Proposed Leasing within the COSO Known Geothermal Resource Area

Final Environmental Impact Statement

Prepared by

Bakersfield District
Department of the Interior
Bureau of Land Management

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SUMMARY

( ) Draft (X) Final Environmental Impact Statement

1. Type of Action: (X) Administrative ( ) Legislative

2. Brief Description of Action:

The BLM proposes to offer competitive and non-competitive geothermal leases on a major portion of the Coso KGRA, Inyo County, California. The Coso Geothermal Study Area (CGSA) covers 72,640 acres centered on public lands within the western side of the China Lake Naval Weapsons Center. It includes some private and NWC acquired lands which would be unavailable for leasing. The EIS assumes a geothermal potential within the CGSA of 600 MW, and a development model of eleven 50 MW generating stations, plus a probable 50 MW plant to be installed under the Navy's geothermal development program.

3. Summary of Environmental Impacts:

Approximately 2150 acres would be disturbed over time by the proposed action of leasing. An additional estimated disturbance of 110 acres from the Navy's geothermal development program is addressed as an accumulation of impacts which would occur concurrently. Fugitive dust emissions should not normally exceed 100 $\mu g/m^3$ which is within all government TSP standards. Local H_2S levels may increase up to the State's one-hour average standard of 30 ppb. Visibility may decrease under worst case conditions from 61 miles to 51 miles. Localized noise level increases would occur and would disturb sensitive receptors. If ground water is used from Rose Valley, the water table would be lowered, with a potential for drying Little Lake. Flow to Coso Hot Springs could be altered. Wind and water erosion would occur on disturbed soils. The wildlife community structure would be adversely affected. If Little Lake were lowered, waterfowl dependent upon it would be adversely affected and the local population of *Spartina gracilis* would be adversely affected. Some visual degradation would occur. Some loss of cultural resources would have to occur unless geothermal development activities were greatly restricted to cleared areas. A new land use, geothermal development, would be imposed upon an area of open space and NWC research and testing activities. The NWC mission should not be substantially hindered. Public fiscal burdens imposed by the need for additional infrastructure may occur before geothermal revenues accrue and are shared with the State.

Native American use of the Coso Hot Springs and the Prayer Site should not be interfered with if proposed mitigation is implemented. The integrity of Coso Hot Springs, highly valued by the Native Aemricans, may be lessened.

4. Alternatives Considered:
   a. No Action-Offer No Leases.
   b. Lease all lands except those with significant surface conflicts.
   c. Partial deferred leasing to protect cultural resources.
   d. Lease with no surface disturbance on lands with significant conflicts.
   e. Defer leasing until a Federal geothermal testing program can be implemented.
   f. Conduct a staged leasing program by area of decreasing geothermal potential.
   g. Unitization at leasing stage.

5. Comments have been requested from the following: See Attached

6. Dates Statement Made Available to the Environmental Protection Agency and the Public:

   Draft Statement: April 1980

   Final Statement: September 1980

ATTACHMENT

Comments on the DRAFT EIS were requested from the following agencies:

Federal Agencies

Department of Agriculture
- *Forest Service
- Soil Conservation Service
- *Rural Electrification Administration

Department of Commerce
*Department of Defense
Department of Energy
Department of Health, Education and Welfare
*Department of Housing and Urban Development
Department of the Interior
- *U.S. Fish and Wildlife Service
- *Geological Survey
- *Hertiage Recreation and Conservation Service
- *Bureau of Indian Affairs
- *Bureau of Mines
- *National Park Service
- *Water and Power Resources Service

Department of Labor
*Department of Transportation
*Environmental Protection Agency
Federal Avaiation Administration
*National Advisory Council on Historic Preservation

*California State Clearinghouse

*Comments received from agencies.

FINAL

ENVIRONMENTAL IMPACT STATEMENT

PROPOSED LEASING WITHIN THE

COSO KNOWN GEOTHERMAL RESOURCE AREA

INYO COUNTY, CALIFORNIA

PREPARED BY

DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BAKERSFIELD DISTRICT

State Director, Bureau of Land Management

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

FOREWORD

This Environmental Impact Statement (EIS) has been prepared by Rockwell International for the Bureau of Land Management under contract YA-512-CT8-216. The EIS team consisted of the Environmental Monitoring & Services Center (EMSC) of Rockwell International and three firms under subcontract to Rockwell. These firms are:

Environmental Resources Group (ERG) - Los Angeles, California. Resource areas of responsibility include Wildlife, Flora, Cultural Resources, Land Use, and Socioeconomics.

Harding-Lawson Associates (HLA) - Novato, California. Resource areas of responsibility are Geology, Hydrology, and Soils.

Bridgers Troller Associates (BTA) - Burbank, California. Responsibility for Visual Resources assessment.

The BLM Contracting Officer's Authorized Representative (COAR) for the project is Ms. Janis Bowles. The BLM technical review team consisted of ten persons of various resource disciplines.

The following individuals contributed to the management of the program:

EMSC Project Director - Dr. George Lauer

EMSC Project Coordinator - Ms. Patricia Casey

ERG Program Manager - Ms. Louise Hall

HLA Program Manager - Mr. Frank Kresse

BTA Program Manager - Mr. Greg Arthur

The following individuals provided significant contributions to the material presented in the EIS and the associated Technical Reports (TR):

1. Climatology - Mr. Timothy Waldron and Mr. Bryan Winkler
2. Air Quality - Dr. Charles McDade
3. Noise - Dr. Charles McDade and Mr. Donald Holcomb
4. Geology - Ms. Theodora Coffey and Dr. James Koenig
5. Hydrology - Mr. Richard Weiss, Mr. Michael Bergstrom, and Dr. John Sharp

6. Soils - Dr. Jeffrey Peters, Mr. George Boust, Dr. Rudolf Ulrich, Ms. Kathy O'Loughlin, Mr. Gary Andrews, Mr. Charles Patterson

7. Wildlife - Dr. C. Robert Feldmeth (Field Ecology and Aquatic Species), Dr. Philip Leitner (Small Mammals and Carnivores), Dr. Daniel A. Guthrie (Avifauna), Dr. Timothy Brown (Herpetofauna), Ms. Susan Woodward (Large Mammals), and Dr. Jerry McDonald (Large Mammals)

8. Vegetation - Dr. James Henrickson, Dr. Robert F. Thorne, and Dr. C.R. Feldmeth

9. Visual Resources - Mr. Samuel W. Bridgers, Mr. Greg Arthur, Mr. Daniel Panetta, Mr. Steven Dee, Mr. Bruce Hostetter, Mrs. Halli Mason, and Mr. James Pickel

10. Cultural Resources - Dr. C. William Clewlow, Mr. David Whitley, and Ms. Helen Wells

11. Land Use - Mr. R. Keith Julian.

12. Socioeconomics - Ms. Louise Hall, Mr. George A. Johnson, Mr. James A. Rabe, and Ms. Gail Jensen

It is the intent of the Bureau of Land Management to present in this Environmental Impact Statement sufficient detail concerning the present environmental setting to permit an individual to assess the degree and importance of the projected impacts should the proposed action be implemented. The EIS, as a document is not intended as a technical document for the specialist, however, it has been prepared by selective incorporation of a large body of material which was compiled into a number of Technical Reports. The subjects covered in these TR's are:

1. Air Quality

2. Noise

3. Geology and Hydrology

4. Field Ecology

5. Cultural Resources

6. Soils

7. Geothermal Development Model for the Coso Geothermal Study Area (CGSA) which is in the Appendix.

The Technical Reports are available to the interested reader by writing to:

Ms. Janis Bowles
Bureau of Land Management
Bakersfield District Office
Public Affairs
800 Truxtun Avenue
Bakersfield, California 93301

1.0 PROPOSED ACTION

1.1 SCOPE

The purpose of the Coso Geothermal Leasing Environmental Statement (EIS) is to analyze the cumulative environmental impacts that may result from the Bureau of Land Management's geothermal leasing program within the Coso Known Geothermal Resource Area and the China Lake Naval Weapons Center's (NWC) geothermal development program, and other related actions.

All stages of geothermal development are considered that could result from the BLM leasing action. These include preliminary exploration, exploratory drilling, field development, electrical power generation and project close-out. Impacts from the NWC's geothermal development program have been addressed in the NWC's Coso Programmatic FEIS, 1979[1]. Those impacts are addressed in this document as an accumulation of impacts from an interrelated project (see Section 1.4).

A staged development is examined with an eventual combined electrical generation capacity of 600 MW for the field if Federal, state, and private actions described in Section 1.3 and analyzed in the EIS are fully implemented. In addition, alternative uses of the geothermal resources are examined as possible scenarios in Chapter 7 of this EIS. The specific time frames of analysis used in this EIS are 1982, 1995, and 2030. It is assumed that exploratory drilling will commence in 1982; approximately 250 MW of electrical generation capacity will be installed by 1995. Although close-out of the field is considered in the EIS, there is insufficient data to permit prediction of the physical limitations of the field and therefore the impacts are analyzed on the basis of cumulative impacts due to construction and operation of all generation stations without regard to those which may be shut down during the course of the program.

Alternatives to the proposed action are presented in Chapter 7 of this EIS. The alternatives considered include:

1. No Action - Offer no leases. This is the "no action" alternative but

---

1 U.S. Navy, Naval Weapons Center, China Lake, "Final Environmental Impact Statement (FEIS) for the Navy Coso Geothermal Development Program", March, 1979, Naval Weapons Center, China Lake, California.

assumes that the NWC geothermal program will continue.

2. Leasing of all lands except those with significant surface conflict

3. Conduct partially deferred leasing in order to protect the cultural resources of the CGSA.

4. Lease with no surface disturbance on areas with sensitive resources.

5. Defer leasing until a comprehensive geotechnical testing program can be carried out under the supervision of an appropriate Federal agency.

6. Conduct a staged leasing program by area of decreasing geothermal potential.

7. Mandatory unitization of the development - In which all lessees would be required to enter into an agreement to operate the field by a single entity.

Any alternatives chosen to implement will be mitigated to a degree similar to those measures presented in Chapter 3. In all cases, measures deemed necessary by the NWC to protect the "mission" will be included. A number of alternatives were considered but not evaluated. These include:

Restrict areas of leasing to only those areas inside of the NWC. This was not considered realistic as the KGRA includes areas outside of the NWC boundaries, and there are noncompetitive lease applications in Rose Valley. There appeared to be no environmental benefit from this alternative.

Limit the number of lease sales. This alternative was dropped as there appeared to be no environmental benefit and is not necessarily consistent with current executive policy.

Lease under larger or smaller lease sizes than the normal 2,650 acres. Dropped as there appeared to be no environmental benefit for smaller lease sizes and larger sizes conflict with current statutes.

Conduct staged leasing by level of geothermal development. Leasee would allow geothermal development by stage. As each stage is completed, further environmental assessment would be prepared on the next stage to determine the environmental acceptability. This alternative was rejected as creating redundant assessment since this document assess all stages of geothermal development.

The proposed action is to lease the land for geothermal development for the primary purpose of generation of electrical energy. It is possible that it may be desirable to utilize some portion of the geothermal resource for non-electrical purposes. These might include:

Space Heating

Food Processing

Pisciculture

Ore processing

In the event that such non-electric utilization is proposed by a lessee, the environmental effects of such action would be evaluated by the Department of the Interior prior to approval.

1.1.1 Location and EIS Area

The Federal lands proposed for leasing are located in Inyo County and cover 72,640 acres centered on public land and lands within the western side of the China Lake Naval Weapons Center (NWC) withdrawal north of Ridgecrest, California. Of the total, 25,650 acres are on public lands, and 41,560 acres are in the NWC withdrawal. Approximately 2,920 acres are NWC acquired lands within the proposed lease area, and are unavailable for leasing. Approximately 1710 acres are privately held lands. The State of Califorrnia and the Los Angeles Department of Water and Power together own approximately 800 acres. Private lands with Federal mineral rights are not proposed for leasing. The location of the proposed lease area is shown in Figure 1.1-1. Figure 1.1-2 at the end of this volume depicts the Coso Geothermal Study Area (CGSA) and the lands under consideration for leasing. The map shows the boundaries of the Known Geothermal Resource Area (KGRA) as currently defined by the USGS. The CGSA is smaller in size as certain areas of the KGRA were determined to be environmentally sensitive and less likely to contain an economic geothermal resource during the establishment of the scope of this EIS.

1.1.2 KGRA History

The Coso area was designated as a KGRA in 1971, with acreage added to the KGRA in 1976 and 1978. However, the geothermal resource is not well characterized. The Department of Energy (DOE) has drilled a test well on NWC withdrawn land to initiate characterization of the reservoir. To date this well has not been successfully flow tested and, therefore, has provided little information. Other detailed surface studies have been conducted in the area to determine

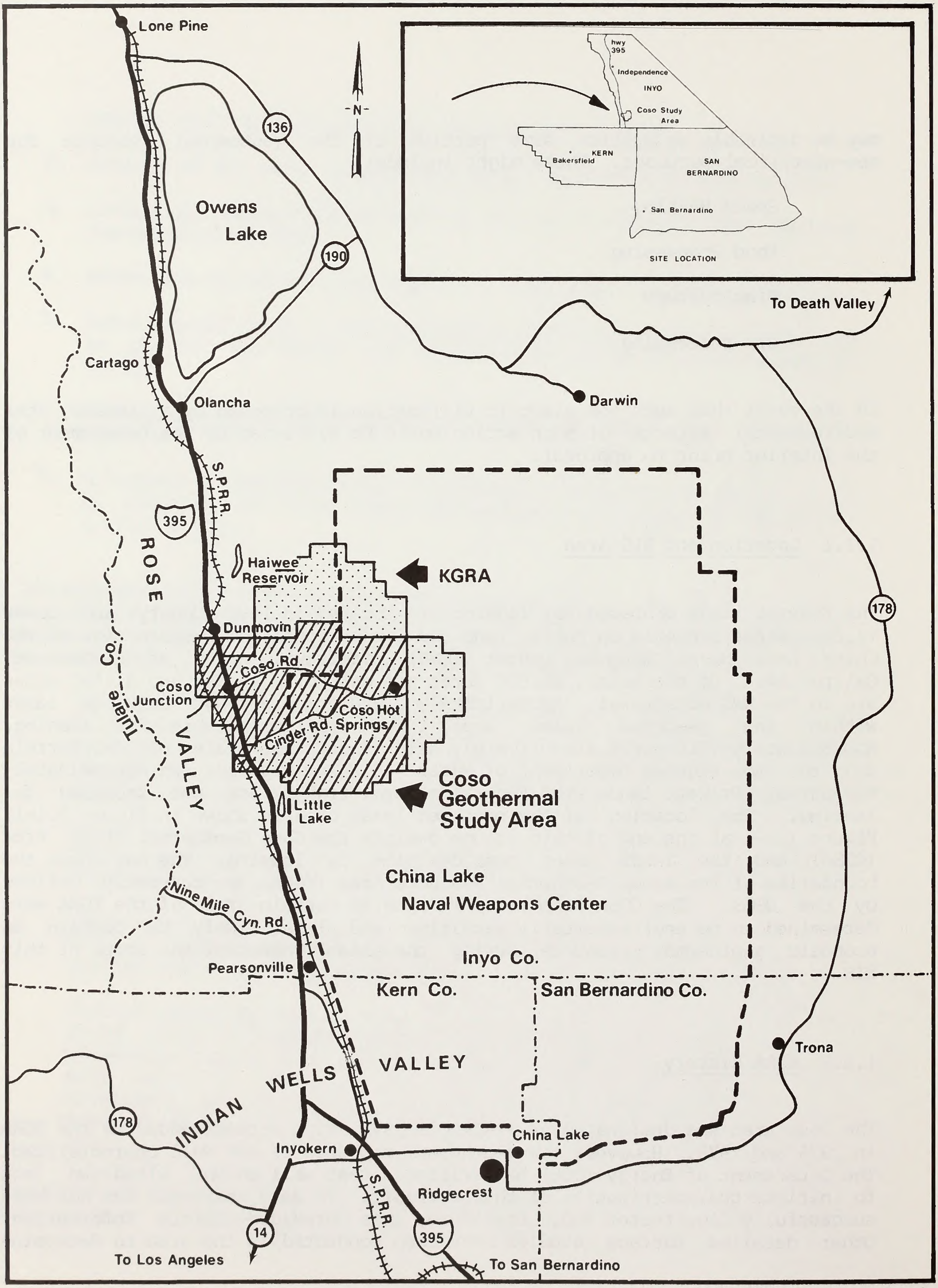


Figure 1.1-1. SITE LOCATION

the characteristics; however, these data are insufficient to properly characterize the reservoir.

Non-competitive geothermal lease applications have been received by the Bureau of Land Management for parcels in the southwest corner of the EIS study area. The lands applied for are included in this EIS.

1.1.3 Agency Authorities and Roles

The Coso Hot Springs CGSA is located on public lands which are administered by the Bureau of Land Management, public lands which are withdrawn under PLO 431, 13 F.R. 22, for use by the Navy at the Naval Weapons Center (NWC), China Lake, California, lands which have been acquired by the Navy to consolidate its holdings at the Weapons Center, and private and state lands (see Figure 1.1-2 at the end of this volume).

Under the provisions of the Geothermal Steam Act, P.L. 91-581, 85 Stat. 1577, 30 U.S.C. Par 1002 et seq., the Secretary of the Interior is authorized to issue leases for the development and utilization of geothermal resources on lands administered by him -- including public, and withdrawn -- under such rules and regulations as he may adopt consistent with the purposes of the Steam Act. With respect to the Coso Hot Springs KGRA, this authority extends to the public lands administered by the BLM and public lands withdrawn under PLO 431. Consistent with the provisions of the Engle Act, P.L. 85-377, 72 Stat. 27, 43 U.S.C. Pars. 155-158, geothermal leases for lands withdrawn for military purposes may only be issued by the Secretary of the Interior after determination by the Secretary of the Navy that such leasing is not inconsistent with the use for which the land was withdrawn. This Environmental Statement has been prepared, in part, to help in determining whether geothermal leasing is consistent with the purposes of this withdrawal.

A Memorandum of Understanding between the Naval Weapons Center and the Bureau of Land Management has been established, December 1977, concerning the production of geothermal resources (see appendix C). The acquired lands within the NWC which are administered by the Navy are not presently available for leasing. However, pursuant to P.L. 95-356, Par. 603, 92 Stat. 585, 30 U.S.C. Par. 1002a, the Secretary of the Navy may enter into contracts for development of geothermal resources on real property under his jurisdiction (other than public lands administered by the Secretary of the Interior, i.e., the land withdrawn by PLO 431) and for the purchase of the energy produced under such contracts. The Navy has filed a phased EIS describing the impacts which would result from development of the acquired lands within the Naval Weapons Center boundaries. The NWC phased EIS is referenced with some frequency within this EIS because of the interrelationships, the adjacency of the lands involved and the similarity of the environmental conditions.

The other legal restraint which may affect the issuance of leases on either the public lands or the withdrawn lands is Executive Order 6206 of July 16, 1933, which states that "lands . . . are hereby temporarily withdrawn from settlement, location, sale, or entry, subject to all valid existing rights, in aid of proposed legislation withdrawing the lands for the protection of the water supply of the City of Los Angeles." The lands under this withdrawal are located principally in the Rose Valley and the eastern slopes of the Coso Range. As noted previously, leases may be issued for these withdrawn lands, (see Geothermal Steam Act, Par. 3, 30 U.S.C. Par. 1002) so long as those leases are considered to insure adequate utilization of the lands for the purposes for which they were withdrawn. (See also Geothermal Steam Act, Par. 15(a), 30 U.S.C. 1014(a)). Since E.O. 6206 was for the protection of the water supply, any geothermal leases which may be issued may be subject to a condition that lease operations not impair the water supply. Depending on the operations proposed and the attendant need for water in those operations, such a condition could have a significant impact on the type and extent of geothermal development in the area. This EIS will address the question of geothermal leasing and development in relation to the other resources in order to assist the Department in determining whether such leasing and development is consistent with E.O. 6206 and, if so, how it may be carried out to protect the water supply.

A detailed discussion of responsibilities of the DOI for the issuance and administration of geothermal leases may be found in the Final Environmental Statement For the Geothermal Leasing Program prepared by DOI and filed with the Council on Environmental Quality in 1973. Briefly, the DOI minerals management policy is to provide for and encourage orderly and timely development of minerals under its jurisdiction while requiring adequate measures to avoid, minimize, or correct both damage to the environment and hazards to the public health and safety.

1.1.3.1 Applicable Regulations

It is implicitly assummed throughout the description of the proposed action and in the analysis of the impacts that the applicable regulations will be enforced. These regulations include:

1. The USGS Geothermal Resource Operational Orders (GRO) which have been issued under the Geothermal Steam Act. These orders are:

    1. Exploratory Operations

    2. Drilling, Completion and Spacing of Geothermal Wells

    3. Plugging and Abandonment of Wells

    4. General Environmental Protection Requirements

5. Plans of Operation, Permits, Reports, Records, and Forms (DRAFT)

6. Pipelines and Surface Production Facilities

7. Production and Royalty Measurement, Equipment, and Testing Procedures

2. 43 CFR 3200 - Establishes leasing terms and basis for royalty payments.

3. 30 CFR 270 - Establishes the authority of the USGS to regulate the development of geothermal resources on leased lands and to require compliance with lease terms and stipulations.

4. Memorandum of Understanding - An agreement between the NWC Department of the Navy and the BLM, Department of the Interior. Establishes a cooperative agreement between the two agencies for geothermal leasing and development to be compatable with the NWC defense mission. In addition, the NWC has developed a constraints package for geothermal operations on NWC lands (see Appendix C).

A comprehensive list of all the regulations and GRO's is provided in Appendix A of this EIS. If the proposed leasing program is implemented, the USGS becomes the lead Federal Agency for all development activities. Prior to commencing operations upon the leased land for any purpose other than "casual use" and certain "exploration operations" as defined in 30 CFR 270.2(p) and (q), a lessee must obtain the joint approval of a plan of operation from the USGS and the BLM. Within the NWC withdrawal, the BLM and NWC will review the various plans for the USGS. The USGS will also work with the U.S. Fish and Wildlife Service, the County of Inyo, certain State of California agencies, and all interested parties to receive advice and support. All drilling for the purposes of finding, testing, or producing geothermal resources is contingent upon an approved plan of operation. "Exploration operation" (including geophysical exploration) may be authorized in advance by the USGS in response to a lessee's Notice of Intent. To assist in the decision-making process regarding a lessee's proposed activities, the USGS prepares an Environmental Assessment (EA) which is site-specific and addresses potential impacts that should be avoided or mitigated. This procedure is repeated for each new proposed activity except that the surface management agency would be expected to have the lead regarding power generating facilities exclusive of research and demonstration facilities of 20 MW or more electrical capacity or net heat energy equivalent. A flow diagram of actions and regulatory overview required for each of the stages of geothermal development is shown in Figure 1.1-3.

A comprehensive listing of the various Federal, state, and local regulations which may apply to geothermal development is presented in Appendix A.

FLOW CHART OF CRITICAL PATH IN GEOTHERMAL EXPLORATION

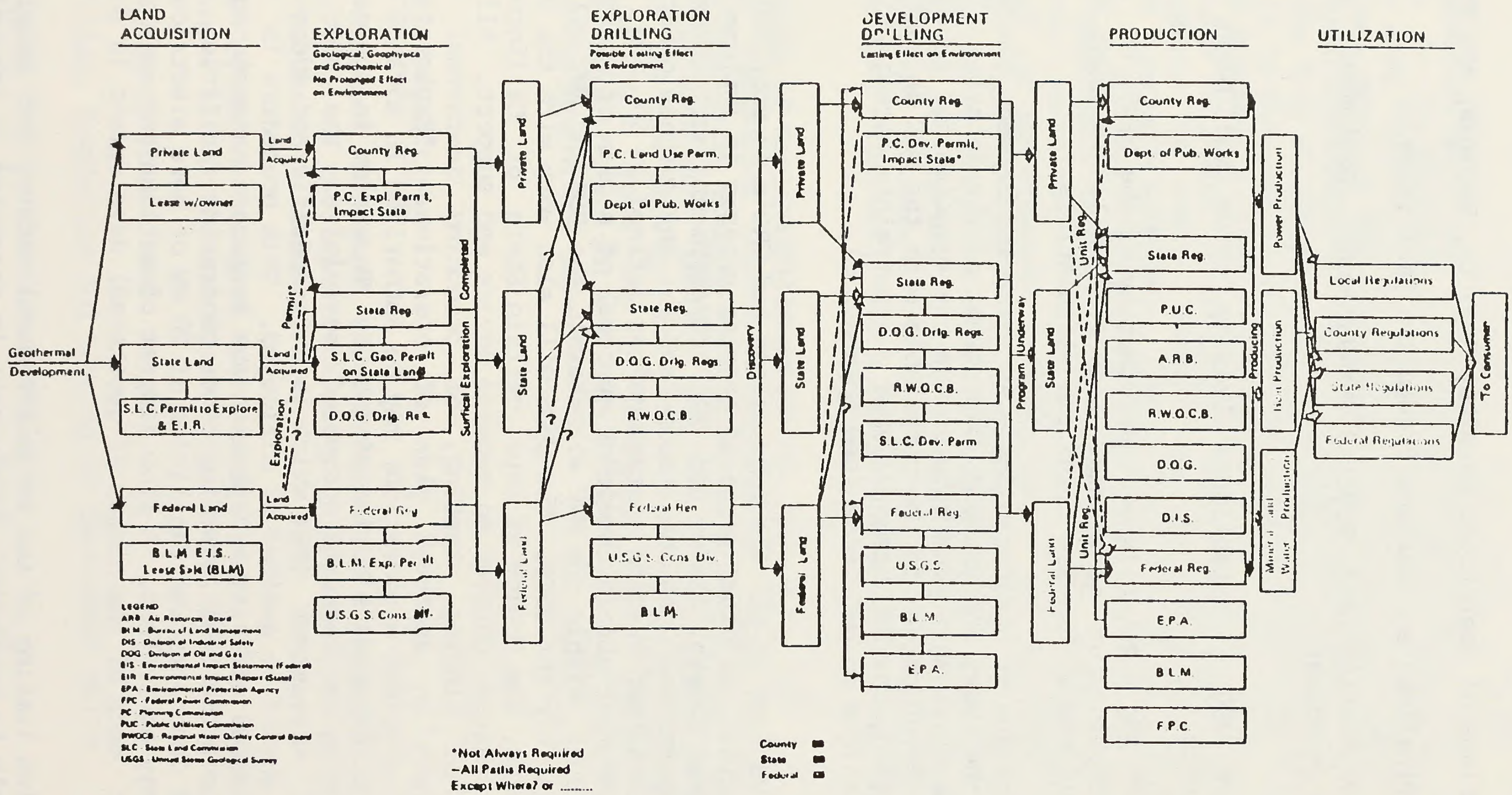


Figure 1.1-3

1.2 OBJECTIVE & NEED

The objective of the proposed leasing action is to make available the development and utilization of geothermal resources for the generation of electrical power. The geothermal resource is an attractive alternate to the use of fossil fuel resources for such generation.

