diego County Archaeological Society
San Diego Historical Society

As Senior Archaeologist, Andrew Pigniolo manages and conducts cultural resource investigations involving compliance with the California Environmental Quality Act (CEQA), and federal regulations associated with the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA). Mr. Pigniolo has more than 14 years of experience as an archaeologist, and has conducted more than 120 projects throughout southern California and western Arizona. He has authored numerous technical reports and prepared cultural resources sections of many Environmental Assessments (EA), Environmental Impact Statements (EIS), and Environmental Impact Reports (EIR) for local, state, and federal review.

Mr. Pigniolo has experience in cultural resource investigations for a wide variety of development and resource management projects, including military installations, geothermal power projects, water resource facilities, transportation projects, commercial and residential developments, and landfills. He has conducted the complete range of technical studies including archaeological overviews, archaeological surveys, test excavations, historical research, evaluations of significance for National Register eligibility, data recovery programs, and monitoring projects.

James Cleland, Ph.D.
Principal Archaeologist

KEA Environmental

Summary
Principal for archaeological and historical studies
Twenty-two years experience directing cultural resource programs
Section 106 compliance specialist

Employment History
KEA Environmental, Inc.
San Diego, CA
1992-present, Principal

Dames & Moore, Inc.
San Diego, CA
1983-1992, Associate/Senior Archaeologist

Wirth Associates, Inc.
San Diego, CA
1978-1983, Senior Archaeologist/ Manager, San Diego Office

Virginia Commonwealth University
Richmond, VA
1976-1978, Assistant Professor and Director of Archaeological Services Center

University of Virginia
Charlottesville, VA
1973-1975, Research Assistant and Assistant Manager of Archaeology Lab

Education
Ph.D., Anthropology
University of Virginia, 1977

M.A., Anthropology
University of Virginia, 1974

B.A., Anthropology
University of Michigan, 1969

Certification
Society of Professional Archaeologists (SOPA): Field Research, Archaeological Administration, and Archaeological Resource Management, 1993-present

Professional Affiliations
Society for California Archaeology
American Anthropological Association
Society for American Archaeology

Principal Archaeologist for KEA, Dr. James Cleland has 22 years of experience conducting archaeological, historical, and ethnographic studies. He is thoroughly familiar with regulations and guidelines implementing the National Historic Preservation Act, NEPA, and CEQA. Dr. Cleland authored the cultural resources sections of many Environmental Assessments (EAs), Environmental Impact Statements (EISs), and Environmental Impact Reports (EIRs), and has provided expert testimony before federal and state administrative agencies regarding the consideration of cultural resources in environmental review.

Dr. Cleland has conducted cultural resources investigations throughout the U.S. and abroad. He manages the full spectrum of technical studies, including archaeological overviews, archaeological surveys, test excavations, historical research, historic structures surveys, Native American contact programs, evaluations of significance for National Register eligibility, data recovery excavations, construction monitoring, long-term resource planning, and pure research.

Cultural resource consulting services have been provided by Dr. Cleland for a broad spectrum of development and resource management projects, including military activities, thermal generating plants, transmission lines, pipelines, oil and gas processing plants, water resource facilities, highways, timber sales, landfills, and commercial and residential developments.

Dr. Cleland has devoted considerable effort to professional archaeological societies and public service. In 1991-1992, he served as President of the Society for California Archaeology (SCA) and also served a three-year term on the SCA Executive Board. In 1992, Dr. Cleland was appointed to Governor Pete Wilson's Heritage Task Force and helped to guide the formulation of archaeological and historic preservation policy at the state level. During this time, he worked closely with the SCA and the State Historic Resources Commission in the successful adoption of statewide archaeological curation guidelines.

Jackson Underwood, Ph.D.

Senior Archaeologist

K·E·A
Environmental

Employment History
KEA Environmental, Inc.
San Diego, CA
1997-present, Senior Heritage Resource Specialist

ASM Affiliates
Encinitas, CA
1996-1997, Heritage Resource Manager

Computer Sciences Corporation
Edwards AFB, CA
1994-1996, Senior Heritage Resource Manager

California State Long Beach
Long Beach, CA
1993, Senior Heritage Resource Manager

University of California Los Angeles
Los Angeles, CA
1984-1991, Ethnographer (1987-1991), Graduate Assistant (1984-1987), Departments of Psychiatry and Anthropology

1978-1984, Archaeologist
Various CRM consulting firms, Fort Irwin Archaeological Project, and Black Mesa Archaeological Project

Education
Ph.D., Anthropology
University of California
Los Angeles, 1990

Graduate Program for Psychocultural Studies and Medical Anthropology, Departments of Psychiatry and Anthropology,
University of California
Los Angeles, 1990

M.A., Anthropology,
San Diego State University, 1984

B.A., Anthropology,
San Diego State University, 1979

Field School in Archaeological Excavation
Northern Arizona University, 1978

A.A., Anthropology,
San Diego Mesa College, 1978

Dr. Jackson Underwood has 19 years of experience in a broad array of cultural resources investigations, including archaeology, ethnography, and history. Dr. Underwood has conducted and directed archaeological surveys and excavations throughout southern California with additional experience in northern California and the Southwest. He has authored technical reports and professional papers on all of these areas.

His project experience includes a variety of military, energy, mining, and infrastructure developments. He has substantial experience at the Fort Irwin National Training Center and at Edwards Air Force Base, where he wrote historic resource management plans, research designs and testing and evaluation reports. He has conducted a variety of fiber-optics, pipeline and transmission surveys in southern and northern California. He also conducted several archaeological investigations on campus for the California State University, Long Beach. Most recently, Dr. Underwood has been conducting bibliographic background research on Native American trail systems and religious sites in the Colorado Desert for the proposed Glamis Imperial Mine.

Dr. Underwood's ethnographic studies include work with the mentally ill homeless in Los Angeles, which was the subject of his doctoral dissertation. He has eight years of professional experience in psychiatric and medical anthropology, including literature review, fieldwork, interview schedule construction, participant observation, field interviews, and qualitative and quantitative data analysis. He also has substantial experience in working with Native American groups. He served as an advisor to the Gabrielino/Tongva Tribal Council on cultural resource and repatriation issues and conducted ethnoarchaeological investigations at Black Mesa, Arizona.

APPENDIX B

MAJOR RESEARCH RESOURCES FOR LOWER COLORADO RIVER PREHISTORY

ANNOTATED BIBLIOGRAPHY OF MAJOR RESEARCH RESOURCES FOR LOWER COLORADO RIVER PREHISTORY

The following is a concise précis of major research efforts that relate to the archaeology and ethnography of the study area. An attempt is made to evaluate the validity and utility of these works for further research of the area. We begin with the work of Malcolm Rogers; other research is presented in approximate chronological order to provide the reader a sense of the additive, historical process of research in our area. Minor works are omitted. Previous CRM work within the study area is discussed in the previous research section (Chapter 4).

The Research of Malcolm J. Rogers

Malcolm J. Rogers was trained as a mining geologist at Syracuse University and had served in the Marine Corps before becoming a citrus farmer in north San Diego County. In 1919, he was looking for some Indian artifacts when he happened upon some very old lithic materials he found completely fascinating. Thus began a lifelong devotion to archaeological survey and synthesis focused on early occupations of the southern portions of California, Arizona, and Nevada, and northern Mexico (McGuire 1982:114-115; Pourade 1966:9). He began to survey, funded by himself, in our study area beginning in 1925. The Indian Pass site was the first recorded focus of his far-ranging research in the Colorado Desert (site C-1, see Waters 1982c). In 1926, he expanded his work to southern Arizona; in 1927 he extended his scope into Nevada. After a brief association with the Arizona Museum, he joined the staff of the San Diego Museum of Man in 1928. Rogers recorded and tested numerous sites in the study area and all over Colorado Desert, the Mojave Desert and northern Baja California. He was apparently first to describe the geoglyphs in the Blythe area (1939). He continued field research, primarily survey, on a sporadic basis until struck and killed by an auto in 1960 (Pourade 1966:19). He left large collections, site forms, notes, sketches and maps at the San Diego Museum of Man. Most of his research remains unanalyzed and unpublished. Over the years, a number of important contributions have been based on the work of Rogers or continuations of his work, e.g., True and Warren 1961; Warren 1966, 1967). In 1982, Michael Waters published three articles based explicitly on a review of the Rogers materials on ceramics (Waters 1982a and b) and the testing of the trail shrines at Indian Pass (Waters 1982c).

To summarize, virtually all discussion of paleoindian and archaic period prehistory for the Pacific Southwest begins with the work of Rogers. His ceramic typology for Southern California, as informed by more recent work of Waters (1982), is still the standard tool for archaeologists. The notes, maps and collections he left behind at the Museum of Man remain a major resource for archaeological research.

Relevant Published Work of Malcolm J. Rogers

Rogers, Malcolm J.

1939 Early Lithic Industries of the Lower Basin of the Colorado River and Adjacent Desert Areas. San Diego Museum of Man Papers 3

In this classic work, Rogers first outlined his San Dieguito complex. Many of the ideas presented here were first based on research in the area west of Indian Pass near our project area.

1945 An Outline of Yuman Prehistory. Southwestern Journal of Anthropology 1(2):167-198.

This was a paper describing the scope of his research, his methods and his conclusions about Yuman (now known as Patayan) culture history. It was based largely on pottery from surface discoveries, the first of which came from the Indian Pass area. However, this article did not present the Rogers pottery typology. Schroeder published his typology first (1952) after a brief survey of the Lower Colorado area and an examination of Rogers' notes and collections. Much to his discredit, Schroeder appropriated Rogers' type names, reworked the collection, and vandalized his notes (Rogers 1959; Waters 1982a:278, 280).

1958 San Dieguito Implements from the Terraces of the Rincon-Patano and Rillito Drainage System. The Kiva 24(1):1-23.

This is a review of early Holocene materials from the Tucson vicinity. It helps establish the presence of San Dieguito materials at considerable distance from San Diego.

Rogers, Malcolm J., H. M. Wormington, E. L. Davis, and C. L. Brott
1966 Ancient Hunters of the Far West. Copley Press, San Diego.

Six years after the death of Rogers, Richard F. Pourade, a former editor of the San Diego Union, published this summary of the Rogers desert research with contributions by H. M. Wormington, Emma Lou Davis, and Clark W. Brott. A well-edited recapitulation of Rogers' life's work with numerous figures and plates, it presents his final ideas on the San Dieguito Complex.

Ethnographic and Ethnohistoric Sources

Font, Pedro
1775 The Colorado Yumans in 1775. In Bolton, Herbert E. (ed.) Font's Complete Diary, 1931. Reprinted in Robert F. Heizer and M. A. Whipple (eds.) The California Indians: A Source Book, Second Edition, University of California Press, Berkeley, pp. 247-254.

A brief ethnographic sketch of the Quechan.

Trippel, E. J.
1889 The Yuma Indians. Overland Monthly, Second Series 13:561-584; 14:1-11.

This is a good, early ethnographic sketch of Quechan life in the late 19th century. Trippel provided information about the subsistence system, recreation, political organization, ceremonies, healing, and warfare. He witnessed a number of traditional Quechan events, including a cremation and a *Keruk* ceremony.

Heffernan, W. T.

1896 Medicine Among the Yumas. California Medicine Journal 17:135-140. Reprinted in Robert F. Heizer (ed.) A Collection of Ethnographical Articles on the California Indians. Ballena Press Publications in Archaeology, Technology, and History No. 7, pp 98-103.

This early article written in a travelogue style offers some observations Heffernan made while a physician at Fort Yuma in the late 19th century. It deals very briefly with diet, healing practices, cosmology, and cremation ceremonies.

Coues, Elliot (ed.)

1900 On the Trail of a Spanish Pioneer: the Diary, and Itinerary of Francisco Garces in his Travels through Sonora, Arizona, and California 1775-1776, 2 Vols., Francis P. Harper, New York.

Garces provides some of the best ethnographic observations of his time.

Bolton, Herbert E. (ed.)

1925 Spanish Exploration in the Southwest, 1543-1709. Charles Scribner's Sons, New York.

1930 Anza's California Expeditions. 5 vols. University of California Press, Berkeley.

Bolton provides translations of early Spanish journals.

Kroeber, A. L.

1920 Yuman Tribes of the Lower Colorado. University of California (Berkeley) Publications in American Archaeology and Ethnology 16(8):475-485.

Based chiefly upon his research among the Mojave, Kroeber discusses the various tribes that lived along the Lower Colorado at the time of various visits by Spanish explorers. He deals with the tangle of early labels for these peoples and where their settlements were.

1925 Handbook of the Indians of California. Bureau of American Ethnology, Smithsonian Institution Bulletin 78. Reissued by Dover Publications, New York.

Kroeber provides brief ethnographic sketches for most Indian tribes of California on the basis of some 17 years of intermittent fieldwork. Of interest to students of Lower Colorado prehistory is his extensive discussions of the Mojave, among whom he conducted extensive ethnographic work. He also discusses the Kumeyaay-Kamia, the Quechan and briefly, other River tribes.

Steward, Julian H.

1929 Petroglyphs of California and Adjoining States. University of California, Berkeley, Publications in American Archaeology and Ethnology 24(2):47-238.

The first systematic study of rock art in the West, this was the foundation for later work by Heizer and Baumhoff, Clewlow and others.

Forde, C. Daryll
1931 Ethnography of the Yuma Indians. University of California (Berkeley) Publications in American Archaeology and Ethnology 28(4)

This is the only ethnographic monograph on the Quechan. It provides only minimal information on material culture. While this is the case for most ethnographies, it is a source of some frustration for archaeologists. However, Forde provides excellent discussions and diagrams of the *Keruk* ceremony, which he witnessed in September, 1929. He also deals well with structure types, the settlement system, the religious system, and the subsistence system. Particularly valuable is Forde's discussion of Quechan spirituality and his recounting of the origin myths and other stories of spiritual significance.

Drucker, Philip
1941 Culture Element Distributions: XVII Yuma-Piman. University of California Berkeley Anthropological Records 6:3

Like the other culture element monographs, this consists primarily of a series of tables listing the presence and absence of traits for the cultural groups covered. A few pages are devoted to a discussion of relationships between Yuman groups, but virtually no other amplifications or explanations are offered. This work was based on a three-month field trip undertaken by Drucker in the spring of 1938. Cultural groups covered included Diegueno, Mohave, Cocopa, and Maricopa bordering our study area and others, but not the Quechan (or Yuma as they were then known) or the Halchidhoma who once lived near the study area. It is of use as a reference for the Lower Colorado River Yuman groups in general, however.

Seltzer, Frank M.
1952 Seeking the Secret of the Giants. National Geographic CII(3):390-404.

During desert training associated with WWII, General George C. Marshall became quite fascinated with intaglios that he had seen from the air. In 1952, he collaborated with Frank M. Seltzer, Head Curator of the Anthropology Department of the Smithsonian Institution. With the help of the National Geographic Society and the U. S. Air Force, aerial reconnaissance of the area around Blythe was undertaken and the intaglio complex at Ripley was discovered. This project produced fine quality aerial photographs of the geoglyphs near Blythe, California and Ripley, Arizona.

Castetter, Edward F. and Willis H. Bell
1951 Yuman Indian Agriculture: Primitive Subsistence on the Lower Colorado and Gila Rivers. University of New Mexico Press.

This work covers the Mojave, Quechan, Cocopa of the Lower Colorado River, and the Maricopa on the Gila. The book has become a classic on the traditional subsistence systems of these tribes, the primary focus of the book. But there is considerable general ethnographic information about other cultural systems and the relation of these to the natural environment. The book is based on fieldwork conducted intermittently from 1937 to 1941.

Forbes, Jack D.
1965 Warriors of the Colorado; The Yumas of the Quechan Nation and their Neighbors. University of Oklahoma Press, Norman.

Forbes begins with a sketch of the origin of the Quechan, their environment, and their relationship with the prehistoric Hohokam of central Arizona and with other Native American groups at the time of contact with the Spanish, e.g., the Ootam, Cocopa, Maricopa, Kumeyaay and Mojave. There is a discussion of origin myths of the pan-Yuman people. The main focus of the book, however, is a history of the Quechan relations with the Spanish and later with the Americans and with other Colorado River tribes. A wealth of information is pulled together from the journals of Alarcón, Oñate, Garcés and other explorers. Throughout the book, one encounters ethnographically valuable information about the traditional lifeways of the Quechan and their neighbors. The work is ordered chronologically, rather than by ethnographic topic, so finding discussions on particular topics of interest to the prehistorian or ethnographer is at times difficult. An excellent and thorough index helps in that regard, however.

Bee, Robert L.
1981 Crosscurrents Along the Colorado: The Impact of Government Policy on the Quechan Indians. University of Arizona Press, Tucson.

This book is the result of 13 years of intermittent research among the Quechan beginning in 1961. While there is some ethnographically useful information about traditional Quechan lifeways, the focus of the work is on the troubled relations with Anglo-Americans, particularly the U.S. Government. The timeframe includes the early Spanish explorers and continues to the present (1981), and deals with a number of problems, most of which are ongoing, e.g. schooling, economics, water issues, unlawful reductions in reservation size, and so on.

Woods, Clyde M.
1982 APS/SDG&E Interconnection Project, Miguel to the Colorado River and Miguel to Mission Tap: Identification and Evaluation of Native American Cultural Resources. Document on file with San Diego Gas & Electric Company.

This is primarily an ethnographic summary of traditional Native American lifeways along a powerline corridor from north coastal San Diego County to the Colorado River. Another important aspect of this work is Native American consultation and documentation of contemporary concerns. There are major discussions on the Kumeyaay and Iipay, by Ruth F. Almstedt; the Kamia (Desert of Eastern Kumeyaay) by Florence C. Shipek; the Quechan by Robert L. Bee; and the Cocopah by Anita Alvarez de Williams. These succinct ethnographic summaries are particularly valuable because they include contemporary views of Native American consultants as well material from the traditional ethnographic sources.

The Handbook of North American Indians

The Handbook is a huge, multi-volume collection published by the Smithsonian Institution, Washington, D.C. Each cultural group is dealt with in a brief ethnographic sketch. Typically these deal with language, general cultural systems (subsistence, settlement, technology, socio-political organization, etc.), population, current socioeconomic situation, synonymy, and source material. The essays tend to be brief outlines, but they tend to be carefully constructed and despite their limitations, are a good introduction to the cultures covered. The Lower Colorado river tribes are unfortunately split off from their close California relatives, but included with their not so close Arizona ones, in Volume 10. The following essays are of some relevance to the study area.

Volume 8, California, 1978, Robert F. Heizer, Volume Editor.

Bean, John Lowell
Cahuilla

Luomala, Katharine
Tipai and Ipai

Heizer, Robert F.
Trade and Trails
Treaties

Shipek, Florence
History of Southern California Mission Indians

Clewlow, C. William Jr.
Prehistoric Rock Art.

Volume 10, The Southwest, 1984, Alfonso Ortiz, Volume Editor

Stewart, Kenneth M.
Yumans: Introduction

Kendall, Martha B.
Yuman Languages

Stewart, Kenneth M.
Mohave

Harwell, Henry O. and Marsha C. S. Kelly
Maricopa

Bee, Robert L.
Quechan

de Williams, Anita Alvarez
Cocopa

Archaeological Sources 1950-1983

Schroeder, Albert H.
1952 A Brief Survey of the Lower Colorado River From Davis Dam to the International Border. Bureau of Reclamation, Boulder City, Arizona.

Schroeder conducted what is popularly known as a windshield survey covering a strip 12 miles wide on both sides of the Rio Colorado. Most was done using a Jeep, but a stretch between Turkey Lake and Picacho on the California side was skipped, and a stretch from Fort Mojave to Davis Dam as investigated by boat. He evidently examined previously recorded sites and spot checked likely places. His primary research interest was in the poorly understood ceramics of the Lower Colorado area, and in the report, he defines Lower Colorado Buff Ware and 23 constituent types, partly on the basis of Rogers' collections and notes at the San Diego Museum of Man.

Sample, L. L.
1950 Trade and Trails in Aboriginal California. Reports of the University of California (Berkeley) Archaeological Survey No. 8.

This is primarily a long list of materials that were traded among Indian groups in California based on far-flung ethnographic sources. A small scale map of Indian trails and trade routes is provided.

Harner, Michael
1953 Gravel Pictographs of the Lower Colorado River Region. University of California (Berkeley) Archaeological Survey Report 20:1-32.

Based on extensive ethnography information, Harner offered some ideas about the origin and function of geoglyphs of the lower Colorado River area. He argued that geoglyphs have physical and functional similarities to sand paintings.

Brooks, Richard H.
n.d. Second Interim Report on the Archaeological Survey of the Lower Colorado River. Document on fine with the Bureau of Land Management, Phoenix.

Brooks, Richard H., Lawrence Alexander, and Robert H. Crabtree
1970 The 1969/1970 Report on the Archeological Survey of the Lower Colorado River. Document on file with the Desert Research Institute, University of Nevada, Reno.

Brooks, Alexander, and Crabtree under the auspices of University of Nevada, Las Vegas conducted survey research funded by the Bureau of Reclamation. This was a sample survey along the Lower Colorado River on the California side from Parker Dam to lower Cibola Valley, and from Laguna Dam to the international border. The Topock Rock Maze near Needles, was investigated as were selected areas on the Arizona side. The research was conducted in response to proposed dredging and rechannelization of the river. Limited excavation was conducted in the Parker vicinity because these sites were in an area slated for extensive grading. The report is brief and of little research value; fieldnotes may be available at the University of Nevada, Las Vegas.

White, Christopher

1974 Lower Colorado River Area Aboriginal Warefare and Allied Dynamics. In Lowell J. Bean and Thomas F. King (eds.) ?Antap, California Political and Economic Organization, Ballena Press, Ramona, California, pp. 111-136.

White discusses economic, environmental, and political underpinning for the institution of endemic warfare among Lower Colorado River tribes.

Smith, Gerald A.

1974 Investigation of Known Intaglios Located Along the Colorado River Between Ripley and Old Fort Mohave. San Bernardino County Museum, Redlands.

This research was funded by the BLM with the goal of documenting known intaglios, assessing their condition, and addressing preservation issues. Smith documented and photographed them in color and black and white from the ground and air. Some 10 intaglios, 8 on the California side of the river were included in the study. He did not speculate about age, function, or cultural affiliation of the sites.

Wilke, Philip J. (ed.)

1976 Background to Prehistory of the Yuha Desert Region: Papers by David L. Weide, James P. Barker, Harry W. Lawton, and Margaret L. Weide. Ballena Press Anthropological Papers No. 5.

While the Yuha Desert is west of the study area by some 60 miles, there is much of value in this volume. Of particular interest are pieces on the ethnography of the by Barker, ethnohistory by Lawton, and a cultural sequence by M. Weide.

Wilke, P. J.

1978 Late Prehistoric Human Ecology at Lake Cahuilla, Coachella Valley, California. Contributions of the University of California (Berkeley) Archaeological Research Facility 38.

Wilke discusses the cyclic rise and fall of Lake Cahuilla and the import of this huge body of fresh water for the late prehistory of the Colorado Desert. On the basis of intensive study of coperlites, he provides insight about prehistoric diet, economy, and the nature of the Lake Cahuilla settlement system.

Heizer, Robert F. and Martin A. Baumhoff

1978 Prehistoric Rock Art of Nevada and Eastern California. University of California Press, Berkeley.

A landmark synthesis on rock art of the West, this work provides a typology that provides the primary framework for this study.

Waters, Michael R.

1980 Lake Cahuilla: Late Quaternary Lacustrine History of the Salton Trough, California. Master's thesis, Department of Geosciences, University of Arizona.

1983 Late Holocene Lacustrine Chronology and Archaeology of Ancient Lake Cahuilla. Quaternary Research 19:373-387.

The focus of Waters' thesis is the historic geology of Lake Cahuilla. It contains an excellent review of past research and historic and ethnographic work relating to the Lake which is still valuable. Of particular interest is the in-depth discussion of the various late prehistoric stands of the Lake, the evidence for their existence, how they have been dated and the myriad problems of lake research in general. He concludes by asserting there were four fillings of Lake Cahuilla during the last 2,000 years. These are tentatively dated to 1300-1150 B.P., 1050-950 B.P., 800-650 B. P., and 500-430 B.P.

Dominici, Debra A.

1982 Archaeological Phase I Survey Report for the Proposed Cargo Material Site, 11520-910035-5958. Document on file with Caltrans, District 11, San Diego.

Caltrans archaeologists conducted a survey of some 122.7 hectares on Sidewinder Road at Jackson Gulch just south of the Cargo Muchacho Mountains. Part of this survey area overlaps the transmission line corridor associated with our current effort. Dominici's survey resulted in the discovery and recording of two pottery scatters, a San Dieguito lithic site, three isolates associated with the San Dieguito site and two historic refuse deposits. The report provides excellent photographs and succinct site descriptions. Little attempt was made to put the results of the survey into a regional perspective or explore how they might contribute to regional research issues.

Baksh, Michael

1994 Ethnographic and Ethnohistoric Insights into the Quen Sabe Intaglios. In Joseph A. Ezzo (ed.) Recent Research Along the Lower Colorado River: Proceedings from a Symposium Presented at the 59th Annual Meeting of the Society for American Archaeology, Anaheim, California, April 1994. Statistical Research Technical Series No. 51, Tucson, pp. 15-48.

Baksh deals with an area north of Blythe, outside our study area. However he offers some helpful ethnographic-based interpretations about the cultural function of intaglio sites in general and possible meanings of particular intaglio design elements. He finds it frustrating that he was not able to obtain more information about specific spiritually significant sites:

> Some information and interpretations on specific sites identified by the archaeological survey was elicited from the Native American Consultants; this information is presented below. In general, however, very little information was elicited that assists in understanding the meaning of specific intaglio and petroglyph sites, or why they were created... The inability

to obtain specific information on several sites is clearly a consequence of cultural loss (1994:21)

Statements about Yuman culture within the article help reveal why more information was not readily forthcoming in the passage that followed:

> Several consultants also noted that information is known about some sites, but that it cannot be divulged. Mr. Milazzo, Ms. Cornelius, and Mr. Martin stated, for example, that they could not discuss the sites without permission of the tribal elders. Similarly, Mr. Johnson and Mr. Bricker were restricted from saying much about the Black Point site (CA RIV 870). The explained that they could not say much because "it would upset the elders." They also noted that there is a long history of whites [sic] laughing at such descriptions and so it was easier to just keep things secret. It was also mentioned that information about these types of sites is not always shared among tribal members. As explained by Mr. Milazzo:
>
>> In the past I have noted and been told by my Elders that traditionally, this type of information [about intaglios and petroglyphs] was not freely shared among all members of the tribe. But, [the knowledge] was reserved for the person(s) chosen to care for and utilized this knowledge for the well being of the people. This information was used by that person only and was related only to the next person chosen to care for this knowledge.
>
> Mr. Bricker made a similar remark: "Even a lot of our own people won't tell us about these things. They're afraid that if they tell us, we'll talk to the white people and the story will get out (Baksh 1994:22).

There is surely some significant cultural loss regarding Quechan and Mojave religion as Baksh suggests. However, the presence of taboos on discussing religious and spiritual matters makes it impossible for an outsider to evaluate the level of cultural loss with regard to religious, ritual, and ceremonial matters on the basis of brief fieldwork.

The strong point of this article is Baksh's review the ethnographic literature on religious belief and stories among the Yuman tribes and how they might relate to intaglio designs in a general way. This more broadly applicable, general discussion may be actually of more value to scholars. The archaeological features he discusses include giant humans, shamans-doctors, snakes, twins, horses, hair, spirals, half circles, features resulting from ceremonies and dances including the *keruk,* trails, sleeping circles, and non-cairn stone piles.

McGuire, Randall H. and Michael B. Schiffer (eds)
1982 Hohokam and Patayan: Prehistory of Southwestern Arizona. Academic Press, New York.

This is a widely ranging volume dealing with a number of archaeological issues some of which are significant for the Lower Colorado region. The book provides sketches of the environmental background, ethnographic research, and past archaeological research and related issues. It is a valuable review. A few articles are worthy of separate discussion for our study area.

Solari, Elaine M. and Boma Johnson

1982 Intaglios: A Synthesis of Known Information and Recommendations for Management. In Randall H. McGuire and Michael B. Schiffer (eds) Hohokam and Patayan: Prehistory of Southwestern Arizona. Academic Press, New York, pp. 417-432.

A review article on intaglios dealing with past research, ethnographic accounts, distribution, similarities to other Native American art forms, and dating. The authors list important intaglio sites and also offer ideas on function in Indian societies and how to protect and manage them.

Waters, Michael R.

1982a The Lowland Patayan Ceramic Tradition. In Randall H. McGuire and Michael B. Schiffer (eds) Hohokam and Patayan: Prehistory of Southwestern Arizona. Academic Press, New York, pp. 275-297.

1982b The Lowland Patayan Ceramic Typology. In Randall H. McGuire and Michael B. Schiffer (eds) Hohokam and Patayan: Prehistory of Southwestern Arizona. Academic Press, New York, pp. 537-570.

1982d Ceramic Data From Lowland Patayan Sites. In Randall H. McGuire and Michael B. Schiffer (eds) Hohokam and Patayan: Prehistory of Southwestern Arizona. Academic Press, New York, pp. 571-580.

These three articles are updates and revisions of Rogers' unpublished pottery typology for the Lower Colorado River area. The typology uses rim forms, vessel shape, and, to a lessor degree, physical characteristics of sherds as diagnostic criteria. Waters utilized the notes and collections of Rogers to provide detailed, explicit descriptions of the Rogers types, with illustrations and photographs of vessel shapes and design elements. He attempts to follow the terminology of Colton and Hargrave (1937) and Colton (1953) and presents his terms in an explicit glossary. This typology has become a standard research tool for the area (Schaefer 1994).

It is unfortunate that Waters continued to use the term Black Mesa in type designations of Rogers since there is no Black Mesa here; the type is actually named for Black Mountain, near Indian Pass. Adding to the confusion is the fact that there is a well-known Black Mesa Black-on-white ceramic type from the "real" Black Mesa, located on the Navajo reservation in northeastern Arizona.

1982c Trail Shrines at Site SDM C-1. In Randall H. McGuire and Michael B. Schiffer (eds) Hohokam and Patayan: Prehistory of Southwestern Arizona. Academic Press, New York, pp. 533-535.

This article documents the survey and limited excavation research of Rogers in the Indian Pass area. This took place in 1925, and was his first research for the San Diego Museum of Man. The area has a major Patayan I trail with at least six associated trail shrines; there may have had more prior to construction of a mining road. Rogers excavated the six and provided plans and profiles of Shrines 1 and 2, which were partly vandalized by relic hunters. Patayan I pottery and incised basalt cobbles were found throughout the excavations; some Santa Cruz Red-on-buff (Colonial Phase Hohokam) sherds were associated. Patayan II pottery was noted on the surface (1982c:533).

The Research of Jay von Werlhof

Jay von Werlhof of the Imperial Valley College (IVC) Museum has conducted archaeological research in the Colorado Desert for some 30 years. He has also developed a repository for archaeological records at the IVC Museum. Von Werlhof has published a synthesis of his research on geoglyphs of the southern Great Basin-Mojave Desert (von Werlhof 1987), and a similar volume on the Colorado Desert is in process. Along with Harry Casey, von Werlhof conducted extensive aerial reconnaissance of the Ripley, Blythe and other areas. Von Werlhof, Casey and others have produced an open-ended National Register of Historic Places nomination for all geoglyph sites in the Colorado Desert. Von Werlhof has conducted field classes in and near the study area which have produced voluminous unpublished notes and maps. He and his associates have also produced a number of CRM reports on areas near the study area. All these materials are on file at the IVC Museum.

von Werlhof, Jay, Sherilee von Werlhof, Morlin Childers, Howard Pritchett, Lorraine Prichett, Ray Avels, and George Collins

1977 Archaeological Survey of the Yuha Basin. Document on file with Imperial Valley College, Barker Museum, El Centro, California.

von Werlhof, Jay

1981 An Archaeological Survey of a Portion of the Cargo Muchacho Mountains: A Report to the State Lands Commission. Document on file with Imperial Valley College Museum.

Von Werlhof and his team of volunteers from the IVC Museum recorded 10 archaeological sites in the Oregon Canyon-Pasadena Peak area of the Cargo Muchacho Mountains. This work, the first to take place in the Cargo Muchacho Mountains, was undertaken as part of the environmental process for a proposed mine prospecting drill operation east of the American Girl Mine. Significant features included a religious shrine, spirit break, and cairns associated with trails and remnants of an historic building made of rock. Von Werlhof suggests that because of its location and the kinds of features he encountered, the entire Cargo Muchacho Mountain area may best be considered and managed as an archaeological district. This report is in five volumes, one of which consists of a lithic analysis conducted Jay and Nancy Hatley.

1988 Trails in Eastern San Diego County and Imperial County: An Interim Report. Pacific Coast Archaeological Society Quarterly 24(1):51-75.

Based on long-term study of trails beginning in 1973, von Werlhof provides a report on trail functions, attributes, associated features, and locations for the area between the east shore of Lake Cahuilla and the Colorado River.

The Gold Fields - Mesquite Projects

Beginning in 1982, various surveys have been undertaken in this area, located some 12 miles northwest of the Indian Pass area. The proposed action was a gold mining complex. Jay von Werlhof completed a series of reports on this area

von Werlhof, Jay

n.d. Archaeological Investigations of Gold Fields Indian Pass Project Area. Document on file with the IVC Barker Museum.

This survey documents the existence of some 28 sites, including trails, ceramic scatters, lithic scatters, rock rings, cleared circles, cairns, hearths, petroglyphs, geoglyphs, and historic and military sites. Included was one San Dieguito II site (IMP 5038), and others that may be very old judging from the heavy desert varnish on some of the artifacts (e.g., IMP 5066).

1984a Archaeological Investigations of the Gold Fields Mesquite District. Document on file at the Imperial Valley College Museum.

This survey report documents the existence of 77 sites, including numerous trail segments, chipping stations, lithic scatters, rock rings, cairns, cleared circles, geoglyphs, ceramic scatters, historic sites, and a single petroglyph complex.

1984b Archaeological Examinations of the Mesquite District Northwest. Document on file at the Imperial Valley College Museum.

This small, additional survey recorded the existence of 15 sites.

Schaefer, Jerry

1984 Cultural Resource Management Plan, Gold Fields - Mesquite Project, Imperial County, California. Document on file at Imperial Valley College Museum and Mooney and Associates, San Diego.

This is a Cultural Resources Management Plan (CRMP) for the testing and data recovery of project sites determined to be potentially eligible to the National Register of Historic Places. Among other things, this report recommended a fencing program to protect an historic wagon road and a prehistoric petroglyph site. This was later implemented by the BLM.

1984b Colorado Desert Cultural Resources in Sections 4, 6, and 7 of Township 18 South, Range 19 East, Imperial County, California. Report on file with the BLM, El Centro, and Mooney and Associates, San Diego.

This is a partly a re-survey and re-evaluation of the von Werlhof (1984b) survey. Schaefer argued that some of the sites recorded by von Werlhof were natural features and not sites, and three new sites were discovered. As re-defined by Schaefer, 19 sites existed on the project including trails, chipping stations, lithic scatters, rock rings, and cleared circles. Four were considered eligible to the National Register of Historic Places; four were indeterminate.

The Gold Fields - Mesquite series of surveys of von Werlhof and Schaefer recorded a total of 100 sites, most of which were ceramic scatters over a project area of over 12 square miles. As a result of the survey and CRMP, the mining project underwent design modifications to avoid sites. A total of 16 sites required testing and data recovery. These efforts are reported in detail in:

Schaefer, Jerry
1986 Hunter-Gatherer Adaptions to a Marginal Desert Environment: Subsistence Practices and Lithic Production in the Chocolate Mountains, Imperial County, California. Document on file with the Bureau of Land Management, El Centro, and Brian Mooney and Associates, San Diego.

Recent Archaeological Sources

Ezzo, Joseph A. and Jeffery H. Altschul (eds.)
1993 Glyphs and Quarries of the Lower Colorado River Valley: The Results of Five Cultural Resources Surveys, with Contributions by James P. Holmlund, Joan S. Schneider, and William G. White. Statistical Research Technical Series No. 44, Tucson.

In this work, Ezzo and Altschul present the results of five survey projects funded by the Bureau of Reclamation, Boulder City, Nevada. Ezzo and Altschul provide concise, explicit descriptions of archaeological site types and features encountered in the area. They introduce this research with a discussion of dating techniques, settlement patterns and site and feature types found in the Lower Colorado area. Particularly valuable is their tightly reasoned discussion of intaglio sites and their place within the socio-religious systems of the Lower Colorado River Indians. They use Pilot Knob and Ripley as examples of major ceremonial centers in this discussion. They briefly review ethnographic material on the *keruk* ceremony among the Cahuilla, the Quechan, the Maricopa, and the Cocopa.

Individual surveys reported in this volume are:

Antelope Hill: A cultural Resources Inventory and Inquiry into Prehistoric Milling Implement Quarrying and Production Behaviors Along the Lower Gila River, Yuma County, Arizona by Joan S. Schneider. This was a 360 acre survey. Antelope Hill is well-known landmark located along the Lower Gila River, Arizona. The major site complex there consists of both prehistoric and historic petroglyphs. However, in this report, Schneider focuses on a workshop complex where ground stone implements were produced.

The Ripley Geoglyph Complex: Results of an Intensive Survey, by James Holmlund. This report documents a survey of some 572 acres in which 510 features were recorded. This site complex lies some 10 miles south of Blythe along the east margin of the Colorado River.

An Archaeological Survey of Pilot Knob, Imperial County, California: A Class III Cultural Resources Survey and Evaluation, by Joseph A. Ezzo and Jeffrey H. Altschul. This survey covered some 2030 acres and resulted in the documentation of 44 sites, most of which occur to the south of Pilot Knob.

Johnson, Boma

1985 Earth Figures of the Lower Colorado and Gila River Deserts: A Functional Analysis. Arizona Archaeological Society, Phoenix.

Johnson begins with a review of past research and terminology. Johnson explores the origins, functions, and meanings of what he calls earth figures (more widely known as intaglios or geoglyphs). He offers a typology of earth figures, and provides sketches of numerous recorded earth figures along the Colorado. Although his terminology and functional analysis may not be agreeable to all, this is a good summary of what is known about geoglyphs to date, and some of the ideas about their function in Native American societies.

Pendleton, Lorann (ed.)

1986 Archaeological Investigations in the Picacho Basin: Southwest Powerlink Project - Sand Hills to the Colorado River Segment.

This is a major contribution to the archaeological literature of the Lower Colorado, with sections written by Lisa Capper, Richard Cerutti, Joyce Clevenger, Ted Cooley, Douglas Kupel, Jerry Schaefer, Bob Thompson, Janet Townsend, Lisa Capper, and Michael Waters. Pendleton approaches her work with a positivist orientation and the work is burdened at times with excessive statistical demonstration of the obvious, e.g. that the frequency of a particular lithic raw material decreases as one gets farther from the source (1986:92-3). The volume begins with a discussion of past research, past environment, and an ethnographic sketch of the Mojave, Quechan, and Cocopa. She provides a recapitulations of Binford's forager-collector model of hunters and gatherers as a way of organizing sites in terms of settlement system issues. A major focus of the volume is on lithic technology and lithic reduction issues are described in detail. One of the more valuable contributions is the discussion of a ground stone quarry complex discovered during the survey. Richard Cerutti conducted replication studies of huge cylindrical basalt cores similar to those ground stone blanks encountered in the field. The volume also contains an important discussion of cleared circles and the difficulties in distinguishing cultural cleared areas from natural ones.

Schaefer, Jerry

1994a Stuff of Creation: Recent Approaches to Ceramics Analysis in the Colorado Desert. In Joseph A. Ezzo (ed.) Recent Research Along the Lower Colorado River: Proceedings from a Symposium Presented at the 59th Annual Meeting of the Society for American Archaeology, Anaheim, California, April 1994. Statistical Research Technical Series No. 51, Tucson, pp. 81-100.

Schaefer reviews and updates the ceramic typology of Waters (1982a and b) and Rogers. He bases his update on recent research in the Lake Cahuilla-Salton Sea area, the Peninsular Range, on trail systems associated with the Lower Colorado River, and a large CRM project he conducted in Tahquitz Canyon near Palm Springs (Schaefer 1992b). He notes that Patayan II and III buff ware types are now known to be more widely distributed than previously thought. Both Tumco Buff (Patayan II) and Colorado Buff (the Patayan III type) are now well documented for the west shore of Lake Cahuilla, as well as their original locations along the Lower Colorado. Schaefer discusses the high degree of apparently stochastic intra-ware variability within the Tizon Brown Ware and the difficulties of distinguishing types (1994:85-86). He presents a new type from the Hedges-Tumco area just south of our study area. He affixes the label Hedges Buff to this a very late Paytayan III type. It is distinguished from Tumco Buff by crushed sherd (grog) temper and vessel shapes influenced by Anglo-American and Mexican ceramics. Some of it may have been produced for sale to Anglos and Mexicans, as was the case for Parker Buff in the Fort Mojave area (1994:87). He provides a cogent, up to date summary of the distributions of brown versus buff ware in Southern California, emphasizing the Lake Cahuilla area.

Schaefer also criticizes the surface collections of Rogers for not being probabilistic, statistically defendable samples and praises contemporary CRM for their statistical sampling techniques. He overlooks the fact that what is being statistically sampled is a living, contemporary cultural landscape that has been intensively scoured by relic hunters, and more casually collected by a constant stream of ORV enthusiasts, campers, rockhounds, and hunters. For example, when Rogers first conducted research at Indian Pass in 1925, he found the area literally paved with pottery sherds, although even at this early date, two of six trail shrines had been partly destroyed by relic hunters. Site visits associated with this project some 72 years later revealed almost no pottery. Another troubling example: von Werlhof conducted field research at the Running Man Site, a few miles west of Indian Pass in 1978. While teaching a class in archaeological field techniques, he and his students flagged some 400 sherds with the intention of returning the next day to map them in. When he arrived the next morning, he discovered all flagged ceramic sherds had been stolen (von Werlhof 1997). The Rogers nonrandom collections of the 1920s, 30s, 40s, and 50s are arguably more representative of all prehistoric materials once present and richer and more informative than any contemporary random collections could be.

1994b The Challenge of Archaeological Research in the Colorado Desert: Recent Approaches and Discoveries. Journal of California and Great Basin Anthropology 16(1):60-80.

This is an excellent, and for the most part, even-handed review of archaeological research in the Colorado Desert. It begins with a sketch of the paleo-environment of the area, about which little is actually known. The work is somewhat flawed by Schaefer's unfounded suggestion that the issue of a pre-Paleoindian occupation has been laid to rest. He dismisses as subjective the views of other, thoroughly experienced and qualified researchers who find evidence for such an occupation. His negative, positivist view, is of course, portrayed as objective (1994b:62). He argues, quite correctly, for the need for more chronological control for research of the Paleoindian Period; actually this is a necessity for all periods of Lower Colorado Desert research. He documents the existence of limited Archaic occupations at Indian Hill in Anza-Borrego Desert State Park, and at his own excavation at Tahquitz Canyon. The paucity of sites from the Archaic argues for a relatively hostile environment during this period. He provides an in-depth review of climatic reconstruction research conducted around Lake Cahuilla and evidence for the various dates for filling and evaporation. He also provides cogent discussions of the ceramics and settlement systems of the Lower Colorado in light of Lake Cahuilla.

Altschul, Jeffery H. and Joseph A. Ezzo

1994 The Expression of Ceremonial Space Along the Lower Colorado River. In Joseph A Ezzo (ed.) Recent Research Along the Lower Colorado River. Technical Series No. 51, Statistical Research, Tucson.

In this valuable paper, Altschul and Ezzo compare and contrast major and local ceremonial centers among the Lower Colorado River tribes:.

Examples of major centers are Pilot Knob with 300 features some 18 miles south of our study area and the Ripley Geoglyph Complex with more than 500 features. These are associated with the major, pan-Yuman ceremony, the *Keruk.* Local ceremonial centers are small groups of intaglios and features or isolated intaglios. These are often associated with a major trail. The example offered by Altschul and Ezzo is a site complex at Senator Wash a few miles east of our study area. This is an area with 11 cleared circles, most likely wickiup pads; and a series of rock alignments with a D-shaped enclosure, suggesting a dance area; 2 rock cluster-geoglyphs.

Altschul and Ezzo argue that differences between major and local sites are in scale, not function. Major religious centers, in our area Pilot Knob and Picacho Peak for example, were of intertribal significance. Presumably the rites taking place there were intertribal, since visiting was a fundamental feature of *keruk* ceremonies throughout Southern California. Local religious centers, like Senator Wash or perhaps the Running Man site in our study area, may have been stops for religious pilgrims on the trek from Pilot Knob to Spirit Mountain. Perhaps these were places where locals and pilgrims celebrated Keruk rituals together. Alternatively, local centers may have simply been utilized for community-based ceremonial and religious practice (Altschul and Ezzo 1994: 63).

White, William G.

1994 Cast Shadows, a Lizard's Tail, and Prehistoric Time Reckoning: a Calendrical Petroglyph on the Lower Colorado River. In Joseph A Ezzo (ed.) Recent Research Along the Lower Colorado River. Technical Series No. 51, Statistical Research, Tucson, pp. 69-80.

In this paper, White presents a description of a rare kind of petroglyph, one that, he argues convincingly, functions as a solar observatory and calendar. This site is located in the Palo Verde Mountains some 30 miles south of Blythe, north of our study area. However, his succinct, cogent discussion and clear graphics and photographs make this article important for any researcher interested in understanding petroglyphs-pictographs in the Lower Colorado cultural area. Moreover, there is a somewhat similar observatory within the study area, the Plug Site, north of Indian Pass Road. White provides some suggestions for future research, emphasizing the need for a greater understanding of pan Yuman cosmology and culture. There may be a similar solar observatory-calendar at the "Plug Site" north of Indian Pass Road near our study area. This site requires further research, however.

Marmaduke, William S. and Steven G. Dosh

1994 The Cultural Evolutionary Context of "Sleeping Circle" sites in the Lower Colorado River Basin. Document on file with Northland Research, Flagstaff, and U.S. Army, Yuma Proving Ground.

This CRM report contains an interesting review of the research on cleared circles. They discuss the possible functions of cleared circles exploring in detail the possibility that they were wickiup foundations, and the possible archaeological manifestations that should be present if that were so. They review Native cultures and population movements along the Lower Colorado and Gila, possible dates for recorded cleared circles based on ceramic seriation, climatic issues, and changes in circle sizes over time.

Stoney, Stephen A.

1994 Rock Art in the Great Basin: The Scratched Style Mystery Reexamined: Is It Illusion or Reality? Pacific Coast Archaeological Society Quarterly 30(4):33-54.

Stoney provides an excellent review of this rock art style, found in profusion in the Indian Pass area. He argues against the use of the term style to refer to this technique, and suggests that it is better thought of as a technique, in the same way that pecking and painting are techniques. Scratched petroglyphs are very widespread and may span considerable time. Scratched technique petroglyphs may be associated with shamanistic trance states, in Stoney's view.

APPENDIX C

NATIVE AMERICAN CONSULTATION FOR THE GLAMIS IMPERIAL PROJECT

NATIVE AMERICAN CONSULTATION
FOR THE
GLAMIS IMPERIAL PROJECT

CONFIDENTIAL

Prepared for:

Environmental Management Associates
1698 Greenbriar Lane, Suite 210
Brea, California 92621

Submitted to:

U.S. Department of the Interior
Bureau of Land Management
El Centro Resource Area
1661 South 4th Street
El Centro, California 92243

Prepared by:

Michael Baksh, Ph.D.
Tierra Environmental Services
9903 Businesspark Ave., Suite E
San Diego, California 92131

September 22, 1997

Kumastamxo, the spiritual leader of the Yuman peoples, was then created by *Kwikumat,* and the latter departed from the world scene. *Kumastamxo* and the various peoples made their home on *Avikwamé*, a mountain located thirty miles north of Needles, California, in Mojave territory. A ceremonial house was built on the summit of this mountain, and it is toward this home of *Kumastamxo* that the Quechans direct their dreams. The several Yuman tribes all descended from the top of *Avikwamé* and spread to their respective territories.

Forbes 1965:4

The Quechan ... were taught that dreaming enabled them to have direct contact with various supernatural beings in order to gain advice and teaching on how to solve the problems of the living. While dreaming their souls returned to the time of creation to learn. The Yuman people have the ability to learn through dreams, but a few individuals have special gifts. The medicine people, so to speak, are born, not made. The powers they develop in adult life are of great assistance to their people.

So the mountains along the Colorado River region are highly significant in regional Native American cultural and ethnic identity. Spiritual activities and events are deeply associated with numerous intaglios, petroglyphs, trails, lithic scatters, and cleared circles present along the Colorado River and surrounding hills.

Today we fear that disturbance of this area ... would result in the destruction of this aspect of traditional culture and religion. As a physical feature and a spiritual cornerstone, some sites cannot be replaced or relocated.... Any damage, once done, can never be undone.... Some cultural resources have been there since creation, according to Quechan beliefs, and the songs in the mountain will last forever as well. This is a very long time to regret a thoughtless act.

Cachora 1994:14

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

This Native American consultation report is intended to assist the U.S. Bureau of Land Management (BLM) with its planning responsibilities for the Glamis Imperial Project (formerly, Chemgold Imperial Project), pursuant to Section 106 of the National Historic Preservation Act. This report focuses primarily upon meetings held by Dr. Michael Baksh with the Cultural Committee of the Quechan Indian Tribe from December 12, 1996 through September 9, 1997. Other sources of information that have been taken into account include the ethnohistoric literature, archaeological survey reports prepared for the project, comments received from the Quechan Indian Tribe on the November 1996 Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR), and testimony provided by members of the Quechan Indian Tribe during two public hearings held by the BLM.

The proposed Glamis Imperial Project site is located in eastern Imperial County, California, and is generally situated east of Ogilby Road in the vicinity of Indian Pass Road (Figure 1). The proposed Glamis Imperial Project consists of a "project mine and process area" of approximately 1,589 acres and a "project ancillary area" of approximately 36 acres. The proposed project also includes the construction of an "overbuilt" transmission line that would connect with an existing line approximately 16 miles to the south at Interstate 8. Additional acreage was archaeologically surveyed to accommodate a 300-foot-wide buffer zone around the mining project, a 650-foot-wide buffer zone around Indian Pass road, and 150 to 300-foot-wide buffer zones around access road centerlines and utility corridors.

Based upon the November 1996 Draft EIS/EIR and upon associated cultural resources inventory reports prepared by ASM Affiliates, 49 sites were found by a survey of 2,212 acres of overall project area, although several of these sites are located within the buffer zone not planned for project development. Additional sites were located along the proposed transmission corridor, and still others were recorded by an earlier survey of 335 acres located in the proposed mining area. The prehistoric sites include trail segments, trail shrines, pot drops, cleared circles, rock rings, geoglyphs, lithic scatters, and a milling slick. Historic World War II-period sites are also located in the project site but are not addressed in this report.

In response to Native American concerns that sites were missed or misinterpreted by the original survey, the project area was comprehensively resurveyed with Native American participation. The new survey was conducted by KEA Environmental, Inc. (KEA). Native American monitors provided by the Quechan tribe accompanied the survey crews. The monitors provided input on the interpretation of potential cultural features and helped to identify and record cultural materials. As a result of surveying virtually the entire mine and process area at a transect interval of 5 meters, in comparison with a 20-meter interval used by ASM Affiliates, the new survey covered the study area more intensively and resulted in a dramatic increase in the total number of recorded cultural features and sites including trails, ceramic concentrations, rock circles, cleared circles, geoglyphs, shaman's hearths, and lithic scatters. Preliminary maps of site distributions were particularly useful during Native American consultation meetings for attempting to define the boundaries of a Traditional Cultural Property in the vicinity of the project site.

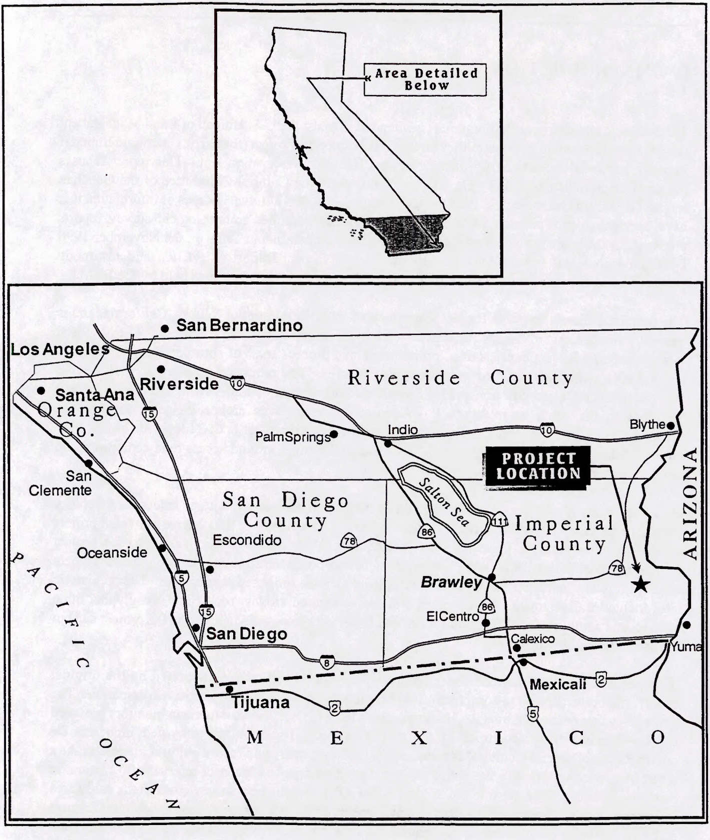


Figure 1
Regional Location Map

0 20 40
MILES

TIERRA
ENVIRONMENTAL SERVICES

The goals of the Native American consultation study conducted by Dr. Baksh were to identify contemporary Native American concerns and values associated with the project area; document current Native American knowledge about the function and/or interpretation of available resources; record the meaning and significance of resources to Native Americans today; and identify mitigation measures that Native Americans feel would be appropriate to minimize impacts to sensitive cultural resources.

This report provides a brief ethnohistoric overview of the Quechan, the results of several meetings conducted by Dr. Baksh with tribal members, and information provided by the tribe in correspondence and during public hearings. The report concludes with a Summary and Conclusions section.

II. ETHNOHISTORIC OVERVIEW

A. ETHNOHISTORIC BACKGROUND

By all ethnohistoric and ethnographic accounts, the project site is clearly situated well within the traditional cultural territory of the Quechan Indians, a Yuman-speaking riverine-based tribe (Figures 2-6). The Quechan occupied the lower portion of the Colorado River in territory now divided by California and Arizona (Bee 1983:86). Based upon ethnohistoric maps and accounts available for the Quechan, their traditional territory extended east along the Colorado River for several miles and up the Gila River almost to Gila Bend; west to the Algodones Sand Dunes, although territory as far west as the eastern base of the Peninsular Range was occasionally used; north to near Blythe, California; and south into Mexico. The Quechan lived in dispersed rancherias north and south of the confluence along the Colorado River and east along the Gila River. Their rancherias were scattered along the river bottom near the projecting spurs of upper terraces (Forde 1931:102). Several hundred people lived in each rancheria and were organized into extended family households. Large permanent semi-subterranean houses were occupied in the winter, and ramadas or brush shades were used in the summer.

The name "Quechan" is from the Quechan name for themselves, *kwatcan*, meaning "those who descended." This name reflects the account of the creation of the Quechan and their neighbors on Spirit Mountain, or *Avikwame*, and their descent down the river (Bee 1983:97). All Yuman tribes, indeed, believe they were created at *Avikwame*. As summarized by Forbes:

> *Kumastamxo*, the spiritual leader of the Yuman peoples, was then created by *Kwikumat,* and the latter departed from the world scene. *Kumastamxo* and the various peoples made their home on *Avikwamé*, a mountain located thirty miles north of Needles, California, in Mojave territory. A ceremonial house was built on the summit of this mountain, and it is toward this home of *Kumastamxo* that the Quechans direct their dreams. The several Yuman tribes all descended from the top of *Avikwamé* and spread to their respective territories (1965:4).

While the earliest inhabitants of the region were hunters and gatherers, the Quechan were primarily agriculturalists and gatherers rather than hunters at historic contact (Forde 1931:107, 118). They planted a wide variety of crops, with an emphasis on maize, tepary beans, pumpkins, and the seeds of wild grasses. After European contact they added wheat, cowpeas, and watermelons. It is likely that agricultural crops yielded less than half of their subsistence. Castetter and Bell (1951) are in agreement with Kroeber's (1920, 1925) estimates that Quechan agriculture likely furnished 30-50% of their subsistence needs.

The most important collected wild foods were the pods of honey mesquite and screwbean (*Prosopis* spp.). Castetter and Bell (1951) reported that informants considered these plants more important than maize. An extensive list of other wild plant foods utilized by the Quechan is provided by Castetter and Bell (1951:187-188). Fish were caught with various nets, in traps or

Figure 2

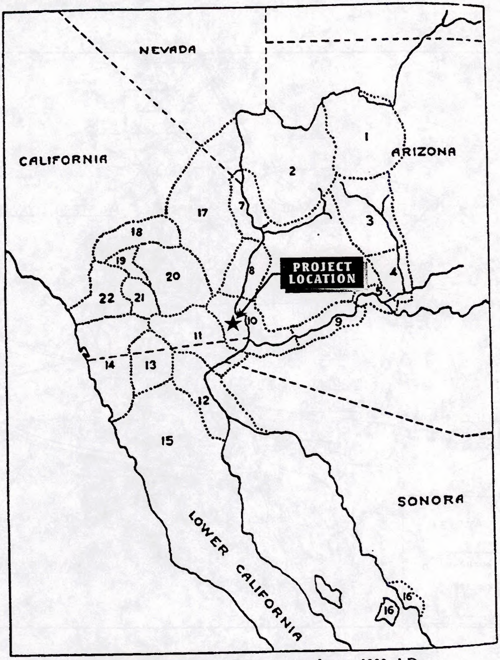
Quechan (Yuma) Traditional Territory (California Only)
In 1770 According To Kroeber (in Heizer and Whipple 1974)

NO SCALE

TIERRA
ENVIRONMENTAL SERVICES

YUMAN POTTERY MAKING

By: Malcolm Rogers (Pet. Ex. RH-84)



YUMAN AND SHOSHONEAN DISTRIBUTION ABOUT 1800 A.D.

YUMANS
1. HAVASUPAI
2. WALAPAI
3. NORTHEASTERN YAVAPAI
4. SOUTHEASTERN YAVAPAI
5. MARICOPA
6. WESTERN YAVAPAI
7. MOHAVE
8. HALCHIDOMA
9. KAVELTCADOM
10. YUMA
11. KAMIA
12. COCOPA
13. SOUTHERN DIEGUENO
14. NORTHERN DIEGUENO
15. KILIWA
16. SERI

SHOSHONEANS
17. CHEMEHUEVI
18. SERRANO
19. PASS CAHUILLA
20. DESERT CAHUILLA
21. MOUNTAIN CAHUILLA
22. LUISENO

- 79 - [51a]

Figure 3
Quechan (Yuma) Traditional Territory About 1800 A.D.
According To Rogers (In Heizer 1974)

TIERRA
ENVIRONMENTAL SERVICES

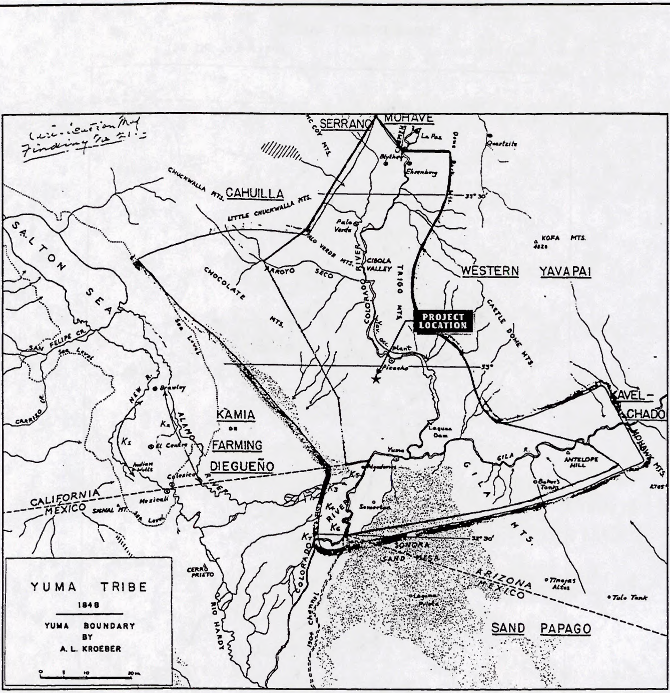


Figure 4
Quechan (Yuma) Traditional Territory in 1848 According To Kroeber (In Beals and Hester 1974)

TIERRA
ENVIRONMENTAL SERVICES

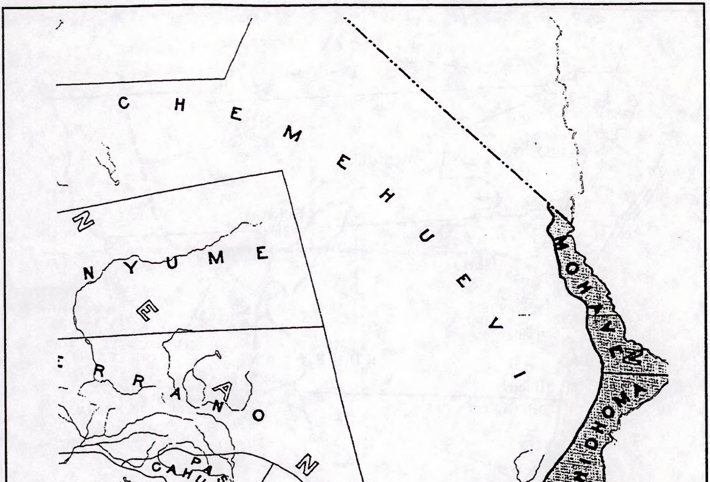


Figure 5
Quechan (Yuma) Traditional Territory (California Only)
According To Kroeber (1925; Plate 1)

TIERRA
ENVIRONMENTAL SERVICES

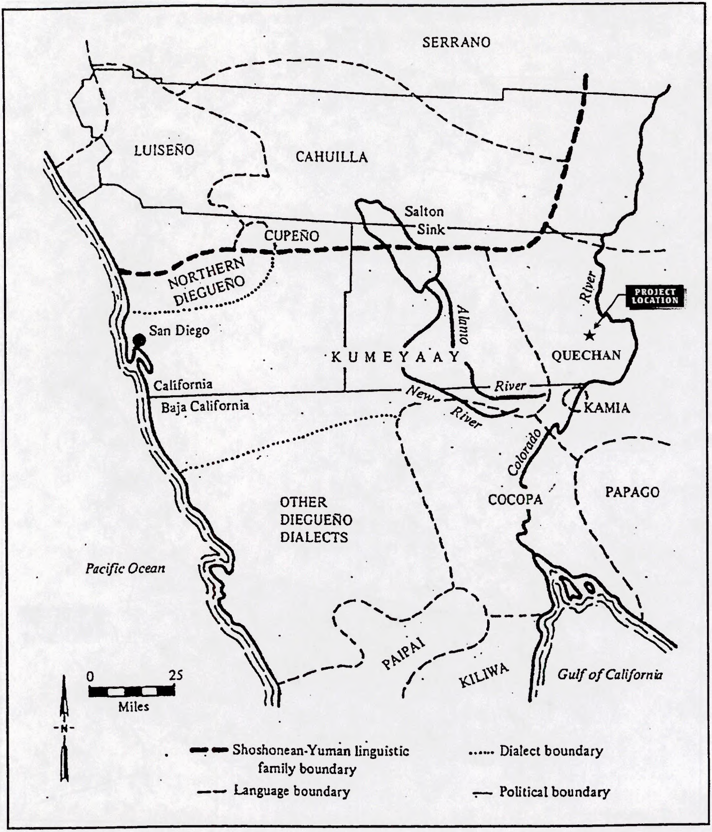


Figure 6
Quechan Traditional Territory According To Hedges (1975)

TIERRA
ENVIRONMENTAL SERVICES

weirs, and with large basketry scoops. Hunting was not a major subsistence activity (Bee 1983:86-87). Rabbits were shot year-around by bow and arrow, and winter trips to the mountainous areas were made by groups of three or four men for deer and mountain sheep (Forde 1931:118). Most food gathering activities were conducted close to the Colorado River (Castetter and Bell 1951; Driver 1957; Forde 1931; Heintzelman 1857; Trippel 1889).

Much of Quechan culture and daily life centered around warfare (Forde 1931:160-175; Bee 1983:93). They maintained particularly hostile relations with the Cocopa, Maricopa, and Pima, and maintained close alliances with the Mojave, Yavapai, and Papago. Warfare was incessant, particularly in the form of small raiding parties.

Regional exchange was also important. The Quechan traded pumpkins, beans, melons, gourds, and maize with several groups. They received rabbitskin blankets, baskets, buckskins, mescal and finished leather goods from the Yavapai, woven blankets from the Hopi, acorns from the Kumeyaay and Cahuilla, eagle feathers from the Mojave, and tobacco from the Kamia or eastern Kumeyaay. The Quechan provided glass trade beads, dried pumpkin, maize, beans, and melons to the Yavapai, tobacco to the Kamia, gourd seeds to the Kumeyaay, and gourd rattles to the Cahuilla.

Quechan religious beliefs and practices, like those of other Native American groups, were intricately related with other aspects of culture; Quechan religion entered into virtually every part of Quechan life and society (Bee 1982:49). Religious beliefs and rituals were therefore effectively inseparable from curing, leadership, warfare, food production, creation beliefs, and the rest of daily life.

Dreams, too, were an integral factor of daily life. As such, dreaming was intricately connected religious beliefs, practices, and experiences and for overall cultural well-being and survival. Leaders, singers, warriors, and shamans all acquired their power through dreams. Power, or *sumá•k*, "was an unseen, impersonal force that could be tapped to help ensure than an individual's or a group's activities would succeed. Individuals received this power in special dreams.... Great leaders, curers, and singers all had such dreams" (Bee 1982:49). According to Cachora, the Quechan were

> instructed by the spiritual leaders on power and dreams. They were taught that dreaming enabled them to have direct contact with various supernatural beings in order to gain advice and teaching on how to solve the problems of the living. While dreaming their souls returned to the time of creation to learn. The Yuman people have the ability to learn through dreams, but a few individuals have special gifts. The medicine people, so to speak, are born, not made. The powers they develop in adult life are of great assistance to their people (1994:14).

Regarding leadership, Quechan rancherias had tribal leaders who settled disputes, organized redistribution, organized ceremonies and led warfare. These leaders, known as *kwaxot* were accepted largely due to their dreams. As described by Forde, "When a man knew he had the power to be a good leader, he told his dreams..." (1931:136). In addition to leaders, dreams gave shamans the power to cure, warriors the power to be victorious, and other men the power to sing or to be funeral orators (Forde 1931:127-128, 138, 182-183; Kroeber 1925:745).

As described by Bee, dreams often involved trips to mountain peaks, "where the dreamer received instructions from spirits on how to make rain, or how to cure certain types of maladies, or would receive the words and music to lengthy song cycles" (1982:50). Dreams nearly always included a visit to Spirit Mountain (Knack 1981:65, Bee 1982:50), where the holy spirits were believed to dwell. According to the Quechan, they were created on Spirit Mountain, or *Avikwamé*, as were the Mojave, Kamia, Maricopa, and Cocopa (Forbes 1965:22). Spirit Mountain "is prominently featured in the tribe's origin narrative as the site of the creation of the Quechan" (Bee 1982:50). The Quechan believed that their culture hero, *Kumastamxo*, moved to this mountain after first residing at *Axavolypo*. After fighting a war with invaders from the east, the Quechan evidently migrated south from Spirit Mountain to the junction of the Colorado and Gila rivers.

Spirit Mountain was therefore the source of all power, and its sacredness was paramount (Forde 1931:176-179). Other mountains in the vicinity of the tribe's reservation are also said to have special religious significance. According to Bee, these peaks "include Picacho, the protruding volcanic neck some 18 miles directly north of the reservation (called Aví milykét "high rock one can see from a distance"); Pilot knob (Aví kwalál, also the site of Aví kwinúr "inscribed rock"); and in the city of Yuma, Tank Hill, or Sierra Prieta, (Aví kwax?a• "cottonwood hill or peak")" (1982:50). The importance of mountains and associated archaeological sites to Quechan religion has been summarized by Cachora: "the mountains along the Colorado River region are highly significant in regional Native American cultural and ethnic identity. Spiritual activities and events are deeply associated with numerous intaglios, petroglyphs, trails, lithic scatters, and cleared circles present along the Colorado River and surrounding hills" (1994:14).

The Quechan regularly held a four-day *keruk* mourning ceremony. The *keruk* re-enacted the events that had originally taken place on Spirit Mountain in mythic time, and served to "commemorate the dead, to protect the people from evil, and to give them power" (Bee 1982:50). According to the Quechan, Spirit Mountain was the destination of the first *keruk* (from *Avikwalal*, Pilot Knob), staged by *Kumastamxo* upon the death of *Kwikumat*. Accounts of the creation myth surrounding Spirit Mountain and *xam kwatcan* (the trail leading to the mountain) have been recorded by Kroeber (1925), Forbes (1965), Spier (1933), Forde (1931), Harrington (1908), and Trippel (1889), and synthesized by Woods, Raven, and Raven (1986).

Four lines of archaeological and ethnohistoric evidence that support the use of Pilot Knob as a major ceremonial center and site of the *keruk* have been documented by Altschul and Ezzo. Pilot Knob is characterized, for example, by more than 300 features and 10,000 meters of trails in an area of approximately 3 km^2 (Ezzo and Altschul 1993). In addition, to quote extensively from Altschul and Ezzo:

> [At Pilot Knob] 4-IMP-6940 has two cleared circles that approximate the diameter of the ceremonial house (ca. 7 m), whereas 4-IMP-6942 and 4-IMP-4654 have one each. The feature from the latter actually consists of a series of trail segments leading into a large cleared area, which may represent paths leading into and out of the ceremonial house during its usage (Figure 5.2). The third line of evidence concerns the repeated ethnographic references to the retelling of creation stories

during the *keruk.* These stories may be represented at Pilot Knob in (1) petroglyphs (particularly at 4-IMP-3550; Figure 5.3), that depict human figures, whirls, and quadrupeds (most likely horses), central to this story; (2) circular cobble mounds that have been interpreted as representing sacred mountains; and (3) anthropomorphic intaglios that some claim represent mythological figures such as *Kumastamho* (Figure 5.4), the creator-god, and *Katarr*, his evil twin (Figure 5.5). Finally, research by Clyde Woods (1986), Boma Johnson (1985), and others (e.g., Stone 1991) have documented the presence of the *keruk* trail, a north-south trail extending from Pilot Knob to Newberry Mountains near Needles, California, where the world began (Figure 5.6). According to Woods, participants in the *keruk* undertook a pilgrimage from Pilot Knob to Newberry Mountain to attend a series of *keruk* ceremonies that began at Pilot Knob. Prominent stops along the way included Picacho Peak, Parker, and Blythe (1994:53).

B. CULTURE CHANGE

The Yuman-speakers of the Colorado River region have experienced severe cultural change, particularly since the late 1800s. Forde summarized some of the changes experienced by the Yuma:

> Relatively undisturbed in Spanish and Mexican times the Yuma maintained their aboriginal culture almost unchanged until the fifties of the last century, when the establishment of the caravan trail to Southern California terminated their freedom. By the eighties they had been gathered on a reservation, had adopted white men's clothing, and had begun to work as laborers in the neighboring town established on the Arizona border. Although the greater part of their religion and non-material culture has been preserved up to the present time, American control and changed economic circumstances have extinguished their tribal organization, obliterated the old settlements, and above all, ended the constant warfare which they practiced (1931:88).

In the early 1900s, Kroeber had a difficult time locating individuals reputed to know creation myths and other stories. "Around 1903..., song-cycle myths were still being learned and dreamed by individual Mohaves; but I now suspect that no one had then learned and reelaborated a version of the migration legend in several decades. If this is a fact, it was the very last of the crop of aged migration dreamers that I encountered at Needles about 1900 to 1905" (1951:71). Kroeber went on to describe the lengths he went to in order to locate an old man in 1902 who knew about the origin of clans and other matters. This man died before Kroeber could finish the story in 1903, and Kroeber was unable to locate another man who could complete the tale (1951:72). In comparing the tale with narratives from other groups, Kroeber observed: "Whatever of something like this tale the Yuma once had, presumably would have disappeared from among them a few decades before its end came among the Mohave in 1900-1910" (1951:108).

Halpern has recently discussed the status of storytelling:

> Quechan storytelling is not yet a lost art, but it is well on the way to becoming one. The decline is comparatively recent. Even people in their 30's, as well as those older than that, remember with pleasure being put to sleep by tales told by their elders, and when a storyteller is now available who will narrate such tales, there are always eager listeners to hear him. At the present time, however, the number of narrators who are confident of their ability to tell the stories is small indeed.
>
> Traditionally, stories always told at night in an atmosphere of intimacy and affection as people falling asleep. "From time to time the narrator would punctuate his tale by asking "Are you listening?" This, of course, was a transparent device to determine that all had fallen asleep, and the recollection usually ends with the comment, "I always fell asleep before the end of the story, so I don't know how to tell it" (1980:51).

In addition to cultural loss and the development of various versions of stories, the Yuman-speaking peoples have a history of being reluctant to share much cultural knowledge with outsiders. As observed by Trippel in 1889, "As already mentioned, it is very difficult to obtain data concerning the traditions of these people, owing to the natural antipathy to discuss such subjects with the whites" (1984 [1889]:166). It is largely due to a loss of cultural knowledge and to a reluctance of many individuals to discuss stories and culture that limited information on traditional culture is currently available.

III. NATIVE AMERICAN CONSULTATION

The BLM has undertaken considerable effort to ensure that appropriate consultation be conducted with the Quechan Indian Tribe, pursuant to Section 106 of the National Historic Preservation Act. A chronology of the contact program with the tribe is provided in Appendix A.

The Quechan have consistently and vehemently expressed complete opposition to the Glamis Imperial Project. Their fervent opposition to the proposed project was expressed at all meetings held between the Quechan Cultural Committee and Dr. Baksh; in the tribe's comment letters on the Draft EIS/EIR and cultural resource inventory reports; and at the two BLM-sponsored public hearings (in Holtville and La Mesa, California) attended by tribal members. Tribal input from these meetings, letters, and hearings are summarized below.

A. MEETINGS WITH QUECHAN CULTURAL COMMITTEE MEMBERS

Dr. Baksh met with members of the Quechan Cultural Committee on 11 occasions including December 12, 1996, December 27, 1996, February 24, 1997, March 28, 1997, June 19, 1997, July 14, 1997, July 15, 1997, August 25, 1997, August 29, 1997, September 9, 1997, and September 10, 1997. The results of these meetings are as follows:

December 12, 1996

Dr. Baksh and Ms. Pat Weller of the BLM El Centro Office met with several members and supporters of the Quechan Cultural Committee at the Quechan Tribal Office on December 16, 1996. These individuals included Ms. Pauline Owl (Chairperson), Mr. Eldred Millard, Ms. Pauline Jose, Mr. Lorey Cachora, Mr. Preston Jefferson, and Mrs. Linda Cachora. Most committee members spoke about the project, and each expressed adamant opposition to it. The committee explained that the area is an extremely sensitive and important area for tribal history and cultural resources, and should be preserved. The overall viewpoint of the meeting was summarized by one committee member who stated that "if anything is destroyed out there, it destroys our past and therefore destroys us today." The committee expressed strong opposition to the 1872 Mining Act and felt that it should be repealed. Committee members also emphasized that the tribe is now prepared to take a stand to stop all further development and encroachment on their traditional territory, and want to take back land for the tribe between Yuma and Blythe. The meeting concluded with the arrangement that Dr. Baksh and Ms. Weller would take members of the committee on a field tour to visit several sites.

December 27, 1996

Dr. Baksh and Ms. Weller took two Cultural Committee members, Mr. Lorey Cachora and Ms. Willa Scott, on a tour of several sites in the project area. These sites included the geoglyph circle near Ogilby Road and Indian Pass Road, the off-site "Running Man" site, the two on-site small geoglyph circles, the possible milling slick, three sleeping circles, some pot drops, several lithic scatters and chipping stations, and several trails. Very little specific information was offered by the tribal members with regard to interpreting the function of these sites, evaluating their significance, or mitigating impacts to them.

The most input received was related to the Running Man site (CA-IMP-2727, -5359T, -5360T). As described in the ASM cultural resources survey report, this site is located at the intersection of a northeast-southwest trail ("Blackmesa Trail") that appears to connect Imperial Valley/Lake Cahuilla with Indian Pass or Black Mesa Wash and the Colorado River, and a northwest-southeast trail ("Mohave War Trail") that appears to pass along the east side of the Cargo Muchacho Mountains and north to Palo Verde Valley on the Colorado River (Schaefer and Schultze 1996). Located on a terrace, this site contains 16 features including the "Running Man Geoglyph", two rock alignments associated with the northeast-southwest trail, five chipping stations, one rock ring, one rock cairn, two pottery scatters, a large core and flake, a rhyolite core, a recent quartz geoglyph, and a rock ring. As described by Schaefer and Schultze, CA-IMP-2727 ... "is a remarkable site, ... with significance for Native American religious and archaeological interpretation of prehistoric travel, land use, and ceremonialism. An extensive complex of pot drops, lithic remains, rock rings, cairns, and rock alignments indicate that this intersection was the scene of much human activity including symbolic and ceremonial behavior" (1996:44).

Based upon a review of field notes, maps, and photographs of this site recorded by Malcolm Rogers in 1939, 1941, and 1942, Schaefer and Schultze (1996) concluded that the Running Man geoglyph feature was made after Roger's studies, since he made no reference to it in his detailed recordings. Schaefer and Schultze state, however, that "consultation with the Quechan should be undertaken to determine if it [the Running Man geoglyph] may be a recent Native American element... " (1996:72). The cultural resources report concludes that 1) site CA-IMP-2727 would not by directly impacted by the proposed project, 2) this site and trail sites CA-IMP-5359T and CA-IMP-5360T are eligible for the National Register under criterion "D", and 3) mitigation measures for indirect impacts to this location should be undertaken in consultation with the Quechan Nation.

During the field tour of the Running Man site and associated trails, Mr. Cachora stated that the Running Man geoglyph "is recent, but still authentic." Mr. Cachora believes that the feature was made by tribal members of his father's generation, and very likely by his father and a friend of his father's who used this area to conduct traditional religious practices. Mr. Cachora noted that the Running Man geoglyph is intimately connected with the trails and rock alignments at this location, and that the geoglyph symbolizes someone running along the trails. Specifically, Mr. Cachora stated that his ancestors used to run along the Blackmesa Trail in the southwest to northeast direction and, at the location where the large rock alignment crosses this trail, would jump over the alignment and through a "window," thereby passing into another time dimension.

A major concern expressed by Mr. Cachora is that the proposed mining site, located in excess of one mile from the Running Man site and associated trails and other features, would obstruct existing views of the horizon to the north and northeast. Mr. Cachora stated that tribal members may want to use this site in the future for the important religious purposes that it was used by his ancestors, but that the project's stockpiles would prevent this use if made too high. Mr. Cachora lamented that the stockpiles, then proposed to be constructed up to 400 feet in height, would "ruin and destroy" this extremely important site if they altered the existing skyline as seen from this location.

Regarding other sites, Mr. Cachora mentioned throughout the field tour that the trails in the project vicinity are "major trails" that were of extreme importance to his ancestors for travel and for religious/ceremonial reasons. While standing on one trail, he stated his belief that it extended south to the highly important and sacred location of Pilot Knob, and mentioned that perhaps he and Dr. Baksh could return some day to trace it towards the eastern side of the Cargo Muchacho Mountains.

The field tour included visits to two small rock circles referred to in the cultural resources survey report as geoglyphs that served functionally as "direction markers" or "power circles." Specifically, visits were made to the rock circles at sites IMP-7393 and IMP-7397. These sites are described in the cultural resources report as follows:

> A second likely "direction marker" or "power circle" was found further south in the same wash.... Recorded as IMP-7393 (CG-39), it was a 60 cm diameter rock ring which circumscribed by (sic) three small rocks aligned to magnetic south. This circle was constructed of white quartz and quartzite cobbles as well as volcanic cobbles.
>
> Further east, at the bank of the next major drainage, was IMP-7397 (CG-44).... This rock circle was 80 cm in diameter and constructed of the same materials as IMP-7393 (CG-39). Instead of a rock alignment, however, this ring encircled an embedded cobble volcanic boulder and two smaller rocks. Less than 25 percent of the embedded cobble is visible in the center of the rock ring. Rocks of the circle are displaced in two places, creating openings in the ring. It is not known if these openings have symbolic meaning or are the result of later disturbances. The function of this feature remains speculative. Lorey Cachora suggested that the internal rocks may represent topographic features. If this is so, then the feature may also have been created to aid travelers along the many aboriginal trails of this region (Schaefer and Schultze 1996).

During the field tour of these sites, Mr. Cachora similarly referred to these circles as power circles and stated that they were associated with travel along trails in the area. He also observed that the circles are generally lined up in a direction facing south towards Pilot Knob along the east side of the Cargo Muchacho Mountains, and stated that more such circles would probably be found if looked for in that direction.

The field tour included a visit to an off-site geoglyph located near the intersection of Ogilby Road and Indian Pass Road. Mr. Cachora identified this site as a "dancing circle." This site is located outside of the area proposed for widening and realignment of Indian Pass Road. However, the site could easily be subjected to indirect impacts, such as off-road vehicles. Noting this, Mr. Cachora stated that it would be a good idea to construct a fence between the site and Indian Pass Road.

No other information regarding the uses and functions of sites, significance evaluation, or mitigation was forthcoming during the site tour.

February 24, 1997

Dr. Baksh met with several members of the Quechan Cultural Committee and its supporters at "The Landing" in Yuma on February 24, 1997. These individuals included Mr. Lorey Cachora, Mrs. Linda Cachora, Mr. Wally Antone, Mrs. Barbara Antone, and Mr. Preston Jefferson. Dr. Baksh stated at the outset that his goals of the meeting were to learn about the uses and functions of site types in the project area, obtain input to help evaluate site significance from a Native American perspective, and to develop or at least initiate discussion regarding mitigation measures to reduce levels of significance associated with impacts to various sites.

The Cultural Committee commenced their discussion by stating that they would like to meet directly with Glamis Imperial Corp. (formerly, Chemgold, Inc.) executives to explain their values first-hand to the project proponent. The Committee felt that if the Glamis Imperial Corp. understood their cultural reasons for opposing the project, they would withdraw the project. The Committee indicated that if the Glamis Imperial Corp. refused to meet with them directly, they would call for a press conference with all local religious leaders in the region. Dr. Baksh relayed this request to Mr. Dwight Carey of Environmental Management Associates (EMA), and two meetings between Mr. Steve Baumann of the Glamis Imperial Corp. and the Quechan Cultural Committee were subsequently held.

The stated goals of the February 24 meeting were not accomplished. Indeed, very little information from the tribe was provided during this meeting at a site-specific or site type level. Like the December 12th meeting, the committee members repeatedly expressed adamant opposition to the project, and virtually all discussion focused on the overall importance of the entire project vicinity to Native American values. The project vicinity was described as a key component that exists within a larger culturally-sensitive region of extreme sensitivity to the tribe. This region corresponds with the tribe's traditional territory, but it was also noted that the entire area along the Colorado River between Pilot Knob and *Avikwame* or Newberry Mountain is extremely important to the tribe.

One committee member, familiar with several cultural resource studies that have been conducted over the past 25 years or so, explained that archaeological knowledge about the Quechan region is just starting to come together. The problem, according to this individual, is that no one has conducted a study to synthesize all available information. It was stated that such a synthesis is needed and would underscore the extreme importance of protecting existing cultural resources in the area for the sake of Quechan religious beliefs and heritage values.

The Cultural Committee emphasized that the project vicinity and, indeed, the entire traditional territory, is extremely sensitive and important to their cultural values and integrity. In general, the tribe is upset with the amount of development that has occurred and/or is being planned throughout its traditional territory. Tribal members indicated that they are intent upon preserving the undeveloped portions of their traditional territory, and on stopping all further "encroachment." In their viewpoint, the entire region is extremely sacred, and any destruction of the past (i.e., impacts to cultural resources) would result in destruction to their present and future heritage. The Committee also emphasized that cultural resources in their traditional territory are important not just to the Quechan but to all Yuman peoples. According to one member, "it's our job to protect the Colorado River area."

According to the Cultural Committee, the project area is a highly spiritual, religious place. Several tribal members stated that destruction of the cultural resources that would occur as a result of the proposed project would be analogous to the destruction of a church. It was also emphasized that our ancestors lived and died out there, and that "we cry for our ancestors." According to one member, "If Chemgold does what they want, I'm going to cry everyday for the rest of my life. I feel like I'm losing someone right now."

Several committee members expressed strong opposition to the 1872 Mining Act, and felt that it is a law that specifically allows the destruction of Native American sites and values. It was stated repeatedly that Congress should immediately repeal this law.

As indicated above, little information was forthcoming during this meeting at a site-specific level despite several requests by Dr. Baksh to pursue this goal. Most site-specific information was limited to comments on the trails and the Running Man site. It was noted that the major north-south trending trail was the trail that people used to travel from Pilot Knob to Newberry Mountain. It was also mentioned that this trip could be made during dreams, with the travel taking place over a period of time as brief as 15 seconds. Small trails in the area were described as "turnpikes" used to connect with other trails. Cultural Committee members stated that these trails might be critical in the future to travel to the north or to the west. With regard to the Running Man site, it was mentioned that this site represents a window to the past, present, and future. It was also noted that Mr. Cachora's father and another man used this site for religious practices. The only other site-specific information was related to the possible milling stone. Some committee members stated that this feature indicates that a village was located at this area.

The Cultural Committee concluded this meeting by stating that they are planning on using this area again for religious purposes. They observed that there has been a lot of disturbance in other areas throughout their traditional territory, partly as a result of mistakes in the past by their own people in allowing property to be lost and development projects to proceed. Now, however, as summarized by one member, "we are going to do everything we can to protect the area since we will need this area for the future."

The Cultural Committee refused to discuss mitigation. From the tribe's perspective, the only acceptable alternative is complete avoidance.

March 28, 1997

Dr. Baksh met with Mr. Lorey Cachora and Mrs. Linda Cachora at the office of Tierra Environmental Services in San Diego on March 28, 1997. The following excerpts have been condensed from transcribed notes of taped discussions with Mr. Cachora.

On Quechan Knowledge:

It is important to keep a lot of information to one's self, or to share it only with certain individuals. That is why sometimes I ask you to turn off the recorder when we are talking, and to keep certain things to yourself. I don't even tell my own people a lot of things. Sometimes I suspect that people criticize me, including those from other tribes, for sharing information. But sometimes it is important to do this, especially if it will help protect our culture.

The Glamis Imperial Corp. people do not share our culture, knowledge, or Native American values. If they did, they would not be proposing to mine that area. And even a lot of our own people don't understand these things. You would have to be training with the tribe for a long time to learn many things. You would have to become a Quechan to learn a lot, which would take 10 years or so of living with us and studying. Even some Quechans have tried and lost patience. You can't see the spirit world unless you go through the proper training -- learning to fast and learning to hallucinate through dreams. Some people hallucinate through jimsom weed and other drugs, but that is kind of a shortcut to the natural way of hallucinating through dreams.

On Quechan Traditional Territory:

Our people came to this area from Newberry Mountain (*Avikwame*), where our ancestors lived for thousands of years. Before that they moved all around, after originally coming from the north. After migrating to this area, our traditional territory extended west past El Centro to the base of the mountains towards San Diego and east into Arizona. It also extended north up to Blythe and south into Mexico. With settlement of this territory, sites such as lithic scatters and petroglyphs developed throughout the entire area. But the main part of our area, and the most important religious area, is the area along the Colorado River. This area is where our ancestors stayed, this is where they healed themselves, and this is where their dreams came true. This area is part of me, it belongs to me. It is this area, in the shape of a small box, that I would like to see protected. This area should be protected, in the way that the area of the Grand Canyon is protected. Is that asking the impossible? This is our life we are talking about.

On Pilot Knob and Picacho Peak:

After settling in this area, our people consisted of South Dwellers and North Dwellers. The South Dwellers went to Pilot Knob (*Avikwalal*) for food and substance, or when they needed to increase their power or were feeling distressed. The North Dwellers went to Picacho Peak for the same reasons. The Sunflower Eaters in the Arizona side used Muggins Peak. The areas in between were used to go into another world. Pilot Knob was an extremely sacred place. Even other tribes were allowed to use it. Our people often migrated from Pilot Knob to Avikwame to worship and obtain power.

On The Importance Of The Project Area:

That area proposed for the mine project is real important to us today -- we still use the area. It is a strong area; people feel it and will sometimes go there without even realizing it or knowing why. I could tell you several examples of people who have been drawn out to that area, and then their lives improved afterwards. We can't lose the sites out there or have that area destroyed. The sites in the project area are of the highest possible religious importance to us, particularly for travel. Too many areas like that have already been destroyed and, whenever another sacred area is destroyed, Native Americans are destroyed. Maybe not necessarily physically as seen by others, but inside.

The sites in that area tie in with something that is bigger in the long run. As I've said before, the whole area along the Colorado River is sacred. But this is not reflected in all the individual archaeology and anthropology studies that have been done over the years. Someone has to look at all those studies and review them all together. If this could by done, others would also come to the conclusion that this is an extremely important area.

We have already sacrificed other areas but at least most of those were away from the important trails. We already knew that this was an important area and were shocked when we learned that they wanted to have a project in the Indian Pass area. When told about the project being planned in this area, I said, "oh no, here we go again." I participated in the survey, but even I was surprised at the large number of important sites out there and at the amount of destruction that was being planned. There are so many sites out there that I know some were missed by the survey.

We thought the Federal government took over that property to protect it, but they don't always do a good job at that. Some people in the government simply do not respect Native American values. The government should look at the area like a church, which is a superior place with superior value and should not be destroyed. If the government doesn't consider religion important, then there is definitely something wrong.

On Dreams:

Everything has to happen through dreams. Dreams are the main way to obtain knowledge and power to make it through the various phases of life. Dreams are for learning songs, learning to become a medicine man, and learning to become an orator. In the past, the old people used to come to Pilot Knob, and they used that same trail that passes through the project area to get to Newberry Mountain or *Avikwame.*

Today, if you are lucky and strong enough, you go to sleep and you see that trail in your dream. That Pilot Knob trail to *Avikwame* is there because I have seen it. And when you take that trail in your dream, you can do some fantastic things -- you can get to Newberry Mountain in seconds and do whatever you want. The ancestors said that if you ever destroy that trail, we would not be able to get to that place if we want to in our dreams. Of course, now we can get there by car, but that is not the same as traveling by dreams. Traveling by dreams is key for obtaining traditional knowledge and power and practicing our religious beliefs.

On Trails:

There are two trails in this area that our ancestors followed to reach *Avikwame*. One was used when our people traveled north from Pilot Knob -- this trail passes through the project area. Another trail travels more closely along the river, and passes through Picacho. We recently took the trail through Picacho to Ward Valley. The trail through the project area is the "Trail of Dreams". The one that we took through Picacho is the "Medicine Trail." If the Trail of Dream was to be physically damaged, it would affect our ability to dream in the future.

There is also an important east/west trail in the project area, and in fact that trail goes west all the way to the ocean. A lot of materials from other tribal areas are found in our area because of trading with other groups; sometimes things were dropped and today they can be found along the trails. In any case, that area is situated at a "crossroads" and is like a major intersection that served the important function of facilitating regional exchange along the Colorado River. The north-south and east-west trails that cross at the Running Man site make this an extremely important place.

A lot of the trail through Picacho has been destroyed. But we know that the trail in the project area still exists. We need the ability to keep going back to the old ways. We still think about the old ways and use them to live in today's world. That's why we say no to the project -- don't touch that area! It's our only avenue to *Avikwame* now.

On "The Trail Of Dreams" And "The Running Man Site":

The Trail of Dreams passes right through the project site, and the site that is called the Running Man site is directly tied into this trail. Although I have said that the Running Man is recent, there is a reason for its importance. My father and other people of his generation went to the area of the Running Man site to use this area for spiritual and religious practices; I believe they made the Running Man geoglyph for an important reason. My father told me that he went to this area to learn and sing his songs. He told me that it is a powerful area and said that there is an important trail passing through there.

At the Running Man site one could run along the trail and, at the spot of the rock alignment, could jump and pass through a "window." This was a way of passing into another world, I guess you could call it. This would be done, again, through dreaming.

On Small Rock Circles:

A circle is a form of power. When you see those small circles near the trails, you could sleep there or rest or do whatever you wish to do. Those circles are "power sources". They go hand in hand with the trail. You could use the circles both to find the trail if traveling in the area and to get power while already traveling along the trail, whether the travel be by foot or by dream. There used to be a feather within each circle, but now they've blown away. People traveling along the trail would stop at a power source and could make the feather dance in that circle. All those circles, and others that extend to Pilot Knob, were made by a single powerful medicine man, probably with two or three student assistants training to become medicine men. Like the trail, destruction of the circles in the project area would represent an obstacle in terms of getting from Pilot Knob to *Avikwame*, both by foot and by dream.

On Life Phases and Final Resting Places:

There are seven phases of life, as there are seven Yuman tribes, although some powerful individuals can reach an eighth. The first phase was when we came down from the north to *Avikwame*, and the second was when we migrated from *Avikwame* to this area. Today we're in the third phase of life; the fourth is when you die; the fifth is when you see the trail; the sixth is when you're at the intersection; and the seventh is when you're home at your final resting place. In the past, some powerful people like singers, orators, and medicine men went to an eighth stage of life, which is what we now call heaven. I'm now in my third phase; when I die it will be up to me to find the fifth. Migrations to *Avikwame* are important for these phases, and I believe our people are about to migrate to *Avikwame* again.

All Quechan have a final resting place to go after they die. Each one's place is given to them by the spirits ahead of time. My final resting place is somewhere in Arizona. The project area is a strong area. We have to keep areas like that protected because I believe it is the final resting place for some ancestors, and it may eventually be for some who are living today. If someone today was to pass on and go there for their final resting place and find it destroyed, it would be like hitting a wall.

On Mitigation:

There is no point in talking about mitigation, because there is no way that impacts to those sites could be mitigated.

June 19, 1997

Dr. Baksh participated in a meeting with several representatives of the Quechan tribe and Cultural Committee, along with representatives from the BLM and KEA, on June 19, 1997 at the Quechan Tribal Office. Tribal representatives included President Michael Jackson, Ms. Pauline Owl, Mr. Lorey Cachora, Mrs. Linda Cachora, Mr. Wally Antone, Mrs. Barbara Antone, Mr. Eldred Millard, and Mr. Earl Hawes (Environmental Coordinator). BLM representatives included Mr. Terry Reed and Ms. Pat Weller. KEA staff included Dr. Jamie Cleland and Mr. Andrew Pigniolo.

The primary purposes of the meeting, requested by Mr. Reed, were to introduce KEA as the firm that been retained to conduct a new cultural resources survey of the project site, and to solicit the tribe's involvement in the new survey effort. President Jackson reiterated his opposition to the mining project, and Mr. Cachora emphasized that the project area is extremely important and should be protected from development. Mr. Cachora also stated that Native American involvement would be required on the new survey so that cultural resources could be interpreted from a Native American perspective. Mr. Cachora and Mr. Antone indicated that they could not participate as Native American observers for the new survey, since they would be working on another project for another firm. The tribe agreed to identify observers to participate in the new survey.

July 14, 1997

Dr. Baksh participated in a meeting with several representatives of the Quechan tribe and Cultural Committee, along with representatives from the BLM, KEA, and Imperial Valley College (IVC) Desert Museum on June 14, 1997 at the Quechan Tribal Office. Tribal representatives included Ms. Pauline Owl, Mr. Lorey Cachora, Mr. Wally Antone, Mrs. Barbara Antone, Ms. Pauline Jose, and Ms. Willa Scott. Ms. Pat Weller from the BLM, Mr. Jay von Werlhof from the IVC Desert Museum, and Dr. Jamie Cleland and Mr. Andrew Pigniolo from KEA were also in attendance.

The primary purposes of the meeting were to provide a status update of the new cultural resources survey that commenced on June 24, 1997, to solicit information from the tribe that would help evaluate a portion of the project site as a Traditional Cultural Property, and to solicit tribal input on mitigation measures that could potentially be incorporated into a Treatment Plan. Following an overview of project activities and preliminary findings, Mrs. Antone expressed concerns regarding artifact collection. KEA staff indicated that artifact collection would only occur if data recovery is implemented. Mr. Antone subsequently expressed concerns that unmarked burials may occur in the project area. In response, Mr. von Werlof, a participant in the new survey, stated that a cairn which is possibly indicative of a grave was found earlier in the day, and needed additional research to determine if a burial is located at the location.

Following discussion among tribal members in the Quechan language, the Cultural Committee stated that other tribes should be involved in the Native American consultation process for this project. The Cultural Committee provided a list of other tribes and requested that a letter be mailed to notify them about the project and invite them to a meeting scheduled for August 25. These tribes included the Fort Mojave Indian Tribe, Colorado River Indian Tribes (CRIT), Hualapai, Yavapai-Prescott, Havasupai, Chemehuevi, Salt River Pima-Maricopa, Tohono O'Odham, Kumeyaay, and Cocopah.

July 15, 1997

Dr. Baksh and Mr. Andrew Pigniolo of KEA escorted two Cultural Committee members, Ms. Barbara Antone and Ms. Willa Scott, on a tour of several sites in the project area. These sites included the geoglyph circle near Ogilby Road and Indian Pass Road, the off-site "Running Man" site, several trail segments and lithic scatters, and new sites recently found by the KEA field survey including a geoglyph, pot drop, and broken metate. Ms. Antone and Ms. Scott also met with and observed KEA's survey crews, and met with two Quechan observers who were working with KEA crews. Very little specific information was offered by the tribal members with regard to interpreting the function of these sites, evaluating their significance, or mitigating impacts to them.

August 25, 1997

Dr. Baksh participated in a meeting with several representatives of the Quechan tribe and Cultural Committee, along with representatives from the Fort Mojave Indian Tribe, CRIT, BLM, EMA, and KEA on August 25, 1997 at the Quechan Tribal Office. Tribal representatives included Ms. Pauline Owl, Mr. Lorey Cachora, Ms. Pauline Jose, and Ms. Willa Scott. Native American representatives from other tribes, who had accepted invitations to provide input as a result of the July 14, 1997 meeting, included Ms. Betty L. Cornelius of CRIT and Mr. Felton Bricker, Sr., of Fort Mojave. Representatives of the BLM included Mr. Terry Reed, Mr. Russell Kaldenberg, Ms. Pat Weller, Ms. Joan Oxendine, and Mr. Douglas Romoli. Others in attendance were Mr. Dwight Carey of EMA, and Dr. Jamie Cleland and Mr. Andrew Pigniolo of KEA.