The majority of the CGSA is located within the KGRA. However non-competitive lease applications for lands adjoining the KGRA have been received by the BLM. If the proposed action is implemented those areas will be leased on a non-competitive basis.

1.3 SPECIFIC PROPOSED ACTION

1.3.1 Stages of Geothermal Development

Based on the experience of other geothermal fields, the development can be broken into five stages:

1. Preliminary exploration - which involves the acquisition of geotechnical data. The methods used require non-intensive uses of the land. These include observations of surface features; application of geologic, geochemical and hydrologic techniques; and geophysical studies.

2. Exploratory well drilling - is the drilling of the first wells to evaluate the extent and physical characteristics of the geothermal resource.

3. Field development - during which sufficient wells to supply the required energy are drilled and power generation facilities are constructed.

4. Resources utilization - during which the resource is utilized to generate electric power. New wells may be drilled as old ones are depleted.

5. Close out - which occurs when a given area does not provide sufficient energy to maintain economic electric generation. This phase includes abandonment of wells and restoration of the area. Although it is considered, at the present time, to be a depletable resource, there is insufficient historic data to indicate what may be the true lifetime of a geothermal field.

Beginning with implementation of exploratory drilling and the addition of successive stages of development, several of these stages would likely be occurring concurrently on adjacent tracts of land.

1.3.2 Lease Size

The assumed lease tracts will each be 2,560 acres in size. This is the maximum size permitted by law. Lease tracts on NWC withdrawal lands will be jointly determined by BLM, USGS, and the NWC in accordance with the Memorandum of Understanding between the BLM and NWC signed in November 1977 (see Appendix C for text).

1.3.3 Geothermal Resource

Due to the fundamental data limitations discussed in Section 1.1, the description of the proposed action requires the utilization of a geothermal development model for the CGSA. This model employs the best estimates of experts (see foreword) as to the basic physical characteristics as well as the energy potential of the field. The model also includes a "most probable" scenario as to how the field will be developed in terms of the required facilities and the amount of surface disturbance due to development and operation activities. The geothermal development program proposed by the NWC for implementation on Naval acquired lands is also incorporated. The complete model is described in Appendix B of this EIS. The reader is cautioned that the model represents the best estimates of various experts in the field. New geotechnical data and changes in technology, as well as new directions in regulatory policy, can all cause major deviations from the forecast.

Based on currently available data, the area can be described in terms of four zones of diminishing potential for economic geothermal development. These zones are:

Zone 1 - High potential with average energy per well estimated to be 2.25 megawatt electrical.

Zone 2 - Medium potential with average energy per well estimated to be 1.67 megawatt electrical.

Zone 3 - Marginal potential, no estimate for energy per well can be made prior to development of zones 1 & 2.

Zone 4 - Low potential, probably not useful for generation of electrical energy but may be useful for alternate uses of geothermal energy.

The four zones are shown in Figure 1.3-1. Zones 1 and 2 will provide sufficient geothermal energy to provide power for five 50 MW power plants plus the currently planned 10-15 MW plant on NWC acquired lands.

1.3.4 Time Staging

The development of the field will take place in an evolutionary manner. The geothermal development potential of the area is shown in Figure 1.3-2. Zone 1 is considered highest potential and Zone 3 lowest potential for the generation of electrical energy from geothermal fluids. Zone 4 is considered to be of such low potential within the present state of knowledge, that no projections as to its use for production of electrical energy are made at the time of writing this EIS.

No assumptions concerning the actual number of leases to be issued will be made in this EIS since not all tracts offered may be bid upon by qualified bidders, or may result in acceptable bids. However, it is assumed for purposes of impact evaluation that the entire area will be offered for leasing initially and that, ultimately, the entire geothermal resource will be exploited fully.

It is assumed that the development of the field will follow the usual trend of geothermal development. The areas showing the greatest potential, as perceived by the lessees, will be developed first. During this period, exploratory studies will be conducted on the other lands to determine the extent of the resource as fully as practicable. After the first development is in full operation, it is assumed that the remainder of the field will be developed. The primary constraint on the rate of development is economic. The cost of exploratory activities is very high; thus, prudent fiscal management requires a slow, staged approach to utilization of this type of resource.

1.3.5 Development Scenario

The following describes the most probable actions which will be taken during the development of the Coso geothermal resource. The steps assumed are, in sequence:

1. Exploratory drilling on NWC acquired lands as part of the NWC geothermal program.

2. Leasing of Federal lands (The Proposed Action). This would probably

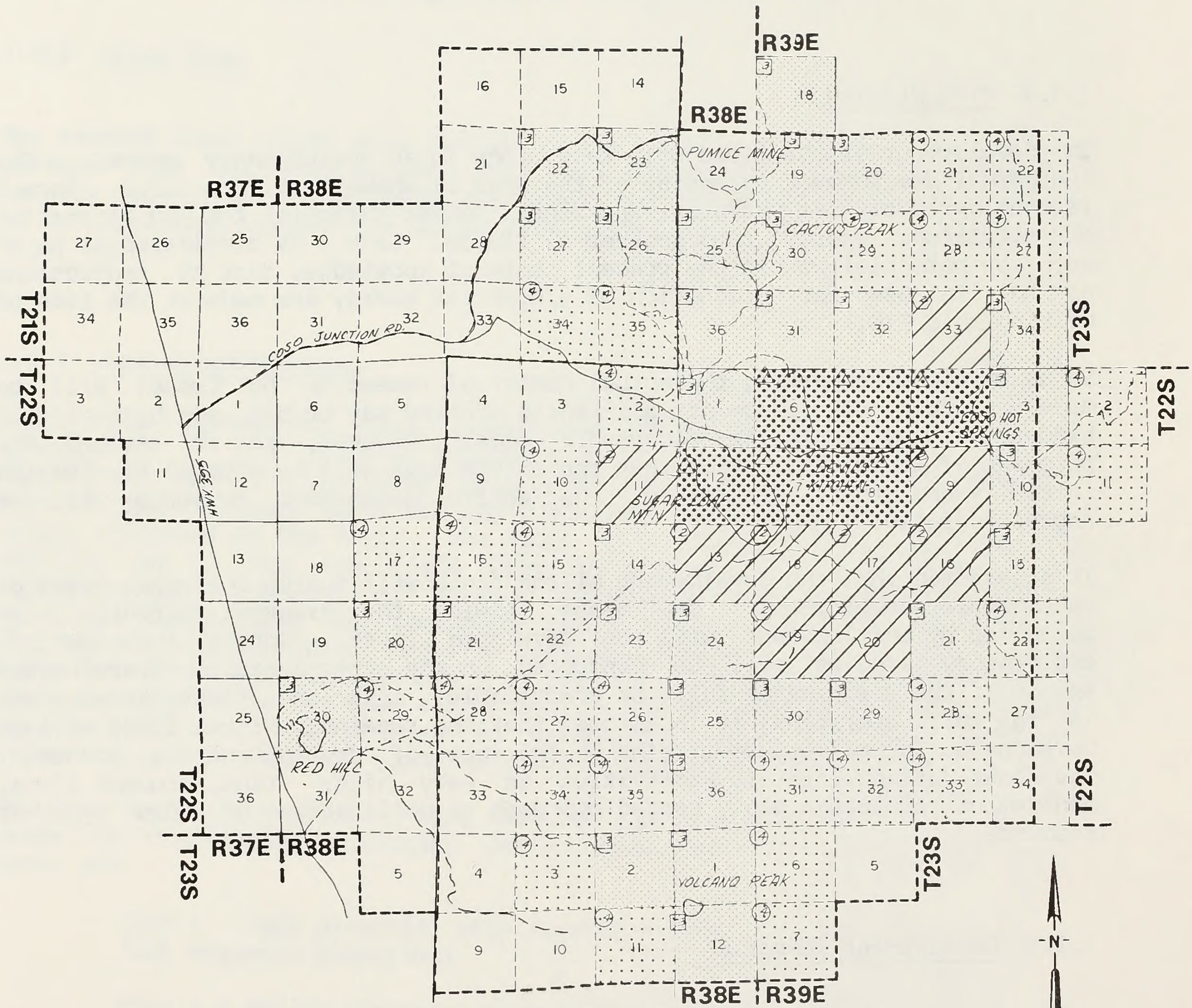


Figure 1.3-1 COSO KGRA ZONES OF PROBABILITY

1 High Probability
3 Low Probability
2 Moderate Probability
4 Uncertain
NWC Boundary

0 5
Miles

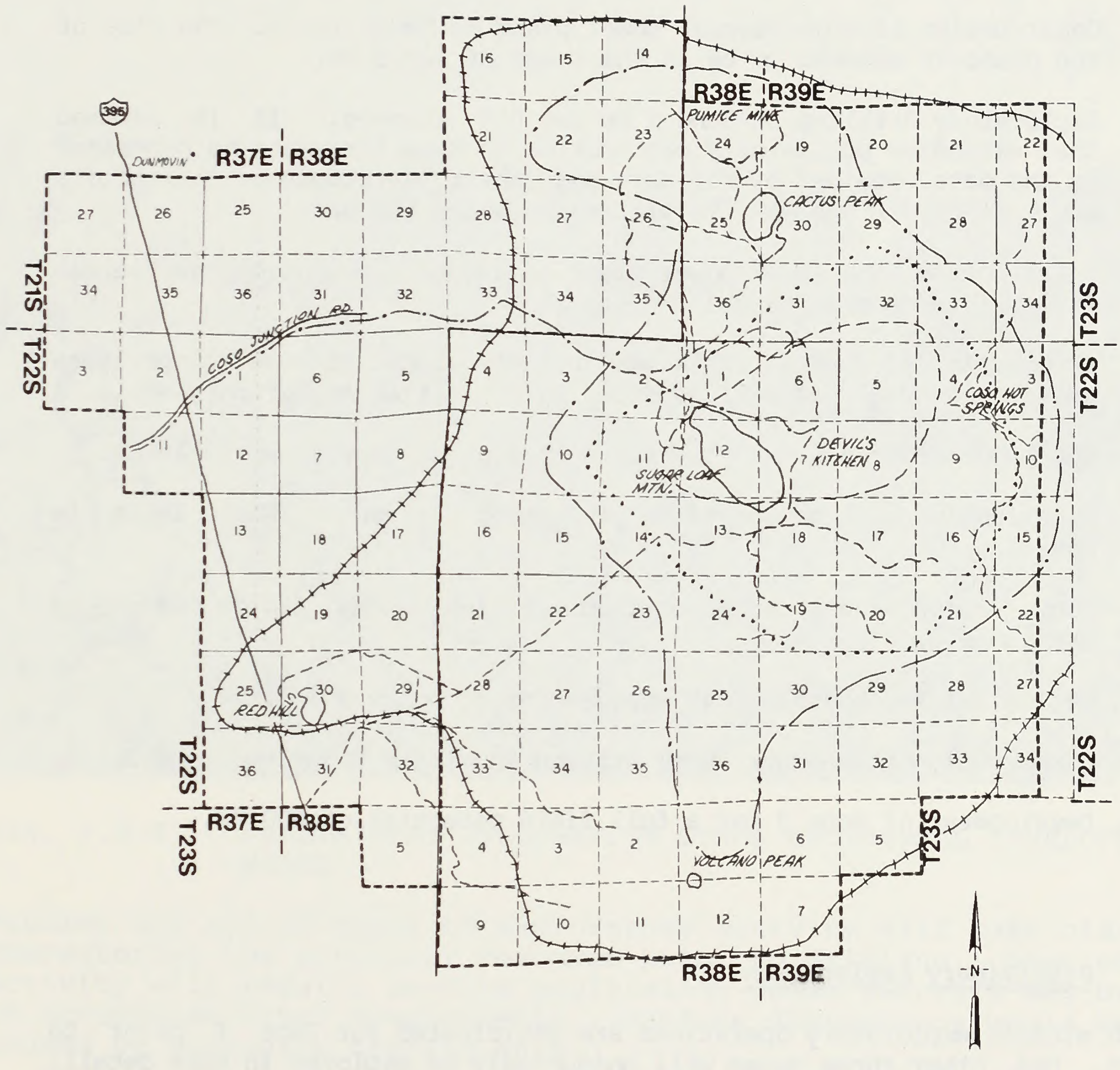


Figure 1.3-2 GEOTHERMAL DEVELOPMENT POTENTIAL AREA

0 1 2 3
Miles

--- Zone 1 High Potential

..... Zone 2 Moderate Potential

-·-· Zone 3 Low Potential

+++ Zone 4 Uncertain Potential

—— NWC Boundary

take place prior to completion of the Naval generation station.

3. Construction of a geothermal power plant on Naval lands. The size of the plant is assumed to be in the range of 10-15 MW.

4. Exploratory drilling in Zone 1 by the BLM lessees. It is assumed that extensive preliminary exploration in Zone 1 may not be necessary as the data obtained by the Navy and their development contractors may suffice, if the Navy is willing to share the data.

5. Construction of a 50 MW power plant on leased lands using geothermal fluids developed in Zone 1.

6. Exploration of Zone 2. This may include seismic studies, temperature gradient studies, as well as drilling of initial exploratory wells.

7. Construction of a 50 MW generation station on Navy acquired lands.

8. Construction of a second 50 MW generation station on leased lands in Zone 1.

9. Construction of a 50 MW generation station using fluids developed from Zone 2.

10. Geological and hydrological exploration of Zones 3 & 4.

11. Construction of another 50 MW station in either Zone 1 or Zone 2.

12. Development of Zone 3 for a full field potential of 600 MW.

1.3.5.1 Preliminary Exploration

Although minimal exploratory operations are anticipated for Zone 1 prior to drilling, the other three zones will undoubtedly be explored in some detail. This section describes some of the types of exploratory activity which may take place in the zones to characterize the potential resource prior to drilling. Geologic, hydrologic, and geochemical techniques are used during this stage. These techniques require minimal ground disturbance. Normally only a four-wheel drive vehicle is required for entry. The simulation presented in Figure 1.3-3 shows a "typical" scene during this phase.

Microseismicity Measurement - This passive technique measures very weak earthquakes which may occur in geothermal anomalies. These earthquakes may indicate the presence of faulting and fracturing that could allow deep hot fluids to rise to shallow depths and form an accumulation of heat in available reservoir rocks. The method requires access to the land by vehicles.

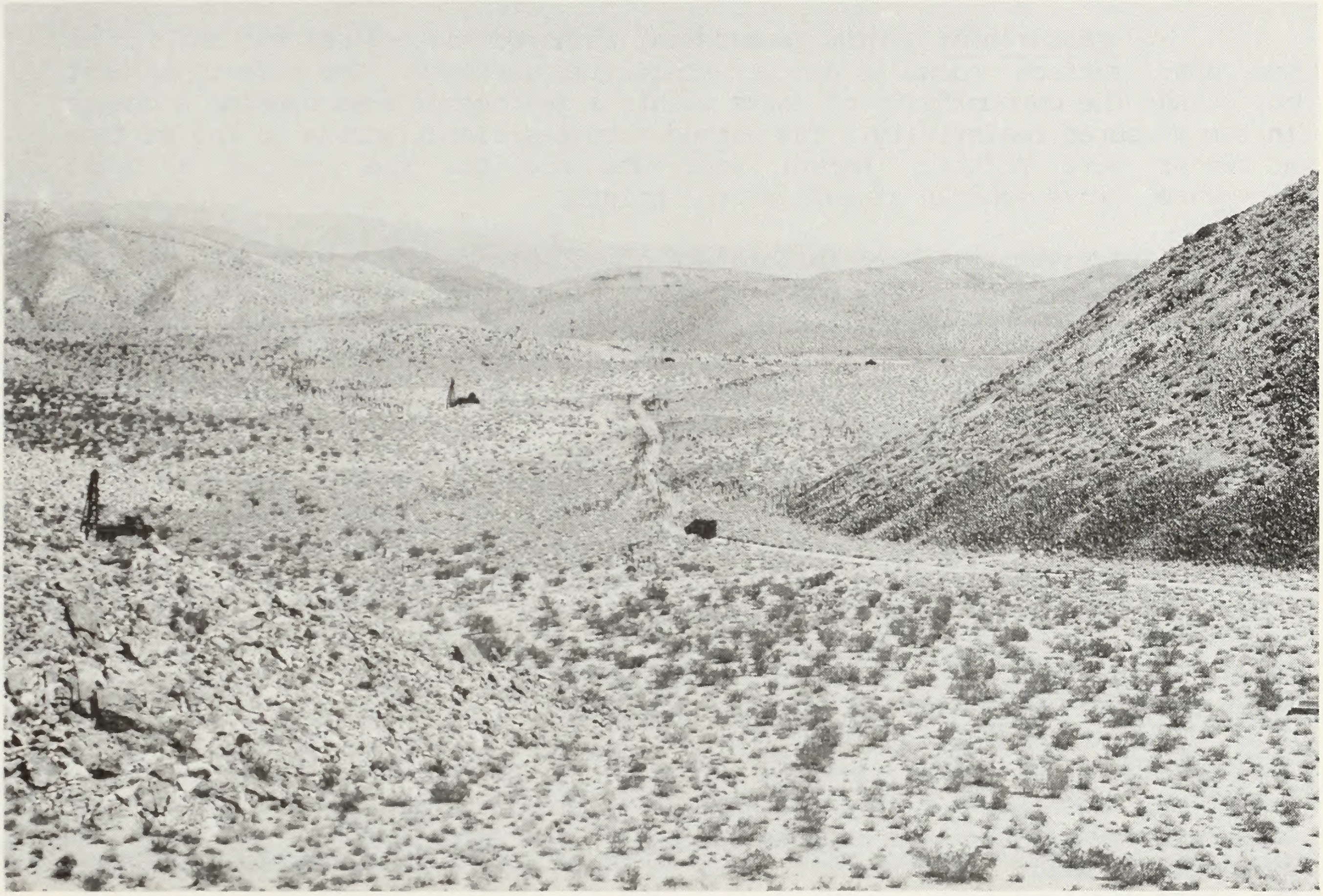


Fig. 1.3-3 PRELIMINARY EXPLORATION STAGE GEOTHERMAL DEVELOPMENT MODEL

Passive and active types of exploratory activity will take place to characterize the potential resource prior to drilling. Some of this activity will require on-site exploration while aircraft may be used to accomplish other measurements. Surface disturbance would be caused by vehicular traffic only.

Simulated Features of Development Activity.

1. Unimproved access roads with low-use volume of traffic.

2. Temporary drilling sites with light, truck-mounted drilling rigs.

3. Ephemeral vehicular traffic. (Four-wheel drive pick-up and water truck).

Measurement - This measurement technique determines the ability of the near surface rocks to conduct electrical currents. The effects of heat may change the conductivity of rocks within a geothermal area causing a change in the measured resistivity. The method requires direct access to the surface at two or more points. Normal procedure requires the use of a small four-wheel drive vehicle at each of the points.

Magnetic Measurements - Used to locate magnetic blanks or low spots in the local magnetic field. The magnetic properties of the rocks are destroyed at temperatures above 550°C (called the "Curie" point); thus, areas with low magnetic readings are indicative of a high temperature zone. Measurements can be taken from low flying aircraft or from the ground. Surface disturbance would be caused by vehicular traffic only.

Heat Flow Measurements - The measurements are used to define the areas of highest heat flow in relatively shallow (200' to 500') drill holes. A light, truck-mounted drilling rig is used to drill the holes; a water truck supplies the drilling fluid, and a pickup truck is used to carry the needed supplies.

1.3.5.2 Exploratory Well Drilling

Upon completion of the preliminary exploration, the only means of proving a geothermal resource is by exploratory well drilling. The steps involved for this activity are the same whether the hole is "exploratory" or is for a development well. A "typical" scene is shown in simulation in Figure 1.3-4. The steps required are:

1. Access road construction
2. Drill site (pad) construction including the mud sump
3. Drilling
4. Well testing
5. Waste disposal
6. Well venting or bleeding if necessary
7. Abandonment in the event the well is not productive or useful for power generation

The road to the site must be capable of allowing access to large trucks carrying the drilling rigs and other equipment; it is assumed that all roads will be 13.8 feet wide. Main roads will be surfaced with gravel or cinder. Site preparation requires clearing and leveling the land. If the site is on a slope, cut and fill operations must be undertaken. The mud sump must be lined with impervious material to insure that toxic substances do not seep into the

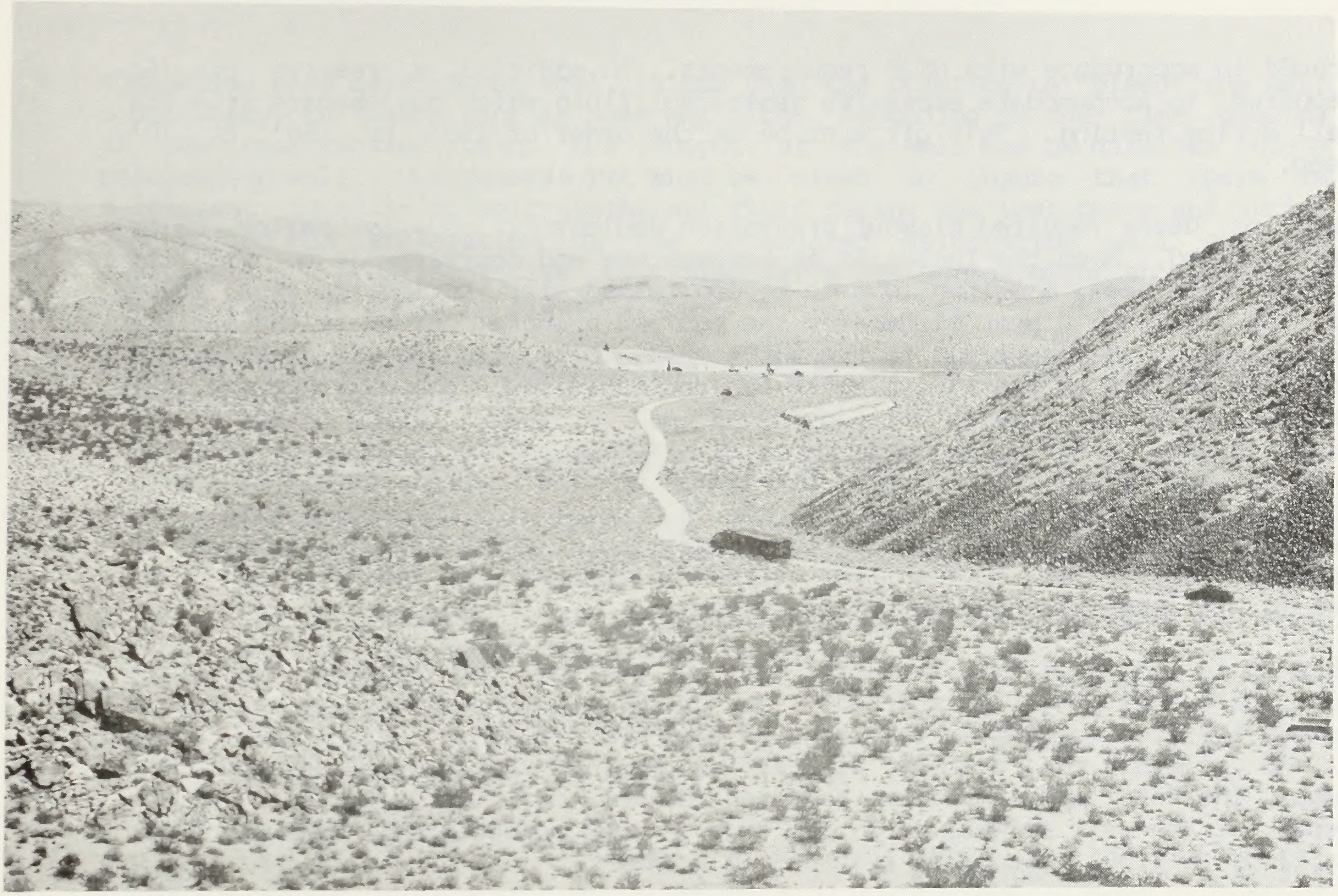


Fig. 1.3-4 EXPLORATORY DRILLING STAGE GEOTHERMAL DEVELOPMENT MODEL

The steps involved for exploratory drilling are the same as those needed for a development well.

Simulated Features of Development Activity.

1. Access road, 13.8 feet wide, surfaced with gravel or cinder.

2. Site preparation requiring clearing and leveling of land surface, and, in some cases, cut and fill operations.

3. Excavation of mud sumps and reserve pits (150' by 150' by 10' deep).

4. Drilling rigs and impedimenta.

5. Large truck vehicular traffic.

ground in accordance with USGS requirements. In addition, a reserve pit is required to accommodate excessive geothermal fluid which may emanate from the well during testing. This pit must be on the order of 150' by 150' by 10' deep.

Drilling, using required blowout prevention equipment, usually begins using drilling mud. When the increases in temperature and decreases in permeability indicate the need, a switch is made to compressed air. During the mud phase of the drilling, a pump circulates the mud and a shaker screen at the surface separates the rock cuttings to the waste sump, while allowing the drilling mud to pass through to the mixing tanks for recirculation. The cuttings and rock from the well are normally not considered to be toxic (RCRA, 1980). The drilling mud, on the other hand, contains a number of additives, some of which may be considered hazardous. Depending on the actual chemicals used, disposition of the mud may require either a Class I or a Class II-I site. The nearest Class I site (at the time of preparation of this EIS) is located in Covina, California; Class II-I sites are located near Elk Hills and Taft, California (approximately 160 miles distant).

When it is indicated that the drill bit is nearing the probable producing zone, air drilling is started. Air drilling has less tendency to clog or damage the steam-producing fractures as does mud drilling. During this phase of the drilling, the returning air carries the rock cuttings and dust into the sump. The total amount of time required for well drilling is dependent on the depth of the well as well as on the type of rock encountered. However normal drilling to 5,000 feet takes from 6 to 8 weeks.

The well is then flow tested. As described in Appendix B, it is assumed that the Coso geothermal reservoir is liquid dominated and, therefore, the fluid from the well will have to be channeled into a reserve pit. For Zone 1 wells, it is assumed that the initial (test) flow will be at the rate of 250,000 lbs per hour. The duration of such tests will normally be approximately two days. At the above rate, approximately 154,000 cubic feet of water will discharge from the well. Including a reasonable safety factor, the reserve pit must, therefore, be capable of containing over 200,000 cubic feet of liquid. During this time, a portion of the fluid will vaporize (flash) and all of the non-condensible gases will escape to the atmosphere. The non-condensible gases include a mixture of carbon dioxide, hydrogen, carbon monoxide, and hydrogen sulfide. Approximately 25 lbs/hr of hydrogen sulfide are estimated to be emitted to the atmosphere during the duration of the tests.

1.3.5.3 Field Development

Development wells are drilled in the same manner as exploratory wells. The anticipated bottom hole spacing for these wells for the CGSA is estimated to be one well per 40 acres. However, it is anticipated that up to six wells can be located on a pad by using directional drilling methods; for purposes of estimating impacts, an average of four wells per pad will be utilized. Upon completion of a development well, it has been the practice to "bleed" the well continously, to insure that it does not clog. Depending on the time phasing of the construction plan, the output of the well may be directed into a reinjection well. The reserve pit must be sized to insure that there is sufficient capacity to hold geothermal fluid during the test phase and during the period of preparation of the associated reinjection well and its equipment. A representative plot plan for a geothermal plant showing wells and the plant is shown in Figure 1.3-5.

For the purpose of estimating the impacts of drilling, the following assumptions(3) are made:

1. Bottom hole well spacing will average one well per 40 acres.

2. To minimize the number of roads, pads, and sumps required, directional drilling from multi-well pads will be employed.

3. The percentages of the exploration wells drilled in Zones 1 & 2 which will be successful development wells are:

   A. 20% of the first 20 wells

   B. 40% of the next 20 wells

   C. 85% of the remainder

4. For Zones 1 & 2 approximately 600 wells will be drilled. Of these, approximately 120 will be less then 1500 meters deep, 180 will be between 1500 and 2000 meters deep, and 300 will be deeper than 2000 meters. It is anticipated that the average life of a well will be seven to ten years. Thus, a replacement factor of about 2.5 during the 30 years of the project, with an 85% success rate in drilling the replacement wells, is assumed.

5. Although up to six wells can theoretically be placed on a single drilling pad, it is assumed, that on the average, four wells per pad will actually be drilled. Each pad will be about 150' by 500' and will have a mud sump which will be about 100' wide, 300' long, and 15' deep. The reserve pit will be a minimum of 150' wide, 150' long, and 10' deep. The first stage flashing equipment will be mounted at each well pad.

6. One reinjection well can be used per two production (development) wells. Each reinjection well pad will occupy an area approximately 150' by 300' and will require a mud sump.

---

(3) A technical basis for the assumptions may be found in Appendix B - Geothermal Development Model.

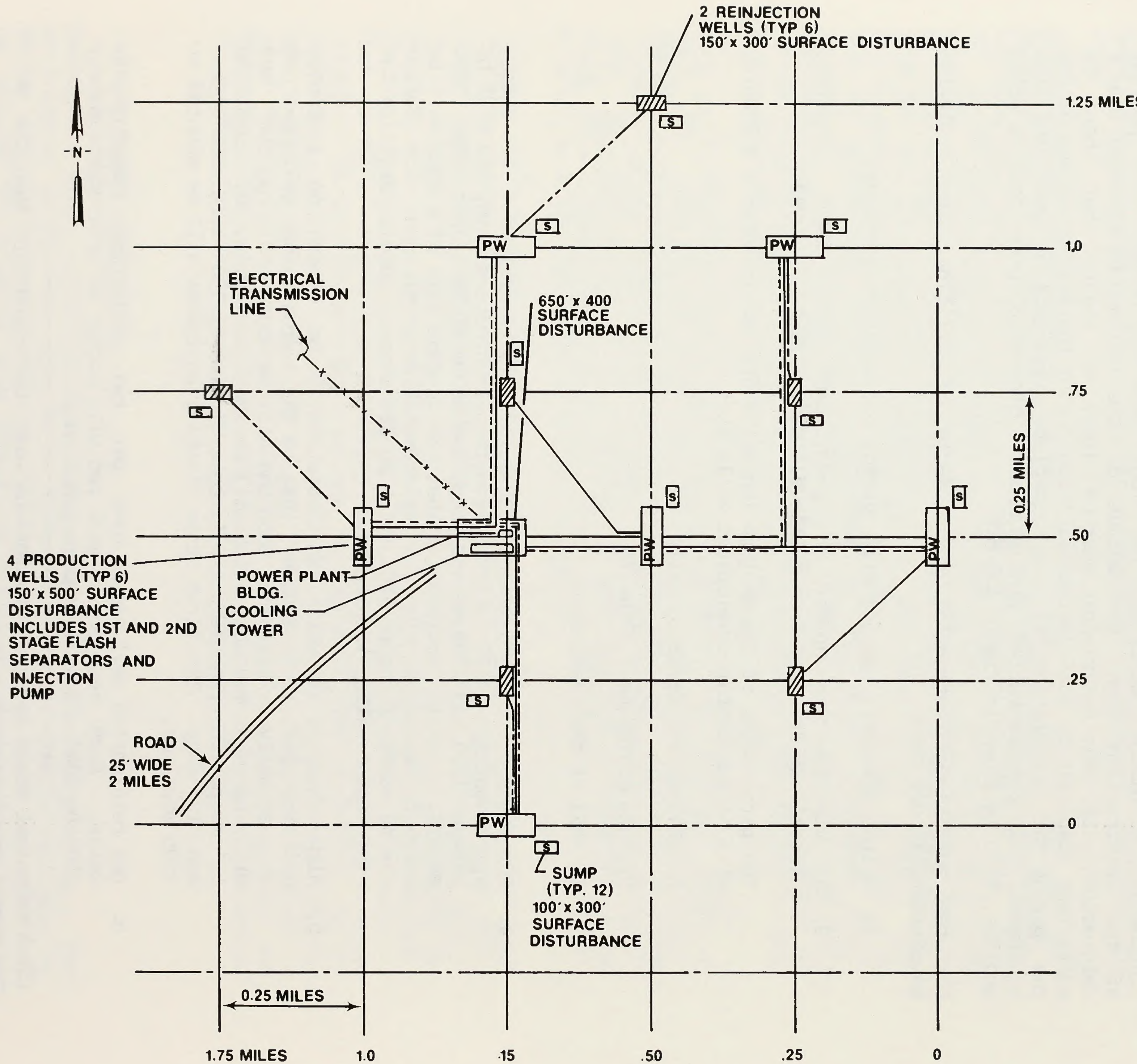


Figure 1.3-5 TYPICAL PLOT PLAN FOR FIELD DEVELOPMENT

Each well, whether to be utilized for extraction of geothermal energy or for reinjection, will require an access road to permit the heavy drilling rigs to get to the pad. It is anticipated that these roads will not normally be paved, but will be graveled.

When a well is to be abandoned, the well head valves will be removed and the well will be plugged to meet the downhole plugging and abandonment requirements as identified in the USGS Geothermal Resources Operations Order (GRO) No. 3. If a complete pad is to be abandoned, the surface will be restored to meet the current restoration requirements of the USGS and BLM. The mud sump will be cleaned of all toxic material, covered, and the surface restored.

1.3.5.4 Resources Utilization

It is necessary, for the purposes of estimating the impacts of the proposed action, to make specific assumptions regarding the nature of the facilities which will be constructed for generation of electrical power from the geothermal fluid. These assumptions are based on current technology utilizing best engineering practice. The reader is cautioned that there may be significant improvements in the technology over the period of development. Such improvements would, in general, tend to reduce the degree of environmental disturbance, and therefore, the impacts described in Chapter 2 of this EIS.

The geothermal fluid coming from the wells will be separated into the fluid and steam components by flashing units located at each pad. The steam then enters the generation station via insulated pipe. A "typical" station is shown in simulation in Figure 1.3-6. A flow diagram of such a station is shown in Figure 1.3-7 and the elevation plan for the station is shown in Figure 1.3-8. The well flow enters a first-stage flash separator where steam is separated from the liquid; also, some liquid may be flashed into steam by lowering the pressure. The liquid then enters a second-stage flash separator where pressure is lowered further and more liquid is flashed to produce low-pressure steam. As the geothermal fluid passes through the two flash separators, it gives up most of its useful enthalpy (work producing heat) in the form of high-pressure and low-pressure steam. The liquid is then piped to the reinjection well(s) and the steam is brought to the generator using insulated piping. At the point of entry to the generator station, the steam will contain some particulate matter which has passed the well head flashing units, as well as non-condensible gases. Based on current estimates, the non-condensible gases will constitute 1% of the total vapor(4). These non-condensibles will be approximately 99% carbon dioxide and less than 1%

---

(4) See Appendix B for the basis of the concentration values used.

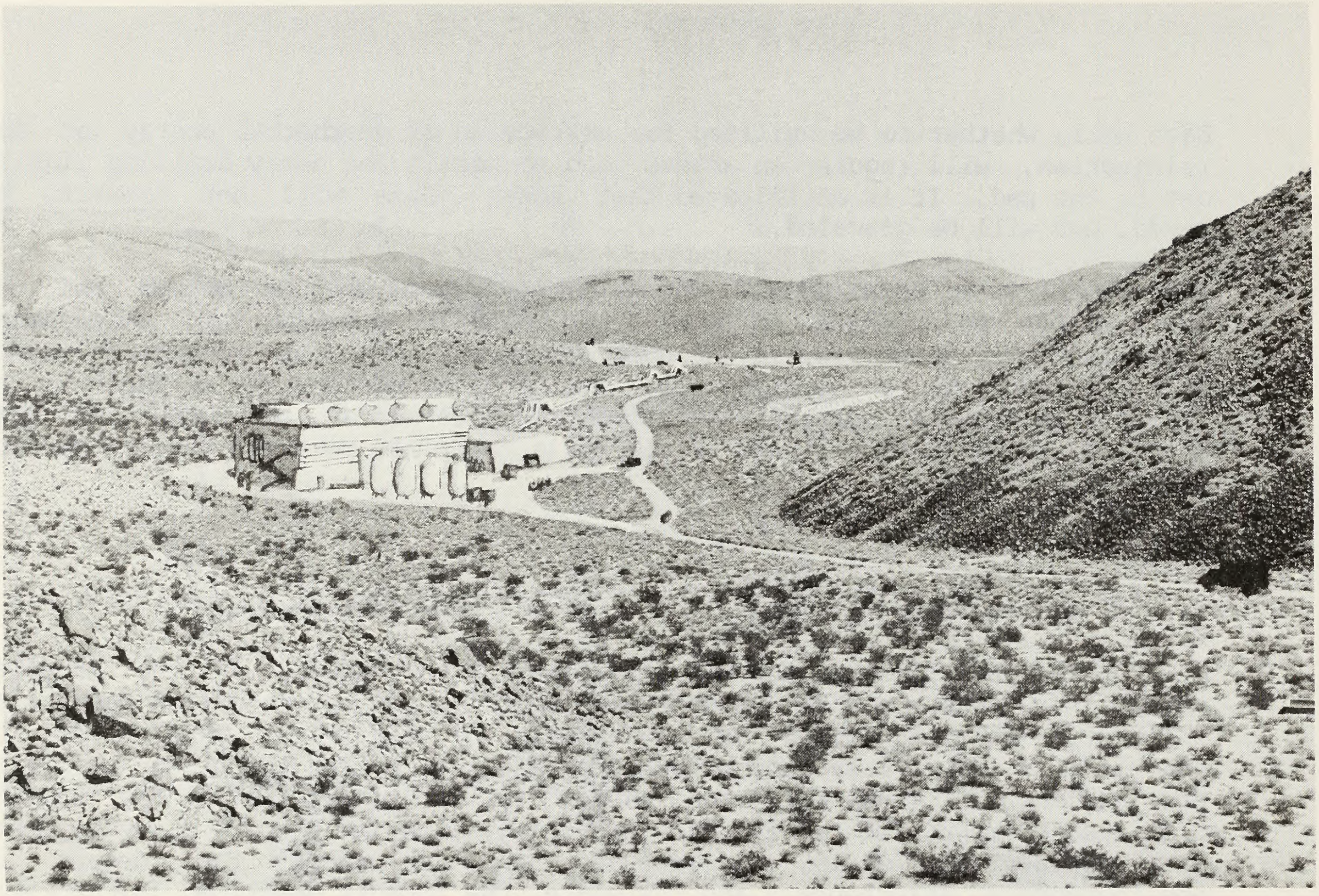


Fig. 1.3-6 FIELD DEVELOPMENT STAGE GEOTHERMAL DEVELOPMENT MODEL

In addition to field development, construction activities will also be short term visual features.

Simulated Features of Development and Construction Activity.

1. Access roads surfaced with gravel or impervious composition.

2. Development and reinjection wells. Well heads would replace drilling rigs. Each pad 150' by 500' or 150' by 300'.

3. Excavation and berms for mud sumps (100' by 300' by 15' deep) and reserve pits (150' by 150' by 10' deep).

4. First stage flashing equipment mounted at each pad.

5. Insulated steam pipes with expansion loops.

6. Cooling towers and turbine generator buildings.

7. Vehicular activity: scrapers, graders, backhoe, tractors, concrete mixers, air compressors, large trucks.

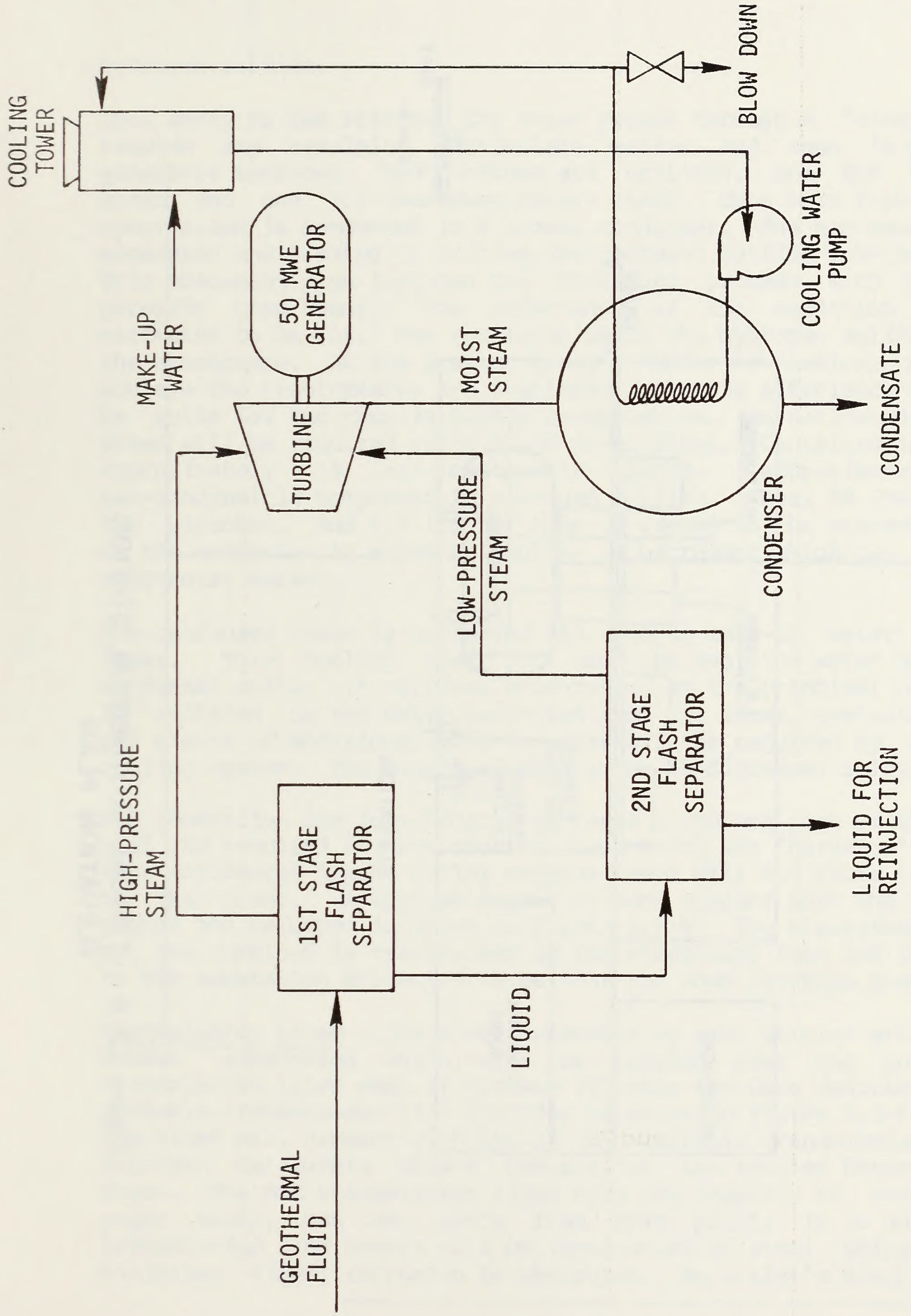


Figure 1.3-7. DIRECT-FLASH STEAM CYCLE, 2-STAGE

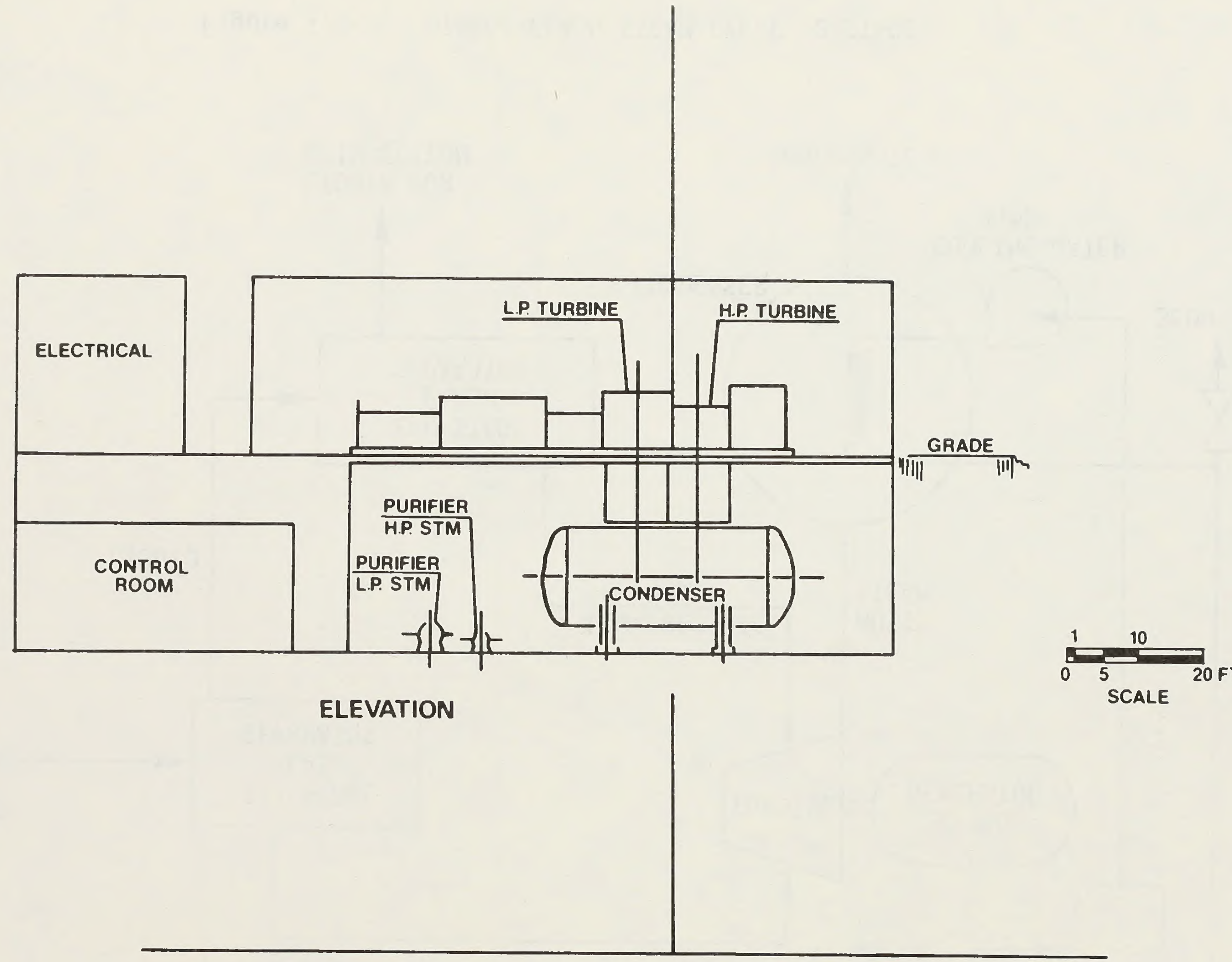


Figure 1.3-8 TYPICAL GEOTHERMAL STATION – ELEVATION PLAN

hydrogen sulfide.

Upon entry to the station, the steam passes through a "cleaning" unit which removes any remaining particulate matter and then is passed through the generator turbines. Two turbines are utilized, one for the high-pressure steam and one for the low-pressure steam. Upon exit from the turbines, the spent steam is condensed in a common condenser. The non-condensible gases are separated and treated to oxidize the hydrogen sulfide into sulfur or sulfates. This abatement plan includes the Stretford process with hydrogen or iron peroxide supplement. The efficiency of the oxidation is conservatively estimated to be 95%; the remaining 5% of the hydrogen sulfide is vented to the atmosphere. At the present time, a number of chemical processes which can achieve the requirements are available; the 95% efficiency is considered to be quite low and thus is highly conservative. An estimated 800,000 lbs/hr of steam will be required for a 50 MW power plant. Contained in this steam is approximately 1% non-condensible gases; approximately 1% of the non-condensible component is hydrogen sulfide. Thus, 80 lbs per hour enters the scrubber, and 4.0 lbs per hour is vented to the atmosphere. The product of the oxidation is elemental sulfur, a byproduct which can be sold on the commercial market.

The condensed steam is collected and used as make-up water for the cooling tower. This cooling tower is used to cool the water passing through the condenser coils; it utilizes evaporation as the principal means of cooling. In addition to the water collected from the steam, approximately 200 gallons per minute of additional make-up water will be required by each power plant cooling system. The source of this water is discussed below.

All generation stations located on lands which are part of the NWC withdrawal will be required to have control rooms which are "hardened"(5). This insures that accidental impact during weapons tests will not cause irreversible damage to the plant. A typical layout of such a plant with the control room below ground and hardened is shown in Figure 1.3-9. The electrical power generated by the turbines is transformed in the electrical room and then is transmitted to the substation projected to be near the Coso Junction Road.

<u>Transmission Lines</u> - The power generated by each station will be brought to a common substation which will be located near the north-south running transmission lines east of Highway 395 near the Coso Junction Road. The most probable transmission line corridor is shown in Figure 1.3-10. At this point, the lines will connect with one of the available transmission lines owned by Southern California Edison Company or Los Angeles Department of Water and Power. The SCE transmission lines have the capacity to carry the projected power south, but not north from this point. It is anticipated that the transmission line towers will be constructed of steel using a design which minimizes visual intrusion to observers. An artist's simulation of what such

---

(5) By "hardening", it is meant that the facility is constructed in such a manner that it is impervious to accidental impacts.

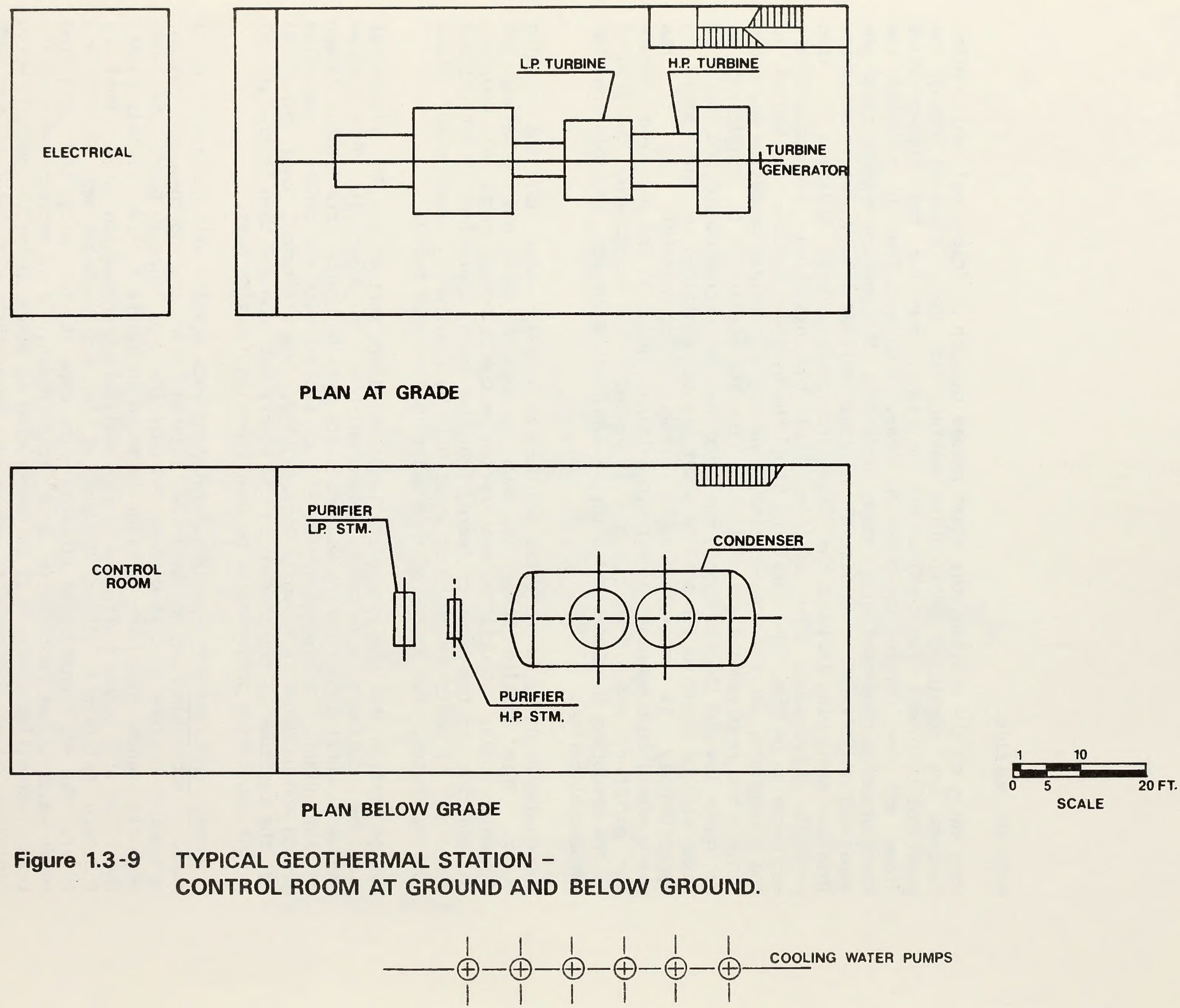


Figure 1.3-9 TYPICAL GEOTHERMAL STATION – CONTROL ROOM AT GROUND AND BELOW GROUND.