The primary purposes of the meeting were to provide an overview of the proposed project, summarize the archaeological and ethnographic work conducted to date, and solicit comments, questions, and input from the Quechan, Fort Mojave, and CRIT representatives. Mr. Terry Reed of the BLM made introductory remarks, Mr. Dwight Carey of EMA provided an overview of the proposed project, Dr. Jamie Cleland and Mr. Andrew Pigniolo of KEA summarized the goals, methods, and preliminary results of the recently completed, comprehensive archaeological survey of the project area, and Dr. Baksh summarized the Native American consultation program conducted to date.

Following the overviews of the proposed project, archaeological work, and Native American consultation, Mr. Cachora offered several comments, questions, and information about the project area. Mr. Cachora reiterated his adamant opposition to the proposed project, stating that it would Quechan culture, religion, and history in several ways. He stated that all seven Yuman tribes originated at *Avikwame*, and emphasized that protection of cultural resources along the Colorado River is of paramount importance to all. He stated that the seven tribes all came into the world as one and in fact are one in the same, and that they are exchanged extensively by using trail systems throughout the region.

Mr. Cachora noted that Quechan tribal members always return to their land sooner or later, that they need to be cremated along the Colorado River, and that their final resting places are located throughout their traditional territory. He lamented that outsiders do not understand Quechan history or understand how development encroaches on their lives.

Mr. Cachora also observed that the Running Man site represents a "window into the past," where religious practitioners could run along the trail and, in the vicinity of a rock alignment, jump and pass into another dimension. He stated that there are a few other examples of these extremely important sites in the area but that he could not reveal their locations, saying that even few if any other tribal members know. Other sensitive sites were said to include locations of broken quartz, which he identified as power spots which can be used today by people who know what they are doing, trails, which, were used for physical travel and travel by dreams, and petroglyphs, which contain ghost figurines embedded in the rocks. Mr. Cachora indicated that he is not at liberty to explain all the reasons why the area is so important to past, present, and future Quechan beliefs and practices. he asked how important sites such as these could ever be restored once damaged.

Mr. Cachora emphasized that "the desert contains our history." He said he always knew that there had to be a lot of sites and artifacts in the project area, which must be protected so that the Quechan can learn more about their history, but stated that even he was surprised about the large number of cultural resources found by the recent archaeological investigations. He also said that he wants to see copies of all archaeological studies that had been done in the area, that he wants an aerial photograph of the region extending from Pilot Knob to north of the project site and east into Arizona to show how sites in the entire area are tied together, and that he wants to hold a seminar to educate archaeologists and anthropologists about the area and why certain artifacts are important to the tribe. He also stated that he would like to meet with higher BLM officials to educate the Federal government about the importance of the area.

Ms. Cornelius stated that the BLM has a responsibility to protect sites that are sacred to Native American tribes, and noted that *Avikwame*, having no boundaries recognized by Native Americans, had recently been nominated to the National Register. She emphasized that the BLM should be seeking to preserve the trail system in the project area rather than considering a decision to let it be destroyed. Ms. Cornelius also expressed concern for tortoises and other animals in the area that would be destroyed or otherwise impacted by the project. Mr. Bricker observed that the project site is extremely important to all Native Americans and urged that the no development be allowed in the area.

August 29, 1997

Dr. Baksh participated in a meeting with several representatives of the Quechan tribe and Cultural Committee, along with representatives from the BLM, Glamis Imperial Corp., and KEA on August 29, 1997 at the Quechan Tribal Office. Tribal representatives included Ms. Pauline Owl, Mr. Lorey Cachora, Mrs. Barbara Antone, Ms. Pauline Jose, and Ms. Willa Scott. Ms. Pat Weller from the BLM, Mr. Steve Baumann from the Glamis Imperial Corp., and Dr. Jamie Cleland, Dr. Jackson Underwood, and Mr. Andrew Pigniolo from KEA were also in attendance.

The primary goals of this meeting were to obtain input from Mr. Cachora and the Cultural Committee regarding the importance of the project area within a regional context, to discuss possible boundaries for a TCP, and to discuss possible elements of a Treatment Plan. The following discussion summarizes a presentation made by Mr. Cachora.

Pointing to a large map of the lower Colorado River and southern California region prepared by Mr. Cachora for teaching purposes, he explained that all Colorado River peoples stretching from the Hualapai in the north to the Cocopah in the south descended from Newberry Mountain or *Avikaame*, which means the "high peak" or the "high mountain." He noted that some of these Native Americans say they originally came from farther to the north, but this would have been as spirits. The first two beings were spiritual leaders; they found that much of the area was covered with water and so they went up the mountain. Representing positive and negative forces, they fought with each other regularly.

They decided to make a trek down the mountain and along the river, following a trail where the water had receded and stopping at Whipple Mountain or *Aviharutat*, which means "jagged rock." Some say that from here they went to Tehachapi. Others say they went to Blythe, then to the Palm Springs area (*Avik te naam*), then to Huntington Beach, Catalina Island, back to the mainland, then to San Diego and into Mexico. They subsequently made a trek back north to Yuma to a mountain named *Avikwaxos*. They settled in the Yuma area east to Muggins Peak, and then migrated back up north towards the trail to *Avikaame*. The seven tribes dispersed from an area named *Aviharutat* on west side of river in vicinity of Parker and Havasu. The Creator taught us everything here, and laid out trails for us. Some say the songs were created there too.

With *Avikaame* being nominated as a TCP, everything down here in the vicinity of the river should also be recognized as important. The trails in the region and everything associated with the trails are extremely important. A squarish box around the Quechan area represents a buffer zone. Within this buffer zone, we once occupied a huge area extending to Phoenix on the east and to Ocotillo on the west, where we had a temporary home and alliances with the Kamia.

There are two key trails in our area: the Medicine Trail to *Avikaame*, and the Trail of Dreams from Pilot Knob to *Avikaame*. On a recent trip along the Medicine Trail, we found another site like Pilot Knob. One cannot get lost in the desert as long as you know the trail and what to look for. Unfortunately, these and other trails are being increasingly destroyed by jeeps, burros, and other means.

The Quechan do not want to give up the mining area which is very sacred and important for learning and teaching purposes. We are trying to educate our kids about history, and we need to learn about the spiritual aspects of the mining area. Until then, we want it left alone. Everything we are learning in the project area is coming together for me like a book. It is important to keep the area intact so that we can continue our studies. We do not care if you go ahead and do the archaeological studies of the project site, but those studies will not help with the spiritual side of things that we need to learn. This is a very, very sacred area for educational purposes, and we must have the opportunity to learn and teach about the area's spiritual components before it is destroyed.

Picacho Basin, the Laguna Dam area, and the Chocolate Mountain area are three areas where there area windows for passing into other spiritual planes. These areas also need to be studied and protected before additional destruction occurs. We also need to have clear views of these areas and other important places such as Picacho Peak (*Avimilket*). So if you are thinking that those rock piles are only going to be 300 feet, this is still going to alter our views. We are very concerned about our children. They will be affected by the loss of cultural resources. This is our home and we are never going to leave. Even if we leave, we will come back here to die.

Mr. Jefferson commented that the white people also descended from Avikwame. Therefore, he added, even if you win by succeeding with the mine, you will be destroying yourselves.

In response to question by Dr. Cleland as to whether the area has a name, Mr. Cachora responded that the old people never mentioned the area but that it is tied in with the petroglyph area near Picacho. The name has always been held confidential, and he would need to talk with the Cultural Committee to see if the name can be released.

In summary, Mr. Cachora stated that we want to keep the area protected to learn from it and to teach our kids. It would take a long time, maybe ten years to learn about the area. We would not be able to learn and teach stories and songs if there is a big pit.

In response to a question by Dr. Cleland as to whether it would be reasonable to have the boundaries of a TCP extend from the Running Man site to Indian Pass, Mr. Cachora stated that we should have an aerial photograph of the regional area to show why the entire area is important. He also explained that although the Medicine Trail is not as important as it used to me, the Dream Trial still exists and should be completely recorded between Pilot Knob and *Avikwame*. Mr. Cachora also expressed a desire to have a comprehensive synthesis of existing studies to see how everything ties together: "Only by recording all sites along the entire trail route can everything be tied together. Maybe the entire area should be a TCP." Mr. Jefferson observed that "If you cut that trail, I won't be able to dream my way back to *Avikwame*."

Mr. Baumann stated that his project could bring something useful to the tribe. He indicated that he wants to provide funding to the tribe for educational purposes and for tribal members to cultural studies. Mr. Cachora stated that respected Mr. Baumann's offer, but that the project area has a considerable amount of value and that he does not want it to get destroyed. Mr. Cachora indicated that there may be alternatives other than a money offer, but did not with to elaborate.

The meeting concluded without opportunities to discuss TCP boundaries or the Treatment Plan in greater detail. However, Mr. Cachora indicated that he would be interested in meeting with KEA staff and Dr. Baksh in San Diego in the near future to focus on these issues.

September 9, 1997

Dr. Baksh participated in a meeting with Mr. Lorey Cachora and Mr. Wally Antone of the Quechan tribe and Dr. Jamie Cleland, Dr. Jackson Underwood, and Mr. Andrew Pigniolo of KEA at KEA's office on September 9, 1997. The primary purposes of this meeting, in follow-up to the August 29 meeting, were to identify potential TCP boundaries and discuss potential mitigation measures to help offset impacts to cultural resources, should the project proceed. The meeting was very successful for both purposes: by reviewing maps of site distributions, consensus was reached with Mr. Cachora and Mr. Antone for the delineation of boundaries for a proposed "Indian Pass-Running Man TCP;" and subsequent conversations resulted in the compilation of a package of potential mitigation measures that would help offset impacts to cultural resources should the project proceed. Much of the following discussion is a result of Mr. Cachora's comments during this meeting.

Mr. Cachora stated that the Running Man site was used for the training of medicine men, or shamans. This site was one "station" of several including others at Pilot Knob and Cargo Muchacho

Basin to the east of the Cargo Muchacho Mountains. He added that the *keruk* ceremony is held this time of the year when the sun is setting and the moon is up. "Petroglyphs represent this with a ring within a ring, as can be seen at Indian Pass," he noted.

The Running Man site is a key "teaching area" for someone to become an orator or ceremonial leader. Many things in life come in "fours". For example, as a teaching area, the project site ties in with three other teaching areas that include Pilot Knob, Picacho Basin, and an area near Muggins Peak. Mr. Cachora emphasized that if the gold mine goes in, this would be "devastating" to Quechan cultural and religious beliefs. He stated that if the gold mine destroys the area, it would be like ripping off the first page of an important book. The project area is an area "where my life begins." This is where people get directions on whether they will be an orator, shaman, leader, etc., or a common person. He wants to be able to use the area in the future and for it to be available for others to use it as well. The area is critical for seeing the "positive" side of things, for countering the "negative" parts of life. It is important to learn things here in order to go to *Avikwame*.

With regard to the development of mitigation measures, Mr. Cachora and Mr. Antone stated that they wanted Dr. Baksh and KEA to send a letter to the Cultural Committee and general tribal population describing treatment plan options. As a brief summary of conversations relating to the development of a Treatment Plan, Mr. Cachora and Mr. Antone found the following mitigation measures to potentially be appropriate as part of an overall package: the nomination of other sites like Picacho Peak, Pilot Knob, etc., as TCP's; the preparation of a video documentary as part of an education program; improvements to the cultural museum; the acquisition and protection of land with sensitive sites; and the preparation of additional studies including those for sensitive off-site locations. Mr. Cachora stated that he has other alternatives in mind which he must still discuss with the Cultural Committee, but observed that we are close to his ideas when talking about education and the nomination of other TCP teaching sites.

The meeting was concluded with the agreement that Dr. Baksh and KEA staff would draft a letter identifying possible mitigation measures to be submitted to the Cultural Committee and general Quechan population. Mr. Cachora and Mr. Antone agreed to review the draft letter on the following morning before leaving town.

September 10, 1997

Dr. Baksh met with Mr. Lorey Cachora and Mr. Wally Antone at the office of Tierra Environmental Services in San Diego on September 10, 1997. The purpose of the meeting was for Mr. Cachora and Mr. Antone to review a draft letter prepared by Dr. Baksh and KEA archaeological staff based on the September 9 meeting. This draft letter was addressed to the Quechan Cultural Committee and tribal Members and solicited input on a package of potential mitigation measures that would most appropriately offset the significant impacts resulting from the proposed project. In addition to the implementation of a data recovery program, these mitigation measures included the following elements:

- Avoidance of cultural features to the extent possible.

- Funding of an education program that would include a professional video documentary of the project area before it is developed, classes in the area supported by a teaching position, and a report summarizing Quechan history written in part or entirety by the Quechan.

- Preparation of a readable archaeological report written for the Quechan on aspects of Quechan history impacted by the mine project.

- Evaluation for nomination of the Indian Pass area and three other educational areas including Pilot Knob, Muggins Peak, and Picacho Basin for Federal recognition as Traditional Cultural Properties.

- Development and implementation of recording and protection programs for the scratch petroglyphs at Indian Pass and a second concentration to the west.

- Acquisition for tribal stewardship and study of an important archaeological site near Bard.

- Funding for implementation of the expansion plan for the Quechan Museum and curation of artifacts from the project in this facility.

Mr. Cachora and Mr. Antone approved the draft letter and requested that it be mailed to both the Cultural Committee and Tribal Office.

B. CORRESPONDENCE RECEIVED FROM THE QUECHAN TRIBE

The Quechan Indian Tribe has provided the BLM with several letters that address cultural resource concerns associated with the proposed Glamis Imperial Project. These letters are itemized below.

- May 14, 1996 -- Letter from Ms. Pauline Owl (Chairman, Cultural Committee) to Mr. Terry A. Reed (BLM Area Manager)

- May 14, 1996 -- Letter from Mr. Earl E. Hawes (Project Manager, Quechan Environmental Programs) to Mr. Terry A. Reed (BLM Area Manager)

- February 10, 1997 -- Letter from Ms. Pauline Owl (Chairperson, Quechan Cultural Committee; also, Mr. Eldred Millard, Ms. Pauline P. Jose, Ms. Willa Scott, Mr. Lorey Cachora, Mrs. Barbara Antone, Mr. Milton Jefferson, and Ms. Starla Cachora) to Ms. Pat Weller (BLM Archaeologist)

- February 10, 1997 -- Letter from Mr. Wally Antone (Tribal Member)

- February 13, 1997 -- Letter from Mr. Mike Jackson, Sr. (President, Quechan Tribal Council) to Mr. Terry Reed (BLM Area Manager)

- February 13, 1997 -- Letter of Introduction from Mr. Mike Jackson, Sr. (President, Quechan Tribal Council) to State Representatives and Leaders

- April 23, 1997 -- Letter from Mr. Lorey Cachora (Tribal Member) to Mr. Terry Reed (BLM Area Manager)

These letters address many of the concerns expressed during meetings conducted with the Quechan Cultural Committee by Dr. Baksh. The letters are provided in Appendix B to facilitate a comprehensive review of Native American concerns regarding the proposed project.

C. PUBLIC HEARINGS ATTENDED BY THE QUECHAN TRIBE

The BLM conducted two public hearings on the proposed Glamis Imperial Project. These public hearings were held in Holtville, California and La Mesa, California, on February 6, 1997 and February 13, 1997, respectively.

Both public hearings were attended by several Quechan tribal members. Quechan tribal representatives who spoke at the February 6 meeting in Holtville included Mr. Preston J. Arroweed, Mr. Lorey Cachora, Mr. Wally Antone, Mr. Earl Hawes, and Mrs. Barbara Antone. Quechan tribal representatives who spoke at the February 13 meeting in La Mesa included Mr. Lorey Cachora, Mr. Preston J. Arroweed, Mr. Mike Jackson, Sr., Mr. Earl Hawes, Mr. Wally Antone, and Mrs. Barbara Antone.

These individuals expressed numerous cultural and environmental concerns during their public presentations. Certified transcripts of these individuals' presentations are provided in Appendix C to help ensure a comprehensive review of Native American concerns regarding the proposed project.

IV. SUMMARY AND CONCLUSIONS

Comprehensive efforts were made to identify current Native American concerns about the proposed mining project and to document knowledge about the function and/or interpretation of specific cultural resources in the project area. Although the Quechan always expressed adamant opposition to the mining project, specific explanations relating to the extreme cultural significance of many cultural resources in the area were often hard to come by. This general observation appears to be the consequence of several factors including a tremendous loss of traditional cultural knowledge, as suggested in Section IIB on cultural change, and an overall lack of recent use of the area for traditional practices. In addition, the reluctance to divulge sensitive cultural information was offered as an explanation for not discussing certain sites such as the "Trail of Dreams," the Running Man site, and the "power circles" in greater detail. This reluctance diminished over time, however, and important additional information was increasingly provided during the consultation process.

One interpretation of the cultural resources in the project area, offered by at least some tribal members, is that these archaeological sites reflect a major village site at this location. This interpretation, however, is not supported by the ethnohistoric literature. Rather, the ethnohistoric literature, as indicated in Section IIA, clearly demonstrates that Quechan villages, or rancherias, were located along flood plains of the Colorado and Gila Rivers where water was permanently available and where agriculture and fishing were extensively pursued. Although there is no question that the project area was used extensively, based upon the vast quantities of lithic artifacts alone, the ethnohistoric literature supports the archaeological interpretation that the area was used primarily for hunting and collecting activities and for activities associated with travel.

A major explanation discussed by the Quechan that accounts for the extreme importance that they attribute to the cultural resources in the project area is related to the trail system. Specifically, it was explained that the north-south trail segments passing through the project site are part of the trail linking Pilot Knob with Spirit Mountain, the two single most important places in Quechan religious mythology and beliefs. According to the Quechan, this trail previously served the important function of accommodating their ancestors' regular return to worship at Spirit Mountain, the place of origin for all Yuman tribes.

The Quechan feel that trails, and particularly the trail linking Pilot Knob with Spirit Mountain, were at least as important for spiritual and religious reasons as they were for actual travel. As indicated in Section IIA, the ethnohistoric literature strongly supports the observation that dreams were a key component of Quechan culture. According to the Quechan, it was through dreaming that their ancestors were also able to travel between Pilot Knob and Spirit Mountain, and this travel was conducted along the same trail, only in a matter of seconds or minutes rather than days.

The importance of dreaming for Yuman tribes, and particularly for the Quechan and Mohave, cannot be denied. The Quechan and Mohave had tribal leaders who settled disputes, organized redistributions, organized ceremonies, and led warfare. Importantly, these leaders, known as *Kwaxot* (Quechan) and *kohota* (Mohave) were accepted largely due to their dreams. As described by Ford

(1931:136), "When a man knew he had the power to be a good leader, he told his dreams..." Many men were dreamers. In addition to leaders, dreams gave shamans the power to cure, warriors the power to be victorious, and other men the power to sing or to be funeral orators (Ford 1931:127-128, 138, 182-183; Kroeber 1925:745).

The importance of trails for actual travel, spiritual travel, and mythology is also supported in the ethnohistoric literature available for the Yuman tribes (especially for the Mohave, who were culturally similar to the Quechan). Connie Stone, in a review of the literature, summarized the importance of trails as follows:

> Trails are particularly relevant to the investigation of regional settlement patterns. they represent established links among sites, resource areas, and social groups.... Major north-south trails linked tribal heartlands along the Colorado River... A major river route, the Quechan trail, was both a real and mythical path, the way of southward migrations from the sacred Mt. Newberry (Avikwame) in southern Nevada. The Quechan trail and other trail segments are frequently associated with geoglyphs and are often incorporated as elements of earth figure sites (1991:82).

The Quechan explained on several occasions that the Running Man site is intimately connected with the trail system. For example, the large rock alignment at this site represented a "window to another time." Their ancestors would sometimes run along the trail at this location and jump over the alignment, and thereby go back to the past or "pass into another dimension." The Running Man geoglyph was said to be made by one of the informant's fathers and a friend of his father, who used the site for spiritual purposes. Although the Running Man site would not be directly impacted by the proposed project, tribal members feel that views of the horizon, including those of Picacho Peak and the Indian Pass area, would be significantly impacted by the construction of 300-foot-high stockpiles. Disruption of current views of the skyline would effectively prevent any future religious use of this site which, from the tribe's perspective, would be detrimental to their religious beliefs and practices.

The Quechan also explained that many of the other sites in the project area (as well as beyond the project area) were directly associated with the Spirit Mountain/Pilot Knob trail. For example, the "power circles" were used by travellers along the trail, both during actual travel and dream travel, to pray and obtain power to assist with the journey. The larger cleared circles, in turn, were used to rest along the way.

A principal concern of the Quechan about the proposed project is that it would significantly jeopardize their present and future ability to travel along this trail, both in a physical sense during dreams. Although they have not used the area since their father's generation, they want to use it in the future. As an example of current use of traditional resources, a contingent from the tribe recently travelled by foot along a major trail from Yuma to Ward Valley.

Dreaming is currently not as extensive as it was during the ethnohistoric period. Few individuals today are able to obtain knowledge and power through dreams. However, some individuals are learning to dream again, and it is felt that this will play a crucial role in maintaining cultural integrity in the future. Any impacts to major trail systems, such as the Pilot Knob/Spirit Mountain trail, would therefore significantly impact the ability of the tribe's cultural leaders to maintain and develop their cultural existence and values.

Another principal concern offered by some Quechan tribal members is that the project vicinity is a "strong" area and likely is the final resting place for their ancestors. At least one individual speculated that the area has also likely been designated by the spirits as the final resting place for Quechan who are still living. The specific concern is that impacts from the proposed project would severely disturb those who seek to rest at this location during their final phase of life.

A final, major important reason that the Quechan are intensely opposed to disturbance of the project area is that it represents a critical learning and teaching center. Although the project area has not been used extensively in the recent past, tribal members want to use the area in the future and feel that they can learn much about spiritual matters and their history by visiting the area. The project area was defined as one of four key "teaching areas," where religious leaders and others can study, learn, and subsequently teach the younger generation aspects of religion and history that are critical for cultural survival.

Based upon the importance of the trail system and several other sites in the project area, the Quechan place the highest possible level of significance on cultural resources at this location. Because of the high significance, no impacts would be acceptable to the tribe. As a consequence, the tribal members have difficulty conceiving any possible mitigation that would minimize impacts to the sites that would result through project implementation. The tribe is not even interested in a scaled-back project that would avoid some sites. It should be noted, however, that during final meetings with Quechan representatives, several types of mitigation measures were discussed which they would find possibly find to be appropriate should there be no way of stopping the project.

As indicated in the Introduction, the project site was been resurveyed based upon input from the tribe and a request by the BLM to help ensure that no archaeological sites are overlooked. The intensive fieldwork for this new survey was conducted by KEA from June 24, 1997 through August 14, 1997, and included the participation of Native American monitors from the Quechan tribe. The results of this survey, which are not yet available due to ongoing analysis and report preparation, should yield a comprehensive description of the archaeological sites that exist on the proposed project site. The results of the new survey, in conjunction with additional Native American consultation, should also go far towards evaluating the significance of historic properties on the project site and identifying the cultural resource impacts that would occur as a result of the proposed action.

Although the Quechan are reluctant to discuss mitigation at this time, it is recommended that they be encouraged to consult on this matter in the future. The tribe should be extensively consulted during preparation of the Treatment Plan for the project area.

V. REFERENCES

Altschul, Jeffrey H. and Joseph A. Ezzo

1994 The Expression of Ceremonial Space Along the Lower Colorado River. In *Recent Research Along The Lower Colorado River*, edited by Joseph A. Ezzo, pp. 51-67. Statistical Research Technical Series No. 51. Tucson, Arizona.

Beals, Ralph L. and Joseph A. Hester, Jr.

1974 Indian Occupancy, Subsistence, and Land Use Patterns in California. *California Indians*, Vol. VI. Garland Publishing Inc. New York and London.

Bee, Robert L.

1982 The Quechan. In *APS/SDG&E Interconnection Project Native American Cultural Resources: Identification and Evaluation of Native American Cultural Resources Situated Within One Mile of the Proposed and Existing Rights-of-Way in California.* Prepared by Clyde Woods, Wirth Associates, San Diego, California. Prepared for San Diego Gas and Electric Company, San Diego, California.

1983 Quechan. In *Southwest*, edited by Alfonso Ortiz, pp. 86-98. Handbook of North American Indians, Vol. 10, William G. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

Cachora, Lorey

1994 The Spirit Life of Yuman-Speaking Peoples: Lower Colorado River Between Arizona and California. In *Recent Research Along The Lower Colorado River*, edited by Joseph A. Ezzo, pp. 13-14. Statistical Research Technical Series No. 51. Tucson, Arizona.

Castetter, Edward F. and William H. Bell

1951 *Yuman Indian Agriculture*. University of New Mexico Press, Albuquerque.

Driver, Harold E.

1957 Estimation of Intensity of Land Use from Ethnobiology Applied to the Yuman Indians. *Ethnohistory* 4:174-197.

Ezzo, Joseph

1994 *On the Trail to Avikwaame: Results of a Noncollection Class II Cultural Resources Survey of Quien Sabe/Big Maria Terrace, Riverside County, California.* Statistical Research Technical Series No. 49. Tucson, Arizona.

Ezzo, Joseph A. and Jeffrey H. Altschul

1993 *Glyphs and Quarries of the Lower Colorado River.* Statistical Research Technical Series No. 44. Tucson, Arizona.

Forbes, Jack D.
1965 *Warriors of the Colorado: The Yumas of the Quechan Nation and Their Neighbors*. University of Oklahoma Press, Norman, Oklahoma.

Forde, C. Daryll
1931 Ethnography of the Yuma Indians. *University of California Publications in American Archaeology and Ethnology* 28(4):83-278. Berkeley.

Halpern, Alan M.
1980 Sex Differences in Quechan Narration. *Journal of California and Great Basin Anthropology* 2(1):51-59.

Harrington, John P.
1908 A Yuma Account of Origins. *Journal of American Folk-Lore* 21(82):324-348.

Hedges, Ken
1975 Notes on the Kumeyaay: A Problem of Identification. *The Journal of California Anthropology* 2(1):71-83.

Heintzelman, S.P.
1857 Report of Brevet Major S.P. Heintzelman, July 15, 1853. In Indian Affairs of the Pacific. House of representatives Executive Document No. 76. (34th Congress, 3rd Session). Washington, D.C.: U.S. Government Printing Office.

Heizer, Robert F.
1974 Indians of California: A Collection of Maps on Tribal Distribution. *California Indians*, Vol. II. Garland Publishing Inc. New York and London.

Heizer, R.F. and M.A. Whipple
1971 *The California Indians: A Source Book.* Second Edition. University of California Press. Berkeley.

Knack, Martha
1981 Ethnology. In *A Cultural Resource Overview of the Colorado Desert Planning Units,* edited by Elizabeth von Till Warren, Robert H. Crabtree, Claude N. Warren, Martha Knack, and Richard McCarty, pp. 55-82. Cultural Resources Publications Anthropology-History, Eric W. Ritter, editor. Bureau of Land Management, Riverside, California.

Kroeber, Alfred L.
1920 California Culture Provinces. *University of California Publications in American Archaeology and Ethnology* 17(2):151-169. Berkeley.

1925 *Handbook of the Indian of California.* Smithsonian Institution, Washington, D.C.

1948 Seven Mohave Myths. *Anthropological Records* 11:1. University of California Press, Berkeley and Los Angeles.

1951 A Mohave Historical Epic. *Anthropological Records* 11(2):71-176.

Schaefer, Jerry and Carol Schultze
1996 Cultural Resources of Indian Pass: An Inventory and Evaluation for the Imperial Project, Imperial County, California. Volume I, Technical Report. Prepared by ASM Affiliates, Inc., Encinitas, California.

Spier, Leslie
1933 *Yuman Tribes of the Gila River*. University of Chicago Press, Chicago. (Reprinted: Cooper Square Press, New York, 1970).

Stone, Connie
1991 The Linear Oasis: Managing Cultural Resources Along the Colorado River. Cultural Resource Series Monograph No. 6. Arizona State Office of the Bureau of Land Management. Phoenix, Arizona.

Trippel, Eugene J.
1889 The Yuma Indians. *The Overland Monthly* (2nd Series) 13:561-584.

Woods, Clyde M., Shelly Raven, and Christopher Raven
1986 *The Archaeology of Creation: Native American Ethnology and the Cultural Resource of Pilot Knob*. Report prepared by Wirth Environmental Services for the U.S. Department of Interior Bureau of Land Management, El Centro Resource Area.

APPENDIX D

FEATURE CODE KEY

This page intentionally left blank
for reproduction purposes.

CHEMGOLD LEGEND 10/10/97

Prehistoric Trail (PT)	Prehistoric Trail (PT)	Begin
		Middle
		End
Historic (H)	Bomb Crater (BC)	
	Can Scatter (CNS)	
	Ceramic Scatter (CS)	
	Concrete Foundation (CF)	
	Cleared Area (CA)	
	Fire Ring (FR)	
	Historic Artifact (HA)	
	Historic Pit (HP)	
	Historic Road (HR)	
	Historic Rock Feature (HRF)	
	Historic Trail (HT)	
	Mining Prospect (MP)	
	Refuse Scatter (RS)	
	Rock Alignments (HRA)	
	Rock Cairn (HRC)	
	Rock Lined Pit (RLP)	
	Rock Rectangle (RRECT)	
	Rock Ring (HRR)	
	Rock Semicircle (RSC)	
	Rock Wall (RW)	
Prehistoric (P)	Biface (B)	
	Bone (BN)	
	Cleared Circle (CC)	
	Core (C)	
	Flaking Station (FS)	
	Groundstone (GS)	
	Groundstone Flaking (GFS)	
	Hammerstone (H)	
	Lithic Scatter (LS)	
	Lithic Quarry (LQ)	
	Mano (M)	
	Metate (MT)	
	Painted Pottery (PP)	
	Pecked Rock (PR)	
	Pot Drop (PD)	
	Pot Sherd (P)	
	Pottery Scatter (PS)	
	Prehistoric Rock Cairn (PRC)	
	Prehistoric Rock Semicircle (PRS)	
	Prehistoric Rock Feature (PRF)	
	Prehistoric Artifact (PA)	
	Rock Hearth (RH)	
	Rock Ring (PRR)	
	Scratched Rock (SR)	
	Shell (S)	
	Tool (T)	
	Tool Scatter (TS)	
Ceremonial (C)	Geoglyphs (G)	

	Human Bone (HB)	
	Lingam (L)	
	Crystal (K)	
	Petroglyph (PG)	
	Prayer Circle (PC)	
	Rock Alignment (PRA)	
	Rock Cairn (PRC)	
	Shaman's Hearth (SH)	
	Spirit Break (SPB)	
	Trail Marker (TM)	
	Trail Shrine (TS)	
	Vision Quest Circle (VQ)	
	Need to identify (info stolen) (Z)	
	Prehistoric Quartz Smash (Q)	
ET	Tool Scatter (TS)	
	Early Tool (ET)	
	Early Tool Site Boundary (ETSB)	
Topographical (T)	Animal/Game Trail (AT)	
(note:assign each of	Drill hole (DH)	
these a T # instead	Site Boundary (SB)	
of a Feature #)	Claim Post (CP)	
	Project Stake (PROJ)	
	Road (RD)	Begin
		Middle
		End
	Control Point (CTP)	
	Survey Marker (SM)	
	Flake Station/Recent (TFS)	
	Rock Cairn (RC)	
	Site Datum (SD)	
	Transect (begin or end point) (TRANS)	
	Test Unit (TU)	
Changes to make:		
H/HTP = H/CA		
P/CA=P/CC or C/VQ		

APPENDIX M VISUAL CONTRAST RATING WORKSHEETS

Form 8400-4
(April 1984)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

Date 8-17-95

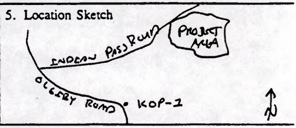
District CALIFORNIA DESERT

Resource Area EL CENTRO

Activity (program) 3809

SECTION A. PROJECT INFORMATION

1. Project Name IMPERIAL PROJECT
2. Key Observation Point KOP-1
3. VRM Class II
4. Location
   Township 14S
   Range 20E
   Section UNSURVEYED
5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/~~WATER~~	2. VEGETATION	3. STRUCTURES
FORM	FAR: RHOMBOID MIDDLE: FLAT	FAR: NONDIRECTIONAL MIDDLE: NONDIRECTIONAL	—
LINE	FAR: ANGULAR/JAGGED + SMOOTH MIDDLE: WEAK, UNDULATING	FAR: WEAK, SOFT MIDDLE: WEAK, SOFT	—
COLOR	FAR: BROWN, TAN MIDDLE: TAN, GRAY	FAR: TAN MIDDLE: GREEN TAN	—
TEXTURE	FAR: SMOOTH + ROUGH MIDDLE: SMOOTH	FAR: MEDIUM(D), FINE (G) E/R MIDDLE: MEDIUM (D) MEDIUM(G) I/R	—

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/~~WATER~~	2. VEGETATION	3. STRUCTURES
FORM	SMOOTH, ROUNDED, RHOMBOID MINOR	SIMPLE, IRREGULAR	—
LINE	SOFT, UNDULATING, DISCONTINUOUS, MINOR ANGULAR	SINUOUS	—
COLOR	TAN, BROWN	TAN	—
TEXTURE	MEDIUM PATCHY	SPARSE ROUGH	—

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

1.

DEGREE OF CONTRAST	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
ELEMENTS	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Form		✓					✓					—
Line		✓						✓				—
Color			✓					✓				—
Texture		✓					✓					—

2. Levels of Change

☐ Very Low, ☐ Low, ☒ Moderate, ☐ High

3. Does project design meet visual resource management objectives? ☐ Yes ☒ No

Explain: (Continue on reverse, if necessary)

4. Additional mitigating measures recommended

☐ Yes ☒ No (Use reverse side if "yes".)

SECTION D. (Continued)

Continuation of comments from item 3.

THE PROPOSED PROJECT DOES NOT RETAIN THE ORIGINAL CHARACTER OF THE LANDSCAPE, AND IS THEREFORE NOT CONSISTENT WITH THE MANAGEMENT OBJECTIVES OF A CLASS II AREA.

Additional Mitigating Measures (See item 4)

Signature	Date 8-17-95

Form 8400-4
(April 1984)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

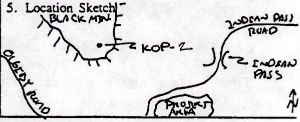
Date: 8-17-95
District: CALIFORNIA DESERT
Resource Area: EL CENTRO
Activity (program): 3809

SECTION A. PROJECT INFORMATION

1. Project Name: IMPERIAL PROJECT
2. Key Observation Point: KOP-2
3. VRM Class: II

4. Location
Township: 13 S
Range: 20 E
Section: UNSURVEYED

5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/~~WATER~~	2. VEGETATION	3. STRUCTURES
FORM	NEAR: STEEP SMOOTH, SIMPLE MIDDLE: FLAT, SMOOTH, SIMPLE	NEAR: UNIFORM MIDDLE: LINEAR	—
LINE	NEAR: GEOMETRIC, SOFT MIDDLE: FLOWING, WEAK	NEAR: DIFFUSE, WEAK MIDDLE: HORIZONTAL, BOLD	—
COLOR	NEAR: BLACK BROWN MIDDLE: TAN, GRAY, BROWN	NEAR: BROWN, TAN MIDDLE: GREEN TAN	—
-	NEAR: GRANULAR, PATCHY MIDDLE: STIPPLED, DIRECTIONAL	NEAR: SPARSE MEDIUM, EVEN, RANDOM MIDDLE: STIPPLED, CONTRASTY	—

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/~~WATER~~	2. VEGETATION	3. STRUCTURES
FORM	SMOOTH, ROUNDED, RHOMBOID MINOR CONICAL	SIMPLE, IRREGULAR	—
LINE	SOFT UNDULATING; DISCONTINUOUS MINOR ANGULAR	SINUOUS	—
COLOR	TAN BROWN	TAN	—
TEXTURE	MEDIUM PATCHY	SPARSE ROUGH	—

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

DEGREE OF CONTRAST	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
ELEMENTS	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Form		✓					✓					—
Line		✓						✓				—
Color			✓					✓				—
Texture		✓					✓					—

2. Levels of Change
☐ Very Low, ☐ Low, ☒ Moderate, ☐ High

3. Does project design meet visual resource management objectives? ☐ Yes ☒ No
Explain: (Continue on reverse, if necessary)

4. Additional mitigating measures recommended
☐ Yes ☒ No (Use reverse side if "yes".)

SECTION D. (Continued)

Continuation of comments from item 3.

THE PROPOSED PROJECT DOES NOT RETAIN THE ORIGINAL CHARACTER OF THE LANDSCAPE, AND IS THEREFORE NOT CONSISTENT WITH THE MANAGEMENT OBJECTIVES OF A CLASS II AREA.

Additional Mitigating Measures (See item 4)

Signature	Date 8-17-95

Form 8400-4
(April 1984)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

Date 8-17-95

District CALIFORNIA DESERT

Resource Area EL CENTRO

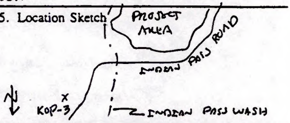
Activity (program) 3809

SECTION A. PROJECT INFORMATION

1. Project Name IMPERIAL PROJECT
2. Key Observation Point KOP-3
3. VRM Class II

4. Location
Township 13 S
Range 21 E
Section UNSURVEYED

5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/~~WATER~~	2. VEGETATION	3. STRUCTURES
FORM	FLAT, SMOOTH/ MINOR ROLLING	LINEAR, IRREGULAR	—
LINE	UNDULATING, IRREGULAR	SINUOUS	—
COLOR	TAN, BROWN BLACK	GREEN TAN	—
-	GRANULAR, SPARSE, PATCHY	STIPPLED/SPARSE ROUGH	—

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/~~WATER~~	2. VEGETATION	3. STRUCTURES
FORM	SMOOTH, ROUNDED, RHOMBOID MINOR CONICAL	STIPPLE IRREGULAR	—
LINE	SOFT, UNDULATING; DISCONTINUOUS MINOR ANGULAR	SINUOUS	—
COLOR	TAN, BROWN	TAN	—
TEXTURE	MEDIUM, PATCHY	SPARSE ROUGH	—

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

DEGREE OF CONTRAST	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
ELEMENTS	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Form		✓					✓					–
Line		✓						✓				–
Color			✓					✓				–
Texture		✓					✓					–

2. Levels of Change
☐ Very Low, ☐ Low, ☒ Moderate, ☐ High

3. Does project design meet visual resource management objectives? ☐ Yes ☒ No
Explain: (Continue on reverse, if necessary)

4. Additional mitigating measures recommended
☐ Yes ☒ No (Use reverse side if "yes".)

SECTION D. (Continued)

Continuation of comments from item 3.

THE PROPOSED PROJECT DOES NOT RETAIN THE ORIGINAL CHARACTER OF THE LANDSCAPE, AND IS THEREFORE NOT CONSISTENT WITH THE MANAGEMENT OBJECTIVES OF A CLASS II AREA.

Additional Mitigating Measures (See item 4)

Signature	Date 8-17-95

Form 8400-4
(April 1984)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

Date 7-11-97

District CALIFORNIA DESERTS

Resource Area EL CENTRO

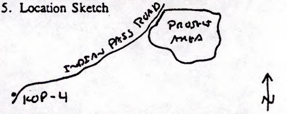
Activity (program) 3809

SECTION A. PROJECT INFORMATION

1. Project Name IMPERIAL PROJECT
2. Key Observation Point KOP-4
3. VRM Class II

4. Location
Township 14 ~~N~~ S
Range 20 E
Section UNSURVEYED

5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/~~WATER~~	2. VEGETATION	3. STRUCTURES
FORM	FAR: RHOMBOID MIDDLE: FLAT	FAR: NONDIRECTIONAL MIDDLE: NON DIRECTIONAL	–
LINE	FAR: SMOOTH / ANGULAR + JAGGED MIDDLE: WEAK, UNDULATING	FAR: WEAK, SOFT MIDDLE: WEAK, SOFT	–
COLOR	FAR: BROWN, TAN MIDDLE: TAN, GREY	FAR: TAN MIDDLE: GREEN, TAN	–
TEXTURE	FAR: SMOOTH + ROUGH MIDDLE: SMOOTH	FAR: MEDIUM (D), FINE (G) E/R MIDDLE: MEDIUM (D), MEDIUM (G) U/R	

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/~~WATER~~	2. VEGETATION	3. STRUCTURES
FORM	SMOOTH, ROUNDED, RHOMBOID	SIMPLE IRREGULAR	–
LINE	SOFT, UNDULATING, DISCONTINUOUS, MINOR ANGULAR	SINUOUS	–
COLOR	TAN, BROWN	TAN, GREEN	–
TEXTURE	MEDIUM PATCHY	SPARSE, ROUGH	–

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

DEGREE OF CONTRAST	LAND/WATER BODY (1) Strong	Moderate	Weak	None	VEGETATION (2) Strong	Moderate	Weak	None	STRUCTURES (3) Strong	Moderate	Weak	None
ELEMENTS: Form		✓					✓					–
Line		✓						✓				–
Color			✓					✓				–
Texture		✓					✓					–

2. Levels of Change
☐ Very Low, ☐ Low, ☒ Moderate, ☐ High

3. Does project design meet visual resource management objectives? ☐ Yes ☒ No
Explain: (Continue on reverse, if necessary)

4. Additional mitigating measures recommended
☐ Yes ☒ No (Use reverse side if "yes".)

SECTION D. (Continued)

Continuation of comments from item 3.

THE PROPOSED PROJECT DOES NOT RETAIN THE ORIGINAL CHARACTER OF THE LANDSCAPE, AND IS THEREFORE NOT CONSISTENT WITH THE MANAGEMENT OBJECTIVES OF A CLASS II AREA.

Additional Mitigating Measures (See item 4)

Signature	Date 7-11-97

APPENDIX N IMPERIAL PROJECT DRAFT 404(B)(1) ALTERNATIVES ANALYSIS (NOVEMBER 5, 1997)

IMPERIAL PROJECT
DRAFT 404(B)(1) ALTERNATIVES ANALYSIS

November 5, 1997

Prepared for:

Glamis Imperial Corporation
P.O. Box 1177
Winterhaven, California 92283

Prepared by:

LSA Associates, Inc.
3403 10th Street, Suite 520
Riverside, California 92501
(909) 781-9310
LSA Project #CGI730

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

PROPOSED FEDERAL ACTION

The applicant, Glamis Imperial Corporation (Glamis Imperial), is applying to the Army Corps of Engineers, Los Angeles District (Corps) for a permit to discharge dredged and fill material into waters of the United States. The permit will be issued under Corps permitting authority pursuant to Section 404 of the federal Clean Water Act. The Corps will evaluate the application and reach a decision based on federal regulations (33 CFR Parts 320 to 330; 40 CFR Part 230) for implementing Section 404 and on related guidance. The Corps must complete two independent analyses as part of the decision making process: a public interest review and an analysis for consistency with the guidelines for specifications of disposal sites for dredged and fill material, commonly referred to as the 404(b)(1) guidelines. The latter analysis is the subject of this document.

This alternatives analysis has been prepared to objectively evaluate the practicability of alternatives to the proposed Imperial Project (project). The purpose of this analysis is to provide the Corps with documentation for their use in evaluating the proposed project permit application for compliance with the 404(b)(1) guidelines.

The 404(b)(1) guidelines require that the alternatives analysis be adequate to establish that the project is the least environmentally damaging, practicable alternative (LEDPA). This is accomplished by comparing the proposed project with other alternatives in terms of practicability, project purpose, and overall environmental effects.

For this analysis, a reasonable statement of overall project purposes has been developed, and three alternatives (including the proposed project) have been evaluated in light of those purposes. This alternatives analysis has been prepared to be consistent with Corps requirements. It is understood that the information provided herein must be verified by the Corps.

REGULATORY BACKGROUND

This section provides an overview of the requirements of the 404(b)(1) guidelines and a discussion of the implementing guidance issued by Corps Headquarters to all Corps Districts regarding implementation of the guidelines. A discussion of the application of the guidelines to the project is provided.

OVERVIEW OF THE 404(B)(1) GUIDELINES

The 404(b)(1) guidelines (guidelines) are the substantive criteria used by the Corps in evaluating discharges of dredged or fill material into waters of the United States under Section 404 of the Clean Water Act. The guidelines require that four criteria be satisfied in order for the Corps to make a decision that a proposed discharge of dredged or fill material is in compliance. Briefly summarized, these criteria are as follows:

1) The discharge must be the least environmentally damaging practicable alternative.

2) The discharge must not violate any water quality standard or toxic effluent standard, or jeopardize the continued existence of an endangered or threatened species.

3) The discharge must not result in a significant degradation of the waters of the United States.

4) Unavoidable impacts to the aquatic ecosystem must be mitigated.

Before the Corps can issue a Section 404 permit, they must find that the requirements of the guidelines have been satisfied.

The key criteria for most permit applications, and the focus of this analysis, is the requirement that the discharge be the least environmentally damaging practicable alternative. This is a simplification of the actual regulatory requirements; the pertinent sections read as follows:

> "Except as provided under Section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem so long as the alternative does not have other significant adverse environmental consequences.
>
> (1) For the purpose of this requirement, practicable alternatives include, but are not limited to:
>
> (I) Activities that do not include a discharge into waters of the United States or ocean waters,
>
> (ii) Discharges of dredged or fill material at other locations in waters of the United States or ocean waters,
>
> (2) An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered;
>
> (3) Where the activity associated with a discharge which is proposed for a special aquatic site (as defined in subpart E) does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water dependent"), practicable alternatives that do not involve special

> aquatic sites are presumed to be available, unless clearly demonstrated otherwise. In addition, where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise."

The key provisions in this language are practicability and overall project purposes. To repeat, an alternative is practicable if it is available to the applicant and capable of being accomplished by the applicant after a consideration of costs, existing technology and logistics, in light of overall project purposes. If a practicable alternative to the proposed project is available, would have less impact on the aquatic ecosystem, and does not include other significant adverse impact, then the proposed project is not the least damaging practicable alternative. Should this occur, the proposed project would not comply with the guidelines.

The proposed project will impact "waters of the United States," that are ephemeral tributaries (washes) conveying surface flows during and immediately following precipitation events and that have been determined to be "isolated waters." There are no wetlands on the site nor on adjoining lands (therefore, the project will not result in impacts to wetlands). Portions of the waters of the United States support microphyll woodland, a habitat type that occupies about 139 acres (9 percent) of the project site. Because this habitat is or would be used by migratory birds protected by migratory bird treaties or which cross state lines, these tributaries are considered by the Corps to be waters of the United States (LSA Associates, Inc. [LSA] Jurisdictional Determination, September 22, 1997). The waters of the United States including the portions supporting microphyll woodland meet the guidelines definition of "aquatic environment" and "aquatic ecosystem."

Subpart E of the guidelines identifies "special aquatic sites" as sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes. Based on Subpart E, the waters of the United States present on the site, including areas of microphyll woodland, do not qualify as a special aquatic site.

REVIEW OF IMPLEMENTING GUIDANCE

Guidance has been issued from the Department of the Army regarding application of the 404(b)(1) guidelines and the analysis of alternatives. This guidance includes memoranda from the Headquarters office in Washington D.C. and a memorandum issued jointly by the Department of the Army and the Environmental Protection Agency (EPA) titled "Appropriate Level of Analysis Required for Evaluating Compliance with the Section 404(b)(1) Guidelines Alternatives Requirements" (August 23, 1993). Salient points taken from this guidance are as follows:

- The statement of overall project purposes must be reasonably defined. It should not include a specific acreage, number of units or design criteria. It must not be so narrowly defined as to preclude the existence of practicable alternatives or so broadly defined as to render the analysis meaningless or impracticable.

- The analysis should be conducted with the intent of avoiding significant impacts to aquatic resources, and not necessarily providing either the optimal project location or the highest and best property use.

- Even where a practicable alternative exists that would have less adverse impact on the aquatic ecosystem, the guidelines allow it to be rejected if it would have "other significant adverse environmental consequences." This allows for consideration of "evidence of damages to other ecosystems in deciding whether there is a 'better' alternative." Hence, in applying the alternatives analysis required by the guidelines, it is not appropriate to select an alternative where minor impacts on the aquatic environment are avoided at the cost of substantial impacts to other environmental values.

- The intent is to consider only those alternatives that are reasonable in terms of the overall scope/cost of the project. If an alternative is unreasonably expensive to the applicant, the alternative is not practicable. The determination of what constitutes an unreasonable cost should generally consider whether the projected cost of an alternative is substantially greater than the costs generally associated with the particular type of project.

Although not specifically stated in the guidance, it is nonetheless clearly implied that an alternative that does not meet the overall project purposes is not considered practicable.

Based on an agreement between the Corps and EPA (Mitigation MOA[1]), efforts must first be directed at avoiding or reducing impacts to waters of the United States prior to the evaluation of potential compensatory mitigation measures. Mitigation may only be applied to unavoidable impacts. In keeping with this guidance, this alternatives analysis does not include potential mitigation measures as a means of demonstrating that a particular alternative has fewer impacts. Alternatives have been evaluated with the goals of practicability, consistency with overall project purposes, and avoiding and minimizing impacts to waters of the United States.

APPLICATION OF THE GUIDELINES TO THE PROJECT

The project, as proposed, would result in the discharge of dredged or fill material into about 77.4 acres of waters of the United States. As presented in the Overview above, to comply with the guidelines, a project must meet four crite-

---

1 Memorandum of Agreement (MOA) between the EPA and the Department of the Army Concerning the Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines, February 1990.

ria. The following discussion addresses each criterion relative to the proposed project:

1) *The discharge must be the least environmentally damaging practicable alternative.*

   This alternatives analysis evaluates two on-site alternatives to the proposed project in terms of environmental effects, practicability, and consistency with overall project purposes.

2) *The discharge must not violate any water quality standard, toxic effluent standard, or jeopardize the continued existence of an endangered or threatened species.*

   The project has incorporated specific measures to reduce the potential for erosion which would also reduce the potential for sedimentation. In addition, Glamis Imperial has committed to comply with the conditions of the Storm Water NPDES General Permit applicable to the project and would prepare and follow the requirements of the Storm Water Pollution Prevention Plan (SWPPP) to control drainage and erosion. As a result the proposed action is not anticipated to produce substantial sediment into the washes retained on site or into washes downstream of the site.

   Glamis Imperial has incorporated specific measures into the project to reduce the potential for spills of chemicals or regulated waste (such as waste oil), and has incorporated measures to reduce erosion and sedimentation that may transport spilled materials or wastes to the watercourses. Together, these measures should substantially reduce the potential for any surface water degradation to insignificance.

   The heap leach system (heap, pad, ponds, etc.) would be designed to provide for the 100 percent containment of the precipitation from the maximum probable one-hour storm event occurring simultaneously with a 24-hour power outage while still maintaining a 2-foot freeboard in the process and overflow ponds. This would greatly limit the potential for failure of the process facilities during high precipitation events that might otherwise result in a discharge of process solution and sediment to the drainage channels.

   The mitigated effects of the proposed action on the only affected endangered or threatened species (desert tortoise) would be below the level of significance. The Biological Assessment Report submitted to the U.S. Fish and Wildlife Service (USFWS) for the Biological Opinion concludes that, with mitigation, the proposed action would not jeopardize the continued existence of the desert tortoise.

3) *The discharge must not result in a significant degradation of the waters of the United States.*

The jurisdictional determination conducted for the Imperial Project site (LSA, August 7, 1997) identified a total of 114.5 acres of the site as waters of the United States. The project would result in the discharge of dredged or fill material into about 77.4 acres of waters of the United States. Indirect impacts would also occur to other waters of the United States both within and immediately adjacent to the project mine and process area, principally through the isolating or dewatering of a given reach of drainage course by excavating or filling upstream areas. However, such indirect impacts would be restricted to short reaches of tributary washes immediately downgradient of the filled or excavated areas, since all of the major stream channels have been diverted to maintain through going flows.

4) *Unavoidable impacts to the aquatic ecosystem must be mitigated.*

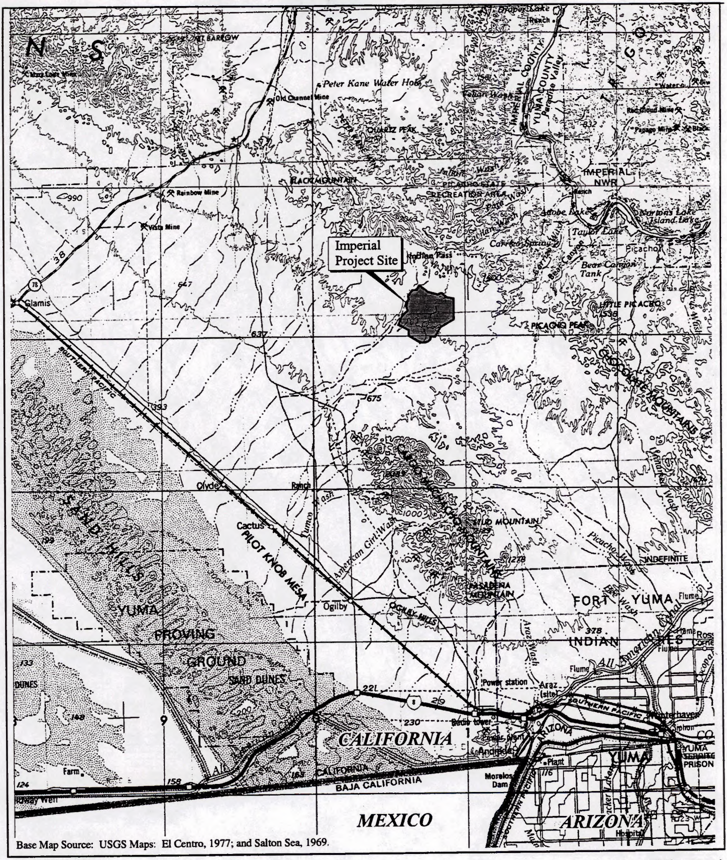
Mitigation measures proposed within the project EIS/EIR would result in the acquisition of lands off site to compensate for the impacts of the project. Acquisition of the lands would facilitate management of a threatened species (desert tortoise) and other wildlife species and would compensate for the loss of microphyll woodland at a ratio of about 3:1 (3 acres acquired for each acre impacted by the project). It is anticipated that the washes on the compensation lands encompass waters of the United States that are comparable to those present on the project site. It is also anticipated that the acquisition and subsequent management of the compensation lands would mitigate any project impacts to waters of the United States to below a level of significance.

PROPOSED PROJECT AND ALTERNATIVES

PROJECT LOCATION

The project is located in eastern Imperial County, California, approximately 45 miles northeast of El Centro, California and 20 miles northwest of Yuma, Arizona (Figure 1). The project area is located within Sections 31, 32, and 33, Township 13 South, Range 21 East, and Sections 4, 5, 6, 7, and 8, Township 14 South, Range 21 East, San Bernardino Meridian (SBM), entirely on public lands administered by the U.S. Bureau of Land Management (BLM). The delineated extent of waters of the United States is shown in Figure 2. The "overbuilt transmission line corridor" would contain all of the activities associated with the "rebuilding" of the utility-owned 34.5 kV transmission line into a 92 kV/34.5 kV transmission line.

The project mine and process area boundary encompasses approximately 1,571 acres on a broad, south- and west-facing, alluvial plain south of Indian Pass in the Chocolate Mountains, between the Cargo Muchacho Mountains, approximately 4 miles south, and Peter Kane Mountain, approximately 6 miles



10/31/97(CGI730)

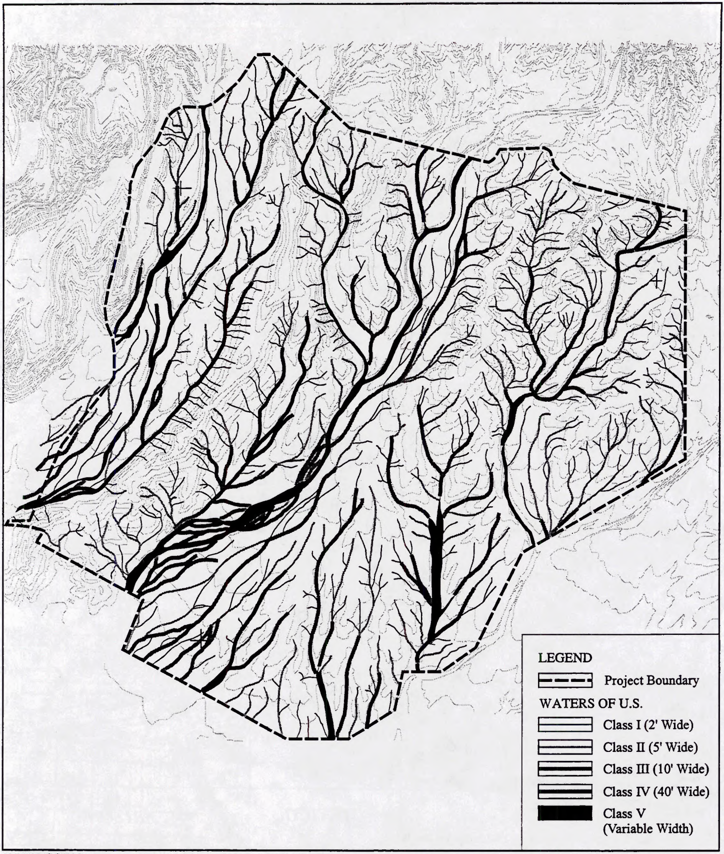
Figure 1

N

LSA

0 2 Mi. 4 Mi.

Regional Location Map



10/31/97(CGI730)

Figure 2

N

LSA 0' 750' 1,500'

Imperial Project
Waters of the U.S.

north. The elevation over the project mine and process area ranges from about 760 to 925 feet. The project mine and process area lies near the center of the mining district formed by the active Picacho Mine, Mesquite Mine, and American Girl Mine heap-leach gold facilities, each located approximately 10 miles from the project mine and process area.

Vegetation of the project area is characterized by microphyll woodland within and adjacent to ephemeral stream channels and creosote bush scrub on upland areas between the stream channels. Dominant species of the microphyll woodland are ironwood (*Olneya tesota*), palo verde (*Cercidium floridum*), cat-claw (*Acacia greggii*), purple heather (*Krameria erecta*), desert lavender (*Hyptis emoryi*), Anderson thornbush (*Lycium andersonii*), and yellow felt-plant (*Horsfordia newberryi*). Dominant species of the creosote bush scrub are creosote bush (*Larrea tridentata*), burrobush (*Ambrosia dumosa*), ocotillo (*Foaquieria splendens*), and brittlebush (*Encelia farinosa*). Also present in the creosote bush scrub are several cacti species in sparsely scattered locations; these include Bigelow cholla (*Opuntia bigelovii*), cottontop cactus (*Echinocactus polycephalus*), beavertail cactus (*Opuntia basilaris*), diamond cactus (*Opuntia ramosissima*), and California barrel cactus (*Ferocactus cylindiceus*).

PROJECT PURPOSE

The project purpose defines the scope and focus of the alternatives analysis. For the purposes of 404(b)(1) evaluations, project purpose is often expressed in terms of basic purpose and overall purpose. While definition of these terms is not provided in the guidelines, in practical application they are generally defined as presented in the following sections.

Basic Project Purpose

This is a very general statement of the basic nature of the project. This statement of purpose is often applied for determinations of water-dependency because the guidelines establish a "regulatory presumption" that: 1) if the project is not water-dependent *and* 2) the project proposes to discharge dredged or fill material into a special aquatic site, a less-environmentally damaging practicable alternative exists. It should be noted that the project site does not contain any wetlands or any other special aquatic site. Therefore, the "water-dependency test" and associated presumption are not applicable to the Proposed Project.

The basic purpose of the proposed project is to mine and recover gold and silver that have been staked or acquired by Glamis under the General Mining Law of 1872. Under the General Mining Law of 1872, qualified prospectors are entitled to reasonable access to mineral deposits on public domain lands.

Overall Project Purpose

The overall project purpose is a statement that reflects the applicant's desired objectives in achieving the basic purpose. It is important that the overall project purpose be defined such that it provides for a meaningful evaluation of alternatives. It should not be so narrowly defined as to give undue deference to the applicant's wishes, thereby unreasonably limiting the consideration of alternatives. Conversely, it should not be so broadly defined as to render the evaluation unreasonable and meaningless.

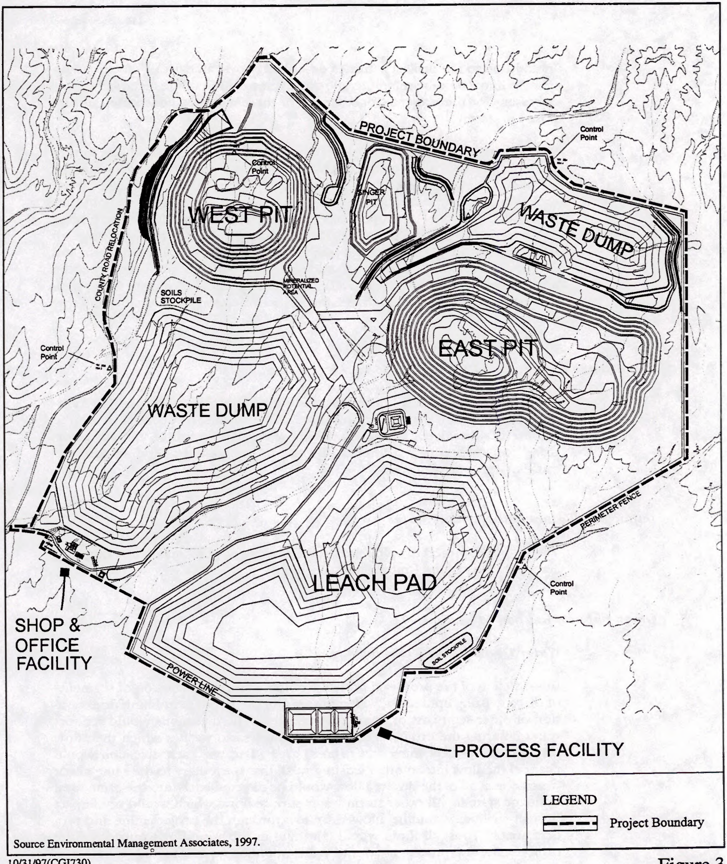
The basic purpose of the project is to develop and operate a mine to recover the gold and silver ore resources identified on mining claims that have been staked or acquired by Glamis Imperial under the General Mining Law of 1872. Gold and silver are precious minerals not commonly found. Glamis Imperial's overall project purposes for the project are as follows:

- Profitably recover precious metals (gold and silver) from these staked mining claims.
- Fully exercise its right under the 1872 Mining Act.
- Reclaim the project area in a manner that is environmentally responsible and in compliance with United States mining laws, the California Desert Conservation Area Plan, the Federal Land Policy and Management Act, the California Surface Mining and Reclamation Act and Imperial County's implementing regulations, and other applicable laws and regulations.
- Continue to provide employment in Imperial County, California and Yuma County, Arizona for those individuals currently working for Chemgold, Inc. at its Picacho Peak Mine in Imperial County when that mine ceases mining operations in late 1997.
- Directly increase the employment in the area by about 80 jobs.

PROPOSED PROJECT

Characteristics of the Proposed Project

Glamis Imperial has proposed the development of the Imperial Project, an open-pit, heap-leach, precious metal mine and processing facility (Figure 3) located in eastern Imperial County, California. The project would utilize conventional heap leach mining methods to extract gold and silver from the mined ore. The project would include mining gold and silver ore and waste rock, constructing and operating facilities to administer the operation and maintenance of all mining and related equipment, processing the ore and stockpiling the waste rock, developing and producing groundwater for use in processing operations and dust control, constructing an electric transmission line to provide electrical power for the operations, conducting geological survey activities, implementing environmental impact reduction measures, and implementing reclamation measures.



Source Environmental Management Associates, 1997.

10/31/97(CGI730)

Figure 3

N

LSA 0' 750' 1,500'

Imperial Project
Proposed Project

In addition to the project activities described above, an existing electric transmission line would be rebuilt to allow the transmission of the electrical energy necessary for the project. Together, all of these activities constitute the proposed project.

With a total mined material of up to 450 million tons, up to 150 million tons of ore would be deposited on the leach pad where the precious metals would be leached. The remainder of the mined material, up to 300 million tons of waste rock would be deposited in the waste rock stockpiles or the mined-out portions of the two of the open pits. Mining activities would be performed 24 hours per day, 7 days per week. The nominal mining rate would average up to 130,000 tons per day, with daily mining rates of between zero and 200,000 tons per day. The mine would commence operation in 1998, after the acquisition of all required approvals. Operations would terminate in approximately the year 2017, although reclamation activities may continue beyond that date.

Consistency with Project Purposes

The proposed project will meet basic and overall project purposes. The Proposed Action mines the entire resource. Due to this, its economics are the most favorable since it maximizes the known mineral resource, thereby amortizing costs over a larger number of tons and decreasing operating costs because of economies of scale.

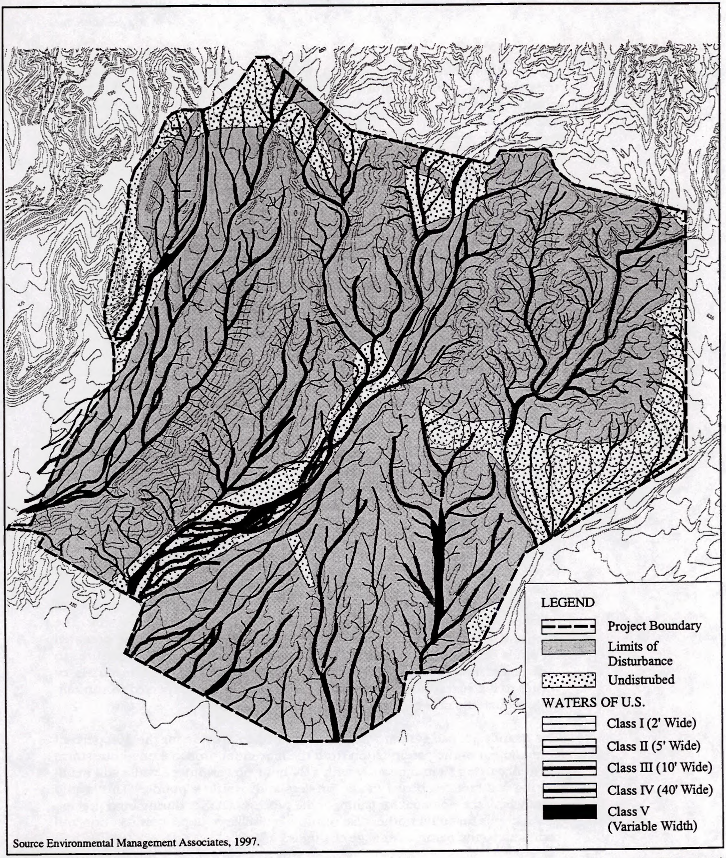
Impacts to Waters of the United States

The proposed project would result in the placement of fill material within 77.4 acres of waters of the United States (Figure 4).

Other Impacts Related to Section 404

Water Quality and Hydrology

Construction of the proposed project would include the diversion of segments of three existing ephemeral watercourses and the permanent filling or excavation of other segments of these watercourses. The diversions would redirect water entering the project mine and process area to washes which then flow through the project mine and process area. Because each diversion would channel the flow into another existing wash that is tributary to the same major watercourse, all of the diverted flow would be directed back into the same local drainage system. All other storm water surface flows which would not impact project facilities would be allowed to flow through the project mine and process area. Thus, all flows would continue in the same flows outside of the project mine and process area, and there would be no substantial alteration of stream flows or patterns outside of the project mine and process area.



10/31/97(CGI730)

LSA

Figure 4

Imperial Project
Proposed Project
Impact to Waters of the U.S.

Precipitation falling within the open pit boundaries would collect on, or infiltrate through, pit floors, thus reducing potential storm water runoff from the proposed project compared to the existing desert floor. Precipitation falling on the heap leach pad or solution ponds would also remain within this closed hydrologic system. Surface runoff and drainage resulting from precipitation falling on the waste rock stockpiles, soil stockpiles, or on project roads and other disturbed areas within the project mine and process area would be conveyed to sediment basins and infiltrated (or consumed in the mining and heap leach process). Because the project mine and process area facilities that may "capture" precipitation are such a minor percentage of the overall surface area of the drainage basins in which they are located, the resulting reduction in downstream storm water flow would be very minor.

There is potential for erosion of materials from the project soil stockpiles, waste rock stockpiles, and other project facilities due to precipitation and resulting overland stormflow. Substantial erosion of project facilities could result in discharge of sediment into the watercourses and could damage or bury vegetation in the washes. Specific measures have been incorporated into the project to reduce the potential for erosion and the associated potential for sedimentation. These measures include placing rip-rap on the outside bends of diverted stream channels, providing setbacks of facilities (such as waste rock stockpiles) from the banks of through going washes, and placing berms around facilities as appropriate. In addition, the applicant has committed to comply with the conditions of the applicable Storm Water National Pollutant Discharge Elimination System (NPDES) General Permit, and would prepare and follow the requirements of the Storm Water Pollution Prevention Plan (SWPPP) to control drainage and erosion. As a result, the proposed project is not expected to produce substantial sediment into the washes.

Substantial quantities of various chemicals would be stored and used within the project area and substantial quantities of regulated waste (such as waste oil) would be generated. These materials could be released into the watercourses that flow through the project area, either through spills directly into the washes or from overland flow of either the spilled material or contaminated soil. The applicant has incorporated measures into the project to reduce the potential for spills of chemicals or regulated waste, and has incorporated measures to reduce erosion and sedimentation that may transport spilled materials or wastes to the watercourses. Together, these measures are expected to substantially reduce the potential for surface water degradation.

The heap leach pad system would be designed to provide for the 100 percent containment of the precipitation from the maximum probable one-hour storm event occurring simultaneously with a 24-hour power outage while still maintaining a 2-foot freeboard in the process and overflow ponds. This would greatly limit the potential for failure of the process facilities during high precipitation events that might otherwise result in a discharge of process solution and sediment to the natural drainage channels.

Groundwater would be produced to supply water for heap leach processing and other service water requirements. A total of 1,000 gallons per minute or 1,200 acre feet per year of groundwater would be supplied from up to four wells drilled in the project ancillary area southwest of the project mine and process area. Comparing the amount of water project to be extracted during the life of the project to the estimated usable and recoverable stored water and estimated recharge, the project should not significantly impact the alluvial groundwater resources of the area. The project's extraction rate of 1,200 acre feet per year represents about 1 percent of the annual recharge of the entire Amos-Ogilby-East Mesa Basin. Over the 20-year projected life of the project, the project would use an estimated 24,000 acre feet of water, representing about 0.01 percent of the estimated 230,000,000 acre feet of useable and recoverable water in the Amos-Ogilby-East Mesa Basin.

Vegetation

The proposed project would impact vegetation primarily through direct destruction of plants by surface disturbance during construction of the mine and ancillary facilities. The project would result in a total surface disturbance of 1,362 acres including 1,260 acres of creosote bush scrub and 87 acres of microphyll woodland. Surface disturbance would occur incrementally throughout much of the life of the project as individual pits are mined and waste rock stockpiles, soil stockpiles, and process facilities are expanded. Vegetation existing in the areas of disturbance would be lost as a result of removal, crushing, burying, soil compaction, or root damage.

As part of the Project Reclamation Plan, revegetation strategies would be implemented to reduce the time involved for natural plant establishment on land disturbed by the proposed project. Examples of strategies in desert revegetation studies include soil preparation (scarification and topsoil restoration), reseeding, transplantation, and plant protection. The project Reclamation Plan provides detailed revegetation techniques and methods based on successful revegetation programs at the applicant's Picacho Peak Mine and other nearby mines in this area of the California Desert. These methods are appropriate to the dry climate and harsh environmental factors of the proposed mine site. These methods use topographic grading and seeding or transplanting of local native species to reestablish a productive, functioning ecosystem.

Of the 1,362 acres disturbed by the proposed project, 1,197 acres would be reclaimed (the slopes of the west pit would not be covered by backfill). Most of the habitat loss would be temporary until completion of final reclamation (approximately 20 years) and subsequent vegetation recovery. Most of the reclaimed areas would be revegetated with creosote bush scrub and, approximately 44 acres of microphyll woodland would be established through revegetation.

Wildlife

Wildlife species that inhabit, move through, or forage within the approximately 1,362 acres of surface area to be disturbed within the project area would be subject to increased mortality or displacement. Increased mortality would result from direct physical impacts or entombment during construction or processing activities; or indirect mortality from stress or increased predation pressure resulting from displacement to off-site areas.

Over the life of the project (approximately 20 years), additional injuries and mortality to wildlife would be expected to result from impacts with motor vehicles commuting to the project area and other equipment traveling to and from the project mine and process area and the ancillary area. Experience in other remote areas suggests that reduced speed limits on public roads as a measure to minimize inadvertent vehicle impacts with wildlife is impractical to enforce. Individual animals could also be subject to: a) drowning in mine fluid impoundments; b) increased mortality from exposure to process chemicals; c) injury and mortality during on-site blasting and continued mining and exploration activities; and d) increased mortality from project-related stresses including night-lighting, continuous noise and human activity, or restricted movement in the vicinity of the project mine and process area. Some species may also come under increased pressure from opportunistic predators (i.e., ravens, coyotes, and kit foxes) that are attracted to the project area by increased water availability, refuse, or noise.

Noise sensitive species would be expected to avoid both the Project area and neighboring areas over the life of the project but, would be expected to return to the area when noise generating operations are discontinued. Similarly, species intolerant of surface disturbance and human activities would also be expected to avoid the project area and neighboring areas over the life of the project.

An existing section of transmission line would be upgraded and a new transmission line would be constructed to provide electrical power to the project mine and process area. Temporary and short-term impacts to wildlife would occur during pole placement and line stringing activities as a result of minor surface disturbance and human presence. The transmission line could also increase the availability of potential perch sites for predatory birds in the area which could result in an increase in predatory pressure on wildlife species comprising their prey base. The transmission lines would also increase the potential for collision or electrocutions of raptors and other bird species.

The proposed project would result in excavation of three open pits, only one of which would be fully backfilled with waste rock. The surface area of the open Singer Pit would be approximately 34 acres; the East Pit would remain as an approximately 227-acre excavation. Individual terrestrial wildlife species could become injured or killed by falls within these retained open pits. Should surface water accumulate in the bottom of the pits, wildlife species coming to drink could be exposed to predators that may use the pits as a hunting or foraging area.

The project includes measures to prevent wildlife from entering process ponds, to minimize impacts from transmission lines, to discourage pit access by terrestrial species, to reduce the potential for the accumulation of surface water in the open pits, and to offset the reduced carrying capacity of the project mine and process area to wildlife resulting from the net reduction in available habitat.

One species listed under the Endangered Species Act, the desert tortoise (listed as a Threatened species), would be directly impacted by the project. The habitats within the project area are unclassified by the BLM with respect to desert tortoise, and the project area has not been designated critical habitat by the USFWS. As of 1996, the number of tortoises present within the project area was estimated to be between 33 and 57 individuals.

Desert tortoise that occupy the project mine and process area may be injured or killed as a result of surface disturbance during project construction or processing activities. The surface modification activities would occur over 1,362 acres and would destroy tortoise burrows or pallets within the area, potentially crushing or entombing individuals. Additional tortoises may also be injured or killed as a result of heavy equipment traffic with the project mine and process area and from impacts with vehicles commuting to and from the project area on existing roads. Tortoise occupying areas adjacent to the project mine and process area, or having home ranges overlapping the project area, would be similarly affected if they wander onto the active Project areas. A total of 1,131 acres of desert tortoise habitat would be reclaimed following cessation of mining activities. Adjacent tortoise populations may slowly recolonize this area as vegetative processes establish native habitats. A total of 261 acres, comprising the East Pit and Singer Pit would be lost as tortoise habitat after completion of project reclamation.

Activities and facilities ancillary to the Project mine and process area could also adversely affect desert tortoises. Tortoises could be injured or killed as a result of construction of the water pipeline or upgrading the electrical transmission line. The water pipeline would be buried so it would not restrict tortoise movement. Construction or upgrade of the transmission line may also attract or provide perches for birds (i.e., ravens) that prey on tortoises. Storage ponds within the project area or other sources of standing water and site refuse could also serve to attract and increase local populations of species that prey on tortoises. Following completion of mining activities, individual tortoises could wander into the East Pit or Singer Pit basins. While pit slopes (estimated at 50 degrees) may allow for the movement of animals, individual tortoises could be injured or killed as a result of falls, or predation from coyotes, kit foxes, or other species.

Desert tortoises within the project area would also be subject to displacement either by capture and removal of individuals to locations outside the project area or, by individuals within or near the project area voluntarily leaving when project activities are initiated.

Some design elements have been incorporated into the project to minimize the effects of the project on desert tortoise. However, the project will result in "take" of the desert tortoise and will require consultation under Section 7 of the Endangered Species Act.

WEST PIT ALTERNATIVE

Characteristics of West Pit Alternative

The West Pit Alternative (Figure 5) would mine only the West Pit and Singer Pit. This option would produce an estimated 60 million tons of ore grade material, and 90 million tons of waste rock for a total of 150 million tons of mined material. In this alternative, approximately 40 percent of the ore grade material and 36 percent of the total tons would be mined as opposed to the Proposed Action.

The West Pit Alternative would eliminate the East Pit, East Waste Rock Stockpile, and the East Pit West and East Pit East Drainage Diversions within the mine and process area. In addition, the size of the leach pad, and the haul and maintenance roads would be reduced from the Proposed Action. The number of groundwater production facilities would also be reduced to two from the four in the Proposed Action. All other components of this alternative, including the associated areas of disturbance, the process plant and facilities, the lime bin area, freshwater pond, soil stockpiles, office and maintenance, power facilities, Indian Pass Road realignments, water pipeline, and transmission lines would be constructed and operated as under the proposed project.

Consistency with Project Purposes

The West Pit Alternative reduces the amount of ore to be mined to 40 percent of that which would be mined under the proposed project, and thus it would not meet one of the objectives of the project, that of fully developing the identified mineral reserves. This produces a corresponding reduction in the revenue the project generates. In addition, because this alternative would still require nearly all of the equipment (haul trucks, shovel, transmission line, etc.) required for the Proposed Action, the projected capital costs and annual operating costs of the West Pit Alternative are very similar to those of the Proposed Project.

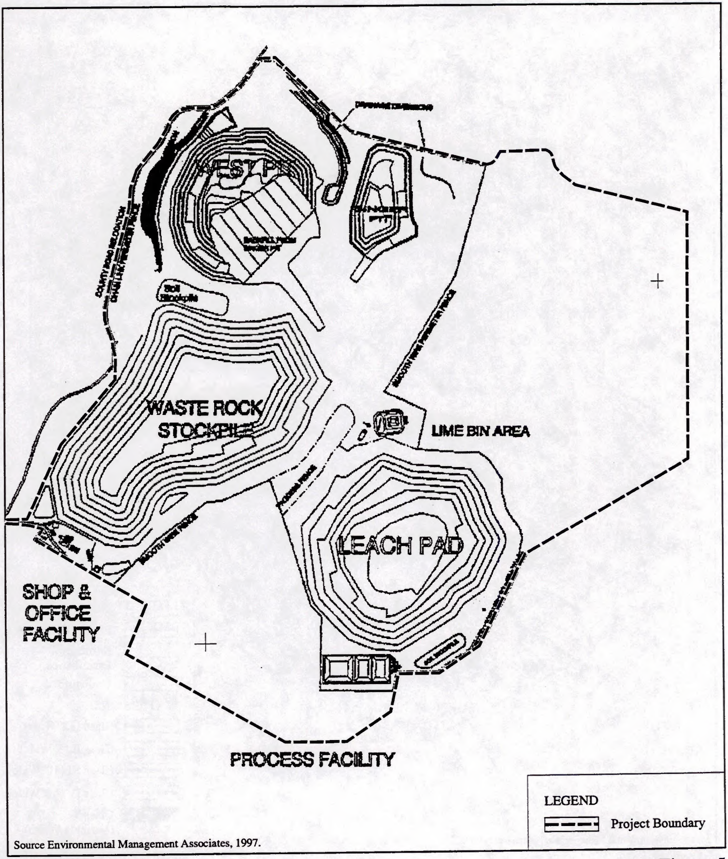
Impacts to Waters of the United States

The West Pit Alternative reduces impacts to Waters of the United States to 55.2 acres, or about 71 percent of the area impacted under the Proposed Project (Figure 6).

Other Environmental Impacts Related to Section 404

Water Quality and Hydrology

The West Pit Alternative would eliminate the need to construct the East Pit West and East Pit East diversion channels, and would eliminate any impact to these existing surface drainage channels. The East Pit would not be mined, the East Waste Rock Stockpile would not be built, and the heap would be reduced in



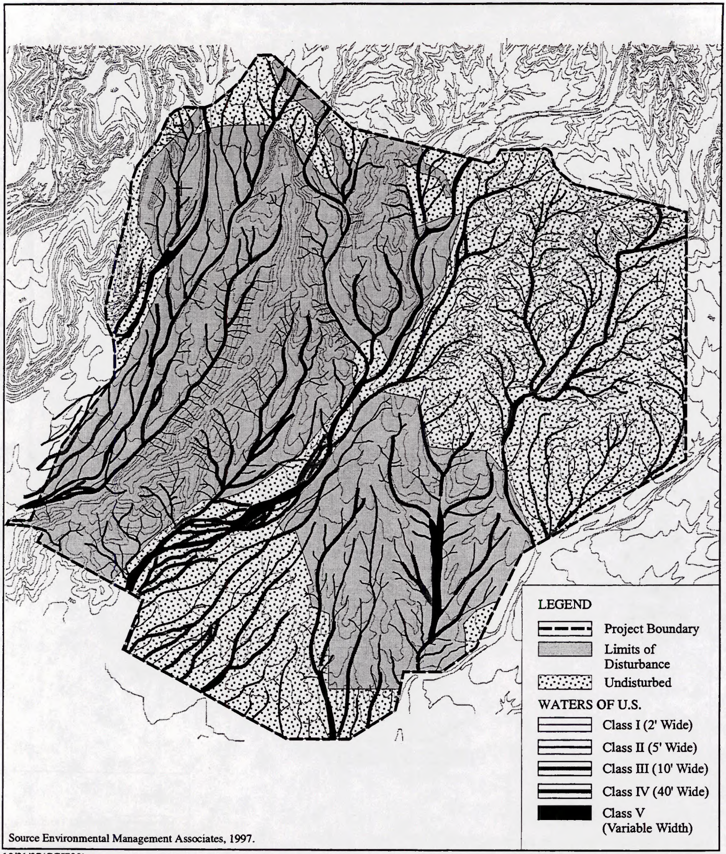
10/31/97(CGI730)

Figure 5

N

LSA 0' 750' 1,500'

Imperial Project
West Pit Alternative



10/31/97(CGI730)

Figure 6

N

LSA 0' 750' 1,500'

Imperial Project
West Pit Alternative
Impacts to Waters of the U.S.

size, so there would be less precipitation contained within the West Pit Alternative project mine and process area and not discharged into surface runoff. Since the East Pit would not be mined, the potential for seeps or a pit lake in the East Pit would be completely eliminated. However, since the West Pit would not be completely backfilled under the West Pit Alternative, and the West Pit is projected to be mined to a depth below the existing groundwater level, seeps, and possibly (but not likely) a pit lake, could form in the West Pit. Since the Singer Pit would not be mined below the elevation of the groundwater table, no pit lake could form from groundwater inflows as a result of not backfilling the Singer Pit.

The West Pit Alternative would produce groundwater for operations at a rate somewhat less than that under the Proposed Action, and from a maximum of only two (2) groundwater wells. Also, since the West Pit Alternative would have an estimated life of only half that of the Proposed Action, the total amount of water produced would be substantially less than half of that produced under the Proposed Action. However, because most of the groundwater table drawdown occurs early in the groundwater production process, the groundwater table drawdown in the area surrounding the groundwater production wells would be only slightly reduced from the Proposed Action. Recovery to pre-project levels would be substantially earlier, however, because pumping would cease sooner. The effects of the West Pit Alternative on groundwater quality and pit water quality would not be different than that of the Proposed Action, although the likelihood of any impacts to groundwater quality or pit water quality would be further reduced because of the reduction in size of the heap pad and the elimination of the East Pit.

Vegetation

The West Pit Alternative would reduce the total surface disturbance from 1,362 acres under the Proposed Action to 853 acres, a reduction of 37 percent. The loss of creosote bush scrub vegetation habitat would be reduced from approximately 1,260 acres under the Proposed Action to approximately 719 acres, and the loss of microphyll woodland vegetation would be reduced from approximately 87 acres under the Proposed Action to approximately 76 acres. In addition, the amount of surface area not reclaimed (the West Pit slopes not covered by backfill) would decrease from 165 acres under the Proposed Action to approximately 88 acres, a reduction of 47 percent. The time required to complete final reclamation would also be reduced to approximately ten (10) years.

Other impacts to vegetation and plant habitat (from dust, groundwater pumping, surface channel diversions, and sensitive plants) would also be reduced proportionately from those of the Proposed Action.

Wildlife

The reduced area of surface disturbance resulting from the West Pit Alternative would also reduce the amount of wildlife habitat lost over that of the Proposed

Action. Approximately 719 acres of creosote bush scrub habitat and 76 acres of microphyll woodland habitat would be lost. Approximately 152 acres of the 947-acre West Pit Alternative project mine and process area would be undisturbed. Most of this habitat loss would be temporary, until the completion of final reclamation (and subsequent vegetation recovery). However, approximately one-half of the disturbed microphyll woodland habitat would be reclaimed not as microphyll woodland habitat but as desert succulent scrub habitat, and the 88 acres of the West Pit slopes would not be reclaimed.

Other impacts from the West Pit Alternative on wildlife and wildlife habitat (from groundwater pumping, surface channel diversions, and sedimentation) would also be reduced proportionately from those of the Proposed Action.

The West Pit Alternative would mine and leave open or partially open the 33-acre Singer Pit and the 110-acre West Pit. This would reduce the potential area over which wildlife could be killed or injured by falls or by opportunistic predators from the 198-acres left open under the Proposed Action.

The West Pit Alternative would have a life of only approximately 10 years, which would reduce the exposure of wildlife and wildlife habitat to impacts from vehicles, hazardous materials, noise, human presence, etc., by about one-half over the Proposed Action.

Although reduced from the Proposed Action, the impacts of the West Pit Alternative on the desert tortoise would, like the Proposed Action, result in "take" of this Threatened species and require consultation under Section 7 of the Endangered Species Act.

Cultural Resources

The West Pit Alternative would create approximately 38 percent less surface disturbance than the Proposed Action within the project area, and identical surface disturbance within the overbuilt 92 kV/34.5 kV transmission line corridor. However, the density of cultural resource features determined eligible for the National Register of Historic Places (NRHP) and identified within the project mine and process area is substantially higher on the west side, in the area of the West Pit and South Waste Rock Stockpile, than on the east side, in the area of the East Pit and the heap leach pad and process facilities. Consequently, the impacts of the West Pit Alternative on cultural resources determined eligible for the NRHP appear to be only slightly less than the impacts to these same type of cultural resources which would result from the implementation of the Proposed Action. The effects of the West Pit Alternative on those cultural resources identified within the overbuilt 92 kV/34.5 kV transmission line corridor would be identical to the Proposed Action.

Costs

Due to the large reduction in valuable commodity produced, with the same capital costs, this alternative will generate insufficient cash flow to provide a profit at the end of mining. In fact, this project would cost approximately $51 million additional dollars and produce a negative present value for the property.

EAST PIT ALTERNATIVE

Characteristics of East Pit Alternative

The East Pit Alternative (Figure 7) would mine only the East Pit and Singer Pit. This option would produce an estimated 90 million tons of ore grade material, and 210 million tons of waste rock for a total of 300 million tons of mined material. In this alternative, approximately 60 percent of the ore grade material and 63 percent of the total tons would be mined as opposed to the Proposed Action.

The East Pit Alternative would eliminate the West Pit, the West Pit West, and West Pit East Drainage Diversions, and the Indian Pass Road realignment within the mine and process area. In addition, the size of the leach pad, and the haul and maintenance roads would be reduced from those in the Proposed Action. The number of groundwater production facilities would also be reduced to two from the four in the Proposed Action. All other components of this alternative, including the associated areas of disturbance, the process plant and facilities, the lime bin area, freshwater pond, soil stockpiles, office and maintenance, power facilities, Indian Pass Road realignments, water pipeline, and transmission lines would be constructed and operated as under the Proposed Action.

Consistency with Project Purposes

The East Pit Alternative reduces the amount of the ore to be mined to 60 percent from that which would be mined under the Proposed Action, and thus it would not meet one of the objectives of the project, that of fully developing the identified mineral reserves. This produces a corresponding reduction in the revenue the project generates. Because the scope of the project remains nearly the same as the Proposed Action, the project capital costs would be very similar.

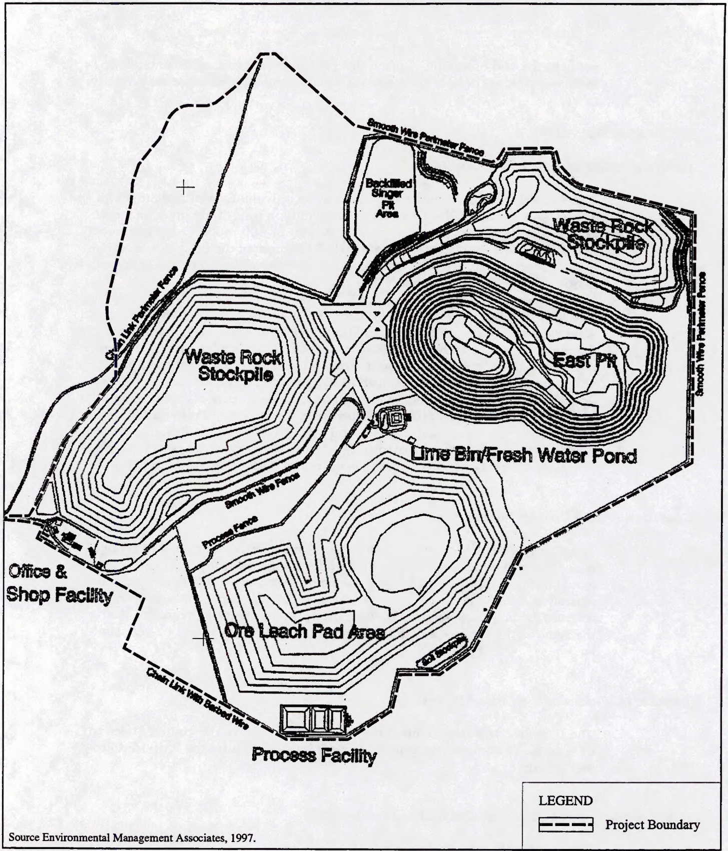
Impacts to Waters of the United States

The East Pit Alternative reduces the impacts to waters of the United States to 64.4 acres, or about 83 percent of the area impacted under the Proposed Project (Figure 8).

Other Environmental Impacts Related to Section 404

Water Quality and Hydrology

The East Pit Alternative would eliminate the need to construct the West Pit West and West Pit East diversion channels, and would eliminate any impact to these



Source Environmental Management Associates, 1997.

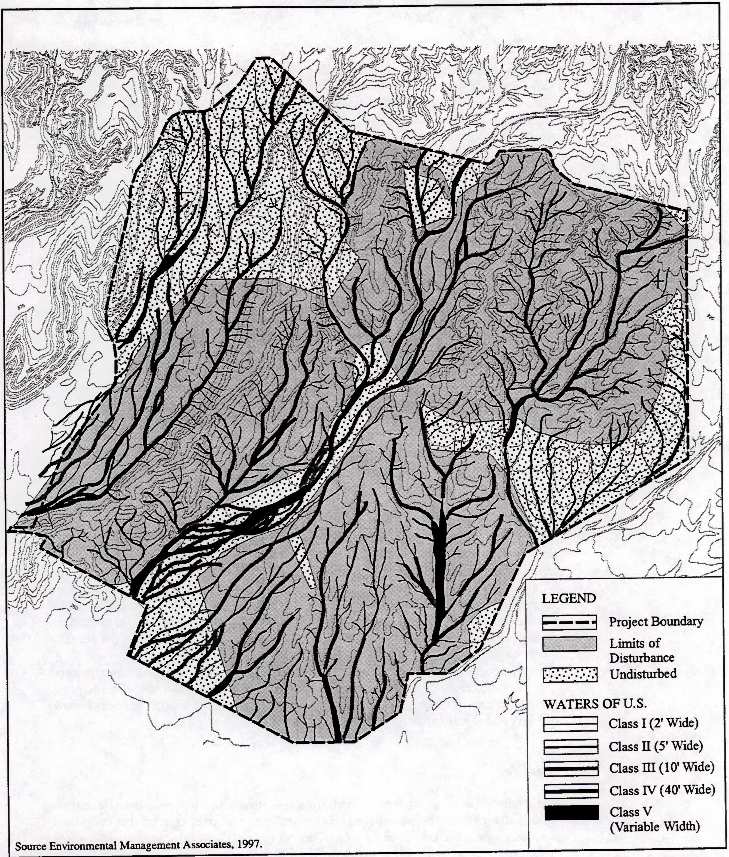
10/31/97(CGI730)

Figure 7

N

LSA 0' 750' 1,500'

Imperial Project
East Pit Alternative



10/31/97(CGI730)

Figure 8

N

LSA

0' 750' 1,500'

Imperial Project
East Pit Alternative
Impacts to Waters of the U.S.

existing surface drainage channels. The West Pit would not be mined, the West Soil Stockpile would not be built, and the heap would be slightly reduced in size, so there would be slightly less precipitation contained within the East Pit Alternative project mine and process area and not discharged into surface runoff. The impact to sediment production of the facilities constructed under the East Pit Alternative would be less than significant.

The East Pit Alternative would produce groundwater for operations at a rate slightly less than that under the Proposed Action, and from a maximum of three (3) groundwater wells. Also, since the East Pit Alternative would have an estimated life of approximately two-thirds that of the Proposed Action, the total amount of water produced would be less than two-thirds that produced under the Proposed Action. However, because most of the groundwater table drawdown occurs early in the groundwater production process, the groundwater table drawdown in the area surrounding the groundwater production wells would be only slightly reduced from the Proposed Action. Recovery to pre-project levels would be earlier, however, because pumping would cease sooner. The effects of the East Pit Alternative on groundwater quality and pit water quality would not be different than that of the Proposed Action, although the likelihood of any impacts to groundwater quality or pit water quality would be slightly reduced because of the reduction in size of the heap pad and the elimination of the West Pit.

Vegetation

The East Pit Alternative would reduce the total surface disturbance from 1,362 acres under the Proposed Action to 1,126 acres, a reduction of 19 percent. The loss of creosote bush scrub would be reduced from approximately 1,260 acres under the Proposed Action to approximately 1,064 acres, and the loss of microphyll woodland would be reduced from approximately 87 acres under the Proposed Action to approximately 62 acres. The amount of surface area not reclaimed (the East Pit slopes not covered by backfill) would remain unchanged from the Proposed Action at 165 acres. The time required to complete final reclamation would also be reduced to approximately 14 years.

Other impacts to vegetation and plant habitat (from dust, groundwater pumping, surface channel diversions, and sensitive plants) would also be reduced proportionately from those of the Proposed Action and would remain below the level of significance.

Wildlife

The reduced area of surface disturbance resulting from the East Pit Alternative would also reduce the amount of wildlife habitat lost over that of the Proposed Action. Approximately 1,064 acres of creosote bush scrub habitat and 62 acres of microphyll woodland habitat would be lost. Approximately 203 acres of the 1,276-acre East Pit Alternative project mine and process area would be undisturbed. Most of this habitat loss would be temporary, until the completion of final reclamation (and subsequent vegetation recovery). However, approximately one-half of the disturbed microphyll woodland habitat would be reclaimed not as microphyll woodland habitat but as creosote bush scrub habitat, and the 165 acres of the East Pit slopes would not be reclaimed.

Other impacts from the East Pit Alternative on wildlife and wildlife habitat (from groundwater pumping, surface channel diversions, and sedimentation) would also be reduced proportionately from those of the Proposed Action.

The East Pit Alternative would mine and leave open the 198-acre East Pit, which is the same potential area over which wildlife could be killed or injured by falls or by opportunistic predators as the Proposed Action.

The East Pit Alternative would have a life of approximately 14 years, which would reduce the exposure of wildlife and wildlife habitat to impacts from vehicles, hazardous materials, noise, human presence, etc., by about one-third over the Proposed Action. These effects would be below the level of significance.

Although slightly reduced from the Proposed Action, the impacts of the East Pit Alternative on the desert tortoise would, like the Proposed Action, result in "take" of this Threatened species and require consultation under Section 7 of the Endangered Species Act.

Cultural Resources

The East Pit Alternative would create approximately 19 percent less surface disturbance than the Proposed Action within the project area, and identical surface disturbance within the overbuilt 92 kV/34.5 kV transmission line corridor. The density of cultural resource features determined eligible for the NRHP and identified within the project mine and process area is substantially higher on the west side, and specifically in the area of the West Pit, than on the east side, in the area of the East Pit and the heap leach pad and process facilities. Thus, the impacts of the East Pit Alternative on cultural resources determined eligible for the NRHP appear to be substantially less than the 19 percent reduction in surface disturbance from the Proposed Action would imply.

The effects of the East Pit Alternative on those cultural resources identified within the overbuilt 92 kV/34.5 kV transmission line corridor would be identical to the Proposed Action.

Costs

Due to the large reduction in valuable commodity produced, and the same capital costs, this alternative will generate insufficient cash flow to provide a profit at the end of mining. In fact, this project would cost approximately $45 million additional dollars and produce a negative present value for the property.

CONCLUSIONS

Two on-site alternatives to the proposed project were evaluated in an effort to determine if the project is the least environmentally damaging practicable alternative. The evaluation was structured around an overall project purpose that was reasonably defined to allow consideration of alternatives.

With the West Pit Alternative, the amount of impact to waters of the United States was reduced to about 55.2 acres or about 71 percent of the area of impact under the proposed project. However, achieving the reduced impact requires a substantial reduction in the amount of ore to be mined. Under the West Pit Alternative, the amount of ore to be mined would be reduced to about 60 million tons or about 40 percent of the ore that would be mined under the proposed project. The projected capital costs of the West Pit Alternative are very similar to those of the proposed project, yet the amount of precious metal recovered is substantially less.