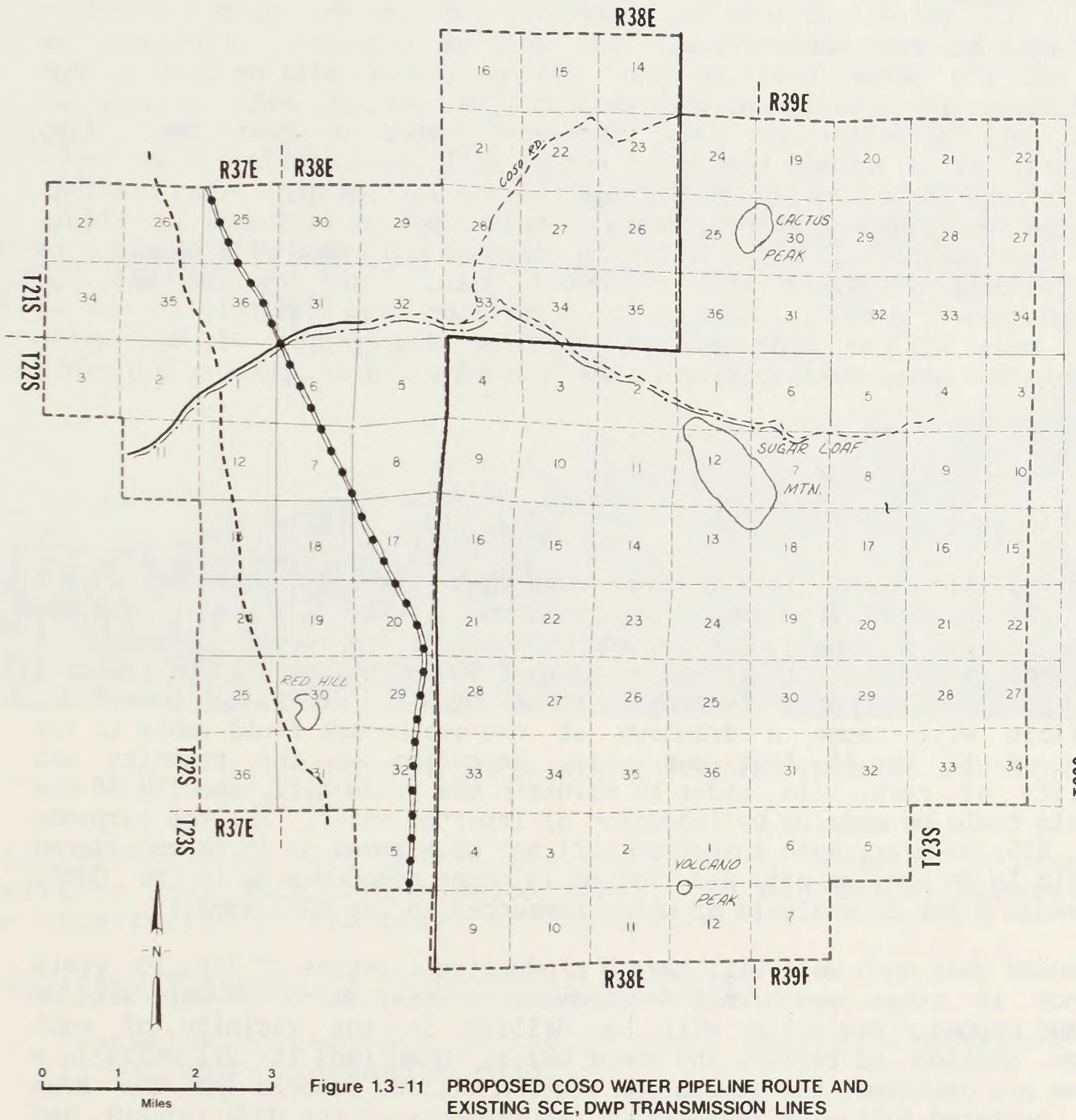


Figure 1.3-11 PROPOSED COSO WATER PIPELINE ROUTE AND EXISTING SCE, DWP TRANSMISSION LINES

---- SCE 115 KVDC Transmission Line

DWP 230 KVAC Transmission Line

NWC Boundary

-·-·- Proposed Coso Water Pipeline Route towers may look like is shown in Figure 1.3-11.

Water Utilization - It is assumed that the liquid fraction of the geothermal fluid will be reinjected into the reservoir, and that the vapor fraction of the fluid will be used consumptively for cooling purposes. Although the majority of the water used by the cooling towers will be derived from condensed steam, it is estimated that each 50 MW station will require an additional 323 acre-feet per year "make-up" water to meet the cooling requirements. It is assumed that this water will be supplied from wells drilled in the Rose Valley and brought to the various generation stations using a pipeline. The most likely route of this pipeline is shown in Figure 1.3-11. The pipeline will be 12 inches in diameter and pumps will be sized to permit transport of 4,000 acre feet per year. The pipeline will be constructed above ground. During the operation approximately 1 MW of electrical power will be consumed. A detailed description of the water requirements and water availability in the area is given in Appendix B of this EIS.

1.3.5.5 Closeout

The estimated life of the field is unknown at this time. One major factor will be the amount of drawdown of the geothermal fluid. A 50 MW steam power generation station in Zone 1 will use approximately 2,300 acre-feet per year (750 million gallons). It is estimated that 600 acre-feet will be replaced annually by natural recharge, leaving an annual deficit of 1,700 acre-feet. This deficit will cause a drawdown of the geothermal fluid table in the reservoir of 17 to 45 feet per year, depending on the porosity and permeability of rock. In order to maintain the productive capacity of the field, this could be made up by injection of imported water. For the purposes of this EIS, however, such injection will not be assumed as it is considered unrealistic in an area as arid and limited in water resources as is the CGSA. (See Appendix B for an analysis of water resources in the CGSA area.)

It is assumed that each well will have a productive lifetime of 7 to 10 years (experience in other geothermal developments), after which the well will be plugged and capped. New wells will be drilled in the vicinity of each generation station to replace the spent wells. When (and if) all wells in a given area are depleted, the generation station will be removed and the area will be restored following restoration requirements of the USGS and BLM, and the NWC within the withdrawal.

1.3.6 Noise

Significant noise emissions are associated with all aspects of drilling operations. During the mud drilling phase, the primary noise producers are

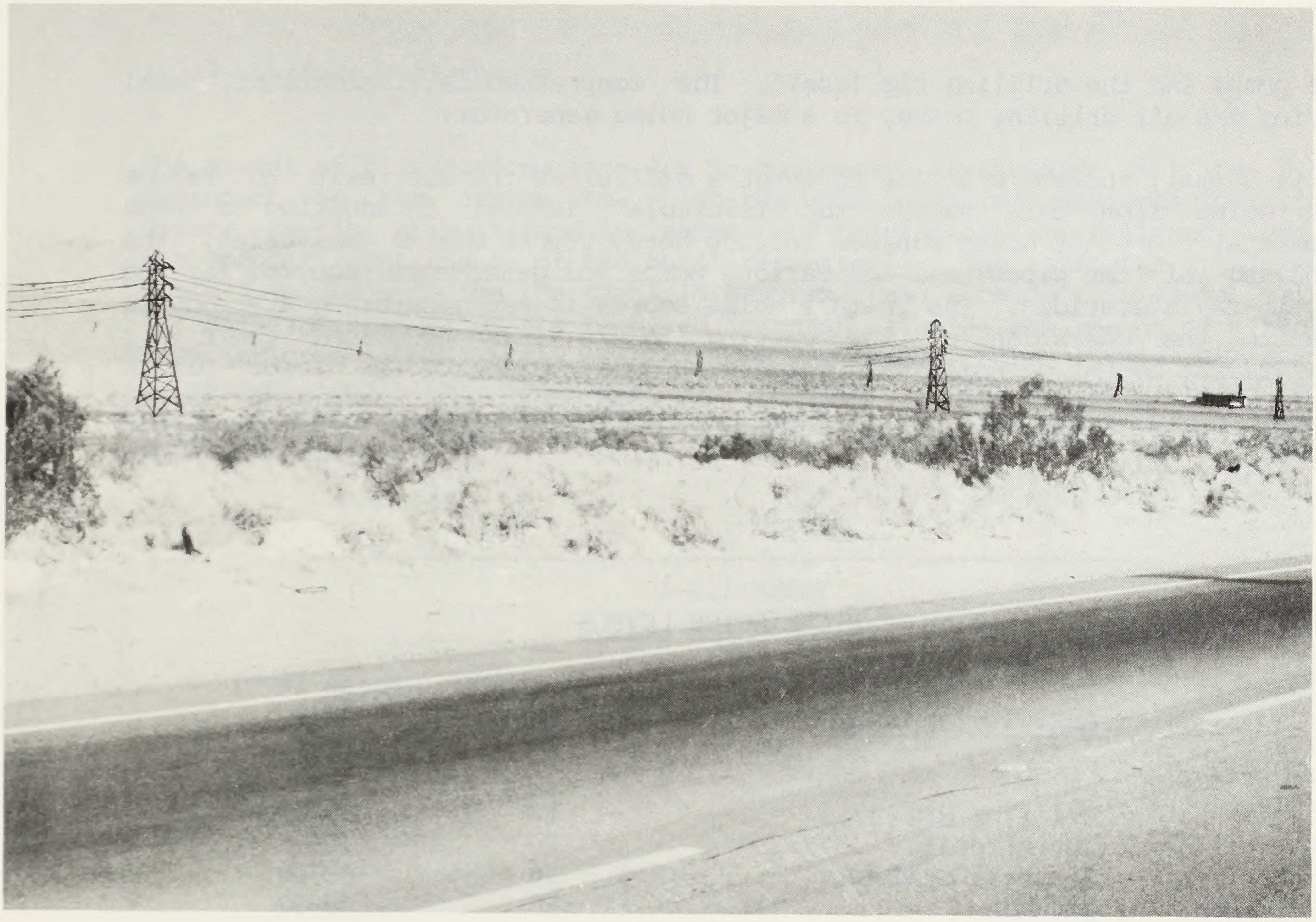


Fig. 1.3-10 RESOURCE UTILIZATION STAGE GEOTHERMAL DEVELOPMENT MODEL

Electrical power will be transmitted from the generation plant to the existing available transmission lines. An electrical substation will be constructed at the point of connection.

Simulated Features of Development Activity.

1. Transmission corridor including steel towers, electrical power lines, and maintenance road.

2. A common substation where power generated by each station will be transferred to a major north-south transmission lines.

the pumps and the drilling rig itself. The compressed air generator, used during the air drilling phase, is a major noise generator.

It is normal, current practice to mount a muffler on the air exit to reduce the noise from this source to "tolerable" levels. In addition to these elements, the other noise sources include heavy trucks making deliveries, the handling of the pipes, and the various pumps and generators required for the day-to-day operations. The primary noise source in the generating stations is due to the operation of the cooling towers. In addition, there is a significant amount of noise associated with construction of the power plants as well as with earth movement required for well pads and sumps. Representative noise levels near equipment which would be utilized are given in Table 1.3-1.

TABLE 1.3-1
TYPICAL NOISE LEVELS

Activity or Source	Distance Feet	Noise Level dB(A)
Drilling Rig	50	90-102
Jet Aircraft	200	120
Scraper, Grader	50	80-94
Backhoe	50	72-92
Tractor	50	76-96
Large Truck (diesel)	50	82-93
Concrete Mixer	50	75-88
Air Compressor	50	75-86
Jack Hammer	50	82-92
Air Drill	50	81-90
Rock Drill	50	85-95
Cooling Tower	10	85
Turbine/Generator (Enclosed)	25	70-75
50 MW Generator Facility	700	60-65

The values given in Table 1.3-1 are representative values derived from measurements taken at the fence line surrounding geothermal development sites. A detailed description of the projected noise environment is presented in Section 2.3.

1.3.7 Surface Disturbance

The amount of disturbed surface due to geothermal development will be highly dependent on the degree to which the USGS Geothermal Resource Operational Orders, special stipulations in leases, and regulations are followed; and on the proper management of the total resource(6). The estimates developed in Table 1.3-2 is based on the scenario described and represent average values. If drilling pad sites are required in rough terrain, the amount of disturbed land could be significantly greater than estimated here. This is due to increased length of access roads, increased amount of land exposed on the sides of hills for cut-and-fill operations, and increased disturbance due to pipeline access.

---

(6) Management of the total resource can be accomplished by "unitization" of the field. By unitization it is meant that the field is operated by a single entity for the various lessees, with each participating in the proceeds according to a predetermined formula. This may be required by USGS if it is determined to be desirable for geothermal reservoir management.

TABLE 1.3-2

ESTIMATED SURFACE DISTURBANCE
PER 50 MW GENERATION STATION

Facility	# Per Station	Disturbed Area Acres
Production Well Pads	6	10.3
Reinjection Well Pads	6	6.1
Mud Sumps	12	8.3
Reserve Pits	6	3.1
Power Plant	1	6.0
Access Road	2 miles	6.1
Maintenance Roads	14 miles	23.4
Unsuccessful Wells Including Sump & Pits	2	5.9
Transmission Line'	1	2.0
Steam Pipelines	5 miles	6.06
Total Acres Disturbed per Station		74.26
1200 Replacement/Exploratory Wells (300) Pads		
Drill pads	300	510
Mud Sumps	600	420
Reserve Pits	300	150
Reinjection Wells	150	150
Access Roads	300	120
Total		1350
11 Operating Plants		800
NWC Plant		110
Total Disturbed Area for the life of the Project		2260

In addition to the above, there will be the surface disturbance caused by the transmission line from the Zone 1 area to the substation near Coso Junction as well as the substation itself. The 1200 replacement/exploratory wells indicated in Table 1.3-2 will be drilled over the lifetime of the project. As complete revegetation is unlikely in this desert environment, the total disturbed acreage considered is shown as the sum total of all of the wells drilled. The transmission line will require a maintenance road with estimated surface disturbance of 7.2 acres and the substation will occupy approximately 2 acres. The total amount of disturbed land, assuming a total of eleven 50 MW generation stations, would thus be approximately 825 acres of land. In addition, the generation stations which will be constructed by the Navy will cause the disturbance of approximately an additional 90-110 acres.

1.3.8 Costs and Employment

The costs of development of a geothermal resource appear to vary widely with geographic area and with the individual developer. If the field is not well characterized, exploration costs, exclusive of a test well, are on the order of $500,000 for a typical lease. Well drilling expenses are highly dependent on the depth of the well and on the local geology. Costs for a well have been estimated to be in the range of $0.5 million to $1.5 million. A typical well in the Geysers area is estimated to cost somewhat over $1.0 million (Glass, 1977). This figure does not include any costs due to problems which may be encountered during the drilling. A common problem encountered during drilling is the loss of a portion of the drill string in the well. If this occurs, it must be "fished" out or (if not removed) drilled around. Well fishing jobs are quite costly and can easily add up to $25,000 per incident. Other costly problems include lost circulation which can range from $10,000 to $20,000 for small problems, and up to $250,000 for major lost circulation incidents. Lost circulation means that the drilling mud does not return to the surface and implies that either the mud is being lost in porous rock or the drilling string has malfunctioned.

The cost of construction of a power plant of the type described is very difficult to estimate. Based on current costs in other areas, it is estimated that a 50 MW plant in the CGSA will cost $20-$30 million. Using the costs experienced in The Geysers area, the estimated cost of eight miles of transmission line from the power plants to the main substation near Coso Junction will be $11.5 million. In addition, the costs of transporting water will have to be added to the costs of the overall project. The cost of the water pipeline is estimated to be $2,500,000 which includes costs of the pipe, installation, and pumping equipment (LADWP, 1978).

Employment projections are based on projections made for similar projects in other geographical areas in the U.S. It should be noted that the constraints imposed by the NWC with respect to access and the requirement that the area be cleared during certain weapons tests may require more hours (and therefore more personnel hours) than would be the case for other areas. This is due to the fact that all personnel must be cleared from the area when tests which may involve the area are conducted by the NWC. The NWC estimates that the area will have to be cleared on the average of 14 times per year. If the time lost is on the average of 4 hours each time the area is cleared, the increase in

---

Glass, W.A., 1977, "Drilling Methods and Costs at the Geysers", Geothermal Resources Council, Transactions, Vol. 1, May, 1977.

drilling costs could be as great as $15,000 per year per drilling crew. Projected employment without regard to NWC constraints is shown in Table 1.3-3.

TABLE 1.3-3
PROJECTED HUMAN RESOURCE REQUIREMENTS

Period	Employment	Average	Total
1980-83	Exploratory Drilling	50	
	Geotechnic Scientists	13	
	Road Crew	4	67
1984-85	Construction of 1 plant	145	
	Exploratory Drilling	110	
	Road Crew	4	
	Water Pipeline (avg.)	0.5	274
1986-90	Plant Operators	15	
	Exploratory Drilling	160	
	Road Crew	4	
	Workover Crew	25	
	Construction Crews	145	349
1991-95	Plant Operators	45	
	Exploratory Drilling	160	
	Road Crew	4	
	Construction Crews	145	
	Workover Crews	45	399
1996-2000	Plant Operators	75	
	Exploratory Drilling	210	
	Road Crew	4	
	Construction Crews	145	
	Workover Crews	45	479
2001-05	Plant Operators	105	
	Exploratory Drilling	210	
	Road Crew	4	
	Construction Crews	145	
	Workover Crews	45	509
2006-10	Plant Operators	135	
	Drilling Crews	160	
	Road Crew	4	
	Construction Crews	145	
	Workover Crews	65	509

2011-15	Plant Operators	165	
	Drilling Crews	110	
	Workover Crews	65	
	Road Crew	4	344
2016-20	Plant Operators	165	
	Road Crew	4	
	Drilling Crews	60	
	Workover Crews	90	319

1.3.9 Hazards

This section describes the environmental hazards associated with geothermal development as identified to date. The environmental impact of the occurrence of an incident due to a hazard is disscussed in Chapter 2 of this EIS.

Over one-half of the area proposed for leasing is within the boundaries of the NWC withdrawal. The mission of the NWC is to be the principal research and development, test and evaluation center for air warfare systems (except anti-submarine warfare systems) and missile weapons systems and the national range/facility for parachute test and evaluation. The range is used for such testing. The probability of an accidental hit of a well head or generation station from a weapons test is low, yet it does constitute a real hazard. The consequences of an accidental hit from a weapons test are difficult to quantify. If the well head itself is struck, the most severe damage would occur due to uncontrolled discharge of the geothermal fluid. If a pipeline is struck, the degree of severity would be far less as the well could be rapidly shutdown. A hit on a generation station would have minimal environmental consequences as the design of these stations calls for "hardening". It should be noted that the danger to personnel associated with the geothermal development is essentially zero as no tests are permitted until the NWC range officer has determined that all personnel have either left the range or are in protective shelters.

A potential hazard associated with development of the Coso geothermal resources is well blowout. When this happens the geothermal fluid under pressure escapes to the surface in an uncontrolled manner. These uncontained fluids can cause severe damage to the environment, and ultimately to the viability of the resource itself. The Geothermal Unit of the California Division of Oil and Gas has identified five types of blowouts. Each of these is potentially capable of occurring if certain conditions are present or when drilling and completion practices are lax and not properly regulated. These types of blowouts are:

1. Punky Earth - A blowout occurs when steam or hot water under pressure

is allowed access to the punky earth below the shoe of the well casing or surface pipe, and pressure is great enough to break through to the surface outside of the casing. Punky earth areas can be recognized in the field and drilling in these areas will be avoided where possible.

2. Landslide - Causes rupture of the well below surface and escape of the geothermal fluid. The likelihood of an earthslide is very low; only one has been reported in the Geysers KGRA. These also can be recognized and avoided in most cases.

3. Improper Well-Head Completion(7) - Results in the escape of geothermal fluid at the casing interface. The probability of the occurrence of this type of hazard can be minimized by proper design, installation and supervision.

4. Inadequate Well-Head Bracing(7) - Caused by large internal pressure differentials which eventually crack and break off the casing below the landing flange. The probability of the occurrence of this type of hazard can be minimized by proper design.

5. Inadequate Casing(7) - Blowouts of this type occur when little or no surface casing is set and abnormally high, shallow reservoir pressures are encountered. The probability of the occurrence of this type of hazard can also be minimized by proper design.

---

(7) GRO Order No. 2 requires that all wells be cased and cemented according to certain specifications, and that blowout preventers and related well control equipment be installed and tested immediately thereafter and maintained ready for use until drilling operations are completed. Therefore, the likelihood of a blowout occurring is very small if existing requirements are met and every unusual situation is handled promptly.

1.4 RELATED PROJECTS

This section describes activities in the geographic area which can contribute to the cumulative environmental impacts which may be ascribed to the development of the Coso geothermal resource. The projects described are logically grouped into two classes:

> Energy production projects which influence the economic feasibility of geothermal energy development at Coso, or which can cause an accumulation of environmental impacts.
>
> Those activities in the immediate area which are within the socio-economic sphere of influence of the Coso development.

1.4.1 Energy Related Projects

The proposed leasing of the Coso KGRA area suggests an eventual development of geothermal energy as a source of electrical power generation. Geothermal energy, as a power source, is a developing industry throughout California and therefore current status of the state's geothermal power should be reviewed.

The five major KGRA regions in California established by USGS are: the Geysers Region; the Eastern Sierra Region; the Northeastern Region; the Central Coast Region; and the Imperial Valley Region (Figure 1.4-1).

The Coso KGRA is within the Eastern Sierra Region. Within this region is the Randsburg KGRA, which is directly south of Coso and the closest proven Federal KGRA. The northern one third of the KGRA is within the proposed California Desert Conservation Area (CDCA). Competitive geothermal leases will not be offered until the boundary of the CDCA and surface disturbance restrictions are finalized. Several noncompetitive lease areas, which border the KGRA, could be offered in 1981. The Mono-Long Valley KGRA, northwest of Coso, is also under consideration for leasing, pending a reevaluation of lease sizes offered by the US Forest Service. Currently an environmental analysis is being performed by the BLM in the Bodie KGRA prior to lease sale consideration. The Saline Valley KGRA, northeast of Coso is a low temperature resource and is currently considered for direct use application rather than electric power generation.

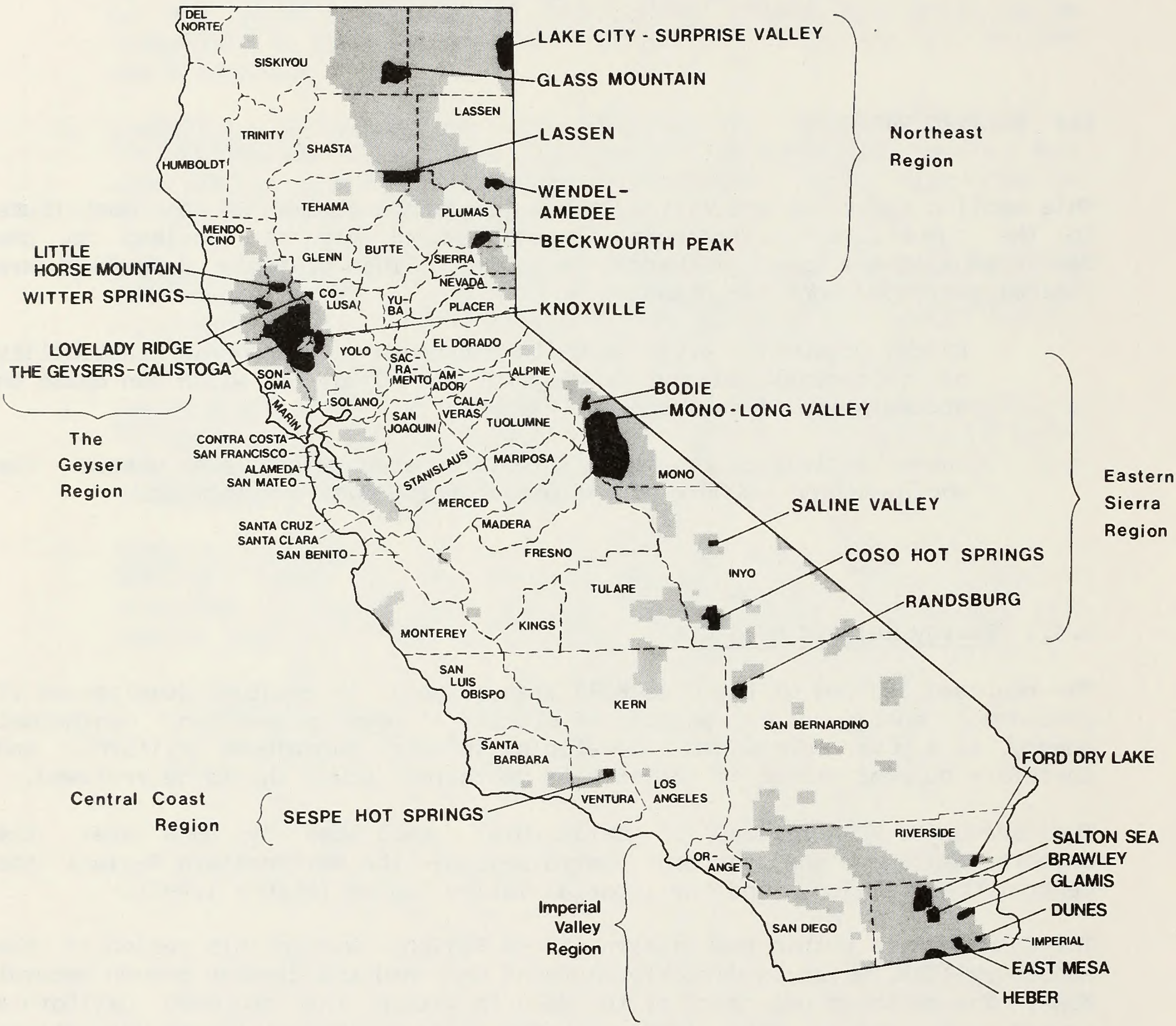


Figure 1.4-1 LOCATIONS OF CALIFORNIA KNOWN GEOTHERMAL RESOURCE AREAS (KGRA'S)

Federal KGRA's

Lands Valuable Prospectively For Geothermal Resources

The Coso KGRA is partially located on the Naval Weapons Center (NWC) in China Lake. The NWC is developing a geothermal program on their fee acquired lands. The NWC plans to develop the resource through a contractor, while still retaining the rights to the geothermal resource. The program is based on an estimated total field potential of 300MW, with plans for an initial development of up to 110MW by 1985. The development of the Navy's program would not necessarily decrease the NWC's commercial electric power usage until their geothermal electric power generation has the capacity to support their power needs at all times. Until then, power required by NWC will have to be held in reserve as a back up supply by the area's operating utility.