With the East Pit Alternative, the amount of impact to waters of the United States was reduced to about 64.4 acres or about 83 percent of the area of impact under the proposed project. However, achieving the reduced impact requires a substantial reduction in the amount of ore to be mined. Under the East Pit Alternative, the amount of ore to be mined would be reduced to about 90 million tons or about 60 percent of the ore that would be mined under the proposed project. The projected capital costs of the East Pit Alternative are very similar to those of the proposed project, yet the amount of precious metal recovered is substantially less.

For the alternatives, the objective was to determine if the impact to waters of the United States could be reduced while also achieving the overall project purpose of mining the overbody present at the project site in terms of economic viability. Each alternative would reduce the impact to waters of the United States when compared to the proposed project. However, for each alternative, the amount of recoverable ore would be substantially reduced without a proportionate reduction in costs. The result would be that costs to operate either the West Pit or the East Pit Alternative would exceed revenue. These results conflict with the stated overall project purpose of profitably recovering precious metal from the staked mining claims because of a potential loss of economic viability. Relevant characteristics of the Proposed Project and both Alternatives are summarized in Table A.

Table A - Characteristics of the Proposed and Alternative Projects

	Proposed Project	West Pit Alternative	East Pit Alternative
Consistent with Basic Project Purpose	Yes	Yes	Yes
Consistent with Overall Project Purpose	Yes	No	No
Mineral Resource used (as percent of total)	100%	40%	60%
Cost	$0	$50,913,000	$45,135,000
Present Value	$41,780,000	-$9,133,000	-$3,355,000
Fill in Waters of the United States (acres)	77.4	55.2	64.4
Other Impacts			
Water Quality & Hydrology	Similar	Similar	Similar
Vegetation	Similar	Reduced	Similar
Wildlife	Similar	Reduced	Similar
Threatened Species	Similar	Similar	Similar

This page intentionally left blank
for reproduction purposes.

APPENDIX O IMPERIAL PROJECT, IMPERIAL COUNTY, CALIFORNIA, AIR QUALITY ANALYSIS (SEPTEMBER 1997)

IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

AIR QUALITY ANALYSIS

SEPTEMBER 1997

Prepared for:

Glamis Imperial Corporation
Post Office Box 758
Winterhaven, California 92883

Prepared by:

Environmental Management Associates, Inc.

EMA Corporate Headquarters
1698 Greenbriar Lane, Suite 210
Brea, California 92821-5919
(714) 529-3695 • Fax (714) 529-8543

EMA Regional Office
100 West Grove Street, Suite 100
Reno, Nevada 89509-4026
(702) 828-3939 • Fax (702) 828-3940

IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

AIR QUALITY ANALYSIS

September 1997

Prepared for:

Glamis Imperial Corporation
Post Office Box 758
Winterhaven, California 92883

LIMITATIONS

This report was prepared by Environmental Management Associates, Inc. (EMA) in conformance with the scope of work prescribed by our client. The work had been conducted in an objective and unbiased manner and in accordance with generally accepted professional practice for this kind of work. No other warranty, either expressed or implied, is made as to the findings, recommendations, specifications, or opinions expressed herein.

ENVIRONMENTAL MANAGEMENT ASSOCIATES, INC.

Joseph M. DeStefano II, CPP
Environmental Specialist

Dwight L. Carey, D.Env.
Principal

EMA Corporate Office
1698 Greenbriar Lane, Suite 210 •Brea, California 92821-5919
(714) 529-3695 • FAX (714) 529-8543

EMA Regional Office
100 West Grove Street, Suite 100 • Reno, Nevada 89509-4026
(702) 828-3939 • FAX (702) 828-3940

IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

AIR QUALITY ANALYSIS

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

IMPERIAL PROJECT
IMPERIAL COUNTY, CALIFORNIA

AIR QUALITY ANALYSIS

1. INTRODUCTION AND PROJECT DESCRIPTION

Glamis Imperial Corporation (Glamis Imperial) has proposed the development of the Imperial Project (Project), an open-pit, heap-leach, precious metal mine and processing facility located in eastern Imperial County, California. The Project would utilize conventional heap leach methods to extract gold and silver from the mined ore.

This document provides an estimate of the air pollutant emissions from the Project mine and process operations when at full capacity, and an analysis of the expected impacts of the Project on air quality in the area during the first year of full operations.

1.1. Project Location

The Project is located in eastern Imperial County, California, approximately 45 miles northeast of El Centro, California and 20 miles northwest of Yuma, Arizona (Figure 1). The Project area is located within Sections 31, 32 and 33, Township 13 South, Range 21 East, and Sections 4, 5, 6, 7, and 8, Township 14 South, Range 21 East, San Bernardino Baseline & Meridian (SBB&M), entirely on public lands administered by the U.S. Bureau of Land Management (BLM). As discussed throughout this document, the "Project area" consists of a "Project mine and process area" and a "Project ancillary area." The "Project mine and process area" would contain all of the open pits, waste rock stockpiles, soil stockpiles, stream diversion channels, administration office and maintenance facility area, heap leach facility, precious metal recovery plant and other facilities, an electric substation, and internal roads and electrical distribution lines. The boundary of the Project mine and process area is shown in Figure 2. The "Project ancillary area" would include ground water production wells and a buried water pipeline, a new 92 kV/13.2 kV transmission line, and relocated portions of Indian Pass Road. The boundary of the Project ancillary area is also shown on Figure 2.

In addition to the "Project area," the "overbuilt 92 kV/34.5 kV transmission line corridor" would contain all of the activities associated with the "overbuilding" of the utility-owned 34.5 kV transmission line into an overbuilt 92 kV/34.5 kV transmission line. Figure 2 also shows the location of the overbuilt 92 kV/34.5 kV transmission line corridor.

Access to the Project area is from Ogilby Road via Interstate Highway 8 from the south, or from State Route 78 to the north (see Figure 2). The Project mine and process area overlaps Imperial County-maintained Indian Pass Road, and is located approximately five (5) miles northeast of the Indian Pass Road/Ogilby Road intersection.

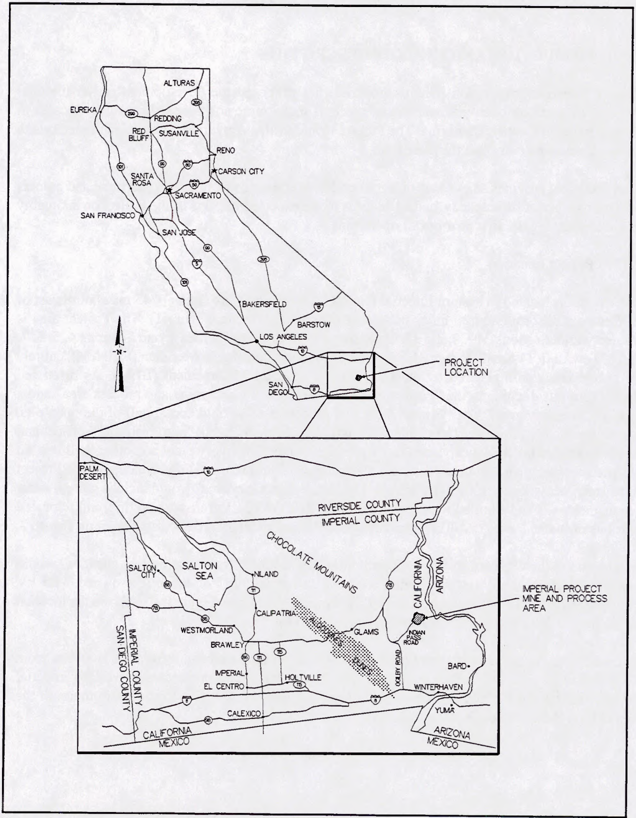


Figure 1: Imperial Project General Location Map

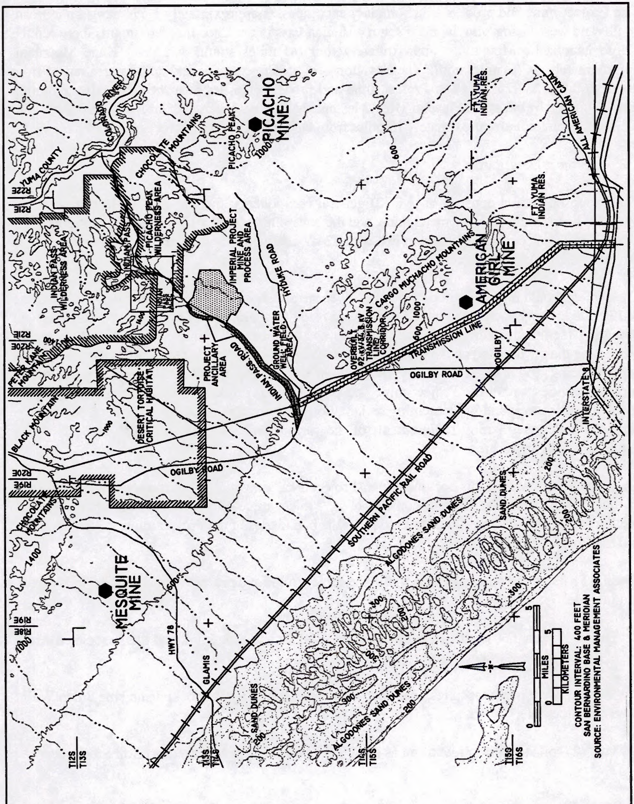


Figure 2: Imperial Project Vicinity Map

The Project mine and process area boundary encompasses approximately 1,571 acres on a broad, south- and west-facing, alluvial plain south of Indian Pass in the Chocolate Mountains, between the Cargo Muchacho Mountains, approximately four (4) miles south, and Peter Kane Mountain, approximately six (6) miles north. The elevation over the Project mine and process area ranges from about 760 feet to 925 feet. The Project mine and process area lies near the center of the mining district formed by the active Picacho Mine, Mesquite Mine, and American Girl Mine heap leach gold facilities, each located approximately 10 miles from the Project mine and process area (see Figure 2).

1.2. Project Description

The Proposed Action consists of two (2) general components: the Imperial Project, a proposed open-pit, heap-leach, precious metal mine; and the "overbuilding" of a 16-mile section of an existing 34.5 kV utility electrical transmission line with 92 kV conductors to deliver the necessary electrical power to the Imperial Project.

The Project would include: mining gold and silver ore and waste rock at a typical daily mining rate of 130,000 tons per day (which would range from zero (0) to 200,000 tons per day); constructing and operating facilities to administer the operation and maintain all mining and related equipment; processing the ore utilizing conventional heap leach methods; stockpiling the waste rock; developing and producing ground water for use in processing operations and dust control; conducting geological survey activities within the Project mine and process area; implementing environmental impact reduction measures; and implementing reclamation measures, all of which have been designed to meet the anticipated permit requirements of the various federal, state and local agencies which regulate mining in the area.

As discussed throughout this document, the "Project area," in which all of the specific components of the Project would be located, consists of a "Project mine and process area" and a "Project ancillary area." Figure 3 shows a closer view of the boundaries of the Project mine and process area and the Project ancillary area.

Specific Project components located within the Project mine and process area are shown in Figure 4, and include:

- Three (3) open pits, identified as the West Pit, East Pit and Singer Pit, and the Associated Areas of Disturbance adjacent to some of the pits;
- Two (2) waste rock stockpiles, identified as the East Waste Rock Stockpile and the South Waste Rock Stockpile;
- Two (2) soil stockpiles, identified as the West Soil Stockpile and the East Soil Stockpile;

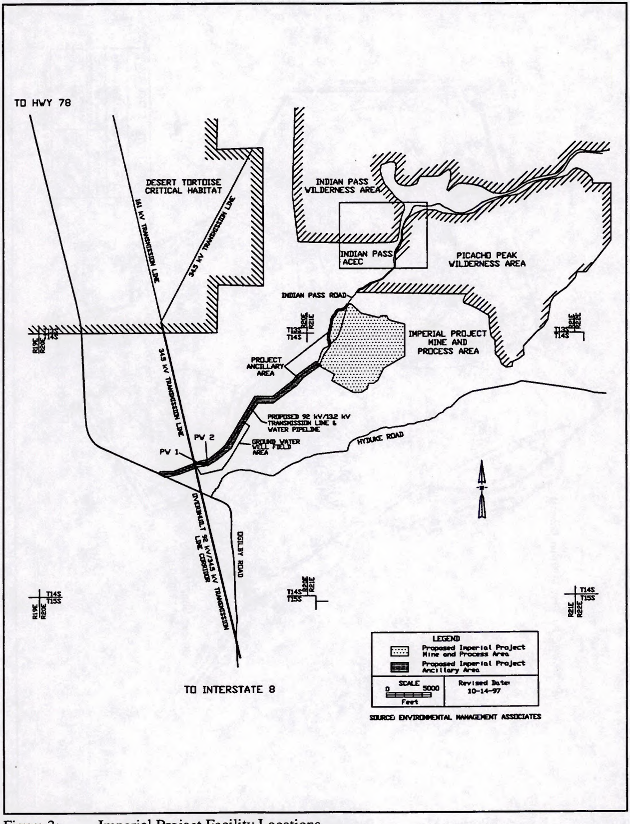


Figure 3: Imperial Project Facility Locations

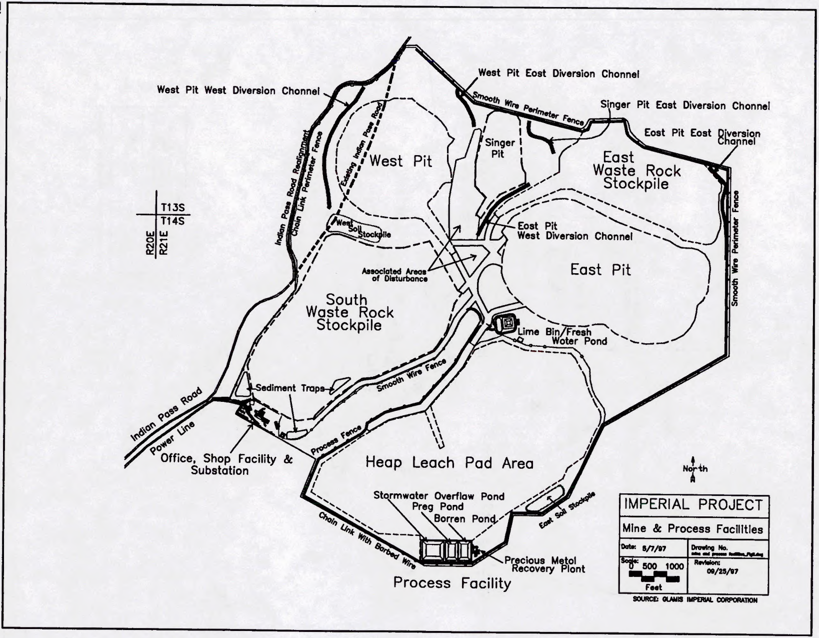


Figure 4: Imperial Project Mine and Process Area Facilities

- Five (5) stream drainage diversion channels, identified as the West Pit West Diversion, the West Pit East Diversion, the Singer Pit East Diversion, the East Pit West Diversion, and the East Pit East Diversion;

- One (1) administration office and equipment maintenance (shop) facility area;

- Ore processing facilities, including a lime bin, heap leach pad, and process solution (barren and pregnant) ponds;

- One (1) precious metal recovery plant;

- One (1) electrical power substation; and

- A system of roads (and associated electrical distribution lines);

Specific Project components located within the Project ancillary area include:

- A ground water well field, consisting of up to four (4) production wells, designed to produce ground water at a combined peak yield of approximately 1,200 acre-feet per year (afy)

- A buried water pipeline to convey the water from the ground water well field to the Project mine and process area;

- An approximately 3.7-mile section of new 92 kV/13.2 kV transmission line; and

- Relocated portions of Indian Pass Road, including the permanent realignment of the intersection of Indian Pass Road and Ogilby Road and the temporary relocation of an approximately 6,000-foot portion of Indian Pass Road, which would be moved approximately 1,000 feet to the west of its current location to provide continuous, safe public access to areas northeast of the Project mine and process area during the completion of Project activities.

Up to 150 million tons of ore would be mined and leached as part of the Project, and up to 300 million tons of waste rock would be mined and deposited in the waste rock stockpiles or the mined-out portions of the West Pit and Singer Pit. Mining activities, performed 24 hours per day and seven (7) days per week, would commence in 1998. Operations would terminate around the year 2017, although completion of all reclamation activities would continue beyond this date if necessary.

In addition to the Project components described above, the Proposed Action includes the "overbuilding" of a sixteen (16)-mile section of existing 34.5 kV utility electrical transmission line with 92 kV conductors to deliver the necessary electrical power to the Imperial Project. All activities associated with the "overbuilding" of this transmission line would occur within the "overbuilt 92 kV/34.5 kV transmission line corridor," located outside of the Project area, as shown in Figure 2. "Overbuilding" the existing 34.5 kV utility transmission line would include: blading the existing access road, as necessary; establishing an equipment lay down area; delivery of new, taller pole(s) to the site of each existing pole; adding insulators and cross arms, as necessary, to each of the new poles; leaning the existing wooden poles out of the current transmission line alignment; setting the new, taller, wooden poles in the same transmission line alignment; stringing new 92 kV wire conductors near the top of the new poles and new 34.5 kV wire conductors below the 92 kV conductors on the new poles; energizing the new conductors; and removing the existing 34.5 kV conductors, poles and any other waste materials.

The Proposed Action would create a maximum of approximately 1,340 acres of new surface disturbance within the Project area, and approximately 22 acres of additional disturbance within the overbuilt 92 kV/34.5 kV transmission line corridor during the "overbuilding" of the 92 kV/34.5 kV transmission line, for a total of approximately 1,362 acres of surface disturbance within the "area of the Proposed Action." An itemized list of the estimated surface disturbance for each of the major Project facilities and overbuilt 92 kV/34.5 kV transmission line, together with the undisturbed and reclaimed acreage within the Project mine and process area, is presented in Table 1.

1.3. Regulatory Framework

Ambient air quality and the emission of air pollutants are regulated under both federal and California laws and regulations. In addition, there are local requirements and standards which provide regulation of both air quality and the emission of air pollutants in the area.

The federal Clean Air Act (CAA), and the subsequent Clean Air Act Amendments of 1990 (CAAA), requires the U.S. Environmental Protection Agency (USEPA) to identify national ambient air quality standards to protect public health and welfare. The established National Ambient Air Quality Standards (NAAQSs) were established for six (6) pollutants, known as "criteria" pollutants because the standards satisfy "criteria" specified in the CAA. A list of the criteria pollutants regulated by the CAA, and the NAAQSs set by the USEPA for each, are listed in Table 2.

In addition to the NAAQSs listed in Table 2, on July 16, 1997 the USEPA adopted revisions to the current primary NAAQSs for particulate matter less than 10 microns in diameter (PM_{10}) and ozone (O_3) (62 *Federal Register* 38652-38760; 62 *Federal Register* 38856-38896). Under these newly adopted standards, the USEPA will be phasing out the current 1-hour O_3 standard (once an area is meeting the 1-hour standard) and adopting a new, 0.08 ppm, 8-hour O_3 standard, effective September 15, 1997, to protect against longer exposures. In addition, the USEPA has added two (2) new primary standards for particulate matter less than 2.5 microns in diameter ($PM_{2.5}$); a 15 $\mu g/m^3$, three (3)-year, annual arithmetic mean standard; and a 65 $\mu g/m^3$, 24-hour average, standard meeting the 98th percentile, averaged over three (3) years. USEPA is also adjusting the current 24-hour PM_{10} standard from a 1-expected-exceedence to a 99th percentile form, averaged over three (3) years. The annual mean PM_{10} standard would remain unchanged .

Table 1: Estimated Disturbed, Reclaimed and Undisturbed Acres for the Proposed Action

COMPONENT			DISTURBED ACRES	RECLAIMED ACRES		UNDISTURBED ACRES
				ON-SITE	OFF-SITE[a]	
PROJECT AREA						
Project Mine and Process Area						
Mining Area	1	West Pit	110	110		
	2	East Pit	198	0	165	
	3	Singer Pit	33	33		
	4	Associated Areas of Disturbance	38	38		
Pad Facilities	5	Leach Pad	334	334		
	6	Process Area	24	24		
	7	Lime Bin Area and Fresh Water Pond	9	9		
Waste Rock Stockpiles	8	East Waste Rock Stockpile	135	135		
	9	South Waste Rock Stockpile	232	232		
Soil Stockpiles	10	West Soil Stockpile	20	20		
	11	East Soil Stockpile	10	10		
Support Facilities	12	Office/Maintenance/Parking/ Power Facilities	21	21		
	13	Haul and Ancillary Roads	94	94		
	14	Drainage Diversions	44	44		
Project Mine and Process Area Subtotal:			**1,302**	**1,104**	**165**	**269**
Project Mine and Process Area Total:			**1,302**	**1,269**		**269**
TOTAL PROJECT MINE AND PROCESS AREA ACREAGE:			**1,571**			
Ancillary Area						
Ancillary	15	County Road Realignment	7	7		
	16	Powerline/Water Pipeline	27	27		
	17	Water Wells and Access Roads	4	4		
Project Ancillary Area Subtotal:			**38**	**38**	**0**	**Not Applicable**
Project Ancillary Area Total:			**38**	**38**		**Not Applicable**
TOTAL PROJECT ANCILLARY AREA ACREAGE:			**38**			
PROJECT AREA ACREAGE SUBTOTAL:			**1,340**	**1,142**	**165**	**269**
PROJECT AREA ACREAGE TOTAL:			**1,340**	**1,307**		**269**
TOTAL PROJECT AREA ACREAGE:			**1,609**			

[a] As compensation for the 165 acres of East Pit slopes which would not be reclaimed, Glamis Imperial has offered to reclaim under an MOA developed with the BLM up to 165 acres of lands located off-site which were previously disturbed by others.

OVERBUILT 92 kV/34.5 kV TRANSMISSION LINE CORRIDOR				
Overbuilt 92 kV/34.5 kV Transmission Line	22	22	0	Not Applicable
TOTAL OVERBUILT TRANSMISSION LINE CORRIDOR ACREAGE:	**22**			

AREA OF THE PROPOSED ACTION SUMMARY				
Proposed Action Subtotal:	**1,362**	**1,164**	**165**	**269**
Proposed Action Total:	**1,362**	**1,329**		**269**
TOTAL PROPOSED ACTION ACREAGE:	**1,631**			

Table 2: Federal and State Ambient Air Quality Standards for Criteria Pollutants

Criteria Pollutant	Averaging Period	California Standards	Federal Standards	
		Concentration[a]	Primary[a]	Secondary[a]
Ozone (O_3)	1-Hour	90 ppbv (180 $\mu g/m^3$)	120 ppbv (235 $\mu g/m^3$)	Same as Primary Standards
Carbon Monoxide (CO)	8-Hour	9 ppmv (10 mg/m^3)	9 ppmv (10 mg/m^3)	-
	1-Hour	20 ppmv (23 mg/m^3)	35 ppmv (40 mg/m^3)	
Oxides of Nitrogen (NO_x) as Nitrogen Dioxide (NO_2)	Annual	-	53 ppbv (100 $\mu g/m^3$)	Same as Primary Standards
	1-Hour	250 ppbv (470 $\mu g/m^3$)	-	
Sulfur Dioxide (SO_2)	Annual	-	30 ppbv (80 $\mu g/m^3$)	-
	24-Hour	40 ppbv (105 $\mu g/m^3$)	140 ppbv (365 $\mu g/m^3$)	-
	3-Hour	-	-	500 ppbv (1,300 $\mu g/m^3$)
	1-Hour	250 ppbv (655 $\mu g/m^3$)	-	-
Particulate Matter ≤ 10 Microns in Diameter (PM_{10})	Annual Geometric Mean	30 $\mu g/m^3$	-	-
	24-Hour	50 $\mu g/m^3$	150$\mu g/m^3$	Same as Primary Standards
	Annual Arithmetic Mean	-	50 $\mu g/m^3$	
Sulfates (SO_4)	24-Hour	25 $\mu g/m^3$	-	-
Lead (Pb)	30-Day	1.5 $\mu g/m^3$	-	-
	Calendar Quarter	-	1.5 $\mu g/m^3$	Same as Primary Standards
Hydrogen Sulfide (H_2S)	1-Hour	30 ppbv (42 $\mu g/m^3$)	-	-

[a]Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 mm mercury. Measurements of air quality are corrected to a reference temperature of 25°C and a reference pressure of 760 mm mercury (1,013.2 millibar); ppmv and ppbv in this table refer to parts by million by volume (micro-moles of pollutant per mole of gas) and parts per billion by volume, (nano-moles of pollutant per mole of gas) respectively. $\mu g/m^3 \equiv$ micrograms per cubic meter (CARB 1994).

At present, a USEPA-accepted monitoring network for ambient $PM_{2.5}$ does not exist, and as such it is expected to take until the year 2003 before sufficient ambient $PM_{2.5}$ measurements can be obtained to allow the USEPA to establish attainment status designations. Depending upon the status of compliance with the current NAAQSs for PM_{10} and the pace with which ambient $PM_{2.5}$ concentrations are established and compliance plans developed and adopted, states may have up to the year 2017 to meet these new $PM_{2.5}$ standards .

The CAA and CAAA delegate primary responsibility for air pollution control to state governments, which in turn have often delegated this responsibility down to local or regional organizations. Many of the day-to-day regulatory functions and contacts with source operators occur at the state level under the provisions of the State Implementation Plan (SIP). Originally the mechanism by which a state set emission limits and allocated pollution control responsibility to meet the NAAQS, the function of a SIP broadened after the 1990 CAAA. These functions now include the implementation of specific technology-based emission standards, permitting of sources, collection of fees, coordination of air quality planning, and prevention of significant deterioration of air quality within regional planning areas and statewide. Section 176 of the CAA, as amended, requires that federal agencies must not engage in, approve, or support in any way any action that does not conform to a State Implementation Plan (SIP) for the purpose of attaining ambient air quality standards (Wooley 1997).

The California Air Resources Board (CARB), which is part of the California Environmental Protection Agency (Cal-EPA), is the California state agency to which the USEPA has delegated primary responsibility for implementation within California of those portions of the CAA, as amended, which entail the day-to-day regulatory functions and contacts with source operators. Under §40002 of the California Health & Safety Code, jurisdiction for air quality and regulation of emissions from all sources other than motor vehicles within Imperial County, including the area of the Proposed Action, has been delegated to the Imperial County Air Pollution Control District (ICAPCD). Under the Rules and Regulations of the ICAPCD, Glamis Imperial would be required to obtain Authorities to Construct (ATCs) and Permits to Operate (PTOs) from the ICAPCD prior to construction and operation of the Project, respectively. All the ATCs/PTOs issued by the ICAPCD include emission limitations which, by law, must be conformed to by the Project.

The CARB also has the responsibility for establishing California Ambient Air Quality Standards (CAAQSs) under the California Clean Air Act (CCAA). The CAAQSs are generally equal to or more stringent than the NAAQSs. A list of the California "criteria" air pollutants, and the CAAQS adopted for each, are also included in Table 2.

Pursuant to the CAA, the USEPA has developed classifications for distinct geographic regions known as air basins. Under these classifications, for each federal criteria pollutant, each air basin (or portion of an air basin, known as a "planning area") is classified as in "attainment" (if the air basin (or planning area) has "attained" compliance with (i.e., not exceeded) the adopted NAAQS for that pollutant) or "non-attainment" (if the levels of ambient air pollution exceed the NAAQS for that pollutant). Air basins which have not received sufficient analysis for certain criteria pollutants are designated as "unclassified" for those particular pollutants. Air basins located within California also receive similar designations with respect to the CAAQSs.

In addition to the NAAQSs, the CAA requires the USEPA to place each airshed within the United States into one (1) of three (3) classes, which are designed to limit the deterioration of air quality when it is below the NAAQSs. Class I is the most restrictive air quality category, and was created by Congress to prevent further deterioration of air quality in national parks and wilderness areas of a threshold size which were in existence prior to 1977 or have since been designated under federal regulations (40 CFR 52.21). All remaining areas outside of the Class I area boundaries were designated as Class II airsheds, which allows a relatively greater deterioration of air quality over that in existence in 1977, although still below NAAQSs. No Class III areas, which would allow air quality to degrade down to the NAAQSs, have been designated.

Federal Prevention of Significant Deterioration (PSD) regulations require that the maximum allowable increase in ambient particulate matter in a Class I airshed resulting from a major stationary source is 5 $\mu g/m^3$ (annual geometric mean) and 10 $\mu g/m^3$ (24-hour average). Specific types of facilities which emit, or have the potential to emit, 100 tons per year or more of PM_{10}, or any facility which emits, or has the potential to emit, 250 tons per year or more of PM_{10}, is considered a major stationary source. However, most fugitive emissions are not counted as part of the calculation of emissions for PSD .

There are no designated Class I airsheds within 100 kilometers of the Project mine and process area; the nearest Class I airshed is the Joshua Tree National Park Class I airshed, which is located approximately 110 kilometers northeast of the Project mine and process area at its closest point (USEPA 1997). Neither of the two (2) wilderness areas recently established in the vicinity of the Project mine and process area were designated as Class I airsheds.

1.4. Meteorological Setting

The area of the Proposed Action is a desert environment characterized by very hot summers and mild winters. Humidity in the area is very low, with the exception being July and August, when humid winds may blow in from the Gulf of California, located southeast of the Project area (BLM and ICPBD 1994a). Precipitation in the area is low, with the average annual rainfall measured at the neighboring Gold Rock Ranch being approximately 3.60 inches per year (GSi/Water 1993).

Two (2) general wind patterns exist in the region (BLM and ICPBD 1994a). From October to May, the prevailing winds are out of the west and northwest, and it is during these periods that humidity is at its lowest. Summer wind patterns, especially during July and August, are dominated by heat-induced low-pressure areas formed over the California desert, which draw air from the Gulf of California and the northern portion of Mexico. During these conditions, humidity is at its highest. The months of June and September are transitional months. Wind speeds in the region tend to be moderate, ranging from 5 to 8 mph at night (weakest in the late spring and strongest in the winter) to daytime winds averaging between 9 and 13 mph (strongest in the winter and early spring, weakest in the fall). These wind speeds tend to promote mixing, and generally transport locally generated air emissions away from the source (BLM and ICPBD 1994a).

1.5. Existing Air Quality

The area of the Proposed Action is located within the Imperial County portion of the newly designated Salton Sea Air Basin (SSAB) (formerly the southern section of the Southeast Desert Air Basin (SEDAB)). The Imperial County portion of the SSAB is entirely under the jurisdiction of the Imperial County Air Pollution Control District (ICAPCD). That portion of Imperial County west of the crest of the Chocolate Mountains, which includes the area of the Proposed Action, is designated as "moderate non-attainment" under the NAAQS, and "non-attainment" under the CAAQS, for PM_{10}. Imperial County is being re-evaluated for designation under the NAAQS for O_3, and is currently designated "moderate non-attainment/Transitional" for O_3. In addition, all of Imperial County is designated "non-attainment" under the CAAQS for O_3, and is designated as "attainment" for sulfates/sulfur dioxide (SO_4/SO_2), oxides of nitrogen (NO_x), and lead (Pb). A small portion of Imperial County (the city of Calexico) is classified as "non-attainment" for carbon monoxide (CO); the remainder of the County, including the portion in which the area of the Proposed Action is located, is designated "unclassified/attainment" under the NAAQS and CAAQS for CO. Imperial County is also designated as "unclassified" relative to the CAAQS for hydrogen sulfide (H_2S).

The ICAPCD-run stations for monitoring atmospheric pollutants located in California nearest the area of the Proposed Action are in El Centro and Brawley, California, approximately 46 miles west-southwest and 42 miles west, respectively, of the Project mine and process area. Both O_3 and PM_{10} are measured at the El Centro station, whereas only PM_{10} is measured at the Brawley station. Since 1985, four (4) PM_{10} monitoring stations have been operated by the operators of the Mesquite Mine, located approximately ten (10) miles northwest of the Project mine and process area. These four (4) stations are located within, or immediately adjacent to, the Mesquite Mine boundary. In addition, through 1996, two (2) PM_{10} monitoring stations were operated by the operators of the American Girl Mine; one (1) at the mine, located about seven (7) miles south of the Project mine and process area, and one (1) at Gold Rock Ranch, located approximately seven (7) miles southwest of the Project mine and process area.

During the 1988-1993 period, daily averages for PM_{10} measured at Brawley exceeded the CAAQS a total of 141 days (CARB 1989-1994). The highest number of exceedence days (35) in a single year was recorded in 1989, with 676 $\mu g/m^3$ being the highest recorded 24-hour PM_{10} concentration. Similarly, daily averages for PM_{10} measured at El Centro during the same period exceeded the CAAQS a total of 122 days. The highest number of exceedence days (31 days) in a single year was also recorded in 1989, with 287 $\mu g/m^3$ being the highest recorded 24-hour PM_{10} concentration (BLM and ICPBD 1994a). PM_{10} monitoring at the Mesquite Mine during 1991 indicated that the 24-hour CAAQS for PM_{10} was likely exceeded a total of 27 days that year (BLM and ICPBD 1994a). The NAAQS was never exceeded at the Mesquite Mine during that year, although measurements taken at Brawley and El Centro did exceed the NAAQS (BLM and ICPBD 1994a). Background (annual) PM_{10} levels calculated from the PM_{10} measured at the Mesquite Mine during 1991 and 1992 are reported as 19.9 $\mu g/m^3$ (arithmetic mean) and 18.1 $\mu g/m^3$ (geometric mean) (BLM and ICPBD 1994a). Background (annual) PM_{10} levels calculated from the PM_{10} measured at Gold Rock Ranch by the American Girl Mine for the year 1996 were 19.0 $\mu g/m^3$ (arithmetic mean) and 17.5 $\mu g/m^3$ (geometric mean). No data are currently available regarding the existing ambient PM_{10} concentrations in or immediately adjacent to the Project mine and process area.

Sources of PM_{10} in Imperial County are both natural and anthropogenic (i.e., related to the activities of man). The primary source of PM_{10} and the related pollutant, total suspended particulates (TSP), in Imperial County is fugitive dust from area sources, principally vehicular traffic on unpaved roads and wind erosion of cultivated agricultural land, although PM_{10} and TSP transported into the Imperial Valley from Mexico are also substantial (Pechan & Associates 1993). PM_{10} can also be created indirectly in the atmosphere from chemical reactions that convert gaseous precursors into small particles. These PM_{10} precursors, which are predominantly products of man-made combustion, include NO_x, reactive organic gases (ROGs), and oxides of sulfur (SO_x). Principal existing PM_{10}/TSP sources in the vicinity of the Project area are wind erosion from disturbed areas, vehicular traffic on unpaved roads, and fugitive and point source emissions from other mining operations in the area.

Ozone is a photochemical oxidant which is not typically emitted directly into the atmosphere but is formed in the atmosphere through chemical reactions among emission precursors and ultraviolet light. Imperial County is classified as "transitional/attainment" by the USEPA for O_3 since recent ambient air monitoring for O_3 at the El Centro station has not indicated any exceedences of the NAAQS for O_3. However, between 1988 and 1993 there were a total of 45 exceedence days (139 hours) of the lower CAAQS for O_3 (CARB 1989-1994). The highest number of exceedence days (25 days) in a single year was recorded in 1993, with 150 ppbv being the highest recorded 24-hour O_3 concentration. A substantial portion of the O_3 measured in Imperial County is believed to be transported into the basin from other areas, principally from the South Coast Air Basin and Mexico, and these area sources are likely the cause of at least some of the measured exceedences of the CAAQS for O_3 (BLM and ICPBD 1994a).

Hydrocarbons, or more specifically reactive organic gases (ROGs) (also known as reactive organic compounds (ROCs)), are not strictly criteria air pollutants but are recognized as precursors of photochemical oxidants, including O_3, and are also precursors to atmospheric particulate matter, both of which are criteria air pollutants. In addition, oxides of nitrogen (NO_x) and oxides of sulfur (SO_x), some forms of which are criteria pollutants, are also precursors to photochemical oxidants and atmospheric particulate matter. Table 3 presents a list of the criteria pollutants which can be created by secondary reactions from emissions of the precursors ROGs, NO_x, and SO_x.

Table 3: Secondary Criteria Pollutants from Emissions of ROG, NO_x, and SO_x

Precursor	Secondary (Criteria) Pollutants
Reactive Organic Gases (ROGs)	a) photochemical oxidants (ozone)
	b) the organic fraction of suspended particulate matter
Oxides of Nitrogen (NO_x)	a) nitrogen dioxide (NO_2)
	b) the nitrate fraction of suspended particulate matter
	c) photochemical oxidants (ozone)
Oxides of Sulfur (SO_x)	a) sulfur dioxide (SO_2)
	b) sulfate (SO_4)
	c) the sulfate fraction of suspended particulate matter

Source: South Coast Air Quality Management District 1994.

Principal sources of ROGs in the atmosphere include vehicular and industrial emissions and unsaturated hydrocarbon emissions from trees and other vegetation. No data are currently available regarding the levels of hydrocarbons in the ambient air in the Project area or immediate vicinity, but they are presumed to be negligible due to the lack of substantial emissions sources, including nearby existing mining operations (which typically have few sources of ROGs except for internal combustion engines). Similarly, no data are available regarding existing levels of sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) in the ambient air in the immediate Project area, although the levels of these pollutants are also presumed to be small because of the absence of local sources.

2. AIR QUALITY ASSESSMENT

2.1. Air Pollutant Emission Sources and Emissions

The Proposed Action consists of many activities and operations, each of which may have the potential to emit air pollutants. Rule 101 (Definitions) of the Rules and Regulations of the ICAPCD (Rules) defines a "source" as, "a specific device, article, or piece of equipment from which air contaminants are emitted, or the distinct place (such as with fires or other chemical activity) from which air pollutants are emitted." Rule 207B. (New and Modified Stationary Source Review-Definitions), goes on to further define "emissions unit" as, "an identifiable operation or piece of process equipment such as an article, machine, or other contrivance which emits, has the potential to emit, or results in the emissions of any affected pollutant directly or as fugitive emissions." Rule 101 goes on to define "fugitive emissions" as "those emissions which cannot reasonably pass through a stack, chimney, vent or other functionally equivalent opening."

A comprehensive list of identified individual potential sources of Project air pollutant emissions ("emission units"), organized into "emission groups" of similar activities (such as mining, heap leaching, etc.), are presented in Table 4. Each of the air pollutants potentially emitted from each of these emission units is presented in Appendix A.

In addition to being organized into emission groups, these emission units can also be characterized by the "type" of emission unit. For the sake of this impact analysis, four (4) different types of emission units were identified, applicable to the Project: stationary "point" sources (e.g., the emergency diesel-fuel electric generator); "fugitive" sources (i.e., those which do not emit pollutants from single points, but from diffuse areas (e.g., dust generated by vehicles moving on unpaved roads)); mobile/non-road combustion sources (e.g., the "tailpipe" emissions from haul trucks, dozers, etc., and mobile drill rigs, etc.); and "other" sources (e.g., vapor emissions from the storage of fuel in storage tanks). Table 4 also provides the emission "type" for each of the Project emission sources.

Estimates of the annual emissions of each applicable criteria air pollutant from each emission unit were calculated using approved, generally available emission estimating techniques from the US EPA's <u>Compilation of Air Pollution Emission Factors (4th & 5th editions)</u>, and using operational parameters for each of the emission units as provided by Glamis Imperial. Appendix B and Appendix C present the Project information provided by Glamis Imperial as used in the emission estimate calculations for the maximum 24-hour and annual operations, respectively. Appendix D and Appendix E present the actual emission calculations for the maximum 24-hour and annual operations, respectively. As indicated in Appendix D and Appendix E, these calculations assume the implementation of the "emission control" techniques proposed to be implemented as a part of the Proposed Action to reduce the emissions (such as the watering and application of chemical surfactants to the roads). Appendix F presents the summary report of the calculations from the U.S. EPA Tanks Program, which was used to calculate the emissions of volatile organic compounds from the fuel storage tanks as presented in Appendix D and Appendix E. Appendix G provides a summary of the maximum estimated daily (in pounds per day) and annual (in tons per year) regulated (criteria) air pollutant emissions expected from the Proposed Action.

Fugitive emission sources, especially emitters of fugitive particulate matter (TSP and PM_{10}), are the largest proportion of the emission units. Mining and heap leaching activities, such as blasting, loading, dumping and dozing, release fugitive particulate matter into the air through the physical movement of the ore or waste rock. Ore and waste rock hauling, and truck and vehicle traffic, all generate fugitive particulate matter emissions by traveling on unpaved roads. Finally, wind erosion of both the waste rock stockpiles and ore heap can generate fugitive particulate matter emissions .

Mobile sources, the next largest category of sources, are principally associated with the mining and heap leaching process. They consist exclusively of large diesel engines which power the haul trucks, dozers, graders, and water trucks. Because of the high percentages of use (many will operate nearly 24 hours per day), these mobile sources will produce substantial quantities of "tailpipe" combustion emissions, such as NO_x, SO_x, and CO.

Most of the mobile sources fall into the category of "non-road engines", generally defined under 40 CFR §89 as internal combustion engines which are in or propel a vehicle which is not a "road" vehicle, or are portable or transportable, but which do not remain in a fixed location for more than a year. These federal regulations require that "non-road engines" must be manufactured to meet specific emission standards for criteria pollutants, based on the size (kW or hp rating) of the engine and date of manufacture, according to a specific timetable commencing on January 1, 1996. Table 5 lists the identified Project "non-road engines", the size (hp rating) of each, whether the engine will be purchased (in 1997) "new" or "used," and whether the engine will be subject to these new federal emission limitations.

Table 4: List of Potential Emission Sources and Type for the Proposed Action

Emission Unit	Emission Unit Description	Emission "Source" Type			
		Stationary Point	Fugitive	Mobile	Other
Emission Unit Group 1: Mining Activity					
1.003	Drilling - Waste Rock		X		
1.002	Drilling - Ore		X		
1.003	Blasting - Waste Rock		X		
1.004	Explosives Detonation - Waste Rock Blasting		X		
1.005	Blasting - Ore		X		
1.0[illegible]8	Explosives Detonation - Ore Blasting		X		
1.007	Waste Rock Loading		X		
1.003	Ore Loading		X		
1.003	Waste Rock Dumping		X		
1.010	Ore Dumping		X		
1.011	Waste Rock Dozing		X		
1.012	Waste Rock Hauling		X		
1.018	Ore Hauling		X		
1.013	Ammonium Nitrate Prill Silo Loading	X			
1.018	Ammonium Nitrate Prill Silo Unloading	X			
1.018	Wind Erosion (Waste Rock Stockpile)		X		
1.018	Wind Erosion (Soil Stockpiles)		X		
1.018	Haul Truck (Combustion)			X	
1.013	Mine Dozer (Combustion)			X	
1.02[illegible]	Drill Rig (Combustion)			X	
1.021	Loader (Combustion)			X	
1.022	Clean-Up Loader (Combustion)			X	
Emission Unit Group 2: Heap Leaching Activity					
2.001	Portable R-O-M Lime Silo Loading	X			
2.002	Portable R-O-M Lime Hopper Loading	X			
2.003	Lime Application to Ore		X		
2.004	Ore Ripping/Spreading/Dozing		X		
2.005	Heap Leach Dozer (Combustion)			X	
2.006	Cyanide Application and Leaching		X		
2.007	Pregnant Solution Pond		X		
2.008	Barren Solution Pond		X		
2.009	Wind Erosion (Heap Leach Pad) - Non-Leach		X		
2.010	Wind Erosion (Heap Leach Pad) - Leach		X		
Emission Unit Group 3: Process Plant					

Emission Unit	Emission Unit Description	Emission "Source" Type			
		Stationary Point	Fugitive	Mobile	Other
8.001	Carbon Adsorption Tank 1		X		
7.002	Carbon Adsorption Tank 2		X		
8.003	Carbon Adsorption Tank 3		X		
3.004	Carbon Adsorption Tank 4		X		
3.006	Carbon Adsorption Tank 5		X		
3.006	Acid Wash Tank				X
3.007	Cyanide Make-up Tank		X		
3.006	Strip Tank		X		
3.009	Electrowinning Cell		X		
Emission Unit Group 4: Refining					
4.001	Mercury Retort Furnace (Electric)	X			
Emission Unit Group 5: Laboratory					
5.001	Jaw Crusher	X			
5.002	Pulverizer	X			
5.003	Fume Hood	X			
5.004	Waste Acid Tank		X		
Emission Unit Group 6: Shop Area					
6.001	Main Diesel Tank 1				X
6.002	Street Diesel Tank				X
8.003	Unleaded Gasoline Tank				X
6.004	Coolant Tank				X
Emission Unit Group 7: Mine & Process Area Support Activities					
7.001	Water Truck (Combustion)			X	
7.002	Water Truck Traffic		X		
7.003	Backup Diesel-Fueled Generator	X			
7.004	Mobile Light Plant - Pit #1			X	
7.005	Mobile Light Plant - Pit #2			X	
7.006	Mobile Light Plant - Heap			X	
7.002	Mobile Light Plant - WRS			X	
7.003	Cable Reel Machine			X	
7.009	Grading of Road Surface		X		
7.010	Grader (Combustion)			X	
Emission Unit Group 8: Other Mobile Emission Units					
8.001	On-Site Delivery Truck Traffic		X		
7.002	On-Site Delivery Truck (Combustion)			X	
8.003	On-Site Light Vehicle Traffic		X		
8.004	On-Site Light Vehicle (Combustion)			X	

Emission Unit	Emission Unit Description	Emission "Source" Type			
		Stationary Point	Fugitive	Mobile	Other
8.005	Off-Site Delivery Truck Traffic		X		
8.006	Off-Site Light Vehicle Traffic		X		

Table 5: List of Project "Non-Road Engines" and Applicability Criteria

Engine (number)	Engine Rating	Year of Manufacture	Applicability of 40 CFR 89
Haul Trucks (8)	3,200 hp	1998	No
Dozers (2)	375 hp	1998	Yes
Drill Rigs (2)	550 hp	1998	Yes
Loader (1)	1,250 hp	1998	No
Light Plants (4)	35 hp	1998	No
Cable Reel Machine (1)	350 hp	<1996	No
Clean-up Loader (1)	690 hp	<1996	No
Water Trucks (2)	1,050 hp	<1996	No
Grader (1)	275 hp	1998	Yes
Back-Up Generator (1)	750 hp	1998	Yes

Based on the Project engine size ratings and their assumed date of manufacture (based on the purchase date), less than half of the Project "non-road engines" would be required to be manufactured to met the new federal emission standards. However, many engine manufacturers are already meeting or exceeding the new emission standards

Although the Project has a number of stationary point sources, these sources are individually and collectively minor sources of criteria air pollutant emissions. About one-half of the stationary point sources are combustion sources, which, as a class, emit substantially more gaseous combustion pollutants (NO_x, SO_x, and CO) than particulate matter .

Finally, the "other" category of criteria pollutant emission sources consist exclusively of the diesel, gasoline and other volatile organic compound storage and dispensing tanks. However, the total quantities of these materials emitted by the Project to the atmosphere are small.

2.2. Air Quality Assessment

2.2.1. Federal PSD Regulations

Federal PSD regulations are applicable only to major stationary sources which are either specific types of facilities which emit, or have the potential to emit, 100 tons per year or more of a criteria pollutant, or any facility which emits, or has the potential to emit, 250 tons per year or more of any criteria pollutant. However, most fugitive emissions are not included as applicable emissions under the federal PSD program. Since the few stationary emission units under the Proposed Action emit collectively substantially less than 1 ton per year of any criteria pollutant, the Project is not subject to federal PSD regulations.

2.2.2. Title V of the CAAA

The CAAA included Title V, which established a very detailed and extensive operating permit system for "major sources" of regulated air pollutants. The ICAPCD has adopted Rule 900 to implement Title V within the District, and EPA's delegation of authority to implement Title V through Rule 900 became effective on June 2, 1995. Rule 900 is applicable only to "major" sources of air pollutants, which are defined as "a stationary source which has the potential to emit a regulated air pollutant or a hazardous air pollutant (HAP) in quantities equal to or exceeding the lesser of any of the following thresholds:"

"100 tons per year (tpy) of any regulated air pollutant;"

"10 tpy of one HAP or 25 tpy of two or more HAP's; or"

"Any lesser quantity threshold promulgated by the U.S. EPA."

At present, no lower quantity threshold has been set by the U.S. EPA.

ICAPCD Rule 900 B.17.(HAZARDOUS AIR POLLUTANT (HAP)) defines a "hazardous air pollutant" as "any air pollutant listed pursuant to section 112(b) of the CAA." ICAPCD Rule 900 B.26 (REGULATED AIR POLLUTANT) defines "regulated air pollutant" as "any pollutant: 1) which is emitted into or otherwise enters the ambient air, and 2) for which the U.S. EPA has adopted an emission limit, standard, or other requirement." In addition to the six (6) identified criteria pollutants (regulated air pollutants) identified as potentially emitted by the Project, the Project would emit, among the 189 listed HAPs, hydrocyanic acid; arsenic, beryllium, cadmium, lead, antimony and other HAPs metals (found in fugitive ore dust); and benzene (found in combustion emissions).

In order to determine the applicability of Title V (Rule 900) to the Project, the summary of the inventory of the annual air pollutant emissions of all emission units provided for the Proposed Action in Appendix G was recalculated in Appendix H to present the annual potential to emit for only the emission units applicable under Title V (Rule 900). Rule 900 B.24 (POTENTIAL TO EMIT) states that: "For the purposes of Rule 900, "potential to emit" as it applies to an emissions unit and a stationary source as [*sic*] defined below."

> "Emission Unit: The "potential to emit" for an emissions unit is the maximum capacity of the unit to emit a regulated air pollutant or HAP considering the unit's physical and operational design. Physical and operational limitations on the emissions unit shall be treated as part of its design, [if?] the limitations are set forth in permit conditions which address applicable federal requirements. Physical and operational limitations shall include, but are not limited to, the following: limits placed on emissions; and restrictions on hours of operation and type of amount of material combusted, stored, or processed." (Rule 900 B.24.a)
>
> "Stationary Source: The "potential to emit" for a stationary source is the sum of the potential to emit from all emissions units at the stationary source. If two or more HAPs are emitted at a stationary source, the potential to emit for each of those HAPs shall be combined to determine applicability. Fugitive emissions shall be considered in determining the potential to emit for: 1) sources as specified in 40 CFR Part 70.2 Major Source (2), and 2) sources of HAPs emissions." (Rule 900 B.24.b)
>
> "40 CFR Part 70.2 Major Source" states that "*Major source* means any stationary source (or group of stationary sources that are located on one or more contiguous or adjacent properties, and are under common control of the same person (or persons under common control)) belonging to a single major industrial grouping and that are described in paragraph (1), (2), or (3) of this definition..."

Paragraph (2) of 40 CFR Part 70.2 states that "A major stationary source of air pollutants, as defined in section 302 of the Act, that directly emits or has the potential to emit, 100 tpy or more of any air pollutant (including any major source of fugitive emissions of any such pollutant, as determined by rule by the Administrator). The fugitive emissions of a stationary source shall not be considered in determining whether it is a major stationary source for the purposes of section 302(j) of the Act, unless the source belongs to one of the following categories of stationary source:..."

Since neither "mining" nor any other applicable description of the Project falls under any of the categories of stationary sources listed under 40 CFR Part 70.2 (2), fugitive emissions are not considered in determining the Project's potential to emit regulated air pollutants. Only fugitive HAPs emissions are included.

Since Title V (Rule 900) is applicable as to criteria (regulated) air pollutants only to stationary point sources, few of the Project's emission units are included in the Title V applicability for criteria pollutants. The largest applicable annual emission rate for a single criteria pollutant for the Proposed

Action is 0.64 tons per year of volatile organic compounds/reactive organic gases (VOCs/ROGs); all of this is emitted from the fuel and other organic liquid storage and dispensing facilities.

HAPs can be found in many of the natural earth materials which will be mined by the Project; in the fuels used and stored by the Project; and in the solution used to leach the precious metals from the ore. Current EPA and ICAPCD guidance provides that reasonably quantifiable HAP emissions from fugitive sources, as well as from stationary sources, must be counted to determine the applicability of Title V for HAPs .

The potential metal HAPs component of the emitted Project particulates has been conservatively estimated in Appendix E by assuming that all of the HAPs contained in the fugitive particulate matter emitted by the Project are subject to Title V (Rule 900). Based upon analyses of ore and waste rock samples collected during exploration drilling (see Appendix C), and using the calculated total annual TSP emission estimates (see Appendix E), the total annual emission of particulate-based HAPs has been estimated. As indicated in Appendix I, the total potential to emit for all Title V applicable metal HAPs generated by the Proposed Action is less than 0.01 tons.

Since they are not stationary sources, HAPs released as a result of the combustion of diesel fuel and gasoline in mobile engines are not subject to Title V (Rule 900). Because of its limited use, combustion HAPs from the diesel-fueled emergency generator total less than one (1) pound (0.0002 ton) per year.

After discussions with the ICAPCD, it was determined that fugitive hydrocyanic acid (HCN) emissions from heap leach mining operations in general, and the Proposed Action in particular, are not "reasonably quantifiable" under the Clean Air Act Title V Operating Permit Program, and therefore should not be included in determining a facility's major source status under the Title V Program (as per the preamble to the proposed Part 70 rule titled *Operating Permits Program Rule Revisions* as published in the *Federal Register, Vol. 59, No. 166, Monday, August 29, 1994,* which states that "[w]ith respect to determinations of major source status under section 112, [the U.S.] EPA believes the Act requires that fugitive emissions, <u>to the extent quantifiable</u>, be counted." [Emphasis added]). As such only the non-fugitive sources of HCN have been quantified in this analysis.

The largest applicable annual emission rate for a single criteria pollutant for the Proposed Action is 0.64 tons per year of volatile organic compounds/reactive organic gases (VOCs/ROGs); all of this is emitted from the fuel and other organic liquid storage and dispensing facilities. The total annual emission of all potentially applicable HAPs from the Project, including emissions of HCN from non-fugitive sources, is approximately 0.5 ton, substantially below the 25-ton Title V threshold for all facility HAPs (see Appendix I).

Given that the total potential to emit expected from the Proposed Action is well below the thresholds for considering it to be a "major source" as defined in ICAPCD Rule 900, the Project will not be subject to Title V of the CAAA.

2.2.3. Air Toxics

The Air Toxics "Hot Spots" Information and Assessment Act (AB2588) ("Hot Spots" Act) was enacted in September 1987, and subsequently amended in 1992 and again in 1997. The goal of the "Hot Spots" Act is to collect emission data indicative of routine predictable releases of toxic substances to the air, to identify facilities having localized impacts, to evaluate health risks from exposure to the emissions, to notify nearby residents of significant risks, and reduce risk below the determined level of significance.

The "Hot Spots" Act requires CARB to compile and maintain a list of substances posing chronic or acute health threats when present in the air. The Air Toxics "Hot Spots" Act currently identifies by reference over 600 substances which are required to be subject to the program, a portion of which must be quantified. Under Section 44321 of the California Health & Safety Code, the Act applies to the following:

> "(a) Any facility which manufactures, formulates, uses, or releases any of the substances listed pursuant to Section 44321 or any other substance which reacts to form a substance listed in Section 44321 and which releases or has the potential to release total organic gases, particulates, or oxides of nitrogen or sulfur in the amounts specified in Section 44322.
>
> "(b) Except as provided in Section 44323, any facility which is listed in any current toxics use or toxics air emission survey, inventory, or report released or compiled by a district. A district may, with the concurrence of the state board, waive the application of this part pursuant to this subdivision for any facility which the district determines will not release any substance listed pursuant to Section 44321 due to a shutdown or a process change."

Of the 600 substances listed under the "Hot Spots" Act, a large portion of them are listed as HAPs under Title V of the Federal CAA. Of those listed as "Substances Which Must Be Quantified" according to the "Hot Spots" Act, the Proposed Action is not expected to emit any additional substances above those emissions quantified under Title V of the Clean Air Act. The Proposed Action will use several chemicals listed as "Substances For Which Production, Use, or Other Presence Must be Reported". Given the use and presence of these chemicals, Glamis Imperial will be expected to prepare and submit to the ICAPCD an AB2588 Emission Inventory Plan (EIP) as specified in the California Health & Safety Code Sections 44300 et. seq. This plan must meet the requirements of the Emission Inventory Criteria and Guidelines Regulation, California Code of Regulations, Subchapter 7.6, Sections 93300 through 93347, and outline "a comprehensive characterization of the full range of hazardous materials that are released, or that may be released, to the surrounding air from the facility." Once the EIP is approved by the ICAPCD, a complete Emission Inventory would be prepared in accordance with the requirements of the Act. Given the low levels of HAPs calculated as potentially emitted from the Proposed Action, the limited number and quantity of additional identified "air toxics" expected to be used by the Project, and the remote location of the site, exposure of sensitive populations to significant concentrations of air toxics from the Project is very unlikely.

2.2.4. Compliance with Ambient Air Quality Standards

The principal pollutant of concern emitted by the Proposed Action is PM_{10} because of the relatively large quantity of PM_{10} emitted by the Project, the relatively low ambient air quality standard for PM_{10}, and the fact that nearly all of the Project PM_{10} emissions are from fugitive and mobile sources which are emitted throughout the Project mine and process area. (The newly adopted $PM_{2.5}$ standard is not yet applicable and, because of the lack of baseline ambient measurements, determinations of attainment for any area cannot yet be made. In addition, the techniques necessary to estimate a project's $PM_{2.5}$ emissions have not yet been fully developed, and thus an evaluation of a project's potential impacts and compliance with the new standard cannot be made.)

In order to assess the Project's potential impacts on air quality in the region and to ensure compliance with both State and Federal Ambient Air Quality Standards, computer-aided dispersion modeling was conducted for "modelable" criteria pollutants potentially emitted from the Project (NO_2, SO_2, CO, and PM_{10}) using the USEPA Industrial Source Complex- Short Term (ISCST3R) dispersion model utilizing the Trinity Consultants, Inc. Breeze "graphical front end" (IBM-PC Version 3.00, Dated 96113). EMA used the USEPA's regulatory default model options as outlined in Appendix A of the Guideline on Air Quality Models (Revised) (USEPA, 1987). In addition, EMA used rural dispersion parameters and elevated terrain.

2.2.4.1. Introduction

Dispersion modeling is a technique for estimating the concentrations of pollutants that will result from a given source's emissions. Emissions may be from "point" sources (stacks or vents); "area" sources (regions with a distinct square footage and little or no vertical velocity, e.g. a lagoon or heap); "volume" sources (buildings or elevated conveyors); "line" sources (road emissions); and "openpit" sources (below grade operations such as open pit coal mining). In modeling a "line" source, the ISCST3 Model (ISC) utilizes a series of "area" or "volume" sources to estimate emissions. Non-reactive, "lighter-than-air" emissions from these sources are modeled based on a gaussian distribution, which is a relatively good mathematical approximation of plume behavior (Schulze, 1991).

2.2.4.2. Modeled Emissions Units and Assumptions

Emissions from the Proposed Action are substantially concentrated within the Project mine and process area. As such, for the purposes of this air quality analysis, the modeled emission sources included only those emission sources which are located within the Project mine and process area. The remainder of the emissions are "off-site" emissions from traffic along Indian Pass Road and

Ogilby road. The emissions from these sources are expected to have minimal effect on ambient air quality, and, as such, are not included in the modeled sources.

Appendix J (Table 1 and Table 2) provides, for each of the modeled emission units, all of the emission parameters used in the ambient air modeling conducted for the proposed Project. Table 1 lists the applicable modeling parameters for each of the proposed "point sources;" Table 2 provides all of the applicable modeling parameters for each of the "area sources;" Table 3 provides all of the applicable modeling parameters for the “volume sources” and "line sources;" and Table 4 provides for all of the applicable modeling parameters used in modeling PM_{10} emissions from sources located within the “pit source.” Modeling of gaseous pollutants from the pit sources was performed using a “volume source,” as the depositional algorithms used for particulate modeling from “pit sources” do not apply.

Emission rates for each of the individual emission units were calculated using the emission estimates presented in Appendix D and Appendix E. Based upon information provided by Glamis Imperial personnel, activities proposed to be conducted during Project Year 2, which is the first full year of full operation of all of the major Project components, were used to place the locations of the emission units. A diagram showing the locations of each of the emission units is provided as Plate 1, located in Appendix K.

In order to simplify the modeling runs, emissions which occur over the same area (i.e., multiple vehicles and/or operations over the same segment of haul road) were combined into one source, with a single emission rate. Emissions from the haul roads were modeled as “volume” line sources, with emissions spread over the entire length of each road segment, using a weighted distribution based on the calculated percentage of time travel would occur on the roads. In addition, emissions from those sources which occur within a pit (e.g. drilling, blasting, loading, and initial hauling) were combined and modeled using the ISC "openpit" source type for PM_{10} and the ISC “volume” source for gaseous pollutants.

EMA ran four (4) separate model runs, one for each modelable criteria pollutant, which calculated concentration values for the appropriate averaging times for each pollutant. Each model run calculated pollutant concentrations from a single source group, "all," consisting of all of the proposed emission units. All emission parameters for each of the emission units were modeled as presented in Appendix J, and used a worst case hourly emission rate based on full operations. This worst case emission rate assumed full production of the mine for a maximum 24-hour operation. This is expected to be extremely conservative given that actual operations for a full year are expected to be far less than modeled.

2.2.4.3. Receptors

One (1) set of discrete receptors and four (4) cartesian receptor grids were used.

A single discrete receptor set, consisting of receptors placed at approximate 50-meter intervals along the Project mine and process area boundary and individual "discrete" receptors located at various points well beyond the modeled grids was used. The individual receptor points, which coincide with areas of potential public concern, and their respective locations are listed in Table 6, below. Appendix K, Plate 2, shows the locations of each of these discrete receptors located along the Project mine and process area boundary in relation to the source areas for each of the emission units.

Table 6: List of Modeled, Non-Fenceline Discrete Receptor Points Locations

Receptor Point	Location (UTM)	
	Northing	Easting
Bard, California	3630500	729000
Fort Yuma Reservation Boundary - Wash	3635200	729000
Fort Yuma Reservation Boundary - NW Corner	3634850	711750
Picacho State Recreation Area	3656000	729000
American Girl Mine	3637300	707200
Glamis, California	3652500	680000
Gold Rock Ranch	3640000	700000
Picacho Mine	3649500	720200
Mesquite Regional Landfill	3655943	685581
Mesquite Mine	3658556	688788

The coarsest receptor grid consisted of a 24 by 21, 1,000-meter spaced, cartesian receptor grid using even 1000-meter UTM coordinates, and covering approximately 240 square miles around the Project Mine and Process area, including a goodly portion of the Picacho Peak and Indian Pass Wilderness Areas located north of the proposed mine and process area. A finer, 21 by 21, 250-meter spaced, cartesian receptor which used even 250-meter UTM coordinates, and which was also roughly centered on the Project mine and process area, was also used. In addition to these two (2) coarse grids, two (2), 6 by 11, 50-meter spaced grids were placed along the "fenceline" where highs were noted to ensure that no exceedences occurred in those areas. Appendix K, Plate 2, shows the locations of each of these receptor grids in relation to the discrete receptors located along the Project mine and process area boundary.

Elevations for all of the fenceline discrete receptors and receptors in the cartesian receptor grids were taken from the USGS Digital Elevation Model (DEM) data for the following 7.5 Minute Series (Topographic) Maps, as applicable:

- Hedges, CA Quadrangle;
- Ogilby, CA Quadrangle;
- Quartz Peak, CA Quadrangle;
- Picacho SW, CA Quadrangle;
- Picacho Peak, CA Quadrangle; and
- Araz, CA Quadrangle.

The DEM data was directly imported into the model by the Trinity Breeze Interface. The elevation for each of the receptors was interpolated by the Interface. The elevations for the non-fenceline, discrete receptors which fell outside the areas quadrangles listed above, and the elevation read from the appropriate USGS 7.5 minute series quadrangle, were input into the model by hand.

2.2.4.4. Meteorological Data

Pursuant to discussions with the ICAPCD, EMA utilized surface meteorological data for the year 1989 from the National Weather Service (NWS) Yuma Surface Station (Yuma, AZ), combined with upper air data (also for 1989) from the NWS Tucson Upper Air Station (Tucson, AZ).

The Yuma Surface Station is the NWS-operated, 24-hour station located closest to the Proposed Action, approximately 20 miles south-southwest of the Project mine and process area. Given the proximity and similar elevations between Yuma and the Proposed Action, the Yuma data was expected to be reasonably representative of the Project mine and process area. According to meteorologists at the National Climatic Data Center (NCDC), 1989 was the last year of complete data from the Yuma Station, and, as such it was the year selected.

The NWS does not currently maintain an upper air station in Yuma, and does not have 1989 upper air data for Yuma. The Marine Corps Air Station (MCAS), Yuma does collect some upper air data, but the MCAS does not collect nor maintain complete upper air data records. Although the Tucson Upper Air Station is not as proximate to the Project mine and process area as a few other sites with upper air data, it is the closest site to the area for which upper air data was believed to be representative of upper air conditions found in the area of the Proposed Action. In addition, a complete 1989 upper air data set was available for Tucson.

2.2.4.5. Results of the Criteria Pollutant Modeling

The principal pollutant of concern from the Proposed Action is PM_{10}. Nearly all of the Project PM_{10} emissions are from fugitive and mobile sources, with emissions occurring throughout the 1,612-acre Project mine and process area. Because of the number of mobile combustion sources in use at the Project site, criteria pollutant emissions from Project combustion sources are also of concern. Separate modeling runs were performed for each of the four (4), modelable, criteria pollutants. These modeling runs assumed maximum 24-hour operations for the Project, and impacts were measured based on the appropriate averaging times for each pollutant, as dictated by their respective CAAQS and NAAQS.

At present, ICAPCD does not have information regarding background levels of criteria pollutants in the area of the Proposed Action. Because of the non-attainment status of the area with regard to PM_{10}, in order to reasonably estimate the impacts from the Project, reasonable background numbers were needed. Currently, ongoing particulate monitoring is underway at Gold Rock Ranch (GRR), located approximately 6.5 miles southwest of the Project mine and process area, and the American

Girl Mine located approximately 7.5 miles south-southeast of the Project mine and process area. Data from GRR was chosen given its relative proximity to the Project Area. Using the full year's worth of monitoring data recorded at GRR during the year 1996, the annual arithmetic mean and geometric means were calculated for use as background data, as appropriate, for this impact analysis. The arithmetic and geometric means calculated from the data were 19.0 and 17.5, respectively. The data set used in calculating the background data is included as Appendix L of this analysis.

2.2.4.5.1. Particulate Matter Less than 10 Microns (PM_{10})

The results of the PM_{10} model runs are presented in Appendix M-1 and M-2. The modeled 24-hour high, at a point near the center of the Project mine and process area, was 68.39 $\mu g/m^3$. The modeled high at a point accessible to the public, a "fence-line" receptor near the southwestern boundary of the Project mine and process area, was 30.73 $\mu g/m^3$, below both the California and federal 24-hour AAQSs (see Table 2), even when the background level calculated from the Gold Rock Ranch particulate monitoring station is added. Calculated 24-hour ambient concentrations at distances greater than 3,750 meters (2.3 miles) from the Project mine and process area boundary were universally below 5 $\mu g/m^3$. Maximum ambient concentrations at a receptor points on the northern boundary of the Ft. Yuma Indian Reservation, a distance of 12,000 meters (7.5 miles) from the southern boundary of the Project mine and process area, were well below 1.0 $\mu g/m^3$ and impossible to distinguish from background concentrations. Impacts from the Project at the other discrete receptors placed at points of potential public concern were universally modeled at below 1.9 $\mu g/m^3$ and likewise would be impossible to distinguish from background concentrations. Appendix K, Plate 3, provides a map of the fenced boundary of the Project mine and process area (equivalent to the discrete receptors) and contours for the results of the 24-hour model runs .

The results of annual average PM_{10} calculated by the run is also presented in Appendix M-1. The modeled high, at a point again near the center of the Project mine and process area, was 22.17 $\mu g/m^3$. The modeled high at a point accessible to the public, again a "fence-line" receptor near the southwestern boundary of the Project mine and process area, was 5.63 $\mu g/m^3$, well below both the California and federal annual AAQSs (see Table 2), even when the assumed background PM_{10} level is added. As was seen in the 24-hr results, impacts from the Project at the other discrete receptors placed at points of potential public concern were universally modeled at below 1.0 $\mu g/m^3$ and would be impossible to distinguish from background concentrations. Appendix K, Plate 4, provides a map of the fenced boundary of the Project mine and process area (equivalent to the "fenceline" discrete receptors) and contours for the results of the annual concentrations.

2.2.4.5.2. Oxides of Nitrogen/Nitrogen Dioxide (NO_X/NO_2)

The modeled 1-Hr and Annual Average impacts from the Project's estimated emissions of NO_X are presented in Appendix M-3. As indicated in Table 2, both the State and Federal AAQSs are for concentrations of the NO_2 portion of NO_X. In order to accurately predict the Project's compliance with the State and Federal AAQSs for NO_2, the NO_2 fraction of NO_X was estimated utilizing guidance provided by Mr. Henry S. Cole and John E. Summerhayes of the USEPA, in their article published in the August 1979 issue of the Journal of the Air Pollution Control Association.

Based on this guidance, the NO_2 fraction of NO_X emissions was estimated to be 10%. In the atmosphere, nitrogen monoxide (NO) and O_3 react in the presence of light and reactive organic compounds (ROCs) to form NO_2, as well as a host of other compounds. The basic photochemical cycle of these three compounds, in the atmosphere is as follows:

$$NO_2 + hv \rightarrow NO + O$$
$$O + O_2 \rightarrow O_3$$

Ozone is "destroyed" in the presence of NO forming NO_2 as follows:

$$NO + O_3 \rightarrow NO_2 + O_2$$

and the cycle renews itself (Pitts 1986). By conservatively assuming 100% of any O_3 present is converted in the presence of NO_X, this concentration can be added to the 10% to obtain a conservative estimate of the NO_2 emitted and caused by emissions from the Proposed Action.

Since there is no historical data providing O_3 concentrations in the Project Area, data from the California Air Resources Board (CARB) for the years 1988-1995 was used. CARB monitoring stations are located in El Centro and in Calexico. Table 7 below provides the measured maximum hourly ozone concentrations at the CARB stations during the years 1988-1994. A weighted maximum hourly O_3 concentration of 0.13 ppm was used to determine the maximum hourly NO_2 concentration estimated from the Project. For the average annual concentrations, the maximum annual average measured from the CARB El Centro Station, 0.036 ppm, was used.

Table 7: Imperial County Measured Ozone Concentrations (1988-1995)

CARB Station	Year	Max. 1-Hr O_3 Conc. (ppmv)	Annual Average O_3 Conc. (ppmv)
El Centro, California	1988	0.12	0.028
El Centro, California	1989	0.11	0.028
El Centro, California	1990	0.11	0.028
El Centro, California	1991	0.11	0.028
Calexico, California (Grant St.)		0.15	0.019
El Centro, California	1992	0.12	0.036
Calexico, California (Grant St.)		0.15	0.037
El Centro, California	1993	0.15	0.036
Calexico, California (Grant St.)		0.21	0.042
El Centro, California	1994	0.13	0.036
Calexico, California (Grant St.)		0.15	0.051
Calexico, California (Ethel St.)		0.13	0.028
El Centro, California	1995	0.15	0.032
Calexico, California (Grant St.)		0.13	0.043
Calexico, California (Ethel St.)		0.23	0.030

Source: CARB

Using the suggested USEPA method as discussed above, the highest estimated 1-hr concentration of NO_2 from the Project mine and process area at any point on or outside of the perimeter fence was 0.23 ppmv, less than the California AAQS of 0.25 ppmv (250 ppbv). The highest annual average ambient NO_2 concentration resulting from the Proposed Action was 0.0116 ppmv, much less than the Federal AAQS of 0.053 ppmv (53 ppbv), at a point well within the Project area. Impacts from the Project mine and process area at the other discrete receptors placed at points of potential public concern were universally modeled at below 0.01 ppmv (10 ppbv) .

A table providing the modeled NO_X concentrations, and the calculations of the 1-hr and annual average NO_2 concentrations from the Proposed Action are provided in Appendices N-1 and N-2 respectively. Appendix K, Plates 5 and 6, provides maps of the fenced boundary of the Project mine and process area (equivalent to the discrete receptors) and contours for the results of the calculated NO_2 concentrations.

2.2.4.5.3. Oxides of Sulfur/Sulfur Dioxide (SO_X/SO_2)

The results of the SO_2 run are presented in Appendix M-4. The modeled 1-hour high SO_2, at a point near the center of the Project mine and process area, was 494.29 µg/m³, well below the California AAQS of 655 µg/m³. All modeled concentrations of SO_2 at points accessible to the public, beyond the boundary of the Project mine and process area, was universally less than 250 µg/m³. Appendix K, Plate 7, provides a map of the fenced boundary of the Project mine and process area (equivalent to the discrete receptors) and contours for the results of the 1-hour model run.

The modeled 3-hour high of SO_2 (also presented in Appendix M-4) at a point near the center of the Project mine and process area, was 263.70 µg/m³, well below the Federal Secondary AAQS of 1,300 µg/m³. All modeled concentrations of SO_2 at points accessible to the public were universally below 150 µg/m³, well below the Federal Secondary AAQS. Appendix K, Plate 8, provides a map of the fenced boundary of the Project mine and process area (equivalent to the discrete receptors) and contours for the results of the 3-hour model run.

The modeled 24-hour high of SO_2 (also presented in Appendix M-3), at a point near the center of the Project mine and process area, was 61.12 µg/m³. The modeled high of SO_2 at a point accessible to the public, a "fence-line" receptor near the southwestern boundary of the Project mine and process area, was 37.1 µg/m³, below both the California and Federal AAQSs (see Table 2). Calculated 24-hour ambient concentrations of SO_2 at distances greater than 3,750 meters (2.3 miles) from the Project mine and process area boundary were universally below 10 µg/m³. Appendix K, Plate 9, provides a map of the fenced boundary of the Project mine and process area (equivalent to the discrete receptors) and contours for the results of the 24-hour high model run.

The results of annual average SO_2 calculated by the run is also presented in Appendix M-4. The modeled high of SO_2, at a point again near the center of the Project mine and process area, was 21.44 µg/m³. The modeled high of SO_2 at a point accessible to the public, again a "fence-line" receptor near the southwestern boundary of the Project mine and process area, was 10.44 µg/m³, well below the Federal annual AAQS (see Table 2). Appendix K, Plate 10, provides a map of the fenced boundary of the Project mine and process area (equivalent to the "fenceline" discrete receptors) and contours for the results of the annual average model run.

2.2.4.5.4. Carbon Monoxide (CO)

The results of the CO run are presented in Appendix M-5. The modeled 1-hour high, at a point near the center of the Project mine and process area, was 2501.18 µg/m³ well below both the California and federal 24-hour AAQSs (see Table 2). In addition, all calculated 1-hour ambient concentrations of CO beyond the Project mine and process area boundary were universally below 1000 µg/m³. Appendix K, Plate 11, provides a map of the fenced boundary of the Project mine and process area (equivalent to the discrete receptors) and contours for the results of the 1-hour concentrations from the CO model run .

The results of 8-hr average CO calculated by the run is also presented in Appendix M-5. The modeled high CO, at a point again near the center of the Project mine and process area, was 992.61 $\mu g/m^3$, also well below both the California and federal annual AAQSs (see Table 2). All modeled concentrations of CO at points accessible to the public, beyond Project mine and process area, were universally below 500 $\mu g/m^3$, well below both the California and federal annual AAQSs (see Table 2). Appendix K, Plate 12, provides a map of the fenced boundary of the Project mine and process area (equivalent to the "fenceline" discrete receptors) and contours for the results of the calculated 8-hr concentrations from the CO model run.

2.2.5. Deposition and Depletion of Suspended Particulate Matter

Deposition of lofted particulate matter from the Proposed Action operations is expected to occur on and around the Project Area. The rate at which particulate matter settles out from the atmosphere is a function of its gravitational settling velocity. Larger particles (those greater than 30 microns in diameter) have sufficient mass to overcome turbulent eddies, and as such settle out much quicker than smaller particles. In order to evaluate the quantity of material potentially deposited on nearby surface and flora in the area, the emissions of total suspended particulates were modeled using the ISCST3 model. The USEPA model has algorithms which simulates the effects of dry and wet deposition of particulates on the surface due to the processes of gravitational settling and turbulent diffusion. The depositional velocity is a function of the meteorology and surface conditions near the source, but it is independent of the distance from the source.

2.2.5.1. Modeled Emission Units and Assumptions

In modeling the deposition of particulate matter, EMA used the same model settings as was used for the criteria pollutant modeling: USEPA's regulatory default model options, rural dispersion parameters, and elevated terrain. In addition, the dry deposition option was enabled.

Given the high gravitational settling velocity of particulate matter greater than 30 microns, only suspendable particulate matter (those less than 30 microns or TSP) were modeled using the same model source parameters as were used in the modeling performed for impacts from PM_{10}, and using annual average emissions of TSP. In addition, the model conservatively assumed that no wet deposition occurred, that no depletion or removal of mass from the plume occurred, and that deposited particulate matter was not re-suspended as a result of additional turbulence or eddies.

2.2.5.2. Receptors

A radial receptor grid consisting of 8 radials with 30 rings spaced at 100-meter intervals was used, roughly centered on the Project mine and process area, and extended approximately 2 kilometers beyond the fenceline. Appendix K, Plate 13, shows the locations of each of these receptors in relation to the Project mine and process area boundary. Consistent with the Cartesian receptors used in the criteria pollutant modeling, elevations for these receptors were imported into the model from USGS DEM data, and interpolated by the Trinity Breeze Interface.

2.2.5.3. Meteorological Data

Consistent with earlier runs, the Yuma/Tucson meteorological data set was used.

2.2.5.4. Results

The modeled annual average deposition values calculated at all points beyond the Project mine and process area boundary were less that six (6.0) grams per square meter (g/m^2). At all points greater than 0.5 kilometers from the boundary, the annual average deposition was less than 2.0 g/m^2. The highest amount of deposition (24.1 g/m^2) occurred at a receptor point located near the center of the Project mine and process area, and the amount of deposited material decreased rapidly as the distance from the source increased. The results of the depositional modeling conducted for the Proposed Action is included as Appendix O of this AQA. Appendix K, Plate 14, provides a map of the fenced boundary of the Project mine and process area (equivalent to the "fenceline" discrete receptors) and contours for the results of the calculated deposition.

2.2.6. Conformity to the California State Implementation Plan (SIP)

Section 176 of the CAA, as amended (42 U.S.C. 7401 et seq.) and regulations under 40 CFR part 51 subpart W, with respect to the conformity of general federal actions to the applicable state implementation plan (SIP) apply to projects within non-attainment areas. Under those authorities, "no department, agency or instrumentality of the Federal Government shall engage in, support in any way or provide financial assistance for, license or permit, or approve any activity which does not conform to an applicable implementation plan". Under CAA 176(c)and 40 CFR part 51 subpart W, a federal agency must make a determination that a federal action conforms to the applicable implementation plan before the action is taken.

As required by the CAAA and the CCAA, in 1992 the ICAPCD filed an air quality attainment plan (AQAP) outlining how the basin would conform to the requirements of the SIP. The ICAPCD AQAP uses emission offsets to prevent net increases in emissions to the air basin. This is implemented by ICAPCD Rule 207, which requires that emissions of nonattainment air pollutants in excess of 137 pounds per day (25 tons per year) from its stationary sources be "offset" with actual net reductions of the same air pollutant or its precursors in excess of the emissions from the Project. Based on the analysis of compliance with Rule 207, the Proposed Action will not emit more than 25 tons per year of any nonattainment pollutant or its precursors, and thus will be in compliance with Rule 207 and conform to the SIP.

2.2.7. Other Air Quality Health Concerns

Coccidioidomycosis ("Valley Fever" or "Desert Fever") is caused by an infection from the fungus, *Coccidiodes immitis*. Spores of this fungus are in the soil of those areas where the disease occurs. According to information from the California Department of Health Services (CDHS), "the soil most likely contaminated with the Coccidiodes spores is the top couple of inches, the lining of rodent burrows, and the soil in and around old Indian camps (CDHS, No date)." Spores are carried by dust in the air, particularly during dust storms, and infection is caused by inhalation of the dust carrying the spores. The CDHS information points out that:

> "Nearly everyone living for many years in areas where coccidioidomycosis occurs becomes exposed to and infected by the fungus that causes the disease... most people never get sick, and ... only two out of every 1,000 individuals infected develop severe illness... Even the mildest 'attack' of coccidioidomycosis confers lifelong immunity (CDHS, No Date)."

Much of Arizona (including Yuma) and portions of San Diego County have been established as endemic areas. In addition, the Northern boundary of Mexico and Baja California is suspected to be endemic for the disease. However, the Imperial Valley has not been established as an endemic area for *coccidioidomycosis*. Moreover, there have been no recorded cases of Valley Fever in Imperial County (Personal Communication: Mr. Thomas Wolfe, Imperial County Department of Health Services, Division of Environmental Health (ICDHS-DEH); May 5, 1997) .

Presuming that the area of the Proposed Action is determined to be endemic for the disease, only the top few inches of soil would be expected to contain the spores (Personal Communication: Dr. C. Talbert, Kern County Health Department, June 6, 1997). This layer of soil would be removed during the first weeks of construction, so any exposure to dust containing the spores would be limited to that time period. Further, heavy application of water during construction and reclamation periods is expected to minimize impact from the spores.

3. REFERENCES

California Air Resources Board, Emission Inventory Branch, 1989. Technical Guidance Document to the Criteria and Guidelines Regulation for AB-2588.

California Department of Health Services, Division of Communicable Disease Control. No Date. Coccidioidomycosis or Valley Fever. Berkeley, California.

Cole, Henry S. and John E. Summerhayes, 1979. "A Review of Techniques Available for Estimating Short Term NO2 Concentrations," Journal of the Air Pollution Control Association, August 1979.

Environmental Solutions, Inc., 1994: Air Quality Analysis for the Mesquite Regional Landfill, March 1994.

Pitts, Dr. James and Dr. Barbara Finlayson-Pitts, 1986: Atmospheric Chemistry: Fundamentals and Experimental Techniques. Wiley-Interscience, New York, New York.

Schulze, Richard H., 1991: Practical Guide to Air Dispersion Modeling. Trinity Consultants, Inc., Dallas, Texas.

South Coast Air Quality Management District (SCAQMD) - Stationary Source Division. 1994. Permit Application Training Program Manual, South Coast Air Quality Management District, Diamond Bar, California.

U.S. Bureau of Land Management and the Imperial County Planning and Building Department, 1994a: Air Quality Assessment Report, Mesquite Regional Landfill (Appendix F), October 1994.

U.S. Environmental Protection Agency. 1995: AP-42; Compilation of Air Pollutant Emission Factors; Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency. 1997a. EPA's Updated Clean Air Standards: A Common Sense Primer. USEPA Website (http://www.epa.gov/airprogm/oar/primer/timeline.htm).

U.S. Environmental Protection Agency. 1997b. Region 9 Federal Class I Areas. USEPA Region 9 Website (http://www.epa.gov/rregion09/air/maps/r9_clss1.html).

Wooley, David R., 1997: Clean Air Act Handbook: A Practical Guide to Compliance (6th Edition). Clark, Boardman, Callaghan, New York.

This page intentionally left blank
for reproduction purposes.

APPENDIX A

MASTER LIST OF SOURCES

Imperial Project
Imperial County, California

Air Pollution Emission Inventory

Master List of All Quantifiable Sources and Pollutants

Emission Unit No.	Emission Unit Description	Pollutants
	Emission Unit Group 1: Mining Activity	
1.001	Drilling - Waste Rock	PM10, PM-Based HAPs
1.002	Drilling - Ore	PM10, PM-Based HAPs
1.003	Blasting - Waste Rock	PM10, PM-Based HAPs
1.004	Explosives Detonation - Waste Rock Blasting	CO, SOx, NOx
1.005	Blasting - Ore	PM10, PM-Based HAPs
1.006	Explosives Detonation - Ore Blasting	CO, SOx, NOx
1.007	Waste Rock Loading	PM10, PM-Based HAPs
1.008	Ore Loading	PM10, PM-Based HAPs
1.009	Waste Rock Dumpting	PM10, PM-Based HAPs
1.010	Ore Dumping	PM10, PM-Based HAPs
1.011	Waste Rock Dozing	PM10, PM-Based HAPs
1.012	Waste Rock Hauling	PM10, PM-Based HAPs
1.013	Ore Hauling	PM10, PM-Based HAPs
1.014	Ammonium Nitrate Prill Silo Loading	PM/PM10
1.015	Ammonium Nitrate Prill Silo Unloading	PM/PM10
1.016	Wind Erosion (Waste Rock Stockpiles)	PM10, PM-Based HAPs
1.017	Wind Erosion (Soil Stockpiles)	PM10, PM-Based HAPs
1.018	Haul Truck (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
1.019	WRS Dozer (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
1.020	Drill Rig (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
1.021	Loader (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
1.022	Clean-up Loader (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
	Emission Unit Group 2: Heap Leaching Activity	
2.001	Portable R-O-M Lime Silo Loading	PM/PM10
2.002	Portable R-O-M Lime Hopper Loading	PM/PM10
2.003	Lime Application to Ore	PM/PM10
2.004	Ore Ripping/Spreading/Dozing	PM10, PM-Based HAPs
2.005	Heap Leach Dozer (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
2.006	Cyanide Application and Leaching	HCN
2.007	Pregnant Solution Pond	HCN
2.008	Barren Solution Pond	HCN
2.009	Wind Erosion (Heap) - Non-Leach	PM10, PM-Based HAPs
2.010	Wind Erosion (Heap) - Leach	PM10, PM-Based HAPs
	Emission Unit Group 3: Process Plant	
3.001	Carbon Adsorption Tank 1	HCN
3.002	Carbon Adsorption Tank 2	HCN
3.003	Carbon Adsorption Tank 3	HCN
3.004	Carbon Adsorption Tank 4	HCN
3.005	Carbon Adsorption Tank 5	HCN
3.006	Acid Wash Tank	HCl
3.007	Cyanide Make-up Tank	HCN
3.008	Strip Tank	HCN
3.009	Electrowinning Cell	HCN
	Emission Unit Group 4: Refining	
4.001	Mercury Retort Furnace (Electric)	HAPs
	Emission Unit Group 5: Laboratory	
5.001	Jaw Crusher	PM10, PM-Based HAPs
5.002	Pulverizer	PM10, PM-Based HAPs

Imperial Project
Air Pollution Emission Inventory
Master List of All Quantifiable Sources and Pollutants

Emission Unit No.	Emission Unit Description	Pollutants
Emission Unit Group 5: Laboratory (Continued)		
5.003	Fume Hood	HCN
5.004	Waste Acid Tank	HCl
Emission Unit Group 6: Shop Area		
6.001	Main Diesel Tank 1	VOCs/ROGs, HAPs
6.002	Street Diesel Tank	VOCs/ROGs, HAPs
6.003	Unleaded Gasoline Tank	VOCs/ROGs, HAPs
6.004	Coolant Tank	VOCs/ROGs, HAPs
Emission Unit Group 7: Mine & Process Area Support Activities		
7.001	Water Truck (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
7.002	Water Truck Traffic	PM10, PM-Based HAPs
7.003	Backup Diesel Generator	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
7.004	Mobile Light Plant - Pit #1	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
7.005	Mobile Light Plant - Pit #2	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
7.006	Mobile Light Plant - Heap	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
7.007	Mobile Light Plant - WRS	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
7.008	Cable Reel Machine	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
7.009	Grading of Road Surface	PM10, PM-Based HAPs
7.010	Grader (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
Emission Unit Group 8: Other Mobile Emission Units		
8.001	On-Site Delivery Truck Traffic	PM10, PM-Based HAPs
8.002	On-Site Delivery Truck (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
8.003	On-Site Light Vehicle Traffic	PM10, PM-Based HAPs
8.004	On-Site Light Vehicle (Combustion)	CO, PM10, VOC/ROGs, SOx, NOx, HAPs
8.005	Off-Site Delivery Truck Traffic	PM10, PM-Based HAPs
8.006	Off-Site Light Vehicle Traffic	PM10, PM-Based HAPs

APPENDIX B

PROJECT INFORMATION - MAXIMUM 24-HOUR OPERATIONS

Imperial Project
Imperial County, California

Air Pollutant Emission Inventory - Daily (24-Hr) Operation

Project Information

Factor	Value	Units	Source
Material moisture content (M) - Ore	3.67	%	Chemgold
Material moisture content (M) - Waste Rock	3.67	%	Chemgold
Material moisture content (M) - Lime	1.00	%	Chemgold
Material silt content (s) - Ore	1.26	%	Chemgold
Material silt content (s) - Waste Rock	1.40	%	Chemgold
Material silt content (s) - Lime	100.00	%	Chemgold
Silt content of road surface material (s) - Project Roads	1.26	%	Chemgold
Sulfur Content of Gas Burned (S) - LPG	0	gr/100 ft3 (gas vapor)	Chemgold
Mined Material	2.00E+05	tons/time	Chemgold
Waste to Ore Ratio	2.000	1.000	Chemgold
Mined Ore	6.67E+04	tons/time	Calc. - Percentage * Throughput
Percentage Ore	33%		Calc. - Ore:Waste Ratio
Mined Waste	1.33E+05	tons/time	Calc. - Percentage * Throughput
Percentage Waste	67%		Calc. - Ore:Waste Ratio
Ore Haul Truck Load Size	320	tons/load	Chemgold
Loads of Ore/Unit Time	208.33	loads/time	Calc. - Mined Ore / tons/load
Waste Rock Haul Truck Load Size	320	tons/load	Chemgold
Loads of Waste Rock/Unit Time	416.67	loads/time	Calc. - Mined Waste / tons/load
Chemgold Operational Hours	354	days/yr	Chemgold
Chemgold Operational Hours	22	hrs/day	Chemgold

Imperial Project
Imperial County, California

Air Pollutant Emission Inventory - Daily (24-Hr) Operation

General Information

Factor	Value	Units	Source
Domes Study NaCN Soln. Temp	2.00	C	Domes Study (1990)
Domes Study NaCN Soln. Vapor Pressure	289.00	mmHg	Domes Study (1990)
Domes Study NaCN Soln. Conc.	65.30	ppm (as CN)	Domes Study (1990)
Domes Study NaCN Soln. pH	11.40		Domes Study (1990)
Domes Study HCN Conc.	0.01	HCN Conc.	Domes Study (1990)
Mean wind speed (U) inside pit	3.00	MPH	Yuma Met Data
Mean wind speed (U)	6.00	MPH	Yuma Met Data
TSP particle size multiplier (PM<30µm)(K_{TSP}) - Drop Sources	0.74	(dimensionless)	AP-42
PM_{10} particle size multiplier (K_{PM10}) - Drop Sources	0.35	(dimensionless)	AP-42
No. days with at least 0.01 in. of precipitation/year (p)	0.00	da/yr	Assume - No Precip. on Worst Case Day
% of time Avg. windspeed greater than 5.4 m/s (f)	9.10	%	Calc. from Met Data (Yuma/Tucson)
Sulfur Content of Gas Burned (S) - Diesel	0.05		CARB Requirement
Diesel Fuel Heat Input Rating	0.133936	mmBTU/gal	AP-42
Molecular Weight of HCN (MW_{HCN})	27.00		CRC Handbook
Molecular Weight of CN (MW_{CN})	26.00		CRC Handbook
Days/Unit Time	1.00	days/time	
Hours/Unit Time	24.00	hours/time	
Months/Unit Time	0.03	months/time	

Imperial Project
Imperial County, California

Air Pollutant Emission Inventory - Daily (24-Hr) Operation

Emission Unit Specific Information

	Factor	Value	Units	Source
Emission Unit Group 1: Mining Activity				
1.001	***Drilling - Waste Rock***			
	Tons of Waste Rock Blasted/Hole	3,303.00	tons/hole	Chemgold
	Holes Drilled/Unit Time	36.67	holes/time	Chemgold
	Emission Control Factor (ECF)	85%	(Water Shrouding, Negative Pressure, Feed Cyclone Separator)	Chemgold
1.002	***Drilling - Ore***			
	Tons of Ore Blasted/Hole	3,303.00	tons/hole	Chemgold
	Holes Drilled/Unit Time	18.33	holes/time	Chemgold
	Emission Control Factor (ECF)	85%	(Water Shrouding, Negative Pressure, Feed Cyclone Separator)	Chemgold
1.003	***Blasting - Waste Rock***			
	Horizontal Area of Blast (A)	56,320	sq.ft.	Chemgold
	Drilled Holes/Blast	55	holes/blast	Chemgold
	Blasts/Unit Time	1.00	blasts/time	Calc. - Holes/time / blasts/hole
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.004	***Explosives Detonation - Waste Rock Blasting***			
	Ammonium Nitrate Used Per Hole (Primary Explosive)	826	lbs/hole	Chemgold
	PETN Used Per Hole (Booster)	1	lbs/hole	Chemgold
	Drilled Holes/Blast	55	holes/blast	Chemgold
	Blasts/Unit Time	1.00	blasts/time	See Above
	Ammonium Nitrate Used Per Unit Time	22.72	tons/time (ANFO)	Calc. - Holes/blast * lbs/hole * blasts/time/2000
	PETN Used Per Unit Time	0.0275	tons/time (PETN)	Calc. - Holes/blast * lbs/hole * blasts/time/2000
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.005	***Blasting - Ore***			
	Horizontal Area of Blast (A)	56,320	sq.ft.	Chemgold
	Drilled Holes/Blast	55	holes/blast	Chemgold
	Blasts/Unit Time	0.00	blasts/time	Calc. - As Above
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.006	***Explosives Detonation - Ore Blasting***			
	Ammonium Nitrate Used Per Hole (Primary Explosive)	826	lbs/hole	Chemgold
	PETN Used Per Hole (Booster)	1	lbs/hole	Chemgold
	Drilled Holes/Blast	55	holes/blast	Chemgold
	Blasts/Unit Time	0.00	blasts/time	See Above
	Ammonium Nitrate Used Per Unit Time	0.00	tons/time (ANFO)	Calc. - Holes/blast * lbs/hole * blasts/time/2000
	PETN Used Per Unit Time	0.00	tons/time (PETN)	Calc. - Holes/blast * lbs/hole * blasts/time/2000