While the Navy's development of geothermal energy will not change the immediate energy supply and demand ratio of the surrounding socio- economic area, it could, however, provide an accumulation of environmental as well as socio-economic impacts. Due to the simultaneous development of the resource by Federal lessees and the Navy, cumulative environmental impacts could be generated.

1.4.2 Related Projects in the Immediate Area

The mountain ranges which surround the Coso KGRA have historically been areas for various mining claims. The Bureau of Mines Mineral Industries Location System data file (MILS) shows a number of scattered claims and prospectes within and peripheral to the CGSA. Mineral commodities include mercury, tungsten, uranium, stone and pumice. throughout the Haiwee Reservoir area there are several uranium exploration projects to date. The Department of Energy (DOE), with the Bendix Company has been exploring for uranium under the National Uranium Resource Evaluation (NURE) program. There are also several private energy mining companies currently drilling and evaluating in the area for this resource. The American Pumice Company owns seven pumice mines in the area, three of which they currently operate. To the west of the study area is the Renegade Mine which is under consideration for the mining of pozzolan. Within the study area is the Red Hill cinder cone, currently mined for cinder. If these proposed projects are developed or current production is increased, cumulative socioeconomic impacts may occur in the Indian Wells Valley during the development of the geothermal resource within the Coso KGRA. The City of Burbank is currently studying the feasibility of construction of a hybrid coal/geothermal power plant in the Rose Valley area. This study is still in the study phase and will undoubtedly be influenced by any development in the

Coso lease area.

Haiwee Reservoir, northwest of the study area, is currently contained by two dams; one near the middle of the reservoir (northern dam) and a second at the southern end. The California State Division of Safety for Dams has performed a safety analysis on the South dam and has found it to be structurally unsafe under the maximum ground shaking which can be expected from an earthquake in the area. The southern half of the reservoir is to be emptied by September 20, 1982. At the present time, the Los Angeles Department of Water and Power, the owner of the dam, has not made a decision on whether to rebuild or alter the dam.

2.0 IMPACTS OF THE PROPOSED ACTION ON THE AFFECTED ENVIRONMENT

This chapter describes the possible impacts to the environment from the proposed action. A description of each of the major components of the environment is presented followed by the respective impacts that could occur.

The Coso Geothermal Study Area (CGSA) is located in the southern California section of the Basin and Range Physiographic Province. The province extends from southern Oregon to the U.S. - Mexico border, generally characterized by isolated, roughly parallel mountain ranges separated by nearly level desert valley basins.

The CGSA is within a corridor of several north-south trending valleys, Owens, Rose, and Indian Wells--leading from the province center to its southwestern corner, the Mohave Desert. The study area roughly parallels Highway 395 and Rose Valley, with Dunmovin at the northern border, and Little Lake at the southern border. Its eastern border includes a portion the Naval Weapons Center China Lake Complex, paralleling the the western edge of the Coso Mountain Range.

The topography of the CGSA ranges in altitude from 2800' to 5950' above sea level. The terrain is uneven, mainly low to medium relief. The climate is harsh, arid and irregular with extremes of temperature and precipitation. This high desert steppe is within the Sierra Nevada rainshadow but receives more moisture than usual desert climates.

2.1 CLIMATE

2.1.1 Present Climatic Setting

The climate of the CGSA, typical of the southern California high desert region, is characterized by hot summers, cool to cold winters, large diurnal temperature ranges, low humidity, and little cloudiness or visibility restriction. The CGSA's latitudinal and continental positions are under the direct influence of the semi-permanent high-pressure cell located over the eastern Pacific Ocean. This high-pressure cell annually migrates north during summer, blocking the passage of cyclonic storms into the CGSA. During the winter season, the high-pressure cell migrates southward, permitting the cyclonic storms to move through the area.

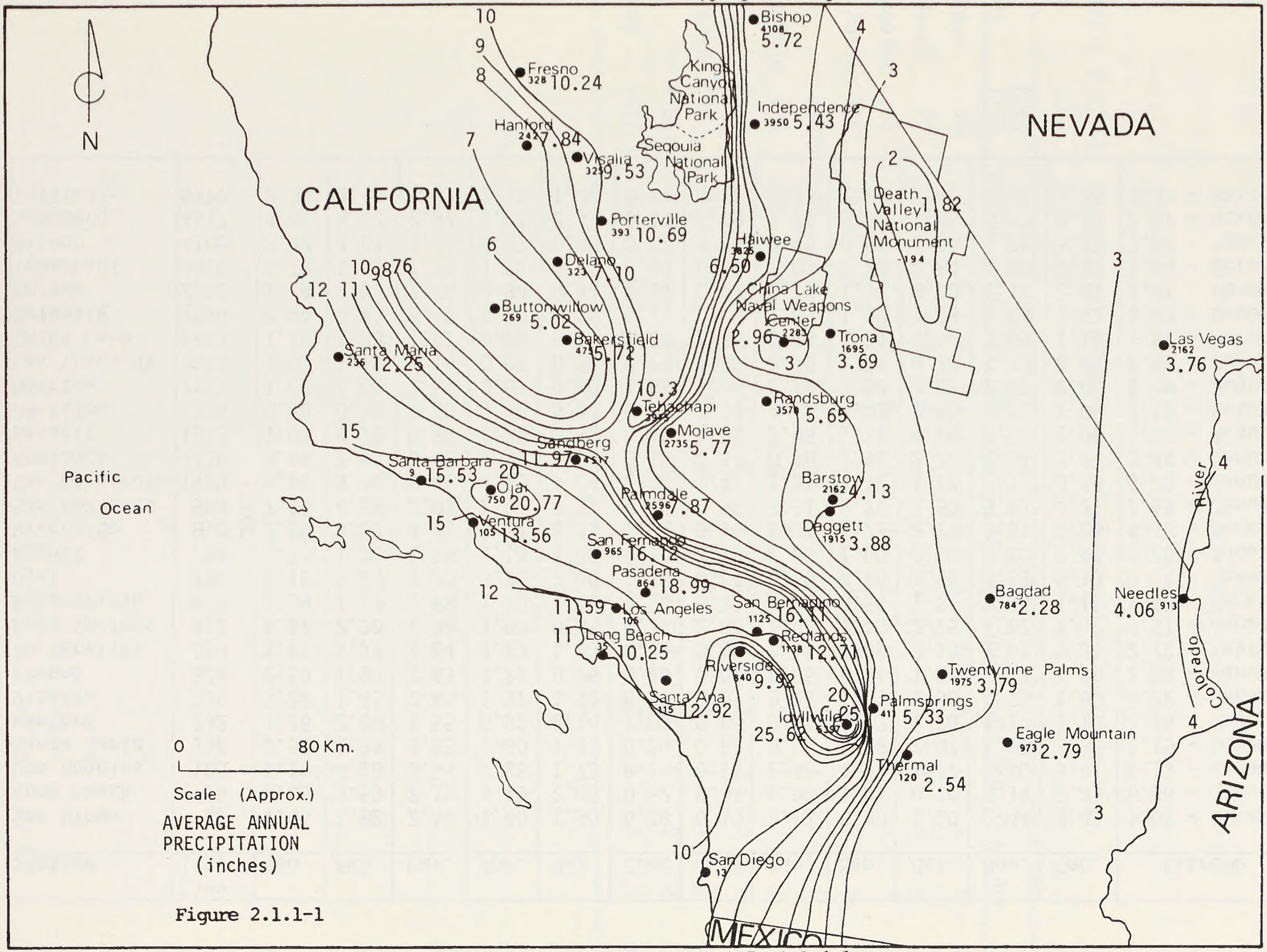
Local topography in the CGSA is an important climatic factor. The Sierra Nevada to the west form a barrier to passing storms and frontal systems, and create a rainshadow effect over the CGSA. The air is warmed as it descends down the leeside of these mountains, and the potential for condensation is decreased. As a result, precipitation varies from 20 to 55 inches on the windward side of the Sierras to less than 10 inches annually in the vicinity of the CGSA. The north-south orientation of the mountains and valleys in the CGSA exert influence on the regional air flow pattern, creating south to southeasterly or north to northwesterly winds most of the year.

The average annual precipitation data for selected southern California stations shown in Figure 2.1.1-1 illustrate the effects of the Sierra Nevada and the mountain ranges north and east of the Los Angeles metropolitan area. Based upon the local contours, the CGSA appears to have an average annual spatial precipitation range of 3 to 6.5 inches.

The Navy weather station at China Lake is the closest station to the CGSA which has long-term averaged precipitation data. The precipitation maxima at China Lake are greatest from November through April due to the southward migration of the eastern Pacific Ocean high pressure cell, permitting the movement of cyclonic storms and frontal systems across the region. From May through September, most of southern California remains dry with one exception. In the Mojave desert and the higher desert regions near the China Lake area, there is another rainfall maximum during the months of July, August, and September. This rainfall maximum is a result of convective activity, stemming from moisture flowing north and northwesterly from the Gulf of California. This convective activity is strongest in the south and east portions of the Mohave desert and decreases in strength heading towards the north and west desert areas.

Table 2.1.1-1 shows the greatest recorded 24-hour precipitation amounts for China Lake. Table 2.1.1-2 shows the mean number of days with precipitation inches. From Table 2.1.1-2, note that China Lake, the station closest to the CGSA, has at least one day per month per year (average) with precipitation $\geq$ 0.01 inches, except the month of June. All data in Tables 2.1.1-1 and 2.1.1-2 were taken from U.S. Naval Weapons Center Climatological Summmaries for 1946-1976.

No snowfall data for the CGSA were available for presentation. Therefore, average annual snowfall amounts (inches) were projected for seven stations with the CGSA using an Exponential Curve Fit program. Known average annual snowfall amounts (inches) and elevations (feet) of several southern California desert stations, together with elevations (feet) of the CGSA stations, were used to project snowfall amounts. The projected amounts for the CGSA are shown in Table 2.1.1-3. The snowfall amounts shown are a function of elevation, with no other factors included.



AVERAGE ANNUAL PRECIPITATION (inches)

Figure 2.1.1-1

Table 2.1.1-1 Greatest Precipitation in 24 Hours (inches)

Station	Elev. (ft)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Extreme
San Diego	13	2.65	1.82	2.40	1.40	1.50	0.28	0.10	2.13	0.90	1.20	2.44	3.07	3.07 - December
Long Beach	35	6.86	3.59	2.13	1.49	2.06	0.52	0.04	1.90	1.21	0.70	3.14	3.43	6.86 - January
Los Angeles	105	6.19	4.16	3.54	1.88	1.72	0.29	0.15	2.40	4.20	1.77	5.60	3.01	6.19 - January
Santa Maria	236	2.55	2.34	2.55	1.60	1.35	0.26	0.62	0.85	1.78	2.07	1.93	3.15	3.15 - December
Hanford	242	1.26	2.00	1.55	0.92	2.16	1.00	0.08	0.28	1.22	1.20	1.10	1.10	2.16 - May
Visalia	325	3.22	1.45	2.45	1.37	1.56	0.50	0.03	0.22	1.81	1.30	1.36	1.50	3.22 - January
Fresno	328	2.59	1.99	1.63	1.23	0.96	0.60	0.04	0.25	0.91	1.55	1.35	1.76	2.59 - January
Porterville	393	1.82	2.72	1.04	1.23	1.83	0.24	0.08	0.13	0.69	2.13	1.61	2.34	2.72 - February
Palm Springs	411	4.57	2.30	1.90	1.97	0.55	0.37	2.80	2.03	1.80	2.75	1.62	4.02	4.57 - January
Bakersfield	475	1.09	1.19	1.68	1.00	1.40	1.10	0.30	1.03	0.56	1.51	1.54	1.15	1.68 - March
Ojai	750	8.15	5.70	7.90	3.30	2.00	0.48	0.24	0.60	4.10	1.95	3.85	5.15	8.14 - January
Bagdad	784	1.50	1.20	1.75	1.10	1.75	0.50	1.29	2.20	1.00	2.00	0.80	1.48	2.20 - August
Riverside	840	2.59	3.22	4.41	3.07	1.39	0.24	0.10	2.01	1.71	2.27	1.31	3.28	4.42 - March
San Fernando	965	7.55	4.55	3.03	2.92	2.51	0.68	0.59	0.51	2.29	1.59	3.43	4.31	7.55 - January
San Bernardino	1125	5.29	3.78	4.46	3.85	1.24	1.02	0.42	1.21	1.72	1.68	2.12	3.86	5.28 - January
Redlands	1138	3.44	2.93	3.08	1.98	1.62	0.55	0.57	0.70	1.55	2.78	1.55	2.49	3.44 - January
Daggett	1915	1.03	0.70	0.88	0.65	0.37	0.45	0.96	2.06	1.11	0.66	1.08	1.01	2.06 - August
29 Palms	1975	0.88	0.73	0.80	0.48	0.34	0.11	2.34	2.16	1.43	2.55	0.82	1.08	2.55 - October
Barstow	2162	1.03	1.00	1.50	0.61	0.80	1.93	1.35	2.79	1.50	0.85	2.00	2.07	2.79 - August
Las Vegas,NV	2162	1.01	1.19	1.14	0.97	0.80	0.75	1.32	2.59	1.07	0.70	1.78	0.95	2.59 - August
China Lake	2283	1.26	1.28	1.62	0.88	0.19	0.29	1.35	0.75	1.54	0.58	1.03	1.14	1.62 - March
Palmdale	2596	2.44	2.43	2.39	0.88	0.35	0.15	0.28	1.05	1.02	1.63	1.63	3.43	3.43 - December
Mojave	2735	1.74	2.03	1.74	0.94	0.43	0.54	0.47	0.76	1.31	0.70	1.18	2.81	2.81 - December
Tehachapi	3975	1.78	1.64	1.74	1.77	0.63	0.63	0.30	2.03	2.20	2.84	1.89	1.47	2.84 - October
Bishop	4108	3.32	3.64	1.49	1.47	0.95	0.32	0.86	0.46	0.59	1.05	1.79	3.35	3.64 - February
Sandberg	4517	4.09	4.87	2.97	2.01	2.43	0.49	0.49	1.83	2.68	1.86	6.87	3.74	6.87 - November
Idyllwild	5397	2.94	3.40	4.37	2.35	1.26	0.37	1.12	2.23	1.80	1.40	2.54	3.26	4.37 - March

Table 2.1.1-2 Mean Number of Days with Precipitation ≥ 0.01 Inches

Station	Elev. (ft)	Annual	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
San Diego	13	41	6	6	7	5	2	1	< ½	< ½	1	2	5	6
Long Beach	35	30	5	4	4	3	1	< ½	< ½	< ½	1	2	3	5
Los Angeles	105	35	6	6	5	3	1	1	1	< ½	1	2	3	5
Santa Maria	236	45	7	7	7	5	2	1	< ½	< ½	1	2	5	7
Fresno	328	42	8	7	6	5	2	1	< ½	< ½	1	2	5	7
Bakersfield	475	36	5	6	6	4	2	< ½	< ½	< ½	1	2	3	5
Las Vegas	2162	24	3	2	2	2	1	1	3	3	2	2	2	2
China Lake	2283	15	2	2	1	1	1	< 1	1	1	1	1	2	2
Bishop	4108	29	4	3	3	3	3	2	2	2	2	2	2	3
Sandberg	4517	40	6	6	6	4	2	< ½	< ½	1	1	2	4	6

Table 2.1.1-3 Data Points Used in the Exponential Curve Fit Equation for Projecting Snowfall Amounts in the CGRA

Southern California Desert Stations	Actual Elev (feet)	Reduced Elev. (x) (feet)	Average Annual (y) Snowfall (inches)
Tehachapi	3975	2060	29.5
Sandberg	4517	2602	28.5
Bishop	4108	2193	8.6
Palmdale	2596	681	2.9
Mojave	2735	820	1.9
Las Vegas	2162	247	1.4
Twentynine Palms	1975	60	1.1
Daggett	1915	0	0.9
China Lake	2283	368	Trace (0.1)

The exponential curve fit program used the equation: $\ln y = \ln a + bx$, where (x) equals the station elevation in feet and (y) equals the average annual snowfall in inches. The station elevations are reduced so that the lowest station elevation equals zero, and the data points better fit the curve. The program computations were as follows:

$$a = 0.57,\ b = 1.51 \times 10^{-3}$$

$$\ln y = \ln(0.57) + 1.51 \times 10^{-3}(x)$$

$$y = 0.57e^{1.51 \times 10^{-3}(x)}$$

Correlation coefficient (r) = 0.84

Temperature within the CGSA may vary up to 15°F as a direct result of differences in elevation. Assuming an atmospheric lapse rate of 5.4°F/1,000 feet, the temperature at Cactus Flats (5,000 feet) would be almost 15°F cooler than the temperature at China Lake (2,283 feet) (see Table 2.1.1-4).

The mean annual temperature at the Naval Weapons Center weather station at China Lake is 64.0°F. Monthly normals range from 43.1°F in January to 86.2°F in July. The daily temperature extremes show a normal daily minimum in January of 28.7°F while the normal daily maximum is 102.3°F in July. Temperature normals and extremes for China Lake are presented in Table 2.1.1-5. Table 2.1.1-6 shows the monthly temperature extremes, °F, for the CGSA and surrounding high desert region (including Las Vegas, Nevada) for The period August 1977 through September 1978. The California data were reported by NWC personnel, and the Nevada data by the National Weather Service. It is difficult to discover patterns due to incompleteness of the data. but the table does reveal the large temperature ranges between the monthly maximum and minimum temperatures, with some differences of 60°F to 70°F.

Based upon long-term data from weather stations at several locations in the Mohave Desert, it can be estimated that the 50 percent probability date of the last spring frost is around April 1.

Typical of most desert areas, the relative humidity in the Coso CGSA is quite low. The mean monthly RH values at China Lake range from 23 percent in July to 52 percent in December. There is an average of 74 days (20.3 percent) per year of total cloud cover, with a maximum number of cloudy days per month during the winter season and a maximum number of clear days per month during the summer and early fall seasons.

Prevailing winds in the CGSA are from the south-southeast or north-northwest at all times of the year. Wind data were collected in the Coso area by the Navy for one year during 1977 and 1978, and a sample monthly average wind rose for August 1978 is shown in Figure 2.1.1-2. Long-term data show the annual average wind speed at China Lake to be 8.2 miles per hour, with the highest monthly average (10.4 mph) occurring in May. There are occasional high winds from the north and from the west, the strongest gust ever recorded at China Lake being 81 mph in March 1952. (See the Air Quality Technical Report.)

2.1.2 Impacts of the Proposed Action on Climate

Any effects of geothermal development upon climate will be localized and should not affect regional patterns. The only potential impacts of any significance should be upon microclimatic variables, and can be expected to occur largely within the study area.

Local temperature patterns will change by several degrees due to waste heat emitted from the power plants, particularly from the cooling towers. There

Table 2.1.1-4 CGSA Daily Temperature Comparisons
1. Daily Maximum Temperature
2. Daily Minimum Temperature
3. Daily Hourly Average Temperature

Date		Airport Lake (2300)	Little Lake (3180)	Rose Valley Ranch(3435)	Coso Basin (3560)	Red Hill (3600)	Haiwee (3820)	Cactus Flats (5000)
8-11-78	1.	104	98	97	98	99	96	92
	2.	72	72	63	72	70	73	66
	3.	87.0	84.3	78.5	84.3	82.3	82.9	78.8
8-12-78	1.	104	98	92	99	100	96	86
	2.	62	62	53	60	68	67	54
	3	83.9	82.1	76.9	79.8	82.7	80.9	71.7
8-13-78	1.	97	93	90	92	92	91	84
	2.	59	68	54	57	68	62	48
	3.	78.6	81.9	76.5	75.3	80.4	79.2	68.1
8-14-78	1.	95	91	90	91	92	89	84
	2.	51	62	49	53	67	63	53
	3.	75.3	76.7	69.5	76.5	77.2	74.9	69.2
8-25-78	1.	94	88	87	89	90	86	81
	2.	41	46	39	40	53	53	34
	3.	70.5	70.5	64.2	66.9	72.3	71.0	60.5
8-26-78	1.	96	90	89	91	93	90	83
	2.	44	52	46	44	52	54	39
	3.	72.2	72.2	68.6	68.9	74.0	74.1	63.7
8-27-78	1.	99	94	94	94	95	95	89
	2.	47	58	52	51	57	62	49
	3.	74.5	77.4	72.2	73.2	77.4	76.4	70.7
8-30-78	1.	103	96	96	96	97	96	89
	2.	50	64	53	54	66	68	49
	3.	78.9	81.8	77.4	76.4	82.1	81.3	69.1
8-31-78	1.	99	94	92	92	93	93	84
	2.	52	57	47	51	54	58	42
	3.	75.9	76.5	70.0	72.5	75.9	76.8	64.4

Table 2.1.1-5

Monthly Temperature Normals and Extremes, °F,
China Lake, California (1946-1976)

Month	Record High	Maximum	Normal Average	Minimum	Record Low
January	77	57.8	43.1	28.7	0
February	83	63.8	49.0	34.2	14
March	92	69.0	54.4	39.7	17
April	98	76.8	61.9	46.6	28
May	107	86.2	70.7	55.2	34
June	114	95.5	79.4	63.1	42
July	116	102.3	86.2	70.0	52
August	112	100.5	84.1	67.7	50
September	110	94.0	77.2	60.3	39
October	102	81.9	65.4	48.8	21
November	88	68.0	52.4	37.0	18
December	86	58.6	43.7	29.1	2
Annual	116	79.5	64.0	48.4	0

Table 2.1.1-6 Monthly Temperature Extremes, ^{o}F
High Desert Stations (including Las Vegas
August 1977 through September 1978

Month	Maximum and Minimum Monthly Temperatures									
	2162 ft Las Vegas NV	2283 ft China Lake	2300 ft Airport Lake	3180 ft Little Lake	3435 ft Rose Valley Ranch	3560 ft Coso Basin	3600 ft Red Hill	3825 ft Haiwee	4150 ft Bishop	5000 ft Cactus Flats
8-77	115 68	113 59	107* 55	N/A N/A	97 * 53	95 * 48	N/A N/A	97* 59	107 51	93 * 48
9-77	109 57	105 49	110* 47	N/A N/A	98 * 37	99 * 37	88 * 46	102* 54	98 36	96 * 41
10-77	96 48	93 36	98* 33	N/A N/A	88 29	65 * 23	94 * 37	91 40	97 29	86 * 38
11-77	84 31	83 23	86* 29	74* 23	74 15	72 11	73 * 39	76 24	78 17	74 * 49
12-77	75 31	77 24	73* 50	71* 27	68 * 16	65 * 16	72 * 27	74* 28	73 20	70 * 59
1-78	66 31	66 26	65* 34	62* 22	58 * 16	58 * 16	62 23	59* 28	61 19	44 * 33
2-78	74 33	74 30	N/A N/A	69 22	64 15	61 * 16	69 20	64* 24	67 20	60 * 20
3-78	85 41	88 37	N/A N/A	66* 33	75 22	81 20	** 103 30	80* 30	77 25	67 * 22
4-78	88 40	89 35	N/A N/A	80* 34	76 19	78 25	** 104 * 50	81 31	82 25	73 20
5-78	102 46	100 40	N/A N/A	92* 38	94 25	92 * 25	** 107 33	97 36	92 28	86 22
6-78	110 62	N/A N/A	N/A N/A	100* 48	100 40	103 * 37	108 * 51	105 53	99 44	95 * 35
7-78	115 66	N/A N/A	111* 54	100* 52	105 40	106 35	108 * 50	106* 51	104 44	99 * 34
8-78	114 61	N/A N/A	117 41	101* 47	109 38	112* 40	109 * 52	109 53	106 41	104 * 32
9-78	106 49	N/A N/A	101* 45	97* 54	N/A N/A	N/A N/A	96 * 52	N/A N/A	94 32	** 8 42

*Only partial data available for the month.