	Factor	Value	Units	Source
1.007	***Waste Rock Loading***			
	Tons Waste Rock/Unit Time	1.33E+05	tons/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.008	***Ore Loading***			
	Tons Ore/Unit Time	6.67E+04	tons/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.009	***Waste Rock Dumping***			
	Tons Waste Rock/Unit Time	1.33E+05	tons/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.010	***Ore Dumping***			
	Tons Ore/Unit Time	6.67E+04	tons/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.011	***Waste Rock Dozing***			
	Hours Dozing/Unit Time	21.42	hours/time	See 1.019
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.012	***Waste Rock Hauling***			
	Vehicle Speed (S) - In-Pit Flat (Loaded)	17.69	MPH	Chemgold
	Vehicle Speed (S) -Pit Ramp (Loaded)	8.50	MPH	Chemgold
	Vehicle Speed (S) -Flat (Loaded)	22.20	MPH	Chemgold
	Vehicle Speed (S) -Up Stockpile (Loaded)	12.30	MPH	Chemgold
	Vehicle Speed (S) -SP Flat (Loaded)	20.80	MPH	Chemgold
	Vehicle Speed (S) -SP Flat (Empty)	28.10	MPH	Chemgold
	Vehicle Speed (S) -Down SP (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -Flat (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -Pit Ramp (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -In-Pit Flat (Empty)	26.25	MPH	Chemgold
	Vehicle Load Weight	320.00	tons	Chemgold
	Loaded Vehicle Weight	530.00	tons	Chemgold
	Empty Vehicle Weight	210.00	tons	Chemgold
	Mean Number of Wheels (w)	6	wheels	Chemgold
	Vehicle Miles Traveled/Load	3.16	VMT/load	Chemgold
	Loads/Unit Time	416.67	loads/time	Project Information
	Vehicle Miles Traveled/Unit Time	1,316.67	VMT/time	Calc. - Loads/time * VMT/Load
	Emission Control Factor (ECF)	98%	(Chemical Trnt/Water)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
1.013	***Ore Hauling***			
	Vehicle Speed (S) -In-Pit Flat (Loaded)	17.69	MPH	Chemgold
	Vehicle Speed (S) -Pit Ramp (Loaded)	8.50	MPH	Chemgold
	Vehicle Speed (S) -Flat (Loaded)	22.20	MPH	Chemgold
	Vehicle Speed (S) -Up Heap (Loaded)	12.30	MPH	Chemgold
	Vehicle Speed (S) -Heap Flat (Loaded)	20.80	MPH	Chemgold
	Vehicle Speed (S) -Heap Flat (Empty)	28.10	MPH	Chemgold
	Vehicle Speed (S) -Down Heap (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -Flat (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -Pit Ramp (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -In-Pit Flat (Empty)	26.25	MPH	Chemgold
	Vehicle Load Weight	320.00	tons	Chemgold
	Loaded Vehicle Weight	530.00	tons	Chemgold
	Empty Vehicle Weight	210.00	tons	Chemgold
	Mean Number of Wheels (w)	6	wheels	Chemgold
	Vehicle Miles Traveled/Load	3.16	VMT/load	Chemgold
	Loads/Unit Time	208.33	loads/time	Project Information
	Vehicle Miles Traveled/Unit Time	658.33	VMT/time	Calc. - Loads/time * VMT/Load
	Emission Control Factor (ECF)	98%	(Chemical Tmt/Water)	Chemgold
1.014	***Ammonium Nitrate Prill Silo Loading***			
	Tons/Delivery	25	tons/delivery	Chemgold
	Deliveries/Unit Time	1.00	deliveries/time	Chemgold - Max. DPD
	Tons/Unit Time	25.00	tons/time	Calc. - del/time * tons/delivery
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.015	***Ammonium Nitrate Prill Silo Unloading***			
	Pounds Used/Hole	826	lbs/hole	Chemgold
	Tons Used/Unit Time	22.72	tons/time	Calc. - holes blasted/time * lbs/hole /2000
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.016	***Wind Erosion (Waste Rock Stockpiles)***			
	Size of Active Waste Rock Stockpile	40	acres	Chemgold
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.017	***Wind Erosion (Soil Stockpiles)***			
	Size of Active Soil Stockpile	10	acres	Chemgold
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
1.018	***Haul Truck (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	87%		Chemgold
	Individual Unit Hours Used/Unit Time	17.75	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.06	1000 gal/hr	Chemgold
	No. Units	8	Units	Chemgold
	Total Fuel Consumption/Unit Time	8.52	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.019	***WRS Dozer (Combustion)***			
	Availability of Individual Units	97%		Chemgold
	Utilization of Individual Units	92%		Chemgold
	Individual Unit Hours Used/Unit Time	21	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.02	1000 gal/hr	Chemgold
	No. Units	1	Unit	Chemgold
	Total Fuel Consumption/Unit Time	0.43	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.020	***Drill Rig (Combustion)***			
	Hours/Hole Drilled	0.67	hours/hole	Chemgold
	Hours/Unit Time	24.00	hours/time	Calc. - holes/time (Proj. Inf.) * hrs/hole
	Fuel Consumption/hour	20	gal/hr	Chemgold
	Fuel Consumption/Unit Time	480	gal/time	Calc. - hrs/time * gal/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.021	***Loader (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	55%		Chemgold
	Individual Unit Hours Used/Unit Time	11	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.048	1000 gal/hr	Chemgold
	No. Units	1	Unit	Chemgold
	Total Fuel Consumption/Unit Time	0.54	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.022	***Clean-up Loader (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	25%		Chemgold
	Individual Unit Hours Used/Unit Time	5	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.028	1000 gal/hr	Chemgold
	No. Units	1	Unit	Chemgold
	Total Fuel Consumption/Unit Time	0.14	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value Units	Source
Emission Unit Group 2: Heap Leaching Activity			
2.001	***Portable R-O-M Lime Silo Loading***		
	Silo Capacity	500 tons	Chemgold
	Tons/Delivery	25 tons/delivery	Chemgold
	Deliveries/Unit Time	2.00 deliveries/time	Calc. - tons/time (2.003) / tons/delivery
	Tons/Unit Time	50.00 tons/time	Calc. - tons/delivery * del./time
	Emission control factor (ECF)	99% (Baghouse)	Chemgold
2.002	***Portable R-O-M Lime Hopper Loading***		
	Tons/Unit Time	50.00 tons/time	See 2.003 Lime Application to Ore
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
2.003	***Lime Application to Ore***		
	Tons/Load of Ore	0.24 tons/load	Chemgold
	Loads of Ore/Unit Time	208.33 loads/time	See 1.008B Ore Hauling
	Tons of Lime Used/Unit Time	50.00 tons/time	Calc. - tons/load * loads/time
	Emission Control Factor (ECF)	70% (Water Sprays)	Chemgold
2.004	***Ore Ripping/Spreading/Dozing***		
	Hours Dozing/Unit Time	21.4 hours/time	See 2.006 Heap Leach Dozer (Comb.)
	Emission Control Factor (ECF)	0% (Uncontrolled)	Chemgold
2.005	***Heap Leach Dozer (Combustion)***		
	Availability of Individual Units	97.0%	Chemgold
	Utilization of Individual Units	92%	Chemgold
	Individual Unit Hours Used/Unit Time	21.4 hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.02 1000 gal/hr	Chemgold
	No. Units	1 Unit	Chemgold
	Total Fuel Consumption/Unit Time	0.43 1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
2.005	***Cyanide Application and Leaching***		
2.009	***Wind Erosion (Heap) - Non-Leach***		
2.010	***Wind Erosion (Heap) - Leach***		
	Size of Heap	329 Acres (Max. Size of Heap)	Chemgold
	Area of Heap Under Leach	20.4 Acres	Chemgold
	Area of Fresh Ore Not Under Leach	20.4 Acres	Chemgold
	Years/Unit Time	0.0027 yr/time	Calc. - Days/time (Proj. Info.) / 365
	Non-Leach Area Emission Control Factor (ECF_{Non})	0% (Uncontrolled)	Chemgold
	Leachate Emission Control Factor (ECF_{Leach})	95% (Heap Under Leach)	Mesquite Landfill EIS
	HCN Emission Control Factor (ECF_{HCN})	0% (Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value Units	Source
2.007	***Pregnant Solution Pond***		
	Surface Area of Pond	54,400 sq. ft.	Chemgold
	Average pH of Pond	10.6	Chemgold
	NaCN Conc. in Pond	25 ppm	Chemgold
	Imperial Soln. Temp.	30 C	Chemgold
	Imperial Soln. Vapor Pressure	796 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	13.27 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	4.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	1 da/time	Project Information
	Emission Control Factor (ECF)	0.00% (Uncontrolled)	Chemgold
2.008	***Barren Solution Pond***		
	Surface Area of Pond	54,400 sq. ft.	Chemgold
	Average pH of Pond	10.6	Chemgold
	NaCN Conc. in Pond	25 ppm	Chemgold
	Imperial Soln. Temp.	28.9 C	Chemgold
	Imperial Soln. Vapor Pressure	795 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	13.27 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	5.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	1 da/time	Project Information
	Emission Control Factor (ECF)	0.00% (Uncontrolled)	Chemgold
Emission Unit Group 3: Process Plant			
3.001-5	***Carbon Adsorption Tanks 1-5***		
	No. Units	5 Units	Chemgold
	Surface Area of Pond	100 sq. ft.	Chemgold
	Average pH of Pond	10.6	Chemgold
	NaCN Conc. in Pond	25 ppm	Chemgold
	Imperial Soln. Temp.	30 C	Chemgold
	Imperial Soln. Vapor Pressure	796 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	13.27 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	4.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	1 da/time	Project Information
	Emission Control Factor (ECF)	0% (Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
3.006	***Acid Wash Tank***			
	Acid strength (%)	5%		Chemgold
	Specific Gravity of HCl	1.16		CRC Handbook
	Weight of H_2O	8.345	#/gal	CRC Handbook
	Consumption - Gal/Month	6,083	gal/mo	Chemgold
	Consumption - Gal/Unit Time	200	gal/time	Calc. - gal/mo * mo/time
	Consumption - Lbs/Unit Time	1,936	lbs/time	Calc. - gal/time * #/gal * Spec. Grav.
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
3.007	***Cyanide Make-up Tank***			
	Surface Area of Pond	113	sq. ft.	Chemgold
	Average pH of Pond	12		Chemgold
	NaCN Conc. in Pond	240,000.00	ppm	Chemgold
	Imperial Soln. Temp.	28.9	C	Chemgold
	Imperial Soln. Vapor Pressure	795	mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	127,346.94	ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	0.00%	HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	1	days/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
3.008	***Strip Tank***			
	Surface Area of Pond	38.50	sq. ft.	Chemgold
	Average pH of Pond	13.5		Chemgold
	NaCN Conc. in Pond	2,000.00	ppm	Chemgold
	Imperial Soln. Temp.	30	C	Chemgold
	Imperial Soln. Vapor Pressure	800	mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	1061.22	ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	0.00%	HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Year Under Leach	1	da/yr	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
3.009	***Electrowinning Cell***			
	Surface Area of Pond	24.00	sq. ft.	Chemgold
	Average pH of Pond	13.5		Chemgold
	NaCN Conc. in Pond	250	ppm	Chemgold
	Imperial Soln. Temp.	369.3	C	Chemgold
	Imperial Soln. Vapor Pressure	825	mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	132.65	ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	0.00%	HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	1	days/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
Emission Unit Group 4: Refining				
4.001	***Mercury Retort Furnace (Electric)***			
	Utilization of Individual Units	25%		Chemgold
	Individual Unit Hours Used/Unit Time	6	hrs/time	Calc. - Util. * hrs/time (Proj. Inf.)
	No. Units	1	Unit	Chemgold
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
	Mercury Emissions in grams/hour	1.87E-03	g/hr	Chemgold
	Mercury Emissions in pounds/hour	4.13E-06	lbs/hr	Calc. - g/hr to lbs/hr conversion
Emission Unit Group 5: Laboratory				
5.001	***Jaw Crusher***			
	Hours/Unit Time	6	hrs/time	Chemgold
	Tons/Hour	0.23	tph	Chemgold
	Tons Processed/Unit Time	1.31	tons/time	Calc. - tph * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
5.002	***Pulverizer***			
	Hours/Unit Time	6	hrs/time	Chemgold
	Tons/Hour	0.23	tph	Chemgold
	Tons Processed/Unit Time	1.31	tons/time	Calc. - tph * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
5.003	***Fume Hood***			
	Surface Area of Pond	0.79	sq. ft.	Chemgold
	Average pH of Pond	12		Chemgold
	NaCN Conc. in Pond	240,000.00	ppm	Chemgold
	Imperial Soln. Temp.	12	C	Chemgold
	Imperial Soln. Vapor Pressure	790	mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	127,346.94	ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	0.00%	HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	1	days/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
5.004	***Waste Acid Tank***	Emissions calculated as part of Emission Unit No. 3.006		

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
	Emission Unit Group 6: Shop Area			
6.001	***Main Diesel Tank 1***			
	Tank Height (Vertical Tank)	20	ft	Chemgold
	Tank Diameter (Vertical Tank)	19	ft	Chemgold
	Liquid Height (Vertical Tank)	19	ft	Chemgold
	Avg. Liquid Height (Vertical Tank)	15	ft	Chemgold
	Working Volume	40,000	gal	Chemgold
	Turnovers/yr	100	turnovers/yr	Calc. - Throughput / tank size
	Throughput	4,016,000	gal/yr	Chemgold
	Standing Losses	7.04	lbs/yr (VOCs)	Calc. - EPA Tanks
	Working Losses	63.85	lbs/yr (VOCs)	Calc. - EPA Tanks
	Total Losses	70.89	lbs/yr (VOCs)	Calc. - EPA Tanks
	Standing Losses	0.02	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	Working Losses	0.17	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	Total Losses	0.19	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
6.002	***Street Diesel Tank***			
	Tank Height (Vertical Tank)	10	ft	Chemgold
	Tank Diameter (Vertical Tank)	6	ft	Chemgold
	Liquid Height (Vertical Tank)	10	ft	Chemgold
	Avg. Liquid Height (Vertical Tank)	8	ft	Chemgold
	Working Volume	2,000	gal	Chemgold
	Turnovers/yr	55	turnovers/yr	Calc. - Throughput / tank size
	Throughput	109,600	gal/yr	Chemgold
	Standing Losses	0.28	lbs/yr (VOCs)	Calc. - EPA Tanks
	Working Losses	2.78	lbs/yr (VOCs)	Calc. - EPA Tanks
	Total Losses	3.06	lbs/yr (VOCs)	Calc. - EPA Tanks
	Standing Losses	0.0008	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	Working Losses	0.0076	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	Total Losses	0.0084	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
6.003	***Unleaded Gasoline Tank***			
	Tank Height (Vertical Tank)	10	ft	Chemgold
	Tank Diameter (Vertical Tank)	6	ft	Chemgold
	Liquid Height (Vertical Tank)	10	ft	Chemgold
	Avg. Liquid Height (Vertical Tank)	7	ft	Chemgold
	Working Volume	2,000	gal	Chemgold
	Turnovers/yr	21	turnovers/yr	Calc. - Throughput / tank size
	Throughput	41,200	gal/yr	Chemgold
	Standing Losses	625.94	lbs/yr (VOCs)	Calc. - EPA Tanks
	Working Losses	563.29	lbs/yr (VOCs)	Calc. - EPA Tanks
	Total Losses	1,189.23	lbs/yr (VOCs)	Calc. - EPA Tanks
	Standing Losses	1.71	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	Working Losses	1.54	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	Total Losses	3.26	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
6.004	***Coolant Tank***			
	Shell Length (Horizontal Tank)	14	ft	Chemgold
	Tank Diameter (Horizontal Tank)	7	ft	Chemgold
	Working Volume	5,000	gal	Chemgold
	Turnovers/yr	1	turnovers/yr	Calc. - Throughput / tank size
	Throughput	5,000.00	gal/yr	Chemgold
	Standing Losses	0.18	lbs/yr (VOCs)	Calc. - EPA Tanks
	Working Losses	0.02	lbs/yr (VOCs)	Calc. - EPA Tanks
	Total Losses	0.20	lbs/yr (VOCs)	Calc. - EPA Tanks
	Standing Losses	0.00049	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	Working Losses	0.00005	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	Total Losses	0.00055	lbs/da (VOCs)	Calc. - lbs/yr / hrs/yr * hrs/da
	% Ethylene Glycol in Fluid	95%		Chemgold
	Emission Unit Group 7: Mine & Process Area Support Activities			
7.001	***Water Truck (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	49%		Chemgold
	Individual Unit Hours Used/Unit Time	10	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.019	1000 gal/hr	Chemgold
	No. Units	2	Unit	Chemgold
	Total Fuel Consumption/Unit Time	0.38	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

	Factor	Value Units	Source
7.002	***Water Truck Traffic***		
	Mean Vehicle Speed (S)	10 MPH	Chemgold
	Mean Vehicle Weight (W)	35 tons	Chemgold
	Mean Number of Wheels (w)	6 wheels	Chemgold
	Vehicle Miles Traveled/Trip	10.00 VMT	Chemgold
	Trips/Unit Time	2 trips/time	Chemgold
	Vehivle Miles Traveled/Unit Time	20 VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	99% (Watering)	Chemgold
7.003	***Backup Diesel Generator***		
	Engine Rating	750 hp	Calculated
	Engine Rating	500 kW	Chemgold
	Hours/Unit Time	0.00 hrs/time	Assumption - Not In Operation
	Fuel Consumption/Hour	9.2 gal/hr	Chemgold
	No. Units	1 units	Chemgold
	Fuel Consumption/Unit Time	0.00 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
7.004-7.007	***Mobile Light Plants***		
	Hours/Unit Time	10.00 hrs/time	Chemgold
	Engine Rating	22 hp	Chemgold
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
7.008	***Cable Reel Machine***		
	Hours/Unit Time	24.00 hrs/time	Chemgold
	Engine Rating	315 hp	Chemgold
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
7.009	***Grading of Road Surface***		
	Speed of Grader	5 MPH	Chemgold
	Hours/Unit Time	18 hours/unit time	Calc. - See Unit 2.005
	Emission control factor (ECF)	98% (Chemical Tmt/Water)	Chemgold
7.010	***Grader (Combustion)***		
	Availability of Individual Units	85%	Chemgold
	Utilization of Individual Units	90%	Chemgold
	Individual Unit Hours Used/Unit Time	18 hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.01 1000 gal/hr	Chemgold
	No. Units	1 Unit	Chemgold
	Total Fuel Consumption/Unit Time	0.18 1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Daily (24-Hr) Operation
Project Variables - Unit Specific

Emission Unit Group 8: Other Mobile Emission Units

	Factor	Value Units	Source
8.001	***On-Site Delivery Truck Traffic***		
8.002	***On-Site Delivery Truck (Combustion)***		
	Mean Vehicle Speed (S)	25 MPH	Chemgold
	Mean Vehicle Weight (W)	35 tons	Chemgold
	Mean Number of Wheels (w)	18 wheels	Chemgold
	Vehicle Miles Traveled/Trip	0.98 VMT	Chemgold
	Trips/Unit Time	4 trips/time	Chemgold
	Vehicle Miles Traveled/Unit Time	4 VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	98% (Chemical Tmt/Water)	Chemgold
8.003	***On-Site Light Vehicle Traffic***		
8.004	***On-Site Light Vehicle (Combustion)***		
	Mean Vehicle Speed (S)	25 MPH	Chemgold
	Mean Vehicle Weight (W)	7.2 tons	Chemgold
	Mean Number of Wheels (w)	5.08 wheels	Chemgold
	Vehicle Miles Traveled/Trip	1.5 VMT	Chemgold
	Trips/Unit Time	147 trips/time	Chemgold
	Vehivle Miles Traveled/Unit Time	221 VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	98% (Chemical Tmt/Water)	Chemgold
8.005	***Off-Site Delivery Truck Traffic***		
	Mean Vehicle Speed (S)	35 MPH	Chemgold
	Mean Vehicle Weight (W)	35 tons	Chemgold
	Mean Number of Wheels (w)	18 wheels	Chemgold
	Vehicle Miles Traveled/Trip	8.33 VMT	Chemgold
	Trips/Unit Time	4 trips/time	Chemgold
	Vehivle Miles Traveled/Unit Time	33 VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	80% (Chemical Stabilizers)	Chemgold
8.006	***Off-Site Light Vehicle Traffic***		
	Mean Vehicle Speed (S)	35 MPH	Chemgold
	Mean Vehicle Weight (W)	7.2 tons	Chemgold
	Mean Number of Wheels (w)	4 wheels	Chemgold
	Vehicle Miles Traveled/Trip	8.33 VMT	Chemgold
	Trips/Unit Time	155 trips/time	Chemgold
	Vehivle Miles Traveled/Unit Time	1,291 VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	80% (Chemical Stabilizers)	Chemgold

Metals Analysis

Ore-Based HAPs Emissions

Hazardous Air Pollutant	Analytical Results (ppm)	Calculated Emission Factor (lbs/lb)	Hazardous Air Pollutant	Analytical Results (ppm)	Calculated Emission Factor (lbs/lb)
Antimony (Sb)	32.80	3.28E-05	Lead (Pb)	13.25	1.33E-05
Arsenic (As)	179.75	1.80E-04	Manganese (Mn)	777.25	7.77E-04
Beryllium (Be)	2.00	2.00E-06	Mercury (Hg)	0.40	4.01E-07
Cadmium (Cd)	5.50	5.50E-06	Nickel (Ni)	25.00	2.50E-05
Chromium (Cr)	80.00	8.00E-05	Selenium (Se)	5.00	5.00E-06
Cobalt (Co)	11.50	1.15E-05			

Waste-Based HAPs Emissions

Hazardous Air Pollutant	Analytical Results (ppm)	Calculated Emission Factor (lbs/lb)	Hazardous Air Pollutant	Analytical Results (ppm)	Calculated Emission Factor (lbs/lb)
Antimony (Sb)	13.16	1.32E-05	Lead (Pb)	5.00	5.00E-06
Arsenic (As)	59.33	5.93E-05	Manganese (Mn)	607.67	6.08E-04
Beryllium (Be)	2.00	2.00E-06	Mercury (Hg)	0.40	3.97E-07
Cadmium (Cd)	5.00	5.00E-06	Nickel (Ni)	20.00	2.00E-05
Chromium (Cr)	109.00	1.09E-04	Selenium (Se)	5.00	5.00E-06
Cobalt (Co)	13.67	1.37E-05			

(Source: Bondar-Clegg Geotechnical Lab Report, 1995)

APPENDIX C

PROJECT INFORMATION - ANNUAL OPERATIONS

Imperial Project
Imperial County, California

Air Pollutant Emission Inventory - Annual Operation

Project Information

Factor	Value	Units	Source
Material moisture content (M) - Ore	3.67	%	Chemgold
Material moisture content (M) - Waste Rock	3.67	%	Chemgold
Material moisture content (M) - Lime	1.00	%	Chemgold
Material silt content (s) - Ore	1.26	%	Chemgold
Material silt content (s) - Waste Rock	1.40	%	Chemgold
Material silt content (s) - Lime	100.00	%	Chemgold
Silt content of road surface material (s) - Project Roads	1.26	%	Chemgold
Sulfur Content of Gas Burned (S) - LPG	0	gr/100 ft3 (gas vapor)	Chemgold
Total Amount Mined Material	4.75E+07	tons/time	Chemgold
Waste to Ore Ratio	2.000	1.000	Chemgold
Mined Ore	1.58E+07	tons/time	Calc. - Percentage * Throughput
Percentage Ore	33%		Calc. - Ore:Waste Ratio
Mined Waste	3.16E+07	tons/time	Calc. - Percentage * Throughput
Percentage Waste	67%		Calc. - Ore:Waste Ratio
Ore Haul Truck Load Size	320	tons/load	Chemgold
Loads of Ore/Unit Time	49,427.08	loads/time	Calc. - Mined Ore / tons/load
Waste Rock Haul Truck Load Size	320	tons/load	Chemgold
Loads of Waste Rock/Unit Time	98,854.17	loads/time	Calc. - Mined Waste / tons/load
Chemgold Operational Hours	354	days/yr	Chemgold
Chemgold Operational Hours	22	hrs/day	Chemgold

Imperial Project
Imperial County, California

Air Pollutant Emission Inventory - Annual Operation

General Information

Factor	Value	Units	Source
Domes Study NaCN Soln. Temp	2.00	C	Domes Study (1990)
Domes Study NaCN Soln. Vapor Pressure	289.00	mmHg	Domes Study (1990)
Domes Study NaCN Soln. Conc.	65.30	ppm (as CN)	Domes Study (1990)
Domes Study NaCN Soln. pH	11.40		Domes Study (1990)
Domes Study HCN Conc.	0.01	HCN Conc.	Domes Study (1990)
Mean wind speed (U) inside pit	3.00	MPH	Yuma Met Data
Mean wind speed (U)	6.00	MPH	Yuma Met Data
TSP particle size multiplier (PM<30μm)(K_{TSP}) - Drop Sources	0.74	(dimensionless)	AP-42
PM_{10} particle size multiplier (K_{PM10}) - Drop Sources	0.35	(dimensionless)	AP-42
No. days with at least 0.01 in. of precipitation/year (p)	8.00	da/yr	AP-42
% of time Avg. windspeed greater than 5.4 m/s (f)	9.10	%	Calc. from Met Data (Yuma/Tucson)
Sulfur Content of Gas Burned (S) - Diesel	0.05		CARB Requirement
Diesel Fuel Heat Input Rating	0.133936	mmBTU/gal	AP-42
Molecular Weight of HCN (MW_{HCN})	27.00		CRC Handbook
Molecular Weight of CN (MW_{CN})	26.00		CRC Handbook
Days/Unit Time	365.00	days/time	
Hours/Unit Time	8760.00	hours/time	
Months/Unit Time	12.00	months/time	

Imperial Project
Imperial County, California

Air Pollutant Emission Inventory - Annual Operation

Emission Unit Specific Information

	Factor	Value	Units	Source
	Emission Unit Group 1: Mining Activity			
1.001	***Drilling - Waste Rock***			
	Tons of Waste Rock Blasted/Hole	3,303.00	tons/hole	Chemgold
	Holes Drilled/Unit Time	9,577.15	holes/time	Chemgold
	Emission Control Factor (ECF)	85%	(Water Shrouding, Negative Pressure, Feed Cyclone Separator)	Chemgold
1.002	***Drilling - Ore***			
	Tons of Ore Blasted/Hole	3,303.00	tons/hole	Chemgold
	Holes Drilled/Unit Time	4,788.58	holes/time	Chemgold
	Emission Control Factor (ECF)	85%	(Water Shrouding, Negative Pressure, Feed Cyclone Separator)	Chemgold
1.003	***Blasting - Waste Rock***			
	Horizontal Area of Blast (A)	56,320	sq.ft.	Chemgold
	Drilled Holes/Blast	55	holes/blast	Chemgold
	Blasts/Unit Time	174.13	blasts/time	Calc. - Holes/time / holes/blast
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.004	***Explosives Detonation - Waste Rock Blasting***			
	Ammonium Nitrate Used Per Hole (Primary Explosive)	826	lbs/hole	Chemgold
	PETN Used Per Hole (Booster)	1	lbs/hole	Chemgold
	Drilled Holes/Blast	55	holes/blast	Chemgold
	Blasts/Unit Time	174.13	blasts/time	See Above
	Ammonium Nitrate Used Per Unit Time	3,955.36	tons/time (ANFO)	Calc. - Holes/blast * lbs/hole * blasts/time/2000
	PETN Used Per Unit Time	4.79	tons/time (PETN)	Calc. - Holes/blast * lbs/hole * blasts/time/2000
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.005	***Blasting - Ore***			
	Horizontal Area of Blast (A)	56,320	sq.ft.	Chemgold
	Drilled Holes/Blast	55	holes/blast	Chemgold
	Blasts/Unit Time	87.07	blasts/time	Calc. - As Above
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.005	***Explosives Detonation - Ore Blasting***			
	Ammonium Nitrate Used Per Hole (Primary Explosive)	826	lbs/hole	Chemgold
	PETN Used Per Hole (Booster)	1	lbs/hole	Chemgold
	Drilled Holes/Blast	55	holes/blast	Chemgold
	Blasts/Unit Time	87.07	blasts/time	See Above
	Ammonium Nitrate Used Per Unit Time	1977.68	tons/time (ANFO)	Calc. - Holes/blast * lbs/hole * blasts/time/2000
	PETN Used Per Unit Time	2.39	tons/time (PETN)	Calc. - Holes/blast * lbs/hole * blasts/time/2000

Imperial Project
Air Pollutant Emission Inventory - Annual Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
1.007	***Waste Rock Loading***			
	Tons Waste Rock/Unit Time	3.16E+07	tons/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.008	***Ore Loading***			
	Tons Ore/Unit Time	1.58E+07	tons/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.009	***Waste Rock Dumping***			
	Tons Waste Rock/Unit Time	3.16E+07	tons/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.010	***Ore Dumping***			
	Tons Ore/Unit Time	1.58E+07	tons/time	Project Information
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.011	***Waste Rock Dozing***			
	Hours Dozing/Unit Time	7,817.42	hours/time	See 1.019
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.012	***Waste Rock Hauling***			
	Vehicle Speed (S) - In-Pit Flat (Loaded)	17.69	MPH	Chemgold
	Vehicle Speed (S) -Pit Ramp (Loaded)	8.50	MPH	Chemgold
	Vehicle Speed (S) -Flat (Loaded)	22.20	MPH	Chemgold
	Vehicle Speed (S) -Up Stockpile (Loaded)	12.30	MPH	Chemgold
	Vehicle Speed (S) -SP Flat (Loaded)	20.80	MPH	Chemgold
	Vehicle Speed (S) -SP Flat (Empty)	28.10	MPH	Chemgold
	Vehicle Speed (S) -Down SP (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -Flat (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -Pit Ramp (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -In-Pit Flat (Empty)	26.25	MPH	Chemgold
	Vehicle Load Weight	320.00	tons	Chemgold
	Loaded Vehicle Weight	530.00	tons	Chemgold
	Empty Vehicle Weight	210.00	tons	Chemgold
	Mean Number of Wheels (w)	6	wheels	Chemgold
	Vehicle Miles Traveled/Load	3.16	VMT/load	Chemgold
	Loads/Unit Time	98,854.17	loads/time	Project Information
	Vehicle Miles Traveled/Unit Time	312,379.17	VMT/time	Calc. - Loads/time * VMT/Load
	Emission Control Factor (ECF)	98%	(Chemical Trnt/Water)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Annual Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
1.013	***Ore Hauling***			
	Vehicle Speed (S) -In-Pit Flat (Loaded)	17.69	MPH	Chemgold
	Vehicle Speed (S) -Pit Ramp (Loaded)	8.50	MPH	Chemgold
	Vehicle Speed (S) -Flat (Loaded)	22.20	MPH	Chemgold
	Vehicle Speed (S) -Up Heap (Loaded)	12.30	MPH	Chemgold
	Vehicle Speed (S) -Heap Flat (Loaded)	20.80	MPH	Chemgold
	Vehicle Speed (S) -Heap Flat (Empty)	28.10	MPH	Chemgold
	Vehicle Speed (S) -Down Heap (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -Flat (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -Pit Ramp (Empty)	35.00	MPH	Chemgold
	Vehicle Speed (S) -In-Pit Flat (Empty)	26.25	MPH	Chemgold
	Vehicle Load Weight	320.00	tons	Chemgold
	Loaded Vehicle Weight	530.00	tons	Chemgold
	Empty Vehicle Weight	210.00	tons	Chemgold
	Mean Number of Wheels (w)	6	wheels	Chemgold
	Vehicle Miles Traveled/Load	3.16	VMT/load	Chemgold
	Loads/Unit Time	49,427.08	loads/time	Project Information
	Vehicle Miles Traveled/Unit Time	156,189.58	VMT/time	Calc. - Loads/time * VMT/Load
	Emission Control Factor (ECF)	98%	(Chemical Trnt/Water)	Chemgold
1.014	***Ammonium Nitrate Prill Silo Loading***			
	Tons/Delivery	25	tons/delivery	Chemgold
	Deliveries/Unit Time	237.32	deliveries/time	Calc. - tons/time (1.015) / tons/del.
	Tons/Unit Time	5,933.05	tons/time	Calc. - del/time * tons/delivery
	Emission Control Factor (ECF)	0%	(Uncontrolled)	Chemgold
1.015	***Ammonium Nitrate Prill Silo Unloading***			
	Pounds Used/Hole	826	lbs/hole	Chemgold
	Tons Used/Unit Time	5,933.05	tons/time	Calc. - holes blasted/time * lbs/hole /2000
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.016	***Wind Erosion (Waste Rock Stockpiles)***			
	Size of Active Waste Rock Stockpile	40	acres	Chemgold
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.017	***Wind Erosion (Soil Stockpiles)***			
	Size of Active Soil Stockpile	10	acres	Chemgold
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Annual Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
1.018	***Haul Truck (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	87%		Chemgold
	Individual Unit Hours Used/Unit Time	6,478.02	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.06	1000 gal/hr	Chemgold
	No. Units	8	Units	Chemgold
	Total Fuel Consumption/Unit Time	3,109.45	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.019	***WRS Dozer (Combustion)***			
	Availability of Individual Units	97%		Chemgold
	Utilization of Individual Units	92%		Chemgold
	Individual Unit Hours Used/Unit Time	7,817	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.02	1000 gal/hr	Chemgold
	No. Units	1	Unit	Chemgold
	Total Fuel Consumption/Unit Time	156.35	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.020	***Drill Rig (Combustion)***			
	Hours/Hole Drilled	0.67	hours/hole	Chemgold
	Hours/Unit Time	9,625.04	hours/time	Calc. - holes/time (Proj. Inf.) * hrs/hole
	Fuel Consumption/hour	20	gal/hr	Chemgold
	Fuel Consumption/Unit Time	192,501	gal/time	Calc. - hrs/time * gal/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.021	***Loader (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	55%		Chemgold
	Individual Unit Hours Used/Unit Time	4,095	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.048	1000 gal/hr	Chemgold
	No. Units	1	Unit	Chemgold
	Total Fuel Consumption/Unit Time	196.57	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
1.022	***Clean-up Loader (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	25%		Chemgold
	Individual Unit Hours Used/Unit Time	1,862	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.028	1000 gal/hr	Chemgold
	No. Units	1	Unit	Chemgold
	Total Fuel Consumption/Unit Time	52.12	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold

	Factor	Value Units	Source
Emission Unit Group 2: Heap Leaching Activity			
2.001	***Portable R-O-M Lime Silo Loading***		
	Silo Capacity	500 tons	Chemgold
	Tons/Delivery	25 tons/delivery	Chemgold
	Deliveries/Unit Time	474.50 deliveries/time	Calc. - tons/time (2.003) / tons/delivery
	Tons/Unit Time	11,862.50 tons/time	Calc. - tons/delivery * del./time
	Emission control factor (ECF)	99% (Baghouse)	Chemgold
2.002	***Portable R-O-M Lime Hopper Loading***		
	Tons/Unit Time	11,862.50 tons/time	See 2.003 Lime Application to Ore
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
2.003	***Lime Application to Ore***		
	Tons/Load of Ore	0.24 tons/load	Chemgold
	Loads of Ore/Unit Time	49,427.08 loads/time	See 1.008B Ore Hauling
	Tons of Lime Used/Unit Time	11,862.50 tons/time	Calc. - tons/load * loads/time
	Emission Control Factor (ECF)	70% (Water Sprays)	Chemgold
2.004	***Ore Ripping/Spreading/Dozing***		
	Hours Dozing/Unit Time	7,817.4 hours/time	See 2.006 Heap Leach Dozer (Comb.)
	Emission Control Factor (ECF)	0% (Uncontrolled)	Chemgold
2.005	***Heap Leach Dozer (Combustion)***		
	Availability of Individual Units	97.0%	Chemgold
	Utilization of Individual Units	92%	Chemgold
	Individual Unit Hours Used/Unit Time	7,817.4 hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.02 1000 gal/hr	Chemgold
	No. Units	1 Unit	Chemgold
	Total Fuel Consumption/Unit Time	156.35 1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
2.006	***Cyanide Application and Leaching***		
2.009	***Wind Erosion (Heap) - Non-Leach***		
2.010	***Wind Erosion (Heap) - Leach***		
	Size of Heap	329 Acres (Max. Size of Heap)	Chemgold
	Area of Heap Under Leach	20.4 Acres	Chemgold
	Area of Fresh Ore Not Under Leach	20.4 Acres	Chemgold
	Years/Unit Time	1.00 yr/time	Calc. - Days/time (Proj. Info.) / 365
	Non-Leach Area Emission Control Factor (ECF_{Non})	0% (Uncontrolled)	Chemgold
	Leachate Emission Control Factor (ECF_{Leach})	95% (Heap Under Leach)	Mesquite Landfill EIS
	HCN Emission Control Factor (ECF_{HCN})	0% (Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Annual Operation
Project Variables - Unit Specific

	Factor	Value Units	Source
2.007	***Pregnant Solution Pond***		
	Surface Area of Pond	54,400 sq. ft.	Chemgold
	Average pH of Pond	10.6	Chemgold
	NaCN Conc. in Pond	25 ppm	Chemgold
	Imperial Soln. Temp.	30 C	Chemgold
	Imperial Soln. Vapor Pressure	796 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	13.27 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	4.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	365 da/time	Project Information
	Emission Control Factor (ECF)	0.00% (Uncontrolled)	Chemgold
2.008	***Barren Solution Pond***		
	Surface Area of Pond	54,400 sq. ft.	Chemgold
	Average pH of Pond	10.6	Chemgold
	NaCN Conc. in Pond	25 ppm	Chemgold
	Imperial Soln. Temp.	28.9 C	Chemgold
	Imperial Soln. Vapor Pressure	795 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	13.27 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	4.75% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	365 da/time	Project Information
	Emission Control Factor (ECF)	0.00% (Uncontrolled)	Chemgold
Emission Unit Group 3: Process Plant			
3.001-5	***Carbon Adsorption Tanks 1-5***		
	No. Units	5 Units	Chemgold
	Surface Area of Pond	100 sq. ft.	Chemgold
	Average pH of Pond	10.6	Chemgold
	NaCN Conc. in Pond	25 ppm	Chemgold
	Imperial Soln. Temp.	30 C	Chemgold
	Imperial Soln. Vapor Pressure	796 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	13.27 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	4.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	365 da/time	Project Information
	Emission Control Factor (ECF)	0% (Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Annual Operation
Project Variables - Unit Specific

	Factor	Value Units	Source
3.006	***Acid Wash Tank***		
	Acid strength (%)	5%	Chemgold
	Specific Gravity of HCl	1.18	CRC Handbook
	Weight of H_2O	8.345 #/gal	CRC Handbook
	Consumption - Gal/Month	6,083 gal/mo	Chemgold
	Consumption - Gal/Unit Time	72,996 gal/time	Calc. - gal/mo * mo/time
	Consumption - Lbs/Unit Time	706,616 lbs/time	Calc. - gal/time * #/gal * Spec. Grav.
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
3.007	***Cyanide Make-up Tank***		
	Surface Area of Pond	113 sq. ft.	Chemgold
	Average pH of Pond	12	Chemgold
	NaCN Conc. in Pond	240,000.00 ppm	Chemgold
	Imperial Soln. Temp.	28.9 C	Chemgold
	Imperial Soln. Vapor Pressure	795 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	127,346.94 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	0.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	365 days/time	Project Information
	Emission Control Factor (ECF)	0% (Uncontrolled)	Chemgold
3.008	***Strip Tank***		
	Surface Area of Pond	38.50 sq. ft.	Chemgold
	Average pH of Pond	13.5	Chemgold
	NaCN Conc. in Pond	2,000.00 ppm	Chemgold
	Imperial Soln. Temp.	30 C	Chemgold
	Imperial Soln. Vapor Pressure	800 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	1061.22 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	0.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Year Under Leach	365 da/yr	Project Information
	Emission Control Factor (ECF)	0% (Uncontrolled)	Chemgold
3.009	***Electrowinning Cell***		
	Surface Area of Pond	24.00 sq. ft.	Chemgold
	Average pH of Pond	13.5	Chemgold
	NaCN Conc. in Pond	250 ppm	Chemgold
	Imperial Soln. Temp.	369.3 C	Chemgold
	Imperial Soln. Vapor Pressure	825 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	132.65 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	0.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	365 days/time	Project Information
	Emission Control Factor (ECF)	0% (Uncontrolled)	Chemgold

Imperial Project
Air Pollutant Emission Inventory - Annual Operation
Project Variables - Unit Specific

	Factor	Value Units	Source
	Emission Unit Group 4: Refining		
4.001	***Mercury Retort Furnace (Electric)***		
	Utilization of Individual Units	25%	Chemgold
	Individual Unit Hours Used/Unit Time	2,190 hrs/time	Calc. - Util. * hrs/time (Proj. Inf.)
	No. Units	1 Unit	Chemgold
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
	Mercury Emissions in grams/hour	1.87E-03 g/hr	Chemgold
	Mercury Emissions in pounds/hour	4.13E-06 lbs/hr	Calc. - g/hr to lbs/hr conversion
	Emission Unit Group 5: Laboratory		
5.001	***Jaw Crusher***		
	Hours/Unit Time	2,080 hrs/time	Chemgold
	Tons/Hour	0.23 tph	Chemgold
	Tons Processed/Unit Time	478.40 tons/time	Calc. - tph * hrs/time
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
5.002	***Pulverizer***		
	Hours/Unit Time	2,080 hrs/time	Chemgold
	Tons/Hour	0.23 tph	Chemgold
	Tons Processed/Unit Time	478.40 tons/time	Calc. - tph * hrs/time
	Emission control factor (ECF)	0% (Uncontrolled)	Chemgold
5.003	***Fume Hood***		
	Surface Area of Pond	0.79 sq. ft.	Chemgold
	Average pH of Pond	12	Chemgold
	NaCN Conc. in Pond	240,000.00 ppm	Chemgold
	Imperial Soln. Temp.	12 C	Chemgold
	Imperial Soln. Vapor Pressure	790 mmHg	Calc. - Vapor Press. of HCN @ Temp.
	Imperial Soln. Conc.	127,346.94 ppm (as CN)	Calc. - CN Conc. at NaCN Soln. Conc.
	Imperial HCN Conc.	0.00% HCN Conc.	Calc. - Volatilization Curve (Domes)
	Days/Unit Time	365 days/time	Project Information
	Emission Control Factor (ECF)	0% (Uncontrolled)	Chemgold
5.004	***Waste Acid Tank***		
	Emissions calculated as part of Emission Unit No. 3.006		

Imperial Project
Air Pollutant Emission Inventory - Annual Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
Emission Unit Group 6: Shop Area				
6.001	***Main Diesel Tank 1***			
	Tank Height (Vertical Tank)	20	ft	Chemgold
	Tank Diameter (Vertical Tank)	19	ft	Chemgold
	Liquid Height (Vertical Tank)	19	ft	Chemgold
	Avg. Liquid Height (Vertical Tank)	15	ft	Chemgold
	Working Volume	40,000	gal	Chemgold
	Turnovers/yr	100	turnovers/yr	Calc. - Throughput / tank size
	Throughput	4,016,000	gal/yr	Chemgold
	Standing Losses	7.04	lbs/yr (VOCs)	Calc. - EPA Tanks
	Working Losses	63.85	lbs/yr (VOCs)	Calc. - EPA Tanks
	Total Losses	70.89	lbs/yr (VOCs)	Calc. - EPA Tanks
6.002	***Street Diesel Tank***			
	Tank Height (Vertical Tank)	10	ft	Chemgold
	Tank Diameter (Vertical Tank)	6	ft	Chemgold
	Liquid Height (Vertical Tank)	10	ft	Chemgold
	Avg. Liquid Height (Vertical Tank)	8	ft	Chemgold
	Working Volume	2,000	gal	Chemgold
	Turnovers/yr	55	turnovers/yr	Calc. - Throughput / tank size
	Throughput	109,600	gal/yr	Chemgold
	Standing Losses	0.28	lbs/yr (VOCs)	Calc. - EPA Tanks
	Working Losses	2.78	lbs/yr (VOCs)	Calc. - EPA Tanks
	Total Losses	3.06	lbs/yr (VOCs)	Calc. - EPA Tanks
6.003	***Unleaded Gasoline Tank***			
	Tank Height (Vertical Tank)	10	ft	Chemgold
	Tank Diameter (Vertical Tank)	6	ft	Chemgold
	Liquid Height (Vertical Tank)	10	ft	Chemgold
	Avg. Liquid Height (Vertical Tank)	7	ft	Chemgold
	Working Volume	2,000	gal	Chemgold
	Turnovers/yr	21	turnovers/yr	Calc. - Throughput / tank size
	Throughput	41,200	gal/yr	Chemgold
	Standing Losses	625.94	lbs/yr (VOCs)	Calc. - EPA Tanks
	Working Losses	563.29	lbs/yr (VOCs)	Calc. - EPA Tanks
	Total Losses	1,189.23	lbs/yr (VOCs)	Calc. - EPA Tanks

Imperial Project
Air Pollutant Emission Inventory - Annual Operation
Project Variables - Unit Specific

	Factor	Value	Units	Source
6.004	***Coolant Tank***			
	Shell Length (Horizontal Tank)	14	ft	Chemgold
	Tank Diameter (Horizontal Tank)	7	ft	Chemgold
	Working Volume	5,000	gal	Chemgold
	Turnovers/yr	1	turnovers/yr	Calc. - Throughput / tank size
	Throughput	5,000.00	gal/yr	Chemgold
	Standing Losses	0.18	lbs/yr (VOCs)	Calc. - EPA Tanks
	Working Losses	0.02	lbs/yr (VOCs)	Calc. - EPA Tanks
	Total Losses	0.20	lbs/yr (VOCs)	Calc. - EPA Tanks
	% Ethylene Glycol in Fluid	95%		Chemgold
Emission Unit Group 7: Mine & Process Area Support Activities				
7.001	***Water Truck (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	49%		Chemgold
	Individual Unit Hours Used/Unit Time	3,649	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.019	1000 gal/hr	Chemgold
	No. Units	2	Unit	Chemgold
	Total Fuel Consumption/Unit Time	138.64	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
7.002	***Water Truck Traffic***			
	Mean Vehicle Speed (S)	10	MPH	Chemgold
	Mean Vehicle Weight (W)	35	tons	Chemgold
	Mean Number of Wheels (w)	6	wheels	Chemgold
	Vehicle Miles Traveled/Trip	10.00	VMT	Chemgold
	Trips/Unit Time	730	trips/time	Chemgold
	Vehivle Miles Traveled/Unit Time	7,300	VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	99%	(Watering)	Chemgold
7.003	***Backup Diesel Generator***			
	Engine Rating	750	hp	Calculated
	Engine Rating	500	kW	Chemgold
	Hours/Unit Time	200.00	hrs/time	Assumption - Not In Operation
	Fuel Consumption/Hour	9.2	gal/hr	Chemgold
	No. Units	1	units	Chemgold
	Fuel Consumption/Unit Time	1,840.00	gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
7.004-7.007	***Mobile Light Plants***			
	Hours/Unit Time	3,650.00	hrs/time	Chemgold
	Engine Rating	22	hp	Chemgold
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold

	Factor	Value	Units	Source
7.006	***Cable Reel Machine***			
	Hours/Unit Time	8,760.00	hrs/time	Chemgold
	Engine Rating	315	hp	Chemgold
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
7.009	***Grading of Road Surface***			
	Speed of Grader	5	MPH	Chemgold
	Hours/Unit Time	6,701	hours/unit time	Calc. - See Unit 2.005
	Emission control factor (ECF)	98%	(Chemical Tmt/Water)	Chemgold
7.010	***Grader (Combustion)***			
	Availability of Individual Units	85%		Chemgold
	Utilization of Individual Units	90%		Chemgold
	Individual Unit Hours Used/Unit Time	6,701	hrs/time	Calc. - Avail. * Util. * hrs/time (Proj. Inf.)
	Individual Unit Fuel Consumption/Hour	0.01	1000 gal/hr	Chemgold
	No. Units	1	Unit	Chemgold
	Total Fuel Consumption/Unit Time	67.01	1000 gal/time	Calc. - fuel use/hr * units * hrs/time
	Emission control factor (ECF)	0%	(Uncontrolled)	Chemgold
Emission Unit Group 8: Other Mobile Emission Units				
8.001	***On-Site Delivery Truck Traffic***			
8.002	***On-Site Delivery Truck (Combustion)***			
	Mean Vehicle Speed (S)	25	MPH	Chemgold
	Mean Vehicle Weight (W)	35	tons	Chemgold
	Mean Number of Wheels (w)	18	wheels	Chemgold
	Vehicle Miles Traveled/Trip	0.98	VMT	Chemgold
	Trips/Unit Time	1,460	trips/time	Chemgold
	Vehicle Miles Traveled/Unit Time	1,431	VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	98%	(Chemical Tmt/Water)	Chemgold
8.003	***On-Site Light Vehicle Traffic***			
8.004	***On-Site Light Vehicle (Combustion)***			
	Mean Vehicle Speed (S)	25	MPH	Chemgold
	Mean Vehicle Weight (W)	7.2	tons	Chemgold
	Mean Number of Wheels (w)	5.08	wheels	Chemgold
	Vehicle Miles Traveled/Trip	1.5	VMT	Chemgold
	Trips/Unit Time	53,655	trips/time	Chemgold
	Vehivle Miles Traveled/Unit Time	80,483	VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	98%	(Chemical Tmt/Water)	Chemgold

	Factor	Value	Units	Source
8.005	***Off-Site Delivery Truck Traffic***			
	Mean Vehicle Speed (S)	35	MPH	Chemgold
	Mean Vehicle Weight (W)	35	tons	Chemgold
	Mean Number of Wheels (w)	18	wheels	Chemgold
	Vehicle Miles Traveled/Trip	8.33	VMT	Chemgold
	Trips/Unit Time	1,460	trips/time	Chemgold
	Vehivle Miles Traveled/Unit Time	12,162	VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	80%	(Chemical Stabilizers)	Chemgold
8.006	***Off-Site Light Vehicle Traffic***			
	Mean Vehicle Speed (S)	35	MPH	Chemgold
	Mean Vehicle Weight (W)	7.2	tons	Chemgold
	Mean Number of Wheels (w)	4	wheels	Chemgold
	Vehicle Miles Traveled/Trip	8.33	VMT	Chemgold
	Trips/Unit Time	56,576	trips/time	Chemgold
	Vehivle Miles Traveled/Unit Time	471,278	VMT/Unit Time	Calc. - VMT * trips/time
	Emission Control Factor (ECF)	80%	(Chemical Stabilizers)	Chemgold

Metals Analysis

Ore-Based HAPs Emissions

Hazardous Air Pollutant	Analytical Results (ppm)	Calculated Emission Factor (lbs/lb)	Hazardous Air Pollutant	Analytical Results (ppm)	Calculated Emission Factor (lbs/lb)
Antimony (Sb)	32.80	3.28E-05	Lead (Pb)	13.25	1.33E-05
Arsenic (As)	179.75	1.80E-04	Manganese (Mn)	777.25	7.77E-04
Beryllium (Be)	2.00	2.00E-06	Mercury (Hg)	0.40	4.01E-07
Cadmium (Cd)	5.50	5.50E-06	Nickel (Ni)	25.00	2.50E-05
Chromium (Cr)	80.00	8.00E-05	Selenium (Se)	5.00	5.00E-06
Cobalt (Co)	11.50	1.15E-05			

Waste-Based HAPs Emissions

Hazardous Air Pollutant	Analytical Results (ppm)	Calculated Emission Factor (lbs/lb)	Hazardous Air Pollutant	Analytical Results (ppm)	Calculated Emission Factor (lbs/lb)
Antimony (Sb)	13.16	1.32E-05	Lead (Pb)	5.00	5.00E-06
Arsenic (As)	59.33	5.93E-05	Manganese (Mn)	607.67	6.08E-04
Beryllium (Be)	2.00	2.00E-06	Mercury (Hg)	0.40	3.97E-07
Cadmium (Cd)	5.00	5.00E-06	Nickel (Ni)	20.00	2.00E-05
Chromium (Cr)	109.00	1.09E-04	Selenium (Se)	5.00	5.00E-06
Cobalt (Co)	13.67	1.37E-05			

(Source: Bondar-Clegg Geotechnical Lab Report, 1995)

APPENDIX D

EMISSION CALCULATIONS - MAXIMUM 24-HOUR OPERATIONS

Calculations - 24-Hr Operations

Drilling Sources
(Emission Factor Source: AP-42 (5th Ed.) Table 11.9-4 (Overburden Drilling))

EF_{TSP} = 1.30 lbs/hole

$EF_{PM10} = 0.5 * EF_{TSP}$ = 0.65 lbs/hole (assumption)

Emission Unit		lbs/hole		Holes/time	Emission Controls		Controlled Emission (lbs/time)			
		EF_{TSP}	EF_{PM10}		ECF	Technology	TSP	PM_{10}	Sb	As
1.001	Drilling - Waste Rock	1.30	0.65	37	85%	(H_2O Shroud)	7.15E+00	3.58E+00	9.41E-05	4.24E-04
1.002	Drilling - Ore	1.30	0.65	18	85%	(H_2O Shroud)	3.58E+00	1.79E+00	1.17E-04	6.43E-04

Emission Unit		Controlled Emission (lbs/time)								
		Be	Cd	Cr	Co	Pb	Mn	Hg	Ni	Se
1.001	Drilling - Waste Rock	1.43E-05	3.58E-05	7.79E-04	9.77E-05	3.58E-05	4.34E-03	2.84E-06	1.43E-04	3.58E-05
1.002	Drilling - Ore	7.15E-06	1.97E-05	2.86E-04	4.11E-05	4.74E-05	2.78E-03	1.43E-06	8.94E-05	1.79E-05

Calculations - 24-Hr Operations

Blasting Sources
(Emission Factor Source: AP-42 (5th Ed.) Table 11.9-4 (Overburden Blasting))

Emission Factor Calculation

$EF_{TSP} = (0.0005A)^{1.5}$ = 149.43 lbs/blast

$EF_{PM10} = 0.5 \times EF_{TSP}$ = 74.72 lbs/blast (Assumption)

Where:

A = Horizontal Area of Blast = 56,320.00 sq.ft

Emission Unit		lbs/blast		Blasts/time	Emission Controls		Cntrld Emission (lbs/time)	
		EF_{TSP}	EF_{PM10}		ECF	Technology	TSP	PM10
1.003	Blasting - Waste Rock	149	74.72	1.00	0%	(Uncontrolled)	1.49E+02	7.47E+01
1.005	Blasting - Ore	149	74.72	0.00	0%	(Uncontrolled)	0.00E+00	0.00E+00

Emission Unit		Controlled Emissions (lbs/time)							
		Sb	As	Be	Cd	Cr	Co	Pb	Mn
1.003	Blasting - Waste Rock	1.97E-03	8.87E-03	2.99E-04	7.47E-04	1.63E-02	2.04E-03	7.47E-04	9.08E-02
1.005	Blasting - Ore	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Emission Unit		Controlled Emissions (lbs/time)		
		Hg	Ni	Se
1.003	Blasting - Waste Rock	5.93E-05	2.99E-03	7.47E-04
1.005	Blasting - Ore	0.00E+00	0.00E+00	0.00E+00

Calculations - 24-Hr Operations

Blasting Sources - Explosives Detonation

(Emission Factor Source: AP-42 (5th Ed.) 13.3-1 (Explosives Detonation))

Emission Factors

Ammonium Nitrate Fuel Oil (ANFO)

EF_{NOx} = 17.00 lbs/ton of Explosive Used

EF_{SOx} = 2.00 lbs/ton of Explosive Used

EF_{CO} = 67.00 lbs/ton of Explosive Used

Pentaerythritol tetranitrate (PETN) - Booster

EF_{CO} = 297.00 lbs/ton of Explosive Used

Emission Unit		lbs/ton of Explosive Used				Tons of Explosive/Time	
		$EF_{NOx\text{-}ANFO}$	$EF_{SOx\text{-}ANFO}$	$EF_{CO\text{-}ANFO}$	$EF_{CO\text{-}PETN}$	ANFO	PETN
1.004	Explosives Detonation - Waste Rock Blasting	17	2.00	67.00	297.00	22.72	0.03
1.006	Explosives Detonation - Ore Blasting	17	2.00	67.00	297.00	0.00	0.00

Emission Unit		Emission Controls		Controlled Emission (lbs/time)		
		ECF	Technology	NOx	SOx	CO
1.004	Explosives Detonation - Waste Rock Blasting	0%	(Uncontrolled)	3.86E+02	4.54E+01	1.53E+03
1.006	Explosives Detonation - Ore Blasting	0%	(Uncontrolled)	0.00E+00	0.00E+00	0.00E+00

Calculations - 24-Hr Operations

Drop Point Sources

(Emission Factor Source: AP-42 (5th Ed.) §13.2.4 - Aggregate Handling and Storage Piles)

EF_{TSP} (lbs/ton) = K x (0.0032) x {[(U/5)^1.3]/[(M/2)^1.4]}

EF_{PM10} (lbs/ton) = K x (0.0032) x {[(U/5)^1.3]/[(M/2)^1.4]}

Where:

K = Particle Size Multiplier (dimensionless)

U = Mean Wind Speed (MPH)

M = Material Moisture Content

Emission Unit		Mean Wind Speed	Mat. Moisture Content	Emission Factors		tons/time	Emission Controls	
				EF_{TSP}	EF_{PM10}		ECF	Technology
1.007	Waste Rock Loading	3.0	3.67	0.0005	0.0002	1.33E+05	0%	(Uncontrolled)
1.008	Ore Loading	3.0	3.67	0.0005	0.0002	6.67E+04	0%	(Uncontrolled)
1.009	Waste Rock Dumping	6.0	3.67	0.0013	0.0006	1.33E+05	0%	(Uncontrolled)
1.010	Ore Dumping	6.0	3.67	0.0013	0.0006	6.67E+04	0%	(Uncontrolled)
2.003	Lime Application to Ore	6.0	1.00	0.0079	0.0037	50.00	70%	(Water Sprays)

Emission Unit		Controlled Emission (lbs/time)						
		TSP	PM_{10}	Sb	As	Be	Cd	Cr
1.007	Waste Rock Loading	6.95E+01	3.29E+01	9.14E-04	4.12E-03	1.39E-04	3.47E-04	7.57E-03
1.008	Ore Loading	3.47E+01	1.64E+01	1.14E-03	6.24E-03	6.95E-05	1.91E-04	2.78E-03
1.009	Waste Rock Dumpting	1.71E+02	8.09E+01	2.25E-03	1.01E-02	3.42E-04	8.55E-04	1.86E-02
1.010	Ore Dumping	8.55E+01	4.05E+01	2.81E-03	1.54E-02	1.71E-04	4.70E-04	6.84E-03
2.003	Lime Application to Ore	1.19E-01	5.62E-02	n/a	n/a	n/a	n/a	n/a

Emission Unit		Controlled Emission (lbs/time)					
		Co	Pb	Mn	Hg	Ni	Se
1.007	Waste Rock Loading	9.50E-04	3.47E-04	4.22E-02	2.76E-05	1.39E-03	3.47E-04
1.008	Ore Loading	3.99E-04	4.60E-04	2.70E-02	1.39E-05	8.68E-04	1.74E-04
1.009	Waste Rock Dumpting	2.34E-03	8.55E-04	1.04E-01	6.79E-05	3.42E-03	8.55E-04
1.010	Ore Dumping	9.84E-04	1.13E-03	6.65E-02	3.43E-05	2.14E-03	4.28E-04
2.003	Lime Application to Ore	n/a	n/a	n/a	n/a	n/a	n/a

Dozing/Ripping/Spreading
(Source: AP-42 (5th Ed.) Table 11.9-4 (Overburden Dozing))

EF_{TSP} (lbs/hr) = (5.7(s)^1.2) / (M^1.3)

EF_{PM10} (lbs/hr) = 0.75 * ((1.0(s)^1.5)/M^1.4))

s = Material silt content

M = Material Moisture Content

Emission Unit		Silt Content	Moisture Content	(lbs/hr) EF_{TSP}	EF_{PM10}	hrs/time	Emission Controls ECF	Technology
1.011	Waste Rock Dozing	1.40	3.67	1.57E+00	2.01E-01	21.42	0%	(Uncontrolled)
2.004	Ore Ripping/Spreading/Dozing	1.26	3.67	1.39E+00	1.72E-01	21.42	0%	(Uncontrolled)

Emission Unit		Calculated Emissions (lbs/time) TSP	PM10	Sb	As	Be	Cd	Cr	Co
1.011	Waste Rock Dozing	3.37E+01	4.31E+00	4.44E-04	2.00E-03	6.74E-05	1.69E-04	3.68E-03	4.61E-04
2.004	Ore Ripping/Spreading/Dozing	2.97E+01	3.68E+00	9.75E-04	5.34E-03	5.94E-05	1.63E-04	2.38E-03	3.42E-04

Emission Unit		Calculated Emissions (lbs/time) Pb	Mn	Hg	Ni	Se
1.011	Waste Rock Dozing	1.69E-04	2.05E-02	1.34E-05	6.74E-04	1.69E-04
2.004	Ore Ripping/Spreading/Dozing	3.94E-04	2.31E-02	1.19E-05	7.43E-04	1.49E-04

Emissions from Unpaved Surfaces
(Emission Factor Source: AP-42 (5th Ed.) §13.2.2 - Unpaved Roads)

EF (lbs/VMT) = K(5.9)*(s/12)*(S/30)*((W/3)^0.7)*((w/4)^0.5)*((365-p)/365))*

Where:

K_{TSP} = 0.80 (dimensionless)

K_{PM10} = 0.36 (dimensionless)

s =Silt content of road surface material

S = Mean Vehicle Speed

W = Mean Vehicle Weight

w = Mean number of wheels

p = No. days with at least 0.01 in. of precipitation/year

Emission Unit		s	S	W	w	p	EF_{TSP}	EF_{PM10}	VMT/trip	VMT/Time
1.012	Waste Rock Hauling									
WR Haul - In-Pit Flat (Loaded)		1.26	17.69	530.00	6.00	0.00	13.39	6.03	0.19	80.02
WR Haul - Pit Ramp (Loaded)		1.26	8.50	530.00	6.00	0.00	6.43	2.90	0.49	202.34
WR Haul - Flat (Loaded)		1.26	22.20	530.00	6.00	0.00	16.80	7.56	0.63	261.05
WR Haul - Up Stockpile (Loaded)		1.26	12.30	530.00	6.00	0.00	9.31	4.19	0.12	49.87
WR Haul - SP Flat (Loaded)		1.26	20.80	530.00	6.00	0.00	15.74	7.08	0.16	65.26
WR Hauling - SP Flat (Empty)		1.26	28.10	210.00	6.00	0.00	11.13	5.01	0.16	65.26
WR Hauling - Down SP (Empty)		1.26	35.00	210.00	6.00	0.00	13.86	6.24	0.12	49.87
WR Hauling - Flat (Empty)		1.26	35.00	210.00	6.00	0.00	13.86	6.24	0.63	261.05
WR Hauling - Pit Ramp (Empty)		1.26	35.00	210.00	6.00	0.00	13.86	6.24	0.49	202.34
WR Hauling - In-Pit Flat (Empty)		1.26	26.25	210.00	6.00	0.00	10.39	4.68	0.19	80.02
	Total - Waste Rock Hauling	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3.16	1,317.08
1.013	Ore Hauling									
Ore Haul - In-Pit Flat (Loaded)		1.26	17.69	530.00	6.00	0.00	13.39	6.03	0.19	40.01
Ore Haul - Pit Ramp (Loaded)		1.26	8.50	530.00	6.00	0.00	6.43	2.90	0.49	101.17
Ore Haul - Flat (Loaded)		1.26	22.20	530.00	6.00	0.00	16.80	7.56	0.63	130.52
Ore Haul - Up Heap (Loaded)		1.26	12.30	530.00	6.00	0.00	9.31	4.19	0.12	24.94
Ore Haul - Heap Flat (Loaded)		1.26	20.80	530.00	6.00	0.00	15.74	7.08	0.16	32.63
Ore Haul - Heap Flat (Empty)		1.26	28.10	210.00	6.00	0.00	11.13	5.01	0.16	32.63
Ore Haul - Down Heap (Empty)		1.26	35.00	210.00	6.00	0.00	13.86	6.24	0.12	24.94
Ore Haul - Flat (Empty)		1.26	35.00	210.00	6.00	0.00	13.86	6.24	0.63	130.52
Ore Haul - Pit Ramp (Empty)		1.26	35.00	210.00	6.00	0.00	13.86	6.24	0.49	101.17
Ore Haul - In-Pit Flat (Empty)		1.26	26.25	210.00	6.00	0.00	10.39	4.68	0.19	40.01
	Total - Ore Hauling	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3.16	658.54
7.002	Water Truck Traffic	1.26	10.00	35.00	6.00	0.00	1.13	0.51	n/a	20.00
8.001	On-Site Delivery Truck Traffic	1.26	25.00	35.00	18.00	0.00	4.89	2.20	n/a	3.92
8.003	On-Site Light Vehicle Traffic	1.26	25.00	7.16	5.08	0.00	0.86	0.39	n/a	220.50
8.005	Off-Site Delivery Truck Traffic	1.26	35.00	18.00	8.33	0.00	2.92	1.32	n/a	33.32

8.006	Off-Site Light Vehicle Traffic	1.26	35.00	7.16	4.00	0.00	1.06	0.48	n/a	1,291.15

Emissions from Unpaved Surfaces (Continued)

Emission Unit		Emission Controls		Controlled Emissions (lbs/time)					
		ECF	Technology	TSP	PM10	Sb	As	Be	Cd
1.012	Waste Rock Hauling								
WR Haul - In-Pit Flat (Loaded)		98%	(Chemical Tmt/Water)	2.14E+01	9.64E+00	n/a	n/a	n/a	n/a
WR Haul - Pit Ramp (Loaded)		98%	(Chemical Tmt/Water)	2.60E+01	1.17E+01	n/a	n/a	n/a	n/a
WR Haul - Flat (Loaded)		98%	(Chamical Tmt/Watar)	8.77E+01	3.95E+01	n/a	n/a	n/a	n/a
WR Haul - Up Stockpile (Loaded)		98%	(Chemical Tmt/Water)	9.29E+00	4.18E+00	n/a	n/a	n/a	n/a
WR Haul - SP Flat (Loaded)		98%	(Chemical Tmt/Water)	2.06E+01	9.25E+00	n/a	n/a	n/a	n/a
WR Hauling - SP Flat (Empty)		98%	(Chemical Tmt/Water)	1.45E+01	6.53E+00	n/a	n/a	n/a	n/a
WR Hauling - Down SP (Empty)		98%	(Chemical Tmt/Water)	1.38E+01	6.22E+00	n/a	n/a	n/a	n/a
WR Hauling - Flat (Empty)		98%	(Chemical Tmt/Water)	7.24E+01	3.26E+01	n/a	n/a	n/a	n/a
WR Hauling - Pit Ramp (Empty)		98%	(Chemical Tmt/Water)	5.61E+01	2.52E+01	n/a	n/a	n/a	n/a
WR Hauling - In-Pit Flat (Empty)		98%	(Chemical Tmt/Water)	1.66E+01	7.48E+00	n/a	n/a	n/a	n/a
	Total - Waste Rock Hauling	98%	(Chemical Tmt/Water)	3.38E+02	1.52E+02	4.45E-03	2.01E-02	6.77E-04	1.69E-03
1.013	Ore Hauling								
Ore Haul - In-Pit Flat (Loaded)		98%	(Chemical Tmt/Water)	1.07E+01	4.82E+00	n/a	n/a	n/a	n/a
Ore Haul - Pit Ramp (Loaded)		98%	(Chemical Tmt/Water)	1.30E+01	5.86E+00	n/a	n/a	n/a	n/a
Ore Haul - Flat (Loaded)		98%	(Chemical Tmt/Water)	4.39E+01	1.97E+01	n/a	n/a	n/a	n/a
Ore Haul - Up Heap (Loaded)		98%	(Chemical Tmt/Water)	4.64E+00	2.09E+00	n/a	n/a	n/a	n/a
Ore Haul - Heap Flat (Loaded)		98%	(Chemical Tmt/Water)	1.03E+01	4.62E+00	n/a	n/a	n/a	n/a
Ore Haul - Heap Flat (Empty)		98%	(Chemical Tmt/Water)	7.26E+00	3.27E+00	n/a	n/a	n/a	n/a
Ore Haul - Down Heap (Empty)		98%	(Chemical Tmt/Water)	6.91E+00	3.11E+00	n/a	n/a	n/a	n/a
Ore Haul - Flat (Empty)		98%	(Chemical Tmt/Water)	3.62E+01	1.63E+01	n/a	n/a	n/a	n/a
Ore Haul - Pit Ramp (Empty)		98%	(Chemical Tmt/Water)	2.80E+01	1.26E+01	n/a	n/a	n/a	n/a
Ore Haul - In-Pit Flat (Empty)		98%	(Chamical Tmt/Water)	8.32E+00	3.74E+00	n/a	n/a	n/a	n/a
	Total - Ore Hauling	98%	(Chemical Tmt/Water)	1.69E+02	7.61E+01	2.23E-03	1.00E-02	3.38E-04	8.46E-04
7.002	Water Truck Traffic	99%	(Watering)	2.26E-01	1.02E-01	2.97E-06	1.34E-05	4.52E-07	1.13E-06
8.001	On-Site Delivery Truck Traffic	98%	(Chemical Tmt/Water)	3.83E-01	1.73E-01	5.05E-06	2.28E-05	7.67E-07	1.92E-06
8.003	On-Site Light Vehicle Traffic	98%	(Chemical Tmt/Water)	3.77E+00	1.70E+00	4.97E-05	2.24E-04	7.55E-06	1.89E-05
8.005	Off-Site Delivery Truck Traffic	80%	(Chemical Stabilizers)	1.95E+01	8.77E+00	2.56E-04	1.16E-03	3.90E-05	9.74E-05
8.006	Off-Site Light Vehicle Traffic	80%	(Chemical Stabilizers)	2.74E+02	1.24E+02	3.61E-03	1.63E-02	5.49E-04	1.37E-03

Emissions from Unpaved Surfaces (Continued)

Emission Unit		Controlled Emissions (lbs/time)					
		Cr	Co	Pb	Mn	Hg	Ni	Se
1.012	Waste Rock Hauling	3.69E-02	4.63E-03	1.69E-03	2.06E-01	1.34E-04	6.77E-03	1.69E-03
1.013	Ore Hauling	1.84E-02	2.31E-03	8.46E-04	1.03E-01	6.72E-05	3.38E-03	8.46E-04
7.002	Water Truck Traffic	2.46E-05	3.09E-06	1.13E-06	1.37E-04	8.97E-08	4.52E-06	1.13E-06
8.001	On-Site Delivery Truck Traffic	4.18E-05	5.24E-06	1.92E-06	2.33E-04	1.52E-07	7.67E-06	1.92E-06
8.003	On-Site Light Vehicle Traffic	4.11E-04	5.16E-05	1.89E-05	2.29E-03	1.50E-06	7.55E-05	1.89E-05
8.005	Off-Site Delivery Truck Traffic	2.12E-03	2.66E-04	9.74E-05	1.18E-02	7.74E-06	3.90E-04	9.74E-05
8.006	Off-Site Light Vehicle Traffic	2.99E-02	3.75E-03	1.37E-03	1.67E-01	1.09E-04	5.49E-03	1.37E-03

Calculations - 24-Hr Operations

Ammonium Nitrate Silo Emissions - Loading/Unloading

(Source: AP-42 (5th Ed.) §8.2; Table 8.2-2 (Ammonium Nitrate Bulk Loading Operations)

EF_{TSP} = *0.02* lbs/ton

$EF_{PM10} = 0.5 * EF_{TSP}$ = *0.01* lbs/ton (assumption)

Emission Unit		(lbs/ton) EF_{TSP}	EF_{PM10}	tons/time	Emission Controls ECF	Technology	Calculated Emissions (lbs/time) TSP	PM10
1.014	Ammonium Nitrate Prill Silo Loading	0.02	0.010	25.00	0%	(Uncontrolled)	5.00E-01	2.50E-01
1.015	Ammonium Nitrate Prill Silo Unloading	0.02	0.010	22.72	0%	(Uncontrolled)	4.54E-01	2.27E-01

Calculations - 24-Hr Operations

Wind Erosion

(Source: AP-42 (4th Ed.) §11.2.3 Aggregate Handling & Storage Piles)

EF_{TSP} (lbs/acre/day) = 1.7 x (s/5) x (f/15) x ((365-p)/235)

EF_{PM10} (lbs/acre/day) = EF_{TSP} x 0.5

s = Silt content of surface material

f = percentage of time that the unobstructed wind speed exceeds 5.4 m/s (12 MPH)

p = No. days/year with at least 0.01 in. of precipitation/year

Emission Unit		Emission Factor Variables s	f (%)	p (%)	(lb/acre/day) EF_{TSP}	EF_{PM10}	Stockpile Size (Acres)
1.016	Wind Erosion (Waste Rock Stockpiles)	1.40	9.10	0.00	0.45	0.22	40.00
1.017	Wind Erosion (Soil Stockpiles)	1.40	9.10	0.00	0.45	0.22	10.00
2.009	Wind Erosion (Heap) - Non-Leach	1.26	9.10	0.00	0.40	0.20	20.40
2.010	Wind Erosion (Heap) - Leach	1.26	9.10	0.00	0.40	0.20	20.40

Emission Unit		Day/Time	Emission Controls ECF	Technology	Controlled Emissions (lbs/time) TSP	PM10	Sb
1.016	Wind Erosion (Waste Rock Stockpiles)	1.00	0%	(Uncontrolled)	1.79E+01	8.97E+00	2.36E-04
1.017	Wind Erosion (Soil Stockpiles)	1.00	0%	(Uncontrolled)	4.49E+00	2.24E+00	5.90E-05
2.009	Wind Erosion (Heap) - Non-Leach	1.00	0%	(Uncontrolled)	8.23E+00	4.12E+00	2.70E-04
2.010	Wind Erosion (Heap) - Leach	1.00	95%	(Leachate)	4.12E-01	2.06E-01	1.35E-05

Emission Unit		Controlled Emissions (lbs/time) As	Be	Cd	Cr	Co	Pb
1.016	Wind Erosion (Waste Rock Stockpiles)	1.06E-03	3.59E-05	8.97E-05	1.96E-03	2.45E-04	8.97E-05
1.017	Wind Erosion (Soil Stockpiles)	2.66E-04	8.97E-06	2.24E-05	4.89E-04	6.13E-05	2.24E-05
2.009	Wind Erosion (Heap) - Non-Leach	1.48E-03	1.65E-05	4.53E-05	6.59E-04	9.47E-05	1.09E-04
2.010	Wind Erosion (Heap) - Leach	7.40E-05	8.23E-07	2.26E-06	3.29E-05	4.74E-06	5.46E-06

Emission Unit		Controlled Emissions (lbs/time) Mn	Hg	Ni	Se
1.016	Wind Erosion (Waste Rock Stockpiles)	1.09E-02	7.12E-06	3.59E-04	8.97E-05
1.017	Wind Erosion (Soil Stockpiles)	2.73E-03	1.78E-06	8.97E-05	2.24E-05
2.009	Wind Erosion (Heap) - Non-Leach	6.40E-03	3.30E-06	2.06E-04	4.12E-05
2.010	Wind Erosion (Heap) - Leach	3.20E-04	1.65E-07	1.03E-05	2.06E-06

Calculations - 24-Hr Operations

Combustion - Mobile Sources (Haul Trucks)

(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Off-Highway Trucks)

EF_{TSP} = 14.10 lbs/1000 gal
$EF_{PM10} = EF_{TSP} \times 0.52$ = 7.33 lbs/1000 gal
EF_{SOx} = 31.20 lbs/1000 gal * N.B. Not Low-Sulfur Fuel - Conservative Numbers
EF_{NOx} = 286.10 lbs/1000 gal
EF_{CO} = 123.46 lbs/1000 gal
EF_{VOC} = 13.60 lbs/1000 gal

Emission Unit		(lbs/1000 gal)							
		EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}	(mgal/time)	ECF
1.018	Haul Truck (Combustion)	14.10	7.33	31.20	286.10	123.46	13.60	8.52	0%

Emission Unit		Controlled Emissions (lbs/time)					
		TSP	PM10	SOx	NOx	CO	VOCs
1.018	Haul Truck (Combustion)	1.20E+02	6.25E+01	2.66E+02	2.44E+03	1.05E+03	1.16E+02

Calculations - 24-Hr Operations

Combustion - Mobile Sources (Dozers)

(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Wheeled Dozer)

EF_{TSP} = 14.80 lbs/1000 gal
$EF_{PM10} = EF_{TSP} \times 0.52$ = 7.70 lbs/1000 gal
EF_{SOx} = 31.20 lbs/1000 gal
EF_{NOx} = 286.10 lbs/1000 gal
EF_{CO} = 123.46 lbs/1000 gal
EF_{VOC} = 13.60 lbs/1000 gal

Emission Unit		(lbs/1000 gal)							
		EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}	(mgal/time)	ECF
1.019	WRS Dozer (Combustion)	14.80	7.70	31.20	286.10	123.46	13.60	0.43	0%
2.005	Heap Leach Dozer (Combustion)	14.80	7.70	31.20	286.10	123.46	13.60	0.43	0%

Emission Unit		Controlled Emissions (lbs/time)					
		TSP	PM10	SOx	NOx	CO	VOCs
1.019	WRS Dozer (Combustion)	6.34E+00	3.30E+00	1.34E+01	1.23E+02	5.29E+01	5.83E+00
2.005	Heap Leach Dozer (Combustion)	6.34E+00	3.30E+00	1.34E+01	1.23E+02	5.29E+01	5.83E+00

Calculations - 24-Hr Operations

Combustion Emissions - Diesel and Gasoline Fueled Engines
(Source: AP-42 (5th Ed.) §3.3 - Gasoline and Diesel Fueled Industrial Engines)

Emission Factors Based on Fuel Consumption

EF_{TSP} = 0.5962 lbs/mmBTU
EF_{PM10} = 0.3100 lbs/mmBTU
EF_{SOx} = 0.29 lbs/mmBTU
EF_{NOx} = 4.41 lbs/mmBTU
EF_{CO} = 0.95 lbs/mmBTU
EF_{VOC} = 0.35 lbs/mmBTU

Emission Unit		(gal/time)	(mmBTU/gal)	ECF	Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOC/ROGs
1.020	Drill Rig (Combustion)	480.00	0.133936	0%	3.83E+01	1.99E+01	1.86E+01	2.84E+02	6.11E+01	2.25E+01

Emission Factors Based on Engine Rating

EF_{TSP} = 4.62E-03 lbs/hp-hr
EF_{PM10} = 2.20E-03 lbs/hp-hr
EF_{SOx} = 2.05E-03 lbs/hp-hr
EF_{NOx} = 3.10E-02 lbs/hp-hr
EF_{CO} = 6.68E-03 lbs/hp-hr
EF_{VOC} = 2.51E-03 lbs/hp-hr

Emission Unit		hp	hrs/time	ECF	Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOC/ROGs
7.004	Mobile Light Plant - Pit #1	22.00	10.00	0%	1.02E+00	4.84E-01	4.51E-01	6.82E+00	1.47E+00	5.53E-01
7.005	Mobile Light Plant - Pit #2	22.00	10.00	0%	1.02E+00	4.84E-01	4.51E-01	6.82E+00	1.47E+00	5.53E-01
7.006	Mobile Light Plant - Heap	22.00	10.00	0%	1.02E+00	4.84E-01	4.51E-01	6.82E+00	1.47E+00	5.53E-01
7.007	Mobile Light Plant - WRS	22.00	10.00	0%	1.02E+00	4.84E-01	4.51E-01	6.82E+00	1.47E+00	5.53E-01

Calculations - 24-Hr Operations

Combustion - Mobile Sources (Loaders)
(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Wheeled Loaders)

EF_{TSP} = 29.30 lbs/1000 gal
$EF_{PM10} = EF_{TSP} \times 0.52$ = 15.24 lbs/1000 gal
EF_{SOx} = 31.20 lbs/1000 gal
EF_{NOx} = 339.82 lbs/1000 gal
EF_{CO} = 98.66 lbs/1000 gal
EF_{VOC} = 43.16 lbs/1000 gal

Emission Unit		(lbs/1000 gal) EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}	(mgal/time)	ECF
1.021	Loader (Combustion)	29.30	15.24	31.20	339.82	98.66	43.16	0.54	0%
1.022	Clean-up Loader (Combustion)	29.30	15.24	31.20	339.82	98.66	43.16	0.14	0%

Emission Unit		Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOCs
1.021	Loader (Combustion)	1.58E+01	8.21E+00	1.68E+01	1.83E+02	5.31E+01	2.32E+01
1.022	Clean-up Loader (Combustion)	4.18E+00	2.18E+00	4.46E+00	4.85E+01	1.41E+01	6.16E+00

Calculations - 24-Hr Operations

Silo Emissions - Loading
(Source: AP-42 (5th Ed.) §11.12, Table 11.12-2: Cement Unloading to Elevated Storage Silo (Pneumatic)

EF_{TSP} = *0.2700* lbs/ton (TSP)

$EF_{PM10} = 0.5 * EF_{TSP}$ = *0.1350* lbs/ton (PM_{10}) (assumption)

Emission Unit		(lbs/ton)			Emission Controls		Controlled Emissions (lbs/time)	
		EF_{TSP}	EF_{PM10}	(tons/time)	ECF	Technology	TSP	PM10
2.001	Portable R-O-M Lime Silo Loading	0.2700	0.1350	50.00	99%	(Baghouse)	1.35E-01	6.75E-02

Calculations - 24-Hr Operations

Silo Emissions - Loading
(Source: AP-42 (5th Ed.) §11.12, Table 11.12-2: Weigh Hopper Loeding)

$EF_{TSP} = (EF_{PM10})$ = *0.0200* lbs/ton (TSP) (assumption)

EF_{PM10} = *0.0200* lbs/ton (PM_{10})

Emission Unit		(lbs/ton)			Emission Controls		Controlled Emissions (lbs/time)	
		EF_{TSP}	EF_{PM10}	(tons/time)	ECF	Technology	TSP	PM10
2.002	Portable R-O-M Lime Hopper Loading	0.0200	0.0200	50.00	0%	(Uncontrolled)	1.00E+00	1.00E+00

Calculations - 24-Hr Operations

Hydrocyanic Acid Emissions from Heap Leach Pads

(Emission Factor Source: Mesquite Mine AB2588 Air Toxic Inventory Report, Addendum - HCN Emissions from Heap Leaching Operations, 1991)

EF_{HCN} = 420.000 lbs/acre-yr

Emission Unit		Size of Heap Under Leach (Acres)	ECF	yrs/time	Controlled Emissions (lbs/time)
2.006	Cyanide Application and Leaching	20.40	0%	0.0027	2.35E+01

Calculations - 24-Hr Operations

Hydrocyanic Acid Emissions from Open Top (Pond) Sources

(Emission Factor Source: Domes Study, 1980)

EF_{HCN} = 5.60E-05 lbs/ft2/da

HCN Emissions= Domes Emission (lb/ft2/da)xFactor(t)xFactor(pH)xFactor(c)x MWHCN/MWCN
x Pond Size x da/yr x (100%-ECF)

Emission Unit		Exposed Suface Area (ft2)	Average pH of Pond	NaCN Conc. (ppm)	Soln. Temp. (C)	HCN VP (mmHg)	Emission Controls ECF	Technology
2.007	Pregnant Solution Pond	54,400.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
2.008	Barren Solution Pond	54,400.0	10.6	25.0	28.9	795.0	0%	(Uncontrolled)
3.001	Carbon Adsorption Tank 1	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.002	Carbon Adsorption Tank 2	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.003	Carbon Adsorption Tank 3	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.004	Carbon Adsorption Tank 4	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.005	Carbon Adsorption Tank 5	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.007	Cyanide Make-up Tank	113.0	12.0	240,000.0	28.9	795.0	0%	(Uncontrolled)
3.008	Strip Tank	38.5	13.5	2,000.0	30.0	800.0	0%	(Uncontrolled)
3.009	Electrowinning Cell	24.0	13.5	250.0	369.3	825.0	0%	(Uncontrolled)
5.003	Fume Hood	0.8	12.0	240,000.0	12.0	790.0	0%	(Uncontrolled)

Hydrocyanic Acid Emissions from Open Top (Pond) Sources - continued
(Emission Factor Source: Domes Study, 1980)

Emission Unit		Soln. Conc. ppm (as CN)	HCN Conc. @ pH	pH Factor	Vapor Press. Factor	Conc. Factor	days/time	lbs/time
2.007	Pregnant Solution Pond	13.27	4.0%	8.00	2.75	0.20	1	1.42E+01
2.008	Barren Solution Pond	13.27	5.0%	10.00	2.75	0.20	1	1.77E+01
3.001	Carbon Adsorption Tank 1	13.27	4.0%	8.00	2.75	0.20	1	2.60E-02
3.002	Carbon Adsorption Tank 2	13.27	4.0%	8.00	2.75	0.20	1	2.60E-02
3.003	Carbon Adsorption Tank 3	13.27	4.0%	8.00	2.75	0.20	1	2.60E-02
3.004	Carbon Adsorption Tank 4	13.27	4.0%	8.00	2.75	0.20	1	2.60E-02
3.005	Carbon Adsorption Tank 5	13.27	4.0%	8.00	2.75	0.20	1	2.60E-02
3.007	Cyanide Make-up Tank	127,346.94	0.00%	0.00	2.75	1,950.18	1	0.00E+00
3.008	Strip Tank	1,061.22	0.00%	0.00	2.77	16.25	1	0.00E+00
3.009	Electrowinning Cell	132.65	0.00%	0.00	2.85	2.03	1	0.00E+00
5.003	Fume Hood	127,346.94	0.00%	0.00	2.73	1,950.18	1	0.00E+00

Acid Emissions - Hydrochloric Acid Storage/Use
(Source: Nevada Mining Association Data, 1995)

EF_{HCl} (lb/lb acid consumed) = 0.01 lb/lb (Acid Consumed) x Acid Strength (%) / 100

Emission Unit		Acid Strength	(lbs/lb) EF_{HCl}	lbs/time	Emission Controls ECF	Emission Controls Technology	Ctrld Emission (lbs/time) HCl
3.006	Acid Wash Tank	5%	0.0005	1,936	0%	(Uncontrolled)	9.68E-01
5.004	Waste Acid Tank	n/a [1]	n/a	n/a	n/a	n/a	n/a

[1] Emissions from Emission Unit 5.004 (Waste Acid Tank) included in emission calculations for Unit 3.006.

Calculations - 24-Hr Operations

Mercury Retort Furnace Emissions
(Source: Chemgold Personnel)

Emission Unit		(lbs/hr) EF_{Hg}	hrs/time	Emission Controls ECF	Technology	Ctrld Emissions (lbs/time) Hg
4.001	Mercury Retort Furnace (Electric)	4.13E-06	6.00	0%	(Uncontrolled)	2.48E-05

Calculations - 24-Hr Operations

Crushing Operations
(Source: AP-42 (5th Ed.) §11.24 - Metallic Mineral Processing (Low Moisture Ore)) - Split 65% Crushers/35% Screens per EPA Guidance

EF_{TSP} = 0.7800 lbs/ton (TSP)
EF_{PM10} = 0.0553 lbs/ton (PM_{10})

Emission Unit		(lbs/ton) EF_{TSP}	EF_{PM10}	(tons/time)	Emission Controls ECF	Technology	Controlled Emissions (lbs/time) TSP	PM10	Sb
5.001	Jaw Crusher	0.7800	0.0553	1.31	0%	(Uncontrolled)	1.02E+00	7.24E-02	3.35E-05
5.002	Pulverizer	0.7800	0.0553	1.31	0%	(Uncontrolled)	1.02E+00	7.24E-02	3.35E-05

Emission Unit		Controlled Emissions (lbs/time) As	Be	Cd	Cr	Co	Pb	Mn	Hg
5.001	Jaw Crusher	1.84E-04	2.04E-06	5.62E-06	8.18E-05	1.18E-05	1.35E-05	7.95E-04	4.10E-07
5.002	Pulverizer	1.84E-04	2.04E-06	5.62E-06	8.18E-05	1.18E-05	1.35E-05	7.95E-04	4.10E-07

Emission Unit		Cntrld Emissions (lbs/time) Ni	Se
5.001	Jaw Crusher	2.56E-05	5.11E-06
5.002	Pulverizer	2.56E-05	5.11E-06

Calculations - 24-Hr Operations

Organic Liquid Storage Tanks - Diesel Storage

(Source: Leaking Underground Fuel Tank Field Manual, California State Water Resources Control Board, 1990.)

$EF_{Napthalene}$ =	0.13%	
$EF_{Cadmium}$ =	4.00E-02 ug/g =	4.00E-08 lbs/lb
$EF_{Chromium}$ =	3.60E-01 ug/g =	3.60E-07 lbs/lb
EF_{Cobalt} =	5.00E-02 ug/g =	5.00E-08 lbs/lb
EF_{Lead} =	1.00E-01 ug/g =	1.00E-07 lbs/lb
EF_{Nickel} =	5.00E-02 ug/g =	5.00E-08 lbs/lb
$EF_{Selenium}$ =	2.00E-02 ug/g =	2.00E-08 lbs/lb

(Source of VOC Emission Calcultations: AP-42 (5th Ed.) §7.1 - Liquid Organic Storage Tanks - Calculated Via US EPA Tanks Program (Vers. 2.0))

Emission Unit		Standing Losses lbs/time (VOCs)	Working Losses lbs/time (VOCs)	Controlled Emissions (lbs/time)			
				VOCs	Napthalene	Cadmium	Chromium
6.001	Main Diesel Tank 1	0.02	0.17	1.94E-01	2.52E-04	7.77E-09	6.99E-08
6.002	Street Diesel Tank	0.00	0.01	8.38E-03	1.09E-05	3.35E-10	3.02E-09

Emission Unit		Controlled Emissions (lbs/time)			
		Cobalt	Lead	Nickel	Selenium
6.001	Main Diesel Tank 1	9.71E-09	1.94E-08	9.71E-09	3.88E-09
6.002	Street Diesel Tank	4.19E-10	8.38E-10	4.19E-10	1.68E-10

Calculations - 24-Hr Operations

Organic Liquid Storage Tanks - Gasoline Storage

(Source: Leaking Underground Fuel Tank Field Manual, California State Water Resources Control Board, 1990.)

$EF_{Benzene}$ =	1.81%	
EF_{Hexane} =	1.87%	
$EF_{2,2,4\text{-}Trimethylpentane}$ =	2.45%	
$EF_{Xylenes}$ =	5.77%	
$EF_{Toluene}$ =	12.27%	
$EF_{Ethylbenzene}$ =	1.61%	
$EF_{Naphalene}$ =	0.29%	
$EF_{Bromine}$ =	2.13E+02 ug/g =	2.13E-04 lbs/lb
$EF_{Cadmium}$ =	4.00E-02 ug/g =	4.00E-08 lbs/lb
$EF_{Chlorine}$ =	1.90E+02 ug/g =	1.90E-04 lbs/lb
EF_{Lead} =	1.30E-02 g/g =	0-Jan-00 lbs/lb

(Source of VOC Emission Calcultations: AP-42 (5th Ed.) §7.1 - Liquid Organic Storage Tanks - Calculated Via US EPA Tanks Program (Vers. 2.0))

Emission Unit		Standing Losses lbs/time (VOCs)	Working Losses lbs/time (VOCs)	Controlled Emissions (lbs/time)		
				VOCs	Benzene	Hexane
6.003	Unleaded Gasoline Tank	1.71	1.54	3.26E+00	5.90E-02	6.09E-02

Emission Unit		Controlled Emissions (lbs/yr)				
		2,2,4-Trimethylpentane	Xylenes	Toluene	Ethylbenzene	Napthalene
6.003	Unleaded Gasoline Tank	7.98E-02	1.88E-01	4.00E-01	5.25E-02	9.45E-03

Emission Unit		Controlled Emissions (lbs/yr)			
		Bromine	Cadmium	Chlorine	Lead
6.003	Unleaded Gasoline Tank	6.92E-04	1.30E-07	6.19E-04	4.24E-02

Calculations - 24-Hr Operations

Organic Liquid Storage Tanks - Ethylene Glycol

(Source of VOC Emission Calcultations: AP-42 (5th Ed.) §7.1 - Liquid Organic Storage Tanks - Calculated Via US EPA Tanks Program (Vers. 2.0))

Emission Unit		% of Ethylene Glycol in Soln.	Standing Losses lbs/time (VOCs)	Working Losses lbs/time (VOCs)	Controlled Emissions (lbs/time) VOCs	Controlled Emissions (lbs/time) Ethylene Glycol
6.004	Coolant Tank	95%	0.00	0.00	5.48E-04	5.21E-04

Calculations - 24-Hr Operations

Combustion - Mobile Sources (Off-Highway Trucks)

(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Off-Highway Trucks)

EF_{TSP} = 17.70 lbs/1000 gal

$EF_{PM10} = EF_{TSP} \times 0.52$ = 9.20 lbs/1000 gal

EF_{SOx} = 31.20 lbs/1000 gal

EF_{NOx} = 286.10 lbs/1000 gal

EF_{CO} = 123.46 lbs/1000 gal

EF_{VOC} = 13.60 lbs/1000 gal

Emission Unit		(lbs/1000 gal) EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}	(mgal/time)	ECF
7.001	Water Truck (Combustion)	17.70	9.20	31.20	286.10	123.46	13.60	0.38	0%

Emission Unit		Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOCs
7.001	Water Truck (Combustion)	6.72E+00	3.50E+00	1.19E+01	1.09E+02	4.69E+01	5.17E+00

Calculations - 24-Hr Operations

Combustion Emissions - Large Stational Diesel Engines
(Source: AP-42 (5th Ed.) §3.4.2 - Large Uncontrolled Stationary I.C. Engines)

EF_{TSP} =	0.0697 lbs/mmBTU	$EF_{Benzene}$ =	7.06E-04 lbs/mmBTU
EF_{PM10} =	0.0573 lbs/mmBTU	$EF_{Toluene}$ =	2.81E-04 lbs/mmBTU
EF_{SOx} = 1.01 x S =	5.05E-02 lbs/mmBTU	$EF_{Xylenes}$=	1.93E-04 lbs/mmBTU
EF_{NOx} =	3.10E+00 lbs/mmBTU	$EF_{Formaldehyde}$ =	7.89E-05 lbs/mmBTU
EF_{CO} =	8.10E-01 lbs/mmBTU	$EF_{Acetaldehyde}$ =	2.52E-05 lbs/mmBTU
EF_{VOC} =	9.00E-02 lbs/mmBTU	$EF_{Acrolein}$ =	7.88E-06 lbs/mmBTU
		$EF_{Naphthalene}$ =	1.30E-04 lbs/mmBTU

Emission Unit		S	(gal/time)	(mmBTU/gal)	ECF	Technology	Controlled Emissions (lbs/time)	
							TSP	PM10
7.003	Backup Diesel Generator	0.05	-	0.133936	0%	(Uncontrolled)	0.00E+00	0.00E+00

Emission Unit		Controlled Emissions (lbs/time)						
		SOx	NOx	CO	VOC/ROGs	Benzene	Toluene	Xylenes
7.003	Backup Diesel Generator	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Emission Unit		Controlled Emissions (lbs/time)			
		Formaldehyde	Acetaldehyde	Acrolein	Naphthalene
7.003	Backup Diesel Generator	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Calculations - 24-Hr Operations

Combustion Emissions - Large Diesel, Non-Road Engines
(Source: CARB Standard 2000 for Engines >=175 hp)

EF_{TSP} =	*1.60E-01*	g/hp-hr	0.00035	#/hp-hr
EF_{PM10} =	*8.16E-02*	g/hp-hr	0.00018	#/hp-hr
EF_{SOx} =	4.52E-06	g/hp-hr	0.00205	#/hp-hr
EF_{NOx} =	5.80E+00	g/hp-hr	0.01279	#/hp-hr
EF_{CO} =	8.50E+00	g/hp-hr	0.01874	#/hp-hr
EF_{VOC} =	1.00E+00	g/hp-hr	0.00220	#/hp-hr

Emission Unit		hp	hrs/time	ECF	Controlled Emissions (lbs/time)					
					TSP	PM10	SOx	NOx	CO	VOC/ROGs
7.008	Cable Reel Machine	315.00	24.00	0%	2.67E+00	1.36E+00	1.55E+01	9.67E+01	1.42E+02	1.67E+01

Calculations - 24-Hr Operations

Grading of Road Surface

(Source: AP-42 (5th Ed.) §11.9 - Western Surface Coal Mining, Motor Grader - Grading)

EF_{TSP} = 0.040(S)^2.5 = 2.24 #/VMT

EF_{PM10} = (0.051(S)^2)*0.6 = 0.77 #/VMT

	Emission Unit	Speed, MPH (S)	hrs/time	VMT/Time	Emission Controls ECF	Technology	Controlled Emissions (lbs/time) TSP	PM10	Sb	As
7.009	Grading of Road Surface	5	18.36	91.8	98%	(Chemical Tmt/Water)	1.40E+00	4.11E+00	1.85E-05	8.33E-05

	Emission Unit	Controlled Emissions (lbs/time) Be	Cd	Cr	Co	Pb	Mn	Hg	Ni	Se
7.009	Grading of Road Surface	2.81E-06	7.02E-06	1.53E-04	1.92E-05	7.02E-06	8.53E-04	5.58E-07	2.81E-05	7.02E-06

Calculations - 24-Hr Operations

Combustion - Mobile Sources (Wheeled Graders)

(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Wheeled Graders)

EF_{TSP} = 22.20 lbs/1000 gal

$EF_{PM10} = EF_{TSP} \times 0.52$ = 11.54 lbs/1000 gal

EF_{SOx} = 31.20 lbs/1000 gal

EF_{NOx} = 253.84 lbs/1000 gal

EF_{CO} = 54.65 lbs/1000 gal

EF_{VOC} = 12.73 lbs/1000 gal

	Emission Unit	(lbs/1000 gal) EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}	(mgal/time)	ECF
7.010	Grader (Combustion)	22.20	11.54	31.20	253.84	54.65	12.73	0.18	0%

	Emission Unit	Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOCs
7.010	Grader (Combustion)	4.08E+00	2.12E+00	5.73E+00	4.66E+01	1.00E+01	2.34E+00

Combustion - Mobile Sources (On-Highway Trucks/Light Vehicles)
(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §A.1.1. Light Duty Trucks)

EF_{TSP} = 0.42 G/VMT = 0.00093 #/VMT
EF_{PM10} = 0.20 G/VMT = 0.00044 #/VMT
EF_{CO} = 3.40 G/VMT = 0.00750 #/VMT
EF_{SOx} = 0.11 G/VMT = 0.00024 #/VMT (Conservatuve Assumption - Avg. NOx: SOx Ratio 9:1)
EF_{NOx} = 1.00 G/VMT = 0.00220 #/VMT
EF_{VOC} = 0.41 G/VMT = 0.00090 #/VMT

Emission Unit		VMT/Time	Emission Controls		Controlled Emissions (lbs/time)					
			ECF	Technology	TSP	PM10	CO	SOx	NOx	VOC/ROGs
8.002	On-Site Delivery Truck (Combustion)	3.92	0%	(Uncontrolled)	1.73E-03	1.73E-03	2.94E-02	9.60E-04	8.64E-03	3.54E-03
8.004	On-Site Light Vehicle (Combustion)	220.50	0%	(Uncontrolled)	2.04E-01	9.72E-02	1.65E+00	5.40E-02	4.86E-01	1.99E-01

APPENDIX E

EMISSION CALCULATIONS - ANNUAL OPERATIONS

Calculations - Annual Operations

Drilling Sources

(Emission Factor Source: AP-42 (5th Ed.) Table 11.9-4 (Overburden Drilling))

EF_{TSP} = 1.30 lbs/hole

$EF_{PM10} = 0.5 * EF_{TSP}$ = 0.65 lbs/hole (assumption)

Emission Unit		lbs/hole		Holes/time	Emission Controls		Controlled Emission (lbs/time)			
		EF_{TSP}	EF_{PM10}		ECF	Technology	TSP	PM_{10}	Sb	As
1.001	Drilling - Waste Rock	1.30	0.65	9,577	85%	(H_2O Shroud)	1.87E+03	9.34E+02	2.46E-02	1.11E-01
1.002	Drilling - Ore	1.30	0.65	4,789	85%	(H_2O Shroud)	9.34E+02	4.67E+02	3.06E-02	1.68E-01

Emission Unit		Controlled Emission (lbs/time)								
		Be	Cd	Cr	Co	Pb	Mn	Hg	Ni	Se
1.001	Drilling - Waste Rock	3.74E-03	9.34E-03	2.04E-01	2.55E-02	9.34E-03	1.13E+00	7.41E-04	3.74E-02	9.34E-03
1.002	Drilling - Ore	1.87E-03	5.14E-03	7.47E-02	1.07E-02	1.24E-02	7.26E-01	3.74E-04	2.33E-02	4.67E-03

Calculations - Annual Operations

Blasting Sources

(Emission Factor Source: AP-42 (5th Ed.) Table 11.9-4 (Overburden Blasting))

Emission Factor Calculation

$EF_{TSP} = (0.0005A)^{1.5}$ = 149.43 lbs/blast

$EF_{PM10} = 0.5 \times EF_{TSP}$ = 74.72 lbs/blast (Assumption)

Where:

A = Horizontal Area of Blast = 56,320.00 sq.ft

Emission Unit		lbs/blast		Blasts/time	Emission Controls		Cntrld Emission (lbs/time)	
		EF_{TSP}	EF_{PM10}		ECF	Technology	TSP	PM10
1.003	Blasting - Waste Rock	149	74.72	174.13	0%	(Uncontrolled)	2.60E+04	1.30E+04
1.005	Blasting - Ore	149	74.72	87.07	0%	(Uncontrolled)	1.30E+04	6.51E+03

Emission Unit		Controlled Emissions (lbs/time)							
		Sb	As	Be	Cd	Cr	Co	Pb	Mn
1.003	Blasting - Waste Rock	3.42E-01	1.54E+00	5.20E-02	1.30E-01	2.84E+00	3.56E-01	1.30E-01	1.58E+01
1.005	Blasting - Ore	4.27E-01	2.34E+00	2.60E-02	7.16E-02	1.04E+00	1.50E-01	1.72E-01	1.01E+01

Emission Unit		Controlled Emissions (lbs/time)		
		Hg	Ni	Se
1.003	Blasting - Waste Rock	1.03E-02	5.20E-01	1.30E-01
1.005	Blasting - Ore	5.22E-03	3.25E-01	6.51E-02

Calculations - Annual Operations

Blasting Sources - Explosives Detonation
(Emission Factor Source: AP-42 (5th Ed.) 13.3-1 (Explosives Detonation))
Emission Factors
Ammonium Nitrate Fuel Oil (ANFO)
EF_{NOx} = 17.00 lbs/ton of Explosive Used
EF_{SOx} = 2.00 lbs/ton of Explosive Used
EF_{CO} = 67.00 lbs/ton of Explosive Used
Pentaerythritol tetranitrate (PETN) - Booster
EF_{CO} = 297.00 lbs/ton of Explosive Used

Emission Unit		lbs/ton of Explosive Used				Tons of Explosive/Time	
		$EF_{NOx-ANFO}$	$EF_{SOx-ANFO}$	$EF_{CO-ANFO}$	$EF_{CO-PETN}$	ANFO	PETN
1.004	Explosives Detonation - Waste Rock Blasting	17	2.00	67.00	297.00	3955.36	4.79
1.006	Explosives Detonation - Ore Blasting	17	2.00	67.00	297.00	1977.68	2.39

Emission Unit		Emission Controls		Controlled Emission (lbs/time)		
		ECF	Technology	NOx	SOx	CO
1.004	Explosives Detonation - Waste Rock Blasting	0%	(Uncontrolled)	6.72E+04	7.91E+03	2.66E+05
1.006	Explosives Detonation - Ore Blasting	0%	(Uncontrolled)	3.36E+04	3.96E+03	1.33E+05

Calculations - Annual Operations

Drop Point Sources
(Emission Factor Source: AP-42 (5th Ed.) §13.2.4 - Aggregate Handling and Storage Piles)
EF_{TSP} (lbs/ton) = K x (0.0032) x {[(U/5)^1.3]/[(M/2)^1.4]}
EF_{PM10} (lbs/ton) = K x (0.0032) x {[(U/5)^1.3]/[(M/2)^1.4]}
Where:
K = Particle Size Multiplier (dimensionless)
U = Mean Wind Speed (MPH)
M = Material Moisture Content

Emission Unit		Mean Wind Speed	Mat. Moisture Content	Emission Factors		tons/time	Emission Controls	
				EF_{TSP}	EF_{PM10}		ECF	Technology
1.007	Waste Rock Loading	3.0	3.67	0.0005	0.0002	3.16E+07	0%	(Uncontrolled)
1.008	Ore Loading	3.0	3.67	0.0005	0.0002	1.58E+07	0%	(Uncontrolled)
1.009	Waste Rock Dumpting	8.0	3.67	0.0013	0.0006	3.16E+07	0%	(Uncontrolled)
1.010	Ore Dumping	6.0	3.67	0.0013	0.0006	1.58E+07	0%	(Uncontrolled)
2.003	Lime Application to Ore	6.0	1.00	0.0079	0.0037	11,862.50	70%	(Water Sprays)

Emission Unit		Controlled Emission (lbs/time)						
		TSP	PM_{10}	Sb	As	Be	Cd	Cr
1.007	Waste Rock Loading	1.65E+04	7.80E+03	2.17E-01	9.78E-01	3.30E-02	8.24E-02	1.80E+00
1.008	Ore Loading	8.24E+03	3.90E+03	2.70E-01	1.48E+00	1.65E-02	4.53E-02	6.59E-01
1.009	Waste Rock Dumpting	4.06E+04	1.92E+04	5.34E-01	2.41E+00	8.12E-02	2.03E-01	4.42E+00
1.010	Ore Dumping	2.03E+04	9.60E+03	6.66E-01	3.65E+00	4.06E-02	1.12E-01	1.62E+00
2.003	Lime Application to Ore	2.82E+01	1.33E+01	n/a	n/a	n/a	n/a	n/a

Emission Unit		Controlled Emission (lbs/time)					
		Co	Pb	Mn	Hg	Ni	Se
1.007	Waste Rock Loading	2.25E-01	8.24E-02	1.00E+01	6.54E-03	3.30E-01	8.24E-02
1.008	Ore Loading	9.48E-02	1.09E-01	6.41E+00	3.30E-03	2.06E-01	4.12E-02
1.009	Waste Rock Dumpting	5.55E-01	2.03E-01	2.47E+01	1.81E-02	8.12E-01	2.03E-01
1.010	Ore Dumping	2.33E-01	2.69E-01	1.58E+01	8.14E-03	5.07E-01	1.01E-01
2.003	Lime Application to Ore	n/a	n/a	n/a	n/a	n/a	n/a

Dozing/Ripping/Spreading

(Source: AP-42 (5th Ed.) Table 11.9-4 (Overburden Dozing))

EF_{TSP} (lbs/hr) = (5.7(s)^1.2) / (M^1.3)

EF_{PM10} (lbs/hr) = 0.75 * ((1.0(s)^1.5)/M^1.4))

s = Material silt content

M = Material Moisture Content

Emission Unit		Silt Content	Moisture Content	(lbs/hr) EF_{TSP}	(lbs/hr) EF_{PM10}	hrs/time	Emission Controls ECF	Emission Controls Technology
1.011	Waste Rock Dozing	1.40	3.67	1.57E+00	2.01E-01	7,817.42	0%	(Uncontrolled)
2.004	Ore Ripping/Spreading/Dozing	1.26	3.67	1.39E+00	1.72E-01	7,817.42	0%	(Uncontrolled)

Emission Unit		Calculated Emissions (lbs/time) TSP	PM10	Sb	As	Be	Cd	Cr	Co
1.011	Waste Rock Dozing	1.23E+04	1.57E+03	1.62E-01	7.30E-01	2.46E-02	6.15E-02	1.34E+00	1.68E-01
2.004	Ore Ripping/Spreading/Dozing	1.08E+04	1.34E+03	3.56E-01	1.95E+00	2.17E-02	5.97E-02	8.68E-01	1.25E-01

Emission Unit		Calculated Emissions (lbs/time) Pb	Mn	Hg	Ni	Se
1.011	Waste Rock Dozing	6.15E-02	7.48E+00	4.89E-03	2.46E-01	6.15E-02
2.004	Ore Ripping/Spreading/Dozing	1.44E-01	8.43E+00	4.35E-03	2.71E-01	5.42E-02

Emissions from Unpaved Surfaces

(Emission Factor Source: AP-42 (5th Ed.) §13.2.2 - Unpaved Roads)

EF (lbs/VMT) = K*(5.9)*(s/12)*(S/30)*((W/3)^0.7)*((w/4)^0.5)*((365-p)/365))

Where:

K_{TSP} = 0.80 (dimensionless)

K_{PM10} = 0.36 (dimensionless)

s =Silt content of road surface material

S = Mean Vehicle Speed

W = Mean Vehicle Weight

w = Mean number of wheels

p = No. days with at least 0.01 in. of precipitation/year

Emission Unit		s	S	W	w	p	EF_{TSP}	EF_{PM10}	VMT/trip	VMT/Time
1.012	Waste Rock Hauling									
WR Haul - In-Pit Flat (Loaded)		1.26	17.69	530.00	6.00	8.00	13.10	5.89	0.19	18,984.49
WR Haul - Pit Ramp (Loaded)		1.26	8.50	530.00	6.00	8.00	6.29	2.83	0.49	48,004.18
WR Haul - Flat (Loaded)		1.26	22.20	530.00	6.00	8.00	16.44	7.40	0.63	61,933.63
WR Haul - Up Stockpile (Loaded)		1.26	12.30	530.00	6.00	8.00	9.11	4.10	0.12	11,832.54
WR Haul - SP Flat (Loaded)		1.26	20.80	530.00	6.00	8.00	15.40	6.93	0.16	15,483.41
WR Hauling - SP Flat (Empty)		1.26	28.10	210.00	6.00	8.00	10.88	4.90	0.16	15,483.41
WR Hauling - Down SP (Empty)		1.26	35.00	210.00	6.00	8.00	13.55	6.10	0.12	11,832.54
WR Hauling - Flat (Empty)		1.26	35.00	210.00	6.00	8.00	13.55	6.10	0.63	61,933.63
WR Hauling - Pit Ramp (Empty)		1.26	35.00	210.00	6.00	8.00	13.55	6.10	0.49	48,004.18
WR Hauling - In-Pit Flat (Empty)		1.26	26.25	210.00	6.00	8.00	10.17	4.57	0.19	18,984.49
	Total - Waste Rock Hauling	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3.16	#########
1.013	Ore Hauling									
Ore Haul - In-Pit Flat (Loaded)		1.26	17.69	530.00	6.00	8.00	13.10	5.89	0.19	9,492.25
Ore Haul - Pit Ramp (Loaded)		1.26	8.50	530.00	6.00	8.00	6.29	2.83	0.49	24,002.09
Ore Haul - Flat (Loaded)		1.26	22.20	530.00	6.00	8.00	16.44	7.40	0.63	30,966.82
Ore Haul - Up Heap (Loaded)		1.26	12.30	530.00	6.00	8.00	9.11	4.10	0.12	5,916.27
Ore Haul - Heap Flat (Loaded)		1.26	20.80	530.00	6.00	8.00	15.40	6.93	0.16	7,741.70
Ore Haul - Heap Flat (Empty)		1.26	28.10	210.00	6.00	8.00	10.88	4.90	0.16	7,741.70
Ore Haul - Down Heap (Empty)		1.26	35.00	210.00	6.00	8.00	13.55	6.10	0.12	5,916.27
Ore Haul - Flat (Empty)		1.26	35.00	210.00	6.00	8.00	13.55	8.10	0.63	30,966.82
Ore Haul - Pit Ramp (Empty)		1.26	35.00	210.00	6.00	8.00	13.55	6.10	0.49	24,002.09
Ore Haul - In-Pit Flat (Empty)		1.26	26.25	210.00	6.00	8.00	10.17	4.57	0.19	9,492.25
	Total - Ore Hauling	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3.16	#########
7.002	Water Truck Traffic	1.26	10.00	35.00	6.00	8.00	1.10	0.50	n/a	7,300.00
8.001	On-Site Delivery Truck Traffic	1.26	25.00	35.00	18.00	8.00	4.78	2.15	n/a	1,430.80
8.003	On-Site Light Vehicle Traffic	1.26	25.00	7.16	5.08	8.00	0.84	0.38	n/a	80,482.50
8.005	Off-Site Delivery Truck Traffic	1.26	35.00	18.00	8.33	8.00	2.86	1.29	n/a	12,161.80

8.006	Off-Site Light Vehicle Traffic	1.26	35.00	7.16	4.00	8.00	1.04	0.47	n/a	#########

Emissions from Unpaved Surfaces (Continued)

Emission Unit		Emission Controls		Controlled Emissions (lbs/time)					
		ECF	Technology	TSP	PM10	Sb	As	Be	Cd
1.012	Waste Rock Hauling								
WR Haul - In-Pit Flat (Loaded)		98%	(Chemical Tmt/Water)	4.97E+03	2.24E+03	n/a	n/a	n/a	n/a
WR Haul - Pit Ramp (Loaded)		98%	(Chemical Tmt/Water)	6.04E+03	2.72E+03	n/a	n/a	n/a	n/a
WR Haul - Flat (Loaded)		98%	(Chemical Tmt/Water)	2.04E+04	9.16E+03	n/a	n/a	n/a	n/a
WR Haul - Up Stockpile (Loaded)		98%	(Chemical Tmt/Water)	2.16E+03	9.70E+02	n/a	n/a	n/a	n/a
WR Haul - SP Flat (Loaded)		98%	(Chemical Tmt/Water)	4.77E+03	2.15E+03	n/a	n/a	n/a	n/a
WR Hauling - SP Flat (Empty)		98%	(Chemical Tmt/Water)	3.37E+03	1.52E+03	n/a	n/a	n/a	n/a
WR Hauling - Down SP (Empty)		98%	(Chemical Tmt/Water)	3.21E+03	1.44E+03	n/a	n/a	n/a	n/a
WR Hauling - Flat (Empty)		98%	(Chemical Tmt/Water)	1.68E+04	7.56E+03	n/a	n/a	n/a	n/a
WR Hauling - Pit Ramp (Empty)		98%	(Chemical Tmt/Water)	1.30E+04	5.86E+03	n/a	n/a	n/a	n/a
WR Hauling - In-Pit Flat (Empty)		98%	(Chemical Tmt/Water)	3.86E+03	1.74E+03	n/a	n/a	n/a	n/a
	Total - Waste Rock Hauling	98%	(Chemical Tmt/Water)	7.85E+04	3.53E+04	1.03E+00	4.66E+00	1.57E-01	3.93E-01
1.013	Ore Hauling								
Ore Haul - In-Pit Flat (Loaded)		98%	(Chemical Tmt/Water)	2.49E+03	1.12E+03	n/a	n/a	n/a	n/a
Ore Haul - Pit Ramp (Loaded)		98%	(Chemical Tmt/Water)	3.02E+03	1.36E+03	n/a	n/a	n/a	n/a
Ore Haul - Flat (Loaded)		98%	(Chemical Tmt/Water)	1.02E+04	4.58E+03	n/a	n/a	n/a	n/a
Ore Haul - Up Heap (Loaded)		98%	(Chemical Tmt/Water)	1.08E+03	4.85E+02	n/a	n/a	n/a	n/a
Ore Haul - Heap Flat (Loaded)		98%	(Chemical Tmt/Water)	2.38E+03	1.07E+03	n/a	n/a	n/a	n/a
Ore Haul - Heap Flat (Empty)		98%	(Chemical Tmt/Water)	1.68E+03	7.58E+02	n/a	n/a	n/a	n/a
Ore Haul - Down Heap (Empty)		98%	(Chemical Tmt/Water)	1.60E+03	7.22E+02	n/a	n/a	n/a	n/a
Ore Haul - Flat (Empty)		98%	(Chemical Tmt/Water)	8.39E+03	3.78E+03	n/a	n/a	n/a	n/a
Ore Haul - Pit Ramp (Empty)		98%	(Chemical Tmt/Water)	6.51E+03	2.93E+03	n/a	n/a	n/a	n/a
Ore Haul - In-Pit Flat (Empty)		98%	(Chemical Tmt/Water)	1.93E+03	8.68E+02	n/a	n/a	n/a	n/a
	Total - Ore Hauling	98%	(Chemical Tmt/Water)	3.93E+04	1.77E+04	5.17E-01	2.33E+00	7.85E-02	1.96E-01
7.002	Water Truck Traffic	99%	(Watering)	8.07E+01	3.63E+01	1.06E-03	4.79E-03	1.61E-04	4.03E-04
8.001	On-Site Delivery Truck Traffic	98%	(Chemical Tmt/Water)	1.37E+02	6.16E+01	1.80E-03	8.12E-03	2.74E-04	6.84E-04
8.003	On-Site Light Vehicle Traffic	98%	(Chemical Tmt/Water)	1.35E+03	6.06E+02	1.77E-02	7.99E-02	2.69E-03	6.74E-03
8.005	Off-Site Delivery Truck Traffic	80%	(Chemical Stabilizers)	6.96E+03	3.13E+03	9.16E-02	4.13E-01	1.39E-02	3.48E-02
8.006	Off-Site Light Vehicle Traffic	80%	(Chemical Stabilizers)	9.80E+04	4.41E+04	1.29E+00	5.81E+00	1.96E-01	4.90E-01

Emissions from Unpaved Surfaces (Continued)

Emission Unit		Controlled Emissions (lbs/time)						
		Cr	Co	Pb	Mn	Hg	Ni	Se
1.012	Waste Rock Hauling	8.56E+00	1.07E+00	3.93E-01	4.77E+01	3.12E-02	1.57E+00	3.93E-01
1.013	Ore Hauling	4.28E+00	5.37E-01	1.96E-01	2.39E+01	1.56E-02	7.85E-01	1.96E-01
7.002	Water Truck Traffic	8.79E-03	1.10E-03	4.03E-04	4.90E-02	3.20E-05	1.61E-03	4.03E-04
8.001	On-Site Delivery Truck Traffic	1.49E-02	1.87E-03	6.84E-04	8.32E-02	5.43E-05	2.74E-03	6.84E-04
8.003	On-Site Light Vehicle Traffic	1.47E-01	1.84E-02	6.74E-03	8.19E-01	5.35E-04	2.69E-02	6.74E-03
8.005	Off-Site Delivery Truck Traffic	7.58E-01	9.51E-02	3.48E-02	4.23E+00	2.76E-03	1.39E-01	3.48E-02
8.006	Off-Site Light Vehicle Traffic	1.07E+01	1.34E+00	4.90E-01	5.96E+01	3.89E-02	1.96E+00	4.90E-01

Ammonium Nitrate Silo Emissions - Loading/Unloading

(Source: AP-42 (5th Ed.) §8.2; Table 8.2-2 (Ammonium Nitrate Bulk Loading Operations)

EF_{TSP} = *0.02* lbs/ton

EF_{PM10} = 0.5 * EF_{TSP} = *0.01* lbs/ton (assumption)

Emission Unit		(lbs/ton) EF_{TSP}	EF_{PM10}	tons/time	Emission Controls ECF	Technology	Calculated Emissions (lbs/time) TSP	PM10
1.014	Ammonium Nitrate Prill Silo Loading	0.02	0.010	5,933.05	0%	(Uncontrolled)	1.19E+02	5.93E+01
1.015	Ammonium Nitrate Prill Silo Unloading	0.02	0.010	5,933.05	0%	(Uncontrolled)	1.19E+02	5.93E+01

Wind Erosion

(Source: AP-42 (4th Ed.) §11.2.3 Aggregate Handling & Storage Piles)

EF_{TSP} (lbs/acre/day) = 1.7 x (s/5) x (f/15) x ((365-p)/235)

EF_{PM10} (lbs/acre/day) = EF_{TSP} x 0.5

s = Silt content of surface material

f = percentage of time that the unobstructed wind speed exceeds 5.4 m/s (12 MPH)

p = No. days/year with at least 0.01 in. of precipitation/year

Emission Unit		Emission Factor Variables s	f (%)	p (%)	(lb/acre/day) EF_{TSP}	EF_{PM10}	Stockpile Size (Acres)
1.016	Wind Erosion (Waste Rock Stockpiles)	1.40	9.10	8.00	0.44	0.22	40.00
1.017	Wind Erosion (Soil Stockpiles)	1.40	9.10	8.00	0.44	0.22	10.00
2.009	Wind Erosion (Heap) - Non-Leach	1.26	9.10	8.00	0.39	0.20	20.40
2.010	Wind Erosion (Heap) - Leach	1.26	9.10	8.00	0.39	0.20	20.40

Emission Unit		Day/Time	Emission Controls ECF	Technology	Controlled Emissions (lbs/time) TSP	PM10	Sb
1.016	Wind Erosion (Waste Rock Stockpiles)	365.00	0%	(Uncontrolled)	6.40E+03	3.20E+03	8.43E-02
1.017	Wind Erosion (Soil Stockpiles)	365.00	0%	(Uncontrolled)	1.60E+03	8.01E+02	2.11E-02
2.009	Wind Erosion (Heap) - Non-Leach	365.00	0%	(Uncontrolled)	2.94E+03	1.47E+03	9.64E-02
2.010	Wind Erosion (Heap) - Leach	365.00	95%	(Leachate)	1.47E+02	7.35E+01	4.82E-03

Emission Unit		Controlled Emissions (lbs/time) As	Be	Cd	Cr	Co	Pb
1.016	Wind Erosion (Waste Rock Stockpiles)	3.80E-01	1.28E-02	3.20E-02	6.98E-01	8.76E-02	3.20E-02
1.017	Wind Erosion (Soil Stockpiles)	9.50E-02	3.20E-03	8.01E-03	1.75E-01	2.19E-02	8.01E-03
2.009	Wind Erosion (Heap) - Non-Leach	5.28E-01	5.88E-03	1.62E-02	2.35E-01	3.38E-02	3.90E-02
2.010	Wind Erosion (Heap) - Leach	2.64E-02	2.94E-04	8.08E-04	1.18E-02	1.69E-03	1.95E-03

Emission Unit		Controlled Emissions (lbs/time) Mn	Hg	Ni	Se
1.016	Wind Erosion (Waste Rock Stockpiles)	3.89E+00	2.54E-03	1.28E-01	3.20E-02
1.017	Wind Erosion (Soil Stockpiles)	9.73E-01	6.36E-04	3.20E-02	8.01E-03
2.009	Wind Erosion (Heap) - Non-Leach	2.28E+00	1.18E-03	7.35E-02	1.47E-02
2.010	Wind Erosion (Heap) - Leach	1.14E-01	5.89E-05	3.67E-03	7.35E-04

Calculations - Annual Operations

Combustion - Mobile Sources (Haul Trucks)

(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Off-Highway Trucks)

EF_{TSP} = 14.10 lbs/1000 gal

$EF_{PM10} = EF_{TSP} \times 0.52$ = 7.33 lbs/1000 gal

EF_{SOx} = 31.20 lbs/1000 gal * N.B. Not Low-Sulfur Fuel - Conservative Numbers

EF_{NOx} = 286.10 lbs/1000 gal

EF_{CO} = 123.46 lbs/1000 gal

EF_{VOC} = 13.60 lbs/1000 gal

Emission Unit		(lbs/1000 gal)						(mgal/time)	ECF
		EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}		
1.018	Haul Truck (Combustion)	14.10	7.33	31.20	286.10	123.46	13.60	3,109.45	0%

Emission Unit		Controlled Emissions (lbs/time)					
		TSP	PM10	SOx	NOx	CO	VOCs
1.018	Haul Truck (Combustion)	4.39E+04	2.28E+04	9.70E+04	8.90E+05	3.84E+05	4.23E+04

Calculations - Annual Operations

Combustion - Mobile Sources (Dozers)

(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Wheeled Dozer)

EF_{TSP} = 14.80 lbs/1000 gal

$EF_{PM10} = EF_{TSP} \times 0.52$ = 7.70 lbs/1000 gal

EF_{SOx} = 31.20 lbs/1000 gal

EF_{NOx} = 286.10 lbs/1000 gal

EF_{CO} = 123.46 lbs/1000 gal

EF_{VOC} = 13.60 lbs/1000 gal

Emission Unit		(lbs/1000 gal)						(mgal/time)	ECF
		EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}		
1.019	WRS Dozer (Combustion)	14.80	7.70	31.20	286.10	123.46	13.60	156.35	0%
2.005	Heap Leach Dozer (Combustion)	14.80	7.70	31.20	286.10	123.46	13.60	156.35	0%

Emission Unit		Controlled Emissions (lbs/time)					
		TSP	PM10	SOx	NOx	CO	VOCs
1.019	WRS Dozer (Combustion)	2.31E+03	1.20E+03	4.88E+03	4.47E+04	1.93E+04	2.13E+03
2.005	Heap Leach Dozer (Combustion)	2.31E+03	1.20E+03	4.88E+03	4.47E+04	1.93E+04	2.13E+03

Combustion Emissions - Diesel and Gasoline Fueled Engines
(Source: AP-42 (5th Ed.) §3.3 - Gasoline and Diesel Fueled Industrial Engines)

Emission Factors Based on Fuel Consumption

EF_{TSP} = 0.5962 lbs/mmBTU
EF_{PM10} = 0.3100 lbs/mmBTU
EF_{SOx} = 0.29 lbs/mmBTU
EF_{NOx} = 4.41 lbs/mmBTU
EF_{CO} = 0.95 lbs/mmBTU
EF_{VOC} = 0.35 lbs/mmBTU

Emission Unit		(gal/time)	(mmBTU/gal)	ECF	Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOC/ROGs
1.020	Drill Rig (Combustion)	192,500.76	0.133936	0%	1.54E+04	7.99E+03	7.48E+03	1.14E+05	2.45E+04	9.02E+03

Emission Factors Based on Engine Rating

EF_{TSP} = 4.62E-03 lbs/hp-hr
EF_{PM10} = 2.20E-03 lbs/hp-hr
EF_{SOx} = 2.05E-03 lbs/hp-hr
EF_{NOx} = 3.10E-02 lbs/hp-hr
EF_{CO} = 6.68E-03 lbs/hp-hr
EF_{VOC} = 2.51E-03 lbs/hp-hr

Emission Unit		hp	hrs/time	ECF	Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOC/ROGs
7.004	Mobile Light Plant - Pit #1	22.00	3,650.00	0%	3.71E+02	1.77E+02	1.65E+02	2.49E+03	5.36E+02	2.02E+02
7.005	Mobile Light Plant - Pit #2	22.00	3,650.00	0%	3.71E+02	1.77E+02	1.65E+02	2.49E+03	5.36E+02	2.02E+02
7.006	Mobile Light Plant - Heap	22.00	3,650.00	0%	3.71E+02	1.77E+02	1.65E+02	2.49E+03	5.36E+02	2.02E+02
7.007	Mobile Light Plant - WRS	22.00	3,650.00	0%	3.71E+02	1.77E+02	1.65E+02	2.49E+03	5.36E+02	2.02E+02

Combustion - Mobile Sources (Loaders)
(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Wheeled Loaders)

EF_{TSP} = 29.30 lbs/1000 gal
$EF_{PM10} = EF_{TSP} \times 0.52$ = 15.24 lbs/1000 gal
EF_{SOx} = 31.20 lbs/1000 gal
EF_{NOx} = 339.82 lbs/1000 gal
EF_{CO} = 98.66 lbs/1000 gal
EF_{VOC} = 43.16 lbs/1000 gal

Emission Unit		(lbs/1000 gal) EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}	(mgal/time)	ECF
1.021	Loader (Combustion)	29.30	15.24	31.20	339.82	98.66	43.16	196.57	0%
1.022	Clean-up Loader (Combustion)	29.30	15.24	31.20	339.82	98.66	43.16	52.12	0%

Emission Unit		Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOCs
1.021	Loader (Combustion)	5.76E+03	3.00E+03	6.13E+03	6.68E+04	1.94E+04	8.48E+03
1.022	Clean-up Loader (Combustion)	1.53E+03	7.94E+02	1.63E+03	1.77E+04	5.14E+03	2.25E+03

Calculations - Annual Operations

Silo Emissions - Loading
(Source: AP-42 (5th Ed.) §11.12, Table 11.12-2: Cement Unloading to Elevated Storage Silo (Pneumatic)

EF_{TSP} = *0.2700* lbs/ton (TSP)

$EF_{PM10} = 0.5 * EF_{TSP}$ = *0.1350* lbs/ton (PM_{10}) (assumption)

Emission Unit		(lbs/ton) EF_{TSP}	EF_{PM10}	(tons/time)	Emission Controls ECF	Technology	Controlled Emissions (lbs/time) TSP	PM10
2.001	Portable R-O-M Lime Silo Loading	0.2700	0.1350	11,862.50	99%	(Baghouse)	3.20E+01	1.60E+01

Calculations - Annual Operations

Silo Emissions - Loading
(Source: AP-42 (5th Ed.) §11.12, Table 11.12-2: Weigh Hopper Loading)

$EF_{TSP} = (EF_{PM10})$ = *0.0200* lbs/ton (TSP) (assumption)

EF_{PM10} = *0.0200* lbs/ton (PM_{10})

Emission Unit		(lbs/ton) EF_{TSP}	EF_{PM10}	(tons/time)	Emission Controls ECF	Technology	Controlled Emissions (lbs/time) TSP	PM10
2.002	Portable R-O-M Lime Hopper Loading	0.0200	0.0200	11,862.50	0%	(Uncontrolled)	2.37E+02	2.37E+02

Hydrocyanic Acid Emissions from Heap Leach Pads

(Emission Factor Source: Mesquite Mine AB2588 Air Toxic Inventory Report, Addendum - HCN Emissions from Heap Leaching Operations, 1991)

EF_{HCN} = 420.000 lbs/acre-yr

Emission Unit		Size of Heap Under Leach (Acres)	ECF	yrs/time	Controlled Emissions (lbs/time)
2.006	Cyanide Application and Leaching	20.40	0%	1.0000	8.57E+03

Hydrocyanic Acid Emissions from Open Top (Pond) Sources

(Emission Factor Source: Domes Study, 1980)

EF_{HCN} = 5.60E-05 lbs/ft2/da

HCN Emissions= Domes Emission (lb/ft2/da)xFactor(t)xFactor(pH)xFactor(c)x MWHCN/MWCN x Pond Size x da/yr x (100%-ECF)

Emission Unit		Exposed Suface Area (ft2)	Average pH of Pond	NaCN Conc. (ppm)	Soln. Temp. (C)	HCN VP (mmHg)	Emission Controls	
							ECF	Technology
2.007	Pregnant Solution Pond	54,400.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
2.008	Barren Solution Pond	54,400.0	10.6	25.0	28.9	795.0	0%	(Uncontrolled)
3.001	Carbon Adsorption Tank 1	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.002	Carbon Adsorption Tank 2	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.003	Carbon Adsorption Tank 3	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.004	Carbon Adsorption Tank 4	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.005	Carbon Adsorption Tank 5	100.0	10.6	25.0	30.0	796.0	0%	(Uncontrolled)
3.007	Cyanide Make-up Tank	113.0	12.0	240,000.0	28.9	795.0	0%	(Uncontrolled)
3.008	Strip Tank	38.5	13.5	2,000.0	30.0	800.0	0%	(Uncontrolled)
3.009	Electrowinning Cell	24.0	13.5	250.0	369.3	825.0	0%	(Uncontrolled)
5.003	Fume Hood	0.8	12.0	240,000.0	12.0	790.0	0%	(Uncontrolled)

Hydrocyanic Acid Emissions from Open Top (Pond) Sources - continued
(Emission Factor Source: Domes Study, 1980)

Emission Unit		Soln. Conc. ppm (as CN)	HCN Conc. @ pH	pH Factor	Vapor Press. Factor	Conc. Factor	days/time	lbs/time
2.007	Pregnant Solution Pond	13.27	4.0%	8.00	2.75	0.20	365	5.17E+03
2.008	Barren Solution Pond	13.27	4.8%	9.50	2.75	0.20	365	6.13E+03
3.001	Carbon Adsorption Tank 1	13.27	4.0%	8.00	2.75	0.20	365	9.50E+00
3.002	Carbon Adsorption Tank 2	13.27	4.0%	8.00	2.75	0.20	365	9.50E+00
3.003	Carbon Adsorption Tank 3	13.27	4.0%	8.00	2.75	0.20	365	9.50E+00
3.004	Carbon Adsorption Tank 4	13.27	4.0%	8.00	2.75	0.20	365	9.50E+00
3.005	Carbon Adsorption Tank 5	13.27	4.0%	8.00	2.75	0.20	365	9.50E+00
3.007	Cyanide Make-up Tank	127,346.94	0.00%	0.00	2.75	1,950.18	365	0.00E+00
3.008	Strip Tank	1,061.22	0.00%	0.00	2.77	16.25	365	0.00E+00
3.009	Electrowinning Cell	132.65	0.00%	0.00	2.85	2.03	365	0.00E+00
5.003	Fume Hood	127,346.94	0.00%	0.00	2.73	1,950.18	365	0.00E+00

Acid Emissions - Hydrochloric Acid Storage/Use
(Source: Nevada Mining Association Data, 1995)

EF_{HCl} (lb/lb acid consumed) = 0.01 lb/lb (Acid Consumed) x Acid Strength (%) / 100

Emission Unit		Acid Strength	(lbs/lb) EF_{HCl}	lbs/time	Emission Controls ECF	Emission Controls Technology	Ctrld Emission (lbs/time) HCl
3.006	Acid Wash Tank	5%	0.0005	706,616	0%	(Uncontrolled)	3.53E+02
5.004	Waste Acid Tank	n/a [1]	n/a	n/a	n/a	n/a	n/a

[1] Emissions from Emission Unit 5.004 (Waste Acid Tank) included in emission calculations for Unit 3.006.

Calculations - Annual Operations

Mercury Retort Furnace Emissions
(Source: Chemgold Personnel)

Emission Unit		(lbs/hr) EF_{Hg}	hrs/time	Emission Controls ECF	Technology	Ctrld Emissions (lbs/time) Hg
4.001	Mercury Retort Furnace (Electric)	4.13E-06	2,190.00	0%	(Uncontrolled)	9.04E-03

Calculations - Annual Operations

Crushing Operations
(Source: AP-42 (5th Ed.) §11.24 - Metallic Mineral Processing (Low Moisture Ore)) - Split 65% Crushers/35% Screens per EPA Guidance

EF_{TSP} = *0.7800* lbs/ton (TSP)

EF_{PM10} = *0.0553* lbs/ton (PM_{10})

Emission Unit		(lbs/ton) EF_{TSP}	EF_{PM10}	(tons/time)	Emission Controls ECF	Technology	Controlled Emissions (lbs/time) TSP	PM10	Sb
5.001	Jaw Crusher	0.7800	0.0553	478.40	0%	(Uncontrolled)	3.73E+02	2.64E+01	1.22E-02
5.002	Pulverizer	0.7800	0.0553	478.40	0%	(Uncontrolled)	3.73E+02	2.64E+01	1.22E-02

Emission Unit		Controlled Emissions (lbs/time) As	Be	Cd	Cr	Co	Pb	Mn	Hg
5.001	Jaw Crusher	6.71E-02	7.46E-04	2.05E-03	2.99E-02	4.29E-03	4.94E-03	2.90E-01	1.50E-04
5.002	Pulverizer	6.71E-02	7.46E-04	2.05E-03	2.99E-02	4.29E-03	4.94E-03	2.90E-01	1.50E-04

Emission Unit		Cntrld Emissions (lbs/time) Ni	Se
5.001	Jaw Crusher	9.33E-03	1.87E-03
5.002	Pulverizer	9.33E-03	1.87E-03

Calculations - Annual Operations

Organic Liquid Storage Tanks - Diesel Storage

(Source: Leaking Underground Fuel Tank Field Manual, California State Water Resources Control Board, 1990.)

$EF_{Napthalene}$ =	0.13%	
$EF_{Cadmium}$ =	4.00E-02 ug/g =	4.00E-08 lbs/lb
$EF_{Chromium}$ =	3.60E-01 ug/g =	3.60E-07 lbs/lb
EF_{Cobalt} =	5.00E-02 ug/g =	5.00E-08 lbs/lb
EF_{Lead} =	1.00E-01 ug/g =	1.00E-07 lbs/lb
EF_{Nickel} =	5.00E-02 ug/g =	5.00E-08 lbs/lb
$EF_{Selenium}$ =	2.00E-02 ug/g =	2.00E-08 lbs/lb

(Source of VOC Emission Calcultations: AP-42 (5th Ed.) §7.1 - Liquid Organic Storage Tanks - Calculated Via US EPA Tanks Program (Vers. 2.0))

Emission Unit		Standing Losses lbs/time (VOCs)	Working Losses lbs/time (VOCs)	Controlled Emissions (lbs/time)			
				VOCs	Napthalene	Cadmium	Chromium
6.001	Main Diesel Tank 1	7.04	63.85	7.09E+01	9.22E-02	2.84E-06	2.55E-05
6.002	Street Diesel Tank	0.28	2.78	3.06E+00	3.98E-03	1.22E-07	1.10E-06

Emission Unit		Controlled Emissions (lbs/time)			
		Cobalt	Lead	Nickel	Selenium
6.001	Main Diesel Tank 1	3.54E-06	7.09E-06	3.54E-06	1.42E-06
6.002	Street Diesel Tank	1.53E-07	3.06E-07	1.53E-07	6.12E-08

Calculations - Annual Operations

Organic Liquid Storage Tanks - Gasoline Storage

(Source: Leaking Underground Fuel Tank Field Manual, California State Water Resources Control Board, 1990.)

$EF_{Benzene}$ =	1.81%	
EF_{Hexane} =	1.87%	
$EF_{2,2,4\text{-}Trimethylpentane}$ =	2.45%	
$EF_{Xylenes}$ =	5.77%	
$EF_{Toluene}$ =	12.27%	
$EF_{Ethylbenzene}$ =	1.61%	
$EF_{Naphalene}$ =	0.29%	
$EF_{Bromine}$ =	2.13E+02 ug/g =	2.13E-04 lbs/lb
$EF_{Cadmium}$ =	4.00E-02 ug/g =	4.00E-08 lbs/lb
$EF_{Chlorine}$ =	1.90E+02 ug/g =	1.90E-04 lbs/lb
EF_{Lead} =	1.30E-02 g/g =	0-Jan-00 lbs/lb

(Source of VOC Emission Calcultations: AP-42 (5th Ed.) §7.1 - Liquid Organic Storage Tanks - Calculated Via US EPA Tanks Program (Vers. 2.0))

Emission Unit		Standing Losses lbs/time (VOCs)	Working Losses lbs/time (VOCs)	Controlled Emissions (lbs/time)		
				VOCs	Benzene	Hexane
6.003	Unleaded Gasoline Tank	625.94	563.29	1.19E+03	2.15E+01	2.22E+01

Emission Unit		Controlled Emissions (lbs/yr)				
		2,2,4-Trimethylpentane	Xylenes	Toluene	Ethylbenzene	Napthalene
6.003	Unleaded Gasoline Tank	2.91E+01	6.86E+01	1.46E+02	1.91E+01	3.45E+00

Emission Unit		Controlled Emissions (lbs/yr)			
		Bromine	Cadmium	Chlorine	Lead
6.003	Unleaded Gasoline Tank	2.53E-01	4.76E-05	2.26E-01	1.55E+01

Organic Liquid Storage Tanks - Ethylene Glycol

(Source of VOC Emission Calcultations: AP-42 (5th Ed.) §7.1 - Liquid Organic Storage Tanks - Calculated Via US EPA Tanks Program (Vers. 2.0))

Emission Unit		% of Ethylene Glycol in Soln.	Standing Losses lbs/time (VOCs)	Working Losses lbs/time (VOCs)	Controlled Emissions (lbs/time)	
					VOCs	Ethylene Glycol
6.004	Coolant Tank	95%	0.18	0.02	2.00E-01	1.90E-01

Combustion - Mobile Sources (Off-Highway Trucks)

(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Off-Highway Trucks)

EF_{TSP} = 17.70 lbs/1000 gal

$EF_{PM10} = EF_{TSP} \times 0.52$ = 9.20 lbs/1000 gal

EF_{SOx} = 31.20 lbs/1000 gal

EF_{NOx} = 286.10 lbs/1000 gal

EF_{CO} = 123.46 lbs/1000 gal

EF_{VOC} = 13.60 lbs/1000 gal

Emission Unit		(lbs/1000 gal)							
		EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}	(mgal/time)	ECF
7.001	Water Truck (Combustion)	17.70	9.20	31.20	286.10	123.46	13.60	138.64	0%

Emission Unit		Controlled Emissions (lbs/time)					
		TSP	PM10	SOx	NOx	CO	VOCs
7.001	Water Truck (Combustion)	2.45E+03	1.28E+03	4.33E+03	3.97E+04	1.71E+04	1.89E+03

Calculations - Annual Operations

Combustion Emissions - Large Stational Diesel Engines

(Source: AP-42 (5th Ed.) §3.4.2 - Large Uncontrolled Stationary I.C. Engines)

EF_{TSP} =	0.0697 lbs/mmBTU	$EF_{Benzene}$ =	7.06E-04 lbs/mmBTU
EF_{PM10} =	0.0573 lbs/mmBTU	$EF_{Toluene}$ =	2.81E-04 lbs/mmBTU
EF_{SOx} = 1.01 x S =	5.05E-02 lbs/mmBTU	$EF_{Xylenes}$=	1.93E-04 lbs/mmBTU
EF_{NOx} =	3.10E+00 lbs/mmBTU	$EF_{Formaldehyde}$ =	7.89E-05 lbs/mmBTU
EF_{CO} =	8.10E-01 lbs/mmBTU	$EF_{Acetaldehyde}$ =	2.52E-05 lbs/mmBTU
EF_{VOC} =	9.00E-02 lbs/mmBTU	$EF_{Acrolein}$ =	7.88E-06 lbs/mmBTU
		$EF_{Naphthalene}$ =	1.30E-04 lbs/mmBTU

Emission Unit		S	(gal/time)	(mmBTU/gal)	ECF	Technology	Controlled Emissions (lbs/time) TSP	PM10
7.003	Backup Diesel Generator	0.05	1,840.00	0.133936	0%	(Uncontrolled)	1.72E+01	1.41E+01

Emission Unit		Controlled Emissions (lbs/time) SOx	NOx	CO	VOC/ROGs	Benzene	Toluene	Xylenes
7.003	Backup Diesel Generator	1.24E+01	7.64E+02	2.00E+02	2.22E+01	1.74E-01	6.93E-02	4.76E-02

Emission Unit		Controlled Emissions (lbs/time) Formaldehyde	Acetaldehyde	Acrolein	Naphthalene
7.003	Backup Diesel Generator	1.94E-02	6.21E-03	1.94E-03	3.20E-02

Calculations - Annual Operations

Combustion Emissions - Large Diesel, Non-Road Engines

(Source: CARB Standard 2000 for Engines >=175 hp)

EF_{TSP} =	*1.60E-01*	g/hp-hr	0.00035	#/hp-hr
EF_{PM10} =	*8.16E-02*	g/hp-hr	0.00018	#/hp-hr
EF_{SOx} =	4.52E-06	g/hp-hr	0.00205	#/hp-hr
EF_{NOx} =	5.80E+00	g/hp-hr	0.01279	#/hp-hr
EF_{CO} =	8.50E+00	g/hp-hr	0.01874	#/hp-hr
EF_{VOC} =	1.00E+00	g/hp-hr	0.00220	#/hp-hr

Emission Unit		hp	hrs/time	ECF	Controlled Emissions (lbs/time) TSP	PM10	SOx	NOx	CO	VOC/ROGs
7.008	Cable Reel Machine	315.00	8,760.00	0%	9.73E+02	4.96E+02	5.66E+03	3.53E+04	5.17E+04	6.08E+03

Calculations - Annual Operations

Grading of Road Surface

(Source: AP-42 (5th Ed.) §11.9 - Western Surface Coal Mining, Motor Grader - Grading)

EF_{TSP} = 0.040(S)^2.5 = 2.24 #/VMT

EF_{PM10} = (0.051(S)^2)*0.6 = 0.77 #/VMT

Emission Unit		Speed, MPH (S)	hrs/time	VMT/Time	Emission Controls		Controlled Emissions (lbs/time)			
					ECF	Technology	TSP	PM10	Sb	As
7.009	Grading of Road Surface	5	6701.4	33507	98%	(Chemical Tmt/Water)	5.13E+02	1.50E+03	6.75E-03	3.04E-02

Emission Unit		Controlled Emissions (lbs/time)								
		Be	Cd	Cr	Co	Pb	Mn	Hg	Ni	Se
7.009	Grading of Road Surface	1.03E-03	2.56E-03	5.59E-02	7.01E-03	2.56E-03	3.12E-01	2.04E-04	1.03E-02	2.56E-03

Calculations - Annual Operations

Combustion - Mobile Sources (Wheeled Graders)

(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §II-7 - Heavy Duty Construction Equipment, Table II-7.1, Wheeled Graders)

EF_{TSP} = 22.20 lbs/1000 gal

$EF_{PM10} = EF_{TSP} \times 0.52$ = 11.54 lbs/1000 gal

EF_{SOx} = 31.20 lbs/1000 gal

EF_{NOx} = 253.84 lbs/1000 gal

EF_{CO} = 54.65 lbs/1000 gal

EF_{VOC} = 12.73 lbs/1000 gal

Emission Unit		(lbs/1000 gal)						(mgal/time)	ECF
		EF_{TSP}	EF_{PM10}	EF_{SOx}	EF_{NOx}	EF_{CO}	EF_{VOC}		
7.010	Grader (Combustion)	22.20	11.54	31.20	253.84	54.65	12.73	67.01	0%

Emission Unit		Controlled Emissions (lbs/time)					
		TSP	PM10	SOx	NOx	CO	VOCs
7.010	Grader (Combustion)	1.49E+03	7.74E+02	2.09E+03	1.70E+04	3.66E+03	8.53E+02

Combustion - Mobile Sources (On-Highway Trucks/Light Vehicles)
(Source: AP-42 - Vol. 2 (Mobile) (4th Ed.) §A.1.1. Light Duty Trucks)

EF_{TSP} = 0.42 G/VMT = 0.00093 #/VMT
EF_{PM10} = 0.20 G/VMT = 0.00044 #/VMT
EF_{CO} = 3.40 G/VMT = 0.00750 #/VMT
EF_{SOx} = 0.11 G/VMT = 0.00024 #/VMT (Conservatuve Assumption - Avg. NOx: SOx Ratio 9:1)
EF_{NOx} = 1.00 G/VMT = 0.00220 #/VMT
EF_{VOC} = 0.41 G/VMT = 0.00090 #/VMT

			Emission Controls		Controlled Emissions (lbs/time)					
Emission Unit		VMT/Time	ECF	Technology	TSP	PM10	CO	SOx	NOx	VOC/ROGs
8.002	On-Site Delivery Truck (Combustion)	1,430.80	0%	(Uncontrolled)	6.31E-01	6.31E-01	1.07E+01	3.50E-01	3.15E+00	1.29E+00
8.004	On-Site Light Vehicle (Combustion)	80,482.50	0%	(Uncontrolled)	7.45E+01	3.55E+01	6.03E+02	1.97E+01	1.77E+02	7.27E+01

APPENDIX F

SUMMARY REPORT OF CALCULATIONS OF EMISSIONS FROM LIQUID ORGANIC TANKS FROM U.S. EPA TANKS PROGRAM (VERSION 3.0)

TANKS PROGRAM 3.0
EMISSIONS REPORT - SUMMARY FORMAT
TANK IDENTIFICATION AND PHYSICAL CHARACTERISTICS

Identification

Identification No.:	IP-6.001
City:	Imperial County
State:	CA
Company:	Glamis Imperial Corp.
Type of Tank:	Vertical Fixed Roof
Description:	Main Diesel Tank

Tank Dimensions

Shell Height (ft):	20.0
Diameter (ft):	19.0
Liquid Height (ft):	19.0
Avg. Liquid Height (ft):	15.0
Volume (gallons):	40000
Turnovers:	100.0
Net Throughput (gal/yr):	4016000

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition:	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Cone
Height (ft):	0.00
Radius (ft) (Dome Roof):	0.00
Slope (ft/ft) (Cone Roof):	0.0000

Breather Vent Settings

Vacuum Setting (psig):	0.00
Pressure Setting (psig):	0.00

Meteorological Data Used in Emission Calculations: Yuma, Arizona (Avg Atmospheric Pressure = 14.7 psia)

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	76.49	69.16	83.82	73.92	0.0110	0.0087	0.0137	130.000			130.00	Option 3: A=12.1010, B=8907.0

Annual Emissions Report

Liquid Contents	Losses (lbs.): Standing	Working	Total
Distillate fuel oil no. 2	7.04	63.85	70.89
Total:	7.04	63.85	70.89

Identification

Identification No.:	IP-6.002
City:	Imperial County
State:	CA
Company:	Glamis Imperial Corp.
Type of Tank:	Vertical Fixed Roof
Description:	Street Diesel Tank

Tank Dimensions

Shell Height (ft):	10.0
Diameter (ft):	6.0
Liquid Height (ft):	10.0
Avg. Liquid Height (ft):	8.0
Volume (gallons):	2000
Turnovers:	55.0
Net Throughput (gal/yr):	109600

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition:	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Cone
Height (ft):	0.00
Radius (ft) (Dome Roof):	0.00
Slope (ft/ft) (Cone Roof):	0.0000

Breather Vent Settings

Vacuum Setting (psig):	0.00
Pressure Setting (psig):	0.00

Meteorological Data Used in Emission Calculations: Yuma, Arizona (Avg Atmospheric Pressure = 14.7 psia)

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	76.49	69.16	83.82	73.92	0.0110	0.0087	0.0137	130.000			130.00	Option 3: A=12.1010, B=8907.0

Annual Emissions Report

Liquid Contents	Losses (lbs.): Standing	Working	Total
Distillate fuel oil no. 2	0.28	2.78	3.06
Total:	0.28	2.78	3.06

Identification	
Identification No.:	IP-6.003
City:	Imperial County
State:	CA
Company:	Glamis Imperial Corp.
Type of Tank:	Vertical Fixed Roof
Description:	Unleaded Gasoline Tank
Tank Dimensions	
Shell Height (ft):	10.0
Diameter (ft):	6.0
Liquid Height (ft):	10.0
Avg. Liquid Height (ft):	7.0
Volume (gallons):	2000
Turnovers:	21.0
Net Throughput (gal/yr):	41200
Paint Characteristics	
Shell Color/Shade:	White/White
Shell Condition:	Good
Roof Color/Shade:	White/White
Roof Condition:	Good
Roof Characteristics	
Type:	Cone
Height (ft):	0.00
Radius (ft) (Dome Roof):	0.00
Slope (ft/ft) (Cone Roof):	0.0000
Breather Vent Settings	
Vacuum Setting (psig):	0.00
Pressure Setting (psig):	0.00

Meteorological Data Used in Emission Calculations: Yuma, Arizona (Avg Atmospheric Pressure = 14.7 psia)

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 13)	All	76.49	69.16	83.82	73.92	9.2617	8.1111	10.5377	62.000			62.00	Option 4: RVP=13.00, ASTM Slope=2.5

Annual Emissions Report

Liquid Contents	Losses (lbs.): Standing	Working	Total
Gasoline (RVP 13)	625.94	563.29	1189.23
Total:	625.94	563.29	1189.23

Identification

Identification No.:	IP-6.004
City:	Imperial County
State:	CA
Company:	Glamis Imperial Corp.
Type of Tank:	Horizontal Fixed Roof
Description:	Coolent Tank

Tank Dimensions

Shell Length (ft):	14.0
Diameter (ft):	7.0
Volume(gallons):	5000
Is tank underground? (Y/N):	N
Turnovers:	1.0
Net Throughput (gal/yr):	5000

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition:	Good

Breather Vent Settings

Vacuum Setting (psig):	0.00
Pressure Setting (psig):	0.00

Meteorological Data Used in Emission Calculations: Yuma, Arizona (Avg Atmospheric Pressure = 14.7 psia)

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Ethylene Glycol	All	76.49	69.16	83.82	73.92	0.0024	0.0018	0.0034	62.070			62.07	Option 3: A=58703.416, B=9.3947

Annual Emissions Report

Liquid Contents	Losses (lbs.): Standing	Working	Total
Ethylene Glycol	0.18	0.02	0.20
Total:	0.18	0.02	0.20

Tank Identification				Losses (lb)
IP-6.001	Glamis Imperial Corp.	Vertical Fixed Roof	Imperial County, CA	70.89
IP-6.002	Glamis Imperial Corp.	Vertical Fixed Roof	Imperial County, CA	3.06
IP-6.003	Glamis Imperial Corp.	Vertical Fixed Roof	Imperial County, CA	1189.23
IP-6.004	Glamis Imperial Corp.	Horizontal Fixed Roof	Imperial County, CA	0.20
Total Emissions for all Tanks:				1263.37

APPENDIX G

SUMMARY TOTAL CALCULATED EMISSIONS OF REGULATED (CRITERIA) AIR POLLUTANTS

Imperial Project
Imperial County, California

Air Pollution Emission Inventory

Summary of Total Calculated Emissions of Regulated Air Pollutants

Emission Unit No.	Emission Unit Description	Regulated Air Pollutants											
		TSP		PM10		SOx		NOx		CO		VOCs/ROGs	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
Emission Unit Group 1: Mining Activity													
1.001	Drilling - Waste Rock	7.15E+00	9.34E-01	3.58E+00	4.67E-01	-	-	-	-	-	-	-	-
1.002	Drilling - Ore	3.58E+00	4.67E-01	1.79E+00	2.33E-01	-	-	-	-	-	-	-	-
1.003	Blasting - Waste Rock	1.49E+02	1.30E+01	7.47E+01	6.51E+00	-	-	-	-	-	-	-	-
1.004	Explosives Detonation - Waste Rock Blasting	-	-	-	-	4.54E+01	3.96E+00	3.86E+02	3.36E+01	1.53E+03	1.33E+02	-	-
1.005	Blasting - Ore	0.00E+00	6.51E+00	0.00E+00	3.25E+00	-	-	-	-	-	-	-	-
1.006	Explosives Detonation - Ore Blasting	-	-	-	-	0.00E+00	1.98E+00	0.00E+00	1.68E+01	0.00E+00	6.66E+01	-	-
1.007	Waste Rock Loading	6.95E+01	8.24E+00	3.29E+01	3.90E+00	-	-	-	-	-	-	-	-
1.008	Ore Loading	3.47E+01	4.12E+00	1.64E+01	1.95E+00	-	-	-	-	-	-	-	-
1.009	Waste Rock Dumpting	1.71E+02	2.03E+01	8.09E+01	9.60E+00	-	-	-	-	-	-	-	-
1.010	Ore Dumping	8.55E+01	1.01E+01	4.05E+01	4.80E+00	-	-	-	-	-	-	-	-
1.011	Waste Rock Dozing	3.37E+01	6.15E+00	4.31E+00	7.87E-01	-	-	-	-	-	-	-	-
1.012	Waste Rock Hauling	3.38E+02	3.93E+01	1.52E+02	1.77E+01	-	-	-	-	-	-	-	-
1.013	Ore Hauling	1.69E+02	1.96E+01	7.61E+01	8.84E+00	-	-	-	-	-	-	-	-
1.014	Ammonium Nitrate Prill Silo Loading	5.00E-01	5.93E-02	2.50E-01	2.97E-02	-	-	-	-	-	-	-	-
1.015	Ammonium Nitrate Prill Silo Unloading	4.54E-01	5.93E-02	2.27E-01	2.97E-02	-	-	-	-	-	-	-	-
1.016	Wind Erosion (Waste Rock Stockpiles)	1.79E+01	3.20E+00	8.97E+00	1.60E+00	-	-	-	-	-	-	-	-
1.017	Wind Erosion (Soil Stockpiles)	4.49E+00	8.01E-01	2.24E+00	4.00E-01	-	-	-	-	-	-	-	-
1.018	Haul Truck (Combustion)	1.20E+02	2.19E+01	6.25E+01	1.14E+01	2.66E+02	4.85E+01	2.44E+03	4.45E+02	1.05E+03	1.92E+02	1.16E+02	2.11E+01
1.019	WRS Dozer (Combustion)	6.34E+00	1.16E+00	3.30E+00	6.02E-01	1.34E+01	2.44E+00	1.23E+02	2.24E+01	5.29E+01	9.65E+00	5.83E+00	1.06E+00
1.020	Drill Rig (Combustion)	3.83E+01	7.69E+00	1.99E+01	4.00E+00	1.86E+01	3.74E+00	2.84E+02	5.69E+01	6.11E+01	1.22E+01	2.25E+01	4.51E+00
1.021	Loader (Combustion)	1.58E+01	2.88E+00	8.21E+00	1.50E+00	1.68E+01	3.07E+00	1.83E+02	3.34E+01	5.31E+01	9.70E+00	2.32E+01	4.24E+00
1.022	Clean-up Loader (Combustion)	4.18E+00	7.64E-01	2.18E+00	3.97E-01	4.46E+00	8.13E-01	4.85E+01	8.86E+00	1.41E+01	2.57E+00	6.16E+00	1.12E+00
	SUBTOTAL - EMISSION UNIT GROUP 1	***1.27E+03***	***1.67E+02***	***5.91E+02***	***7.80E+01***	***3.64E+02***	***6.45E+01***	***3.46E+03***	***6.17E+02***	***2.76E+03***	***4.26E+02***	***1.74E+02***	***3.21E+01***
Emission Unit Group 2: Heap Leaching Activity													
2.001	Portable R-O-M Lime Silo Loading	1.35E-01	1.60E-02	6.75E-02	8.01E-03	-	-	-	-	-	-	-	-
2.002	Portable R-O-M Lime Hopper Loading	1.00E+00	1.19E-01	1.00E+00	1.19E-01	-	-	-	-	-	-	-	-
2.003	Lime Application to Ore	1.19E-01	1.41E-02	5.62E-02	6.67E-03	-	-	-	-	-	-	-	-
2.004	Ore Ripping/Spreading/Dozing	2.97E+01	5.42E+00	3.68E+00	6.72E-01	-	-	-	-	-	-	-	-
2.005	Heap Leach Dozer (Combustion)	6.34E+00	1.16E+00	3.30E+00	6.02E-01	1.34E+01	2.44E+00	1.23E+02	2.24E+01	5.29E+01	9.65E+00	5.83E+00	1.06E+00
2.006	Cyanide Application and Leaching	-	-	-	-	-	-	-	-	-	-	-	-
2.007	Pregnant Solution Pond	-	-	-	-	-	-	-	-	-	-	-	-
2.008	Barren Solution Pond	-	-	-	-	-	-	-	-	-	-	-	-
2.009	Wind Erosion (Heap) - Non-Leach	8.23E+00	1.47E+00	4.12E+00	7.35E-01	-	-	-	-	-	-	-	-
2.010	Wind Erosion (Heap) - Leach	4.12E-01	7.35E-02	2.06E-01	3.67E-02	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 2	***4.60E+01***	***8.27E+00***	***1.24E+01***	***2.18E+00***	***1.34E+01***	***2.44E+00***	***1.23E+02***	***2.24E+01***	***5.29E+01***	***9.65E+00***	***5.83E+00***	***1.06E+00***

Imperial Project
Air Pollution Emission Inventory
Summary of Total Calculated Emissions of Regulated Air Pollutants

Emission Unit No.	Emission Unit Description	Regulated Air Pollutants											
		TSP		PM10		SOx		NOx		CO		VOCs/ROGs	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
Emission Unit Group 3: Process Plant													
3.001	Carbon Adsorption Tank 1	-	-	-	-	-	-	-	-	-	-	-	-
3.002	Carbon Adsorption Tank 2	-	-	-	-	-	-	-	-	-	-	-	-
3.003	Carbon Adsorption Tank 3	-	-	-	-	-	-	-	-	-	-	-	-
3.004	Carbon Adsorption Tank 4	-	-	-	-	-	-	-	-	-	-	-	-
3.005	Carbon Adsorption Tank 5	-	-	-	-	-	-	-	-	-	-	-	-
3.006	Acid Wash Tank	-	-	-	-	-	-	-	-	-	-	-	-
3.007	Cyanide Make-up Tank	-	-	-	-	-	-	-	-	-	-	-	-
3.008	Strip Tank	-	-	-	-	-	-	-	-	-	-	-	-
3.009	Electrowinning Cell	-	-	-	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 3	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***
Emission Unit Group 4: Refining													
4.001	Mercury Retort Furnace (Electric)	-	-	-	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 4	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***
Emission Unit Group 5: Laboratory													
5.001	Jaw Crusher	1.02E+00	1.87E-01	7.24E-02	1.32E-02	-	-	-	-	-	-	-	-
5.002	Pulverizer	1.02E+00	1.87E-01	7.24E-02	1.32E-02	-	-	-	-	-	-	-	-
5.003	Fume Hood	-	-	-	-	-	-	-	-	-	-	-	-
5.004	Waste Acid Tank	-	-	-	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 5	***2.04E+00***	***3.73E-01***	***1.45E-01***	***2.64E-02***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***
Emission Unit Group 6: Shop Area													
6.001	Main Diesel Tank 1	-	-	-	-	-	-	-	-	-	-	1.94E-01	3.54E-02
6.002	Street Diesel Tank	-	-	-	-	-	-	-	-	-	-	8.38E-03	1.53E-03
6.003	Unleaded Gasoline Tank	-	-	-	-	-	-	-	-	-	-	3.26E+00	5.95E-01
6.004	Coolant Tank	-	-	-	-	-	-	-	-	-	-	5.48E-04	1.00E-04
	SUBTOTAL - EMISSION UNIT GROUP 6	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00***	***0.00E+00***	***0.00***	***0.00E+00***	***0.00***	***0.00E+00***	***0.00***	***3.46E+00***	***6.32E-01***
Emission Unit Group 7: Mine & Process Area Support Activities													
7.001	Water Truck (Combustion)	6.72E+00	1.23E+00	3.50E+00	6.38E-01	1.19E+01	2.16E+00	1.09E+02	1.98E+01	4.69E+01	8.56E+00	5.17E+00	9.43E-01
7.002	Water Truck Traffic	2.26E-01	4.03E-02	1.02E-01	1.81E-02	-	-	-	-	-	-	-	-
7.003	Backup Diesel Generator	0.00E+00	8.59E-03	0.00E+00	7.06E-03	0.00E+00	6.22E-03	0.00E+00	3.82E-01	0.00E+00	9.98E-02	0.00E+00	1.11E-02
7.004	Mobile Light Plant - Pit #1	1.02E+00	1.85E-01	4.84E-01	8.83E-02	4.51E-01	8.23E-02	6.82E+00	1.24E+00	1.47E+00	2.68E-01	5.53E-01	1.01E-01
7.005	Mobile Light Plant - Pit #2	1.02E+00	1.85E-01	4.84E-01	8.83E-02	4.51E-01	8.23E-02	6.82E+00	1.24E+00	1.47E+00	2.68E-01	5.53E-01	1.01E-01
7.006	Mobile Light Plant - Heap	1.02E+00	1.85E-01	4.84E-01	8.83E-02	4.51E-01	8.23E-02	6.82E+00	1.24E+00	1.47E+00	2.68E-01	5.53E-01	1.01E-01
7.007	Mobile Light Plant - WRS	1.02E+00	1.85E-01	4.84E-01	8.83E-02	4.51E-01	8.23E-02	6.82E+00	1.24E+00	1.47E+00	2.68E-01	5.53E-01	1.01E-01
7.008	Cable Reel Machine	2.67E+00	4.87E-01	1.36E+00	2.48E-01	1.55E+01	2.83E+00	9.67E+01	1.76E+01	1.42E+02	2.59E+01	1.67E+01	3.04E+00
7.009	Grading of Road Surface	1.40E+00	2.56E-01	4.11E+00	7.49E-01	-	-	-	-	-	-	-	-
7.010	Grader (Combustion)	4.08E+00	7.44E-01	2.12E+00	3.87E-01	5.73E+00	1.05E+00	4.66E+01	8.51E+00	1.00E+01	1.83E+00	2.34E+00	4.27E-01
	SUBTOTAL - EMISSION UNIT GROUP 7	***1.92E+01***	***3.50E+00***	***1.31E+01***	***2.40E+00***	***3.49E+01***	***6.37E+00***	***2.79E+02***	***5.13E+01***	***2.04E+02***	***3.74E+01***	***2.64E+01***	***4.83E+00***

Imperial Project
Air Pollution Emission Inventory
Summary of Total Calculated Emissions of Regulated Air Pollutants

Emission Unit No.	Emission Unit Description	Regulated Air Pollutants											
		TSP		PM10		SOx		NOx		CO		VOCs/ROGs	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
Emission Unit Group 8: Other Mobile Emission Units													
8.001	On-Site Delivery Truck Traffic	3.83E-01	6.84E-02	1.73E-01	3.08E-02	-	-	-	-	-	-	-	-
8.002	On-Site Delivery Truck (Combustion)	1.73E-03	3.15E-04	1.73E-03	3.15E-04	9.60E-04	1.75E-04	8.64E-03	1.58E-03	2.94E-02	5.36E-03	3.54E-03	6.47E-04
8.003	On-Site Light Vehicle Traffic	3.77E+00	6.74E-01	1.70E+00	3.03E-01	-	-	-	-	-	-	-	-
8.004	On-Site Light Vehicle (Combustion)	2.04E-01	3.73E-02	9.72E-02	1.77E-02	5.40E-02	9.86E-03	4.86E-01	8.87E-02	1.65E+00	3.02E-01	1.99E-01	3.64E-02
8.005	Off-Site Delivery Truck Traffic	1.95E+01	3.48E+00	8.77E+00	1.57E+00	-	-	-	-	-	-	-	-
8.006	Off-Site Light Vehicle Traffic	2.74E+02	4.90E+01	1.24E+02	2.20E+01	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 8	***2.98E+02***	***5.33E+01***	***1.34E+02***	***2.40E+01***	***5.50E-02***	***1.00E-02***	***4.95E-01***	***9.03E-02***	***1.68E+00***	***3.07E-01***	***2.03E-01***	***3.70E-02***
	TOTAL - ALL EMISSION GROUPS	**1.64E+03**	**2.33E+02**	**7.51E+02**	**1.07E+02**	**4.13E+02**	**7.33E+01**	**3.86E+03**	**6.91E+02**	**3.02E+03**	**473.31**	**2.09E+02**	**3.86E+01**

APPENDIX H

TOTAL FACILITY POTENTIAL TO EMIT FOR TITLE V APPLICABLE REGULATED (CRITERIA) AIR POLLUTANTS

Imperial Project
Imperial County, California

Air Pollution Emission Inventory

Total Potential to Emit for all Title V Applicable Regulated Air Pollutants

Emission Unit No.	Emission Unit Description	TSP (lbs/yr)	PM10 (lbs/yr)	SOx (lbs/yr)	NOx (lbs/yr)	CO (lbs/yr)	VOCs/ROGs (lbs/yr)
	Emission Unit Group 1: Mining Activity						
1.001	Drilling - Waste Rock	-	-	-	-	-	-
1.002	Drilling - Ore	-	-	-	-	-	-
1.003	Blasting - Waste Rock	-	-	-	-	-	-
1.004	Explosives Detonation - Waste Rock Blasting	-	-	-	-	-	-
1.005	Blasting - Ore	-	-	-	-	-	-
1.006	Explosives Detonation - Ore Blasting	-	-	-	-	-	-
1.007	Waste Rock Loading	-	-	-	-	-	-
1.008	Ore Loading	-	-	-	-	-	-
1.009	Waste Rock Dumpting	-	-	-	-	-	-
1.010	Ore Dumping	-	-	-	-	-	-
1.011	Waste Rock Dozing	-	-	-	-	-	-
1.012	Waste Rock Hauling	-	-	-	-	-	-
1.013	Ore Hauling	-	-	-	-	-	-
1.014	Ammonium Nitrate Prill Silo Loading	1.19E+02	5.93E+01	-	-	-	-
1.015	Ammonium Nitrate Prill Silo Unloading	1.19E+02	5.93E+01	-	-	-	-
1.016	Wind Erosion (Waste Rock Stockpiles)	-	-	-	-	-	-
1.017	Wind Erosion (Soil Stockpiles)	-	-	-	-	-	-
1.018	Haul Truck (Combustion)	-	-	-	-	-	-
1.019	WRS Dozer (Combustion)	-	-	-	-	-	-
1.020	Drill Rig (Combustion)	-	-	-	-	-	-
1.021	Loader (Combustion)	-	-	-	-	-	-
1.022	Clean-up Loader (Combustion)	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 1	*2.37E+02*	*1.19E+02*	*0.00E+00*	*0.00E+00*	*0.00E+00*	*0.00E+00*
	Emission Unit Group 2: Heap Leaching Activity						
2.001	Portable R-O-M Lime Silo Loading	3.20E+01	1.60E+01	-	-	-	-
2.002	Portable R-O-M Lime Hopper Loading	2.37E+02	2.37E+02	-	-	-	-
2.003	Lime Application to Ore	-	-	-	-	-	-
2.004	Ore Ripping/Spreading/Dozing	-	-	-	-	-	-
2.005	Heap Leach Dozer (Combustion)	-	-	-	-	-	-
2.006	Cyanide Application and Leaching	-	-	-	-	-	-
2.007	Pregnant Solution Pond	-	-	-	-	-	-
2.008	Barren Solution Pond	-	-	-	-	-	-
2.009	Wind Erosion (Heap) - Non-Leach	-	-	-	-	-	-
2.010	Wind Erosion (Heap) - Leach	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 2	*2.69E+02*	*2.53E+02*	*0.00E+00*	*0.00E+00*	*0.00E+00*	*0.00E+00*
	Emission Unit Group 3: Process Plant						
3.001	Carbon Adsorption Tank 1	-	-	-	-	-	-
3.002	Carbon Adsorption Tank 2	-	-	-	-	-	-
3.003	Carbon Adsorption Tank 3	-	-	-	-	-	-
3.004	Carbon Adsorption Tank 4	-	-	-	-	-	-
3.005	Carbon Adsorption Tank 5	-	-	-	-	-	-
3.006	Acid Wash Tank	-	-	-	-	-	-
3.007	Cyanide Make-up Tank	-	-	-	-	-	-
3.008	Strip Tank	-	-	-	-	-	-
3.009	Electrowinning Cell	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 3	*0.00E+00*	*0.00E+00*	*0.00E+00*	*0.00E+00*	*0.00E+00*	*0.00E+00*
	Emission Unit Group 4: Refining						
4.001	Mercury Retort Furnace (Electric)	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 4	*0.00E+00*	*0.00E+00*	*0.00E+00*	*0.00E+00*	*0.00E+00*	*0.00E+00*

Total Potential to Emit for all Title V Applicable Regulated Air Pollutants

Emission Unit No.	Emission Unit Description	TSP (lbs/yr)	PM10 (lbs/yr)	SOx (lbs/yr)	NOx (lbs/yr)	CO (lbs/yr)	VOCs/ROGs (lbs/yr)
	Emission Unit Group 5: Laboratory						
5.001	Jaw Crusher	-	-	-	-	-	-
5.002	Pulverizer	-	-	-	-	-	-
5.003	Fume Hood	-	-	-	-	-	-
5.004	Waste Acid Tank	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 5	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***
	Emission Unit Group 6: Shop Area						
6.001	Main Diesel Tank 1	-	-	-	-	-	7.09E+01
6.002	Street Diesel Tank	-	-	-	-	-	3.06E+00
6.003	Unleaded Gasoline Tank	-	-	-	-	-	1.19E+03
6.004	Coolant Tank	-	-	-	-	-	2.00E-01
	SUBTOTAL - EMISSION UNIT GROUP 6	***0.00E+00***	***0.00***	***0.00***	***0.00***	***0.00***	***1.26E+03***
	Emission Unit Group 7: Mine & Process Area Support Activities						
7.001	Water Truck (Combustion)	-	-	-	-	-	-
7.002	Water Truck Traffic	-	-	-	-	-	-
7.003	Backup Diesel Generator	1.72E+01	1.41E+01	1.24E+01	7.64E+02	2.00E+02	2.22E+01
7.004	Mobile Light Plant - Pit #1	-	-	-	-	-	-
7.005	Mobile Light Plant - Pit #2	-	-	-	-	-	-
7.006	Mobile Light Plant - Heap	-	-	-	-	-	-
7.007	Mobile Light Plant - WRS	-	-	-	-	-	-
7.008	Cable Reel Machine	-	-	-	-	-	-
7.009	Grading of Road Surface	-	-	-	-	-	-
7.010	Grader (Combustion)	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 7	***1.72E+01***	***1.41E+01***	***1.24E+01***	***7.64E+02***	***2.00E+02***	***2.22E+01***
	Emission Unit Group 8: Other Mobile Emission Units						
8.001	On-Site Delivery Truck Traffic	-	-	-	-	-	-
8.002	On-Site Delivery Truck (Combustion)	-	-	-	-	-	-
8.003	On-Site Light Vehicle Traffic	-	-	-	-	-	-
8.004	On-Site Light Vehicle (Combustion)	-	-	-	-	-	-
8.005	Off-Site Delivery Truck Traffic	-	-	-	-	-	-
8.006	Off-Site Light Vehicle Traffic	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 8	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***	***0.00E+00***
	TOTAL EMISSIONS (lbs/yr)	5.24E+02	3.86E+02	1.24E+01	7.64E+02	2.00E+02	1.29E+03
	TOTAL EMISSIONS (tons/yr)	2.62E-01	1.93E-01	6.22E-03	3.82E-01	9.98E-02	6.43E-01

APPENDIX I

TOTAL FACILITY POTENTIAL TO EMIT FOR TITLE V APPLICABLE HAZARDOUS AIR POLLUTANTS (HAPs)

Imperial Project
Imperial County, California

Air Pollution Emission Inventory

Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)								
		Sb	As	Be	Cd	Cr	Co	Pb	Mn	Hg
	Emission Unit Group 1: Mining Activity									
1.001	Drilling - Waste Rock	2.46E-02	1.11E-01	3.74E-03	9.34E-03	2.04E-01	2.55E-02	9.34E-03	1.13E+00	7.41E-04
1.002	Drilling - Ore	3.06E-02	1.68E-01	1.87E-03	5.14E-03	7.47E-02	1.07E-02	1.24E-02	7.26E-01	3.74E-04
1.003	Blasting - Waste Rock	3.42E-01	1.54E+00	5.20E-02	1.30E-01	2.84E+00	3.56E-01	1.30E-01	1.58E+01	1.03E-02
1.004	Explosives Detonation - Waste Rock Blasting	-	-	-	-	-	-	-	-	-
1.005	Blasting - Ore	4.27E-01	2.34E+00	2.60E-02	7.16E-02	1.04E+00	1.50E-01	1.72E-01	1.01E+01	5.22E-03
1.006	Explosives Detonation - Ore Blasting	-	-	-	-	-	-	-	-	-
1.007	Waste Rock Loading	2.17E-01	9.78E-01	3.30E-02	8.24E-02	1.80E+00	2.25E-01	8.24E-02	1.00E+01	6.54E-03
1.008	Ore Loading	2.70E-01	1.48E+00	1.65E-02	4.53E-02	6.59E-01	9.48E-02	1.09E-01	6.41E+00	3.30E-03
1.009	Waste Rock Dumpting	5.34E-01	2.41E+00	8.12E-02	2.03E-01	4.42E+00	5.55E-01	2.03E-01	2.47E+01	1.61E-02
1.010	Ore Dumping	6.66E-01	3.65E+00	4.06E-02	1.12E-01	1.62E+00	2.33E-01	2.69E-01	1.58E+01	8.14E-03
1.011	Waste Rock Dozing	1.62E-01	7.30E-01	2.46E-02	6.15E-02	1.34E+00	1.68E-01	6.15E-02	7.48E+00	4.89E-03
1.012	Waste Rock Hauling	1.03E+00	4.66E+00	1.57E-01	3.93E-01	8.56E+00	1.07E+00	3.93E-01	4.77E+01	3.12E-02
1.013	Ore Hauling	5.17E-01	2.33E+00	7.85E-02	1.96E-01	4.28E+00	5.37E-01	1.96E-01	2.39E+01	1.56E-02
1.014	Ammonium Nitrate Prill Silo Loading	-	-	-	-	-	-	-	-	-
1.015	Ammonium Nitrate Prill Silo Unloading	-	-	-	-	-	-	-	-	-
1.016	Wind Erosion (Waste Rock Stockpiles)	8.43E-02	3.80E-01	1.28E-02	3.20E-02	6.98E-01	8.76E-02	3.20E-02	3.89E+00	2.54E-03
1.017	Wind Erosion (Soil Stockpiles)	2.11E-02	9.50E-02	3.20E-03	8.01E-03	1.75E-01	2.19E-02	8.01E-03	9.73E-01	6.36E-04
1.018	Haul Truck (Combustion)	-	-	-	-	-	-	-	-	-
1.019	WRS Dozer (Combustion)	-	-	-	-	-	-	-	-	-
1.020	Drill Rig (Combustion)	-	-	-	-	-	-	-	-	-
1.021	Loader (Combustion)	-	-	-	-	-	-	-	-	-
1.022	Clean-up Loader (Combustion)	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 1	**4.33E+00**	**2.09E+01**	**5.31E-01**	**1.35E+00**	**2.77E+01**	**3.54E+00**	**1.68E+00**	**1.69E+02**	**1.06E-01**
	Emission Unit Group 2: Heap Leaching Activity									
2.001	Portable R-O-M Lime Silo Loading	-	-	-	-	-	-	-	-	-
2.002	Portable R-O-M Lime Hopper Loading	-	-	-	-	-	-	-	-	-
2.003	Lime Application to Ore	-	-	-	-	-	-	-	-	-
2.004	Ore Ripping/Spreading/Dozing	3.56E-01	1.95E+00	2.17E-02	5.97E-02	8.68E-01	1.25E-01	1.44E-01	8.43E+00	4.35E-03
2.005	Heap Leach Dozer (Combustion)	-	-	-	-	-	-	-	-	-
2.006	Cyanide Application and Leaching	-	-	-	-	-	-	-	-	-
2.007	Pregnant Solution Pond	-	-	-	-	-	-	-	-	-
2.008	Barren Solution Pond	-	-	-	-	-	-	-	-	-
2.009	Wind Erosion (Heap) - Non-Leach	9.64E-02	5.28E-01	5.88E-03	1.62E-02	2.35E-01	3.38E-02	3.90E-02	2.28E+00	1.18E-03
2.010	Wind Erosion (Heap) - Leach	4.82E-03	2.64E-02	2.94E-04	8.08E-04	1.18E-02	1.69E-03	1.95E-03	1.14E-01	5.89E-05
	SUBTOTAL - EMISSION UNIT GROUP 2	**4.57E-01**	**2.50E+00**	**2.79E-02**	**7.66E-02**	**1.11E+00**	**1.60E-01**	**1.85E-01**	**1.08E+01**	**5.59E-03**

Imperial Project
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)							
		Ni	Se	Benzene	Toluene	Xylenes	Formaldehyde	Acetaldehyde	Acrolein
Emission Unit Group 1: Mining Activity									
1.001	Drilling - Waste Rock	3.74E-02	9.34E-03	-	-	-	-	-	-
1.002	Drilling - Ore	2.33E-02	4.67E-03	-	-	-	-	-	-
1.003	Blasting - Waste Rock	5.20E-01	1.30E-01	-	-	-	-	-	-
1.004	Explosives Detonation - Waste Rock Blasting	-	-	-	-	-	-	-	-
1.005	Blasting - Ore	3.25E-01	6.51E-02	-	-	-	-	-	-
1.006	Explosives Detonation - Ore Blasting	-	-	-	-	-	-	-	-
1.007	Waste Rock Loading	3.30E-01	8.24E-02	-	-	-	-	-	-
1.008	Ore Loading	2.06E-01	4.12E-02	-	-	-	-	-	-
1.009	Waste Rock Dumpting	8.12E-01	2.03E-01	-	-	-	-	-	-
1.010	Ore Dumping	5.07E-01	1.01E-01	-	-	-	-	-	-
1.011	Waste Rock Dozing	2.46E-01	6.15E-02	-	-	-	-	-	-
1.012	Waste Rock Hauling	1.57E+00	3.93E-01	-	-	-	-	-	-
1.013	Ore Hauling	7.85E-01	1.96E-01	-	-	-	-	-	-
1.014	Ammonium Nitrate Prill Silo Loading	-	-	-	-	-	-	-	-
1.015	Ammonium Nitrate Prill Silo Unloading	-	-	-	-	-	-	-	-
1.016	Wind Erosion (Waste Rock Stockpiles)	1.28E-01	3.20E-02	-	-	-	-	-	-
1.017	Wind Erosion (Soil Stockpiles)	3.20E-02	8.01E-03	-	-	-	-	-	-
1.018	Haul Truck (Combustion)	-	-	-	-	-	-	-	-
1.019	WRS Dozer (Combustion)	-	-	-	-	-	-	-	-
1.020	Drill Rig (Combustion)	-	-	-	-	-	-	-	-
1.021	Loader (Combustion)	-	-	-	-	-	-	-	-
1.022	Clean-up Loader (Combustion)	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 1	**5.52E+00**	**1.33E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Emission Unit Group 2: Heap Leaching Activity									
2.001	Portable R-O-M Lime Silo Loading	-	-	-	-	-	-	-	-
2.002	Portable R-O-M Lime Hopper Loading	-	-	-	-	-	-	-	-
2.003	Lime Application to Ore	-	-	-	-	-	-	-	-
2.004	Ore Ripping/Spreading/Dozing	2.71E-01	5.42E-02	-	-	-	-	-	-
2.005	Heap Leach Dozer (Combustion)	-	-	-	-	-	-	-	-
2.006	Cyanide Application and Leaching	-	-	-	-	-	-	-	-
2.007	Pregnant Solution Pond	-	-	-	-	-	-	-	-
2.008	Barren Solution Pond	-	-	-	-	-	-	-	-
2.009	Wind Erosion (Heap) - Non-Leach	7.35E-02	1.47E-02	-	-	-	-	-	-
2.010	Wind Erosion (Heap) - Leach	3.67E-03	7.35E-04	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 2	**3.48E-01**	**6.97E-02**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**

Imperial Project
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)							
		Naphthalene	Propylene	1,3-Butadiene	HCl	HCN	Hexane	2,2,4-Trimethylpentane	Bromine
	Emission Unit Group 1: Mining Activity								
1.001	Drilling - Waste Rock	-	-	-	-	-	-	-	-
1.002	Drilling - Ore	-	-	-	-	-	-	-	-
1.003	Blasting - Waste Rock	-	-	-	-	-	-	-	-
1.004	Explosives Detonation - Waste Rock Blasting	-	-	-	-	-	-	-	-
1.005	Blasting - Ore	-	-	-	-	-	-	-	-
1.006	Explosives Detonation - Ore Blasting	-	-	-	-	-	-	-	-
1.007	Waste Rock Loading	-	-	-	-	-	-	-	-
1.008	Ore Loading	-	-	-	-	-	-	-	-
1.009	Waste Rock Dumpting	-	-	-	-	-	-	-	-
1.010	Ore Dumping	-	-	-	-	-	-	-	-
1.011	Waste Rock Dozing	-	-	-	-	-	-	-	-
1.012	Waste Rock Hauling	-	-	-	-	-	-	-	-
1.013	Ore Hauling	-	-	-	-	-	-	-	-
1.014	Ammonium Nitrate Prill Silo Loading	-	-	-	-	-	-	-	-
1.015	Ammonium Nitrate Prill Silo Unloading	-	-	-	-	-	-	-	-
1.016	Wind Erosion (Waste Rock Stockpiles)	-	-	-	-	-	-	-	-
1.017	Wind Erosion (Soil Stockpiles)	-	-	-	-	-	-	-	-
1.018	Haul Truck (Combustion)	-	-	-	-	-	-	-	-
1.019	WRS Dozer (Combustion)	-	-	-	-	-	-	-	-
1.020	Drill Rig (Combustion)	-	-	-	-	-	-	-	-
1.021	Loader (Combustion)	-	-	-	-	-	-	-	-
1.022	Clean-up Loader (Combustion)	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Emission Unit Group 2: Heap Leaching Activity								
2.001	Portable R-O-M Lime Silo Loading	-	-	-	-	-	-	-	-
2.002	Portable R-O-M Lime Hopper Loading	-	-	-	-	-	-	-	-
2.003	Lime Application to Ore	-	-	-	-	-	-	-	-
2.004	Ore Ripping/Spreading/Dozing	-	-	-	-	-	-	-	-
2.005	Heap Leach Dozer (Combustion)	-	-	-	-	-	-	-	-
2.006	Cyanide Application and Leaching	-	-	-	-	-	-	-	-
2.007	Pregnant Solution Pond	-	-	-	-	-	-	-	-
2.008	Barren Solution Pond	-	-	-	-	-	-	-	-
2.009	Wind Erosion (Heap) - Non-Leach	-	-	-	-	-	-	-	-
2.010	Wind Erosion (Heap) - Leach	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Imperial Project
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)			
		Chlorine	Ethylene Glycol	Ethylbenzene	ALL HAPS
Emission Unit Group 1: Mining Activity					
1.001	Drilling - Waste Rock	-	-	-	1.57E+00
1.002	Drilling - Ore	-	-	-	1.06E+00
1.003	Blasting - Waste Rock	-	-	-	2.19E+01
1.004	Explosives Detonation - Waste Rock Blasting	-	-	-	0.00E+00
1.005	Blasting - Ore	-	-	-	1.47E+01
1.006	Explosives Detonation - Ore Blasting	-	-	-	0.00E+00
1.007	Waste Rock Loading	-	-	-	1.38E+01
1.008	Ore Loading	-	-	-	9.33E+00
1.009	Waste Rock Dumpting	-	-	-	3.41E+01
1.010	Ore Dumping	-	-	-	2.30E+01
1.011	Waste Rock Dozing	-	-	-	1.03E+01
1.012	Waste Rock Hauling	-	-	-	6.60E+01
1.013	Ore Hauling	-	-	-	3.30E+01
1.014	Ammonium Nitrate Prill Silo Loading	-	-	-	0.00E+00
1.015	Ammonium Nitrate Prill Silo Unloading	-	-	-	0.00E+00
1.016	Wind Erosion (Waste Rock Stockpiles)	-	-	-	5.38E+00
1.017	Wind Erosion (Soil Stockpiles)	-	-	-	1.35E+00
1.018	Haul Truck (Combustion)	-	-	-	0.00E+00
1.019	WRS Dozer (Combustion)	-	-	-	0.00E+00
1.020	Drill Rig (Combustion)	-	-	-	0.00E+00
1.021	Loader (Combustion)	-	-	-	0.00E+00
1.022	Clean-up Loader (Combustion)	-	-	-	0.00E+00
	SUBTOTAL - EMISSION UNIT GROUP 1	**0.00E+00**	**0.00E+00**	**0.00E+00**	**2.36E+02**
Emission Unit Group 2: Heap Leaching Activity					
2.001	Portable R-O-M Lime Silo Loading	-	-	-	0.00E+00
2.002	Portable R-O-M Lime Hopper Loading	-	-	-	0.00E+00
2.003	Lime Application to Ore	-	-	-	0.00E+00
2.004	Ore Ripping/Spreading/Dozing	-	-	-	1.23E+01
2.005	Heap Leach Dozer (Combustion)	-	-	-	0.00E+00
2.006	Cyanide Application and Leaching	-	-	-	0.00E+00
2.007	Pregnant Solution Pond	-	-	-	0.00E+00
2.008	Barren Solution Pond	-	-	-	0.00E+00
2.009	Wind Erosion (Heap) - Non-Leach	-	-	-	3.33E+00
2.010	Wind Erosion (Heap) - Leach	-	-	-	1.66E-01
	SUBTOTAL - EMISSION UNIT GROUP 2	**0.00E+00**	**0.00E+00**	**0.00E+00**	**1.58E+01**

Imperial Project
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)								
		Sb	As	Be	Cd	Cr	Co	Pb	Mn	Hg
Emission Unit Group 3: Process Plant										
3.001	Carbon Adsorption Tank 1	-	-	-	-	-	-	-	-	-
3.002	Carbon Adsorption Tank 2	-	-	-	-	-	-	-	-	-
3.003	Carbon Adsorption Tank 3	-	-	-	-	-	-	-	-	-
3.004	Carbon Adsorption Tank 4	-	-	-	-	-	-	-	-	-
3.005	Carbon Adsorption Tank 5	-	-	-	-	-	-	-	-	-
3.006	Acid Wash Tank	-	-	-	-	-	-	-	-	-
3.007	Cyanide Make-up Tank	-	-	-	-	-	-	-	-	-
3.008	Strip Tank	-	-	-	-	-	-	-	-	-
3.009	Electrowinning Cell	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Emission Unit Group 4: Refining										
4.001	Mercury Retort Furnace (Electric)	-	-	-	-	-	-	-	-	9.04E-03
	SUBTOTAL - EMISSION UNIT GROUP 4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.04E-03
Emission Unit Group 5: Laboratory										
5.001	Jaw Crusher	1.22E-02	6.71E-02	7.46E-04	2.05E-03	2.99E-02	4.29E-03	4.94E-03	2.90E-01	1.50E-04
5.002	Pulverizer	1.22E-02	6.71E-02	7.46E-04	2.05E-03	2.99E-02	4.29E-03	4.94E-03	2.90E-01	1.50E-04
5.003	Fume Hood	-	-	-	-	-	-	-	-	-
5.004	Waste Acid Tank	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 5	**2.45E-02**	**1.34E-01**	**1.49E-03**	**4.10E-03**	**5.97E-02**	**8.58E-03**	**9.89E-03**	**5.80E-01**	**2.99E-04**
Emission Unit Group 6: Shop Area										
6.001	Main Diesel Tank 1	-	-	-	2.84E-06	2.55E-05	3.54E-06	7.09E-06	-	-
6.002	Street Diesel Tank	-	-	-	1.22E-07	1.10E-06	1.53E-07	3.06E-07	-	-
6.003	Unleaded Gasoline Tank	-	-	-	4.76E-05	-	-	1.55E+01	-	-
6.004	Coolant Tank	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 6	0.00E+00	0.00E+00	0.00E+00	5.05E-05	**2.66E-05**	**3.70E-06**	**1.55E+01**	0.00E+00	0.00E+00
Emission Unit Group 7: Mine & Process Area Support Activities										
7.001	Water Truck (Combustion)	-	-	-	-	-	-	-	-	-
7.002	Water Truck Traffic	1.06E-03	4.79E-03	1.61E-04	4.03E-04	8.79E-03	1.10E-03	4.03E-04	4.90E-02	3.20E-05
7.003	Backup Diesel Generator	-	-	-	-	-	-	-	-	-
7.004	Mobile Light Plant - Pit #1	-	-	-	-	-	-	-	-	-
7.005	Mobile Light Plant - Pit #2	-	-	-	-	-	-	-	-	-
7.006	Mobile Light Plant - Heap	-	-	-	-	-	-	-	-	-
7.007	Mobile Light Plant - WRS	-	-	-	-	-	-	-	-	-
7.008	Cable Reel Machine	-	-	-	-	-	-	-	-	-
7.009	Grading of Road Surface	6.75E-03	3.04E-02	1.03E-03	2.56E-03	5.59E-02	7.01E-03	2.56E-03	3.12E-01	2.04E-04
7.010	Grader (Combustion)	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 7	**7.81E-03**	**3.52E-02**	**1.19E-03**	**2.97E-03**	**6.47E-02**	**8.11E-03**	**2.97E-03**	**3.61E-01**	**2.36E-04**

Imperial Project
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)							
		Ni	Se	Benzene	Toluene	Xylenes	Formaldehyde	Acetaldehyde	Acrolein
Emission Unit Group 3: Process Plant									
3.001	Carbon Adsorption Tank 1	-	-	-	-	-	-	-	-
3.002	Carbon Adsorption Tank 2	-	-	-	-	-	-	-	-
3.003	Carbon Adsorption Tank 3	-	-	-	-	-	-	-	-
3.004	Carbon Adsorption Tank 4	-	-	-	-	-	-	-	-
3.005	Carbon Adsorption Tank 5	-	-	-	-	-	-	-	-
3.006	Acid Wash Tank	-	-	-	-	-	-	-	-
3.007	Cyanide Make-up Tank	-	-	-	-	-	-	-	-
3.008	Strip Tank	-	-	-	-	-	-	-	-
3.009	Electrowinning Cell	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 3	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Emission Unit Group 4: Refining									
4.001	Mercury Retort Furnace (Electric)	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 4	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Emission Unit Group 5: Laboratory									
5.001	Jaw Crusher	9.33E-03	1.87E-03	-	-	-	-	-	-
5.002	Pulverizer	9.33E-03	1.87E-03	-	-	-	-	-	-
5.003	Fume Hood	-	-	-	-	-	-	-	-
5.004	Waste Acid Tank	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 5	**1.87E-02**	**3.73E-03**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Emission Unit Group 6: Shop Area									
6.001	Main Diesel Tank 1	3.54E-06	1.42E-06	-	-	-	-	-	-
6.002	Street Diesel Tank	1.53E-07	6.12E-08	-	-	-	-	-	-
6.003	Unleaded Gasoline Tank	-	-	2.15E+01	1.46E+02	6.86E+01	-	-	-
6.004	Coolant Tank	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 6	**3.70E-06**	**1.48E-06**	**2.15E+01**	**1.46E+02**	**6.86E+01**	**0.00E+00**	**0.00E+00**	**0.00E+00**
Emission Unit Group 7: Mine & Process Area Support Activities									
7.001	Water Truck (Combustion)	-	-	-	-	-	-	-	-
7.002	Water Truck Traffic	1.61E-03	4.03E-04	-	-	-	-	-	-
7.003	Backup Diesel Generator	-	-	1.74E-01	6.93E-02	4.76E-02	1.94E-02	6.21E-03	1.94E-03
7.004	Mobile Light Plant - Pit #1	-	-	-	-	-	-	-	-
7.005	Mobile Light Plant - Pit #2	-	-	-	-	-	-	-	-
7.006	Mobile Light Plant - Heap	-	-	-	-	-	-	-	-
7.007	Mobile Light Plant - WRS	-	-	-	-	-	-	-	-
7.008	Cable Reel Machine	-	-	-	-	-	-	-	-
7.009	Grading of Road Surface	1.03E-02	2.56E-03	-	-	-	-	-	-
7.010	Grader (Combustion)	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 7	**1.19E-02**	**2.97E-03**	**1.74E-01**	**6.93E-02**	**4.76E-02**	**1.94E-02**	**6.21E-03**	**1.94E-03**

Imperial Project
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)							
		Naphthalene	Propylene	1,3-Butadiene	HCl	HCN	Hexane	2,2,4-Trimethylpentane	Bromine
				Emission Unit Group 3: Process Plant					
3.001	Carbon Adsorption Tank 1	-	-	-	-	9.50E+00	-	-	-
3.002	Carbon Adsorption Tank 2	-	-	-	-	9.50E+00	-	-	-
3.003	Carbon Adsorption Tank 3	-	-	-	-	9.50E+00	-	-	-
3.004	Carbon Adsorption Tank 4	-	-	-	-	9.50E+00	-	-	-
3.005	Carbon Adsorption Tank 5	-	-	-	-	9.50E+00	-	-	-
3.006	Acid Wash Tank	-	-	-	3.53E+02	-	-	-	-
3.007	Cyanide Make-up Tank	-	-	-	-	0.00E+00	-	-	-
3.008	Strip Tank	-	-	-	-	0.00E+00	-	-	-
3.009	Electrowinning Cell	-	-	-	-	0.00E+00	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 3	**0.00E+00**	**0.00E+00**	**0.00E+00**	**3.53E+02**	**4.75E+01**	**0.00E+00**	**0.00E+00**	**0.00E+00**
				Emission Unit Group 4: Refining					
4.001	Mercury Retort Furnace (Electric)	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 4	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
				Emission Unit Group 5: Laboratory					
5.001	Jaw Crusher	-	-	-	-	-	-	-	-
5.002	Pulverizer	-	-	-	-	-	-	-	-
5.003	Fume Hood	-	-	-	-	0.00E+00	-	-	-
5.004	Waste Acid Tank	-	-	-	n/a	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 5	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
				Emission Unit Group 6: Shop Area					
6.001	Main Diesel Tank 1	9.22E-02	-	-	-	-	-	-	-
6.002	Street Diesel Tank	3.98E-03	-	-	-	-	-	-	-
6.003	Unleaded Gasoline Tank	3.45E+00	-	-	-	-	2.22E+01	2.91E+01	2.53E-01
6.004	Coolant Tank	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 6	**3.54E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**2.22E+01**	**2.91E+01**	**2.53E-01**
				Emission Unit Group 7: Mine & Process Area Support Activities					
7.001	Water Truck (Combustion)	-	-	-	-	-	-	-	-
7.002	Water Truck Traffic	-	-	-	-	-	-	-	-
7.003	Backup Diesel Generator	3.20E-02	-	-	-	-	-	-	-
7.004	Mobile Light Plant - Pit #1	-	-	-	-	-	-	-	-
7.005	Mobile Light Plant - Pit #2	-	-	-	-	-	-	-	-
7.006	Mobile Light Plant - Heap	-	-	-	-	-	-	-	-
7.007	Mobile Light Plant - WRS	-	-	-	-	-	-	-	-
7.008	Cable Reel Machine	-	-	-	-	-	-	-	-
7.009	Grading of Road Surface	-	-	-	-	-	-	-	-
7.010	Grader (Combustion)	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 7	**3.20E-02**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**

Imperial Project
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)			
		Chlorine	Ethylene Glycol	Ethylbenzene	ALL HAPS
Emission Unit Group 3: Process Plant					
3.001	Carbon Adsorption Tank 1	-	-	-	9.50E+00
3.002	Carbon Adsorption Tank 2	-	-	-	9.50E+00
3.003	Carbon Adsorption Tank 3	-	-	-	9.50E+00
3.004	Carbon Adsorption Tank 4	-	-	-	9.50E+00
3.005	Carbon Adsorption Tank 5	-	-	-	9.50E+00
3.006	Acid Wash Tank	-	-	-	3.53E+02
3.007	Cyanide Make-up Tank	-	-	-	0.00E+00
3.008	Strip Tank	-	-	-	0.00E+00
3.009	Electrowinning Cell	-	-	-	0.00E+00
	SUBTOTAL - EMISSION UNIT GROUP 3	**0.00E+00**	**0.00E+00**	**0.00E+00**	**4.01E+02**
Emission Unit Group 4: Refining					
4.001	Mercury Retort Furnace (Electric)	-	-	-	9.04E-03
	SUBTOTAL - EMISSION UNIT GROUP 4	**0.00E+00**	**0.00E+00**	**0.00E+00**	**9.04E-03**
Emission Unit Group 5: Laboratory					
5.001	Jaw Crusher	-	-	-	4.23E-01
5.002	Pulverizer	-	-	-	4.23E-01
5.003	Fume Hood	-	-	-	0.00E+00
5.004	Waste Acid Tank	-	-	-	0.00E+00
	SUBTOTAL - EMISSION UNIT GROUP 5	**0.00E+00**	**0.00E+00**	**0.00E+00**	**8.45E-01**
Emission Unit Group 6: Shop Area					
6.001	Main Diesel Tank 1	-	-	-	9.22E-02
6.002	Street Diesel Tank	-	-	-	3.98E-03
6.003	Unleaded Gasoline Tank	2.26E-01	-	1.91E+01	3.26E+02
6.004	Coolant Tank	-	1.90E-01	-	1.90E-01
	SUBTOTAL - EMISSION UNIT GROUP 6	**2.26E-01**	**1.90E-01**	**1.91E+01**	**3.26E+02**
Emission Unit Group 7: Mine & Process Area Support Activities					
7.001	Water Truck (Combustion)	-	-	-	0.00E+00
7.002	Water Truck Traffic	-	-	-	6.78E-02
7.003	Backup Diesel Generator	-	-	-	3.50E-01
7.004	Mobile Light Plant - Pit #1	-	-	-	0.00E+00
7.005	Mobile Light Plant - Pit #2	-	-	-	0.00E+00
7.006	Mobile Light Plant - Heap	-	-	-	0.00E+00
7.007	Mobile Light Plant - WRS	-	-	-	0.00E+00
7.008	Cable Reel Machine	-	-	-	0.00E+00
7.009	Grading of Road Surface	-	-	-	4.31E-01
7.010	Grader (Combustion)	-	-	-	0.00E+00
	SUBTOTAL - EMISSION UNIT GROUP 7	**0.00E+00**	**0.00E+00**	**0.00E+00**	**8.49E-01**

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)								
		Sb	As	Be	Cd	Cr	Co	Pb	Mn	Hg
	Emission Unit Group 8: Other Mobile Emission Units									
8.001	On-Site Delivery Truck Traffic	1.80E-03	8.12E-03	2.74E-04	6.84E-04	1.49E-02	1.87E-03	6.84E-04	8.32E-02	5.43E-05
8.002	On-Site Delivery Truck (Combustion)	-	-	-	-	-	-	-	-	-
8.003	On-Site Light Vehicle Traffic	1.77E-02	7.99E-02	2.69E-03	6.74E-03	1.47E-01	1.84E-02	6.74E-03	8.19E-01	5.35E-04
8.004	On-Site Light Vehicle (Combustion)	-	-	-	-	-	-	-	-	-
8.005	Off-Site Delivery Truck Traffic	-	-	-	-	-	-	-	-	-
8.006	Off-Site Light Vehicle Traffic	-	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 8	**1.95E-02**	**8.80E-02**	**2.97E-03**	**7.42E-03**	**1.62E-01**	**2.03E-02**	**7.42E-03**	**9.02E-01**	**5.89E-04**
	TOTAL EMISSIONS (lbs/yr)	***4.84E+00***	***2.36E+01***	***5.65E-01***	***1.44E+00***	***2.91E+01***	***3.74E+00***	***1.73E+01***	***1.81E+02***	***1.21E-01***
	TOTAL EMISSIONS (tons/yr)	***2.42E-03***	***1.18E-02***	***2.82E-04***	***7.20E-04***	***1.46E-02***	***1.87E-03***	***8.67E-03***	***9.06E-02***	***6.07E-05***