**Maximum temperature questionable

N/A No monthly data available

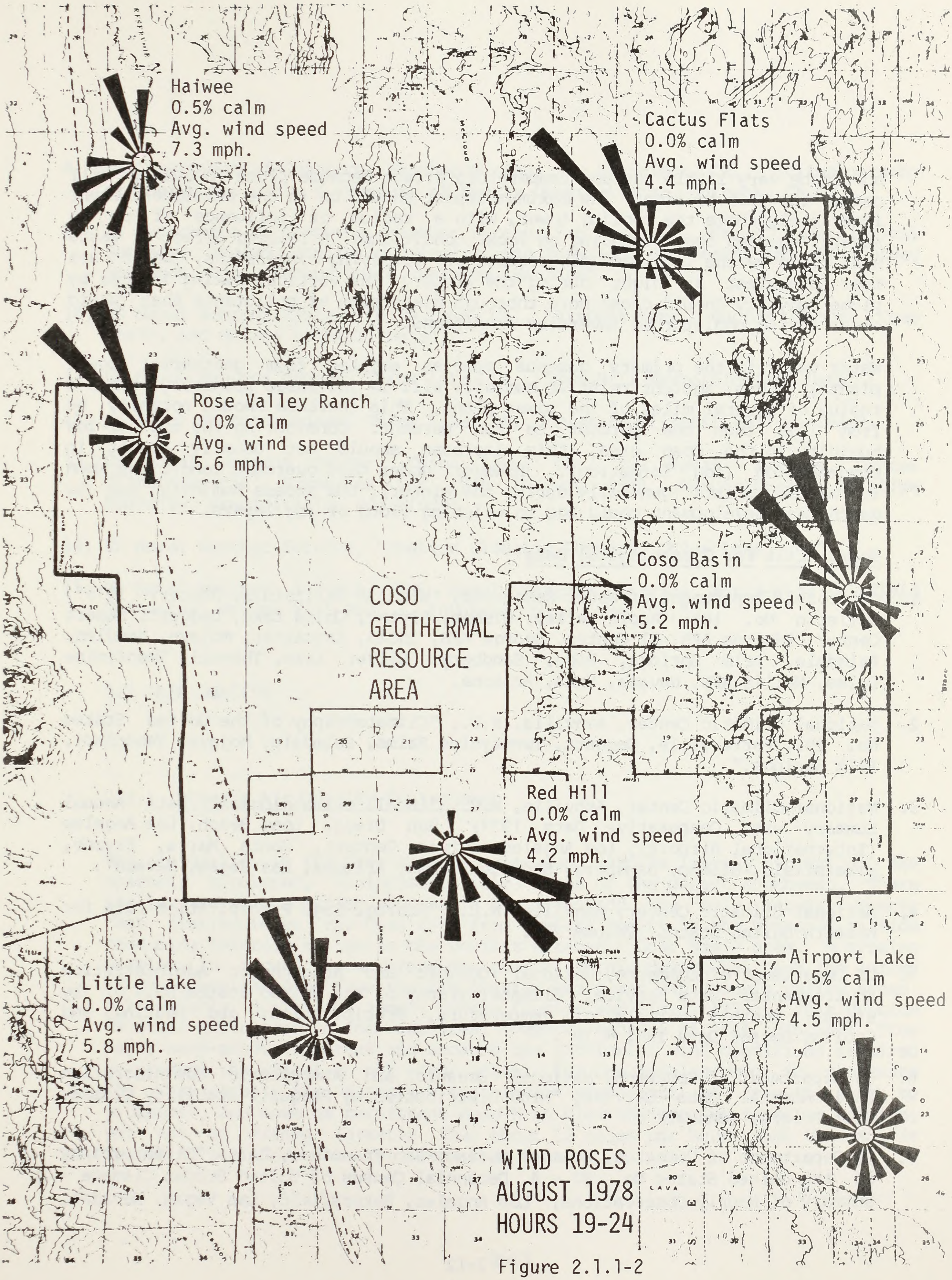

Haiwee
0.5% calm
Avg. wind speed
7.3 mph.
Cactus Flats
0.0% calm
Avg. wind speed
4.4 mph.
Rose Valley Ranch
0.0% calm
Avg. wind speed
5.6 mph.
Coso Basin
0.0% calm
Avg. wind speed
5.2 mph.
COSO
GEOTHERMAL
RESOURCE
AREA
Red Hill
0.0% calm
Avg. wind speed
4.2 mph.
Little Lake
0.0% calm
Avg. wind speed
5.8 mph.
Airport Lake
0.5% calm
Avg. wind speed
4.5 mph.
WIND ROSES
AUGUST 1978
HOURS 19-24

Figure 2.1.1-2

should be very little surface temperature effect because plume buoyancy will cause the heat to rise. The maximum impact should be in the atmosphere layer immediately above the cooling tower, with a radius of influence of up to several hundred feet depending on local conditions. A related effect of waste heat could be the localized disturbance of low-lying inversions, which are most prevalent at night during the winter. The vertical mixing induced by plume buoyancy should cause more thorough dispersion of pollutants than would occur during undisturbed inversion conditions.

Water vapor is the primary gaseous species emitted from geothermal power plants; thus, ambient relative humidity will be increased primarily within a radius of several miles of the power plant. This increase should normally be from less than one percent to ten percent. Considering the typical low humidity in the Coso area, this increase should not usually result in condensation (fog formation). However, under cold overcast conditions when fog already exists (generally during the winter), the excess humidity due to geothermal development could add to existing cloud or fog layers.

<u>Source List For Cimatological Data</u>

1. California Department of Water Resources, "Wind in California, January 1978", Bulletin No. 185; Apple Valley, Bishop, Blythe, China Lake, Daggett, Desert Center, Edwards AFB, El Centro, George AFB, Indio, Lancaster, Mojave, Needles, Palmdale, Palm Springs, Rice, Sandberg, Silver Lake, Thermal, Twentynine Palms, Nellis AFB, Nevada, Yuma, Arizona.

2. National Climatic Center, Ashville, N.C., "Climatography of the United States No. 20., Porterville, Daggett, Twentynine Palms, Palmdale, Mojave, Tehachapi, Palm Springs."

3. National Climatic Center, Ashville, N.C., "Local Climatological Data Annual Summary with Comparative Data 1977; San Diego, Long Beach, Los Angeles (International Airport), Los Angeles (Civic Center), Santa Maria, Fresno, Bakersfield, Bishop, Sandberg, Stockton, Yuma, Arizona, Las Vegas, Nevada".

4. National Climatic Center, Ashville, N.C., "Storage-Gage Precipitation Data for Western United States, Volume 21".

5. US Department of Commerce, National Oceanic and Atmospheric Administration Environmental Data Service, "Climatolography of the United States No. 81 (by state); Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1941 - 70".

6. US Department of Commerce, National Oceanic and Atmospheric Administration Environmental Data Service, "Wind Distribution by Pasquill Stability Classes Star Program (annual)".

7. US Department of Commerce, Weather Bureau, San Francisco, CA., "Climatography of the United States No. 82 - 4, Decennial Census of United States Climate - Summary of Hourly Observations; Los Angeles, Bakersfield, Las Vegas, Nevada".

8. US Department of Commerce, Weather Bureau, San Francisco, CA., "Climatography of the US No. 30 - 4, Summary of Hourly Observations; Burbank, CA.".

9. US Department of Commerce, Weather Bureau, San Francisco, CA., "Climatological Summary; Bagdad, Idyllwild, Visalia, San Fernando, San Bernardino, Riverside, Redlands, Ojai, Backus Ranch, Barstow, Hanford".

10. US Naval Weapons Center, China Lake, CA., "Airport Lake, Cactus Flats, Coso Basin, and Haiwee Rainfall Data".

11. US Naval Weapons Center, China Lake, CA., "Red Hill Meteorological Data".

12. US Naval Weapons Center, China Lake, CA., "Summary of April 1977 Weather".

13. US Naval Weapons Center, China Lake, CA., "US Naval Weapons Center Climatological Summaries for 1946 Through 1976, Temperatures, Relative Humidity, Precipitation and Winds".

14. US Naval Weather Service, "Station Climatic Summary, China Lake, CA.".

15. US Naval Weather Service, "US Naval Weather Service World-Wide Airfield Summaries, Volume VIII Part 1, Inyokern/China Lake, CA.".

2.2 AIR QUALITY

2.2.1 Present Air Quality Environment

The air quality in the Coso area is quite good, and is largely typical of the sparsely populated, nonindustrialized areas of the desert southwest. There are few man-made emission sources in the area, and the only natural source that distinguishes the Coso area from typical desert is the hydrogen sulfide producing fumarole system in the Devil's Kitchen - Coso Basin area. A growing problem in recent years throughout the California desert has been the influx of photochemical smog from the Los Angeles Basin and San Joaquin Valley areas, particularly during the summer months (Lester and Simon, 1978). This problem is still quite rare in the Coso area, however, because of the distance from major smog-producing areas and because the particular wind conditions required to produce the effect do not occur often. For Los Angeles smog to penetrate the Coso area, for example, the local wind must be from the south to southeast, and must be persistent enough to blow the smog up from Los Angeles, yet not so strong (greater than about 12 miles per hour) that the smog is funnelled past Coso into the Owens Lake area.

Air quality data are available for both Coso and China Lake. Long-term averages for ozone, light scattering extinction (B scat), and total suspended particulate (TSP) have been compiled for China Lake. Average winter ozone values range between 2 and 4 pphm, and average summer ozone values range between 4 and 6 pphm, with a peak recorded instantaneous value of 15 pphm and a peak hourly average of 13 pphm. Average B scat over a three- year period was approximately 0.4 (10 -4 m -1), and the latest annual geometric mean (1977) TSP value was 51.3 ug/m3.

The China Lake NWC staff conducted a monitoring program at several locations in the Coso area from August 1977 to May 1978. They measured carbon dioxide, ozone, hydrogen sulfide, total sulfur, and B scat, as well as ambient temperature and dew point. The data are summarized in Table 2.2.1-1, with the sampling periods listed for each site.

Table 2.2.1-1
Summary of Coso Air Quality Data

Species/Location Sampling Period	Average Hourly Concentration	Peak Hourly Average
Carbon Dioxide (ppm)		
Rose Valley Ranch, 9/77	354	380
Coso Basin, 9/77-1/78	346	390
Coso Resort, 2/78-4/78	335	360
Devil's Kitchen, 4/78-5/78	345	370
Ozone (pphm)		
Rose Valley Ranch, 8/77-9/77	4.0	8.0
Coso Basin, 9/77-12/77	3.6	9.0
Coso Resort, 1/78-4/78	3.0	8.0
Devil's Kitchen, 4/78-5/78	4.3	8.0
Hydrogen Sulfide (ppb)		
Rose Valley Ranch, 8/77-9/77	0	-
Coso Basin, 10/77	0	-
Coso Resort, 11/77-4/78	0	-
Devil's Kitchen, 4/78-5/78	22	140
B(scat) (x 10-4 m-1)		
Rose Valley Ranch, 8/77-9/77	0.46	1.40
Coso Basin, 9/77-1/78	0.38	2.65
Coso Resort, 3/78-4/78	0.27	1.40
Devils Kitchen, 4/78-5/78	0.35	0.80

Most of the values listed in Table 2.2.1-1 lie within the range that one would expect for a nonindustrialized desert region. The major exception is the hydrogen sulfide concentration at Devil's Kitchen. The average value is over two-thirds of the state standard one-hour average of 30 ppb, and the peak hourly average is almost five times the state standard. Devil's Kitchen is a man-made canyon area with a number of fumaroles, drill holes, and old wells, all of which are potential sources of hydrogen sulfide. The monitor was located only about 50 feet from the hydrogen sulfide source, and this, combined with very localized topographical and meteorological effects, would account for the high readings at Devil's Kitchen. Excessive ambient hydrogen sulfide is limited to a small area immediately surrounding Devil's Kitchen. The only other station to record even a trace of H_2S was Coso Resort, which also experiences intermittent fumarole activity within a quarter mile of the monitor.

It is instructive to consider B scat in terms of actual visual range. The Koschmieder formulation (Middleton, 1952) expresses visibility in terms of B scat:

$$V = 24/(3 \times B\ scat),$$

where V is the visual range in miles and B scat is in units (10^{-4} m^{-1}). Referring to Table 2.2.1-1, this yields a maximum long-term average visibility of 90 miles (Coso Resort, 3/78 - 4/78), and a minimum hourly average visibility of 9 miles (Coso Basin). These results indicate generally excellent visibility, with even the lowest long-term average visibility being over 50 miles (Rose Valley Ranch, 8/77-9/77). The 3-year average visibility at China Lake was approximately 60 miles.

Although a full range of pollutants such as CO, NOx, and hydrocarbons was not measured during the Navy study in the Coso area, ozone is generally considered to be a reasonable indicator of the presence of photochemmical smog. The average ozone concentrations were all quite low, falling well below the Federal one-hour average standard of 12 pphm. Thus, photochemical smog appears to be at worst a minor problem in the Coso area, even adjacent to U.S. 395 at Rose Valley Ranch.

In attempting to understand the present air quality at Coso, it is useful to consider the major emission sources in the region. There are major stationary sources (greater than 25 tons per year emissions) at China Lake, Inyokern, Olancha, Ridgecrest, and Trona. None of these lie within the boundaries of the CGSA. Mobile sources include traffic on U.S. 395, the Southern Pacific Railroad through Rose Valley, and aircraft overflights. Table 2.2.1-2 lists the total yearly emissions within the CGSA (EPA, 1977). Aircraft emissions have been estimated by assuming that 10 percent of all flights originating at Armitage Field (China Lake NWC) will fly over the study area (Ouimette, 1974).

Table 2.2.1-2
Emission Rates Within the CGSA
(Tons per Year)

Pollutant	U.S. 395	Railroad	Aircraft	Total
CO	403	1	76	480
Hydrocarbons	63.5	0.5	28	92
Oxides of Nitrogen	108	2	38	148
Particulate	9	--	90	99
Sulfur Oxides	3	--	15	18

Footnote: Emission rates were calculated using 1978 vehicle counts and emission factors from EPA Publication AP-42.

Fugitive dust can affect both visibility and public health. Lack of abundant rainfall means that the soil will be dry a great portion of the time, so dust can be re-suspended either by wind erosion or by mechanical turbulence such as automobile traffic. The wind speed threshold for wind erosion of exposed areas is 12 miles/hour (Bohn, Cuscino, and Cowherd, 1978), which is higher than the average wind speed for both Coso and China Lake. Thus, automobile traffic and other mechanical processes such as road grading and mining are the major fugitive dust contributors much of the time. The most recent (1977) annual geometric mean TSP value of 51.3 ug/m^3 for China Lake does not exceed either the state standard (60 ug/m^3) or the Federal primary standard (75 ug/m^3).

A drastic divergence from the normally occurring fugitive dust levels at China Lake is the case of the Owens Lake dust storm, which might occur up to a dozen times a year. Strong winds of 50 miles per hour or more flow in from the north, carrying with them tremendous quantities of dust from the dry bed of Owens Lake. During such episodes, TSP concentrations have been estimated to be well over 1000 ug/m^3 (Reinking, Mathews, and St. Amand, 1975), and visibility can decrease to less than one mile. The dust can extend over an area as large as 3500 square miles (NWC, 1978), encompassing both the Coso and Indian Wells Valley areas.

The 1977 Clean Air Act amendments specify prevention of significant deterioration (PSD) regulations to insure preservation of current air quality in sensitive areas. According to the regulations, all areas are placed in one of three classes. In Class I areas, only very limited air quality degradation is permitted. In Class II areas, moderate deterioration is allowed in line with somewhat limited growth. Class III regulations specify very liberal allowed increments. The Coso study area currently has a Class II designation, although it is possible that it may be reclassified Class I at some future date. Of The nearby National Park Service lands, Death Valley National Monument carries a Class II designation; both Sequoia and Kings Canyon National Parks are Class I. The closest Class I area to the CGSA is Domeland Wilderness Area in Sequoia National Forest, approximately 25 miles west-southwest of Coso Basin.

2.2.2 Impacts of the Proposed Action on Air Quality

This section addresses the air quality impacts of geothermal development considering ambient pollutant levels in terms of state and Federal standards as well as in terms of potential visibility degradation. Further details may be found in the Air Quality Technical Report.

2.2.2.1 Emission Rates

The principal gaseous emissions associated with geothermal development are the noncondensible gases hydrogen sulfide (H_2S) and carbon dioxide (CO_2), water vapor from flow testing and from the cooling tower, and exhaust from cars, trucks, and construction equipment. Trace amounts of mercury (Hg) have also been detected in the cooling tower air in a number of geothermal areas, (Robertson, et al., 1978); boron and arsenic are additional possible trace elements. In addition, fugitive dust will be emitted into the atmosphere as a result of vehicle and construction activity, as well as by wind erosion of exposed areas.

Predicted emission rates for an undeveloped geothermal area such as Coso, are at best rough estimates. The chemical composition of the effluent varies from one geothermal field to the next, and may even vary significantly from point to point within a single field. Thus, most probable emission rates can be predicted, but may have to be updated as the geothermal field is further explored and developed.

Noncondensible gases will be emitted during well flow testing and also from the off-gas ejector during power production. The emission rates of hydrogen sulfide and carbon dioxide for flow testing of one well are estimated to be 3.2 g/sec and 320 g/sec, respectively. For each 50 MW power plant, the carbon dioxide emission rate from the off-gas ejector should be approximately 1000 g/sec. Total H_2S production per plant is projected to be 10 g/sec but it will be scrubbed with 95 percent efficiency giving an actual emission rate of 0.5 g/sec.

The water vapor emission rate per well during flow testing should be approximately 3.2×10^4 g/sec. During power production, water vapor should be emitted from the cooling tower at a rate of 1.1×10^5 g/sec per 50 MW of power production. Cooling tower water is scrubbed of particulate matter before entering the plant cycle, so the cooling tower emissions can be assumed to be essentially pure water vapor, with the exception of trace amounts of mercury and other inorganic impurities (Crecelius, et al., 1976). Mercury emission rates are typically about 1.0×10^{-8} by weight of water vapor emission rates.

Exhaust emissions from automobiles, trucks, and drilling and construction equipment will vary as the level of field development changes, but should reach a maximum during the power plant construction stage. The total yearly average emissions predicted from the exhaust sources during this stage are listed in Table 2.2.2-1 (EPA, 1977). For comparison, the current CGSA emission rates (primarily due to U.S. 395 traffic) are also shown in Table 2.2.2-1.

As with exhaust emissions, fugitive dust emissions due to vehicle traffic and construction will vary with development. The maximum should occur during the high traffic volume periods of power plant construction when the dust suspension rate due to vehicles should reach approximately 200 g/sec per mile of access road during peak traffic periods. The maximum dust emission rates due to wind erosion of exposed areas should also occur during the plant construction and resource utilization periods, when exposed area is at at a maximum. Twelve miles/hour is the threshold wind velocity for dust production; below this value no wind erosion can be expected. The emission rate is a function of meteorological conditions, being proportional to the cube of the wind speed.

TABLE 2.2.2-1
Vehicle and Equipment Exhaust Emissions

Species	Yearly Average Emission Rate (Tons per Year) Existing in CGSA	Predicted During Development
CO	480	300
Hydrocarbons	92	33.5
Oxides of Nitrogen	148	43
Particulate	99	3.6
Oxides of Sulfur	18	3.8

2.2.2.2 Air Quality Impacts

Ambient pollutant levels have been calculated using an EPA approved Gaussian atmospheric dispersion model known as RAMR (*). Input information supplied to the model includes emission rates and other source physical parameters such as stack height and stack gas exit velocity, as well as meteorological information including wind speed, wind direction, mixing height, and atmospheric stability class. The model computer calculations estimate ground level concentrations within approximately a 20 km radius of the source. Models do not provide exact results, but rather give rough estimates. Uncertainties of at least ±50 percent should be attached to any model estimates. A short term model was used in the present calculations making it possible to directly address the one hour average state standard for hydrogen sulfide which is of major interest in geothermal development.

Model calculations were performed under a number of different meteorological conditions which could be expected to occur in the Coso area. In most cases, the maximum ground level ambient concentration was estimated to occur within about a kilometer of the source. In order to understand the air quality impacts of geothermal development, it is useful to point out the maximum

---

* A "model" is a mathematical description of the dispersion of a pollutant taking into account the effect of wind speed, wind direction, and atmospheric stability.

calculated concentration of each pollutant and to relate these concentrations to Federal and state air quality standards. The maximum concentrations of gaseous pollutants will be due to vehicular traffic and are shown in Table 2.2.2-2, along with Federal and state one hour average standards. The maxima are predicted to occur under stable meteorological conditions with winds of four miles per hour or less. As is obvious from Table 2.2.2-2, no exceedance of either Federal or state standards is predicted.

TABLE 2.2.2-2
MAXIMUM GASEOUS POLLUTANT CONCENTRATIONS
(Micrograms per Cubic Meter)

Pollutant	Maximum	Federal Standard	State Standard
CO	760	40,000	46,000
Hydrocarbons	70	160(6 a.m.- 9 a.m.)	-------
NO_x	12	100(annual)	470 (hourly)
Particulate	1.8	260(24hour)	100(24hour)
Oxides of Sulfur	0.4	365(24hour)	1310 (hourly)

The maximum ambient hydrogen sulfide concentration to be expected from full power plant operation is 21 ug/m^3, exactly one half of the state one hour standard of 42 ug/m^3. The hydrogen sulfide maximum from well flow testing is 33 ug/m^3. Although this is, by itself, well below the state standard, it is possible that power plant operation and flow testing could combine to cause an exceedance of the standard in a localized area. The model reveals that such an exceedance is most likely to occur during periods of wind speed greater than five miles per hour. Field sampling by NWC personnel has shown ambient atmospheric hydrogen sulfide to exist only in trace amounts in most parts of the CGSA, the exception being Devil's Kitchen where the state standard is currently violated due to natural sources.

Maximum concentrations of carbon dioxide and water vapor during full power plant operation are calculated to be 4.2×10^4 ug/m^3 and 6.5×10^6 ug/m^3, respectively. There are, of course, no government standards for these compounds. Based on the water maximum, the maximum expected mercury concentration is 65 nanograms per cubic meter (ng/m^3), although under most meteorological conditions this number will be about a factor of 10 lower. For comparison, ambient background mercury concentrations tend to be on the order of 1 ng/m^3. The ambient level at which long-term exposure is believed to cause damage to plants and animals (including humans) is approximately 100 nanograms per cubic meter. See the Flora and Wildlife Sections of this EIS for more details.

Fugitive dust is typically addressed in terms of 24 hour standards. The state standard is 100 ug/m^3; the Federal primary standard is 260 ug/m^3 and the secondary is 150 ug/m^3. The predicted 24 hour fugitive dust average due to vehicle traffic under stable (worst-case) meteorological conditions is about 1000 micrograms per cubic meter. This exceeds all state and Federal standards for suspended particulate matter. The 24 hour average for around-the-clock power plant grading and construction is 2300 ug/m^3, again exceeding all standards. For comparison, the current annual geometric mean total suspended particulate value is approximately 50 ug/m^3 at China Lake.

The maximum predicted fugitive dust concentration due to wind erosion of exposed areas is 2600 ug/m^3. It should be pointed out, however, that this should occur during periods of extremely high winds (greater than 50 mph), during which natural dust sources commonly cause exceedance of suspended particulate matter standards. The maximum under less extreme conditions (less than 18 mph) is 300 ug/m^3. If the wind remained at threshold (12 mph) for at least eight hours out of twenty-four, then the state standard would be violated; at least twelve hours would violate the Federal secondary standard, and twenty hours would violate the Federal primary standard.

A secondary effect of these fugitive dust emissions will be the endangerment of the health of people in the dust-laden sections of the CGSA. The Federal primary standards were written to protect the public health with an adequate margin of safety, so any exceedance can be viewed as a health hazard.

The model results show that maximum pollutant concentrations should usually occur within about a kilometer of the source, and that levels decrease consistently and rather quickly with increasing downwind distance. Therefore, it can be concluded that any primary pollutant impacts that may arise due to geothermal development will most likely occur within the Coso Range. The probability that government standards will be exceeded in Indian Wells Valley due to Coso development seems to be quite small.

2.2.2.3 Visibility Impact

One of the major air quality concerns is the impact of geothermal development upon visibility. The California desert has traditionally enjoyed very good visibility, and preservation of this visibility is considered to be important both to the public for its aesthetic value, and to the NWC for its value in allowing weapons to be observed from long range during tests. The Navy is concerned with visibility not only in the "visible" range (i.e., as perceived by the human eye), but also in the infrared due to their weapons system requirements. Both spectral regions are addressed in this section.

Considering the emission levels projected for geothermal development at Coso, the gaseous pollutant most likely to lead to visibility degradation is hydrogen sulfide. Hydrogen sulfide in itself, however, should not cause an impact. Rather, hydrogen sulfide can react to form sulfur dioxide, which can then undergo further chemical conversion to sulfate aerosol which, along with nitrate aerosol, is one of the most common visibility reducing species (see, for example, Cass, 1976). The hydrogen sulfide to sulfate conversion process is rather slow, so hydrogen sulfide emitted at Coso on a given day will not have formed appreciable quantities of sulfate aerosol until the next day.

Due to the time scale involved, the dispersion of sulfate aerosol should have a regional impact, not confined to the Coso study area. Considering the prevailing wind direction at Coso, the adjacent area of most interest would be Owens Valley and Indian Wells Valley. Since the dispersion models used in this analysis are not regional models, the sulfate concentrations in these areas cannot be calculated explicitly. As a conservative estimate, however, an upper limit to regional visibility impairment can be calculated using the dispersion model results for the outskirts of the CGSA. Doing so, full power plant development can be estimated to decrease visibility from about 61 miles to about 55 miles. This represents approximately 10 percent decrease in visibility. Although this is an upper limit and dispersion should decrease the visibility impacts downwind of the CGSA, it can nevertheless be expected that some degree of visibility degradation will occur throughout the extent of Owens Valley and Indian Wells Valley, depending upon wind direction. The NWC has indicated that this amount is not likely to adversely affect their mission, assuming that there is no further degradation of air quality in the region.

(See the Air Quality Technical Report.)

Fugitive dust from wind erosion has a potential impact on visibility only when the wind velocity is above the 12 mph wind erosion threshold (approximately 10 percent of the time). Normally under these circumstances, however, natural dust sources have already markedly decreased the visual range. During an Owens Lake dust storm, for example, which might occur up to a dozen times a year, strong winds of 50 mph or more flow in from the north, carrying with them tremendous quantities of dust from the dry bed of Owens Lake and decreasing visibility to less than one mile. Project-related disturbed area erosion should have little further effect. A more important impact ascribable to geothermal development is that of dust from vehicle traffic and construction activities during sub-threshold winds, when wind erosion will not be a factor. This is likely to have a local rather than a regional impact, since the heavier dust particles commonly settle out within a few kilometers of their source. Again using a conservative model to calculate the upper limit to the visibility impact, one can predict a visual range of 51 miles, compared to the annual mean of 61 miles, a decrease of 16 percent. However, this assumes the dust cloud to extend over the entire visual range (which is usually not the case), so the actual dust visibility impact will probably not be as severe as indicated here.