Imperial Project
Air Pollution Emission Inventory
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)							
		Ni	Se	Benzene	Toluene	Xylenes	Formaldehyde	Acetaldehyde	Acrolein
	Emission Unit Group 8: Other Mobile Emission Units								
8.001	On-Site Delivery Truck Traffic	2.74E-03	6.84E-04	-	-	-	-	-	-
8.002	On-Site Delivery Truck (Combustion)	-	-	-	-	-	-	-	-
8.003	On-Site Light Vehicle Traffic	2.69E-02	6.74E-03	-	-	-	-	-	-
8.004	On-Site Light Vehicle (Combustion)	-	-	-	-	-	-	-	-
8.005	Off-Site Delivery Truck Traffic	-	-	-	-	-	-	-	-
8.006	Off-Site Light Vehicle Traffic	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 8	**2.97E-02**	**7.42E-03**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
	TOTAL EMISSIONS (lbs/yr)	***5.93E+00***	***1.41E+00***	***2.17E+01***	***1.46E+02***	***6.87E+01***	***1.94E-02***	***6.21E-03***	***1.94E-03***
	TOTAL EMISSIONS (tons/yr)	***2.97E-03***	***7.06E-04***	***1.08E-02***	***7.30E-02***	***3.43E-02***	***9.72E-06***	***3.11E-06***	***9.71E-07***

Imperial Project
Air Pollution Emission Inventory
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)							
		Naphthalene	Propylene	1,3-Butadiene	HCl	HCN	Hexane	2,2,4-Trimethylpentane	Bromine
Emission Unit Group 8: Other Mobile Emission Units									
8.001	On-Site Delivery Truck Traffic	-	-	-	-	-	-	-	-
8.002	On-Site Delivery Truck (Combustion)	-	-	-	-	-	-	-	-
8.003	On-Site Light Vehicle Traffic	-	-	-	-	-	-	-	-
8.004	On-Site Light Vehicle (Combustion)	-	-	-	-	-	-	-	-
8.005	Off-Site Delivery Truck Traffic	-	-	-	-	-	-	-	-
8.006	Off-Site Light Vehicle Traffic	-	-	-	-	-	-	-	-
	SUBTOTAL - EMISSION UNIT GROUP 8	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**
	TOTAL EMISSIONS (lbs/yr)	***3.58E+00***	***0.00E+00***	***0.00E+00***	***3.53E+02***	***4.75E+01***	***2.22E+01***	***2.91E+01***	***2.53E-01***
	TOTAL EMISSIONS (tons/yr)	***1.79E-03***	***0.00E+00***	***0.00E+00***	***1.77E-01***	***2.38E-02***	***1.11E-02***	***1.46E-02***	***1.26E-04***

Imperial Project
Air Pollution Emission Inventory
Total Potential to Emit for all Title V Applicable Hazardous Air Pollutants

Emission Unit No.	Emission Unit Description	Hazardous Air Pollutants (lbs/yr)			
		Chlorine	Ethylene Glycol	Ethylbenzene	ALL HAPS
Emission Unit Group 8: Other Mobile Emission Units					
8.001	On-Site Delivery Truck Traffic	-	-	-	1.15E-01
8.002	On-Site Delivery Truck (Combustion)	-	-	-	0.00E+00
8.003	On-Site Light Vehicle Traffic	-	-	-	1.13E+00
8.004	On-Site Light Vehicle (Combustion)	-	-	-	0.00E+00
8.005	Off-Site Delivery Truck Traffic	-	-	-	0.00E+00
8.006	Off-Site Light Vehicle Traffic	-	-	-	0.00E+00
	SUBTOTAL - EMISSION UNIT GROUP 8	**0.00E+00**	**0.00E+00**	**0.00E+00**	**1.25E+00**
	TOTAL EMISSIONS (lbs/yr)	***2.26E-01***	***1.90E-01***	***1.91E+01***	**9.81E+02**
	TOTAL EMISSIONS (tons/yr)	***1.13E-04***	***9.50E-05***	***9.57E-03***	***4.91E-01***

APPENDIX J

MODELING SOURCE PARAMETER TABLES

MODELED POINT SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	STKHT (M)	STKTMP (K)	STKVEL (M/S)	STKDIA (M)
Emergency Diesel Generator	DIESGENR	705194.0	3650203.0	231.648	3.048	366.48	36.576	0.201168
Mobile Light Plant - Heap	HEAPLT	706739.4	3650142.3	274.32	1.8288	366.48	36.576	0.0762
Mobile Light Plant - WRS	WRSLT	705766.6	3650747.3	274.32	1.8288	366.48	36.576	0.0762
AN Silo Baghouse	ANSILOLD	706625.4	3650722.3	243.84	22.15896	Ambient	8.16864	0.201168
Lime Silo Baghouse	LIMELOAD	706571.9	3650732.5	243.84	22.15896	Ambient	8.16864	0.201168
Lab Jaw Crusher	JAWCRUSH	706504.0	3649378.0	231.648	4.572	Ambient	0.009144	1.8288
Lab Pulverizer	PULVERIZ	706503.6	3649371.0	231.648	1.524	Ambient	0.009144	1.8288

MODELED PIT SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	XINIT (M)	YINIT (M)	PITVOL (m3)	ROTANGL
West Pit Operations (PM Only)	WESTPIT	705719.0	3651733.0	249.936	6	563.88	563.88	6.21E+07	45

MODELED AREA SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	XINIT (M)	YINIT (M)	ROTANGL	SZINIT (M)
Heap Dozing	HEAPLOW	706234.6	3650207.0	274.32	0	640.08	457.2	55	6.096
Heap Dozing	HEAPHIGH	706672.1	3650393.8	274.32	0	518.16	273.9847	55	6.096
Waste Rock Stockpile	WRSPA	705182.1	3650419.0	274.32	0	335.28	1005.84	35	6.096
WRS Dozing	WRSPB	705690.0	3650566.5	274.32	0	160.4223	762	35	6.096
WRS Dozing	WRSPC	705884.6	3650563.5	274.32	0	182.88	609.6	35	6.096
WRS Dozing	WRSPD	705931.4	3651125.3	274.32	0	121.92	91.44	35	6.096
WRS Dozing	WRSPE	705536.9	3650339.3	274.32	0	45.72	274.32	35	6.096
AN Silo Chute	ANSILOUN	706625.4	3650722.3	243.84	0	0.9144	0.9144	0	3.048
Lime Hopper Load Chute	LIMEHOPP	706569.6	3650732.5	243.84	0	0.9144	0.9144	90	8.096
Waste Rock Dumping - WRS	ZWRSADMP	705182.1	3650419.0	274.32	4.572	335.28	1005.84	35	6.096
Waste Rock Dumping - WRS	ZWRSBDMP	705690.0	3650566.5	274.32	4.572	160.4223	762	35	6.096
Waste Rock Dumping - WRS	ZWRSCDMP	705884.6	3650563.5	274.32	4.572	182.88	609.6	35	6.096
Waste Rock Dumping - WRS	ZWRSDDMP	705931.4	3651125.3	274.32	4.572	121.92	91.44	35	6.096
Waste Rock Dumping - WRS	ZWRSEDMP	705159.9	3650469.0	274.32	4.572	45.72	274.32	35	6.096
WRS Wind Erosion	ZWRSAAWE	705182.1	3650419.0	274.32	0	335.28	1005.84	35	6.096
WRS Wind Erosion	ZWRSBAWE	705690.0	3650566.5	274.32	0	160.4223	762	35	6.096
WRS Wind Erosion	ZWRSCAWE	705884.6	3650563.5	274.32	0	182.88	609.6	35	6.096
WRS Wind Erosion	ZWRSDAWE	705931.4	3651125.3	274.32	0	121.92	91.44	35	6.096
WRS Wind Erosion	ZWRSEAWE	705536.9	3650339.3	274.32	0	45.72	274.32	35	6.096
Lime Application to Ore	ZLIMEDMP	706571.0	3650731.8	243.84	6.096	1.524	3.048	-90	7.62
Heap Wind Erosion	ZHEAPIWE	706672.1	3650393.8	274.32	0	518.16	273.9847	55	6.096
Heap Wind Erosion	ZHEAPAWE	706234.6	3650207.0	274.32	0	640.08	457.2	55	6.096
Ore Dumping on Heap	ZHEAPDMP	706234.6	3650207.0	274.32	4.572	640.08	457.2	55	6.096

MODELED VOLUME SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	σYINT (M)	σZINIT (M)
Road Source Emissions - Heap	HEAPROAD	706741.3	3650142.3	266.7	4.572	165.6	4.253
Road Source Emissions - WRS	WRSROAD	705766.6	3650747.3	289.56	4.572	151.2	4.253
In-Pit Combustion Sources (Non-PM)	WESTPITV	706000.0	3651740.0	234.7	15.24	135.317	14.177
Road Source Emissions - Haul Road	HAULRD1	706259.1	3651343.0	246.888	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD2	706286.2	3651312.8	246.888	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD3	706313.2	3651284.0	246.888	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD4	706333.5	3651253.5	246.888	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD5	706360.9	3651221.8	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD6	706380.2	3651185.8	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD7	706400.6	3651150.8	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD8	706423.5	3651114.8	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD9	706447.5	3651083.5	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD10	706465.6	3651048.8	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD11	706483.6	3651012.5	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD12	706452.4	3650988.5	249.936	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD13	706420.4	3650956.5	256.032	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD14	706359.4	3650892.5	262.128	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD15	706388.5	3650926.0	268.224	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD16	706323.2	3650866.3	274.32	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD17	706502.8	3650976.5	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD18	706519.6	3650944.0	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD19	706538.9	3650904.5	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD20	706559.3	3650870.0	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD21	706578.8	3650835.3	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD22	706593.6	3650797.8	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD23	706580.4	3650752.3	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD24	706559.8	3650717.0	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD25	706537.1	3650677.5	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD26	706517.4	3650638.0	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD27	706494.8	3650601.3	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD28	706482.2	3650568.0	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD29	706497.4	3650535.5	243.84	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD30	706527.5	3650505.3	249.936	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD31	706558.3	3650476.8	256.032	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD32	706586.0	3650447.0	262.128	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD33	706615.1	3650420.5	268.224	4.572	21.97303	4.253
Road Source Emissions - Haul Road	HAULRD34	706648.0	3650393.0	274.32	4.572	21.97303	4.253
Road Source Emissions - Delivery Roads	DELRD1	704912.3	3650274.0	231.648	4.572	7.087999	4.253
Road Source Emissions - Delivery Roads	DELRD2	704921.8	3650273.3	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD3	704933.5	3650273.3	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD4	704943.8	3650273.3	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD5	704953.2	3650272.5	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD6	704963.4	3650272.5	231.648	4.572	7.088	4.253

MODELED VOLUME SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	σYINT (M)	σZINIT (M)
Road Source Emissions - Delivery Roads	DELRD7	704983.1	3650271.8	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD8	704973.6	3650272.5	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD9	704993.3	3650271.0	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD10	705002.0	3650271.0	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD11	705011.4	3650270.3	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD12	705019.3	3650270.3	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD13	705028.8	3650269.8	231.648	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD14	705038.9	3650269.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD15	705050.0	3650267.5	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD18	705061.0	3650266.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD17	705071.3	3650263.5	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD18	705080.7	3650258.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD19	705090.9	3650252.5	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD20	705098.8	3650244.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD21	705082.7	3650175.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD22	705099.3	3650166.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD23	705090.8	3650171.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD24	705107.4	3850161.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD25	705115.7	3650157.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD26	705123.9	3650153.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD27	705132.4	3650148.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD28	705141.9	3650143.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD29	705150.7	3650139.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD30	705160.8	3650134.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD31	705170.3	3650128.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD32	705180.4	3650124.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD33	705189.9	3650118.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD34	705199.4	3650114.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD35	705209.2	3650112.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD36	705219.3	3650112.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD37	705228.1	3650113.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD38	705237.6	3650115.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD39	705247.1	3650117.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD40	705256.0	3650118.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD41	705265.4	3650121.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD42	705274.3	3650123.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD43	705282.6	3650123.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD44	705292.0	3650123.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD45	705300.6	3650124.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD46	705309.6	3650124.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD47	705318.6	3650122.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD48	705327.4	3650122.0	234.696	4.572	7.088	4.253

MODELED VOLUME SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	σYINT (M)	σZINIT (M)
Road Source Emissions - Delivery Roads	DELRD49	705335.1	3650120.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD50	705343.6	3650117.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD51	705351.0	3650114.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD52	705357.9	3650111.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD53	705364.7	3650110.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD54	705371.6	3650108.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD55	705378.3	3650107.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD56	705385.1	3650107.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD57	705392.0	3650107.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD58	705399.1	3650107.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD59	705406.3	3650107.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD60	705413.9	3650108.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD61	705423.4	3650108.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD62	705431.9	3650109.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD63	705441.4	3650110.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD64	705449.8	3650111.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD65	705457.4	3650113.0	234.696	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD66	705464.6	3650114.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD67	705473.4	3650116.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD68	705481.8	3650117.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD69	705491.8	3650120.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD70	705504.1	3650125.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD71	705512.1	3650132.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD72	705520.9	3650140.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD73	705529.8	3650146.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD74	705537.8	3650152.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD75	705545.8	3650158.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD76	705555.5	3650164.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD77	705564.3	3650170.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD78	705574.1	3650179.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD79	705583.8	3650186.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD80	705591.8	3650194.0	237.744	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD81	705599.9	3650202.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD82	705607.6	3650209.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD83	705615.6	3650216.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD84	705622.7	3650224.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD85	705630.6	3650232.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD86	705639.4	3650237.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD87	705646.5	3650243.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD88	705653.6	3650250.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD89	705660.7	3650255.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD90	705668.6	3650262.0	240.792	4.572	7.088	4.253

MODELED VOLUME SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	σYINT (M)	σZINIT (M)
Road Source Emissions - Delivery Roads	DELRD91	705678.1	3650269.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD92	705686.4	3650276.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD93	705695.4	3650283.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD94	705702.4	3650292.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD95	705710.2	3650298.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD96	705717.4	3650304.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD97	705725.5	3650309.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD98	705733.2	3650316.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD99	705740.3	3650321.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD100	705746.8	3650327.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD101	705755.7	3650332.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD102	705763.4	3650338.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD103	705770.9	3650342.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD104	705777.9	3650347.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD105	705785.3	3650351.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD106	705792.8	3650355.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD107	705801.1	3650359.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD108	705809.0	3650362.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD109	705817.8	3650365.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD110	705825.7	3650367.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD111	705834.0	3650369.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD112	705842.3	3650372.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD113	705850.3	3650374.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD114	705859.5	3650377.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD115	705868.0	3650380.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD116	705876.7	3650384.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD117	705885.4	3650387.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD118	705894.3	3650391.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD119	705903.0	3650394.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD120	705910.8	3650397.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD121	705919.1	3650401.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD122	705928.5	3650405.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD123	705938.4	3650409.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD124	705948.3	3650412.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD125	705958.1	3650415.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD126	705967.5	3650418.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD127	705976.4	3650422.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD128	705985.8	3650426.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD129	705995.6	3650429.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD130	706005.5	3650432.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD131	706014.9	3650435.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD132	706025.3	3650440.0	240.792	4.572	7.088	4.253

MODELED VOLUME SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	σYINT (M)	σZINIT (M)
Road Source Emissions - Delivery Roads	DELRD133	706035.2	3650444.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD134	706046.1	3650448.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD135	706056.0	3650453.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD136	706066.4	3650457.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD137	706076.8	3650461.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD138	706086.7	3650465.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD139	706095.1	3650469.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD140	706103.4	3650474.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD141	706112.3	3650477.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD142	706120.6	3650481.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD143	706129.9	3650484.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD144	706138.4	3650488.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD145	706146.8	3650492.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD146	706154.6	3650495.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD147	706162.3	3650499.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD148	706169.8	3650503.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD149	706177.3	3650508.0	240.792	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD150	706184.8	3650511.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD151	706192.0	3650514.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD152	706199.3	3650518.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD153	706206.0	3650521.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD154	706213.4	3650525.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD155	706219.8	3650528.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD156	706226.6	3650531.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD157	706233.6	3650534.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD158	706240.6	3650537.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD159	706247.3	3650540.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD160	706253.6	3650544.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD161	706260.1	3650547.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD162	706267.1	3650550.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD163	706272.7	3650553.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD164	706278.9	3650557.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD165	706284.6	3650562.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD166	706290.9	3650567.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD167	706297.9	3650572.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD168	706303.1	3650577.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD169	706308.8	3650582.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD170	706313.6	3650589.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD171	706318.6	3650595.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD172	706323.4	3650602.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD173	706327.9	3650609.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD174	706332.4	3650616.0	243.84	4.572	7.088	4.253

MODELED VOLUME SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	σYINT (M)	σZINIT (M)
Road Source Emissions - Delivery Roads	DELRD175	706336.5	3650623.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD176	706341.0	3650630.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD177	706345.5	3650639.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD178	706350.0	3650647.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD179	706354.1	3650656.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD180	706359.3	3650666.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD181	706365.4	3650674.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD182	706370.5	3650684.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD183	706374.8	3650693.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD184	706378.3	3650703.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD185	706382.6	3650711.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD186	706387.8	3650720.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD187	706392.9	3650729.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD188	706399.2	3650737.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD189	706403.8	3650746.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD190	706410.2	3650755.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD191	706415.6	3650764.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD192	706420.3	3650773.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD193	706423.9	3650783.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD194	706429.4	3650793.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD195	706433.9	3650802.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD196	706437.6	3650812.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD197	706442.2	3650821.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD198	706448.6	3650829.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD199	706454.1	3650837.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD200	706461.4	3650843.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD201	706467.8	3650849.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD202	706477.9	3650855.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD203	706486.1	3650860.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD204	706495.3	3650862.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD205	706504.4	3650864.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD206	706513.6	3650865.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD207	706522.8	3650865.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD208	706531.9	3650864.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD209	706540.1	3650863.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD210	706548.7	3650860.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD211	706556.6	3650857.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD212	706563.0	3650851.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD213	706568.5	3650843.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD214	706574.0	3650836.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD215	706576.8	3650827.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD216	706580.4	3650819.0	243.84	4.572	7.088	4.253

MODELED VOLUME SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	σYINT (M)	σZINT (M)
Road Source Emissions - Delivery Roads	DELRD217	706580.4	3650810.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD218	706581.3	3650801.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD219	706580.4	3650791.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD220	706578.6	3650780.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD221	706575.8	3650772.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD222	706574.0	3650763.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD223	706573.1	3650755.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD224	706570.3	3650745.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD225	706568.5	3650736.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD226	706567.6	3650728.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD227	706567.6	3650720.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD228	706573.1	3650714.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD229	706583.1	3650710.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD230	706594.1	3650709.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD231	706603.3	3650710.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD232	706613.4	3650710.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD233	706623.4	3650710.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD234	706632.9	3650710.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD235	706644.1	3650711.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD236	706645.4	3650702.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD237	706647.1	3650694.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD238	706652.8	3650688.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD239	706659.9	3650687.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD240	706667.4	3650689.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD241	706675.0	3650690.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD242	706682.9	3650692.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD243	706690.3	3650693.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD244	706697.4	3650695.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD245	706704.7	3650696.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD246	706711.3	3650697.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD247	706717.6	3650698.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD248	706724.1	3650699.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD249	706730.9	3650701.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD250	706737.5	3650701.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD251	706743.9	3650703.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD252	706751.1	3650704.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD253	706757.1	3650705.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD254	706763.3	3650707.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD255	706770.1	3650707.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD256	706773.6	3650712.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD257	706773.6	3650717.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD258	706772.7	3650724.0	243.84	4.572	7.088	4.253

MODELED VOLUME SOURCE PARAMETERS

DESCRIPTION	MODEL ID	EASTING	NORTHING	ELEV(M)	RELHT (M)	σYINT (M)	σZINT (M)
Road Source Emissions - Delivery Roads	DELRD259	706771.4	3650730.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD260	706769.7	3650737.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD261	706768.4	3650746.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD262	706767.1	3650753.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD263	706765.8	3650761.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD264	706764.9	3650768.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD265	706763.6	3650775.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD266	706762.3	3650782.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD267	706761.0	3650789.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD268	706759.3	3650796.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD269	706757.6	3650803.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD270	706755.6	3650810.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD271	706751.6	3650816.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD272	706745.3	3650817.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD273	706738.4	3650816.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD274	706731.3	3650815.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD275	706724.6	3650814.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD276	706717.4	3650813.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD277	706710.4	3650812.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD278	706702.8	3650811.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD279	706694.8	3650809.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD280	706687.3	3650808.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD281	706679.6	3650807.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD282	706672.3	3650806.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD283	706664.0	3650805.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD284	706655.8	3650803.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD285	706647.6	3650802.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD286	706639.8	3650800.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD287	706634.6	3650798.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD288	706632.4	3650792.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD289	706631.1	3650785.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD290	706632.8	3650777.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD291	706634.1	3650768.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD292	706635.9	3650760.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD293	706637.1	3650752.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD294	706638.9	3650744.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD295	706640.6	3650734.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD296	706641.5	3650726.0	243.84	4.572	7.088	4.253
Road Source Emissions - Delivery Roads	DELRD297	706642.8	3650718.0	243.84	4.572	7.088	4.253
Heap Combustion Emissions - Dozer	HEAPOTHR	706739.4	3650142.3	266.7	4.572	165.6	4.253
WRS Combustion Emissions - Dozer	WRSOTHR	705766.6	3650747.3	289.56	4.572	151.2	4.253

Calculation of Emissions on Road Segments
SOx Emissions

		% of Time Hauling		
		Waste	Ore	
% of Round Trip Total Combustion - Pit	42.00%	28.00%	14.00%	42.00%
% of Round Trip Total Combustion - Flat	36.00%	24.00%	12.00%	36.00%
% of Round Trip Total Combustion - Heap/WRS	22.00%	14.67%	7.33%	22.00%
% Haul - Ore	33%			100.00%
% Haul - Waste	67%			

35.00	Haul Road Volume Sources	
297.00	Delivery Road Volume Sources	39.33
332.00	Total Road Volume Sources	

Volume Source	% Time Delivery Truck on Road	% Time Water Truck on Road	% Time Light Vehicle on Rd.	% Time Grader On Road	% Time Haul Truck on Road	SOx Comb. Emissions Del. Truck g/s	Water Truck g/s	Lt. Vehicle g/s	Grader g/s	Haul Truck g/s	Total Emis. for Source g/s
HAULRD1	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD2	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD3	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD4	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD5	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD6	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD7	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD8	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD9	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD10	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD11	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD12	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	2.53E-02	0.0254490
HAULRD13	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	1.97E-02	0.0198673
HAULRD14	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	1.97E-02	0.0198673
HAULRD15	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	1.97E-02	0.0198673
HAULRD16	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	1.97E-02	0.0198673
HAULRD17	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	1.97E-02	0.0198673
HAULRD18	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD19	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD20	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD21	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD22	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD23	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD24	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD25	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD26	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD27	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD28	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD29	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD30	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD31	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD32	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490

HAULRD33	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD34	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
HAULRD35	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.12E-04	5.12E-07	5.44E-05	5.58E-03	0.0057490
DELRD1	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD2	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD3	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD4	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD5	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD6	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD7	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD8	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD9	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD10	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD11	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD12	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD13	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD14	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD15	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD16	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD17	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD18	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD19	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD20	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD21	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD22	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD23	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD24	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD25	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD26	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD27	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD28	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD29	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD30	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD31	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD32	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD33	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD34	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD35	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD36	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD37	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD38	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD39	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD40	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD41	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD42	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD43	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD44	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673

Calculation of Emissions on Road Segments

SOx Emissions

DELRD45	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD46	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD47	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD48	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD49	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD50	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD51	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD52	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD53	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD54	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD55	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD56	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD57	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD58	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD59	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD60	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD61	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD62	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD63	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD64	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD65	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD66	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD67	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD68	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD69	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD70	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD71	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD72	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD73	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD71	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD75	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD76	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD77	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD72	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD79	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD80	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD81	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD82	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD83	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD84	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD85	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD86	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD87	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD88	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD89	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD90	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD91	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673

Calculation of Emissions on Road Segments

SOx Emissions

DELRD92	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD93	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD94	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD95	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD96	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD97	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD98	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD99	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD100	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD101	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD102	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD103	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD104	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD105	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD106	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD107	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD108	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD109	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD110	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD111	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD112	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD113	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD114	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD115	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD116	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD117	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD118	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD119	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD120	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD121	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD122	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD123	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD124	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD125	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD126	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD127	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD128	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD129	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD130	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD131	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD132	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD133	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD134	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD135	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD136	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD137	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD138	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673

Calculation of Emissions on Road Segments

SOx Emissions

DELRD139	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD140	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD141	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD142	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD143	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD144	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD145	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD146	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD147	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD148	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD149	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD150	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD151	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD152	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD153	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD154	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD155	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD156	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD157	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD158	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD159	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD161	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD162	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD164	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD167	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD169	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD170	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD179	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD172	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD179	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD174	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD175	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD179	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD177	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD178	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD179	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD181	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD182	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD183	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673

Calculation of Emissions on Road Segments

SOx Emissions

DELRD186	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD187	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD188	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD189	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD190	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD191	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD192	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD193	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD194	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD195	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD196	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD197	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD198	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD199	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD200	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD201	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD202	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD203	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD204	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD205	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD206	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD207	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD208	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD209	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD210	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD211	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD212	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD213	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD214	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD215	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD216	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD217	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD218	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD219	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD220	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD221	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD222	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD223	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD224	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD225	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD226	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD227	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD228	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD229	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD230	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD231	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD232	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673

Calculation of Emissions on Road Segments

SOx Emissions

DELRD233	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD234	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD235	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD236	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD237	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD238	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD239	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD240	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD241	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD242	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD243	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD244	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD245	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD246	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD247	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD248	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD249	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD250	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD251	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD252	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD253	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD254	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD255	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD256	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD257	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD258	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD259	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD260	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD261	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD262	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD263	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD264	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD265	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD266	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD267	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD268	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD269	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD270	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD271	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD272	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD271	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD274	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD275	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD276	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD277	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD278	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD279	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673

Calculation of Emissions on Road Segments

SOx Emissions

DELRD280	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD281	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD282	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD283	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD284	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD285	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD286	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD287	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD288	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD289	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD290	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD291	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD292	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD293	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD294	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD295	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD296	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
DELRD297	0.34%	0.18%	0.18%	0.18%	0.00%	1.70E-08	1.12E-04	5.12E-07	5.44E-05	0.00E+00	0.0001673
HEAPROAD	0.00%	10.00%	10.00%	10.00%	7.33%	0.00E+00	6.22E-03	2.84E-05	3.01E-03	1.02E-01	0.1115883
WRSROAD	0.00%	10.00%	10.00%	10.00%	14.67%	0.00E+00	6.22E-03	2.84E-05	3.01E-03	2.05E-01	0.2139191
WESTPTV	0.00%	20.00%	20.00%	20.00%	42.00%	0.00E+00	1.24E-02	5.67E-05	6.01E-03	5.86E-01	0.6045911
Total	100.00%	100.00%	100.00%	100.00%	100.00%						

Calculation of Emissions on Road Segments
NOx Emissions

		% of Time Hauling		
		Waste	Ore	
% of Round Trip Total Combustion - Pit	42.00%	28.00%	14.00%	42.00%
% of Round Trip Total Combustion - Flat	36.00%	24.00%	12.00%	36.00%
% of Round Trip Total Combustion - Heap/WRS	22.00%	14.67%	7.33%	22.00%
% Haul - Ore	33%			100.00%
% Haul - Waste	67%			

35.00 Haul Road Volume Sources
297.00 Delivery Road Volume Sources 39.33
332.00 Total Road Volume Sources

Volume Source	% Time Delivery Truck on Road	% Time Water Truck on Road	% Time Light Vehicle on Rd.	% Time Grader On Road	% Time Haul Truck on Road	SOx Comb. Emissions Del. Truck g/s	Water Truck g/s	Lt. Vehicle g/s	Grader g/s	Haul Truck g/s	Total Emis. for Source g/s
HAULRD1	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD2	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD3	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD4	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD5	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD6	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD7	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD8	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD9	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD10	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD11	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD12	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	2.32E-01	0.2333079
HAULRD13	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	1.81E-01	0.1821246
HAULRD14	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	1.81E-01	0.1821246
HAULRD15	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	1.81E-01	0.1821246
HAULRD16	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	1.81E-01	0.1821246
HAULRD17	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	1.81E-01	0.1821246
HAULRD18	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD19	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD20	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD21	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD22	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD23	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD24	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD25	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD26	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD27	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD28	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD29	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD30	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD31	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD32	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611

Calculation of Emissions on Road Segments
NOx Emissions

HAULRD33	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD34	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
HAULRD35	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	1.03E-03	4.61E-06	4.42E-04	5.12E-02	0.0526611
DELRD1	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD2	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD3	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD4	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD5	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD6	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD7	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD8	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD9	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD10	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD11	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD12	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD13	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD14	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD15	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD16	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD17	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD18	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD19	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD20	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD21	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD22	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD23	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD24	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD25	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD26	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD27	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD28	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD29	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD30	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD31	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD32	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD33	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD34	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD35	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD36	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD37	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD38	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD39	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD40	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD41	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD42	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD43	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD44	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780

Calculation of Emissions on Road Segments

NOx Emissions

DELRD45	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD46	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD47	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD48	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD49	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD50	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD51	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD52	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD53	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD54	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD55	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD56	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD57	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD58	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD59	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD60	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD61	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD62	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD63	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD64	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD65	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD66	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD67	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD68	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD69	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD70	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD71	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD72	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD73	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD74	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD75	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD76	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD77	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD78	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD79	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD80	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD81	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD82	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD83	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD84	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD85	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD86	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD87	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD88	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD89	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD90	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD91	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780

Calculation of Emissions on Road Segments

NOx Emissions

DELRD92	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD93	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD94	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD95	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD96	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD97	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD98	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD99	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD100	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD101	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD102	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD103	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD104	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD105	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD106	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD107	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD108	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD109	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD110	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD111	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD112	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD113	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD114	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD115	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD116	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD117	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD118	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD119	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD120	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD121	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD122	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD123	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD124	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD125	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD126	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD127	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD128	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD129	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD130	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD131	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD132	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD133	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD134	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD135	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD136	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD137	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD138	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780

Calculation of Emissions on Road Segments

NOx Emissions

DELRD139	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD140	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD141	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD142	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD143	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD144	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD145	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD146	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD147	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD148	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD149	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD150	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD151	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD152	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD153	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD154	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD155	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD156	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD157	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD158	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD159	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD160	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD161	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD162	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD163	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD164	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD166	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD167	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD188	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD169	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD175	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD171	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD172	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD179	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD174	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD175	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD175	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD177	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD179	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD179	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD180	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD169	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD182	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD183	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD184	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD185	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780

Calculation of Emissions on Road Segments

NOx Emissions

DELRD186	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD187	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD188	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD189	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD190	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD191	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD192	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD193	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD194	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD195	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD196	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD197	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD198	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD199	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD200	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD201	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD202	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD203	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD204	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD205	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD206	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD207	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD208	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD206	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD216	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD219	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD212	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD213	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD214	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD216	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD216	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD217	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD213	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD219	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD220	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD221	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD222	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD223	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD224	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD225	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD226	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD227	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD228	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD229	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD230	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD231	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD232	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780

Calculation of Emissions on Road Segments

NOx Emissions

DELRD233	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD234	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD235	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD236	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD237	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD238	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD239	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD240	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD241	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD242	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD243	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD244	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD245	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD246	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD247	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD248	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD249	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD250	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD251	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD252	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD253	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD254	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD255	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD256	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD257	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD258	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD259	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD260	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD261	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD262	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD263	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD264	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD265	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD266	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD267	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD268	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD269	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD270	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD271	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD272	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD273	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD274	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD275	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD276	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD277	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD278	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD279	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780

Calculation of Emissions on Road Segments

NOx Emissions

DELRD280	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD281	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD282	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD283	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD284	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD285	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD286	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD287	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD288	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD289	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD290	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD291	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD292	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD293	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD294	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD295	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD296	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
DELRD297	0.34%	0.18%	0.18%	0.18%	0.00%	1.53E-07	1.03E-03	4.61E-06	4.42E-04	0.00E+00	0.0014780
HEAPROAD	0.00%	10.00%	10.00%	10.00%	7.33%	0.00E+00	5.71E-02	2.55E-04	2.45E-02	9.38E-01	1.0201364
WRSROAD	0.00%	10.00%	10.00%	10.00%	14.67%	0.00E+00	5.71E-02	2.55E-04	2.45E-02	1.88E+00	1.9584959
WESTPTV	0.00%	20.00%	20.00%	20.00%	42.00%	0.00E+00	1.14E-01	5.10E-04	4.89E-02	5.37E+00	5.5377946
Total	100.00%	100.00%	100.00%	100.00%	100.00%	4.54E-06	5.71E-01	2.55E-03	2.45E-01	1.28E+01	

Calculation of Emissions on Road Segments
CO Emissions

		% of Time Hauling Wasts	Ore	
% of Round Trip Total Combustion - Pit	42.00%	28.00%	14.00%	42.00%
% of Round Trip Total Combustion - Flat	36.00%	24.00%	12.00%	36.00%
% of Round Trip Total Combustion - Heap/WRS	22.00%	14.67%	7.33%	22.00%
% Haul - Ore	33%			100.00%
% Haul - Wasts	67%			

35.00	Haul Road Volume Sources	
297.00	Delivery Road Volume Sources	39.33
332.00	Total Road Volume Sources	

Volume Source	% Time Delivery Truck on Road	% Time Water Truck on Road	% Time Light Vehicle on Rd.	% Time Grader On Road	% Time Haul Truck on Road	CO Comb. Emissions Del. Truck g/s	Water Truck g/s	Lt. Vehicle g/s	Grader g/s	Haul Truck g/s	Total Emis. for Source g/s
HAULRD1	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD2	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD3	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD4	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD5	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD6	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD7	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD8	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD9	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD10	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD11	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD12	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	1.00E-01	0.1005968
HAULRD13	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	7.80E-02	0.0785099
HAULRD14	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	7.80E-02	0.0785099
HAULRD15	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	7.80E-02	0.0785099
HAULRD16	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	7.80E-02	0.0785099
HAULRD17	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	7.80E-02	0.0785099
HAULRD18	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD19	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD20	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD21	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD22	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD23	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD24	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD25	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD26	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD27	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD28	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD29	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD30	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD31	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD32	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428

Calculation of Emissions on Road Segments
CO Emissions

HAULRD33	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD34	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
HAULRD35	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	4.45E-04	1.57E-05	9.52E-05	2.21E-02	0.0226428
DELRD1	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD2	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD3	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD4	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD5	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD6	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD7	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD8	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD9	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD10	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD11	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD12	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD13	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD14	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD15	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD16	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD17	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD18	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD19	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD20	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD21	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD22	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD23	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD24	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD25	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD26	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD21	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD28	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD29	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD30	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD31	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD32	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD33	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD34	0.34%	0.18%	[illegible]	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD35	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD36	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD37	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD38	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD39	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD40	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD41	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD42	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD43	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD44	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563

Calculation of Emissions on Road Segments
CO Emissions

DELRD45	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD46	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD47	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD48	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD49	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD50	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD51	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD52	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD53	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD54	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD55	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD56	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD57	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD58	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD59	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD60	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD61	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD62	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD63	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD64	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD65	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD66	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD67	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD68	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD69	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD70	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD71	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD72	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD73	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD74	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD75	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD76	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD77	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD78	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD79	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD80	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD81	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD82	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD83	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD84	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD85	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD86	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD87	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD88	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD89	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD90	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD91	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563

Calculation of Emissions on Road Segments
CO Emissions

DELRD92	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD93	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD94	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD95	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD96	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD97	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD98	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD99	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD100	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD101	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD102	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD103	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD104	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD105	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD106	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD107	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD108	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD109	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD110	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD111	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD112	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD113	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD114	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD115	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD116	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD117	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD118	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD119	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD120	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD121	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD122	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD123	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD124	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD125	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD126	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD127	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD128	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD129	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD130	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD131	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD132	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD133	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD134	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD135	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD136	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD137	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD138	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563

Calculation of Emissions on Road Segments

CO Emissions

DELRD139	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD140	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD141	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD142	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD143	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	8.52E-05	0.00E+00	0.0005563
DELRD144	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD145	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD148	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD147	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD148	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD149	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD150	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	8.52E-05	0.00E+00	0.0005563
DELRD151	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD152	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD153	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD154	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD155	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	8.52E-05	0.00E+00	0.0005563
DELRD156	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD157	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD158	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD159	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD160	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD161	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD162	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD163	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD164	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD165	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD166	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD167	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD168	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD169	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD170	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD171	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD172	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD173	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD174	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD175	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD176	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD177	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD178	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD179	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD180	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD181	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD182	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD183	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD184	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD185	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563

Calculation of Emissions on Road Segments

CO Emissions

DELRD186	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD187	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	8.52E-05	0.00E+00	0.0005563
DELRD188	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD189	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD190	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD191	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD192	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD193	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD194	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD195	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD196	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD197	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD198	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD199	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD200	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD201	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD202	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD203	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD204	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD205	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD206	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD207	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD208	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD209	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD210	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD211	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD212	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD213	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD214	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD215	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD216	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD217	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD218	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD219	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD220	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD221	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD222	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD223	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD224	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD225	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD226	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD227	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD228	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD229	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD230	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD231	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD232	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563

Calculation of Emissions on Road Segments

CO Emissions

DELRD233	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD234	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD235	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD236	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD237	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD238	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD239	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD240	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD241	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD242	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD243	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD244	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD245	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD246	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD247	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD248	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD249	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD250	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD251	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD252	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD253	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD254	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD255	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD256	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD257	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD258	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD259	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD260	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD261	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD262	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD263	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD264	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD265	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD266	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD267	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD268	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD269	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD270	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD271	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD272	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD273	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD274	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD275	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD276	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD277	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD278	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD279	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563

Calculation of Emissions on Road Segments

CO Emissions

DELRD280	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD281	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD282	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD283	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD284	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD285	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD286	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD287	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD288	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD289	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD290	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD291	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD292	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD293	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD294	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD295	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD296	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
DELRD297	0.34%	0.18%	0.18%	0.18%	0.00%	5.19E-07	4.45E-04	1.57E-05	9.52E-05	0.00E+00	0.0005563
HEAPRDAD	0.00%	10.00%	10.00%	10.00%	7.33%	0.00E+00	2.46E-02	8.68E-04	5.27E-03	4.05E-01	0.4356837
WRSRDAD	0.00%	10.00%	10.00%	10.00%	14.67%	0.00E+00	2.46E-02	8.68E-04	5.27E-03	8.10E-01	0.8406116
WESTPTV	0.00%	20.00%	20.00%	20.00%	42.00%	0.00E+00	4.92E-02	1.74E-03	1.05E-02	2.32E+00	2.3806440
Total	100.00%	100.00%	100.00%	100.00%	100.00%						

Calculation of Emissions on Road Segments
PM_{10} Emissions

		% of Time Hauling Waste	Ore	
% of Round Trip Total Combustion - Pit	42.00%	28.00%	14.00%	42.00%
% of Round Trip Total Combustion - Flat	36.00%	24.00%	12.00%	36.00%
% of Round Trip Total Combustion - Heap/WRS	22.00%	14.67%	7.33%	22.00%
% Haul - Ore	33%			100.00%
% Haul - Waste	67%			

35.00	Haul Road Volume Sources	
297.00	Delivery Road Volume Sources	39.33
332.00	Total Road Volume Sources	

Volume Source	% Time Delivery Truck on Road	% Time Water Truck on Road	% Time Light Vehicle on Rd.	% Time Grader On Road	% Time Haul Truck on Road	CO Comb. Emissions Del. Truck g/s	DTTraffic g/s	Water Truck g/s	WTTraffic g/s	Lt. Vehicle g/s	LVTraffic g/s	Grader g/s	Grading g/s	HT Traff g/s	Haul Truck g/s	Total Emis. for Source g/s
HAULRD1	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD2	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD3	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD4	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD5	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD6	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD7	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD8	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD9	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD10	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD11	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD12	0.00%	0.18%	0.18%	0.18%	1.81%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	2.17E-02	5.94E-03	0.0277827
HAULRD13	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	1.69E-02	4.63E-03	0.0216732
HAULRD14	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	1.69E-02	4.63E-03	0.0216732
HAULRD15	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	1.69E-02	4.63E-03	0.0216732
HAULRD16	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	1.69E-02	4.63E-03	0.0216732
HAULRD17	0.00%	0.18%	0.18%	0.18%	1.41%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	1.69E-02	4.63E-03	0.0216732
HAULRD18	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD19	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD20	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD21	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD22	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD23	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD24	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD25	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD26	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD27	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD28	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD29	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD30	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD31	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD32	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD33	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD34	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
HAULRD35	0.00%	0.18%	0.18%	0.18%	0.40%	0.00E+00	0.00E+00	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	4.90E-03	1.31E-03	0.0062197
DELRD1	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD2	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD3	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD4	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD5	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD6	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD7	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD8	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD9	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD10	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD11	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD12	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD13	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD14	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD15	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD16	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133

Calculation of Emissions on Road Segments
PM_{10} Emissions

DELRD17	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD18	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD19	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD20	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD21	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD22	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD23	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD24	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD25	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD26	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD27	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD28	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD29	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD30	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD31	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD32	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD33	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD34	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD35	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD36	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD37	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD38	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD39	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD40	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD41	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD42	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD43	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD44	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD45	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD46	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD47	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD48	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD49	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD50	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD51	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD52	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD53	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD54	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD55	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD56	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD57	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD58	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD59	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD60	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD61	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD62	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD63	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD64	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD65	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD66	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD67	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD68	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD69	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD70	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD71	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD72	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD73	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD74	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD75	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD76	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD77	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD78	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD79	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD80	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD81	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD82	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-05	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133

Calculation of Emissions on Road Segments
PM_{10} Emissions

DELRD83	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001132
DELRD84	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD85	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD86	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD87	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD88	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD89	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD90	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD91	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD92	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD93	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD94	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD95	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD96	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD97	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD98	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD99	0.34%	0.18%	0.19%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD100	0.34%	0.18%	0.19%	0.18%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD101	0.34%	0.18%	0.19%	0.19%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD102	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD103	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD104	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD105	0.34%	0.18%	0.18%	0.19%	0.00%	3.05E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD106	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD107	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD108	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD109	0.34%	0.19%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD110	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD111	0.34%	0.19%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD112	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD113	0.34%	0.18%	0.18%	0.19%	0.00%	3.05E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD114	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD115	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD116	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD117	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD118	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.85E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD119	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD120	0.34%	0.19%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD121	0.34%	0.19%	0.18%	0.18%	0.00%	3.06E-06	3.05E-06	3.32E-05	8.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD122	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD123	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.91E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD124	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD125	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD126	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD127	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD128	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD129	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD130	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD131	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD132	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.00E-05	0.00E+00	0.00E+00	0.0001133
DELRD133	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD134	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD135	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD136	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD137	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD138	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD139	0.34%	0.19%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD140	0.34%	0.19%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD141	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD142	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD143	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD144	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD145	0.34%	0.18%	0.19%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	8.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD146	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD147	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	8.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD148	0.34%	0.19%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133

Calculation of Emissions on Road Segments
PM_{10} Emissions

DELRD149	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD150	0.34%	0.18%	0.18%	0.18%	0.00%	3.05E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD151	0.34%	0.18%	0.18%	0.19%	0.00%	3.05E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD152	0.34%	0.18%	0.19%	0.18%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD153	0.34%	0.18%	0.19%	0.18%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD154	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD155	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD156	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD157	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD158	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD159	0.34%	0.18%	0.19%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD160	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD161	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD162	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD163	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD164	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD165	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD166	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD167	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD168	0.34%	0.18%	0.18%	0.19%	0.00%	3.05E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD169	0.34%	0.18%	0.18%	0.19%	0.00%	3.05E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001132
DELRD170	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD171	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD172	0.34%	0.19%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD173	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD174	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001132
DELRD175	0.34%	0.18%	0.18%	0.18%	0.00%	3.05E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD176	0.34%	0.19%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD177	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD178	0.34%	0.19%	0.18%	0.18%	0.00%	3.06E-08	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001132
DELRD179	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD180	0.34%	0.19%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD181	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001132
DELRD182	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	8.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001132
DELRD183	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD184	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-08	3.32E-05	9.65E-07	8.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD185	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD186	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD187	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-05	3.32E-05	8.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD188	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	8.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD189	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD190	0.34%	0.19%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD191	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD192	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD193	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD194	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD195	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001132
DELRD196	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD197	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-06	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD198	0.34%	0.18%	0.18%	0.19%	0.00%	3.05E-06	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD199	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001132
DELRD200	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-05	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD201	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD202	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD203	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD204	0.34%	0.18%	0.19%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD205	0.34%	0.18%	0.18%	0.18%	0.00%	3.05E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD206	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD207	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD208	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD209	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD210	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	8.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD211	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD212	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD213	0.34%	0.18%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.61E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD214	0.34%	0.19%	0.18%	0.19%	0.00%	3.06E-08	3.05E-08	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133

Calculation of Emissions on Road Segments
PM_{10} Emissions

DELRD215	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD216	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD217	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD218	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD219	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD220	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD221	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD222	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD223	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD224	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD225	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD226	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD227	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD228	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD229	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD230	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD231	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD232	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD233	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD234	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD235	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD236	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD237	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD238	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD239	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD240	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD241	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD242	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD243	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD244	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD245	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD246	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD247	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD248	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD249	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD250	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD251	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD252	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD253	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD254	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD255	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD256	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD257	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD258	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD259	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD260	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD261	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD262	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD263	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD264	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD265	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD266	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD267	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD268	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD269	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD270	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD271	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD272	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD273	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD274	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD275	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD276	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD277	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD278	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD279	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD280	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133

Calculation of Emissions on Road Segments
PM_{10} Emissions

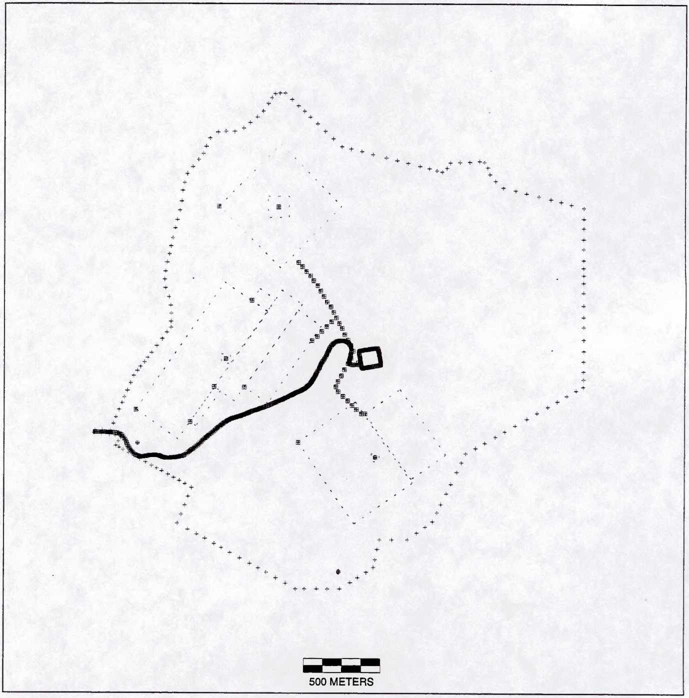
DELRD281	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD282	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD283	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD284	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD285	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD286	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD287	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD288	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD289	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD290	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD291	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD292	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD293	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD294	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD295	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD296	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
DELRD297	0.34%	0.18%	0.18%	0.18%	0.00%	3.06E-08	3.05E-06	3.32E-05	9.65E-07	9.22E-07	1.81E-05	2.01E-05	3.90E-05	0.00E+00	0.00E+00	0.0001133
HEAPROAD	0.00%	10.00%	10.00%	10.00%	7.33%	0.00E+00	0.00E+00	1.84E-03	5.34E-05	5.10E-05	8.91E-04	1.11E-03	2.16E-03	8.80E-02	2.41E-02	0.1181072
WRSROAD	0.00%	10.00%	10.00%	10.00%	14.67%	0.00E+00	0.00E+00	1.84E-03	5.34E-05	5.10E-05	8.91E-04	1.11E-03	2.16E-03	1.76E-01	4.81E-02	0.2301149
WESTPTV	0.00%	20.00%	20.00%	20.00%	42.00%	0.00E+00	0.00E+00	3.67E-03	1.07E-04	1.02E-04	1.76E-03	2.23E-03	4.31E-03	5.06E-01	1.38E-01	0.6536976
Total	100.00%	100.00%	100.00%	100.00%	100.00%											

APPENDIX K

PLATES

Plate 1

Modeled Emission Sources and Fenceline (Discrete) Receptor Location Diagram



Pla[illegible]

Model Grid and Discrete Receptor Location Diagram

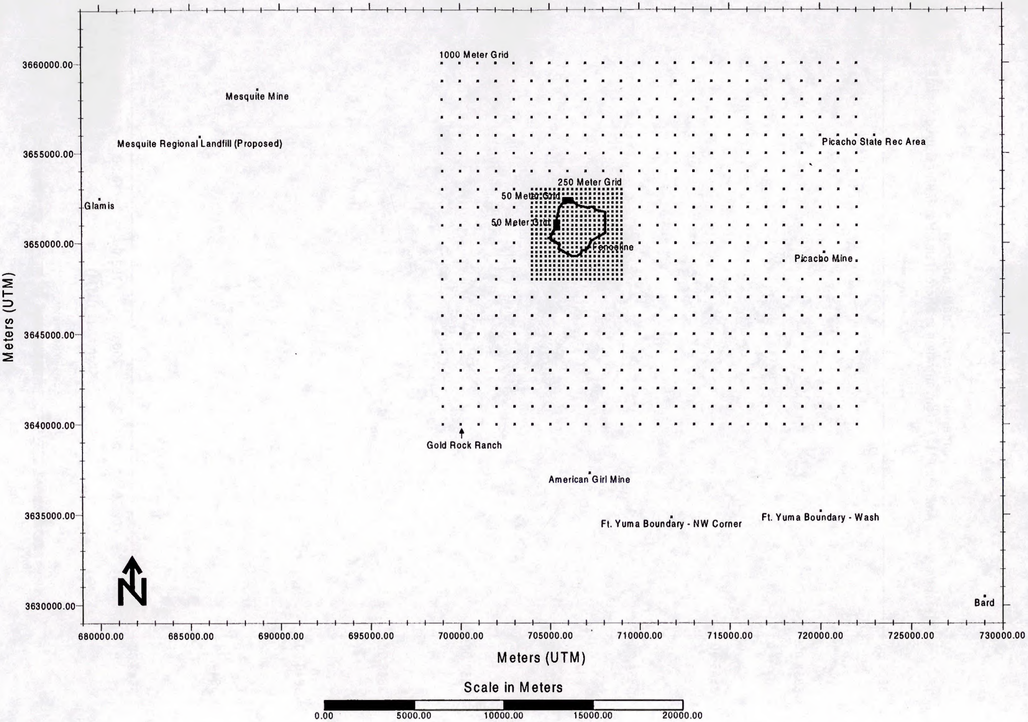


Plate 3

Imperial Project Air Quality Analysis
Maximum 24-Hr Ambient PM_{10} Concentration in Micrograms Per Meter Cubed (ug/m^3)

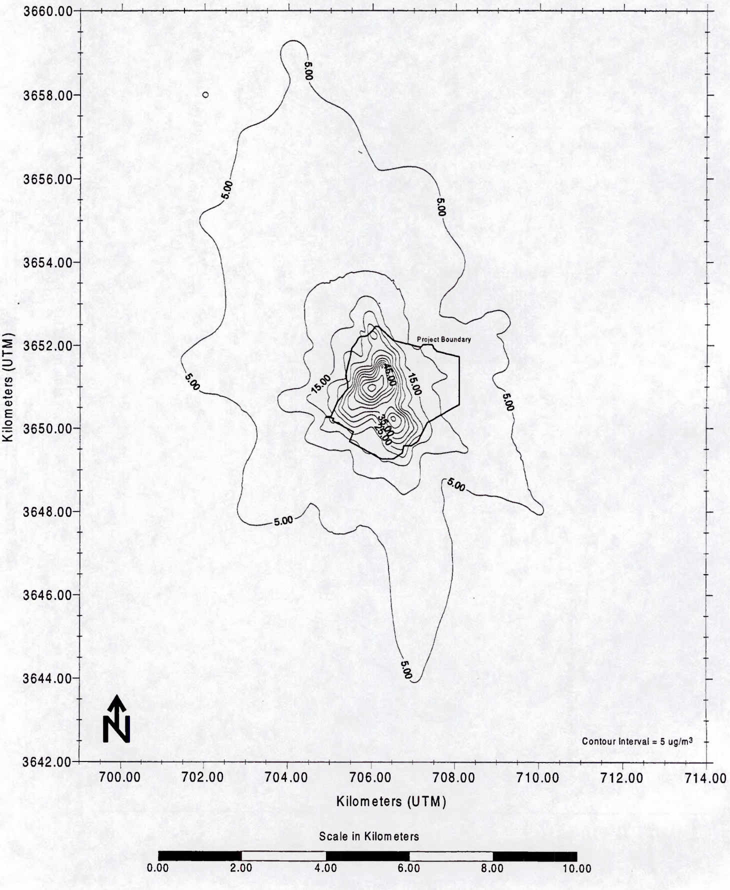


Plate 4

Imperial Project Air Quality Analysis
Average Annual Ambient PM_{10} Concentration in Micrograms Per Meter Cubed (ug/m^3)

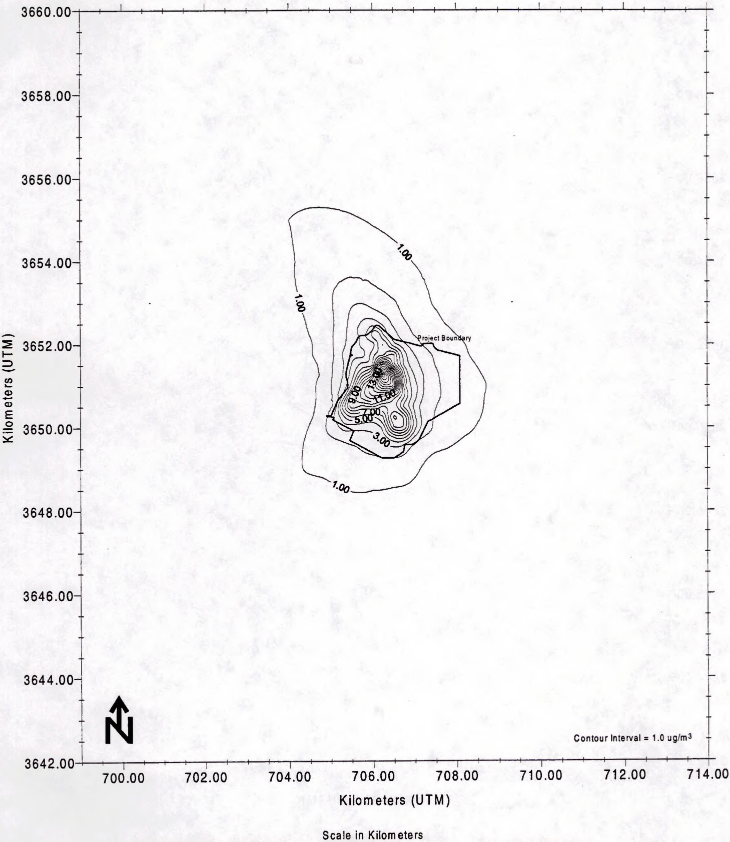


Plate 5

Imperial Project Air Quality Analysis
Maximum 1-Hr Ambient NO_2 Concentration in Micrograms Per Meter Cubed (ug/m^3)

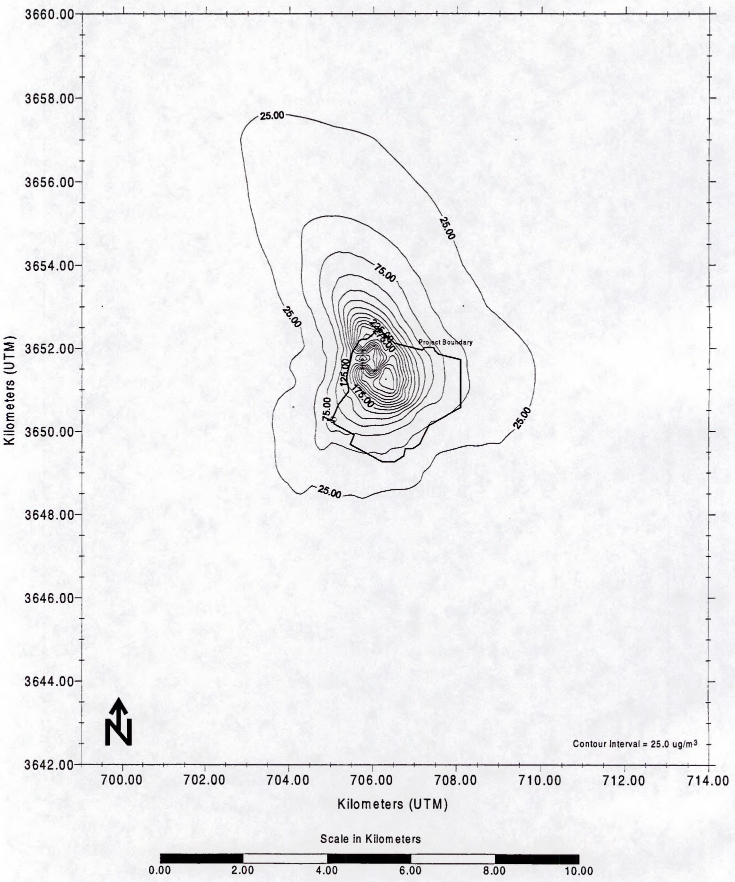


Plate 6

Imperial Project Air Quality Analysis
Average Annual Ambient NO_2 Concentration in Micrograms Per Meter Cubed (ug/m^3)

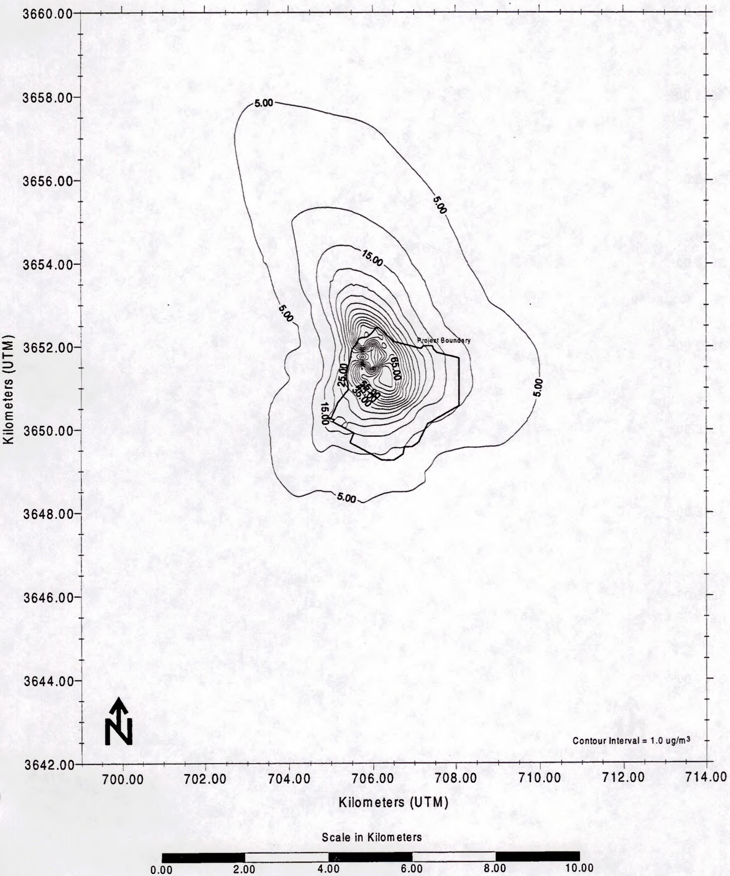


Plate 7

Imperial Project Air Quality Analysis
Maximum 1-Hr Ambient SO_2 Concentration in Micrograms Per Meter Cubed (ug/m^3)

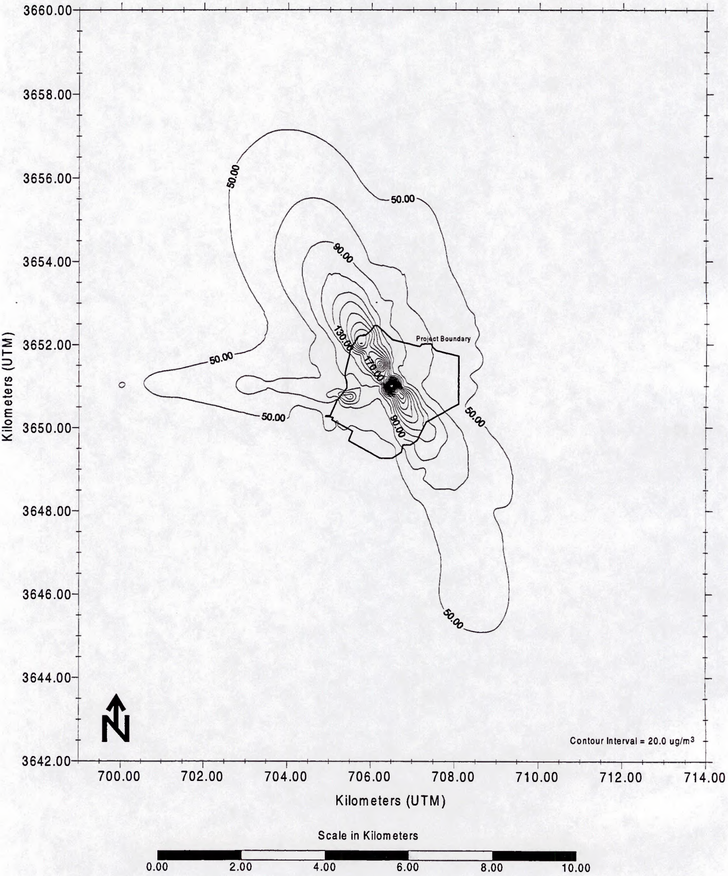


Plate 8

Imperial Project Air Quality Analysis
Maximum 3-Hr Ambient SO_2 Concentration in Micrograms Per Meter Cubed (ug/m^3)

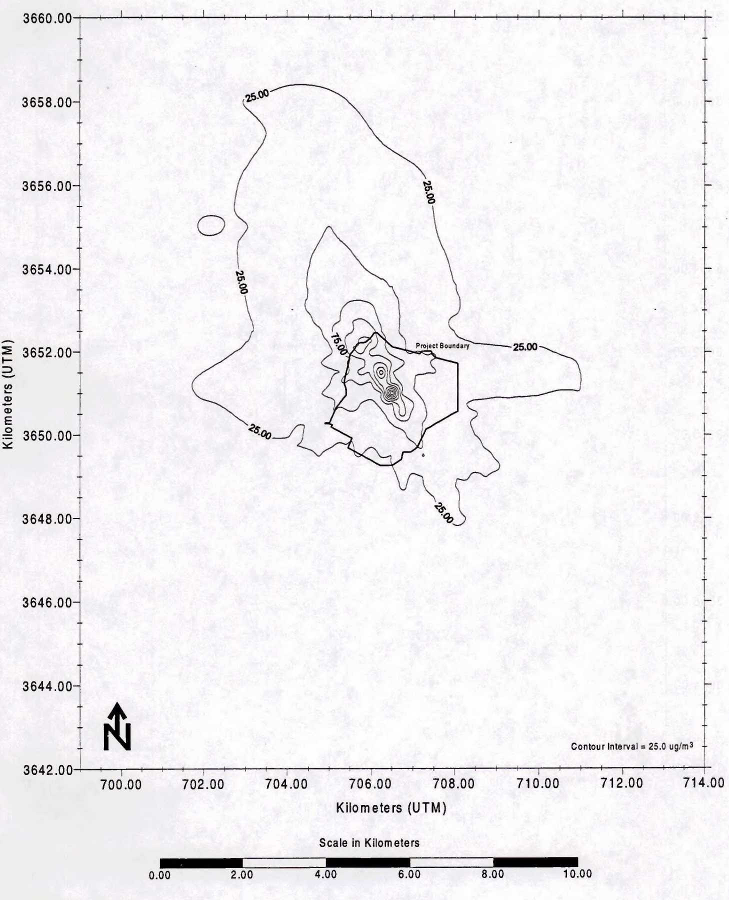


Plate 9

Imperial Project Air Quality Analysis
Maximum 24-Hr Ambient SO_2 Concentration in Micrograms Per Meter Cubed (ug/m^3)

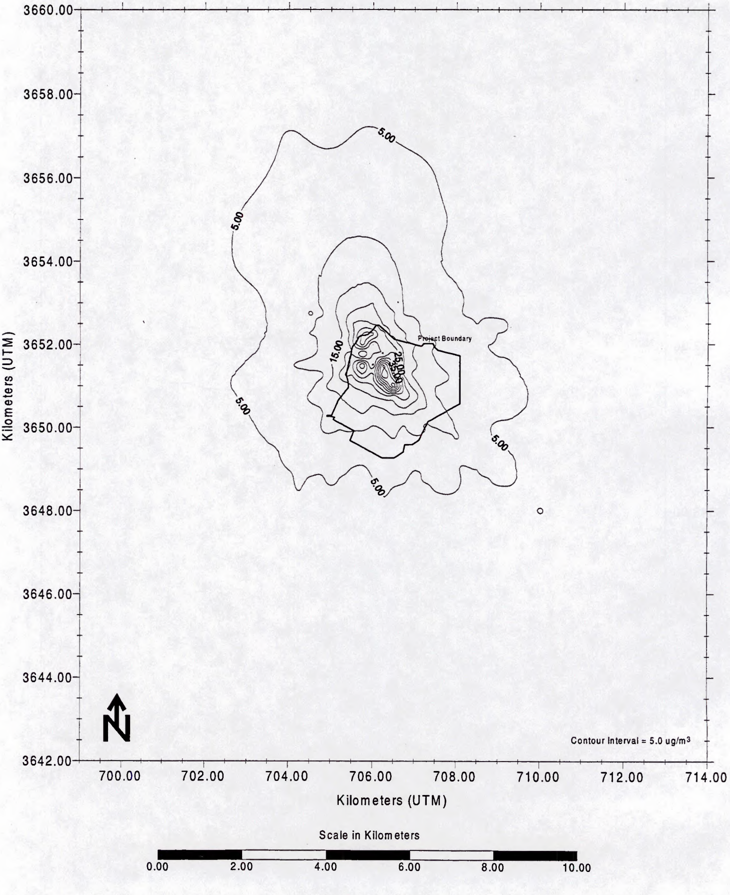


Plate 10

Imperial Project Air Quality Analysis
Average Annual Ambient SO_2 Concentration in Micrograms Per Meter Cubed (ug/m^3)

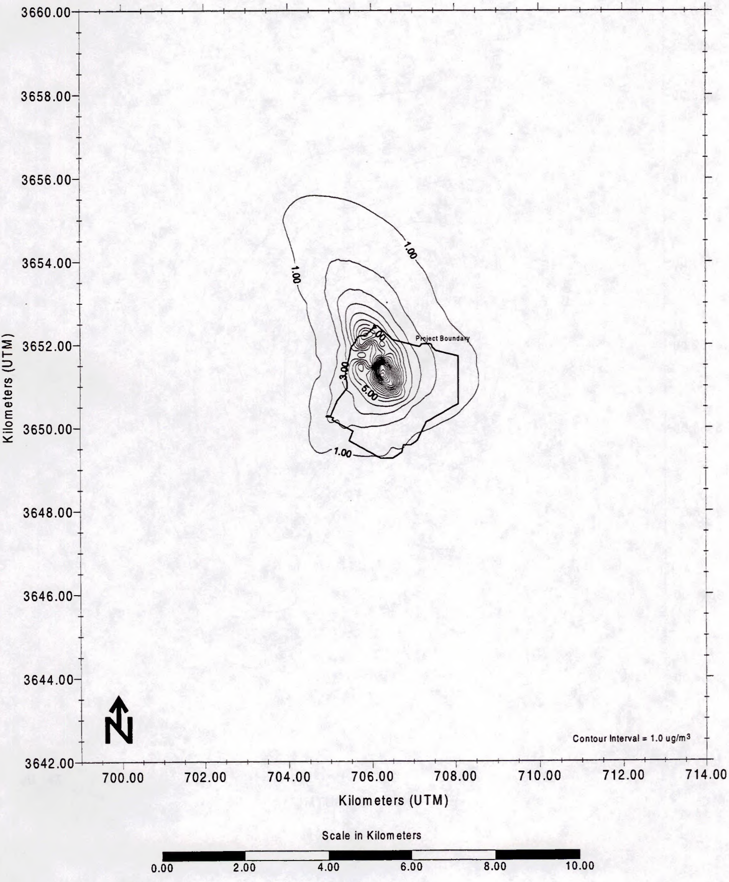


Plate 11

Imperial Project Air Quality Analysis
Maximum 1-Hr Ambient CO Concentration in Micrograms Per Meter Cubed (ug/m^3)

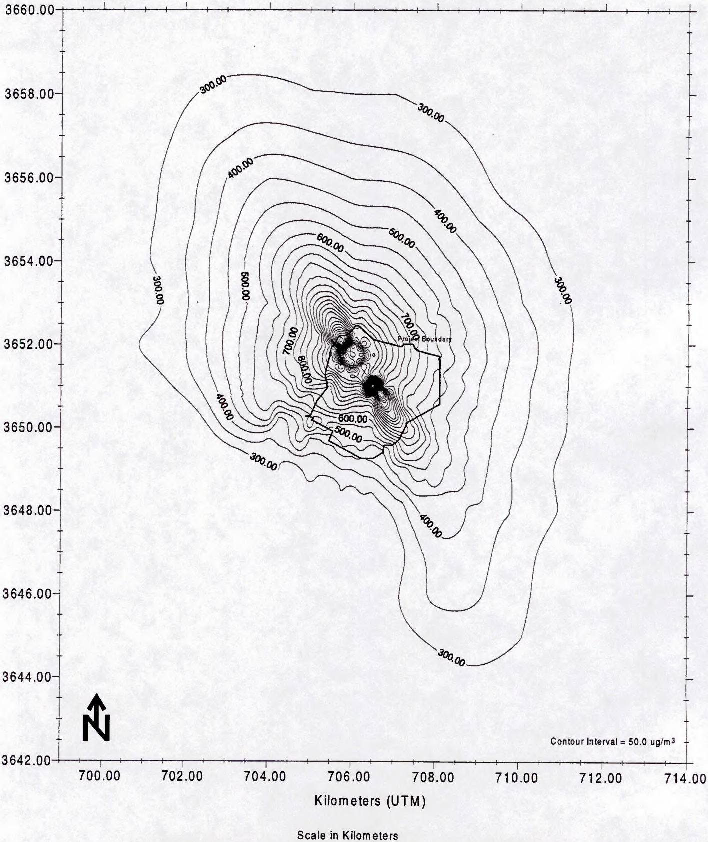


Plate 12

Imperial Project Air Quality Analysis
Maximum 8-Hr Ambient CO Concentration in Micrograms Per Meter Cubed (ug/m^3)

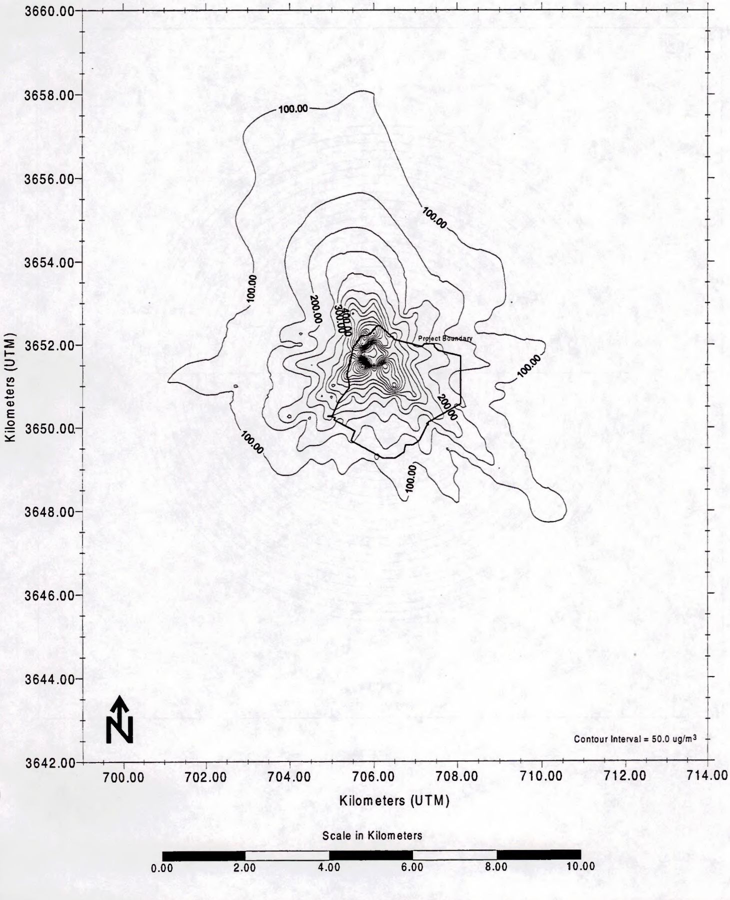


Plate 13

DEPOSITION/DEPLETION SOURCE & RECEPTOR LOCATION DIAGRAM

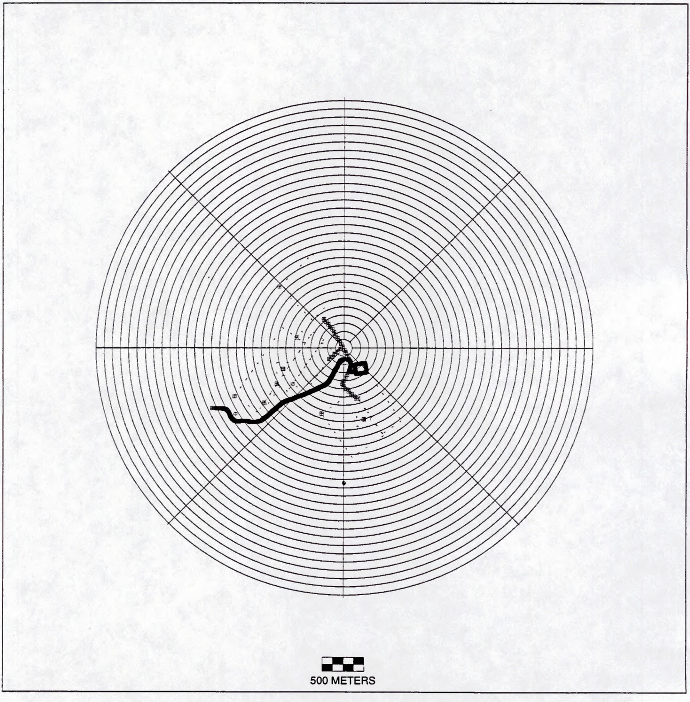
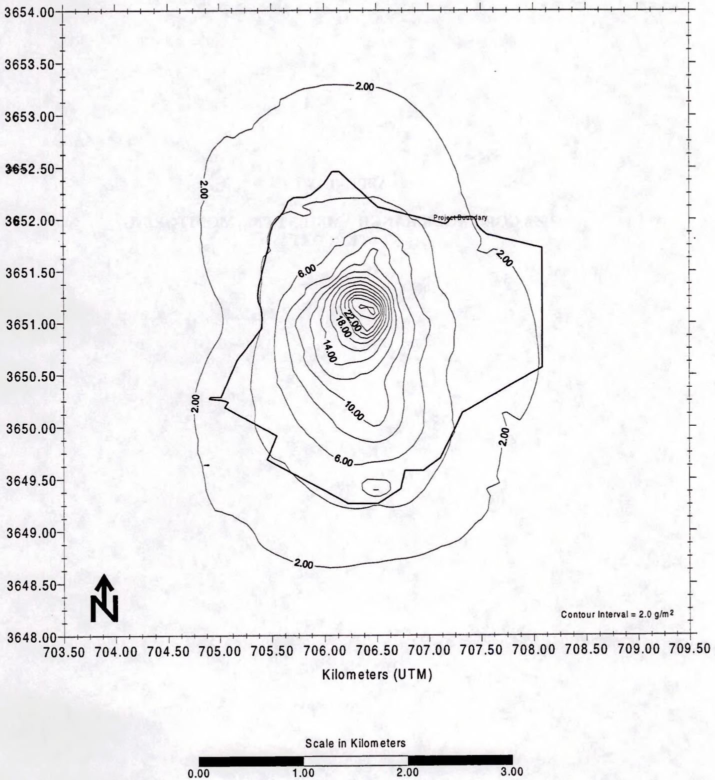


Plate 14

Imperial Project Air Quality Analysis
Average Annual Deposition of Particulate Matter in Grams Per Square Meter (g/m^2)



APPENDIX L

1996 GOLD ROCK RANCH AMBIENT PM_{10} MONITORING STATION DATA

1996 Gold Rock Ranch Particulate Monitoring Data Data
(Collected by Aerodynamics)

Statistical Results

	Arithmetic Mean (ug/m3)	Geometric Mean (ug/m3)	Maximum Value (ug/m3)
1st Quarter	16.7	15.3	31.1
2nd Quarter	21.0	19.5	31.6
3rd Quarter	21.6	20.7	30.8
4th Quarter	16.7	15.2	25.7
Annual	19.0	17.5	31.6

Weekly Data Tabulation

Date	Filter #	Net Weight (mg)	Qindicated (in H2O)	Qcorrected (m3/min)	Duration (hrs)	Loading (ug/m3)
4-Jan-96	13025	26.1	3.20	1.09	24.05	16.6
10-Jan-96	13027	17.8	3.00	1.06	24.04	11.6
16-Jan-96	50202	47.9	3.05	1.07	24.03	31.1
22-Jan-96	50204	15.5	3.05	1.07	24.04	10.1
28-Jan-96	50206	16.6	3.00	1.06	24	10.9
3-Feb-96	50208	20.3	3.00	1.06	24.03	13.3
9-Feb-96	50210	39.9	3.00	1.06	24.02	26.1
15-Feb-96	50212	28.1	3.05	1.07	23.9	18.4
21-Feb-96	50214	20.4	3.10	1.08	24	13.2
27-Feb-96	50216	12	3.00	1.06	24.02	7.9
4-Mar-96	50218	16.5	3.00	1.06	24.02	10.8
10-Mar-96	50220	26.8	3.00	1.06	24.01	17.6
16-Mar-96	50222	17	3.10	1.08	24.06	11.0
22-Mar-96	50224	41.9	3.00	1.06	24.01	27.4
28-Mar-96	50226	37.3	3.00	1.06	24.02	24.4
3-Apr-96	50228	24.3	3.00	1.06	24.02	15.9
9-Apr-96	50230	29.6	3.10	1.08	24.01	19.1
15-Apr-96	50232	18.0	3.00	1.06	24	11.8
21-Apr-96	50234	28.3	3.10	1.08	24.03	18.3
27-Apr-96	50236	31.8	3.30	1.11	24.04	20.0
3-May-96	50238	37.2	3.10	1.08	24.04	24.0
9-May-96	50240	33.7	3.20	1.09	24.01	21.5
15-May-96	50242	32.7	3.20	1.09	24.02	20.8
21-May-96	50244	49.3	3.10	1.08	24.01	31.6
27-May-96	50246	49.3	3.10	1.08	24.02	31.6
2-Jun-96	50248	8.8	3.10	1.08	24.01	5.6
8-Jun-96	50250	***				
14-Jun-96	50252	32.6	3.20	1.10	24.06	20.6
20-Jun-96	50254	45.4	3.10	1.08	24.02	29.1
26-Jun-96	50256	38.0	3.10	1.08	24.02	24.4
2-Jul-96	50258	47.7	3.10	1.08	24.01	30.8
8-Jul-96	50260	41.9	3.20	1.09	24.03	26.7
14-Jul-96	50262	33.2	3.20	1.09	24	21.2
20-Jul-96	50264	37.5	3.20	1.09	24	23.9
26-Jul-96	50266	47.2	3.20	1.09	24.04	30.0
1-Aug-96	50268	16.4	3.20	1.09	24.02	10.4
7-Aug-96	50270	36	3.20	1.09	24	22.9
13-Aug-96	50272	34.4	3.20	1.09	24.02	21.9
19-Aug-96	50274	48.4	3.20	1.09	24	30.8
25-Aug-96	50276	24.2	3.20	1.09	24.01	15.4
31-Aug-96	50278	19.4	3.20	1.09	24	12.4
6-Sep-96	50280	28.1	3.10	1.08	24	18.2
12-Sep-96	50282	32.1	3.70	1.08	24.2	20.5
18-Sep-96	50284	28.1	3.70	1.08	24.04	18.1
24-Sep-96	50286	28.8	3.70	1.08	24.01	18.5
30-Sep-96	50288	37.3	3.70	1.08	24.01	24.0
6-Oct-96	50290	23.7	3.85	1.19	24	13.9
12-Oct-96	50292	33.5	3.80	1.18	24.03	19.7
18-Oct-96	50294	38.8	3.60	1.15	24	23.4
24-Oct-96	50296	35.8	3.65	1.16	24.02	21.5
30-Oct-96	50298	29.3	3.65	1.16	24.03	17.6
5-Nov-96	50300	32.6	3.70	1.17	24.08	19.4
11-Nov-96	60878	12.2	3.80	1.18	24	7.2
17-Nov-96	60880	29.6	3.50	1.14	24	18.1
23-Nov-96	60882	8	3.65	1.16	24	4.8
29-Nov-96	60884	43.6	3.75	1.17	24.07	25.7
5-Dec-96	60886	33.3	3.65	1.16	23	20.8
11-Dec-96	60888	30.6	3.70	1.17	25.03	17.5
17-Dec-96	60890	25.8	3.75	1.17	24	15.3
23-Dec-96	60892	12.7	3.75	1.17	24	7.5
29-Dec-96	60894	29.8	3.80	1.18	24.02	17.5

APPENDIX M

U.S. EPA INDUSTRIAL SOURCE COMPLEX - SHORT TERM (ISCST3) DISPERSION MODELING RESULTS

APPENDIX M-1

Maximum 24-Hour and Annual PM_{10} Concentrations
1000 and 250 Meter Screening Grids With Discrete (Boundary) Receptors

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX M-2

Maximum 24-Hour and Annual PM_{10} Concentrations
50-Meter Assessment Grids With Discrete (Boundary) Receptors

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX M-3

Maximum 1-hr and Annual Average NOx Concentrations
1000 and 250 Meter Screening Grid & Discrete (Boundary) Receptors

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX M-4

1-Hr, 3-Hr, 24-Hr, and Average Annual SO_2 Concentrations
1000 and 250 Meter Screening Grid & Discrete (Boundary) Receptors

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX M-5

1-Hr and 8-Hr CO Concentrations
1000 and 250 Meter Screening Grid & Discrete (Boundary) Receptors

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

APPENDIX N

CALCULATED NO_2 CONCENTRATIONS BASED ON DISPERSION MODELING RESULTS FOR NO_X

APPENDIX N-1

Calculated Maximum 1-Hr Ambient NO_2 Concentrations

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
250 METER GRID (INCLUDING POINTS WITHIN FACILITY)								
704	3648	181.6546	0.097	0.010	0.13	0.10	0.25	No
704.25	3648	198.0774	0.105	0.011	0.13	0.11	0.25	No
704.5	3648	186.0789	0.099	0.010	0.13	0.10	0.25	No
704.75	3648	211.9098	0.113	0.011	0.13	0.11	0.25	No
705	3648	211.0786	0.112	0.011	0.13	0.11	0.25	No
705.25	3648	208.3969	0.111	0.011	0.13	0.11	0.25	No
705.5	3648	225.7848	0.120	0.012	0.13	0.12	0.25	No
705.75	3648	194.1535	0.103	0.010	0.13	0.10	0.25	No
706	3648	256.0063	0.136	0.014	0.13	0.14	0.25	No
706.25	3648	275.5028	0.147	0.015	0.13	0.14	0.25	No
706.5	3648	251.018	0.134	0.013	0.13	0.14	0.25	No
706.75	3648	316.0544	0.168	0.017	0.13	0.15	0.25	No
707	3648	393.8717	0.210	0.021	0.13	0.15	0.25	No
707.25	3648	438.7868	0.233	0.023	0.13	0.15	0.25	No
707.5	3648	529.3893	0.282	0.028	0.13	0.16	0.25	No
707.75	3648	566.2482	0.301	0.030	0.13	0.16	0.25	No
708	3648	563.2574	0.300	0.030	0.13	0.16	0.25	No
708.25	3648	594.0884	0.316	0.032	0.13	0.16	0.25	No
708.5	3648	573.1096	0.305	0.030	0.13	0.16	0.25	No
708.75	3648	518.8026	0.276	0.028	0.13	0.16	0.25	No
709	3648	438.8822	0.233	0.023	0.13	0.15	0.25	No
704	3648.25	204.539	0.109	0.011	0.13	0.11	0.25	No
704.25	3648.25	209.2478	0.111	0.011	0.13	0.11	0.25	No
704.5	3648.25	200.932	0.107	0.011	0.13	0.11	0.25	No
704.75	3648.25	224.9355	0.120	0.012	0.13	0.12	0.25	No
705	3648.25	219.6709	0.117	0.012	0.13	0.12	0.25	No
705.25	3648.25	222.7581	0.118	0.012	0.13	0.12	0.25	No
705.5	3648.25	234.3995	0.125	0.012	0.13	0.12	0.25	No
705.75	3648.25	271.8025	0.145	0.014	0.13	0.14	0.25	No
706	3648.25	257.0702	0.137	0.014	0.13	0.14	0.25	No
706.25	3648.25	275.8065	0.147	0.015	0.13	0.14	0.25	No
706.5	3648.25	291.2243	0.155	0.015	0.13	0.15	0.25	No
706.75	3648.25	359.2317	0.191	0.019	0.13	0.15	0.25	No
707	3648.25	450.3304	0.240	0.024	0.13	0.15	0.25	No
707.25	3648.25	480.6339	0.256	0.026	0.13	0.16	0.25	No
707.5	3648.25	568.9161	0.303	0.030	0.13	0.16	0.25	No
707.75	3648.25	565.7205	0.301	0.030	0.13	0.16	0.25	No
708	3648.25	521.8601	0.278	0.028	0.13	0.16	0.25	No
708.25	3648.25	549.5574	0.292	0.029	0.13	0.16	0.25	No
708.5	3648.25	523.9982	0.279	0.028	0.13	0.16	0.25	No
708.75	3648.25	514.2302	0.274	0.027	0.13	0.16	0.25	No
709	3648.25	534.9979	0.285	0.028	0.13	0.16	0.25	No
704	3648.5	235.617	0.125	0.013	0.13	0.13	0.25	No
704.25	3648.5	231.282	0.123	0.012	0.13	0.12	0.25	No
704.5	3648.5	230.3605	0.123	0.012	0.13	0.12	0.25	No
704.75	3648.5	223.2415	0.119	0.012	0.13	0.12	0.25	No
705	3648.5	226.5647	0.121	0.012	0.13	0.12	0.25	No
705.25	3648.5	272.627	0.145	0.015	0.13	0.14	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
705.5	3648.5	255.8945	0.136	0.014	0.13	0.14	0.25	No
705.75	3648.5	281.0464	0.149	0.015	0.13	0.14	0.25	No
706	3648.5	267.6978	0.142	0.014	0.13	0.14	0.25	No
706.25	3648.5	289.8268	0.154	0.015	0.13	0.15	0.25	No
706.5	3648.5	302.3853	0.161	0.016	0.13	0.15	0.25	No
706.75	3648.5	386.8513	0.206	0.021	0.13	0.15	0.25	No
707	3648.5	498.8696	0.265	0.027	0.13	0.16	0.25	No
707.25	3648.5	548.952	0.292	0.029	0.13	0.16	0.25	No
707.5	3648.5	645.3499	0.343	0.034	0.13	0.16	0.25	No
707.75	3648.5	648.7787	0.345	0.035	0.13	0.16	0.25	No
708	3648.5	655.8809	0.349	0.035	0.13	0.16	0.25	No
708.25	3648.5	603.2471	0.321	0.032	0.13	0.16	0.25	No
708.5	3648.5	590.4457	0.314	0.031	0.13	0.16	0.25	No
708.75	3648.5	558.5529	0.297	0.030	0.13	0.16	0.25	No
709	3648.5	491.5654	0.261	0.026	0.13	0.16	0.25	No
704	3648.75	243.4022	0.129	0.013	0.13	0.13	0.25	No
704.25	3648.75	250.8373	0.133	0.013	0.13	0.14	0.25	No
704.5	3648.75	216.9615	0.115	0.012	0.13	0.12	0.25	No
704.75	3648.75	250.1059	0.133	0.013	0.13	0.14	0.25	No
705	3648.75	293.9826	0.156	0.016	0.13	0.15	0.25	No
705.25	3648.75	263.7913	0.140	0.014	0.13	0.14	0.25	No
705.5	3648.75	267.8445	0.142	0.014	0.13	0.14	0.25	No
705.75	3648.75	288.5067	0.153	0.015	0.13	0.15	0.25	No
706	3648.75	296.4426	0.158	0.016	0.13	0.15	0.25	No
706.25	3648.75	320.9643	0.171	0.017	0.13	0.15	0.25	No
706.5	3648.75	334.0146	0.178	0.018	0.13	0.15	0.25	No
706.75	3648.75	449.7686	0.239	0.024	0.13	0.15	0.25	No
707	3648.75	557.7754	0.297	0.030	0.13	0.16	0.25	No
707.25	3648.75	652.8942	0.347	0.035	0.13	0.16	0.25	No
707.5	3648.75	700.2833	0.372	0.037	0.13	0.17	0.25	No
707.75	3648.75	650.1354	0.346	0.035	0.13	0.16	0.25	No
708	3648.75	693.6936	0.369	0.037	0.13	0.17	0.25	No
708.25	3648.75	652.9208	0.347	0.035	0.13	0.16	0.25	No
708.5	3648.75	629.5641	0.335	0.033	0.13	0.16	0.25	No
708.75	3648.75	541.5547	0.288	0.029	0.13	0.16	0.25	No
709	3648.75	509.5629	0.271	0.027	0.13	0.16	0.25	No
704	3649	266.2087	0.142	0.014	0.13	0.14	0.25	No
704.25	3649	280.2045	0.149	0.015	0.13	0.14	0.25	No
704.5	3649	249.2177	0.133	0.013	0.13	0.14	0.25	No
704.75	3649	274.5194	0.146	0.015	0.13	0.14	0.25	No
705	3649	294.5277	0.157	0.016	0.13	0.15	0.25	No
705.25	3649	294.9774	0.157	0.016	0.13	0.15	0.25	No
705.5	3649	306.901	0.163	0.016	0.13	0.15	0.25	No
705.75	3649	324.7949	0.173	0.017	0.13	0.15	0.25	No
706	3649	326.7524	0.174	0.017	0.13	0.15	0.25	No
706.25	3649	345.9149	0.184	0.018	0.13	0.15	0.25	No
706.5	3649	362.4539	0.193	0.019	0.13	0.15	0.25	No
706.75	3649	499.6659	0.266	0.027	0.13	0.16	0.25	No
707	3649	646.9113	0.344	0.034	0.13	0.16	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
707.25	3649	615.4443	0.327	0.033	0.13	0.16	0.25	No
707.5	3649	728.8517	0.388	0.039	0.13	0.17	0.25	No
707.75	3649	742.8849	0.395	0.040	0.13	0.17	0.25	No
708	3649	698.2285	0.371	0.037	0.13	0.17	0.25	No
708.25	3649	670.9122	0.357	0.036	0.13	0.17	0.25	No
708.5	3649	594.3473	0.316	0.032	0.13	0.16	0.25	No
708.75	3649	530.0762	0.282	0.028	0.13	0.16	0.25	No
709	3649	530.325	0.282	0.028	0.13	0.16	0.25	No
704	3649.25	293.2887	0.156	0.016	0.13	0.15	0.25	No
704.25	3649.25	283.634	0.151	0.015	0.13	0.15	0.25	No
704.5	3649.25	286.9644	0.153	0.015	0.13	0.15	0.25	No
704.75	3649.25	305.5286	0.163	0.016	0.13	0.15	0.25	No
705	3649.25	305.8596	0.163	0.016	0.13	0.15	0.25	No
705.25	3649.25	308.0302	0.164	0.016	0.13	0.15	0.25	No
705.5	3649.25	331.6154	0.176	0.018	0.13	0.15	0.25	No
705.75	3649.25	352.3405	0.187	0.019	0.13	0.15	0.25	No
706	3649.25	353.9516	0.188	0.019	0.13	0.15	0.25	No
706.25	3649.25	365.4994	0.194	0.019	0.13	0.15	0.25	No
706.5	3649.25	389.2433	0.207	0.021	0.13	0.15	0.25	No
706.75	3649.25	571.0109	0.304	0.030	0.13	0.16	0.25	No
707	3649.25	737.6115	0.392	0.039	0.13	0.17	0.25	No
707.25	3649.25	877.5708	0.467	0.047	0.13	0.18	0.25	No
707.5	3649.25	831.8141	0.442	0.044	0.13	0.17	0.25	No
707.75	3649.25	784.4445	0.417	0.042	0.13	0.17	0.25	No
708	3649.25	719.8	0.383	0.038	0.13	0.17	0.25	No
708.25	3649.25	670.8468	0.357	0.036	0.13	0.17	0.25	No
708.5	3649.25	597.4601	0.318	0.032	0.13	0.16	0.25	No
708.75	3649.25	570.7963	0.304	0.030	0.13	0.16	0.25	No
709	3649.25	509.3363	0.271	0.027	0.13	0.16	0.25	No
704	3649.5	306.3925	0.163	0.016	0.13	0.15	0.25	No
704.25	3649.5	316.5551	0.168	0.017	0.13	0.15	0.25	No
704.5	3649.5	329.6937	0.175	0.018	0.13	0.15	0.25	No
704.75	3649.5	393.3765	0.209	0.021	0.13	0.15	0.25	No
705	3649.5	341.685	0.182	0.018	0.13	0.15	0.25	No
705.25	3649.5	349.0123	0.186	0.019	0.13	0.15	0.25	No
705.5	3649.5	357.6492	0.190	0.019	0.13	0.15	0.25	No
705.75	3649.5	403.661	0.215	0.021	0.13	0.15	0.25	No
706	3649.5	392.9505	0.209	0.021	0.13	0.15	0.25	No
706.25	3649.5	432.071	0.230	0.023	0.13	0.15	0.25	No
706.5	3649.5	371.0397	0.197	0.020	0.13	0.15	0.25	No
706.75	3649.5	632.7765	0.337	0.034	0.13	0.16	0.25	No
707	3649.5	803.0719	0.427	0.043	0.13	0.17	0.25	No
707.25	3649.5	962.9764	0.512	0.051	0.13	0.18	0.25	No
707.5	3649.5	912.1929	0.485	0.049	0.13	0.18	0.25	No
707.75	3649.5	781.2383	0.416	0.042	0.13	0.17	0.25	No
708	3649.5	739.1018	0.393	0.039	0.13	0.17	0.25	No
708.25	3649.5	667.0105	0.355	0.035	0.13	0.17	0.25	No
708.5	3649.5	593.8234	0.316	0.032	0.13	0.16	0.25	No
708.75	3649.5	545.7953	0.290	0.029	0.13	0.16	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
709	3649.5	487.7998	0.259	0.026	0.13	0.16	0.25	No
704	3649.75	320.3609	0.170	0.017	0.13	0.15	0.25	No
704.25	3649.75	331.265	0.176	0.018	0.13	0.15	0.25	No
704.5	3649.75	362.9124	0.193	0.019	0.13	0.15	0.25	No
704.75	3649.75	452.3579	0.241	0.024	0.13	0.15	0.25	No
705	3649.75	365.18	0.194	0.019	0.13	0.15	0.25	No
705.25	3649.75	377.4277	0.201	0.020	0.13	0.15	0.25	No
705.5	3649.75	403.0823	0.214	0.021	0.13	0.15	0.25	No
705.75	3649.75	440.1292	0.234	0.023	0.13	0.15	0.25	No
706	3649.75	453.6754	0.241	0.024	0.13	0.15	0.25	No
706.25	3649.75	480.0384	0.255	0.026	0.13	0.16	0.25	No
706.5	3649.75	564.33	0.300	0.030	0.13	0.16	0.25	No
706.75	3649.75	825.6804	0.439	0.044	0.13	0.17	0.25	No
707	3649.75	966.5223	0.514	0.051	0.13	0.18	0.25	No
707.25	3649.75	1053.532	0.560	0.056	0.13	0.19	0.25	No
707.5	3649.75	1030.408	0.548	0.055	0.13	0.18	0.25	No
707.75	3649.75	884.2712	0.470	0.047	0.13	0.18	0.25	No
708	3649.75	747.4604	0.398	0.040	0.13	0.17	0.25	No
708.25	3649.75	634.5886	0.338	0.034	0.13	0.16	0.25	No
708.5	3649.75	575.9379	0.306	0.031	0.13	0.16	0.25	No
708.75	3649.75	499.0048	0.265	0.027	0.13	0.16	0.25	No
709	3649.75	456.4926	0.243	0.024	0.13	0.15	0.25	No
704	3650	394.2969	0.210	0.021	0.13	0.15	0.25	No
704.25	3650	328.9057	0.175	0.017	0.13	0.15	0.25	No
704.5	3650	369.9568	0.197	0.020	0.13	0.15	0.25	No
704.75	3650	421.5276	0.224	0.022	0.13	0.15	0.25	No
705	3650	528.3162	0.281	0.028	0.13	0.16	0.25	No
705.25	3650	469.0394	0.249	0.025	0.13	0.15	0.25	No
705.5	3650	451.8954	0.240	0.024	0.13	0.15	0.25	No
705.75	3650	490.9908	0.261	0.026	0.13	0.16	0.25	No
706	3650	484.8832	0.258	0.026	0.13	0.16	0.25	No
706.25	3650	506.3675	0.269	0.027	0.13	0.16	0.25	No
706.5	3650	575.0167	0.306	0.031	0.13	0.16	0.25	No
706.75	3650	1022.515	0.544	0.054	0.13	0.18	0.25	No
707	3650	1255.587	0.668	0.067	0.13	0.20	0.25	No
707.25	3650	1195.614	0.636	0.064	0.13	0.19	0.25	No
707.5	3650	1048.6	0.558	0.056	0.13	0.19	0.25	No
707.75	3650	841.8909	0.448	0.045	0.13	0.17	0.25	No
708	3650	681.8403	0.363	0.036	0.13	0.17	0.25	No
708.25	3650	612.8712	0.326	0.033	0.13	0.16	0.25	No
708.5	3650	514.1626	0.273	0.027	0.13	0.16	0.25	No
708.75	3650	466.8123	0.248	0.025	0.13	0.15	0.25	No
709	3650	407.4485	0.217	0.022	0.13	0.15	0.25	No
704	3650.25	490.8782	0.261	0.026	0.13	0.16	0.25	No
704.25	3650.25	363.2889	0.193	0.019	0.13	0.15	0.25	No
704.5	3650.25	389.2407	0.207	0.021	0.13	0.15	0.25	No
704.75	3650.25	440.2327	0.234	0.023	0.13	0.15	0.25	No
705	3650.25	549.4944	0.292	0.029	0.13	0.16	0.25	No
705.25	3650.25	505.6093	0.269	0.027	0.13	0.16	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
705.5	3650.25	540.1965	0.287	0.029	0.13	0.16	0.25	No
705.75	3650.25	571.0814	0.304	0.030	0.13	0.16	0.25	No
706	3650.25	559.556	0.298	0.030	0.13	0.16	0.25	No
706.25	3650.25	583.4514	0.310	0.031	0.13	0.16	0.25	No
706.5	3650.25	725.8196	0.386	0.039	0.13	0.17	0.25	No
706.75	3650.25	1375.626	0.732	0.073	0.13	0.20	0.25	No
707	3650.25	1581.412	0.841	0.084	0.13	0.21	0.25	No
707.25	3650.25	1212.819	0.645	0.065	0.13	0.19	0.25	No
707.5	3650.25	934.8268	0.497	0.050	0.13	0.18	0.25	No
707.75	3650.25	730.3058	0.388	0.039	0.13	0.17	0.25	No
708	3650.25	602.7319	0.321	0.032	0.13	0.16	0.25	No
708.25	3650.25	511.7208	0.272	0.027	0.13	0.16	0.25	No
708.5	3650.25	454.5665	0.242	0.024	0.13	0.15	0.25	No
708.75	3650.25	419.2926	0.223	0.022	0.13	0.15	0.25	No
709	3650.25	397.0528	0.211	0.021	0.13	0.15	0.25	No
704	3650.5	515.9834	0.274	0.027	0.13	0.16	0.25	No
704.25	3650.5	452.2452	0.241	0.024	0.13	0.15	0.25	No
704.5	3650.5	496.6625	0.264	0.026	0.13	0.16	0.25	No
704.75	3650.5	512.4951	0.273	0.027	0.13	0.16	0.25	No
705	3650.5	551.3361	0.293	0.029	0.13	0.16	0.25	No
705.25	3650.5	604.6283	0.322	0.032	0.13	0.16	0.25	No
705.5	3650.5	662.4591	0.352	0.035	0.13	0.17	0.25	No
705.75	3650.5	678.3212	0.361	0.036	0.13	0.17	0.25	No
706	3650.5	637.5151	0.339	0.034	0.13	0.16	0.25	No
706.25	3650.5	641.5079	0.341	0.034	0.13	0.16	0.25	No
706.5	3650.5	894.0531	0.476	0.048	0.13	0.18	0.25	No
706.75	3650.5	1896.52	1.009	0.101	0.13	0.23	0.25	No
707	3650.5	1488.381	0.792	0.079	0.13	0.21	0.25	No
707.25	3650.5	939.2994	0.500	0.050	0.13	0.18	0.25	No
707.5	3650.5	767.0303	0.408	0.041	0.13	0.17	0.25	No
707.75	3650.5	591.0313	0.314	0.031	0.13	0.16	0.25	No
708	3650.5	497.006	0.264	0.026	0.13	0.16	0.25	No
708.25	3650.5	474.324	0.252	0.025	0.13	0.16	0.25	No
708.5	3650.5	448.264	0.238	0.024	0.13	0.15	0.25	No
708.75	3650.5	426.1642	0.227	0.023	0.13	0.15	0.25	No
709	3650.5	414.0803	0.220	0.022	0.13	0.15	0.25	No
704	3650.75	533.611	0.284	0.028	0.13	0.16	0.25	No
704.25	3650.75	576.7405	0.307	0.031	0.13	0.16	0.25	No
704.5	3650.75	637.1331	0.339	0.034	0.13	0.16	0.25	No
704.75	3650.75	721.5946	0.384	0.038	0.13	0.17	0.25	No
705	3650.75	840.5101	0.447	0.045	0.13	0.17	0.25	No
705.25	3650.75	1011.17	0.538	0.054	0.13	0.18	0.25	No
705.5	3650.75	1266.822	0.674	0.067	0.13	0.20	0.25	No
705.75	3650.75	791.1617	0.421	0.042	0.13	0.17	0.25	No
706	3650.75	760.5338	0.405	0.040	0.13	0.17	0.25	No
706.25	3650.75	756.2748	0.402	0.040	0.13	0.17	0.25	No
706.5	3650.75	1205.487	0.641	0.064	0.13	0.19	0.25	No
706.75	3650.75	2321.252	1.235	0.123	0.13	0.25	0.25	Yes
707	3650.75	1279.298	0.680	0.068	0.13	0.20	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
707.25	3650.75	734.8306	0.391	0.039	0.13	0.17	0.25	No
707.5	3650.75	607.4011	0.323	0.032	0.13	0.16	0.25	No
707.75	3650.75	555.0408	0.295	0.030	0.13	0.16	0.25	No
708	3650.75	517.6805	0.275	0.028	0.13	0.16	0.25	No
708.25	3650.75	485.6038	0.258	0.026	0.13	0.16	0.25	No
708.5	3650.75	469.3788	0.250	0.025	0.13	0.15	0.25	No
708.75	3650.75	439.1578	0.234	0.023	0.13	0.15	0.25	No
709	3650.75	412.8979	0.220	0.022	0.13	0.15	0.25	No
704	3651	761.0286	0.405	0.040	0.13	0.17	0.25	No
704.25	3651	758.1954	0.403	0.040	0.13	0.17	0.25	No
704.5	3651	733.1407	0.390	0.039	0.13	0.17	0.25	No
704.75	3651	682.733	0.363	0.036	0.13	0.17	0.25	No
705	3651	732.5831	0.390	0.039	0.13	0.17	0.25	No
705.25	3651	712.8662	0.379	0.038	0.13	0.17	0.25	No
705.5	3651	680.0078	0.362	0.036	0.13	0.17	0.25	No
705.75	3651	861.8837	0.458	0.046	0.13	0.18	0.25	No
706	3651	888.1211	0.472	0.047	0.13	0.18	0.25	No
706.25	3651	881.5404	0.469	0.047	0.13	0.18	0.25	No
706.5	3651	4558.666	2.425	0.242	0.13	0.37	0.25	Yes
706.75	3651	1006.949	0.536	0.054	0.13	0.18	0.25	No
707	3651	827.4658	0.440	0.044	0.13	0.17	0.25	No
707.25	3651	640.9371	0.341	0.034	0.13	0.16	0.25	No
707.5	3651	601.2527	0.320	0.032	0.13	0.16	0.25	No
707.75	3651	572.6865	0.305	0.030	0.13	0.16	0.25	No
708	3651	532.2716	0.283	0.028	0.13	0.16	0.25	No
708.25	3651	505.5636	0.269	0.027	0.13	0.16	0.25	No
708.5	3651	479.4118	0.255	0.026	0.13	0.16	0.25	No
708.75	3651	453.3056	0.241	0.024	0.13	0.15	0.25	No
709	3651	415.0544	0.221	0.022	0.13	0.15	0.25	No
704	3651.25	584.3351	0.311	0.031	0.13	0.16	0.25	No
704.25	3651.25	576.5223	0.307	0.031	0.13	0.16	0.25	No
704.5	3651.25	638.8041	0.340	0.034	0.13	0.16	0.25	No
704.75	3651.25	650.0979	0.346	0.035	0.13	0.16	0.25	No
705	3651.25	775.1812	0.412	0.041	0.13	0.17	0.25	No
705.25	3651.25	817.0112	0.435	0.043	0.13	0.17	0.25	No
705.5	3651.25	802.0702	0.427	0.043	0.13	0.17	0.25	No
705.75	3651.25	978.1102	0.520	0.052	0.13	0.18	0.25	No
706	3651.25	1029.646	0.548	0.055	0.13	0.18	0.25	No
706.25	3651.25	1725.17	0.918	0.092	0.13	0.22	0.25	No
706.5	3651.25	1064.814	0.566	0.057	0.13	0.19	0.25	No
706.75	3651.25	825.489	0.439	0.044	0.13	0.17	0.25	No
707	3651.25	753.4077	0.401	0.040	0.13	0.17	0.25	No
707.25	3651.25	703.3047	0.374	0.037	0.13	0.17	0.25	No
707.5	3651.25	638.8043	0.340	0.034	0.13	0.16	0.25	No
707.75	3651.25	590.7898	0.314	0.031	0.13	0.16	0.25	No
708	3651.25	532.355	0.283	0.028	0.13	0.16	0.25	No
708.25	3651.25	477.5997	0.254	0.025	0.13	0.16	0.25	No
708.5	3651.25	462.2599	0.246	0.025	0.13	0.15	0.25	No
708.75	3651.25	446.3691	0.237	0.024	0.13	0.15	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modeled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
709	3651.25	419.2634	0.223	0.022	0.13	0.15	0.25	No
704	3651.5	542.431	0.289	0.029	0.13	0.16	0.25	No
704.25	3651.5	603.3151	0.321	0.032	0.13	0.16	0.25	No
704.5	3651.5	659.546	0.351	0.035	0.13	0.17	0.25	No
704.75	3651.5	676.1246	0.360	0.036	0.13	0.17	0.25	No
705	3651.5	805.0388	0.428	0.043	0.13	0.17	0.25	No
705.25	3651.5	876.756	0.466	0.047	0.13	0.18	0.25	No
705.5	3651.5	997.7198	0.531	0.053	0.13	0.18	0.25	No
705.75	3651.5	1133.091	0.603	0.060	0.13	0.19	0.25	No
706	3651.5	1581.455	0.841	0.084	0.13	0.21	0.25	No
706.25	3651.5	2778.583	1.478	0.148	0.13	0.28	0.25	Yes
706.5	3651.5	981.5974	0.522	0.052	0.13	0.18	0.25	No
706.75	3651.5	866.9404	0.461	0.046	0.13	0.18	0.25	No
707	3651.5	794.9587	0.423	0.042	0.13	0.17	0.25	No
707.25	3651.5	700.5399	0.373	0.037	0.13	0.17	0.25	No
707.5	3651.5	650.4521	0.346	0.035	0.13	0.16	0.25	No
707.75	3651.5	603.315	0.321	0.032	0.13	0.16	0.25	No
708	3651.5	555.4047	0.295	0.030	0.13	0.18	0.25	No
708.25	3651.5	520.5922	0.277	0.028	0.13	0.16	0.25	No
708.5	3651.5	491.6454	0.262	0.026	0.13	0.16	0.25	No
708.75	3651.5	463.1844	0.246	0.025	0.13	0.15	0.25	No
709	3651.5	432.8818	0.230	0.023	0.13	0.15	0.25	No
704	3651.75	557.4202	0.297	0.030	0.13	0.16	0.25	No
704.25	3651.75	606.1213	0.322	0.032	0.13	0.16	0.25	No
704.5	3651.75	663.1983	0.353	0.035	0.13	0.17	0.25	No
704.75	3651.75	731.0393	0.389	0.039	0.13	0.17	0.25	No
705	3651.75	808.1381	0.430	0.043	0.13	0.17	0.25	No
705.25	3651.75	895.8431	0.477	0.048	0.13	0.18	0.25	No
705.5	3651.75	1030.335	0.548	0.055	0.13	0.18	0.25	No
705.75	3651.75	1179.046	0.627	0.063	0.13	0.19	0.25	No
706	3651.75	2113.262	1.124	0.112	0.13	0.24	0.25	No
706.25	3651.75	1685.866	0.897	0.090	0.13	0.22	0.25	No
706.5	3651.75	1029.062	0.547	0.055	0.13	0.18	0.25	No
706.75	3651.75	894.1282	0.476	0.048	0.13	0.18	0.25	No
707	3651.75	815.9375	0.434	0.043	0.13	0.17	0.25	No
707.25	3651.75	731.0394	0.389	0.039	0.13	0.17	0.25	No
707.5	3651.75	663.1984	0.353	0.035	0.13	0.17	0.25	No
707.75	3651.75	606.1211	0.322	0.032	0.13	0.16	0.25	No
708	3651.75	557.4185	0.296	0.030	0.13	0.16	0.25	No
708.25	3651.75	531.0739	0.282	0.028	0.13	0.16	0.25	No
708.5	3651.75	495.3522	0.263	0.026	0.13	0.16	0.25	No
708.75	3651.75	463.8441	0.247	0.025	0.13	0.15	0.25	No
709	3651.75	435.849	0.232	0.023	0.13	0.15	0.25	No
704	3652	551.7724	0.293	0.029	0.13	0.16	0.25	No
704.25	3652	601.239	0.320	0.032	0.13	0.16	0.25	No
704.5	3652	653.4241	0.348	0.035	0.13	0.16	0.25	No
704.75	3652	714.456	0.380	0.038	0.13	0.17	0.25	No
705	3652	791.9236	0.421	0.042	0.13	0.17	0.25	No
705.25	3652	946.0118	0.503	0.050	0.13	0.18	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modeled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
705.5	3652	1486.689	0.791	0.079	0.13	0.21	0.25	No
705.75	3652	2401.736	1.278	0.128	0.13	0.26	0.25	Yes
706	3652	1599.924	0.851	0.085	0.13	0.22	0.25	No
706.25	3652	1184.385	0.630	0.063	0.13	0.19	0.25	No
706.5	3652	979.7388	0.521	0.052	0.13	0.18	0.25	No
706.75	3652	875.7582	0.466	0.047	0.13	0.18	0.25	No
707	3652	802.709	0.427	0.043	0.13	0.17	0.25	No
707.25	3652	724.0815	0.385	0.039	0.13	0.17	0.25	No
707.5	3652	658.5877	0.350	0.035	0.13	0.17	0.25	No
707.75	3652	601.2356	0.320	0.032	0.13	0.16	0.25	No
708	3652	551.6994	0.293	0.029	0.13	0.16	0.25	No
708.25	3652	512.8284	0.273	0.027	0.13	0.16	0.25	No
708.5	3652	470.046	0.250	0.025	0.13	0.16	0.25	No
708.75	3652	447.929	0.238	0.024	0.13	0.15	0.25	No
709	3652	422.9673	0.225	0.022	0.13	0.15	0.25	No
704	3652.25	530.6885	0.282	0.028	0.13	0.16	0.25	No
704.25	3652.25	570.8467	0.304	0.030	0.13	0.16	0.25	No
704.5	3652.25	621.1408	0.330	0.033	0.13	0.16	0.25	No
704.75	3652.25	683.3437	0.363	0.036	0.13	0.17	0.25	No
705	3652.25	898.3074	0.478	0.048	0.13	0.18	0.25	No
705.25	3652.25	1235.576	0.657	0.066	0.13	0.20	0.25	No
705.5	3652.25	1762.723	0.938	0.094	0.13	0.22	0.25	No
705.75	3652.25	2083.298	1.108	0.111	0.13	0.24	0.25	No
706	3652.25	1856.458	0.987	0.099	0.13	0.23	0.25	No
706.25	3652.25	1028.574	0.547	0.055	0.13	0.18	0.25	No
706.5	3652.25	912.2782	0.485	0.049	0.13	0.18	0.25	No
706.75	3652.25	826.9772	0.440	0.044	0.13	0.17	0.25	No
707	3652.25	749.7856	0.399	0.040	0.13	0.17	0.25	No
707.25	3652.25	703.395	0.374	0.037	0.13	0.17	0.25	No
707.5	3652.25	643.5438	0.342	0.034	0.13	0.16	0.25	No
707.75	3652.25	591.5109	0.315	0.031	0.13	0.18	0.25	No
708	3652.25	545.9161	0.290	0.029	0.13	0.16	0.25	No
708.25	3652.25	518.4625	0.275	0.027	0.13	0.16	0.25	No
708.5	3652.25	486.4641	0.259	0.026	0.13	0.16	0.25	No
708.75	3652.25	455.7344	0.242	0.024	0.13	0.15	0.25	No
709	3652.25	430.1378	0.229	0.023	0.13	0.15	0.25	No
704	3652.5	536.5315	0.285	0.029	0.13	0.16	0.25	No
704.25	3652.5	575.5904	0.306	0.031	0.13	0.16	0.25	No
704.5	3652.5	672.5859	0.358	0.036	0.13	0.17	0.25	No
704.75	3652.5	861.1619	0.458	0.046	0.13	0.18	0.25	No
705	3652.5	1071.764	0.570	0.057	0.13	0.19	0.25	No
705.25	3652.5	1407.306	0.749	0.075	0.13	0.20	0.25	No
705.5	3652.5	1658.183	0.882	0.088	0.13	0.22	0.25	No
705.75	3652.5	1809.366	0.962	0.096	0.13	0.23	0.25	No
706	3652.5	1410.178	0.750	0.075	0.13	0.21	0.25	No
706.25	3652.5	978.5569	0.521	0.052	0.13	0.18	0.25	No
706.5	3652.5	830.6561	0.442	0.044	0.13	0.17	0.25	No
706.75	3652.5	790.3572	0.420	0.042	0.13	0.17	0.25	No
707	3652.5	730.2361	0.388	0.039	0.13	0.17	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
707.25	3652.5	672.9982	0.358	0.036	0.13	0.17	0.25	No
707.5	3652.5	593.8415	0.316	0.032	0.13	0.16	0.25	No
707.75	3652.5	557.1223	0.296	0.030	0.13	0.16	0.25	No
708	3652.5	550.4236	0.293	0.029	0.13	0.16	0.25	No
708.25	3652.5	512.0153	0.272	0.027	0.13	0.16	0.25	No
708.5	3652.5	471.0442	0.251	0.025	0.13	0.16	0.25	No
708.75	3652.5	448.4589	0.239	0.024	0.13	0.15	0.25	No
709	3652.5	425.8437	0.227	0.023	0.13	0.15	0.25	No
704	3652.75	549.3881	0.292	0.029	0.13	0.16	0.25	No
704.25	3652.75	642.3644	0.342	0.034	0.13	0.16	0.25	No
704.5	3652.75	772.1018	0.411	0.041	0.13	0.17	0.25	No
704.75	3652.75	935.6694	0.498	0.050	0.13	0.18	0.25	No
705	3652.75	1147.111	0.610	0.061	0.13	0.19	0.25	No
705.25	3652.75	1404.249	0.747	0.075	0.13	0.20	0.25	No
705.5	3652.75	1575.052	0.838	0.084	0.13	0.21	0.25	No
705.75	3652.75	1503.497	0.800	0.080	0.13	0.21	0.25	No
706	3652.75	1127.491	0.600	0.060	0.13	0.19	0.25	No
706.25	3652.75	947.4697	0.504	0.050	0.13	0.18	0.25	No
706.5	3652.75	828.9234	0.441	0.044	0.13	0.17	0.25	No
706.75	3652.75	731.4832	0.389	0.039	0.13	0.17	0.25	No
707	3652.75	683.8821	0.364	0.036	0.13	0.17	0.25	No
707.25	3652.75	638.6161	0.340	0.034	0.13	0.16	0.25	No
707.5	3652.75	594.9803	0.316	0.032	0.13	0.16	0.25	No
707.75	3652.75	554.5404	0.295	0.029	0.13	0.16	0.25	No
708	3652.75	502.8231	0.267	0.027	0.13	0.16	0.25	No
708.25	3652.75	492.4613	0.262	0.026	0.13	0.16	0.25	No
708.5	3652.75	470.8644	0.250	0.025	0.13	0.16	0.25	No
708.75	3652.75	434.7449	0.231	0.023	0.13	0.15	0.25	No
709	3652.75	417.2706	0.222	0.022	0.13	0.15	0.25	No
704	3653	620.9457	0.330	0.033	0.13	0.16	0.25	No
704.25	3653	709.7813	0.378	0.038	0.13	0.17	0.25	No
704.5	3653	824.1855	0.438	0.044	0.13	0.17	0.25	No
704.75	3653	990.6392	0.527	0.053	0.13	0.18	0.25	No
705	3653	1153.575	0.614	0.061	0.13	0.19	0.25	No
705.25	3653	1301.963	0.693	0.069	0.13	0.20	0.25	No
705.5	3653	1421.179	0.756	0.076	0.13	0.21	0.25	No
705.75	3653	1268.224	0.675	0.067	0.13	0.20	0.25	No
706	3653	964.9894	0.513	0.051	0.13	0.18	0.25	No
706.25	3653	838.5859	0.446	0.045	0.13	0.17	0.25	No
706.5	3653	850.0062	0.452	0.045	0.13	0.18	0.25	No
706.75	3653	685.3375	0.365	0.036	0.13	0.17	0.25	No
707	3653	639.4634	0.340	0.034	0.13	0.16	0.25	No
707.25	3653	601.4865	0.320	0.032	0.13	0.16	0.25	No
707.5	3653	565.7517	0.301	0.030	0.13	0.16	0.25	No
707.75	3653	547.1807	0.291	0.029	0.13	0.16	0.25	No
708	3653	514.4053	0.274	0.027	0.13	0.16	0.25	No
708.25	3653	478.6997	0.255	0.025	0.13	0.16	0.25	No
708.5	3653	426.3271	0.227	0.023	0.13	0.15	0.25	No
708.75	3653	431.7083	0.230	0.023	0.13	0.15	0.25	No
709	3653	402.271	0.214	0.021	0.13	0.15	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
1000 METER GRID (INCLUDING POINTS WITHIN FACILITY)								
699	3640	49.7257	0.026	0.003	0.13	0.03	0.25	No
700	3640	40.4333	0.022	0.002	0.13	0.02	0.25	No
701	3640	45.821	0.024	0.002	0.13	0.02	0.25	No
702	3640	53.524	0.028	0.003	0.13	0.03	0.25	No
703	3640	78.3176	0.042	0.004	0.13	0.04	0.25	No
704	3640	142.8536	0.076	0.008	0.13	0.08	0.25	No
705	3640	199.6268	0.106	0.011	0.13	0.11	0.25	No
706	3640	218.5656	0.116	0.012	0.13	0.12	0.25	No
707	3640	235.1799	0.125	0.013	0.13	0.13	0.25	No
708	3640	239.0531	0.127	0.013	0.13	0.13	0.25	No
709	3640	249.7481	0.133	0.013	0.13	0.14	0.25	No
710	3640	239.6332	0.127	0.013	0.13	0.13	0.25	No
711	3640	202.1995	0.108	0.011	0.13	0.11	0.25	No
712	3640	204.1047	0.109	0.011	0.13	0.11	0.25	No
713	3640	183.4084	0.098	0.010	0.13	0.10	0.25	No
714	3640	147.3576	0.078	0.008	0.13	0.08	0.25	No
715	3640	116.8719	0.062	0.006	0.13	0.06	0.25	No
716	3640	87.1991	0.046	0.005	0.13	0.05	0.25	No
717	3640	95.591	0.051	0.005	0.13	0.05	0.25	No
718	3640	75.3387	0.040	0.004	0.13	0.04	0.25	No
719	3640	65.7866	0.035	0.003	0.13	0.03	0.25	No
720	3640	63.1364	0.034	0.003	0.13	0.03	0.25	No
721	3640	51.4012	0.027	0.003	0.13	0.03	0.25	No
722	3640	48.8767	0.026	0.003	0.13	0.03	0.25	No
699	3641	104.1326	0.055	0.006	0.13	0.06	0.25	No
700	3641	48.4687	0.026	0.003	0.13	0.03	0.25	No
701	3641	53.5548	0.028	0.003	0.13	0.03	0.25	No
702	3641	52.1608	0.028	0.003	0.13	0.03	0.25	No
703	3641	114.763	0.061	0.006	0.13	0.06	0.25	No
704	3641	226.9283	0.121	0.012	0.13	0.12	0.25	No
705	3641	234.3443	0.125	0.012	0.13	0.12	0.25	No
706	3641	232.4634	0.124	0.012	0.13	0.12	0.25	No
707	3641	250.4063	0.133	0.013	0.13	0.14	0.25	No
708	3641	265.2266	0.141	0.014	0.13	0.14	0.25	No
709	3641	271.995	0.145	0.014	0.13	0.14	0.25	No
710	3641	270.2845	0.144	0.014	0.13	0.14	0.25	No
711	3641	239.1022	0.127	0.013	0.13	0.13	0.25	No
712	3641	193.8515	0.103	0.010	0.13	0.10	0.25	No
713	3641	206.0701	0.110	0.011	0.13	0.11	0.25	No
714	3641	198.1183	0.105	0.011	0.13	0.11	0.25	No
715	3641	108.1763	0.058	0.006	0.13	0.06	0.25	No
716	3641	105.4053	0.056	0.006	0.13	0.06	0.25	No
717	3641	98.7268	0.053	0.005	0.13	0.05	0.25	No
718	3641	89.3697	0.048	0.005	0.13	0.05	0.25	No
719	3641	77.9624	0.041	0.004	0.13	0.04	0.25	No
720	3641	77.4449	0.041	0.004	0.13	0.04	0.25	No
721	3641	70.5845	0.038	0.004	0.13	0.04	0.25	No
722	3641	62.5943	0.033	0.003	0.13	0.03	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modeled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
699	3642	152.8562	0.081	0.008	0.13	0.08	0.25	No
700	3642	85.3825	0.045	0.005	0.13	0.05	0.25	No
701	3642	55.7714	0.030	0.003	0.13	0.03	0.25	No
702	3642	73.1092	0.039	0.004	0.13	0.04	0.25	No
703	3642	139.2787	0.074	0.007	0.13	0.07	0.25	No
704	3642	241.5278	0.128	0.013	0.13	0.13	0.25	No
705	3642	250.1872	0.133	0.013	0.13	0.14	0.25	No
706	3642	247.5311	0.132	0.013	0.13	0.14	0.25	No
707	3642	264.0235	0.140	0.014	0.13	0.14	0.25	No
708	3642	286.9451	0.153	0.015	0.13	0.15	0.25	No
709	3642	297.0544	0.158	0.016	0.13	0.15	0.25	No
710	3642	293.5575	0.156	0.016	0.13	0.15	0.25	No
711	3642	287.2657	0.153	0.015	0.13	0.15	0.25	No
712	3642	275.2266	0.146	0.015	0.13	0.14	0.25	No
713	3642	181.6713	0.097	0.010	0.13	0.10	0.25	No
714	3642	134.8489	0.072	0.007	0.13	0.07	0.25	No
715	3642	107.7297	0.057	0.006	0.13	0.06	0.25	No
716	3642	119.7931	0.064	0.006	0.13	0.06	0.25	No
717	3642	120.3608	0.064	0.006	0.13	0.06	0.25	No
718	3642	106.5227	0.057	0.006	0.13	0.06	0.25	No
719	3642	106.4353	0.057	0.006	0.13	0.06	0.25	No
720	3642	88.828	0.047	0.005	0.13	0.05	0.25	No
721	3642	91.5111	0.049	0.005	0.13	0.05	0.25	No
722	3642	54.5519	0.029	0.003	0.13	0.03	0.25	No
699	3643	134.7115	0.072	0.007	0.13	0.07	0.25	No
700	3643	152.1153	0.081	0.008	0.13	0.08	0.25	No
701	3643	67.9377	0.036	0.004	0.13	0.04	0.25	No
702	3643	89.114	0.047	0.005	0.13	0.05	0.25	No
703	3643	151.5463	0.081	0.008	0.13	0.08	0.25	No
704	3643	264.2995	0.141	0.014	0.13	0.14	0.25	No
705	3643	271.8695	0.145	0.014	0.13	0.14	0.25	No
706	3643	263.6923	0.140	0.014	0.13	0.14	0.25	No
707	3643	274.4868	0.146	0.015	0.13	0.14	0.25	No
708	3643	328.7919	0.175	0.017	0.13	0.15	0.25	No
709	3643	338.9154	0.180	0.018	0.13	0.15	0.25	No
710	3643	337.8527	0.180	0.018	0.13	0.15	0.25	No
711	3643	286.977	0.153	0.015	0.13	0.15	0.25	No
712	3643	283.2793	0.151	0.015	0.13	0.15	0.25	No
713	3643	162.6179	0.086	0.009	0.13	0.09	0.25	No
714	3643	136.5552	0.073	0.007	0.13	0.07	0.25	No
715	3643	142.847	0.076	0.008	0.13	0.08	0.25	No
716	3643	147.7712	0.079	0.008	0.13	0.08	0.25	No
717	3643	133.6997	0.071	0.007	0.13	0.07	0.25	No
718	3643	129.4502	0.069	0.007	0.13	0.07	0.25	No
719	3643	132.0911	0.070	0.007	0.13	0.07	0.25	No
720	3643	121.7266	0.065	0.006	0.13	0.06	0.25	No
721	3643	129.4756	0.069	0.007	0.13	0.07	0.25	No
722	3643	79.041	0.042	0.004	0.13	0.04	0.25	No
699	3644	119.8773	0.064	0.006	0.13	0.06	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modeled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
700	3644	159.9309	0.085	0.009	0.13	0.09	0.25	No
701	3644	138.848	0.074	0.007	0.13	0.07	0.25	No
702	3644	108.1775	0.058	0.006	0.13	0.06	0.25	No
703	3644	188.6626	0.100	0.010	0.13	0.10	0.25	No
704	3644	261.5731	0.139	0.014	0.13	0.14	0.25	No
705	3644	255.8294	0.136	0.014	0.13	0.14	0.25	No
706	3644	277.1181	0.147	0.015	0.13	0.14	0.25	No
707	3644	293.4322	0.156	0.016	0.13	0.15	0.25	No
708	3644	370.0916	0.197	0.020	0.13	0.15	0.25	No
709	3644	391.6824	0.208	0.021	0.13	0.15	0.25	No
710	3644	365.4974	0.194	0.019	0.13	0.15	0.25	No
711	3644	329.5482	0.175	0.018	0.13	0.15	0.25	No
712	3644	273.8042	0.146	0.015	0.13	0.14	0.25	No
713	3644	201.1731	0.107	0.011	0.13	0.11	0.25	No
714	3644	146.2031	0.078	0.008	0.13	0.08	0.25	No
715	3644	167.1735	0.089	0.009	0.13	0.09	0.25	No
716	3644	167.917	0.089	0.009	0.13	0.09	0.25	No
717	3644	153.5586	0.082	0.008	0.13	0.08	0.25	No
718	3644	164.1276	0.087	0.009	0.13	0.09	0.25	No
719	3644	143.5035	0.076	0.008	0.13	0.08	0.25	No
720	3644	124.1756	0.066	0.007	0.13	0.07	0.25	No
721	3644	100.7144	0.054	0.005	0.13	0.05	0.25	No
722	3644	97.8005	0.052	0.005	0.13	0.05	0.25	No
699	3645	64.7301	0.034	0.003	0.13	0.03	0.25	No
700	3645	130.4839	0.069	0.007	0.13	0.07	0.25	No
701	3645	184.3834	0.098	0.010	0.13	0.10	0.25	No
702	3645	115.5085	0.061	0.006	0.13	0.06	0.25	No
703	3645	187.5318	0.100	0.010	0.13	0.10	0.25	No
704	3645	226.2274	0.120	0.012	0.13	0.12	0.25	No
705	3645	233.0162	0.124	0.012	0.13	0.12	0.25	No
706	3645	286.352	0.152	0.015	0.13	0.15	0.25	No
707	3645	347.5457	0.185	0.018	0.13	0.15	0.25	No
708	3645	436.7884	0.232	0.023	0.13	0.15	0.25	No
709	3645	451.3828	0.240	0.024	0.13	0.15	0.25	No
710	3645	410.4164	0.218	0.022	0.13	0.15	0.25	No
711	3645	323.8914	0.172	0.017	0.13	0.15	0.25	No
712	3645	274.9133	0.146	0.015	0.13	0.14	0.25	No
713	3645	191.6359	0.102	0.010	0.13	0.10	0.25	No
714	3645	182.0284	0.097	0.010	0.13	0.10	0.25	No
715	3645	193.3186	0.103	0.010	0.13	0.10	0.25	No
716	3645	196.4579	0.104	0.010	0.13	0.10	0.25	No
717	3645	174.4532	0.093	0.009	0.13	0.09	0.25	No
718	3645	153.8984	0.082	0.008	0.13	0.08	0.25	No
719	3645	147.1915	0.078	0.008	0.13	0.08	0.25	No
720	3645	115.1532	0.061	0.006	0.13	0.06	0.25	No
721	3645	117.9326	0.063	0.006	0.13	0.06	0.25	No
722	3645	134.9233	0.072	0.007	0.13	0.07	0.25	No
699	3646	80.3538	0.043	0.004	0.13	0.04	0.25	No
700	3646	72.5161	0.039	0.004	0.13	0.04	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM)		Modellad NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yas/No?
701	3646	142.0947	0.076	0.008	0.13	0.08	0.25	No
702	3646	200.8645	0.107	0.011	0.13	0.11	0.25	No
703	3646	136.7879	0.073	0.007	0.13	0.07	0.25	No
704	3646	178.2988	0.095	0.009	0.13	0.09	0.25	No
705	3646	224.5409	0.119	0.012	0.13	0.12	0.25	No
706	3646	260.8463	0.139	0.014	0.13	0.14	0.25	No
707	3646	364.2332	0.194	0.019	0.13	0.15	0.25	No
708	3646	514.7607	0.274	0.027	0.13	0.16	0.25	No
709	3646	482.4575	0.257	0.026	0.13	0.16	0.25	No
710	3646	406.3643	0.216	0.022	0.13	0.15	0.25	No
711	3646	337.8834	0.180	0.018	0.13	0.15	0.25	No
712	3646	234.41	0.125	0.012	0.13	0.12	0.25	No
713	3646	223.2618	0.119	0.012	0.13	0.12	0.25	No
714	3646	221.5599	0.118	0.012	0.13	0.12	0.25	No
715	3646	202.9796	0.108	0.011	0.13	0.11	0.25	No
716	3646	196.9351	0.105	0.010	0.13	0.10	0.25	No
717	3646	173.7344	0.092	0.009	0.13	0.09	0.25	No
718	3646	159.6436	0.085	0.008	0.13	0.08	0.25	No
719	3646	157.9008	0.084	0.008	0.13	0.08	0.25	No
720	3646	133.6491	0.071	0.007	0.13	0.07	0.25	No
721	3646	134.2466	0.071	0.007	0.13	0.07	0.25	No
722	3646	137.1672	0.073	0.007	0.13	0.07	0.25	No
699	3647	87.2241	0.046	0.005	0.13	0.05	0.25	No
700	3647	97.9677	0.052	0.005	0.13	0.05	0.25	No
701	3647	87.5286	0.047	0.005	0.13	0.05	0.25	No
702	3647	153.9149	0.082	0.008	0.13	0.08	0.25	No
703	3647	197.4339	0.105	0.011	0.13	0.11	0.25	No
704	3647	132.8001	0.071	0.007	0.13	0.07	0.25	No
705	3647	189.4304	0.101	0.010	0.13	0.10	0.25	No
706	3647	223.8403	0.119	0.012	0.13	0.12	0.25	No
707	3647	327.9205	0.174	0.017	0.13	0.15	0.25	No
708	3647	515.2156	0.274	0.027	0.13	0.16	0.25	No
709	3647	475.4557	0.253	0.025	0.13	0.16	0.25	No
710	3647	412.2516	0.219	0.022	0.13	0.15	0.25	No
711	3647	345.4134	0.184	0.018	0.13	0.15	0.25	No
712	3647	294.0969	0.156	0.016	0.13	0.15	0.25	No
713	3647	253.8161	0.135	0.014	0.13	0.14	0.25	No
714	3647	231.3107	0.123	0.012	0.13	0.12	0.25	No
715	3647	204.1816	0.109	0.011	0.13	0.11	0.25	No
716	3647	188.6061	0.100	0.010	0.13	0.10	0.25	No
717	3647	180.2891	0.096	0.010	0.13	0.10	0.25	No
718	3647	159.7139	0.085	0.008	0.13	0.08	0.25	No
719	3647	158.4478	0.084	0.008	0.13	0.08	0.25	No
720	3647	144.126	0.077	0.008	0.13	0.08	0.25	No
721	3647	142.5833	0.076	0.008	0.13	0.08	0.25	No
722	3647	135.0826	0.072	0.007	0.13	0.07	0.25	No
699	3648	91.3805	0.049	0.005	0.13	0.05	0.25	No
700	3648	93.9945	0.050	0.005	0.13	0.05	0.25	No
701	3648	105.4636	0.056	0.006	0.13	0.06	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concantrations

Location Kilometers (UTM)		Modalled NOx Impact		Out of Stk NO_2	Availabla O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yas/No?
702	3648	123.3863	0.066	0.007	0.13	0.07	0.25	No
703	3648	192.1719	0.102	0.010	0.13	0.10	0.25	No
704	3648	181.6546	0.097	0.010	0.13	0.10	0.25	No
705	3648	211.0786	0.112	0.011	0.13	0.11	0.25	No
706	3648	256.0063	0.136	0.014	0.13	0.14	0.25	No
707	3648	393.8717	0.210	0.021	0.13	0.15	0.25	No
708	3648	563.2574	0.300	0.030	0.13	0.16	0.25	No
709	3648	438.8822	0.233	0.023	0.13	0.15	0.25	No
710	3648	425.1661	0.226	0.023	0.13	0.15	0.25	No
711	3648	351.4081	0.187	0.019	0.13	0.15	0.25	No
712	3648	284.9151	0.152	0.015	0.13	0.15	0.25	No
713	3648	249.1802	0.133	0.013	0.13	0.14	0.25	No
714	3648	222.0434	0.118	0.012	0.13	0.12	0.25	No
715	3648	202.6914	0.108	0.011	0.13	0.11	0.25	No
716	3648	190.2439	0.101	0.010	0.13	0.10	0.25	No
717	3648	170.7955	0.091	0.009	0.13	0.09	0.25	No
718	3648	166.8225	0.089	0.009	0.13	0.09	0.25	No
719	3648	156.9196	0.083	0.008	0.13	0.08	0.25	No
720	3648	144.8751	0.077	0.008	0.13	0.08	0.25	No
721	3648	121.6266	0.065	0.006	0.13	0.06	0.25	No
722	3648	95.0163	0.051	0.005	0.13	0.05	0.25	No
699	3649	106.7655	0.057	0.006	0.13	0.06	0.25	No
700	3649	121.6664	0.065	0.006	0.13	0.06	0.25	No
701	3649	127.5648	0.068	0.007	0.13	0.07	0.25	No
702	3649	173.2083	0.092	0.009	0.13	0.09	0.25	No
703	3649	188.6824	0.100	0.010	0.13	0.10	0.25	No
704	3649	266.2087	0.142	0.014	0.13	0.14	0.25	No
705	3649	294.5277	0.157	0.016	0.13	0.15	0.25	No
706	3649	326.7524	0.174	0.017	0.13	0.15	0.25	No
707	3649	646.9113	0.344	0.034	0.13	0.16	0.25	No
708	3649	698.2285	0.371	0.037	0.13	0.17	0.25	No
709	3649	530.325	0.282	0.028	0.13	0.16	0.25	No
710	3649	384.8687	0.205	0.020	0.13	0.15	0.25	No
711	3649	312.5588	0.166	0.017	0.13	0.15	0.25	No
712	3649	275.5287	0.147	0.015	0.13	0.14	0.25	No
713	3649	234.1413	0.125	0.012	0.13	0.12	0.25	No
714	3649	212.2731	0.113	0.011	0.13	0.11	0.25	No
715	3649	200.4967	0.107	0.011	0.13	0.11	0.25	No
716	3649	180.8803	0.096	0.010	0.13	0.10	0.25	No
717	3649	155.4255	0.083	0.008	0.13	0.08	0.25	No
718	3649	144.6664	0.077	0.008	0.13	0.08	0.25	No
719	3649	147.867	0.079	0.008	0.13	0.08	0.25	No
720	3649	137.7309	0.073	0.007	0.13	0.07	0.25	No
721	3649	133.7657	0.071	0.007	0.13	0.07	0.25	No
722	3649	104.3884	0.056	0.006	0.13	0.06	0.25	No
699	3650	121.9196	0.065	0.006	0.13	0.06	0.25	No
700	3650	157.8367	0.084	0.008	0.13	0.08	0.25	No
701	3650	207.3048	0.110	0.011	0.13	0.11	0.25	No
702	3650	198.7982	0.106	0.011	0.13	0.11	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location									
Kilometers (UTM)		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation	
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?	
703	3650	330.3311	0.176	0.018	0.13	0.15	0.25	No	
704	3650	394.2969	0.210	0.021	0.13	0.15	0.25	No	
705	3650	528.3162	0.281	0.028	0.13	0.16	0.25	No	
706	3650	484.8832	0.258	0.026	0.13	0.16	0.25	No	
707	3650	1255.587	0.668	0.067	0.13	0.20	0.25	No	
708	3650	681.8403	0.363	0.036	0.13	0.17	0.25	No	
709	3650	407.4485	0.217	0.022	0.13	0.15	0.25	No	
710	3650	340.5103	0.181	0.018	0.13	0.15	0.25	No	
711	3650	289.4185	0.154	0.015	0.13	0.15	0.25	No	
712	3650	254.4913	0.135	0.014	0.13	0.14	0.25	No	
713	3650	218.0343	0.116	0.012	0.13	0.12	0.25	No	
714	3650	193.6232	0.103	0.010	0.13	0.10	0.25	No	
715	3650	186.3728	0.099	0.010	0.13	0.10	0.25	No	
716	3650	174.353	0.093	0.009	0.13	0.09	0.25	No	
717	3650	168.8655	0.090	0.009	0.13	0.09	0.25	No	
718	3650	159.9641	0.085	0.009	0.13	0.09	0.25	No	
719	3650	142.2548	0.076	0.008	0.13	0.08	0.25	No	
720	3650	86.2303	0.046	0.005	0.13	0.05	0.25	No	
721	3650	75.9042	0.040	0.004	0.13	0.04	0.25	No	
722	3650	77.4778	0.041	0.004	0.13	0.04	0.25	No	
699	3651	390.3755	0.208	0.021	0.13	0.15	0.25	No	
700	3651	442.778	0.236	0.024	0.13	0.15	0.25	No	
701	3651	502.8718	0.267	0.027	0.13	0.16	0.25	No	
702	3651	576.7256	0.307	0.031	0.13	0.16	0.25	No	
703	3651	674.2443	0.359	0.036	0.13	0.17	0.25	No	
704	3651	761.0286	0.405	0.040	0.13	0.17	0.25	No	
705	3651	732.5831	0.390	0.039	0.13	0.17	0.25	No	
706	3651	888.1211	0.472	0.047	0.13	0.18	0.25	No	
707	3651	827.4658	0.440	0.044	0.13	0.17	0.25	No	
708	3651	532.2716	0.283	0.028	0.13	0.16	0.25	No	
709	3651	415.0544	0.221	0.022	0.13	0.15	0.25	No	
710	3651	334.8513	0.178	0.018	0.13	0.15	0.25	No	
711	3651	289.4556	0.154	0.015	0.13	0.15	0.25	No	
712	3651	210.3797	0.112	0.011	0.13	0.11	0.25	No	
713	3651	222.2614	0.118	0.012	0.13	0.12	0.25	No	
714	3651	194.3462	0.103	0.010	0.13	0.10	0.25	No	
715	3651	146.0732	0.078	0.008	0.13	0.08	0.25	No	
716	3651	137.7093	0.073	0.007	0.13	0.07	0.25	No	
717	3651	156.7401	0.083	0.008	0.13	0.08	0.25	No	
718	3651	148.0827	0.079	0.008	0.13	0.08	0.25	No	
719	3651	137.5761	0.073	0.007	0.13	0.07	0.25	No	
720	3651	71.3528	0.038	0.004	0.13	0.04	0.25	No	
721	3651	39.6856	0.021	0.002	0.13	0.02	0.25	No	
722	3651	44.6999	0.024	0.002	0.13	0.02	0.25	No	
699	3652	331.9121	0.177	0.018	0.13	0.15	0.25	No	
700	3652	275.7896	0.147	0.015	0.13	0.14	0.25	No	
701	3652	290.1932	0.154	0.015	0.13	0.15	0.25	No	
702	3652	317.7534	0.169	0.017	0.13	0.15	0.25	No	
703	3652	423.274	0.225	0.023	0.13	0.15	0.25	No	

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location								
Kilometers (UTM)		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
704	3652	551.7724	0.293	0.029	0.13	0.16	0.25	No
705	3652	791.9236	0.421	0.042	0.13	0.17	0.25	No
706	3652	1599.924	0.851	0.085	0.13	0.22	0.25	No
707	3652	802.709	0.427	0.043	0.13	0.17	0.25	No
708	3652	551.6994	0.293	0.029	0.13	0.16	0.25	No
709	3652	422.9673	0.225	0.022	0.13	0.15	0.25	No
710	3652	348.3073	0.185	0.019	0.13	0.15	0.25	No
711	3652	290.8048	0.155	0.015	0.13	0.15	0.25	No
712	3652	236.6982	0.126	0.013	0.13	0.13	0.25	No
713	3652	200.1569	0.106	0.011	0.13	0.11	0.25	No
714	3652	109.1382	0.058	0.006	0.13	0.06	0.25	No
715	3652	140.104	0.075	0.007	0.13	0.07	0.25	No
716	3652	160.9299	0.086	0.009	0.13	0.09	0.25	No
717	3652	160.1812	0.085	0.009	0.13	0.09	0.25	No
718	3652	126.3245	0.067	0.007	0.13	0.07	0.25	No
719	3652	144.3345	0.077	0.008	0.13	0.08	0.25	No
720	3652	48.2168	0.026	0.003	0.13	0.03	0.25	No
721	3652	37.2647	0.020	0.002	0.13	0.02	0.25	No
722	3652	39.8213	0.021	0.002	0.13	0.02	0.25	No
699	3653	208.4051	0.111	0.011	0.13	0.11	0.25	No
700	3653	210.5217	0.112	0.011	0.13	0.11	0.25	No
701	3653	250.3062	0.133	0.013	0.13	0.14	0.25	No
702	3653	322.2583	0.171	0.017	0.13	0.15	0.25	No
703	3653	423.4638	0.225	0.023	0.13	0.15	0.25	No
704	3653	620.9457	0.330	0.033	0.13	0.16	0.25	No
705	3653	1153.575	0.814	0.061	0.13	0.19	0.25	No
706	3653	964.9894	0.513	0.051	0.13	0.18	0.25	No
707	3653	639.4634	0.340	0.034	0.13	0.16	0.25	No
708	3653	514.4053	0.274	0.027	0.13	0.16	0.25	No
709	3653	402.271	0.214	0.021	0.13	0.15	0.25	No
710	3653	323.7369	0.172	0.017	0.13	0.15	0.25	No
711	3653	282.682	0.150	0.015	0.13	0.15	0.25	No
712	3653	243.552	0.130	0.013	0.13	0.13	0.25	No
713	3653	100.7322	0.054	0.005	0.13	0.05	0.25	No
714	3653	148.1195	0.079	0.008	0.13	0.08	0.25	No
715	3653	96.1148	0.051	0.005	0.13	0.05	0.25	No
716	3653	51.3178	0.027	0.003	0.13	0.03	0.25	No
717	3653	76.0101	0.040	0.004	0.13	0.04	0.25	No
718	3653	96.9116	0.052	0.005	0.13	0.05	0.25	No
719	3653	40.779	0.022	0.002	0.13	0.02	0.25	No
720	3653	36.3549	0.019	0.002	0.13	0.02	0.25	No
721	3653	33.2141	0.018	0.002	0.13	0.02	0.25	No
722	3653	25.189	0.013	0.001	0.13	0.01	0.25	No
699	3654	211.0217	0.112	0.011	0.13	0.11	0.25	No
700	3654	247.1754	0.131	0.013	0.13	0.14	0.25	No
701	3654	304.3116	0.162	0.016	0.13	0.15	0.25	No
702	3654	375.2715	0.200	0.020	0.13	0.15	0.25	No
703	3654	501.6037	0.267	0.027	0.13	0.16	0.25	No
704	3654	734.4175	0.391	0.039	0.13	0.17	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
705	3654	989.9185	0.527	0.053	0.13	0.18	0.25	No
706	3654	631.9781	0.336	0.034	0.13	0.16	0.25	No
707	3654	620.2866	0.330	0.033	0.13	0.16	0.25	No
708	3654	436.4499	0.232	0.023	0.13	0.15	0.25	No
709	3654	368.4289	0.196	0.020	0.13	0.15	0.25	No
710	3654	308.4055	0.164	0.016	0.13	0.15	0.25	No
711	3654	262.5043	0.140	0.014	0.13	0.14	0.25	No
712	3654	235.7837	0.125	0.013	0.13	0.13	0.25	No
713	3654	204.8396	0.109	0.011	0.13	0.11	0.25	No
714	3654	97.4631	0.052	0.005	0.13	0.05	0.25	No
715	3654	45.0937	0.024	0.002	0.13	0.02	0.25	No
716	3654	82.5964	0.044	0.004	0.13	0.04	0.25	No
717	3654	41.4036	0.022	0.002	0.13	0.02	0.25	No
718	3654	38.9349	0.021	0.002	0.13	0.02	0.25	No
719	3654	32.0151	0.017	0.002	0.13	0.02	0.25	No
720	3654	28.5963	0.015	0.002	0.13	0.02	0.25	No
721	3654	53.4128	0.028	0.003	0.13	0.03	0.25	No
722	3654	22.8682	0.012	0.001	0.13	0.01	0.25	No
699	3655	236.1812	0.126	0.013	0.13	0.13	0.25	No
700	3655	275.5028	0.147	0.015	0.13	0.14	0.25	No
701	3655	326.967	0.174	0.017	0.13	0.15	0.25	No
702	3655	402.5983	0.214	0.021	0.13	0.15	0.25	No
703	3655	510.0604	0.271	0.027	0.13	0.16	0.25	No
704	3655	664.1769	0.353	0.035	0.13	0.17	0.25	No
705	3655	737.3801	0.392	0.039	0.13	0.17	0.25	No
706	3655	502.3391	0.267	0.027	0.13	0.16	0.25	No
707	3655	531.8369	0.283	0.028	0.13	0.16	0.25	No
708	3655	406.9532	0.216	0.022	0.13	0.15	0.25	No
709	3655	327.7694	0.174	0.017	0.13	0.15	0.25	No
710	3655	283.4096	0.151	0.015	0.13	0.15	0.25	No
711	3655	249.2496	0.133	0.013	0.13	0.14	0.25	No
712	3655	213.6369	0.114	0.011	0.13	0.11	0.25	No
713	3655	201.5395	0.107	0.011	0.13	0.11	0.25	No
714	3655	121.5385	0.065	0.006	0.13	0.06	0.25	No
715	3655	60.7164	0.032	0.003	0.13	0.03	0.25	No
716	3655	54.7295	0.029	0.003	0.13	0.03	0.25	No
717	3655	42.3227	0.023	0.002	0.13	0.02	0.25	No
718	3655	41.5129	0.022	0.002	0.13	0.02	0.25	No
719	3655	25.2579	0.013	0.001	0.13	0.01	0.25	No
720	3655	24.5523	0.013	0.001	0.13	0.01	0.25	No
721	3655	25.0826	0.013	0.001	0.13	0.01	0.25	No
722	3655	26.276	0.014	0.001	0.13	0.01	0.25	No
699	3656	219.4142	0.117	0.012	0.13	0.12	0.25	No
700	3656	286.5742	0.152	0.015	0.13	0.15	0.25	No
701	3656	334.8938	0.178	0.018	0.13	0.15	0.25	No
702	3656	404.4586	0.215	0.022	0.13	0.15	0.25	No
703	3656	503.0239	0.268	0.027	0.13	0.16	0.25	No
704	3656	583.1538	0.310	0.031	0.13	0.16	0.25	No
705	3656	561.6871	0.299	0.030	0.13	0.16	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
706	3656	418.5906	0.223	0.022	0.13	0.15	0.25	No
707	3656	428.5609	0.228	0.023	0.13	0.15	0.25	No
708	3656	394.8555	0.210	0.021	0.13	0.15	0.25	No
709	3656	302.345	0.161	0.016	0.13	0.15	0.25	No
710	3656	232.7275	0.124	0.012	0.13	0.12	0.25	No
711	3656	181.1087	0.096	0.010	0.13	0.10	0.25	No
712	3656	139.7859	0.074	0.007	0.13	0.07	0.25	No
713	3656	136.258	0.072	0.007	0.13	0.07	0.25	No
714	3656	93.5165	0.050	0.005	0.13	0.05	0.25	No
715	3656	85.5882	0.046	0.005	0.13	0.05	0.25	No
716	3656	51.3813	0.027	0.003	0.13	0.03	0.25	No
717	3656	54.3741	0.029	0.003	0.13	0.03	0.25	No
718	3656	53.2387	0.028	0.003	0.13	0.03	0.25	No
719	3656	45.8746	0.024	0.002	0.13	0.02	0.25	No
720	3656	35.4365	0.019	0.002	0.13	0.02	0.25	No
721	3656	25.1299	0.013	0.001	0.13	0.01	0.25	No
722	3656	21.8024	0.012	0.001	0.13	0.01	0.25	No
699	3657	264.4224	0.141	0.014	0.13	0.14	0.25	No
700	3657	291.8892	0.155	0.016	0.13	0.15	0.25	No
701	3657	334.8608	0.178	0.018	0.13	0.15	0.25	No
702	3657	389.5956	0.207	0.021	0.13	0.15	0.25	No
703	3657	444.1089	0.236	0.024	0.13	0.15	0.25	No
704	3657	474.6667	0.252	0.025	0.13	0.16	0.25	No
705	3657	445.9876	0.237	0.024	0.13	0.15	0.25	No
706	3657	366.3002	0.195	0.019	0.13	0.15	0.25	No
707	3657	367.8285	0.196	0.020	0.13	0.15	0.25	No
708	3657	357.0732	0.190	0.019	0.13	0.15	0.25	No
709	3657	307.9864	0.164	0.016	0.13	0.15	0.25	No
710	3657	268.4634	0.143	0.014	0.13	0.14	0.25	No
711	3657	221.1387	0.118	0.012	0.13	0.12	0.25	No
712	3657	187.113	0.100	0.010	0.13	0.10	0.25	No
713	3657	51.6092	0.027	0.003	0.13	0.03	0.25	No
714	3657	50.5939	0.027	0.003	0.13	0.03	0.25	No
715	3657	65.3473	0.035	0.003	0.13	0.03	0.25	No
716	3657	86.8767	0.046	0.005	0.13	0.05	0.25	No
717	3657	69.4069	0.037	0.004	0.13	0.04	0.25	No
718	3657	40.6147	0.022	0.002	0.13	0.02	0.25	No
719	3657	46.7542	0.025	0.002	0.13	0.02	0.25	No
720	3657	49.7686	0.026	0.003	0.13	0.03	0.25	No
721	3657	46.373	0.025	0.002	0.13	0.02	0.25	No
722	3657	38.8643	0.021	0.002	0.13	0.02	0.25	No
699	3658	254.4422	0.135	0.014	0.13	0.14	0.25	No
700	3658	288.9773	0.154	0.015	0.13	0.15	0.25	No
701	3658	336.7864	0.179	0.018	0.13	0.15	0.25	No
702	3658	377.3323	0.201	0.020	0.13	0.15	0.25	No
703	3658	414.3149	0.220	0.022	0.13	0.15	0.25	No
704	3658	417.1573	0.222	0.022	0.13	0.15	0.25	No
705	3658	387.5247	0.206	0.021	0.13	0.15	0.25	No
706	3658	334.9867	0.178	0.018	0.13	0.15	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM)		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
707	3658	334.4703	0.178	0.018	0.13	0.15	0.25	No
708	3658	313.572	0.167	0.017	0.13	0.15	0.25	No
709	3658	290.3715	0.154	0.015	0.13	0.15	0.25	No
710	3658	263.4158	0.140	0.014	0.13	0.14	0.25	No
711	3658	229.6893	0.122	0.012	0.13	0.12	0.25	No
712	3658	119.1285	0.063	0.006	0.13	0.06	0.25	No
713	3658	90.3911	0.048	0.005	0.13	0.05	0.25	No
714	3658	29.6977	0.016	0.002	0.13	0.02	0.25	No
715	3658	28.1213	0.015	0.001	0.13	0.01	0.25	No
716	3658	40.7973	0.022	0.002	0.13	0.02	0.25	No
717	3658	72.6431	0.039	0.004	0.13	0.04	0.25	No
718	3658	76.3564	0.041	0.004	0.13	0.04	0.25	No
719	3658	56.3781	0.030	0.003	0.13	0.03	0.25	No
720	3658	32.4705	0.017	0.002	0.13	0.02	0.25	No
721	3658	40.199	0.021	0.002	0.13	0.02	0.25	No
722	3658	44.988	0.024	0.002	0.13	0.02	0.25	No
699	3659	251.8168	0.134	0.013	0.13	0.14	0.25	No
700	3659	264.1729	0.141	0.014	0.13	0.14	0.25	No
701	3659	310.1565	0.165	0.016	0.13	0.15	0.25	No
702	3659	337.7052	0.180	0.018	0.13	0.15	0.25	No
703	3659	357.3943	0.190	0.019	0.13	0.15	0.25	No
704	3659	355.2408	0.189	0.019	0.13	0.15	0.25	No
705	3659	342.2823	0.182	0.018	0.13	0.15	0.25	No
706	3659	309.1386	0.164	0.016	0.13	0.15	0.25	No
707	3659	296.5964	0.158	0.016	0.13	0.15	0.25	No
708	3659	284.1451	0.151	0.015	0.13	0.15	0.25	No
709	3659	273.0185	0.145	0.015	0.13	0.14	0.25	No
710	3659	208.0417	0.111	0.011	0.13	0.11	0.25	No
711	3659	231.4882	0.123	0.012	0.13	0.12	0.25	No
712	3659	63.1206	0.034	0.003	0.13	0.03	0.25	No
713	3659	41.6877	0.022	0.002	0.13	0.02	0.25	No
714	3659	42.0763	0.022	0.002	0.13	0.02	0.25	No
715	3659	29.8887	0.016	0.002	0.13	0.02	0.25	No
716	3659	24.5293	0.013	0.001	0.13	0.01	0.25	No
717	3659	24.3067	0.013	0.001	0.13	0.01	0.25	No
718	3659	53.8529	0.029	0.003	0.13	0.03	0.25	No
719	3659	71.4135	0.038	0.004	0.13	0.04	0.25	No
720	3659	65.5282	0.035	0.003	0.13	0.03	0.25	No
721	3659	46.0229	0.024	0.002	0.13	0.02	0.25	No
722	3659	26.3832	0.014	0.001	0.13	0.01	0.25	No
699	3660	249.1652	0.133	0.013	0.13	0.14	0.25	No
700	3660	267.834	0.142	0.014	0.13	0.14	0.25	No
701	3660	290.9247	0.155	0.015	0.13	0.15	0.25	No
702	3660	318.8459	0.170	0.017	0.13	0.15	0.25	No
703	3660	315.408	0.168	0.017	0.13	0.15	0.25	No
704	3660	320.5001	0.170	0.017	0.13	0.15	0.25	No
705	3660	308.1281	0.164	0.016	0.13	0.15	0.25	No
706	3660	286.3376	0.152	0.015	0.13	0.15	0.25	No
707	3660	274.4328	0.146	0.015	0.13	0.14	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM)		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
708	3660	243.4199	0.129	0.013	0.13	0.13	0.25	No
709	3660	177.0922	0.094	0.009	0.13	0.09	0.25	No
710	3660	83.3446	0.044	0.004	0.13	0.04	0.25	No
711	3660	91.3091	0.049	0.005	0.13	0.05	0.25	No
712	3660	50.2687	0.027	0.003	0.13	0.03	0.25	No
713	3660	33.5134	0.018	0.002	0.13	0.02	0.25	No
714	3660	27.9885	0.015	0.001	0.13	0.01	0.25	No
715	3660	39.4617	0.021	0.002	0.13	0.02	0.25	No
716	3660	29.9373	0.016	0.002	0.13	0.02	0.25	No
717	3660	17.8384	0.009	0.001	0.13	0.01	0.25	No
718	3660	18.9005	0.010	0.001	0.13	0.01	0.25	No
719	3660	37.2593	0.020	0.002	0.13	0.02	0.25	No
720	3660	59.6112	0.032	0.003	0.13	0.03	0.25	No
721	3660	66.1342	0.035	0.004	0.13	0.04	0.25	No
722	3660	55.6672	0.030	0.003	0.13	0.03	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
MODELED FENCELINE DISCRETE RECEPTORS								
705.547	3649.915	441.9186	0.235	0.024	0.13	0.15	0.25	No
705.504	3649.939	445.766	0.237	0.024	0.13	0.15	0.25	No
705.467	3649.96	449.5264	0.239	0.024	0.13	0.15	0.25	No
705.429	3649.979	475.2899	0.253	0.025	0.13	0.16	0.25	No
705.392	3650	508.6898	0.271	0.027	0.13	0.16	0.25	No
705.352	3650.021	530.0642	0.282	0.028	0.13	0.16	0.25	No
705.318	3650.04	517.2552	0.275	0.028	0.13	0.16	0.25	No
705.285	3650.057	522.658	0.278	0.028	0.13	0.16	0.25	No
705.246	3650.08	517.6984	0.275	0.028	0.13	0.16	0.25	No
705.208	3650.099	458.9801	0.244	0.024	0.13	0.15	0.25	No
705.17	3650.12	455.2104	0.242	0.024	0.13	0.15	0.25	No
705.135	3650.139	477.2526	0.254	0.025	0.13	0.16	0.25	No
705.099	3650.16	521.4808	0.277	0.028	0.13	0.16	0.25	No
705.072	3650.174	549.7958	0.292	0.029	0.13	0.16	0.25	No
705.052	3650.186	573.0446	0.305	0.030	0.13	0.16	0.25	No
705.067	3650.214	524.6259	0.279	0.028	0.13	0.16	0.25	No
705.083	3650.238	504.4758	0.268	0.027	0.13	0.16	0.25	No
705.048	3650.25	527.3952	0.281	0.028	0.13	0.16	0.25	No
705.01	3650.257	550.0028	0.293	0.029	0.13	0.16	0.25	No
704.956	3650.264	488.8369	0.260	0.026	0.13	0.16	0.25	No
704.904	3650.268	497.5083	0.265	0.026	0.13	0.16	0.25	No
704.911	3650.283	494.4146	0.263	0.026	0.13	0.16	0.25	No
704.961	3650.285	472.8228	0.252	0.025	0.13	0.16	0.25	No
705.015	3650.285	516.6691	0.275	0.027	0.13	0.16	0.25	No
705.034	3650.329	515.1811	0.274	0.027	0.13	0.16	0.25	No
705.052	3650.37	541.9491	0.288	0.029	0.13	0.16	0.25	No
705.072	3650.419	550.3477	0.293	0.029	0.13	0.16	0.25	No
705.092	3650.462	560.5645	0.298	0.030	0.13	0.16	0.25	No
705.107	3650.499	574.1329	0.305	0.031	0.13	0.16	0.25	No
705.126	3650.542	587.3247	0.312	0.031	0.13	0.16	0.25	No
705.147	3650.591	609.0611	0.324	0.032	0.13	0.16	0.25	No
705.168	3650.638	621.7307	0.331	0.033	0.13	0.16	0.25	No
705.192	3650.67	616.6452	0.328	0.033	0.13	0.16	0.25	No
705.237	3650.726	867.9902	0.462	0.046	0.13	0.18	0.25	No
705.212	3650.697	676.9845	0.360	0.036	0.13	0.17	0.25	No
705.259	3650.755	1042.543	0.555	0.055	0.13	0.19	0.25	No
705.283	3650.787	1153.644	0.614	0.061	0.13	0.19	0.25	No
705.318	3650.831	1071.892	0.570	0.057	0.13	0.19	0.25	No
705.352	3650.878	814.2031	0.433	0.043	0.13	0.17	0.25	No
705.384	3650.918	679.8435	0.362	0.036	0.13	0.17	0.25	No
705.41	3650.949	688.1292	0.366	0.037	0.13	0.17	0.25	No
705.41	3650.989	685.0876	0.364	0.036	0.13	0.17	0.25	No
705.412	3651.04	701.514	0.373	0.037	0.13	0.17	0.25	No
705.408	3651.093	756.2092	0.402	0.040	0.13	0.17	0.25	No
705.398	3651.147	773.3072	0.411	0.041	0.13	0.17	0.25	No
705.373	3651.206	842.5185	0.448	0.045	0.13	0.17	0.25	No
705.368	3651.262	873.6094	0.465	0.046	0.13	0.18	0.25	No
705.373	3651.314	892.2193	0.475	0.047	0.13	0.18	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
705.384	3651.372	911.4156	0.485	0.048	0.13	0.18	0.25	No
705.398	3651.425	929.8848	0.495	0.049	0.13	0.18	0.25	No
705.408	3651.476	946.6821	0.504	0.050	0.13	0.18	0.25	No
705.42	3651.528	962.9855	0.512	0.051	0.13	0.18	0.25	No
705.436	3651.592	975.1853	0.519	0.052	0.13	0.18	0.25	No
705.45	3651.646	994.8597	0.529	0.053	0.13	0.18	0.25	No
705.466	3651.707	1004.827	0.534	0.053	0.13	0.18	0.25	No
705.478	3651.765	1016.421	0.541	0.054	0.13	0.18	0.25	No
705.483	3651.834	1101.286	0.586	0.059	0.13	0.19	0.25	No
705.495	3651.884	1261.034	0.671	0.067	0.13	0.20	0.25	No
705.514	3651.942	1411.015	0.751	0.075	0.13	0.21	0.25	No
705.549	3651.985	1605.718	0.854	0.085	0.13	0.22	0.25	No
705.585	3652.032	1839.988	0.979	0.098	0.13	0.23	0.25	No
705.615	3652.07	1975.252	1.051	0.105	0.13	0.24	0.25	No
705.634	3652.116	2073	1.103	0.110	0.13	0.24	0.25	No
705.658	3652.17	2086.807	1.110	0.111	0.13	0.24	0.25	No
705.711	3652.208	2156.156	1.147	0.115	0.13	0.24	0.25	No
705.761	3652.213	2141.612	1.139	0.114	0.13	0.24	0.25	No
705.818	3652.213	2199.199	1.170	0.117	0.13	0.25	0.25	No
705.874	3652.234	2122.977	1.129	0.113	0.13	0.24	0.25	No
705.916	3652.269	1960.656	1.043	0.104	0.13	0.23	0.25	No
705.961	3652.305	1845.96	0.982	0.098	0.13	0.23	0.25	No
705.999	3652.343	1670.061	0.888	0.089	0.13	0.22	0.25	No
706.032	3652.392	1485.282	0.790	0.079	0.13	0.21	0.25	No
706.057	3652.428	1373.579	0.731	0.073	0.13	0.20	0.25	No
706.078	3652.455	1263.483	0.672	0.067	0.13	0.20	0.25	No
706.109	3652.459	1197.623	0.637	0.064	0.13	0.19	0.25	No
706.144	3652.458	1110.261	0.591	0.059	0.13	0.19	0.25	No
706.187	3652.418	1053.918	0.561	0.056	0.13	0.19	0.25	No
706.229	3652.378	1025.676	0.546	0.055	0.13	0.18	0.25	No
706.267	3652.343	983.0912	0.523	0.052	0.13	0.18	0.25	No
706.309	3652.305	955.4514	0.508	0.051	0.13	0.18	0.25	No
706.356	3652.262	959.8327	0.511	0.051	0.13	0.18	0.25	No
706.406	3652.215	958.8284	0.510	0.051	0.13	0.18	0.25	No
706.458	3652.166	955.6	0.508	0.051	0.13	0.18	0.25	No
706.516	3652.116	951.7994	0.506	0.051	0.13	0.18	0.25	No
706.575	3652.102	930.439	0.495	0.049	0.13	0.18	0.25	No
706.644	3652.084	894.074	0.478	0.048	0.13	0.18	0.25	No
706.717	3652.065	877.3036	0.467	0.047	0.13	0.18	0.25	No
706.803	3652.044	847.2261	0.451	0.045	0.13	0.18	0.25	No
706.872	3652.027	820.0347	0.436	0.044	0.13	0.17	0.25	No
706.942	3652.01	825.851	0.439	0.044	0.13	0.17	0.25	No
707.018	3651.99	798.2968	0.425	0.042	0.13	0.17	0.25	No
707.079	3651.975	777.8497	0.414	0.041	0.13	0.17	0.25	No
707.128	3651.962	763.2513	0.406	0.041	0.13	0.17	0.25	No
707.164	3651.954	751.6356	0.400	0.040	0.13	0.17	0.25	No
707.194	3651.978	741.8132	0.395	0.039	0.13	0.17	0.25	No
707.215	3652.013	731.0829	0.389	0.039	0.13	0.17	0.25	No
707.277	3652.015	715.7554	0.381	0.038	0.13	0.17	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
707.342	3652.018	697.5786	0.371	0.037	0.13	0.17	0.25	No
707.404	3652.022	680.7009	0.362	0.036	0.13	0.17	0.25	No
707.435	3652.015	673.8552	0.358	0.036	0.13	0.17	0.25	No
707.456	3651.982	668.8341	0.356	0.036	0.13	0.17	0.25	No
707.47	3651.938	667.6372	0.355	0.036	0.13	0.17	0.25	No
707.509	3651.895	636.0596	0.338	0.034	0.13	0.16	0.25	No
707.559	3651.853	648.8257	0.345	0.035	0.13	0.16	0.25	No
707.639	3651.834	630.0568	0.335	0.034	0.13	0.16	0.25	No
707.71	3651.815	613.1915	0.326	0.033	0.13	0.16	0.25	No
707.79	3651.796	598.138	0.318	0.032	0.13	0.16	0.25	No
707.867	3651.777	576.3102	0.307	0.031	0.13	0.16	0.25	No
707.933	3651.761	566.8801	0.302	0.030	0.13	0.16	0.25	No
708.001	3651.743	558.0736	0.297	0.030	0.13	0.16	0.25	No
708.082	3651.723	558.8897	0.297	0.030	0.13	0.16	0.25	No
708.082	3651.653	541.2944	0.288	0.029	0.13	0.16	0.25	No
708.082	3651.592	551.066	0.293	0.029	0.13	0.16	0.25	No
708.082	3651.521	548.6636	0.292	0.029	0.13	0.16	0.25	No
708.082	3651.457	556.986	0.296	0.030	0.13	0.16	0.25	No
708.082	3651.386	538.792	0.287	0.029	0.13	0.16	0.25	No
708.082	3651.337	529.2216	0.282	0.028	0.13	0.16	0.25	No
708.083	3651.288	505.4626	0.269	0.027	0.13	0.16	0.25	No
708.082	3651.239	532.6718	0.283	0.028	0.13	0.16	0.25	No
708.082	3651.175	547.3099	0.291	0.029	0.13	0.16	0.25	No
708.082	3651.093	527.5374	0.281	0.028	0.13	0.16	0.25	No
708.082	3651.019	538.4765	0.286	0.029	0.13	0.16	0.25	No
708.082	3650.954	518.2974	0.276	0.028	0.13	0.16	0.25	No
708.082	3650.873	528.7033	0.281	0.028	0.13	0.16	0.25	No
708.082	3650.798	511.1013	0.272	0.027	0.13	0.16	0.25	No
708.082	3650.732	502.5875	0.267	0.027	0.13	0.16	0.25	No
708.082	3650.666	497.7016	0.265	0.026	0.13	0.16	0.25	No
708.082	3650.615	498.2349	0.265	0.027	0.13	0.16	0.25	No
708.082	3650.568	494.7784	0.263	0.026	0.13	0.16	0.25	No
708.035	3650.542	483.2123	0.257	0.026	0.13	0.16	0.25	No
707.975	3650.508	497.5461	0.265	0.026	0.13	0.16	0.25	No
707.914	3650.473	530.512	0.282	0.028	0.13	0.16	0.25	No
707.851	3650.438	584.0743	0.311	0.031	0.13	0.16	0.25	No
707.781	3650.398	625.3049	0.333	0.033	0.13	0.16	0.25	No
707.717	3650.36	689.7145	0.367	0.037	0.13	0.17	0.25	No
707.641	3650.316	777.797	0.414	0.041	0.13	0.17	0.25	No
707.573	3650.278	853.6318	0.454	0.045	0.13	0.18	0.25	No
707.512	3650.243	930.926	0.495	0.050	0.13	0.18	0.25	No
707.444	3650.203	947.1724	0.504	0.050	0.13	0.18	0.25	No
707.385	3650.17	982.6302	0.523	0.052	0.13	0.18	0.25	No
707.322	3650.136	1150.542	0.612	0.061	0.13	0.19	0.25	No
707.295	3650.078	1115.77	0.593	0.059	0.13	0.19	0.25	No
707.265	3650.016	1211.815	0.645	0.064	0.13	0.19	0.25	No
707.227	3649.939	1221.516	0.650	0.065	0.13	0.19	0.25	No
707.197	3649.878	1140.562	0.607	0.061	0.13	0.19	0.25	No
707.162	3649.809	1068.834	0.569	0.057	0.13	0.19	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
707.138	3649.755	1000.699	0.532	0.053	0.13	0.18	0.25	No
707.109	3649.698	955.1221	0.508	0.051	0.13	0.18	0.25	No
707.062	3649.663	897.9625	0.478	0.048	0.13	0.18	0.25	No
707.006	3649.625	805.8134	0.429	0.043	0.13	0.17	0.25	No
706.947	3649.581	720.1941	0.383	0.038	0.13	0.17	0.25	No
706.848	3649.581	720.4799	0.383	0.038	0.13	0.17	0.25	No
706.768	3649.581	720.8433	0.383	0.038	0.13	0.17	0.25	No
706.754	3649.52	651.5878	0.347	0.035	0.13	0.16	0.25	No
706.74	3649.454	560.9054	0.298	0.030	0.13	0.16	0.25	No
706.73	3649.404	581.4574	0.309	0.031	0.13	0.16	0.25	No
706.683	3649.374	545.9853	0.290	0.029	0.13	0.16	0.25	No
706.627	3649.338	491.746	0.262	0.026	0.13	0.16	0.25	No
706.578	3649.306	445.1577	0.237	0.024	0.13	0.15	0.25	No
706.512	3649.265	397.1855	0.211	0.021	0.13	0.15	0.25	No
706.431	3649.265	384.203	0.204	0.020	0.13	0.15	0.25	No
706.36	3649.265	374.9187	0.199	0.020	0.13	0.15	0.25	No
706.279	3649.265	373.1921	0.199	0.020	0.13	0.15	0.25	No
706.22	3649.265	374.7413	0.199	0.020	0.13	0.15	0.25	No
706.156	3649.301	388.5011	0.207	0.021	0.13	0.15	0.25	No
706.091	3649.336	394.4559	0.210	0.021	0.13	0.15	0.25	No
706.029	3649.371	379.7196	0.202	0.020	0.13	0.15	0.25	No
705.978	3649.399	388.5321	0.207	0.021	0.13	0.15	0.25	No
705.924	3649.428	408.0646	0.217	0.022	0.13	0.15	0.25	No
705.86	3649.463	399.4484	0.212	0.021	0.13	0.15	0.25	No
705.798	3649.498	411.3481	0.219	0.022	0.13	0.15	0.25	No
705.74	3649.529	412.0751	0.219	0.022	0.13	0.15	0.25	No
705.693	3649.555	398.6183	0.212	0.021	0.13	0.15	0.25	No
705.634	3649.588	378.471	0.201	0.020	0.13	0.15	0.25	No
705.58	3649.616	387.6334	0.206	0.021	0.13	0.15	0.25	No
705.523	3649.647	376.8254	0.200	0.020	0.13	0.15	0.25	No
705.455	3649.685	396.3277	0.211	0.021	0.13	0.15	0.25	No
705.479	3649.743	400.8156	0.213	0.021	0.13	0.15	0.25	No
705.502	3649.802	403.7775	0.215	0.021	0.13	0.15	0.25	No
705.524	3649.859	427.6097	0.227	0.023	0.13	0.15	0.25	No

Imperial Project
Imperial County, California

Calculated Maximum Hourly NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
MODELED, NON-FENCELINE DISCRETE RECEPTORS								
Bard, California								
729	3630.5	17.2329	0.009	0.001	0.13	0.01	0.25	No
Fort Yuma Reservation Boundary - Wash								
720	3635.2	26.1262	0.014	0.001	0.13	0.01	0.25	No
Picacho State Rec Area								
723	3656	18.1169	0.010	0.001	0.13	0.01	0.25	No
American Girl Mine								
707.2	3637.3	154.9583	0.082	0.008	0.13	0.08	0.25	No
Glamis, California								
680	3652.5	205.8284	0.109	0.011	0.13	0.11	0.25	No
Fort Yuma Reservation Boundary - NW Corner								
711.75	3634.85	172.1314	0.092	0.009	0.13	0.09	0.25	No
Gold Rock Ranch								
700	3640	40.4333	0.022	0.002	0.13	0.02	0.25	No
Picacho Mine								
720.2	3649.5	110.323	0.059	0.006	0.13	0.06	0.25	No
Mesquite Regional Landfill								
685.581	3655.943	97.5116	0.052	0.005	0.13	0.05	0.25	No
Mesquite Mine								
688.788	3658.556	110.7319	0.059	0.006	0.13	0.06	0.25	No

APPENDIX N-2

Calculated Maximum Annual Ambient NO_2 Concentrations

Imperial Project
Imparial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilomatars (UTM) Easting	Northing	Modellad NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
250 METER GRID (INCLUDING POINTS WITHIN FACILITY)								
704	3648	4.0143	2.13E-03	2.13E-04	0.032	2.13E-03	0.053	No
704.25	3648	4.0455	2.14E-03	2.14E-04	0.032	2.14E-03	0.053	No
704.5	3648	3.7372	1.98E-03	1.98E-04	0.032	1.98E-03	0.053	No
704.75	3648	4.0699	2.16E-03	2.16E-04	0.032	2.16E-03	0.053	No
705	3648	3.9653	2.10E-03	2.10E-04	0.032	2.10E-03	0.053	No
705.25	3648	3.8725	2.05E-03	2.05E-04	0.032	2.05E-03	0.053	No
705.5	3648	4.2059	2.23E-03	2.23E-04	0.032	2.23E-03	0.053	No
705.75	3648	3.7346	1.98E-03	1.98E-04	0.032	1.98E-03	0.053	No
706	3648	4.4301	2.35E-03	2.35E-04	0.032	2.35E-03	0.053	No
706.25	3648	4.2569	2.26E-03	2.26E-04	0.032	2.26E-03	0.053	No
706.5	3648	3.711	1.97E-03	1.97E-04	0.032	1.97E-03	0.053	No
706.75	3648	3.8311	2.03E-03	2.03E-04	0.032	2.03E-03	0.053	No
707	3648	3.861	2.05E-03	2.05E-04	0.032	2.05E-03	0.053	No
707.25	3648	3.452	1.83E-03	1.83E-04	0.032	1.83E-03	0.053	No
707.5	3648	3.5439	1.88E-03	1.88E-04	0.032	1.88E-03	0.053	No
707.75	3648	3.1839	1.69E-03	1.69E-04	0.032	1.69E-03	0.053	No
708	3648	2.7183	1.44E-03	1.44E-04	0.032	1.44E-03	0.053	No
708.25	3648	2.7337	1.45E-03	1.45E-04	0.032	1.45E-03	0.053	No
708.5	3648	2.556	1.35E-03	1.35E-04	0.032	1.35E-03	0.053	No
708.75	3648	2.1359	1.13E-03	1.13E-04	0.032	1.13E-03	0.053	No
709	3648	2.1387	1.13E-03	1.13E-04	0.032	1.13E-03	0.053	No
704	3648.25	4.4625	2.37E-03	2.37E-04	0.032	2.37E-03	0.053	No
704.25	3648.25	4.6213	2.45E-03	2.45E-04	0.032	2.45E-03	0.053	No
704.5	3648.25	4.2526	2.25E-03	2.25E-04	0.032	2.25E-03	0.053	No
704.75	3648.25	4.4915	2.38E-03	2.38E-04	0.032	2.38E-03	0.053	No
705	3648.25	4.5011	2.39E-03	2.39E-04	0.032	2.39E-03	0.053	No
705.25	3648.25	4.4576	2.36E-03	2.36E-04	0.032	2.36E-03	0.053	No
705.5	3648.25	4.6688	2.47E-03	2.47E-04	0.032	2.47E-03	0.053	No
705.75	3648.25	5.0907	2.70E-03	2.70E-04	0.032	2.70E-03	0.053	No
706	3648.25	4.7693	2.53E-03	2.53E-04	0.032	2.53E-03	0.053	No
706.25	3648.25	4.5522	2.41E-03	2.41E-04	0.032	2.41E-03	0.053	No
706.5	3648.25	4.4335	2.35E-03	2.35E-04	0.032	2.35E-03	0.053	No
706.75	3648.25	4.4453	2.36E-03	2.36E-04	0.032	2.36E-03	0.053	No
707	3648.25	4.4039	2.33E-03	2.33E-04	0.032	2.33E-03	0.053	No
707.25	3648.25	3.7127	1.97E-03	1.97E-04	0.032	1.97E-03	0.053	No
707.5	3648.25	3.9032	2.07E-03	2.07E-04	0.032	2.07E-03	0.053	No
707.75	3648.25	3.231	1.71E-03	1.71E-04	0.032	1.71E-03	0.053	No
708	3648.25	2.8795	1.53E-03	1.53E-04	0.032	1.53E-03	0.053	No
708.25	3648.25	2.7223	1.44E-03	1.44E-04	0.032	1.44E-03	0.053	No
708.5	3648.25	2.4438	1.30E-03	1.30E-04	0.032	1.30E-03	0.053	No
708.75	3648.25	2.3494	1.25E-03	1.25E-04	0.032	1.25E-03	0.053	No
709	3648.25	2.4648	1.31E-03	1.31E-04	0.032	1.31E-03	0.053	No
704	3648.5	4.9796	2.64E-03	2.64E-04	0.032	2.64E-03	0.053	No
704.25	3648.5	5.3832	2.85E-03	2.85E-04	0.032	2.85E-03	0.053	No
704.5	3648.5	5.098	2.70E-03	2.70E-04	0.032	2.70E-03	0.053	No
704.75	3648.5	4.8904	2.59E-03	2.59E-04	0.032	2.59E-03	0.053	No
705	3648.5	4.9507	2.62E-03	2.62E-04	0.032	2.62E-03	0.053	No
705.25	3648.5	5.6345	2.99E-03	2.99E-04	0.032	2.99E-03	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
705.5	3648.5	5.388	2.86E-03	2.86E-04	0.032	2.86E-03	0.053	No
705.75	3648.5	5.5851	2.96E-03	2.96E-04	0.032	2.96E-03	0.053	No
706	3648.5	5.3402	2.83E-03	2.83E-04	0.032	2.83E-03	0.053	No
706.25	3648.5	5.1182	2.71E-03	2.71E-04	0.032	2.71E-03	0.053	No
706.5	3648.5	4.9811	2.64E-03	2.64E-04	0.032	2.64E-03	0.053	No
706.75	3648.5	4.9879	2.64E-03	2.64E-04	0.032	2.64E-03	0.053	No
707	3648.5	4.8556	2.57E-03	2.57E-04	0.032	2.57E-03	0.053	No
707.25	3648.5	4.2374	2.25E-03	2.25E-04	0.032	2.25E-03	0.053	No
707.5	3648.5	4.1717	2.21E-03	2.21E-04	0.032	2.21E-03	0.053	No
707.75	3648.5	3.4513	1.83E-03	1.83E-04	0.032	1.83E-03	0.053	No
708	3648.5	3.3176	1.76E-03	1.76E-04	0.032	1.76E-03	0.053	No
708.25	3648.5	2.8543	1.51E-03	1.51E-04	0.032	1.51E-03	0.053	No
708.5	3648.5	2.6064	1.38E-03	1.38E-04	0.032	1.38E-03	0.053	No
708.75	3648.5	2.7024	1.43E-03	1.43E-04	0.032	1.43E-03	0.053	No
709	3648.5	2.5338	1.34E-03	1.34E-04	0.032	1.34E-03	0.053	No
704	3648.75	5.3927	2.86E-03	2.86E-04	0.032	2.86E-03	0.053	No
704.25	3648.75	6.0186	3.19E-03	3.19E-04	0.032	3.19E-03	0.053	No
704.5	3648.75	5.3287	2.82E-03	2.82E-04	0.032	2.82E-03	0.053	No
704.75	3648.75	5.7904	3.07E-03	3.07E-04	0.032	3.07E-03	0.053	No
705	3648.75	6.4762	3.43E-03	3.43E-04	0.032	3.43E-03	0.053	No
705.25	3648.75	5.8074	3.08E-03	3.08E-04	0.032	3.08E-03	0.053	No
705.5	3648.75	6.0578	3.21E-03	3.21E-04	0.032	3.21E-03	0.053	No
705.75	3648.75	6.1595	3.26E-03	3.26E-04	0.032	3.26E-03	0.053	No
706	3648.75	6.3191	3.35E-03	3.35E-04	0.032	3.35E-03	0.053	No
706.25	3648.75	6.0795	3.22E-03	3.22E-04	0.032	3.22E-03	0.053	No
706.5	3648.75	5.8555	3.10E-03	3.10E-04	0.032	3.10E-03	0.053	No
706.75	3648.75	5.8305	3.09E-03	3.09E-04	0.032	3.09E-03	0.053	No
707	3648.75	5.4727	2.90E-03	2.90E-04	0.032	2.90E-03	0.053	No
707.25	3648.75	5.0553	2.68E-03	2.68E-04	0.032	2.68E-03	0.053	No
707.5	3648.75	4.3684	2.32E-03	2.32E-04	0.032	2.32E-03	0.053	No
707.75	3648.75	3.6606	1.94E-03	1.94E-04	0.032	1.94E-03	0.053	No
708	3648.75	3.4793	1.84E-03	1.84E-04	0.032	1.84E-03	0.053	No
708.25	3648.75	2.9956	1.59E-03	1.59E-04	0.032	1.59E-03	0.053	No
708.5	3648.75	3.1619	1.68E-03	1.68E-04	0.032	1.68E-03	0.053	No
708.75	3648.75	2.9237	1.55E-03	1.55E-04	0.032	1.55E-03	0.053	No
709	3648.75	2.7446	1.45E-03	1.45E-04	0.032	1.45E-03	0.053	No
704	3649	6.1223	3.24E-03	3.24E-04	0.032	3.24E-03	0.053	No
704.25	3649	6.6626	3.53E-03	3.53E-04	0.032	3.53E-03	0.053	No
704.5	3649	6.4209	3.40E-03	3.40E-04	0.032	3.40E-03	0.053	No
704.75	3649	6.7304	3.57E-03	3.57E-04	0.032	3.57E-03	0.053	No
705	3649	6.9162	3.67E-03	3.67E-04	0.032	3.67E-03	0.053	No
705.25	3649	7.0197	3.72E-03	3.72E-04	0.032	3.72E-03	0.053	No
705.5	3649	7.1631	3.80E-03	3.80E-04	0.032	3.80E-03	0.053	No
705.75	3649	7.41	3.93E-03	3.93E-04	0.032	3.93E-03	0.053	No
706	3649	7.4568	3.95E-03	3.95E-04	0.032	3.95E-03	0.053	No
706.25	3649	7.228	3.83E-03	3.83E-04	0.032	3.83E-03	0.053	No
706.5	3649	6.866	3.64E-03	3.64E-04	0.032	3.64E-03	0.053	No
706.75	3649	6.784	3.60E-03	3.60E-04	0.032	3.60E-03	0.053	No
707	3649	6.0982	3.23E-03	3.23E-04	0.032	3.23E-03	0.053	No

Imperial Project
Imperial County, California

Calculatad Annuel Averega NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modellad NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
707.25	3649	5.0278	2.66E-03	2.66E-04	0.032	2.66E-03	0.053	No
707.5	3649	4.3511	2.31E-03	2.31E-04	0.032	2.31E-03	0.053	No
707.75	3649	4.1074	2.18E-03	2.18E-04	0.032	2.18E-03	0.053	No
708	3649	3.504	1.86E-03	1.86E-04	0.032	1.86E-03	0.053	No
708.25	3649	3.5763	1.90E-03	1.90E-04	0.032	1.90E-03	0.053	No
708.5	3649	3.3903	1.80E-03	1.80E-04	0.032	1.80E-03	0.053	No
708.75	3649	3.1547	1.67E-03	1.67E-04	0.032	1.67E-03	0.053	No
709	3649	3.2178	1.71E-03	1.71E-04	0.032	1.71E-03	0.053	No
704	3649.25	8.6611	3.53E-03	3.53E-04	0.032	3.53E-03	0.053	No
704.25	3649.25	8.9148	3.66E-03	3.66E-04	0.032	3.66E-03	0.053	No
704.5	3649.25	7.2633	3.85E-03	3.85E-04	0.032	3.85E-03	0.053	No
704.75	3649.25	7.9519	4.21E-03	4.21E-04	0.032	4.21E-03	0.053	No
705	3649.25	7.9783	4.23E-03	4.23E-04	0.032	4.23E-03	0.053	No
705.25	3649.25	8.1336	4.31E-03	4.31E-04	0.032	4.31E-03	0.053	No
705.5	3649.25	8.4242	4.46E-03	4.46E-04	0.032	4.46E-03	0.053	No
705.75	3649.25	8.5869	4.55E-03	4.55E-04	0.032	4.55E-03	0.053	No
706	3649.25	8.7009	4.61E-03	4.61E-04	0.032	4.61E-03	0.053	No
706.25	3649.25	8.616	4.57E-03	4.57E-04	0.032	4.57E-03	0.053	No
706.5	3649.25	8.1365	4.31E-03	4.31E-04	0.032	4.31E-03	0.053	No
706.75	3649.25	8.0253	4.25E-03	4.25E-04	0.032	4.25E-03	0.053	No
707	3649.25	6.9814	3.70E-03	3.70E-04	0.032	3.70E-03	0.053	No
707.25	3649.25	8.311	3.34E-03	3.34E-04	0.032	3.34E-03	0.053	No
707.5	3649.25	4.8739	2.58E-03	2.58E-04	0.032	2.58E-03	0.053	No
707.75	3649.25	4.3837	2.32E-03	2.32E-04	0.032	2.32E-03	0.053	No
708	3649.25	4.2922	2.27E-03	2.27E-04	0.032	2.27E-03	0.053	No
708.25	3649.25	4.1282	2.19E-03	2.19E-04	0.032	2.19E-03	0.053	No
708.5	3649.25	3.8545	2.04E-03	2.04E-04	0.032	2.04E-03	0.053	No
708.75	3649.25	3.887	2.06E-03	2.06E-04	0.032	2.06E-03	0.053	No
709	3649.25	3.9757	2.11E-03	2.11E-04	0.032	2.11E-03	0.053	No
704	3649.5	6.6754	3.54E-03	3.54E-04	0.032	3.54E-03	0.053	No
704.25	3649.5	7.8498	4.05E-03	4.05E-04	0.032	4.05E-03	0.053	No
704.5	3649.5	8.5318	4.52E-03	4.52E-04	0.032	4.52E-03	0.053	No
704.75	3649.5	10.533	5.58E-03	5.58E-04	0.032	5.58E-03	0.053	No
705	3649.5	9.3075	4.93E-03	4.93E-04	0.032	4.93E-03	0.053	No
705.25	3649.5	9.694	5.14E-03	5.14E-04	0.032	5.14E-03	0.053	No
705.5	3649.5	10.3487	5.48E-03	5.48E-04	0.032	5.48E-03	0.053	No
705.75	3649.5	10.8418	5.75E-03	5.75E-04	0.032	5.75E-03	0.053	No
706	3649.5	10.5007	5.57E-03	5.57E-04	0.032	5.57E-03	0.053	No
706.25	3649.5	11.3977	6.04E-03	6.04E-04	0.032	8.04E-03	0.053	No
706.5	3649.5	8.7396	4.63E-03	4.63E-04	0.032	4.63E-03	0.053	No
706.75	3649.5	9.2123	4.88E-03	4.88E-04	0.032	4.88E-03	0.053	No
707	3649.5	7.7491	4.11E-03	4.11E-04	0.032	4.11E-03	0.053	No
707.25	3649.5	6.4692	3.43E-03	3.43E-04	0.032	3.43E-03	0.053	No
707.5	3649.5	5.516	2.92E-03	2.92E-04	0.032	2.92E-03	0.053	No
707.75	3649.5	5.1687	2.74E-03	2.74E-04	0.032	2.74E-03	0.053	No
708	3649.5	4.9283	2.61E-03	2.61E-04	0.032	2.61E-03	0.053	No
708.25	3649.5	4.7606	2.52E-03	2.52E-04	0.032	2.52E-03	0.053	No
708.5	3649.5	4.749	2.52E-03	2.52E-04	0.032	2.52E-03	0.053	No
708.75	3649.5	4.7555	2.52E-03	2.52E-04	0.032	2.52E-03	0.053	No