The areas of visibility impact due to fugitive dust and sulfate aerosol should not overlap. Dust impact is a localized effect because heavier particles settle out as dispersion progresses. Conversely, suflate aerosol will not normally affect the area adjacent to the source because of the 24 hour hydrogen sulfide to sulfate conversion time. The two effects should cause a cumulative reduction of visibility only when both dust and sulfate concentrations are high and the field of view crosses through both the local source area and the sulfate-laden extended region. The cumulative effect should never be any greater than the previously mentioned worst case decrease of 16 percent.

A specific consideration in terms of air quality, and visibility in particular, is that of Class I areas. Class I areas in the Coso region are Sequoia and Kings Canyon National Parks, and Domeland Wilderness area in Sequoia National Forest (approximately 25 miles from the CGSA). Due to the meteorology and topography of the area, it is unlikely that more than trace amounts of pollutants from the Coso geothermal development would find their way to these areas. Easterly, up-slope winds extending to the Sierra Nevada crest are extremely rare. Thus, it can be estimated that there will be no impact upon the Prevention of Significant Deterioration (PSD) increments allowed for Class I areas. Nevertheless, there could be visibility impacts in terms of vistas from mountain peaks in the Class I areas, looking across Owens Valley or Indian Wells Valley. The impact would most likely manifest itself as a uniform haze in the valley areas. The upper limit to visibility degradation discussed in this section would apply here. Domeland is the closest Class I area to Coso; however, it has few areas over 8000 feet in elevation, and thus offers few sweeping views to the east because of the intervening Sierra Nevada ridge. Sequoia and Kings Canyon, on the other hand, have a number of peaks at over 12,000 feet along their eastern boundaries, including Mt. Whitney at 14,494 feet, so visibility may be of more interest in these parks.

The main infrared absorbing species which can be expected from geothermal development are carbon dioxide and water vapor. Conservative regional estmates assuming full power plant development predict upper limit ambient level increases of 0.2 percent and 2.0 percent for carbon doixide and water, respectively. These increases should be insignificant in terms of infrared attenuation since natural levels of carbon dioxide and water can fluctuate more than this quite readily and quite often.

2.3 NOISE

2.3.1 Existing Noise Setting

Although the Coso study area is largely a very quiet, undeveloped region, there are a number of noise sources which can be considered significant. The greatest constant noise source in the area is U.S. 395, which runs approximately north-south through the western section of the CGSA. Computer modeling by Caltrans using traffic volume data has produced a noise contour map for U.S. 395 at Dunmovin, near the northwest boundary of the Coso study area (Caltrans, 1978). This map is shown as Figure 2.3.1-1, with all sound contours reported as L_{10} values, using the A-weighted decibel scale. As a general rule, it can be approximated that the ambient noise level decreases by 6 dBA with each doubling of distance from the source, so the highway noise contribution will be reduced to the typical desert background level of approximately 40 dBA (L_{10}) within about a mile of the highway.

There are several other man-made noise sources within or adjacent to the CGSA. There are mines near Cactus Peak, Haiwee Reservoir, and Red Hill, and an alfalfa ranch is located inside the study area just to the southeast of the abandoned community of Dunmovin. China Lake NWC contributes both ground-based and airborne noise sources. Navy vehicles use U.S. 395 and the Coso access road, and military aircraft can cause elevated noise levels for brief periods throughout the study area due to noise from the aircraft engines as well as from sonic booms. Military aircraft and small private planes and helicopters occasionally use the Rose Valley airspace as a north-south flyway. Rose Valley is also a low-level corridor frequently used by the Navy and Air Force during air combat manuevers.

Natural sources can make major contributions to ambient noise levels in the CGSA. In many sections, wind noise is probably the greatest of all noise sources, especially during the spring when windspeeds tend to reach a maximum. Rainstorms also provide limited periods of elevated natural noise, and large animals can make small contributions to natural ambient levels.

There are few existing human noise receptors outside of the western section of the CGSA. A few ranchers live along U.S. 395 in Rose Valley, and there is a small settlement at Little Lake, which includes a hotel and a gasoline station. There are workers at the mines and ranches in the area, and NWC personnel periodically visit most sections of the CGSA. However, none are stationed there, and seldom does anyone stay overnight. Two highly sensitive intermittent use areas are Coso Hot Springs and the Prayer Site near Devil's Kitchen, both of which are used periodically for Native American religious and medicinal purposes. There are no permanent residents at either of these locations. The largest population of human noise receptors in the CGSA consists of transients along U.S. 395. Most of these people do not stop in

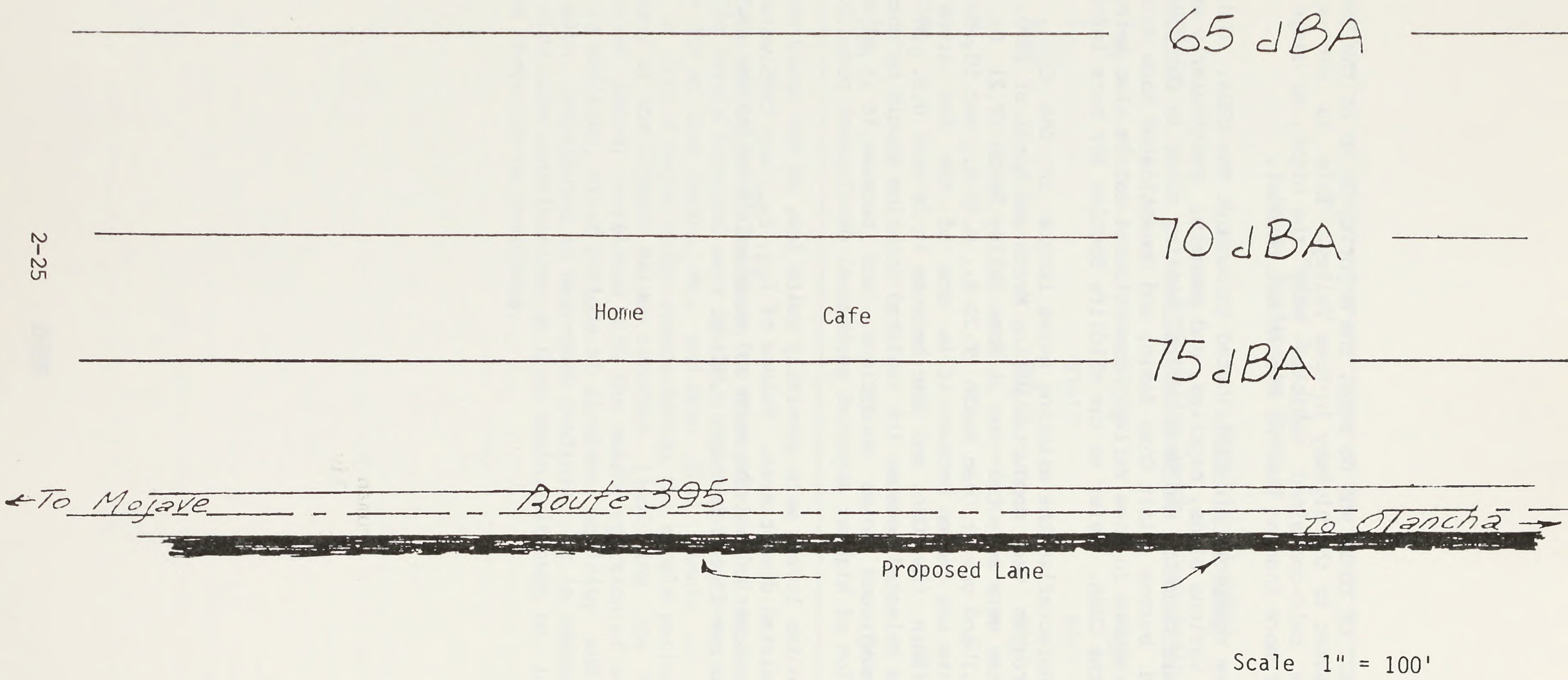


Figure 2.3.1-1 Existing Noise Contours at Dunmovin Resort, 1978

the Coso area. Of those who do stop, the majority do so at the Coso Junction Rest Area adjacent to the highway in Rose Valley. This is not a campsite, although some self-contained vehicles stay the night, so usage by any one individual for more than an hour or two is not unusual.

Non-human noise receptors are distributed throughout the CGSA. Indigenous to the area are various birds, reptiles, and mammals. Particularly sensitive to excess noise are raptors, who have several nesting sites in the Coso Range. A herd of wild burros visit Coso Basin, and domesticated farm animals can be found at the ranches in Rose Valley. Domesticated cattle also forage on the range within the CGSA. Refer to the Wildlife Section for more information.

In order to characterize the existing noise levels in the CGSA, a limited monitoring program was conducted during March and April of 1979. Two field monitoring sites were selected--one at Rose Valley Ranch (T.21 S., R.37 E., sec 26, S 1/2.) and one at Coso Basin (T.22 S., R.39 E., sec 10, NW 1/4). The Rose Valley site was chosen because it is one of the few areas of human habitation within the CGSA, and also because it is near U.S. 395. The Coso Basin site was selected because its isolated location should be characteristic of desert background noise conditions, and because it is adjacent to the localized region of highest expected geothermal development potential.

The observed noise levels were generally quite low, as one would expect for a largely unpopulated desert area. Values of L_eq, L_{dn}, and CNEL were calculated for each 24-hour period and the mean and standard deviation for each site were determined and are listed in Table 2.3.1-1.

Table 2.3.1-1
Noise Monitoring Results

Quantity	Sound Level (dBA) Rose Valley Ranch	Coso Basin
L_{eq}	52 ± 18	40 ± 5
L_{dn}	57 ± 17	44 ± 7
CNEL	58 ± 17	44 ± 7
L_5	55	51
L_{10}	46	43
L_{20}	37	33

Values L_5, L_10, and L_{20} are also shown in the table. The maximum 10-minute average noise levels recorded were 94 dBA (instrument maximum) at Rose Valley Ranch and 59 dBA at Coso Basin. Mr. and Mrs. Phil Hennis of Rose Valley Ranch kept a log of major noise events during the sample period, and it was found that many of the highest values recorded (including the 94 dBA peak value mentioned above) correlated with the nearby opertion of unmuffled farm equipment. In addition, brief periods of airplane activity and periods of high wind also contributed to near-peak readings. It is assumed that these two sources also made contributions at Coso Basin, although no log was kept there because there are no residents.

2.3.2 Impacts of the Proposed Action on Noise Levels

Noise impacts can result from direct geothermal activities such as well drilling and power plant operation, as well as from related activities such as automobile and truck traffic. Ambient noise levels should increase during the exploratory and early development stages, and should reach a maximum during the intensive field development and power plant construction phases. The noise impacts of geothermal development without mitigation measures are analyzed in this section. (See the Noise Technical Report.)

Noise sources due to direct geothermal activity will be restricted to several clearly defined areas. Vehicle noise sources, however, will exist intermittently along the entire network of roads which will be utilized during geothermal development and power production. U.S. Highway 395, which runs approximately north-south through the western section of the CGSA, is presently a heavily travelled roadway, with an average traffic volume of 4200 vehicles per day and a peak volume of 7600 vehicles per day on summer weekends. The approximately 300 vehicles per day that Coso geothermal development would contribute to this traffic volume should not significantly alter the current noise contours along the highway. Noise impacts should be observed, however, on the secondary access roads within the CGSA. These roads are currently lightly travelled, with an average of 20 or fewer vehicles per day. Single noise events during geothermal operations will range from 90 +dBA at roadside when trucks pass a point to 55 to 60 dBA at the passage of a small vehicle (NWC, 1979).

Noise impacts due to direct geothermal activity can occur at several stages of development. The first major impacts should come during site preparation and construction of well pads and power plants. Grading, in particular, could be a significant noise source since it may require several large pieces of earth-moving equipment to be operating simultaneously. Grading and construction equipment noise can be of two types; continuous noise generated by equipment such as generators or tractors, and sporadic noise from devices such as jack hammers or power saws. Typical noise levels from equipment likely to be used in geothermal construction are listed in Table 1.3.6-1. Table 2.3.2-1 shows typical overall drill site preparation and construction noise as a function of distance from the source. All values in Table 2.3.2-1 are taken from a noise analysis of a fluid-dominated geothermal project in the Imperial Valley (County of Imperial, 1979).

Table 2.3.2-1
NOISE FROM GEOTHERMAL DEVELOPMENT

Activity	Noise Level (dBA) At 100'	200'	500'	1000'	2000'	5000'
Site Preparation And Construction	78	73	66	58	50	38
Well Drilling	75	68	60	53	44	30
Well Cleanout	75	68	58	50	41	25
Flow Testing	78	73	66	59	52	42
Plant Operation	72	67	58	51	43	28

Further noise impact is likely to occur during drilling, cleanout, and flow testing of new wells. These are short-term operations compared to continous processes such as power plant operation. Cleanout, for example, commonly lasts only a few hours; well drilling requires several weeks of activity. Typical noise levels associated with drilling, cleanout, and testing activities are shown in Table 2.3.2-1.

Operation of the power plant represents the major long-term continuous noise source resulting from geothermal development. Major contributors include cooling towers, turbines, and steam jet ejectors. Because the cooling tower is physically large and has a large band frequency spectrum, it becomes the dominant noise source at distances greater than 200 feet from the unit (PG&E, 1979). Table 2.3.2-2 shows the contributions of individual power plant operations at close range (PG&E, 1979).

Changes in L_{eq}, L_{dn}, and CNEL values as a result of geothermal development will be a function of distance from the noise source as well as duration of the noise. The numbers listed in Table 2.3.2-1 are good approximations of L_{eq} values because they are all representative of long-duration continuous processes. L_{eq} values for non-continuous processes are more difficult to predict, but can often be approximated using similar conditions continuous processes. For example, heavy truck traffic on an access road during the construction phase should be similar to site preparation and can thus be estimated from Table 2.3.2-1. L_{dn} and CNEL values should be slightly higher than the numbers in Table 2.3.2-1 because they are more heavily weighted in the night and evening that is L_{eq}. Due to the logarithmic nature of the decibel scale, the impacts of geothermal development upon existing L_{eq}, L_{dn}, and CNEL values discussed in this chapter are not linearly additive. The logarithmic scale weights large values very heavily, so if the current background is more than about 5 dBA higher than the predicted geothermal contribution to the noise level, it can be approximated that the background will not be changed. Similarly, if the geothermal contribution is greater than five dBA above background, it can be estimated to be the new background.

Table 2.3.2-2
NOISE FROM POWER PLANT OPERATION

Noise Source	Distance (feet)	Noise Level (dBA)
Cooling Tower	10	85
Outside Turbine Building	25	75
Steam Jet Ejector	10	93

The noise levels estimated in this section need to be considered in two ways. First of all, the local effects upon construction and power plant workers should be addressed. These workers will be in close proximity to the noise sources for usually eight hours per day. They will be exposed to both continuous and short-term (intermittent) noise. The state standards for occupational noise exposure are shown in Table 2.3.2-3 (California Administrative Code). Examination of the previous tables in this section reveals that several operations can cause these standards to be violated at close range.

Table 2.3.2-3
STANDARDS FOR OCCUPATIONAL NOISE EXPOSURE

Duration for Day (hours)	Noise Level (dBA)
8	90
6	92
4	95
3	97
2	100
1-1.25	102
1	105
0.5	110
0.25 or less	115

The other major noise consideration concerns people who are in or adjacent to the CGSA, but not in the immediate vicinity of any geothermal development. Most such areas of human noise reception lie adjacent to U.S. Highway 395. There are presently people living in Rose Valley and at Little Lake, and it has been suggested that a village may be constructed near the Coso Junction Rest Area, to house geothermal workers. Transients on U.S. 395 also stop at Coso Junction Rest Area, usually for periods of an hour or less. The data in Table 2.3.2-1 predict that a hypothetical power plant built more than one and a half miles from U.S. 395 should not be audible over the 52 dBA background noise level near the highway. Trucks and cars on the highway and on access roads should cause intermittent noise as they pass by human noise receptors. For reference, a summary of noise levels identified as requisite to protect public health and welfare with an adequate safety margin is presented in Table 2.3.2-4 (EPA, 1974).

Table 2.3.2-4
RECOMMENDED SAFE NOISE LEVELS

Effect	24-hour Average Noise Level (dBA)
Hearing Loss	70
Outdoor Activity Inteference and Annoyance	55
Indoor Activity Interference And Annoyance	45

The area of most probable geothermal development lies six to eight miles to the east of U.S. 395, in the vicinity of Devil's Kitchen. Also in this area is an Indian Prayer Site and Coso Hot Springs, both of which are used intermittently for religious observances. Power production near these two sites could have a significant noise impact, so topographical noise contours were calculated assuming a power plant approximately one mile from each site. The contour lines represent L_{eq} values as a function of distance from the noise source.

The resulting contour maps are shown for the Prayer Site and for Coso Hot Springs in Figures 2.3.2-1 and 2.3.2-2, respectively. In each figure, the power plant source is shown at the center of the polar graph and the receptor is shown as a triangle. The power plant in Figure 2.3.2-1 is at the site of Coso Geothermal Exploratory Hole (CGEH) No. 1; in Figure 2.3.2-2 it is in the Coso Basin area approximately one mile southeast of Coso Hot Springs. Both maps are the same scale. The contours are shown without consideration of ambient background noise levels; any values lower than the L_{eq} value of 40 dBA reported in this chapter will actually be at 40 dBA. Thus, it is seen in both figures that the noise levels at both religious sites will be at background if power plants are located as shown. It must be noted, however, that the current background level is a result of an extremely quiet natural setting. A power plant is a continuous noise source which, even at a distance here the projected value is equal to the existing noise level, will create a distinct new background noise environment. This changed noise background may be perceived as an adverse impact by Native Americans using the Hot Springs or Prayer Site.

The noise impacts upon non-human receptors should also be considered. Many animals will avoid an area when there is excessive noise, resulting in changes in mating, feeding, migratory, or nesting habits. Raptors are particularly sensitive to noise changes, and the Coso area is one of the their nesting

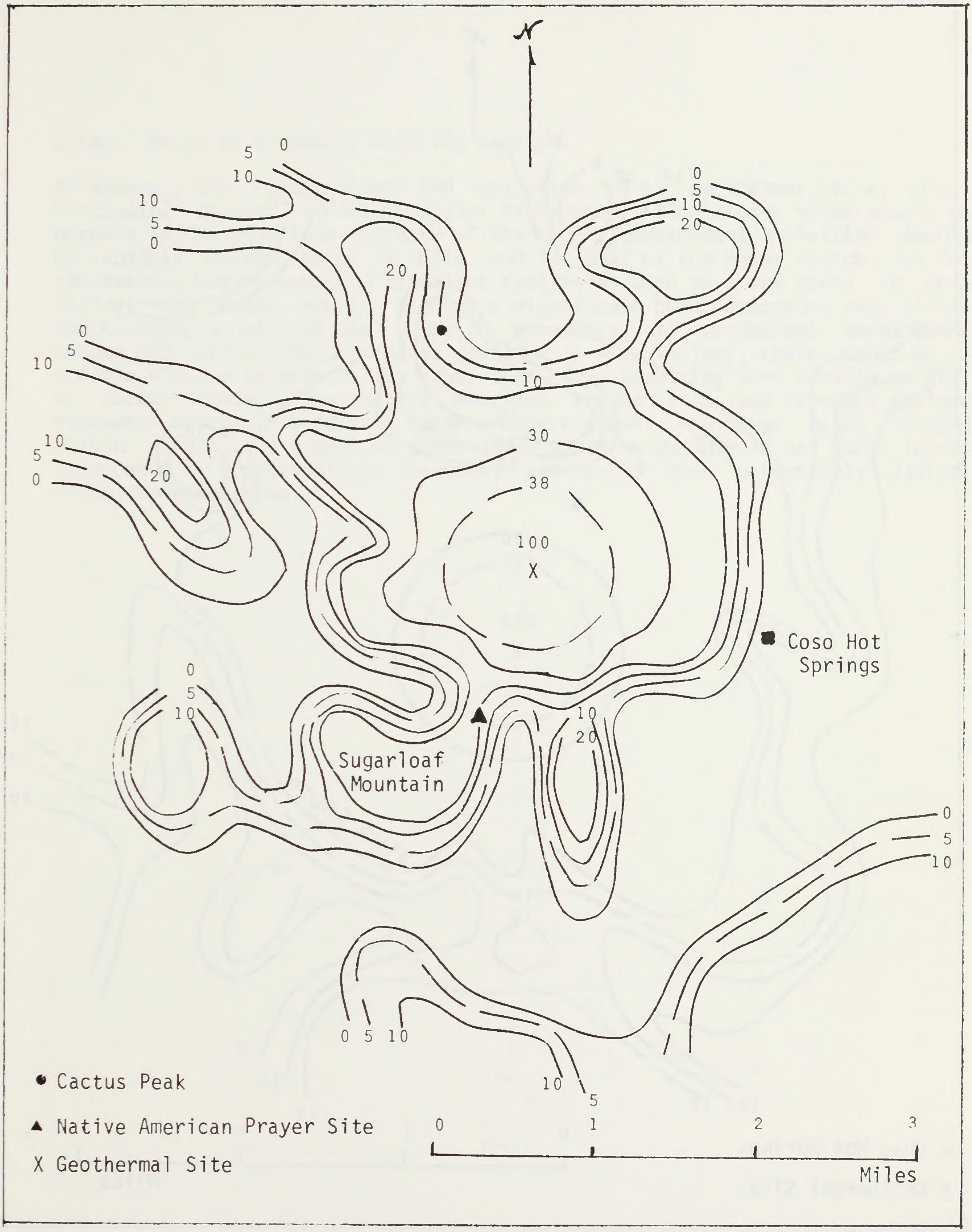


Figure 2.3.2-1 Prayer Site Noise Level Contours (dBA)

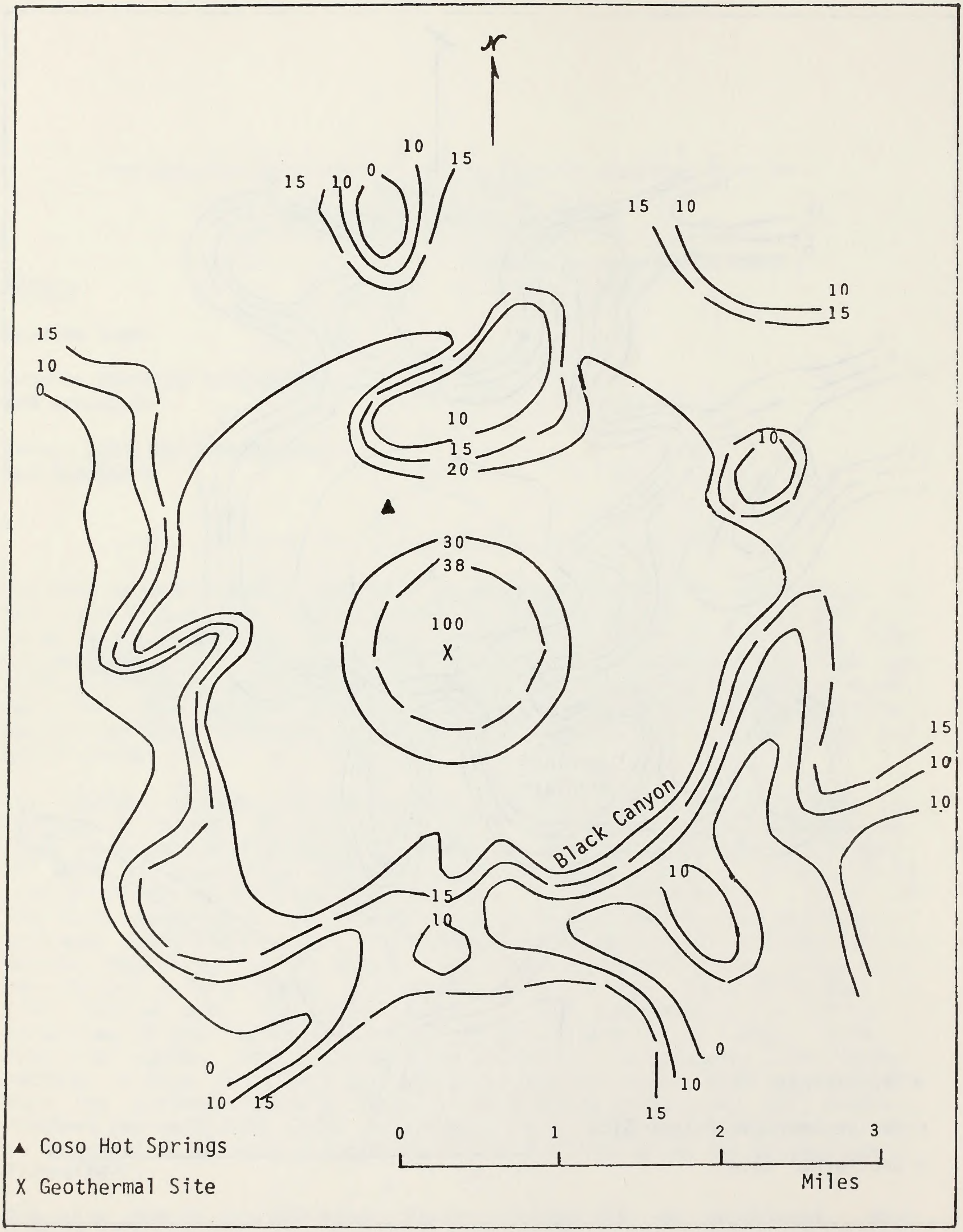


Figure 2.3.2-2 Coso Hot Springs Noise Level Contours (dBA)

sites. Refer to Chapter 2 Wildlife section.

In summary, the construction and operation of a geothermal power plant (including related vehicle traffic) represents a significant noise source to workers in the immediate vicinity of the plant. Geothermal activities should be audible within about a mile and a half of the noise source, but for residences, businesses, and transient facilities such as those found in Rose Valley, the noise should present a significant human annoyance only within about a quarter mile of the source. Therefore, if geothermal development occurs only within the Coso Range (and not in Rose Valley), there should be no audible effects in Rose Valley other than those resulting from vehicle traffic on access roads. the Native American Prayer site and Coso Hot Springs represent extremely sensitive human receptor sites. Any power plant located within a mile and a half of these sites could be audible if not sufficiently attenuated by topographical features, and could thus potentially disrupt religious ceremonies.