Imperial Project
Imperial County, Californie

Calculated Annuel Averege NO_2 Concentrations

Location Kilometers (UTM) Eesting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Aveilable O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violetion Yes/No?
709	3649.5	4.695	2.49E-03	2.49E-04	0.032	2.49E-03	0.053	No
704	3649.75	6.1872	3.28E-03	3.28E-04	0.032	3.28E-03	0.053	No
704.25	3649.75	7.7898	4.13E-03	4.13E-04	0.032	4.13E-03	0.053	No
704.5	3649.75	9.3331	4.95E-03	4.95E-04	0.032	4.95E-03	0.053	No
704.75	3649.75	12.2807	8.51E-03	8.51E-04	0.032	6.51E-03	0.053	No
705	3649.75	10.7001	5.67E-03	5.67E-04	0.032	5.67E-03	0.053	No
705.25	3649.75	11.406	6.05E-03	6.05E-04	0.032	6.05E-03	0.053	No
705.5	3649.75	12.5385	6.65E-03	6.65E-04	0.032	6.65E-03	0.053	No
705.75	3649.75	13.6559	7.24E-03	7.24E-04	0.032	7.24E-03	0.053	No
706	3649.75	13.899	7.37E-03	7.37E-04	0.032	7.37E-03	0.053	No
706.25	3649.75	14.1079	7.48E-03	7.48E-04	0.032	7.48E-03	0.053	No
706.5	3649.75	13.7362	7.28E-03	7.28E-04	0.032	7.28E-03	0.053	No
706.75	3649.75	11.9925	6.36E-03	6.36E-04	0.032	6.36E-03	0.053	No
707	3649.75	8.8158	4.67E-03	4.67E-04	0.032	4.67E-03	0.053	No
707.25	3649.75	7.427	3.94E-03	3.94E-04	0.032	3.94E-03	0.053	No
707.5	3649.75	6.9882	3.70E-03	3.70E-04	0.032	3.70E-03	0.053	No
707.75	3649.75	6.6209	3.51E-03	3.51E-04	0.032	3.51E-03	0.053	No
708	3649.75	6.1082	3.24E-03	3.24E-04	0.032	3.24E-03	0.053	No
708.25	3649.75	5.688	3.01E-03	3.01E-04	0.032	3.01E-03	0.053	No
708.5	3649.75	5.7866	3.07E-03	3.07E-04	0.032	3.07E-03	0.053	No
708.75	3649.75	5.4	2.86E-03	2.86E-04	0.032	2.86E-03	0.053	No
709	3649.75	5.4623	2.90E-03	2.90E-04	0.032	2.90E-03	0.053	No
704	3650	8.6503	3.52E-03	3.52E-04	0.032	3.52E-03	0.053	No
704.25	3650	8.911	3.66E-03	3.66E-04	0.032	3.66E-03	0.053	No
704.5	3650	9.4429	5.00E-03	5.00E-04	0.032	5.00E-03	0.053	No
704.75	3650	12.0521	6.39E-03	8.39E-04	0.032	6.39E-03	0.053	No
705	3650	16.2556	8.62E-03	8.82E-04	0.032	8.62E-03	0.053	No
705.25	3650	16.149	8.56E-03	8.56E-04	0.032	8.56E-03	0.053	No
705.5	3650	18.5176	8.75E-03	8.75E-04	0.032	8.75E-03	0.053	No
705.75	3650	18.0929	9.59E-03	9.59E-04	0.032	9.59E-03	0.053	No
706	3650	17.448	9.25E-03	9.25E-04	0.032	9.25E-03	0.053	No
706.25	3650	17.0559	9.04E-03	9.04E-04	0.032	9.04E-03	0.053	No
706.5	3650	15.6428	8.29E-03	8.29E-04	0.032	8.29E-03	0.053	No
706.75	3650	13.0902	6.94E-03	6.94E-04	0.032	6.94E-03	0.053	No
707	3650	11.6104	6.15E-03	6.15E-04	0.032	6.15E-03	0.053	No
707.25	3650	9.9142	5.25E-03	5.25E-04	0.032	5.25E-03	0.053	No
707.5	3650	9.0003	4.77E-03	4.77E-04	0.032	4.77E-03	0.053	No
707.75	3650	7.946	4.21E-03	4.21E-04	0.032	4.21E-03	0.053	No
708	3650	7.6012	4.03E-03	4.03E-04	0.032	4.03E-03	0.053	No
708.25	3650	7.7803	4.12E-03	4.12E-04	0.032	4.12E-03	0.053	No
708.5	3650	6.9411	3.68E-03	3.68E-04	0.032	3.68E-03	0.053	No
708.75	3650	6.3467	3.36E-03	3.36E-04	0.032	3.36E-03	0.053	No
709	3650	5.647	2.99E-03	2.99E-04	0.032	2.99E-03	0.053	No
704	3650.25	7.1391	3.78E-03	3.78E-04	0.032	3.78E-03	0.053	No
704.25	3650.25	6.7712	3.59E-03	3.59E-04	0.032	3.59E-03	0.053	No
704.5	3650.25	8.9191	4.73E-03	4.73E-04	0.032	4.73E-03	0.053	No
704.75	3650.25	12.4912	6.62E-03	6.62E-04	0.032	6.62E-03	0.053	No
705	3650.25	22.9787	1.22E-02	1.22E-03	0.032	1.22E-02	0.053	No
705.25	3650.25	19.3654	1.03E-02	1.03E-03	0.032	1.03E-02	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
705.5	3650.25	21.3247	1.13E-02	1.13E-03	0.032	1.13E-02	0.053	No
705.75	3650.25	25.5373	1.35E-02	1.35E-03	0.032	1.35E-02	0.053	No
706	3650.25	24.3569	1.29E-02	1.29E-03	0.032	1.29E-02	0.053	No
706.25	3650.25	25.0254	1.33E-02	1.33E-03	0.032	1.33E-02	0.053	No
706.5	3650.25	22.4016	1.19E-02	1.19E-03	0.032	1.19E-02	0.053	No
706.75	3650.25	19.5313	1.04E-02	1.04E-03	0.032	1.04E-02	0.053	No
707	3650.25	15.0236	7.96E-03	7.96E-04	0.032	7.96E-03	0.053	No
707.25	3650.25	11.7605	6.23E-03	6.23E-04	0.032	6.23E-03	0.053	No
707.5	3650.25	10.6957	5.67E-03	5.67E-04	0.032	5.67E-03	0.053	No
707.75	3650.25	9.8284	5.21E-03	5.21E-04	0.032	5.21E-03	0.053	No
708	3650.25	9.004	4.77E-03	4.77E-04	0.032	4.77E-03	0.053	No
708.25	3650.25	8.2131	4.35E-03	4.35E-04	0.032	4.35E-03	0.053	No
708.5	3650.25	7.8512	4.16E-03	4.16E-04	0.032	4.16E-03	0.053	No
708.75	3650.25	7.0746	3.75E-03	3.75E-04	0.032	3.75E-03	0.053	No
709	3650.25	6.4296	3.41E-03	3.41E-04	0.032	3.41E-03	0.053	No
704	3650.5	6.6326	3.52E-03	3.52E-04	0.032	3.52E-03	0.053	No
704.25	3650.5	6.7477	3.58E-03	3.58E-04	0.032	3.58E-03	0.053	No
704.5	3650.5	9.4557	5.01E-03	5.01E-04	0.032	5.01E-03	0.053	No
704.75	3650.5	13.06	6.92E-03	6.92E-04	0.032	6.92E-03	0.053	No
705	3650.5	18.7867	9.96E-03	9.96E-04	0.032	9.96E-03	0.053	No
705.25	3650.5	21.7738	1.15E-02	1.15E-03	0.032	1.15E-02	0.053	No
705.5	3650.5	26.2422	1.39E-02	1.39E-03	0.032	1.39E-02	0.053	No
705.75	3650.5	30.7335	1.63E-02	1.63E-03	0.032	1.63E-02	0.053	No
706	3650.5	33.989	1.80E-02	1.80E-03	0.032	1.80E-02	0.053	No
706.25	3650.5	35.3695	1.87E-02	1.87E-03	0.032	1.87E-02	0.053	No
706.5	3650.5	35.0155	1.86E-02	1.86E-03	0.032	1.86E-02	0.053	No
706.75	3650.5	25.8228	1.37E-02	1.37E-03	0.032	1.37E-02	0.053	No
707	3650.5	17.6343	9.35E-03	9.35E-04	0.032	9.35E-03	0.053	No
707.25	3650.5	13.7556	7.29E-03	7.29E-04	0.032	7.29E-03	0.053	No
707.5	3650.5	13.2752	7.04E-03	7.04E-04	0.032	7.04E-03	0.053	No
707.75	3650.5	11.3668	6.02E-03	6.02E-04	0.032	6.02E-03	0.053	No
708	3650.5	10.1581	5.38E-03	5.38E-04	0.032	5.38E-03	0.053	No
708.25	3650.5	9.0852	4.82E-03	4.82E-04	0.032	4.82E-03	0.053	No
708.5	3650.5	8.4593	4.48E-03	4.48E-04	0.032	4.48E-03	0.053	No
708.75	3650.5	7.5977	4.03E-03	4.03E-04	0.032	4.03E-03	0.053	No
709	3650.5	6.863	3.64E-03	3.64E-04	0.032	3.64E-03	0.053	No
704	3650.75	6.2161	3.29E-03	3.29E-04	0.032	3.29E-03	0.053	No
704.25	3650.75	6.953	3.69E-03	3.69E-04	0.032	3.69E-03	0.053	No
704.5	3650.75	8.9006	4.72E-03	4.72E-04	0.032	4.72E-03	0.053	No
704.75	3650.75	13.2698	7.03E-03	7.03E-04	0.032	7.03E-03	0.053	No
705	3650.75	17.2094	9.12E-03	9.12E-04	0.032	9.12E-03	0.053	No
705.25	3650.75	23.7779	1.26E-02	1.26E-03	0.032	1.26E-02	0.053	No
705.5	3650.75	26.111	1.38E-02	1.38E-03	0.032	1.38E-02	0.053	No
705.75	3650.75	35.1082	1.86E-02	1.86E-03	0.032	1.86E-02	0.053	No
706	3650.75	44.6194	2.36E-02	2.36E-03	0.032	2.36E-02	0.053	No
706.25	3650.75	57.9971	3.07E-02	3.07E-03	0.032	3.07E-02	0.053	No
706.5	3650.75	56.5897	3.00E-02	3.00E-03	0.032	3.00E-02	0.053	No
706.75	3650.75	47.7753	2.53E-02	2.53E-03	0.032	2.53E-02	0.053	No
707	3650.75	30.1285	1.60E-02	1.60E-03	0.032	1.60E-02	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
707.25	3650.75	19.1725	1.02E-02	1.02E-03	0.032	1.02E-02	0.053	No
707.5	3650.75	17.1433	9.09E-03	9.09E-04	0.032	9.09E-03	0.053	No
707.75	3650.75	14.3387	7.60E-03	7.60E-04	0.032	7.60E-03	0.053	No
708	3650.75	11.9488	6.33E-03	6.33E-04	0.032	6.33E-03	0.053	No
708.25	3650.75	9.8994	5.25E-03	5.25E-04	0.032	5.25E-03	0.053	No
708.5	3650.75	8.9975	4.77E-03	4.77E-04	0.032	4.77E-03	0.053	No
708.75	3650.75	7.9697	4.22E-03	4.22E-04	0.032	4.22E-03	0.053	No
709	3650.75	7.1316	3.78E-03	3.78E-04	0.032	3.78E-03	0.053	No
704	3651	5.3103	2.81E-03	2.81E-04	0.032	2.81E-03	0.053	No
704.25	3651	5.6704	3.01E-03	3.01E-04	0.032	3.01E-03	0.053	No
704.5	3651	7.7001	4.08E-03	4.08E-04	0.032	4.08E-03	0.053	No
704.75	3651	12.6634	6.71E-03	6.71E-04	0.032	6.71E-03	0.053	No
705	3651	18.8543	9.99E-03	9.99E-04	0.032	9.99E-03	0.053	No
705.25	3651	25.5117	1.35E-02	1.35E-03	0.032	1.35E-02	0.053	No
705.5	3651	32.3713	1.72E-02	1.72E-03	0.032	1.72E-02	0.053	No
705.75	3651	44.5336	2.36E-02	2.36E-03	0.032	2.36E-02	0.053	No
706	3651	62.3245	3.30E-02	3.30E-03	0.032	3.53E-02	0.053	No
706.25	3651	102.6635	5.44E-02	5.44E-03	0.032	3.74E-02	0.053	No
706.5	3651	141.7882	7.51E-02	7.51E-03	0.032	3.95E-02	0.053	No
706.75	3651	47.3473	2.51E-02	2.51E-03	0.032	2.51E-02	0.053	No
707	3651	36.2591	1.92E-02	1.92E-03	0.032	1.92E-02	0.053	No
707.25	3651	23.1803	1.23E-02	1.23E-03	0.032	1.23E-02	0.053	No
707.5	3651	18.6206	9.87E-03	9.87E-04	0.032	9.87E-03	0.053	No
707.75	3651	14.9363	7.92E-03	7.92E-04	0.032	7.92E-03	0.053	No
708	3651	12.6405	6.70E-03	6.70E-04	0.032	6.70E-03	0.053	No
708.25	3651	10.8749	5.76E-03	5.76E-04	0.032	5.76E-03	0.053	No
708.5	3651	9.5222	5.05E-03	5.05E-04	0.032	5.05E-03	0.053	No
708.75	3651	8.3207	4.41E-03	4.41E-04	0.032	4.41E-03	0.053	No
709	3651	7.3754	3.91E-03	3.91E-04	0.032	3.91E-03	0.053	No
704	3651.25	4.9482	2.62E-03	2.62E-04	0.032	2.62E-03	0.053	No
704.25	3651.25	5.6343	2.99E-03	2.99E-04	0.032	2.99E-03	0.053	No
704.5	3651.25	7.4737	3.96E-03	3.96E-04	0.032	3.96E-03	0.053	No
704.75	3651.25	8.9657	4.75E-03	4.75E-04	0.032	4.75E-03	0.053	No
705	3651.25	15.633	8.29E-03	8.29E-04	0.032	8.29E-03	0.053	No
705.25	3651.25	24.2555	1.29E-02	1.29E-03	0.032	1.29E-02	0.053	No
705.5	3651.25	39.3314	2.08E-02	2.08E-03	0.032	2.08E-02	0.053	No
705.75	3651.25	63.9091	3.39E-02	3.39E-03	0.032	3.54E-02	0.053	No
706	3651.25	76.7872	4.07E-02	4.07E-03	0.032	3.61E-02	0.053	No
706.25	3651.25	197.0795	1.04E-01	1.04E-02	0.032	4.24E-02	0.053	No
706.5	3651.25	132.4619	7.02E-02	7.02E-03	0.032	3.90E-02	0.053	No
706.75	3651.25	56.6376	3.00E-02	3.00E-03	0.032	3.00E-02	0.053	No
707	3651.25	36.0767	1.91E-02	1.91E-03	0.032	1.91E-02	0.053	No
707.25	3651.25	26.1082	1.38E-02	1.38E-03	0.032	1.38E-02	0.053	No
707.5	3651.25	19.8221	1.05E-02	1.05E-03	0.032	1.05E-02	0.053	No
707.75	3651.25	15.3583	8.14E-03	8.14E-04	0.032	8.14E-03	0.053	No
708	3651.25	12.7081	6.74E-03	6.74E-04	0.032	6.74E-03	0.053	No
708.25	3651.25	10.764	5.70E-03	5.70E-04	0.032	5.70E-03	0.053	No
708.5	3651.25	9.5979	5.09E-03	5.09E-04	0.032	5.09E-03	0.053	No
708.75	3651.25	8.2273	4.36E-03	4.36E-04	0.032	4.36E-03	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
709	3651.25	7.1721	3.80E-03	3.80E-04	0.032	3.80E-03	0.053	No
704	3651.5	5.3291	2.82E-03	2.82E-04	0.032	2.82E-03	0.053	No
704.25	3651.5	6.0611	3.21E-03	3.21E-04	0.032	3.21E-03	0.053	No
704.5	3651.5	7.8813	4.18E-03	4.18E-04	0.032	4.18E-03	0.053	No
704.75	3651.5	8.5302	4.52E-03	4.52E-04	0.032	4.52E-03	0.053	No
705	3651.5	14.5365	7.70E-03	7.70E-04	0.032	7.70E-03	0.053	No
705.25	3651.5	20.5729	1.09E-02	1.09E-03	0.032	1.09E-02	0.053	No
705.5	3651.5	40.0023	2.12E-02	2.12E-03	0.032	2.12E-02	0.053	No
705.75	3651.5	78.7503	4.17E-02	4.17E-03	0.032	3.62E-02	0.053	No
706	3651.5	27.4095	1.45E-02	1.45E-03	0.032	1.45E-02	0.053	No
706.25	3651.5	177.2194	9.39E-02	9.39E-03	0.032	4.14E-02	0.053	No
706.5	3651.5	90.0784	4.77E-02	4.77E-03	0.032	3.68E-02	0.053	No
706.75	3651.5	49.8803	2.64E-02	2.64E-03	0.032	2.64E-02	0.053	No
707	3651.5	33.7768	1.79E-02	1.79E-03	0.032	1.79E-02	0.053	No
707.25	3651.5	25.5055	1.35E-02	1.35E-03	0.032	1.35E-02	0.053	No
707.5	3651.5	19.2351	1.02E-02	1.02E-03	0.032	1.02E-02	0.053	No
707.75	3651.5	15.1663	8.04E-03	8.04E-04	0.032	8.04E-03	0.053	No
708	3651.5	12.324	6.53E-03	6.53E-04	0.032	6.53E-03	0.053	No
708.25	3651.5	10.5288	5.58E-03	5.58E-04	0.032	5.58E-03	0.053	No
708.5	3651.5	9.3193	4.94E-03	4.94E-04	0.032	4.94E-03	0.053	No
708.75	3651.5	8.3045	4.40E-03	4.40E-04	0.032	4.40E-03	0.053	No
709	3651.5	7.3761	3.91E-03	3.91E-04	0.032	3.91E-03	0.053	No
704	3651.75	5.1902	2.75E-03	2.75E-04	0.032	2.75E-03	0.053	No
704.25	3651.75	5.7848	3.07E-03	3.07E-04	0.032	3.07E-03	0.053	No
704.5	3651.75	8.2948	4.40E-03	4.40E-04	0.032	4.40E-03	0.053	No
704.75	3651.75	9.8068	5.20E-03	5.20E-04	0.032	5.20E-03	0.053	No
705	3651.75	11.5628	6.13E-03	6.13E-04	0.032	6.13E-03	0.053	No
705.25	3651.75	22.1567	1.17E-02	1.17E-03	0.032	1.17E-02	0.053	No
705.5	3651.75	35.3731	1.87E-02	1.87E-03	0.032	1.87E-02	0.053	No
705.75	3651.75	14.4224	7.64E-03	7.64E-04	0.032	7.64E-03	0.053	No
706	3651.75	38.5593	2.04E-02	2.04E-03	0.032	2.04E-02	0.053	No
706.25	3651.75	50.7912	2.69E-02	2.69E-03	0.032	2.69E-02	0.053	No
706.5	3651.75	77.863	4.13E-02	4.13E-03	0.032	3.61E-02	0.053	No
706.75	3651.75	46.2647	2.45E-02	2.45E-03	0.032	2.45E-02	0.053	No
707	3651.75	31.2208	1.65E-02	1.65E-03	0.032	1.65E-02	0.053	No
707.25	3651.75	24.5192	1.30E-02	1.30E-03	0.032	1.30E-02	0.053	No
707.5	3651.75	18.5014	9.81E-03	9.81E-04	0.032	9.81E-03	0.053	No
707.75	3651.75	15.0662	7.99E-03	7.99E-04	0.032	7.99E-03	0.053	No
708	3651.75	12.2467	6.49E-03	6.49E-04	0.032	6.49E-03	0.053	No
708.25	3651.75	10.5025	5.57E-03	5.57E-04	0.032	5.57E-03	0.053	No
708.5	3651.75	9.3502	4.96E-03	4.96E-04	0.032	4.96E-03	0.053	No
708.75	3651.75	8.0836	4.28E-03	4.28E-04	0.032	4.28E-03	0.053	No
709	3651.75	7.1482	3.79E-03	3.79E-04	0.032	3.79E-03	0.053	No
704	3652	4.745	2.51E-03	2.51E-04	0.032	2.51E-03	0.053	No
704.25	3652	4.9122	2.60E-03	2.60E-04	0.032	2.60E-03	0.053	No
704.5	3652	6.0607	3.21E-03	3.21E-04	0.032	3.21E-03	0.053	No
704.75	3652	10.5752	5.60E-03	5.60E-04	0.032	5.60E-03	0.053	No
705	3652	13.2913	7.04E-03	7.04E-04	0.032	7.04E-03	0.053	No
705.25	3652	18.1062	9.60E-03	9.60E-04	0.032	9.60E-03	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
705.5	3652	36.4615	1.93E-02	1.93E-03	0.032	1.93E-02	0.053	No
705.75	3652	82.0267	4.35E-02	4.35E-03	0.032	3.63E-02	0.053	No
706	3652	30.7876	1.63E-02	1.63E-03	0.032	1.63E-02	0.053	No
706.25	3652	85.0356	4.51E-02	4.51E-03	0.032	3.65E-02	0.053	No
706.5	3652	56.0176	2.97E-02	2.97E-03	0.032	2.97E-02	0.053	No
706.75	3652	37.2985	1.98E-02	1.98E-03	0.032	1.98E-02	0.053	No
707	3652	26.1798	1.39E-02	1.39E-03	0.032	1.39E-02	0.053	No
707.25	3652	20.2271	1.07E-02	1.07E-03	0.032	1.07E-02	0.053	No
707.5	3652	16.4688	8.73E-03	8.73E-04	0.032	8.73E-03	0.053	No
707.75	3652	13.391	7.10E-03	7.10E-04	0.032	7.10E-03	0.053	No
708	3652	11.7128	6.21E-03	8.21E-04	0.032	8.21E-03	0.053	No
708.25	3652	9.8929	5.24E-03	5.24E-04	0.032	5.24E-03	0.053	No
708.5	3652	8.696	4.61E-03	4.61E-04	0.032	4.61E-03	0.053	No
708.75	3652	7.6619	4.06E-03	4.06E-04	0.032	4.06E-03	0.053	No
709	3652	6.8409	3.63E-03	3.63E-04	0.032	3.63E-03	0.053	No
704	3652.25	4.2702	2.26E-03	2.26E-04	0.032	2.26E-03	0.053	No
704.25	3652.25	4.9686	2.63E-03	2.63E-04	0.032	2.63E-03	0.053	No
704.5	3652.25	7.0327	3.73E-03	3.73E-04	0.032	3.73E-03	0.053	No
704.75	3652.25	10.5121	5.57E-03	5.57E-04	0.032	5.57E-03	0.053	No
705	3652.25	13.5056	7.16E-03	7.16E-04	0.032	7.16E-03	0.053	No
705.25	3652.25	22.1865	1.18E-02	1.18E-03	0.032	1.18E-02	0.053	No
705.5	3652.25	44.8514	2.38E-02	2.38E-03	0.032	2.38E-02	0.053	No
705.75	3652.25	83.6648	4.43E-02	4.43E-03	0.032	3.64E-02	0.053	No
706	3652.25	93.0405	4.93E-02	4.93E-03	0.032	3.69E-02	0.053	No
706.25	3652.25	62.7204	3.32E-02	3.32E-03	0.032	3.53E-02	0.053	No
706.5	3652.25	40.6033	2.15E-02	2.15E-03	0.032	2.15E-02	0.053	No
706.75	3652.25	29.9583	1.59E-02	1.59E-03	0.032	1.59E-02	0.053	No
707	3652.25	21.1048	1.12E-02	1.12E-03	0.032	1.12E-02	0.053	No
707.25	3652.25	16.8583	8.93E-03	8.93E-04	0.032	8.93E-03	0.053	No
707.5	3652.25	13.5561	7.18E-03	7.18E-04	0.032	7.18E-03	0.053	No
707.75	3652.25	11.5531	6.12E-03	8.12E-04	0.032	8.12E-03	0.053	No
708	3652.25	10.0303	5.32E-03	5.32E-04	0.032	5.32E-03	0.053	No
708.25	3652.25	8.7988	4.66E-03	4.66E-04	0.032	4.66E-03	0.053	No
708.5	3652.25	7.7905	4.13E-03	4.13E-04	0.032	4.13E-03	0.053	No
708.75	3652.25	6.9526	3.68E-03	3.68E-04	0.032	3.68E-03	0.053	No
709	3652.25	6.2331	3.30E-03	3.30E-04	0.032	3.30E-03	0.053	No
704	3652.5	4.5006	2.39E-03	2.39E-04	0.032	2.39E-03	0.053	No
704.25	3652.5	5.0612	2.68E-03	2.68E-04	0.032	2.68E-03	0.053	No
704.5	3652.5	8.4676	4.49E-03	4.49E-04	0.032	4.49E-03	0.053	No
704.75	3652.5	12.6003	6.68E-03	6.68E-04	0.032	6.68E-03	0.053	No
705	3652.5	15.0223	7.96E-03	7.96E-04	0.032	7.96E-03	0.053	No
705.25	3652.5	24.9735	1.32E-02	1.32E-03	0.032	1.32E-02	0.053	No
705.5	3652.5	47.3241	2.51E-02	2.51E-03	0.032	2.51E-02	0.053	No
705.75	3652.5	62.7164	3.32E-02	3.32E-03	0.032	3.53E-02	0.053	No
706	3652.5	58.6926	3.11E-02	3.11E-03	0.032	3.11E-02	0.053	No
706.25	3652.5	44.8729	2.38E-02	2.38E-03	0.032	2.38E-02	0.053	No
706.5	3652.5	31.1634	1.65E-02	1.65E-03	0.032	1.65E-02	0.053	No
706.75	3652.5	24.2169	1.28E-02	1.28E-03	0.032	1.28E-02	0.053	No
707	3652.5	18.6435	9.88E-03	9.88E-04	0.032	9.88E-03	0.053	No

Imparial Project
Imperial County, California

Calculated Annual Averaga NO_2 Concentrations

Location		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
707.25	3652.5	14.4533	7.66E-03	7.66E-04	0.032	7.66E-03	0.053	No
707.5	3652.5	12.2212	6.48E-03	6.48E-04	0.032	6.48E-03	0.053	No
707.75	3652.5	9.9665	5.28E-03	5.28E-04	0.032	5.28E-03	0.053	No
708	3652.5	8.8683	4.70E-03	4.70E-04	0.032	4.70E-03	0.053	No
708.25	3652.5	7.7289	4.10E-03	4.10E-04	0.032	4.10E-03	0.053	No
708.5	3652.5	7.0832	3.75E-03	3.75E-04	0.032	3.75E-03	0.053	No
708.75	3652.5	6.4642	3.43E-03	3.43E-04	0.032	3.43E-03	0.053	No
709	3652.5	5.7395	3.04E-03	3.04E-04	0.032	3.04E-03	0.053	No
704	3652.75	5.2566	2.79E-03	2.79E-04	0.032	2.79E-03	0.053	No
704.25	3652.75	6.7116	3.56E-03	3.56E-04	0.032	3.56E-03	0.053	No
704.5	3652.75	9.546	5.06E-03	5.06E-04	0.032	5.06E-03	0.053	No
704.75	3652.75	13.2445	7.02E-03	7.02E-04	0.032	7.02E-03	0.053	No
705	3652.75	17.334	9.19E-03	9.19E-04	0.032	9.19E-03	0.053	No
705.25	3652.75	29.2888	1.55E-02	1.55E-03	0.032	1.55E-02	0.053	No
705.5	3652.75	43.4416	2.30E-02	2.30E-03	0.032	2.30E-02	0.053	No
705.75	3652.75	47.1857	2.50E-02	2.50E-03	0.032	2.50E-02	0.053	No
706	3652.75	42.0979	2.23E-02	2.23E-03	0.032	2.23E-02	0.053	No
706.25	3652.75	34.6342	1.84E-02	1.84E-03	0.032	1.84E-02	0.053	No
706.5	3652.75	26.7361	1.42E-02	1.42E-03	0.032	1.42E-02	0.053	No
706.75	3652.75	19.7448	1.05E-02	1.05E-03	0.032	1.05E-02	0.053	No
707	3652.75	16.1386	8.55E-03	8.55E-04	0.032	8.55E-03	0.053	No
707.25	3652.75	12.6687	6.71E-03	6.71E-04	0.032	6.71E-03	0.053	No
707.5	3652.75	11.1797	5.93E-03	5.93E-04	0.032	5.93E-03	0.053	No
707.75	3652.75	9.3672	4.96E-03	4.96E-04	0.032	4.96E-03	0.053	No
708	3652.75	8.106	4.30E-03	4.30E-04	0.032	4.30E-03	0.053	No
708.25	3652.75	7.0064	3.71E-03	3.71E-04	0.032	3.71E-03	0.053	No
708.5	3652.75	6.3683	3.38E-03	3.38E-04	0.032	3.38E-03	0.053	No
708.75	3652.75	5.8717	3.11E-03	3.11E-04	0.032	3.11E-03	0.053	No
709	3652.75	5.469	2.90E-03	2.90E-04	0.032	2.90E-03	0.053	No
704	3653	5.9099	3.13E-03	3.13E-04	0.032	3.13E-03	0.053	No
704.25	3653	7.8048	4.14E-03	4.14E-04	0.032	4.14E-03	0.053	No
704.5	3653	9.4797	5.02E-03	5.02E-04	0.032	5.02E-03	0.053	No
704.75	3653	14.3293	7.59E-03	7.59E-04	0.032	7.59E-03	0.053	No
705	3653	19.7977	1.05E-02	1.05E-03	0.032	1.05E-02	0.053	No
705.25	3653	30.4478	1.61E-02	1.61E-03	0.032	1.61E-02	0.053	No
705.5	3653	35.9638	1.91E-02	1.91E-03	0.032	1.91E-02	0.053	No
705.75	3653	35.8501	1.90E-02	1.90E-03	0.032	1.90E-02	0.053	No
706	3653	32.4178	1.72E-02	1.72E-03	0.032	1.72E-02	0.053	No
706.25	3653	27.3976	1.45E-02	1.45E-03	0.032	1.45E-02	0.053	No
706.5	3653	22.8855	1.21E-02	1.21E-03	0.032	1.21E-02	0.053	No
706.75	3653	17.5487	9.30E-03	9.30E-04	0.032	9.30E-03	0.053	No
707	3653	14.186	7.52E-03	7.52E-04	0.032	7.52E-03	0.053	No
707.25	3653	11.75	6.23E-03	6.23E-04	0.032	6.23E-03	0.053	No
707.5	3653	9.674	5.13E-03	5.13E-04	0.032	5.13E-03	0.053	No
707.75	3653	8.4948	4.50E-03	4.50E-04	0.032	4.50E-03	0.053	No
708	3653	7.6217	4.04E-03	4.04E-04	0.032	4.04E-03	0.053	No
708.25	3653	6.8228	3.62E-03	3.62E-04	0.032	3.62E-03	0.053	No
708.5	3653	5.8965	3.13E-03	3.13E-04	0.032	3.13E-03	0.053	No
708.75	3653	5.1815	2.75E-03	2.75E-04	0.032	2.75E-03	0.053	No
709	3653	4.8648	2.58E-03	2.58E-04	0.032	2.58E-03	0.053	No

Imperial Project
Imparial County, Califomia

Calculated Annual Average NO_2 Concentrationa

Location		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
1000 METER GRID (INCLUDING POINTS WITHIN FACILITY)								
699	3640	0.3768	2.00E-04	2.00E-05	0.032	2.00E-04	0.053	No
700	3640	0.3954	2.10E-04	2.10E-05	0.032	2.10E-04	0.053	No
701	3640	0.3847	2.04E-04	2.04E-05	0.032	2.04E-04	0.053	No
702	3640	0.4607	2.44E-04	2.44E-05	0.032	2.44E-04	0.053	No
703	3640	0.6296	3.34E-04	3.34E-05	0.032	3.34E-04	0.053	No
704	3640	0.9276	4.92E-04	4.92E-05	0.032	4.92E-04	0.053	No
705	3640	1.1429	6.06E-04	6.06E-05	0.032	6.06E-04	0.053	No
706	3640	1.1043	5.85E-04	5.85E-05	0.032	5.85E-04	0.053	No
707	3640	0.9828	5.21E-04	5.21E-05	0.032	5.21E-04	0.053	No
708	3640	1.1145	5.91E-04	5.91E-05	0.032	5.91E-04	0.053	No
709	3640	1.0199	5.41E-04	5.41E-05	0.032	5.41E-04	0.053	No
710	3640	0.9085	4.82E-04	4.82E-05	0.032	4.82E-04	0.053	No
711	3640	0.822	4.36E-04	4.36E-05	0.032	4.36E-04	0.053	No
712	3640	0.5348	2.83E-04	2.83E-05	0.032	2.83E-04	0.053	No
713	3640	0.5147	2.73E-04	2.73E-05	0.032	2.73E-04	0.053	No
714	3640	0.4095	2.17E-04	2.17E-05	0.032	2.17E-04	0.053	No
715	3640	0.2761	1.46E-04	1.46E-05	0.032	1.46E-04	0.053	No
716	3640	0.2687	1.42E-04	1.42E-05	0.032	1.42E-04	0.053	No
717	3640	0.2614	1.39E-04	1.39E-05	0.032	1.39E-04	0.053	No
718	3640	0.1602	8.49E-05	8.49E-06	0.032	8.49E-05	0.053	No
719	3640	0.1565	8.29E-05	8.29E-06	0.032	8.29E-05	0.053	No
720	3640	0.1803	9.56E-05	9.56E-06	0.032	9.56E-05	0.053	No
721	3640	0.1735	9.20E-05	9.20E-06	0.032	9.20E-05	0.053	No
722	3640	0.18	9.54E-05	9.54E-06	0.032	9.54E-05	0.053	No
699	3641	0.4613	2.44E-04	2.44E-05	0.032	2.44E-04	0.053	No
700	3641	0.4951	2.62E-04	2.62E-05	0.032	2.62E-04	0.053	No
701	3641	0.517	2.74E-04	2.74E-05	0.032	2.74E-04	0.053	No
702	3641	0.5305	2.81E-04	2.81E-05	0.032	2.81E-04	0.053	No
703	3641	0.907	4.81E-04	4.81E-05	0.032	4.81E-04	0.053	No
704	3641	1.3965	7.40E-04	7.40E-05	0.032	7.40E-04	0.053	No
705	3641	1.4165	7.51E-04	7.51E-05	0.032	7.51E-04	0.053	No
706	3641	1.2651	6.71E-04	8.71E-05	0.032	6.71E-04	0.053	No
707	3641	1.1226	5.95E-04	5.95E-05	0.032	5.95E-04	0.053	No
708	3641	1.317	6.98E-04	6.98E-05	0.032	6.98E-04	0.053	No
709	3641	1.0859	5.76E-04	5.76E-05	0.032	5.76E-04	0.053	No
710	3641	1.0803	5.73E-04	5.73E-05	0.032	5.73E-04	0.053	No
711	3641	0.7772	4.12E-04	4.12E-05	0.032	4.12E-04	0.053	No
712	3641	0.6711	3.56E-04	3.56E-05	0.032	3.56E-04	0.053	No
713	3641	0.6281	3.33E-04	3.33E-05	0.032	3.33E-04	0.053	No
714	3641	0.4468	2.37E-04	2.37E-05	0.032	2.37E-04	0.053	No
715	3641	0.3363	1.78E-04	1.78E-05	0.032	1.78E-04	0.053	No
716	3641	0.2967	1.57E-04	1.57E-05	0.032	1.57E-04	0.053	No
717	3641	0.2108	1.12E-04	1.12E-05	0.032	1.12E-04	0.053	No
718	3641	0.2114	1.12E-04	1.12E-05	0.032	1.12E-04	0.053	No
719	3641	0.2291	1.21E-04	1.21E-05	0.032	1.21E-04	0.053	No
720	3641	0.259	1.37E-04	1.37E-05	0.032	1.37E-04	0.053	No
721	3641	0.2484	1.32E-04	1.32E-05	0.032	1.32E-04	0.053	No
722	3641	0.2233	1.18E-04	1.18E-05	0.032	1.18E-04	0.053	No

Imperial Project
Imperial County, California

Calculated Annuel Averege NO_2 Concentretiona

Location		Modelled NOx Impect		Out of Stk NO_2	Avelleble O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
699	3642	0.6201	3.29E-04	3.29E-05	0.032	3.29E-04	0.053	No
700	3642	0.5802	3.08E-04	3.08E-05	0.032	3.08E-04	0.053	No
701	3642	0.6794	3.60E-04	3.60E-05	0.032	3.60E-04	0.053	No
702	3642	0.7495	3.97E-04	3.97E-05	0.032	3.97E-04	0.053	No
703	3642	1.1188	5.93E-04	5.93E-05	0.032	5.93E-04	0.053	No
704	3642	1.6092	8.53E-04	8.53E-05	0.032	8.53E-04	0.053	No
705	3642	1.6588	8.79E-04	8.79E-05	0.032	8.79E-04	0.053	No
706	3642	1.4762	7.82E-04	7.82E-05	0.032	7.82E-04	0.053	No
707	3642	1.3104	6.95E-04	6.95E-05	0.032	6.95E-04	0.053	No
708	3642	1.5479	8.20E-04	8.20E-05	0.032	8.20E-04	0.053	No
709	3642	1.1763	8.23E-04	6.23E-05	0.032	8.23E-04	0.053	No
710	3642	1.1968	6.34E-04	6.34E-05	0.032	6.34E-04	0.053	No
711	3642	0.835	4.43E-04	4.43E-05	0.032	4.43E-04	0.053	No
712	3642	0.8469	4.49E-04	4.49E-05	0.032	4.49E-04	0.053	No
713	3642	0.5055	2.68E-04	2.68E-05	0.032	2.68E-04	0.053	No
714	3642	0.4441	2.35E-04	2.35E-05	0.032	2.35E-04	0.053	No
715	3642	0.3216	1.70E-04	1.70E-05	0.032	1.70E-04	0.053	No
716	3642	0.2664	1.41E-04	1.41E-05	0.032	1.41E-04	0.053	No
717	3642	0.2964	1.57E-04	1.57E-05	0.032	1.57E-04	0.053	No
718	3642	0.3236	1.72E-04	1.72E-05	0.032	1.72E-04	0.053	No
719	3642	0.3602	1.91E-04	1.91E-05	0.032	1.91E-04	0.053	No
720	3642	0.3215	1.70E-04	1.70E-05	0.032	1.70E-04	0.053	No
721	3642	0.3219	1.71E-04	1.71E-05	0.032	1.71E-04	0.053	No
722	3642	0.2397	1.27E-04	1.27E-05	0.032	1.27E-04	0.053	No
699	3643	0.6911	3.66E-04	3.66E-05	0.032	3.66E-04	0.053	No
700	3643	0.7283	3.86E-04	3.86E-05	0.032	3.86E-04	0.053	No
701	3643	0.9235	4.89E-04	4.89E-05	0.032	4.89E-04	0.053	No
702	3643	1.0457	5.54E-04	5.54E-05	0.032	5.54E-04	0.053	No
703	3643	1.2725	6.74E-04	6.74E-05	0.032	8.74E-04	0.053	No
704	3643	1.8743	9.93E-04	9.93E-05	0.032	9.93E-04	0.053	No
705	3643	1.9763	1.05E-03	1.05E-04	0.032	1.05E-03	0.053	No
706	3643	1.7583	9.32E-04	9.32E-05	0.032	9.32E-04	0.053	No
707	3643	1.5775	8.36E-04	8.36E-05	0.032	8.36E-04	0.053	No
708	3643	1.7941	9.51E-04	9.51E-05	0.032	9.51E-04	0.053	No
709	3643	1.4737	7.81E-04	7.81E-05	0.032	7.81E-04	0.053	No
710	3643	1.2251	6.49E-04	6.49E-05	0.032	6.49E-04	0.053	No
711	3643	0.9531	5.05E-04	5.05E-05	0.032	5.05E-04	0.053	No
712	3643	0.8276	4.39E-04	4.39E-05	0.032	4.39E-04	0.053	No
713	3643	0.525	2.78E-04	2.78E-05	0.032	2.78E-04	0.053	No
714	3643	0.4178	2.21E-04	2.21E-05	0.032	2.21E-04	0.053	No
715	3643	0.3382	1.79E-04	1.79E-05	0.032	1.79E-04	0.053	No
716	3643	0.4044	2.14E-04	2.14E-05	0.032	2.14E-04	0.053	No
717	3643	0.4307	2.28E-04	2.28E-05	0.032	2.28E-04	0.053	No
718	3643	0.4673	2.48E-04	2.48E-05	0.032	2.48E-04	0.053	No
719	3643	0.4638	2.46E-04	2.46E-05	0.032	2.46E-04	0.053	No
720	3643	0.4501	2.39E-04	2.39E-05	0.032	2.39E-04	0.053	No
721	3643	0.4668	2.47E-04	2.47E-05	0.032	2.47E-04	0.053	No
722	3643	0.3272	1.73E-04	1.73E-05	0.032	1.73E-04	0.053	No
699	3644	0.678	3.59E-04	3.59E-05	0.032	3.59E-04	0.053	No

Imperial Project
Imperial County, California

Celculated Annuel Averege NO_2 Concentretions

Location		Modelled NOx Impect		Out of Stk NO_2	Avelleble O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometars (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
700	3644	0.9132	4.84E-04	4.84E-05	0.032	4.84E-04	0.053	No
701	3644	1.1415	8.05E-04	6.05E-05	0.032	6.05E-04	0.053	No
702	3644	1.4846	7.87E-04	7.87E-05	0.032	7.87E-04	0.053	No
703	3644	1.7715	9.39E-04	9.39E-05	0.032	9.39E-04	0.053	No
704	3644	2.1413	1.13E-03	1.13E-04	0.032	1.13E-03	0.053	No
705	3644	2.2415	1.19E-03	1.19E-04	0.032	1.19E-03	0.053	No
706	3644	2.0796	1.10E-03	1.10E-04	0.032	1.10E-03	0.053	No
707	3644	1.9597	1.04E-03	1.04E-04	0.032	1.04E-03	0.053	No
708	3644	1.9239	1.02E-03	1.02E-04	0.032	1.02E-03	0.053	No
709	3644	1.8	9.54E-04	9.54E-05	0.032	9.54E-04	0.053	No
710	3644	1.167	6.19E-04	8.19E-05	0.032	8.19E-04	0.053	No
711	3644	1.1421	8.05E-04	6.05E-05	0.032	6.05E-04	0.053	No
712	3644	0.7439	3.94E-04	3.94E-05	0.032	3.94E-04	0.053	No
713	3644	0.6287	3.33E-04	3.33E-05	0.032	3.33E-04	0.053	No
714	3644	0.3832	2.03E-04	2.03E-05	0.032	2.03E-04	0.053	No
715	3644	0.4969	2.63E-04	2.63E-05	0.032	2.63E-04	0.053	No
716	3644	0.6076	3.22E-04	3.22E-05	0.032	3.22E-04	0.053	No
717	3644	0.6017	3.19E-04	3.19E-05	0.032	3.19E-04	0.053	No
718	3644	0.6145	3.26E-04	3.26E-05	0.032	3.26E-04	0.053	No
719	3644	0.5631	2.98E-04	2.98E-05	0.032	2.98E-04	0.053	No
720	3644	0.4941	2.62E-04	2.62E-05	0.032	2.62E-04	0.053	No
721	3644	0.4254	2.25E-04	2.25E-05	0.032	2.25E-04	0.053	No
722	3644	0.4069	2.16E-04	2.16E-05	0.032	2.16E-04	0.053	No
699	3645	0.6138	3.25E-04	3.25E-05	0.032	3.25E-04	0.053	No
700	3645	0.9682	5.13E-04	5.13E-05	0.032	5.13E-04	0.053	No
701	3645	1.3519	7.17E-04	7.17E-05	0.032	7.17E-04	0.053	No
702	3645	1.8217	9.66E-04	9.66E-05	0.032	9.66E-04	0.053	No
703	3645	2.2561	1.20E-03	1.20E-04	0.032	1.20E-03	0.053	No
704	3645	2.3121	1.23E-03	1.23E-04	0.032	1.23E-03	0.053	No
705	3645	2.3731	1.26E-03	1.26E-04	0.032	1.26E-03	0.053	No
706	3645	2.4284	1.29E-03	1.29E-04	0.032	1.29E-03	0.053	No
707	3645	2.4229	1.28E-03	1.28E-04	0.032	1.28E-03	0.053	No
708	3645	2.257	1.20E-03	1.20E-04	0.032	1.20E-03	0.053	No
709	3645	1.8788	9.96E-04	9.96E-05	0.032	9.96E-04	0.053	No
710	3645	1.3946	7.39E-04	7.39E-05	0.032	7.39E-04	0.053	No
711	3645	0.951	5.04E-04	5.04E-05	0.032	5.04E-04	0.053	No
712	3645	0.9078	4.81E-04	4.81E-05	0.032	4.81E-04	0.053	No
713	3645	0.5561	2.95E-04	2.95E-05	0.032	2.95E-04	0.053	No
714	3645	0.6303	3.34E-04	3.34E-05	0.032	3.34E-04	0.053	No
715	3645	0.7672	4.07E-04	4.07E-05	0.032	4.07E-04	0.053	No
716	3645	0.8038	4.26E-04	4.26E-05	0.032	4.26E-04	0.053	No
717	3645	0.7674	4.07E-04	4.07E-05	0.032	4.07E-04	0.053	No
718	3645	0.6604	3.50E-04	3.50E-05	0.032	3.50E-04	0.053	No
719	3645	0.6341	3.36E-04	3.36E-05	0.032	3.36E-04	0.053	No
720	3645	0.512	2.71E-04	2.71E-05	0.032	2.71E-04	0.053	No
721	3645	0.5112	2.71E-04	2.71E-05	0.032	2.71E-04	0.053	No
722	3645	0.5513	2.92E-04	2.92E-05	0.032	2.92E-04	0.053	No
699	3646	0.563	2.98E-04	2.98E-05	0.032	2.98E-04	0.053	No
700	3646	0.8238	4.37E-04	4.37E-05	0.032	4.37E-04	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
701	3646	1.4088	7.47E-04	7.47E-05	0.032	7.47E-04	0.053	No
702	3646	2.071	1.10E-03	1.10E-04	0.032	1.10E-03	0.053	No
703	3646	2.296	1.22E-03	1.22E-04	0.032	1.22E-03	0.053	No
704	3646	2.2995	1.22E-03	1.22E-04	0.032	1.22E-03	0.053	No
705	3646	2.7132	1.44E-03	1.44E-04	0.032	1.44E-03	0.053	No
706	3646	2.7076	1.44E-03	1.44E-04	0.032	1.44E-03	0.053	No
707	3646	2.6863	1.42E-03	1.42E-04	0.032	1.42E-03	0.053	No
708	3646	2.5656	1.36E-03	1.36E-04	0.032	1.36E-03	0.053	No
709	3646	1.7424	9.23E-04	9.23E-05	0.032	9.23E-04	0.053	No
710	3646	1.4343	7.60E-04	7.60E-05	0.032	7.60E-04	0.053	No
711	3646	1.198	6.35E-04	6.35E-05	0.032	6.35E-04	0.053	No
712	3646	0.7725	4.09E-04	4.09E-05	0.032	4.09E-04	0.053	No
713	3646	0.865	4.58E-04	4.58E-05	0.032	4.58E-04	0.053	No
714	3646	0.9953	5.28E-04	5.28E-05	0.032	5.28E-04	0.053	No
715	3646	0.9364	4.96E-04	4.96E-05	0.032	4.96E-04	0.053	No
716	3646	0.9305	4.93E-04	4.93E-05	0.032	4.93E-04	0.053	No
717	3646	0.8486	4.50E-04	4.50E-05	0.032	4.50E-04	0.053	No
718	3646	0.769	4.08E-04	4.08E-05	0.032	4.08E-04	0.053	No
719	3646	0.7454	3.95E-04	3.95E-05	0.032	3.95E-04	0.053	No
720	3646	0.6315	3.35E-04	3.35E-05	0.032	3.35E-04	0.053	No
721	3646	0.6394	3.39E-04	3.39E-05	0.032	3.39E-04	0.053	No
722	3646	0.6246	3.31E-04	3.31E-05	0.032	3.31E-04	0.053	No
699	3647	0.4889	2.59E-04	2.59E-05	0.032	2.59E-04	0.053	No
700	3647	0.8214	4.35E-04	4.35E-05	0.032	4.35E-04	0.053	No
701	3647	1.1759	6.23E-04	6.23E-05	0.032	6.23E-04	0.053	No
702	3647	1.8056	9.57E-04	9.57E-05	0.032	9.57E-04	0.053	No
703	3647	2.3748	1.26E-03	1.26E-04	0.032	1.26E-03	0.053	No
704	3647	2.4111	1.28E-03	1.28E-04	0.032	1.28E-03	0.053	No
705	3647	2.8719	1.52E-03	1.52E-04	0.032	1.52E-03	0.053	No
706	3647	3.0796	1.63E-03	1.63E-04	0.032	1.63E-03	0.053	No
707	3647	2.8913	1.53E-03	1.53E-04	0.032	1.53E-03	0.053	No
708	3647	2.8477	1.51E-03	1.51E-04	0.032	1.51E-03	0.053	No
709	3647	2.0067	1.06E-03	1.06E-04	0.032	1.06E-03	0.053	No
710	3647	1.5712	8.33E-04	8.33E-05	0.032	8.33E-04	0.053	No
711	3647	1.3128	6.96E-04	6.96E-05	0.032	6.96E-04	0.053	No
712	3647	1.4301	7.58E-04	7.58E-05	0.032	7.58E-04	0.053	No
713	3647	1.2936	6.86E-04	6.86E-05	0.032	6.86E-04	0.053	No
714	3647	1.2483	6.62E-04	6.62E-05	0.032	6.62E-04	0.053	No
715	3647	1.1069	5.87E-04	5.87E-05	0.032	5.87E-04	0.053	No
716	3647	1.054	5.59E-04	5.59E-05	0.032	5.59E-04	0.053	No
717	3647	0.9868	5.23E-04	5.23E-05	0.032	5.23E-04	0.053	No
718	3647	0.8902	4.72E-04	4.72E-05	0.032	4.72E-04	0.053	No
719	3647	0.8208	4.35E-04	4.35E-05	0.032	4.35E-04	0.053	No
720	3647	0.7557	4.01E-04	4.01E-05	0.032	4.01E-04	0.053	No
721	3647	0.6907	3.66E-04	3.66E-05	0.032	3.66E-04	0.053	No
722	3647	0.6096	3.23E-04	3.23E-05	0.032	3.23E-04	0.053	No
699	3648	0.5968	3.16E-04	3.16E-05	0.032	3.16E-04	0.053	No
700	3648	0.7287	3.86E-04	3.86E-05	0.032	3.86E-04	0.053	No
701	3648	1.1252	5.96E-04	5.96E-05	0.032	5.96E-04	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
702	3648	1.7326	9.18E-04	9.18E-05	0.032	9.18E-04	0.053	No
703	3648	3.1024	1.64E-03	1.64E-04	0.032	1.64E-03	0.053	No
704	3648	4.0143	2.13E-03	2.13E-04	0.032	2.13E-03	0.053	No
705	3648	3.9653	2.10E-03	2.10E-04	0.032	2.10E-03	0.053	No
706	3648	4.4301	2.35E-03	2.35E-04	0.032	2.35E-03	0.053	No
707	3648	3.861	2.05E-03	2.05E-04	0.032	2.05E-03	0.053	No
708	3648	2.7183	1.44E-03	1.44E-04	0.032	1.44E-03	0.053	No
709	3648	2.1387	1.13E-03	1.13E-04	0.032	1.13E-03	0.053	No
710	3648	1.9595	1.04E-03	1.04E-04	0.032	1.04E-03	0.053	No
711	3648	2.1438	1.14E-03	1.14E-04	0.032	1.14E-03	0.053	No
712	3648	1.9243	1.02E-03	1.02E-04	0.032	1.02E-03	0.053	No
713	3648	1.6591	8.79E-04	8.79E-05	0.032	8.79E-04	0.053	No
714	3648	1.4923	7.91E-04	7.91E-05	0.032	7.91E-04	0.053	No
715	3648	1.3192	6.99E-04	6.99E-05	0.032	6.99E-04	0.053	No
716	3648	1.1728	6.22E-04	6.22E-05	0.032	6.22E-04	0.053	No
717	3648	1.0474	5.55E-04	5.55E-05	0.032	5.55E-04	0.053	No
718	3648	0.9319	4.94E-04	4.94E-05	0.032	4.94E-04	0.053	No
719	3648	0.8142	4.32E-04	4.32E-05	0.032	4.32E-04	0.053	No
720	3648	0.7134	3.78E-04	3.78E-05	0.032	3.78E-04	0.053	No
721	3648	0.5948	3.15E-04	3.15E-05	0.032	3.15E-04	0.053	No
722	3648	0.5381	2.85E-04	2.85E-05	0.032	2.85E-04	0.053	No
699	3649	0.3928	2.08E-04	2.08E-05	0.032	2.08E-04	0.053	No
700	3649	0.6711	3.56E-04	3.56E-05	0.032	3.56E-04	0.053	No
701	3649	0.9671	5.13E-04	5.13E-05	0.032	5.13E-04	0.053	No
702	3649	1.6508	8.75E-04	8.75E-05	0.032	8.75E-04	0.053	No
703	3649	2.8412	1.51E-03	1.51E-04	0.032	1.51E-03	0.053	No
704	3649	6.1223	3.24E-03	3.24E-04	0.032	3.24E-03	0.053	No
705	3649	6.9162	3.67E-03	3.67E-04	0.032	3.67E-03	0.053	No
706	3649	7.4568	3.95E-03	3.95E-04	0.032	3.95E-03	0.053	No
707	3649	6.0982	3.23E-03	3.23E-04	0.032	3.23E-03	0.053	No
708	3649	3.504	1.86E-03	1.86E-04	0.032	1.86E-03	0.053	No
709	3649	3.2178	1.71E-03	1.71E-04	0.032	1.71E-03	0.053	No
710	3649	3.0875	1.64E-03	1.64E-04	0.032	1.64E-03	0.053	No
711	3649	2.8573	1.51E-03	1.51E-04	0.032	1.51E-03	0.053	No
712	3649	2.3815	1.26E-03	1.26E-04	0.032	1.26E-03	0.053	No
713	3649	1.9408	1.03E-03	1.03E-04	0.032	1.03E-03	0.053	No
714	3649	1.6761	8.88E-04	8.88E-05	0.032	8.88E-04	0.053	No
715	3649	1.4369	7.62E-04	7.62E-05	0.032	7.62E-04	0.053	No
716	3649	1.2144	6.44E-04	6.44E-05	0.032	6.44E-04	0.053	No
717	3649	1.0345	5.48E-04	5.48E-05	0.032	5.48E-04	0.053	No
718	3649	0.9003	4.77E-04	4.77E-05	0.032	4.77E-04	0.053	No
719	3649	0.805	4.27E-04	4.27E-05	0.032	4.27E-04	0.053	No
720	3649	0.6882	3.65E-04	3.65E-05	0.032	3.65E-04	0.053	No
721	3649	0.6616	3.51E-04	3.51E-05	0.032	3.51E-04	0.053	No
722	3649	0.5238	2.78E-04	2.78E-05	0.032	2.78E-04	0.053	No
699	3650	0.5812	3.08E-04	3.08E-05	0.032	3.08E-04	0.053	No
700	3650	0.7516	3.98E-04	3.98E-05	0.032	3.98E-04	0.053	No
701	3650	1.0249	5.43E-04	5.43E-05	0.032	5.43E-04	0.053	No
702	3650	1.3119	6.95E-04	6.95E-05	0.032	6.95E-04	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM)		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
703	3650	3.0639	1.62E-03	1.62E-04	0.032	1.62E-03	0.053	No
704	3650	6.6503	3.52E-03	3.52E-04	0.032	3.52E-03	0.053	No
705	3650	16.2556	8.62E-03	8.62E-04	0.032	8.62E-03	0.053	No
706	3650	17.448	9.25E-03	9.25E-04	0.032	9.25E-03	0.053	No
707	3650	11.6104	6.15E-03	6.15E-04	0.032	6.15E-03	0.053	No
708	3650	7.6012	4.03E-03	4.03E-04	0.032	4.03E-03	0.053	No
709	3650	5.647	2.99E-03	2.99E-04	0.032	2.99E-03	0.053	No
710	3650	4.2868	2.27E-03	2.27E-04	0.032	2.27E-03	0.053	No
711	3650	3.3152	1.76E-03	1.76E-04	0.032	1.76E-03	0.053	No
712	3650	2.6304	1.39E-03	1.39E-04	0.032	1.39E-03	0.053	No
713	3650	2.1097	1.12E-03	1.12E-04	0.032	1.12E-03	0.053	No
714	3650	1.6424	8.70E-04	8.70E-05	0.032	8.70E-04	0.053	No
715	3650	1.3449	7.13E-04	7.13E-05	0.032	7.13E-04	0.053	No
716	3650	1.2013	6.37E-04	6.37E-05	0.032	6.37E-04	0.053	No
717	3650	1.1184	5.93E-04	5.93E-05	0.032	5.93E-04	0.053	No
718	3650	0.9993	5.30E-04	5.30E-05	0.032	5.30E-04	0.053	No
719	3650	0.8291	4.39E-04	4.39E-05	0.032	4.39E-04	0.053	No
720	3650	0.5463	2.90E-04	2.90E-05	0.032	2.90E-04	0.053	No
721	3650	0.4715	2.50E-04	2.50E-05	0.032	2.50E-04	0.053	No
722	3650	0.4394	2.33E-04	2.33E-05	0.032	2.33E-04	0.053	No
699	3651	0.7636	4.05E-04	4.05E-05	0.032	4.05E-04	0.053	No
700	3651	1.1338	6.01E-04	6.01E-05	0.032	6.01E-04	0.053	No
701	3651	1.4755	7.82E-04	7.82E-05	0.032	7.82E-04	0.053	No
702	3651	1.9484	1.03E-03	1.03E-04	0.032	1.03E-03	0.053	No
703	3651	2.7162	1.44E-03	1.44E-04	0.032	1.44E-03	0.053	No
704	3651	5.3103	2.81E-03	2.81E-04	0.032	2.81E-03	0.053	No
705	3651	18.8543	9.99E-03	9.99E-04	0.032	9.99E-03	0.053	No
706	3651	62.3245	3.30E-02	3.30E-03	0.032	3.53E-02	0.053	No
707	3651	36.2591	1.92E-02	1.92E-03	0.032	1.92E-02	0.053	No
708	3651	12.6405	6.70E-03	6.70E-04	0.032	8.70E-03	0.053	No
709	3651	7.3754	3.91E-03	3.91E-04	0.032	3.91E-03	0.053	No
710	3651	4.9531	2.63E-03	2.63E-04	0.032	2.63E-03	0.053	No
711	3651	3.4459	1.83E-03	1.83E-04	0.032	1.83E-03	0.053	No
712	3651	2.2521	1.19E-03	1.19E-04	0.032	1.19E-03	0.053	No
713	3651	2.2562	1.20E-03	1.20E-04	0.032	1.20E-03	0.053	No
714	3651	1.6809	8.91E-04	8.91E-05	0.032	8.91E-04	0.053	No
715	3651	1.2364	6.55E-04	6.55E-05	0.032	6.55E-04	0.053	No
716	3651	1.0611	5.62E-04	5.62E-05	0.032	5.62E-04	0.053	No
717	3651	1.0966	5.81E-04	5.81E-05	0.032	5.81E-04	0.053	No
718	3651	1.0069	5.34E-04	5.34E-05	0.032	5.34E-04	0.053	No
719	3651	0.928	4.92E-04	4.92E-05	0.032	4.92E-04	0.053	No
720	3651	0.5049	2.68E-04	2.68E-05	0.032	2.68E-04	0.053	No
721	3651	0.2838	1.50E-04	1.50E-05	0.032	1.50E-04	0.053	No
722	3651	0.326	1.73E-04	1.73E-05	0.032	1.73E-04	0.053	No
699	3652	0.7347	3.89E-04	3.89E-05	0.032	3.89E-04	0.053	No
700	3652	0.9424	4.99E-04	4.99E-05	0.032	4.99E-04	0.053	No
701	3652	1.4023	7.43E-04	7.43E-05	0.032	7.43E-04	0.053	No
702	3652	1.6436	8.71E-04	8.71E-05	0.032	8.71E-04	0.053	No
703	3652	2.6627	1.41E-03	1.41E-04	0.032	1.41E-03	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM)		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
704	3652	4.745	2.51E-03	2.51E-04	0.032	2.51E-03	0.053	No
705	3652	13.2913	7.04E-03	7.04E-04	0.032	7.04E-03	0.053	No
706	3652	30.7876	1.63E-02	1.63E-03	0.032	1.63E-02	0.053	No
707	3652	26.1798	1.39E-02	1.39E-03	0.032	1.39E-02	0.053	No
708	3652	11.7128	6.21E-03	8.21E-04	0.032	6.21E-03	0.053	No
709	3652	6.8409	3.63E-03	3.63E-04	0.032	3.63E-03	0.053	No
710	3652	4.8236	2.56E-03	2.56E-04	0.032	2.56E-03	0.053	No
711	3652	3.5236	1.87E-03	1.87E-04	0.032	1.87E-03	0.053	No
712	3652	2.5374	1.34E-03	1.34E-04	0.032	1.34E-03	0.053	No
713	3652	1.9648	1.04E-03	1.04E-04	0.032	1.04E-03	0.053	No
714	3652	1.1347	8.01E-04	6.01E-05	0.032	8.01E-04	0.053	No
715	3652	1.2345	6.54E-04	6.54E-05	0.032	6.54E-04	0.053	No
716	3652	1.2852	6.81E-04	6.81E-05	0.032	6.81E-04	0.053	No
717	3652	1.2593	6.67E-04	6.67E-05	0.032	6.67E-04	0.053	No
718	3652	0.9236	4.90E-04	4.90E-05	0.032	4.90E-04	0.053	No
719	3652	1.0042	5.32E-04	5.32E-05	0.032	5.32E-04	0.053	No
720	3652	0.4235	2.24E-04	2.24E-05	0.032	2.24E-04	0.053	No
721	3652	0.287	1.52E-04	1.52E-05	0.032	1.52E-04	0.053	No
722	3652	0.309	1.64E-04	1.64E-05	0.032	1.64E-04	0.053	No
699	3653	0.4619	2.45E-04	2.45E-05	0.032	2.45E-04	0.053	No
700	3653	0.5717	3.03E-04	3.03E-05	0.032	3.03E-04	0.053	No
701	3653	0.791	4.19E-04	4.19E-05	0.032	4.19E-04	0.053	No
702	3653	1.1014	5.84E-04	5.84E-05	0.032	5.84E-04	0.053	No
703	3653	2.4052	1.27E-03	1.27E-04	0.032	1.27E-03	0.053	No
704	3653	5.9099	3.13E-03	3.13E-04	0.032	3.13E-03	0.053	No
705	3653	19.7977	1.05E-02	1.05E-03	0.032	1.05E-02	0.053	No
706	3653	32.4178	1.72E-02	1.72E-03	0.032	1.72E-02	0.053	No
707	3653	14.186	7.52E-03	7.52E-04	0.032	7.52E-03	0.053	No
708	3653	7.6217	4.04E-03	4.04E-04	0.032	4.04E-03	0.053	No
709	3653	4.8648	2.58E-03	2.58E-04	0.032	2.58E-03	0.053	No
710	3653	3.5583	1.89E-03	1.89E-04	0.032	1.89E-03	0.053	No
711	3653	2.743	1.45E-03	1.45E-04	0.032	1.45E-03	0.053	No
712	3653	2.1306	1.13E-03	1.13E-04	0.032	1.13E-03	0.053	No
713	3653	0.9598	5.09E-04	5.09E-05	0.032	5.09E-04	0.053	No
714	3653	1.1422	6.05E-04	6.05E-05	0.032	8.05E-04	0.053	No
715	3653	0.7806	4.14E-04	4.14E-05	0.032	4.14E-04	0.053	No
716	3653	0.4956	2.63E-04	2.63E-05	0.032	2.63E-04	0.053	No
717	3653	0.5843	3.10E-04	3.10E-05	0.032	3.10E-04	0.053	No
718	3653	0.6503	3.45E-04	3.45E-05	0.032	3.45E-04	0.053	No
719	3653	0.3554	1.88E-04	1.88E-05	0.032	1.88E-04	0.053	No
720	3653	0.2796	1.48E-04	1.48E-05	0.032	1.48E-04	0.053	No
721	3653	0.2343	1.24E-04	1.24E-05	0.032	1.24E-04	0.053	No
722	3653	0.1681	8.91E-05	8.91E-06	0.032	8.91E-05	0.053	No
699	3654	0.4826	2.56E-04	2.56E-05	0.032	2.56E-04	0.053	No
700	3654	0.6069	3.22E-04	3.22E-05	0.032	3.22E-04	0.053	No
701	3654	1.0844	5.75E-04	5.75E-05	0.032	5.75E-04	0.053	No
702	3654	1.6374	8.68E-04	8.68E-05	0.032	8.68E-04	0.053	No
703	3654	3.2255	1.71E-03	1.71E-04	0.032	1.71E-03	0.053	No
704	3654	7.4602	3.95E-03	3.95E-04	0.032	3.95E-03	0.053	No

Imperial Project
Imperial County, California

Calculatad Annual Averaga NO_2 Concentrations

Location Kilomaters (UTM) Easting	Northing	Modellad NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Availabla O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
705	3654	18.3392	9.72E-03	9.72E-04	0.032	9.72E-03	0.053	No
706	3654	16.1153	8.54E-03	8.54E-04	0.032	8.54E-03	0.053	No
707	3654	9.6089	5.09E-03	5.09E-04	0.032	5.09E-03	0.053	No
708	3654	5.6305	2.98E-03	2.98E-04	0.032	2.98E-03	0.053	No
709	3654	3.7714	2.00E-03	2.00E-04	0.032	2.00E-03	0.053	No
710	3654	2.8525	1.51E-03	1.51E-04	0.032	1.51E-03	0.053	No
711	3654	2.4594	1.30E-03	1.30E-04	0.032	1.30E-03	0.053	No
712	3654	1.8725	9.92E-04	9.92E-05	0.032	9.92E-04	0.053	No
713	3654	1.5697	8.32E-04	8.32E-05	0.032	8.32E-04	0.053	No
714	3654	0.7405	3.92E-04	3.92E-05	0.032	3.92E-04	0.053	No
715	3654	0.3522	1.87E-04	1.87E-05	0.032	1.87E-04	0.053	No
716	3654	0.5914	3.13E-04	3.13E-05	0.032	3.13E-04	0.053	No
717	3654	0.2743	1.45E-04	1.45E-05	0.032	1.45E-04	0.053	No
718	3654	0.2561	1.36E-04	1.36E-05	0.032	1.36E-04	0.053	No
719	3654	0.2201	1.17E-04	1.17E-05	0.032	1.17E-04	0.053	No
720	3654	0.2121	1.12E-04	1.12E-05	0.032	1.12E-04	0.053	No
721	3654	0.335	1.78E-04	1.78E-05	0.032	1.78E-04	0.053	No
722	3654	0.1104	5.85E-05	5.85E-06	0.032	5.85E-05	0.053	No
699	3655	0.6868	3.64E-04	3.64E-05	0.032	3.64E-04	0.053	No
700	3655	0.9138	4.84E-04	4.84E-05	0.032	4.84E-04	0.053	No
701	3655	1.311	6.95E-04	6.95E-05	0.032	6.95E-04	0.053	No
702	3655	2.191	1.16E-03	1.16E-04	0.032	1.16E-03	0.053	No
703	3655	4.526	2.40E-03	2.40E-04	0.032	2.40E-03	0.053	No
704	3655	9.8273	5.21E-03	5.21E-04	0.032	5.21E-03	0.053	No
705	3655	11.3814	6.03E-03	6.03E-04	0.032	6.03E-03	0.053	No
706	3655	9.9713	5.28E-03	5.28E-04	0.032	5.28E-03	0.053	No
707	3655	7.5067	3.98E-03	3.98E-04	0.032	3.98E-03	0.053	No
708	3655	4.5882	2.43E-03	2.43E-04	0.032	2.43E-03	0.053	No
709	3655	3.1009	1.64E-03	1.64E-04	0.032	1.64E-03	0.053	No
710	3655	2.3526	1.25E-03	1.25E-04	0.032	1.25E-03	0.053	No
711	3655	2.0473	1.09E-03	1.09E-04	0.032	1.09E-03	0.053	No
712	3655	1.7295	9.17E-04	9.17E-05	0.032	9.17E-04	0.053	No
713	3655	1.3611	7.21E-04	7.21E-05	0.032	7.21E-04	0.053	No
714	3655	0.813	4.31E-04	4.31E-05	0.032	4.31E-04	0.053	No
715	3655	0.3551	1.88E-04	1.88E-05	0.032	1.88E-04	0.053	No
716	3655	0.352	1.87E-04	1.87E-05	0.032	1.87E-04	0.053	No
717	3655	0.2534	1.34E-04	1.34E-05	0.032	1.34E-04	0.053	No
718	3655	0.2636	1.40E-04	1.40E-05	0.032	1.40E-04	0.053	No
719	3655	0.1369	7.26E-05	7.26E-06	0.032	7.26E-05	0.053	No
720	3655	0.1356	7.19E-05	7.19E-06	0.032	7.19E-05	0.053	No
721	3655	0.1189	6.30E-05	6.30E-06	0.032	8.30E-05	0.053	No
722	3655	0.0992	5.26E-05	5.26E-06	0.032	5.26E-05	0.053	No
699	3656	0.7393	3.92E-04	3.92E-05	0.032	3.92E-04	0.053	No
700	3656	1.1638	8.17E-04	6.17E-05	0.032	6.17E-04	0.053	No
701	3656	1.5459	8.19E-04	8.19E-05	0.032	8.19E-04	0.053	No
702	3656	2.9549	1.57E-03	1.57E-04	0.032	1.57E-03	0.053	No
703	3656	5.3682	2.85E-03	2.85E-04	0.032	2.85E-03	0.053	No
704	3656	8.0208	4.25E-03	4.25E-04	0.032	4.25E-03	0.053	No
705	3656	7.7212	4.09E-03	4.09E-04	0.032	4.09E-03	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Averaga NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modalled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Availabla O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
706	3656	7.0463	3.73E-03	3.73E-04	0.032	3.73E-03	0.053	No
707	3656	5.3337	2.83E-03	2.83E-04	0.032	2.83E-03	0.053	No
708	3656	3.7824	2.00E-03	2.00E-04	0.032	2.00E-03	0.053	No
709	3656	2.5626	1.36E-03	1.36E-04	0.032	1.36E-03	0.053	No
710	3656	1.757	9.31E-04	9.31E-05	0.032	9.31E-04	0.053	No
711	3656	1.2448	6.60E-04	6.60E-05	0.032	6.60E-04	0.053	No
712	3656	0.9257	4.91E-04	4.91E-05	0.032	4.91E-04	0.053	No
713	3656	0.9399	4.98E-04	4.98E-05	0.032	4.98E-04	0.053	No
714	3656	0.4332	2.30E-04	2.30E-05	0.032	2.30E-04	0.053	No
715	3656	0.4669	2.47E-04	2.47E-05	0.032	2.47E-04	0.053	No
716	3656	0.1336	7.08E-05	7.08E-06	0.032	7.08E-05	0.053	No
717	3656	0.321	1.70E-04	1.70E-05	0.032	1.70E-04	0.053	No
718	3656	0.1432	7.59E-05	7.59E-06	0.032	7.59E-05	0.053	No
719	3656	0.1335	7.08E-05	7.08E-06	0.032	7.08E-05	0.053	No
720	3656	0.1151	6.10E-05	6.10E-06	0.032	6.10E-05	0.053	No
721	3656	0.0826	4.38E-05	4.38E-06	0.032	4.38E-05	0.053	No
722	3656	0.1055	5.59E-05	5.59E-06	0.032	5.59E-05	0.053	No
699	3657	0.9722	5.15E-04	5.15E-05	0.032	5.15E-04	0.053	No
700	3657	1.222	6.48E-04	6.48E-05	0.032	6.48E-04	0.053	No
701	3657	2.0989	1.11E-03	1.11E-04	0.032	1.11E-03	0.053	No
702	3657	3.1437	1.67E-03	1.67E-04	0.032	1.67E-03	0.053	No
703	3657	5.7393	3.04E-03	3.04E-04	0.032	3.04E-03	0.053	No
704	3657	6.2564	3.32E-03	3.32E-04	0.032	3.32E-03	0.053	No
705	3657	5.7682	3.06E-03	3.06E-04	0.032	3.06E-03	0.053	No
706	3657	5.3745	2.85E-03	2.85E-04	0.032	2.85E-03	0.053	No
707	3657	4.0228	2.13E-03	2.13E-04	0.032	2.13E-03	0.053	No
708	3657	3.4087	1.81E-03	1.81E-04	0.032	1.81E-03	0.053	No
709	3657	2.3557	1.25E-03	1.25E-04	0.032	1.25E-03	0.053	No
710	3657	1.7682	9.37E-04	9.37E-05	0.032	9.37E-04	0.053	No
711	3657	1.4348	7.60E-04	7.60E-05	0.032	7.60E-04	0.053	No
712	3657	1.1646	6.17E-04	6.17E-05	0.032	6.17E-04	0.053	No
713	3657	0.2848	1.51E-04	1.51E-05	0.032	1.51E-04	0.053	No
714	3657	0.3171	1.68E-04	1.68E-05	0.032	1.68E-04	0.053	No
715	3657	0.1394	7.39E-05	7.39E-06	0.032	7.39E-05	0.053	No
716	3657	0.2395	1.27E-04	1.27E-05	0.032	1.27E-04	0.053	No
717	3657	0.1672	8.86E-05	8.86E-06	0.032	8.86E-05	0.053	No
718	3657	0.0954	5.06E-05	5.06E-06	0.032	5.06E-05	0.053	No
719	3657	0.0935	4.96E-05	4.96E-06	0.032	4.96E-05	0.053	No
720	3657	0.0828	4.39E-05	4.39E-06	0.032	4.39E-05	0.053	No
721	3657	0.0743	3.94E-05	3.94E-06	0.032	3.94E-05	0.053	No
722	3657	0.0717	3.80E-05	3.80E-06	0.032	3.80E-05	0.053	No
699	3658	0.9573	5.07E-04	5.07E-05	0.032	5.07E-04	0.053	No
700	3658	1.635	8.67E-04	8.67E-05	0.032	8.67E-04	0.053	No
701	3658	2.1163	1.12E-03	1.12E-04	0.032	1.12E-03	0.053	No
702	3658	3.9356	2.09E-03	2.09E-04	0.032	2.09E-03	0.053	No
703	3658	4.8215	2.56E-03	2.56E-04	0.032	2.56E-03	0.053	No
704	3658	4.7156	2.50E-03	2.50E-04	0.032	2.50E-03	0.053	No
705	3658	4.4703	2.37E-03	2.37E-04	0.032	2.37E-03	0.053	No
706	3658	4.3369	2.30E-03	2.30E-04	0.032	2.30E-03	0.053	No

Imperial Project
Imparial County, California

Calculated Annuel Average NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
707	3658	3.385	1.79E-03	1.79E-04	0.032	1.79E-03	0.053	No
708	3658	3.0102	1.60E-03	1.60E-04	0.032	1.60E-03	0.053	No
709	3658	2.1069	1.12E-03	1.12E-04	0.032	1.12E-03	0.053	No
710	3658	1.7065	9.04E-04	9.04E-05	0.032	9.04E-04	0.053	No
711	3658	1.2771	6.77E-04	6.77E-05	0.032	6.77E-04	0.053	No
712	3658	0.7567	4.01E-04	4.01E-05	0.032	4.01E-04	0.053	No
713	3658	0.5935	3.15E-04	3.15E-05	0.032	3.15E-04	0.053	No
714	3658	0.1443	7.65E-05	7.65E-06	0.032	7.65E-05	0.053	No
715	3658	0.09	4.77E-05	4.77E-06	0.032	4.77E-05	0.053	No
716	3658	0.1242	6.58E-05	6.58E-06	0.032	6.58E-05	0.053	No
717	3658	0.0856	4.54E-05	4.54E-06	0.032	4.54E-05	0.053	No
718	3658	0.0674	3.57E-05	3.57E-06	0.032	3.57E-05	0.053	No
719	3658	0.0666	3.53E-05	3.53E-06	0.032	3.53E-05	0.053	No
720	3658	0.07	3.71E-05	3.71E-06	0.032	3.71E-05	0.053	No
721	3658	0.0666	3.53E-05	3.53E-06	0.032	3.53E-05	0.053	No
722	3658	0.1199	6.35E-05	6.35E-06	0.032	6.35E-05	0.053	No
699	3659	1.3224	7.01E-04	7.01E-05	0.032	7.01E-04	0.053	No
700	3659	1.5865	8.41E-04	8.41E-05	0.032	8.41E-04	0.053	No
701	3659	2.7528	1.46E-03	1.46E-04	0.032	1.46E-03	0.053	No
702	3659	3.8954	2.06E-03	2.06E-04	0.032	2.06E-03	0.053	No
703	3659	4.0525	2.15E-03	2.15E-04	0.032	2.15E-03	0.053	No
704	3659	3.7784	2.00E-03	2.00E-04	0.032	2.00E-03	0.053	No
705	3659	3.5457	1.88E-03	1.88E-04	0.032	1.88E-03	0.053	No
706	3659	3.6183	1.92E-03	1.92E-04	0.032	1.92E-03	0.053	No
707	3659	2.9067	1.54E-03	1.54E-04	0.032	1.54E-03	0.053	No
708	3659	2.5149	1.33E-03	1.33E-04	0.032	1.33E-03	0.053	No
709	3659	2.0242	1.07E-03	1.07E-04	0.032	1.07E-03	0.053	No
710	3659	1.3128	6.96E-04	6.96E-05	0.032	6.96E-04	0.053	No
711	3659	1.2966	6.87E-04	6.87E-05	0.032	6.87E-04	0.053	No
712	3659	0.384	2.04E-04	2.04E-05	0.032	2.04E-04	0.053	No
713	3659	0.2208	1.17E-04	1.17E-05	0.032	1.17E-04	0.053	No
714	3659	0.1356	7.19E-05	7.19E-06	0.032	7.19E-05	0.053	No
715	3659	0.1062	5.63E-05	5.63E-06	0.032	5.63E-05	0.053	No
716	3659	0.0717	3.80E-05	3.80E-06	0.032	3.80E-05	0.053	No
717	3659	0.0564	2.99E-05	2.99E-06	0.032	2.99E-05	0.053	No
718	3659	0.0644	3.41E-05	3.41E-06	0.032	3.41E-05	0.053	No
719	3659	0.0685	3.63E-05	3.63E-06	0.032	3.63E-05	0.053	No
720	3659	0.0586	3.11E-05	3.11E-06	0.032	3.11E-05	0.053	No
721	3659	0.0614	3.25E-05	3.25E-06	0.032	3.25E-05	0.053	No
722	3659	0.1008	5.34E-05	5.34E-06	0.032	5.34E-05	0.053	No
699	3660	1.2784	6.78E-04	6.78E-05	0.032	6.78E-04	0.053	No
700	3660	1.9047	1.01E-03	1.01E-04	0.032	1.01E-03	0.053	No
701	3660	2.928	1.55E-03	1.55E-04	0.032	1.55E-03	0.053	No
702	3660	3.3064	1.75E-03	1.75E-04	0.032	1.75E-03	0.053	No
703	3660	3.4018	1.80E-03	1.80E-04	0.032	1.80E-03	0.053	No
704	3660	3.2204	1.71E-03	1.71E-04	0.032	1.71E-03	0.053	No
705	3660	2.8748	1.52E-03	1.52E-04	0.032	1.52E-03	0.053	No
706	3660	3.0886	1.64E-03	1.64E-04	0.032	1.64E-03	0.053	No
707	3660	2.4884	1.32E-03	1.32E-04	0.032	1.32E-03	0.053	No

Imperial Project
Imparial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
708	3660	2.0023	1.06E-03	1.06E-04	0.032	1.06E-03	0.053	No
709	3660	1.4747	7.82E-04	7.82E-05	0.032	7.82E-04	0.053	No
710	3660	0.6749	3.58E-04	3.58E-05	0.032	3.58E-04	0.053	No
711	3660	0.6657	3.53E-04	3.53E-05	0.032	3.53E-04	0.053	No
712	3660	0.2903	1.54E-04	1.54E-05	0.032	1.54E-04	0.053	No
713	3660	0.1682	8.91E-05	8.91E-06	0.032	8.91E-05	0.053	No
714	3660	0.1249	6.62E-05	6.62E-06	0.032	6.62E-05	0.053	No
715	3660	0.0848	4.49E-05	4.49E-06	0.032	4.49E-05	0.053	No
716	3660	0.0598	3.17E-05	3.17E-06	0.032	3.17E-05	0.053	No
717	3660	0.051	2.70E-05	2.70E-06	0.032	2.70E-05	0.053	No
718	3660	0.0516	2.73E-05	2.73E-06	0.032	2.73E-05	0.053	No
719	3660	0.0553	2.93E-05	2.93E-06	0.032	2.93E-05	0.053	No
720	3660	0.058	3.07E-05	3.07E-06	0.032	3.07E-05	0.053	No
721	3660	0.0682	3.61E-05	3.61E-06	0.032	3.61E-05	0.053	No
722	3660	0.0815	4.32E-05	4.32E-06	0.032	4.32E-05	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
MODELED FENCELINE DISCRETE RECEPTORS								
705.547	3649.915	15.1561	8.03E-03	8.03E-04	0.032	8.03E-03	0.053	No
705.504	3649.939	15.4627	8.20E-03	8.20E-04	0.032	8.20E-03	0.053	No
705.467	3649.96	16.2397	8.61E-03	8.61E-04	0.032	8.61E-03	0.053	No
705.429	3649.979	17.3544	9.20E-03	9.20E-04	0.032	9.20E-03	0.053	No
705.392	3650	18.5567	9.84E-03	9.84E-04	0.032	9.84E-03	0.053	No
705.352	3650.021	19.8066	1.05E-02	1.05E-03	0.032	1.05E-02	0.053	No
705.318	3650.04	20.1421	1.07E-02	1.07E-03	0.032	1.07E-02	0.053	No
705.285	3650.057	20.039	1.06E-02	1.06E-03	0.032	1.06E-02	0.053	No
705.246	3650.08	19.9494	1.06E-02	1.06E-03	0.032	1.06E-02	0.053	No
705.208	3650.099	16.7554	8.88E-03	8.88E-04	0.032	8.88E-03	0.053	No
705.17	3650.12	16.0885	8.53E-03	8.53E-04	0.032	8.53E-03	0.053	No
705.135	3650.139	17.0439	9.03E-03	9.03E-04	0.032	9.03E-03	0.053	No
705.099	3650.16	18.502	9.81E-03	9.81E-04	0.032	9.81E-03	0.053	No
705.072	3650.174	19.4316	1.03E-02	1.03E-03	0.032	1.03E-02	0.053	No
705.052	3650.186	20.0956	1.07E-02	1.07E-03	0.032	1.07E-02	0.053	No
705.067	3650.214	19.49	1.03E-02	1.03E-03	0.032	1.03E-02	0.053	No
705.083	3650.238	20.2672	1.07E-02	1.07E-03	0.032	1.07E-02	0.053	No
705.048	3650.25	21.9432	1.16E-02	1.16E-03	0.032	1.16E-02	0.053	No
705.01	3650.257	24.713	1.31E-02	1.31E-03	0.032	1.31E-02	0.053	No
704.956	3650.264	19.9171	1.06E-02	1.06E-03	0.032	1.06E-02	0.053	No
704.904	3650.268	17.1125	9.07E-03	9.07E-04	0.032	9.07E-03	0.053	No
704.911	3650.283	16.9396	8.98E-03	8.98E-04	0.032	8.98E-03	0.053	No
704.961	3650.285	21.6463	1.15E-02	1.15E-03	0.032	1.15E-02	0.053	No
705.015	3650.285	25.5338	1.35E-02	1.35E-03	0.032	1.35E-02	0.053	No
705.034	3650.329	21.5163	1.14E-02	1.14E-03	0.032	1.14E-02	0.053	No
705.052	3650.37	21.2873	1.13E-02	1.13E-03	0.032	1.13E-02	0.053	No
705.072	3650.419	20.5432	1.09E-02	1.09E-03	0.032	1.09E-02	0.053	No
705.092	3650.462	20.5528	1.09E-02	1.09E-03	0.032	1.09E-02	0.053	No
705.107	3650.499	20.6747	1.10E-02	1.10E-03	0.032	1.10E-02	0.053	No
705.126	3650.542	20.8601	1.11E-02	1.11E-03	0.032	1.11E-02	0.053	No
705.147	3650.591	21.4757	1.14E-02	1.14E-03	0.032	1.14E-02	0.053	No
705.168	3650.638	22.0125	1.17E-02	1.17E-03	0.032	1.17E-02	0.053	No
705.192	3650.67	22.1306	1.17E-02	1.17E-03	0.032	1.17E-02	0.053	No
705.237	3650.726	23.3518	1.24E-02	1.24E-03	0.032	1.24E-02	0.053	No
705.212	3650.697	22.5891	1.20E-02	1.20E-03	0.032	1.20E-02	0.053	No
705.259	3650.755	23.974	1.27E-02	1.27E-03	0.032	1.27E-02	0.053	No
705.283	3650.787	24.8681	1.32E-02	1.32E-03	0.032	1.32E-02	0.053	No
705.318	3650.831	25.2367	1.34E-02	1.34E-03	0.032	1.34E-02	0.053	No
705.352	3650.878	26.7368	1.42E-02	1.42E-03	0.032	1.42E-02	0.053	No
705.384	3650.918	28.2422	1.50E-02	1.50E-03	0.032	1.50E-02	0.053	No
705.41	3650.949	29.2543	1.55E-02	1.55E-03	0.032	1.55E-02	0.053	No
705.41	3650.989	29.8254	1.58E-02	1.58E-03	0.032	1.58E-02	0.053	No
705.412	3651.04	30.8965	1.64E-02	1.64E-03	0.032	1.64E-02	0.053	No
705.408	3651.093	33.1124	1.75E-02	1.75E-03	0.032	1.75E-02	0.053	No
705.398	3651.147	33.0076	1.75E-02	1.75E-03	0.032	1.75E-02	0.053	No
705.373	3651.206	33.5741	1.78E-02	1.78E-03	0.032	1.78E-02	0.053	No
705.368	3651.262	33.21	1.76E-02	1.76E-03	0.032	1.76E-02	0.053	No
705.373	3651.314	33.1916	1.76E-02	1.76E-03	0.032	1.76E-02	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location		Modelled NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Kilometers (UTM)								
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
705.384	3651.372	32.2423	1.71E-02	1.71E-03	0.032	1.71E-02	0.053	No
705.398	3651.425	32.4125	1.72E-02	1.72E-03	0.032	1.72E-02	0.053	No
705.408	3651.476	32.1221	1.70E-02	1.70E-03	0.032	1.70E-02	0.053	No
705.42	3651.528	30.6379	1.62E-02	1.62E-03	0.032	1.62E-02	0.053	No
705.436	3651.592	30.6576	1.62E-02	1.62E-03	0.032	1.62E-02	0.053	No
705.45	3651.646	31.2507	1.66E-02	1.66E-03	0.032	1.66E-02	0.053	No
705.466	3651.707	32.7041	1.73E-02	1.73E-03	0.032	1.73E-02	0.053	No
705.478	3651.765	32.9757	1.75E-02	1.75E-03	0.032	1.75E-02	0.053	No
705.483	3651.834	32.3694	1.72E-02	1.72E-03	0.032	1.72E-02	0.053	No
705.495	3651.884	34.1774	1.81E-02	1.81E-03	0.032	1.81E-02	0.053	No
705.514	3651.942	36.3205	1.92E-02	1.92E-03	0.032	1.92E-02	0.053	No
705.549	3651.985	40.9072	2.17E-02	2.17E-03	0.032	2.17E-02	0.053	No
705.585	3652.032	48.4322	2.57E-02	2.57E-03	0.032	2.57E-02	0.053	No
705.615	3652.07	55.2587	2.93E-02	2.93E-03	0.032	2.93E-02	0.053	No
705.634	3652.116	60.5208	3.21E-02	3.21E-03	0.032	3.52E-02	0.053	No
705.658	3652.17	67.2597	3.56E-02	3.56E-03	0.032	3.56E-02	0.053	No
705.711	3652.208	78.6863	4.17E-02	4.17E-03	0.032	3.62E-02	0.053	No
705.761	3652.213	87.9032	4.66E-02	4.66E-03	0.032	3.67E-02	0.053	No
705.818	3652.213	96.4132	5.11E-02	5.11E-03	0.032	3.71E-02	0.053	No
705.874	3652.234	98.173	5.20E-02	5.20E-03	0.032	3.72E-02	0.053	No
705.916	3652.269	92.855	4.92E-02	4.92E-03	0.032	3.69E-02	0.053	No
705.961	3652.305	85.3039	4.52E-02	4.52E-03	0.032	3.65E-02	0.053	No
705.999	3652.343	76.9286	4.08E-02	4.08E-03	0.032	3.61E-02	0.053	No
706.032	3652.392	68.4588	3.63E-02	3.63E-03	0.032	3.56E-02	0.053	No
706.057	3652.428	63.0443	3.34E-02	3.34E-03	0.032	3.53E-02	0.053	No
706.078	3652.455	59.0774	3.13E-02	3.13E-03	0.032	3.13E-02	0.053	No
706.109	3652.459	56.7976	3.01E-02	3.01E-03	0.032	3.01E-02	0.053	No
706.144	3652.458	54.5248	2.89E-02	2.89E-03	0.032	2.89E-02	0.053	No
706.187	3652.418	54.6857	2.90E-02	2.90E-03	0.032	2.90E-02	0.053	No
706.229	3652.378	54.2964	2.88E-02	2.88E-03	0.032	2.88E-02	0.053	No
706.267	3652.343	53.3005	2.82E-02	2.82E-03	0.032	2.82E-02	0.053	No
706.309	3652.305	52.0347	2.76E-02	2.76E-03	0.032	2.76E-02	0.053	No
706.356	3652.262	50.3424	2.67E-02	2.67E-03	0.032	2.67E-02	0.053	No
706.406	3652.215	48.4498	2.57E-02	2.57E-03	0.032	2.57E-02	0.053	No
706.458	3652.166	48.7086	2.58E-02	2.58E-03	0.032	2.58E-02	0.053	No
706.516	3652.116	46.3502	2.46E-02	2.46E-03	0.032	2.46E-02	0.053	No
706.575	3652.102	42.7288	2.26E-02	2.26E-03	0.032	2.26E-02	0.053	No
706.644	3652.084	39.6203	2.10E-02	2.10E-03	0.032	2.10E-02	0.053	No
706.717	3652.065	36.8749	1.95E-02	1.95E-03	0.032	1.95E-02	0.053	No
706.803	3652.044	32.4267	1.72E-02	1.72E-03	0.032	1.72E-02	0.053	No
706.872	3652.027	29.6981	1.57E-02	1.57E-03	0.032	1.57E-02	0.053	No
706.942	3652.01	27.726	1.47E-02	1.47E-03	0.032	1.47E-02	0.053	No
707.018	3651.99	25.8474	1.37E-02	1.37E-03	0.032	1.37E-02	0.053	No
707.079	3651.975	24.2114	1.28E-02	1.28E-03	0.032	1.28E-02	0.053	No
707.128	3651.962	22.9003	1.21E-02	1.21E-03	0.032	1.21E-02	0.053	No
707.164	3651.954	22.5912	1.20E-02	1.20E-03	0.032	1.20E-02	0.053	No
707.194	3651.978	21.641	1.15E-02	1.15E-03	0.032	1.15E-02	0.053	No
707.215	3652.013	20.5112	1.09E-02	1.09E-03	0.032	1.09E-02	0.053	No
707.277	3652.015	19.585	1.04E-02	1.04E-03	0.032	1.04E-02	0.053	No

Imperial Project
Imperial County, California

Calculatad Annual Avaraga NO_2 Concantrations

Location Kilomatars (UTM)		Modallad NOx Impact		Out of Stk NO_2	Available O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
707.342	3652.018	18.669	9.89E-03	9.89E-04	0.032	9.89E-03	0.053	No
707.404	3652.022	17.6505	9.35E-03	9.35E-04	0.032	9.35E-03	0.053	No
707.435	3652.015	17.2876	9.16E-03	9.16E-04	0.032	9.16E-03	0.053	No
707.456	3651.982	17.4487	9.25E-03	9.25E-04	0.032	9.25E-03	0.053	No
707.47	3651.938	17.6862	9.37E-03	9.37E-04	0.032	9.37E-03	0.053	No
707.509	3651.895	17.2645	9.15E-03	9.15E-04	0.032	9.15E-03	0.053	No
707.559	3651.853	16.8386	8.92E-03	8.92E-04	0.032	8.92E-03	0.053	No
707.639	3651.834	16.0268	8.49E-03	8.49E-04	0.032	8.49E-03	0.053	No
707.71	3651.815	15.4472	8.19E-03	8.19E-04	0.032	8.19E-03	0.053	No
707.79	3651.796	14.5811	7.73E-03	7.73E-04	0.032	7.73E-03	0.053	No
707.867	3651.777	13.4359	7.12E-03	7.12E-04	0.032	7.12E-03	0.053	No
707.933	3651.761	12.5702	6.66E-03	6.66E-04	0.032	6.66E-03	0.053	No
708.001	3651.743	12.26	6.50E-03	6.50E-04	0.032	6.50E-03	0.053	No
708.082	3651.723	11.5382	6.12E-03	6.12E-04	0.032	6.12E-03	0.053	No
708.082	3651.653	11.4304	6.06E-03	6.06E-04	0.032	6.06E-03	0.053	No
708.082	3651.592	11.8592	6.29E-03	6.29E-04	0.032	6.29E-03	0.053	No
708.082	3651.521	11.6452	6.17E-03	6.17E-04	0.032	6.17E-03	0.053	No
708.082	3651.457	11.7428	6.22E-03	8.22E-04	0.032	6.22E-03	0.053	No
708.082	3651.386	11.886	8.30E-03	6.30E-04	0.032	6.30E-03	0.053	No
708.082	3651.337	12.0086	6.36E-03	6.36E-04	0.032	8.36E-03	0.053	No
708.083	3651.288	12.0614	6.39E-03	6.39E-04	0.032	6.39E-03	0.053	No
708.082	3651.239	12.0448	6.38E-03	6.38E-04	0.032	6.38E-03	0.053	No
708.082	3651.175	12.1112	6.42E-03	6.42E-04	0.032	6.42E-03	0.053	No
708.082	3651.093	12.2069	8.47E-03	6.47E-04	0.032	6.47E-03	0.053	No
708.082	3651.019	12.1247	6.43E-03	6.43E-04	0.032	6.43E-03	0.053	No
708.082	3650.954	11.9638	6.34E-03	6.34E-04	0.032	6.34E-03	0.053	No
708.082	3650.873	11.8141	6.26E-03	6.26E-04	0.032	6.26E-03	0.053	No
708.082	3650.798	11.7606	6.23E-03	8.23E-04	0.032	6.23E-03	0.053	No
708.082	3650.732	11.0983	5.88E-03	5.88E-04	0.032	5.88E-03	0.053	No
708.082	3650.666	10.8239	5.74E-03	5.74E-04	0.032	5.74E-03	0.053	No
708.082	3650.615	10.4559	5.54E-03	5.54E-04	0.032	5.54E-03	0.053	No
708.082	3650.568	10.1062	5.36E-03	5.36E-04	0.032	5.36E-03	0.053	No
708.035	3650.542	10.1113	5.36E-03	5.36E-04	0.032	5.36E-03	0.053	No
707.975	3650.508	10.2157	5.41E-03	5.41E-04	0.032	5.41E-03	0.053	No
707.914	3650.473	10.5837	5.61E-03	5.61E-04	0.032	5.61E-03	0.053	No
707.851	3650.438	10.5845	5.61E-03	5.61E-04	0.032	5.61E-03	0.053	No
707.781	3650.398	10.536	5.58E-03	5.58E-04	0.032	5.58E-03	0.053	No
707.717	3650.36	10.5573	5.60E-03	5.60E-04	0.032	5.60E-03	0.053	No
707.641	3650.316	10.7369	5.69E-03	5.69E-04	0.032	5.69E-03	0.053	No
707.573	3650.278	10.6766	5.66E-03	5.66E-04	0.032	5.66E-03	0.053	No
707.612	3650.243	10.6303	5.63E-03	5.63E-04	0.032	5.63E-03	0.053	No
707.444	3650.203	10.169	5.39E-03	5.39E-04	0.032	5.39E-03	0.053	No
707.385	3650.17	10.2375	5.43E-03	5.43E-04	0.032	5.43E-03	0.053	No
707.322	3650.136	10.5767	5.81E-03	5.61E-04	0.032	5.61E-03	0.053	No
707.295	3650.078	10.3529	5.49E-03	5.49E-04	0.032	5.49E-03	0.053	No
707.265	3650.016	9.963	5.28E-03	5.28E-04	0.032	5.28E-03	0.053	No
707.227	3649.939	9.726	5.15E-03	5.15E-04	0.032	5.15E-03	0.053	No
707.197	3649.878	8.8362	4.68E-03	4.68E-04	0.032	4.68E-03	0.053	No
707.162	3649.809	8.1342	4.31E-03	4.31E-04	0.032	4.31E-03	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM)		Modellad NOx Impact		Out of Stk NO_2	Availabla O_3	Total NO_2	Calif. NO_2 Std.	Std. Violation
Easting	Northing	ug/m**3	ppm	ppm	ppm	ppm	ppm	Yes/No?
707.138	3649.755	7.5282	3.99E-03	3.99E-04	0.032	3.99E-03	0.053	No
707.109	3649.698	7.4934	3.97E-03	3.97E-04	0.032	3.97E-03	0.053	No
707.062	3649.663	7.7422	4.10E-03	4.10E-04	0.032	4.10E-03	0.053	No
707.006	3649.625	7.9706	4.22E-03	4.22E-04	0.032	4.22E-03	0.053	No
706.947	3649.581	7.692	4.08E-03	4.08E-04	0.032	4.08E-03	0.053	No
706.848	3649.581	8.7136	4.62E-03	4.62E-04	0.032	4.62E-03	0.053	No
706.768	3649.581	10.0161	5.31E-03	5.31E-04	0.032	5.31E-03	0.053	No
706.754	3649.52	9.3784	4.97E-03	4.97E-04	0.032	4.97E-03	0.053	No
706.74	3649.454	8.488	4.50E-03	4.50E-04	0.032	4.50E-03	0.053	No
706.73	3649.404	8.6908	4.61E-03	4.61E-04	0.032	4.81E-03	0.053	No
706.683	3649.374	8.7075	4.61E-03	4.61E-04	0.032	4.61E-03	0.053	No
706.627	3649.338	8.6314	4.57E-03	4.57E-04	0.032	4.57E-03	0.053	No
706.578	3649.306	8.4338	4.47E-03	4.47E-04	0.032	4.47E-03	0.053	No
706.512	3649.265	8.2406	4.37E-03	4.37E-04	0.032	4.37E-03	0.053	No
706.431	3649.265	8.4261	4.47E-03	4.47E-04	0.032	4.47E-03	0.053	No
706.36	3649.265	8.5988	4.56E-03	4.56E-04	0.032	4.56E-03	0.053	No
706.279	3649.265	8.8079	4.67E-03	4.67E-04	0.032	4.67E-03	0.053	No
706.22	3649.265	8.7213	4.62E-03	4.62E-04	0.032	4.62E-03	0.053	No
706.156	3649.301	9.1613	4.86E-03	4.86E-04	0.032	4.86E-03	0.053	No
706.091	3649.336	9.409	4.99E-03	4.99E-04	0.032	4.99E-03	0.053	No
706.029	3649.371	9.4623	5.02E-03	5.02E-04	0.032	5.02E-03	0.053	No
705.978	3649.399	9.8776	5.24E-03	5.24E-04	0.032	5.24E-03	0.053	No
705.924	3649.428	10.2526	5.43E-03	5.43E-04	0.032	5.43E-03	0.053	No
705.86	3649.463	10.588	5.61E-03	5.61E-04	0.032	5.61E-03	0.053	No
705.798	3649.498	10.8397	5.75E-03	5.75E-04	0.032	5.75E-03	0.053	No
705.74	3649.529	11.2598	5.97E-03	5.97E-04	0.032	5.97E-03	0.053	No
705.693	3649.555	11.4112	6.05E-03	6.05E-04	0.032	6.05E-03	0.053	No
705.634	3649.588	11.2404	5.96E-03	5.96E-04	0.032	5.96E-03	0.053	No
705.58	3649.616	11.2927	5.99E-03	5.99E-04	0.032	5.99E-03	0.053	No
705.523	3649.647	11.3736	6.03E-03	6.03E-04	0.032	6.03E-03	0.053	No
705.455	3649.685	11.8541	6.28E-03	6.28E-04	0.032	6.28E-03	0.053	No
705.479	3649.743	12.4523	6.60E-03	6.60E-04	0.032	6.60E-03	0.053	No
705.502	3649.802	12.9394	6.86E-03	6.86E-04	0.032	6.86E-03	0.053	No
705.524	3649.859	14.1443	7.50E-03	7.50E-04	0.032	7.50E-03	0.053	No

Imperial Project
Imperial County, California

Calculated Annual Average NO_2 Concentrations

Location Kilometers (UTM) Easting	Northing	Modelled NOx Impact ug/m**3	ppm	Out of Stk NO_2 ppm	Available O_3 ppm	Total NO_2 ppm	Calif. NO_2 Std. ppm	Std. Violation Yes/No?
MODELED, NON-FENCELINE DISCRETE RECEPTORS								
Bard, California								
729	3630.5	0.0144	7.63E-06	7.63E-07	0.032	7.63E-06	0.053	No
Fort Yuma Reservation Boundary - Wash								
720	3635.2	0.063	3.34E-05	3.34E-06	0.032	3.34E-05	0.053	No
Picacho State Rec Area								
723	3656	0.0866	4.59E-05	4.59E-06	0.032	4.59E-05	0.053	No
American Girl Mine								
707.2	3637.3	0.5888	3.12E-04	3.12E-05	0.032	3.12E-04	0.053	No
Glamis, California								
680	3652.5	0.0562	2.98E-05	2.98E-06	0.032	2.98E-05	0.053	No
Fort Yuma Reservation Boundary - NW Corner								
711.75	3634.85	0.5575	2.95E-04	2.95E-05	0.032	2.95E-04	0.053	No
Gold Rock Ranch								
700	3640	0.4209	2.23E-04	2.23E-05	0.032	2.23E-04	0.053	No
Picacho Mine								
720.2	3649.5	0.6069	3.22E-04	3.22E-05	0.032	3.22E-04	0.053	No
Mesquite Regional Landfill								
685.581	3655.943	0.0818	4.34E-05	4.34E-06	0.032	4.34E-05	0.053	No
Mesquite Mine								
688.788	3658.556	0.12	6.36E-05	6.36E-06	0.032	6.36E-05	0.053	No

APPENDIX O

U.S. EPA INDUSTRIAL SOURCE COMPLEX - SHORT TERM (ISCST3) DEPOSITIONAL MODELING RESULTS

The information otherwise contained in this
Appendix/Attachment has been removed from this version of the
Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

The removed information can be viewed in its entirety at the
Bureau of Land Management
El Centro Resource Area Office

This page intentionally left blank
for reproduction purposes.