2.4 GEOLOGY

2.4.1 Present Geologic Setting

2.4.1.1 Regional Geology

The CGSA is in the western Basin and Range structural province of southeastern California, separated by Rose Valley from the adjacent Sierra Nevada province (Figure 2.4.1-1). It is about 45 miles north of the east-west trending Garlock fault which forms the boundary between the Mojave Desert and Basin and Range provinces.

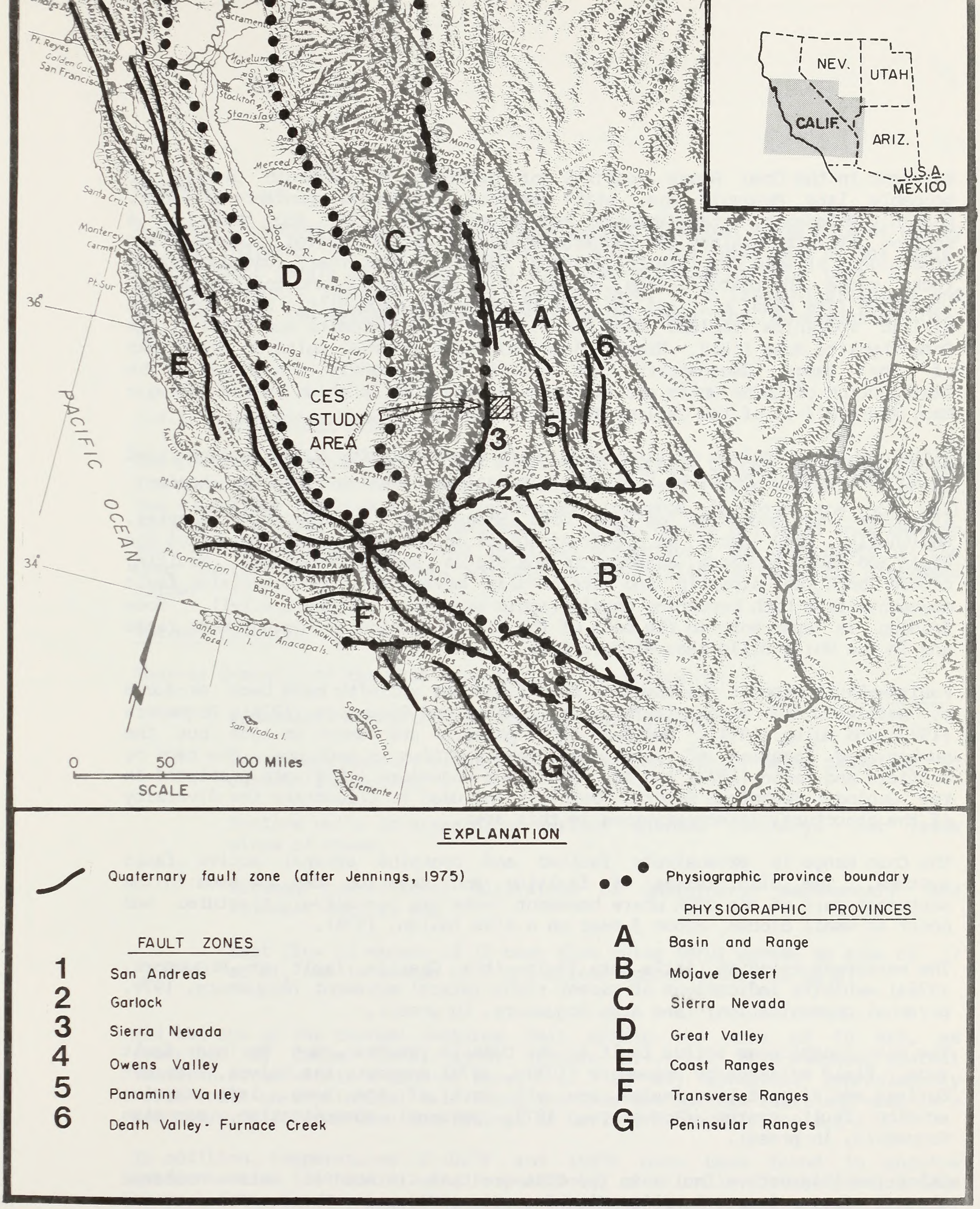
The Basin and Range province is characterized by northerly trending fault block mountains separated by deep alluvial valleys. It is an area of high heat flow and general east-west crustal extension. The oldest rocks exposed in the western Basin and Range province are complexly folded Precambrian metasediments and metavolcanics. These are intruded by Jurassic to late Cretaceous stocks and plugs. The intrusives range in composition from gabbro to granite, with quartz-monzonite and granodiorite predominant.

Late Cenozoic volcanics, ranging from rhyolite to basalt, unconformably overlie the intrusive and older rocks. These include the silicic volcanics of the Coso rhyolite dome field, west of Coso Hot Springs. The volcanic rocks are interbedded with terrestrial clastic and lacustrine sedimentary deposits.

Relief of the western Basin and Range is rugged, due primarily to movement on the northerly trending, high angle normal faults. However, a number of major Basin and Range faults such as the Panamint Valley and Death Valley - Furnace Creek fault zones east of the CGSA and the Owens Valley to the north (Figure 2.4.1-1) have features in common with the San Andreas fault, e.g., great length and consistent right-lateral offset. Several active right-lateral faults also occur within and south of the Coso Range (Roquemore, 1978b).

2.4.1.2 Local Geology

Topography of the CGSA is typical of Basin and Range structure, with highest elevations in the north and a gradual southwest slope. Maximum elevations reach 5947 feet in the northeast corner of the CGSA, along the eastern Coso Range. The minimum elevation of 2800 feet is in Coso Basin. Most of the area is accessible with some portions quite rugged.



Location Map Showing Physiographic Provinces and Major Faults

Figure 2.4.1-1

Basement in the Coso Range consists of granitic to gabbroic plutons of probable late Mesozoic age, with numerous widespread pendants of older, possibly Paleozoic, metasedimentary and metavolcanic rocks. Atop these is a section of late Tertiary and Quaternary volcanic rocks ranging in composition from highly silicic rhyolite to olivine basalt. Quaternary unconsolidated rocks range in texture from coarse volcanic breccia and conglomerate to windblown fine sand, silt and ash, and to playa clay and silt. Late Cenozoic silicic volcanics include the domes, pyroclastic deposits and flows of the Coso rhyolite dome field. Highly dissected older alluvial units on the flanks of the range demonstrate that uplift is presently continuing. The distribution of these units and structure of the area is shown on the Geologic Map, Plate 2.4-1, of the Geology Technical Report.

Lithology--Descriptions of lithologic units exposed in the CGSA are summarized on the explanation sheet of Plate II-1 in Geology/Hydeology Technical Report.

Structure--The mountains of the Coso Range are structurally complex. Regionally, they occur as a tectonic block on the westernmost border of the Basin and Range Province, adjacent to the Sierra Nevada Province. Faulting occurs both as dip-slip and strike-slip movements, characterizing fault movements from both bordering physiographic provinces (Figure 2.4.1-1). Some folding is apparent in the beds of the Coso formation in the northern range and in the White Hills near Airport Lake.

Faults--Fault maps of the rhyolite dome field and vicinity have been produced by Duffield and Bacon (1978), St. Amand and Roquemore (1978), Roquemore (1977) and Hulen (1978). Dominant fault patterns are common to each but the number and location of individual faults differ in each one. The maps by Duffield and Bacon (1977) and St. Amand and Roquemore (1978) are presented in the Geology Technical Report. Both are included to illustrate the diversity of the structural interpretations in this area.

The Coso Range is extensively faulted and contains several active fault systems. The high degree of faulting and shearing can be seen in the southeast part of the CGSA where basement rocks are pervasively fractured and occur as small blocks, about 3 feet on a side (Hulen, 1978).

The northwest trending Little Lake fault (the Charlie fault of Roquemore, 1978a) exhibits indications of recent right-lateral movement (Roquemore, 1979, personal communication; see also Roquemore, in press).

The most conspicuous active fault in the CGSA is the Coso Hot Springs fault zone. Field evidence by Roquemore (1978a, 1979) suggests the Haiwee, Coso Hot Springs and Airport Lake faults are all part of the same, left-stepping echelon fault system (Roquemore, 1979, personal communication, see also Roquemore, in press).

Other possibly active faults in the CGSA are those related to active surface thermal features at Devil's Kitchen, Nicol Prospect, Wheeler Prospect and several other areas where either fumaroles or hydrothermally altered ground is present.

A highly dissected older fan on the west side of the Coso Range in Rose Valley is an indicator of uplift continuing along the west part of the range. Gravity data (Healy and Press, 1964) show that alluvium in this part of the valley abruptly deepens several thousand feet. This large displacement and the dissected fan suggest normal frontal faults bound the southwestern Coso Range.

2.4.1.3 Geothermal System

The geothermal system in the CGSA consists of surface thermal manifestations, fractured crystalline rock containing hot fluids and a heat source. Presently the subsurface features of the geothermal resource at Coso are not well defined. Details of any geothermal system can be confirmed only through exploration drilling, well tests and fluid production. The components of the Coso system that are known, and exploratory drilling to date, are discussed below.

Thermal Features

Thermal features of the Coso area include the following:

- Fumaroles, mud pots, and steaming warm ground,
- Quaternary mercury mineralization, probably still being deposited at certain fumaroles,
- Shallow wells in areas of no surface thermal discharge that issue wisps of steam,
- Intense hydrothermal alteration of Quaternary sedimentary and volcanic debris, and
- Heat flow in excess of 10 heat flow units (HFU) across an area of 17 sq mi, and in excess of 5 HFU across approximately 32 sq mi.

All but one of the thermal features fall within the zone of 10 HFU, as described by Combs (1975, 1976) (Figure 2.4.1-2). At a minimum, thermal features occur within a zone of about 6 or 7 sq mi, elongated approximately north-south on a principal axis along the Coso Hot Springs fault and west on a secondary axis, from Coso Hot Springs to Devil's Kitchen (Plate 2.4-1).

In addition, temperatures of 102°F and 199°F have been found in shallow gradient holes (150 and 312 ft, respectively) over 1 mile distant from surface thermal features (Koenig, 1978, personal communication); and a temperature of 288°F was encountered at 375 feet in Coso No. 1 hole, drilled in the

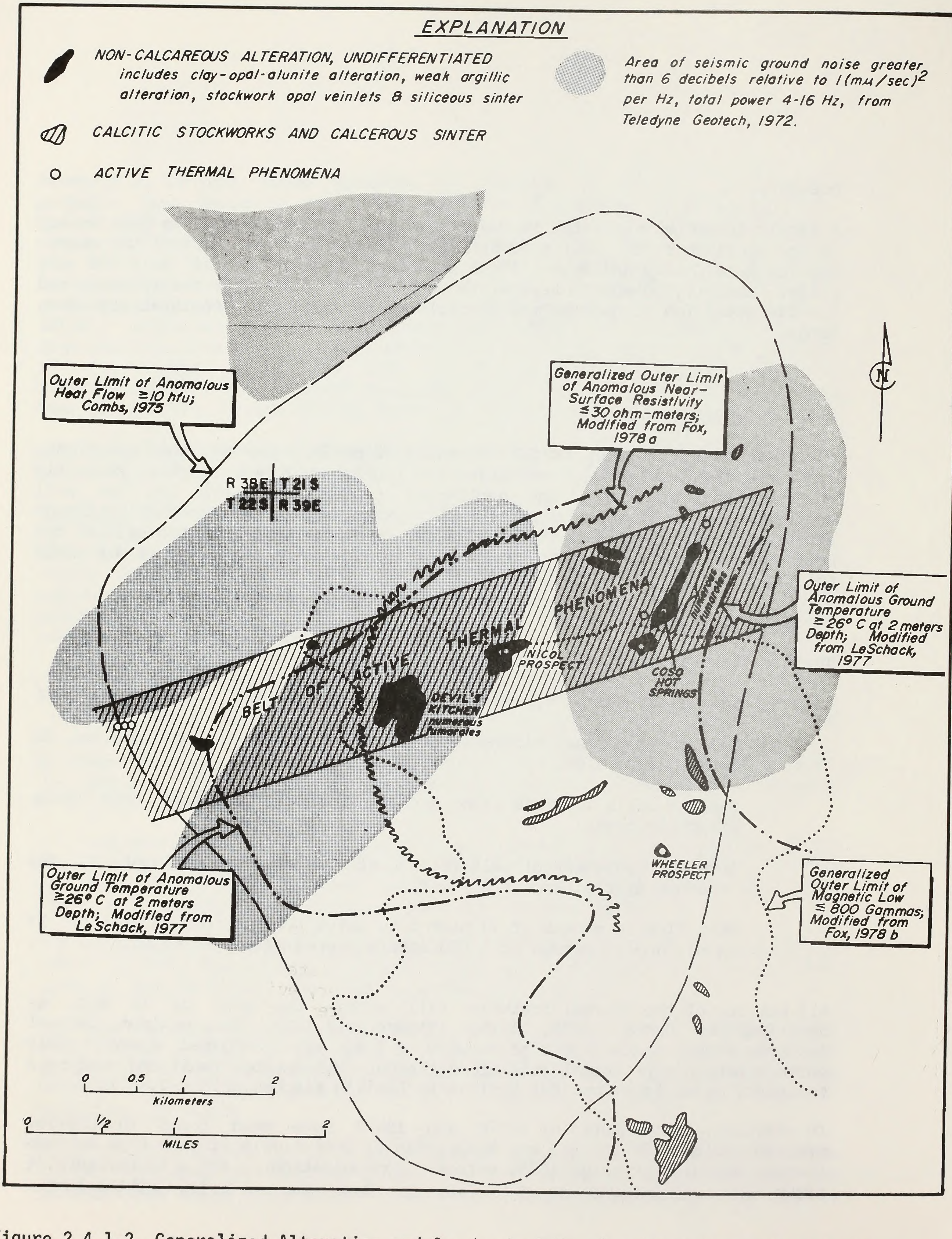


Figure 2.4.1-2 Generalized Alteration and Geophysical Map (modified from Hulen, 1978)

principal fumarole zone at Coso Hot Springs (Austin and Pringle, 1970). On the western flank of Sugarloaf Mountain, a series of shallow drill holes in altered ground produce wisps of low-pressure steam. No surface thermal discharges existed prior to this drilling.

With the exception of Sugarloaf Mountain and two perlitic domes south and northwest of the Devil's Kitchen, no thermal features are known at any other of the 38 volcanic domes. Many of these domes lie outside of the 5 HFU heat flow anomaly as presently defined by drilling (Combs, 1975, 1976).

No thermal features are observed in association with the youngest basaltic cinder cones and flows, despite their equivalence in age to the rhyolite domes. The few heat flow holes drilled near or within the Quaternary basalt field have heat flow values of about 2.5 to 3 HFU.

Geothermal Reservoir and Fluid at Coso

The extent, permeability and exact bounds of the geothermal reservoir have not yet been defined. However, it is known that the geothermal reservoir rocks are fractured Mesozoic granitic basement rocks of the southern Coso Range. It is envisioned as a boiling water table system (Galbraith, 1978, pp. 22-25). Based on currently determined ground and water level elevations the top of the reservoir is at about 3660 feet (see Hydrology Section). The depth of the fluid circulation is not known.

The geothermal system at Coso is structurally controlled. Fluid is "piped" along subsurface faults and other fractures which form secondary permeability in otherwise impermeable basement rocks. The older northwest to west-northwest and east-northeast faults are important in development of permeability. Crushed zones within these are brittle. When these faults are cut by younger faults, permeable zones are produced. The geothermal system is bounded on the east by the Coso Hot Springs fault where high heat flow values abruptly terminate. Boundaries on the north, south and west appear more gradational.

Earlier estimates of the reservoir size were much greater due to previous structural interpretation of the geothermal reservoir area as a "caldera-like feature" (Duffield, 1975). It was envisioned as encompassing a 1500-square-kilometer oval-shaped zone of late Cenozoic ring faulting (Duffield, 1975; Renner, et al., 1975). However, evidence to support this ring fault structure has been lacking and current structural interpretations omit this feature (Duffield and Bacon, 1977).

Primary porosity of reservoir rocks is nil with secondary fracture porosity developed. Fracture porosity will vary widely from place to place, depending on the size and openness of fractures. Based on the known hydraulic properties of similar reservoirs, porosity of the Coso geothermal fluid bearing rocks probably varies from 3 to 5 percent (see Appendix B for discussion). Direction of thermal water flow, storage and the extent of the reservoir are structurally controlled.

Fractures in basement rock occur as joints, cleavage planes, young fault zones and shatter zones at major fault intersections. Dominant fracture trends are north-northeast, east-northeast and west-northwest. Intersections of north-northeast and east-northeast faults appear to control major thermal discharges at Coso Hot Springs, Devil's Kitchen and the Nicol Prospect.

Geothermal fluid is sodium chloride water with total dissolved solids of around 5000 to 6000 mg/l. Localized steam caps above the thermal water table may be present in fumarole areas (Austin and Pringle, 1970). Typical geothermal water analyses from the two exploration wells, Coso No. 1 and CGEH-1 are presented in Table 2.5.1-3. Maximum equilibrium reservoir temperatures estimated by Fournier, et al. (1978) from water chemistry data are 240°C to 275°C. Maximum observed temperature in CGEH-1 was 195°C (382°F) at 1900-foot depth along a fracture zone (Galbraith, 1978).

Geothermal Exploration Drilling

The only deep exploratory hole, CGEH-1, was completed in December 1977 to a depth of 4845 feet. The CGEH-1 drill site is located in a closed valley about 2 miles west of the Coso Hot Springs. The site is bounded by four rhyolite domes to the west and south and high granitic ridges to the east and north. It is roughly at the center of the 10 HFU contour, as defined by Combs (1975, 1976) see Figure 2.4.1-2. Highest temperature in the well (382°F) was encountered in a fracture zone at 1900 feet (Galbraith, 1978). Lost fluid circulation and hole deviation from vertical were recurrent problems during drilling.

Two flow tests of CGEH No. 1 were performed by Lawrence Berkeley Laboratory (LBL) in the Fall of 1978 (Goranson and Schroeder, 1978). Flows of less than 5 gpm were reported from these tests. An obstruction in the well at 4500 feet implies that the well cannot be used below this interval.

It is not known whether the low production is due to low permeability in this portion of the reservoir or due to plugging of the permeable zones by the copious amounts of mud that were injected during drilling to prevent loss of circulation. DOE abandoned the well shortly after the LBL flow test.

Exploration Geophysics

Exploration geophysical techniques are employed to detect anomalous conditions indicative of a geothermal reservoir at depth, to define its limits and to define target areas for deep exploratory drilling. Techniques used at Coso include heat flow, shallow ground temperature, seismic ground noise, electrical resistivity, gravity and low altitude aeromagnetics. The geophysical anomalies defined in these surveys generally coincide, lie within the 10 heat flow units (HFU) contour and converge around the active thermal manifestations of the region (Figure 2.4.1-2). Together, the geologic, geochemical and geophysical data indicate the possible extent of the geothermal system at Coso.

2.4.1.4 Seismicity

The CGSA lies near several of the most seismically active areas of California. Large active fault systems within 100 kilometers of the Hot Springs include the Owens Valley fault zone (about 20 miles north), the southern Sierra Nevada fault zone (about 10 miles west), the Panamint Valley fault zone (about 30 miles east), the Furnace Creek - Death Valley fault zone (about 55 miles east) and the Garlock fault zone (about 40 miles south (Figure 2.4.1-1). Smaller active faults which lie within the CGSA include the Haiwee Spring - Coso Hot Springs - Airport Lake fault zone and the Little Lake fault. Microearthquake patterns infer a north-northeast trending seismically active zone of crustal spreading (Weaver and Hill, 1978/79; Walter and Weaver, in press).

Earthquake History

The southern Sierra Front and surrounding area is characterized by a high level of strain release (Allen, et al, 1965), microseismic activity, and generation of several large to moderate magnitude earthquakes. More than 10 events of magnitude 5 to 5.9, two of magnitude 6 to 6.9 and one of magnitude 8+ have occurred within 62 miles of the study area since 1872.

Figure 2.4.1-3 shows the location of earthquakes occurring from 1900 to 1974 reported by the California Division of Mines and Geology, California Institute of Technology and the National Oceanic and Atmospheric Administration (Real, et al., 1978) with the location of the 1872 Owens Valley earthquake added. Events prior to 1930 are located mainly from reports by people who felt the earthquake in specific areas. Most earthquakes occurring after 1932 are instrumentally located.

The areas of highest seismicity within a 100-kilometer radius of the Coso Hot Springs are in Owens Valley and the Sierra Front southeast of Little Lake. The great 1872 earthquake and another large reported earthquake in 1790 were located in Owens Valley (Coffman and von Hake, 1973). A series of magnitude 5 to 6 earthquakes occurred southeast of Little Lake in 1946 (Real, et al., 1978).

Microseismicity

CGSA is an area of high seismic activity, occurring in swarm-type sequences and with relatively shallow hypocenters. A survey by Combs (1975) was of limited scope and duration. Additional data provided by a longer term, more comprehensive study conducted by Walter and Weaver (in progress) lead to different conclusions than those indicated by the Combs (1975) study.

The Walter and Weaver (in press) study revealed an apparent belt of seismicity trending northwest-southeast from Haiwee Reservoir to Sugarloaf Mountain, then south toward China Lake. Focal depths were generally from 4 to 8 kilometers. Historic data also infers a northwest trend of seismicity in this region. Seismic activity has been variable with very high levels (more than 100 events per day) to lower levels from month to month. However, some areas, such as

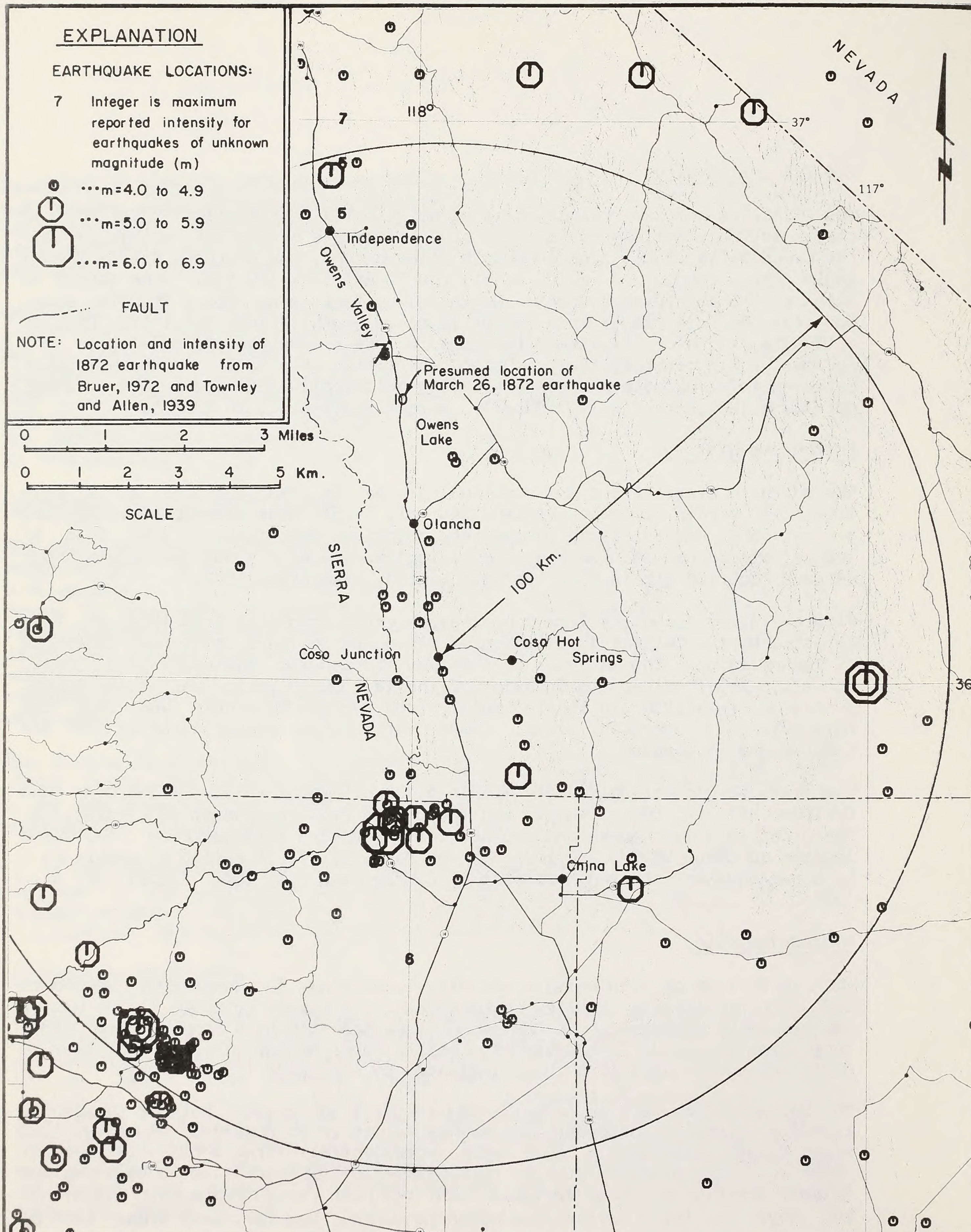


Figure 2.4.1-3 Historic Seismicity for the Coso Area, 1900-1974, (with location of 1872 earthquake) (modified from Real, et al.,1978)

Sugarloaf Mountain, were recurrently active. Focal mechanisms of microearthquakes are both strike-slip and dip-slip. The predominant trends are north-northeast trending dip-slip, northwest-trending, right lateral strike-slip, and northeast-trending left-lateral strike-slip. No mappable surface faults were correlated with microseismic activity. Earthquake swarms were noted around Sugarloaf Mountain, as they were during the Combs (1975) survey. However, in disagreement with the Combs survey, no clustering of events shallower than 2 kilometers was noted around active thermal areas.

2.4.2 Impacts of the Proposed Action on Geology

Potential geologic impacts can be divided into two general categories:

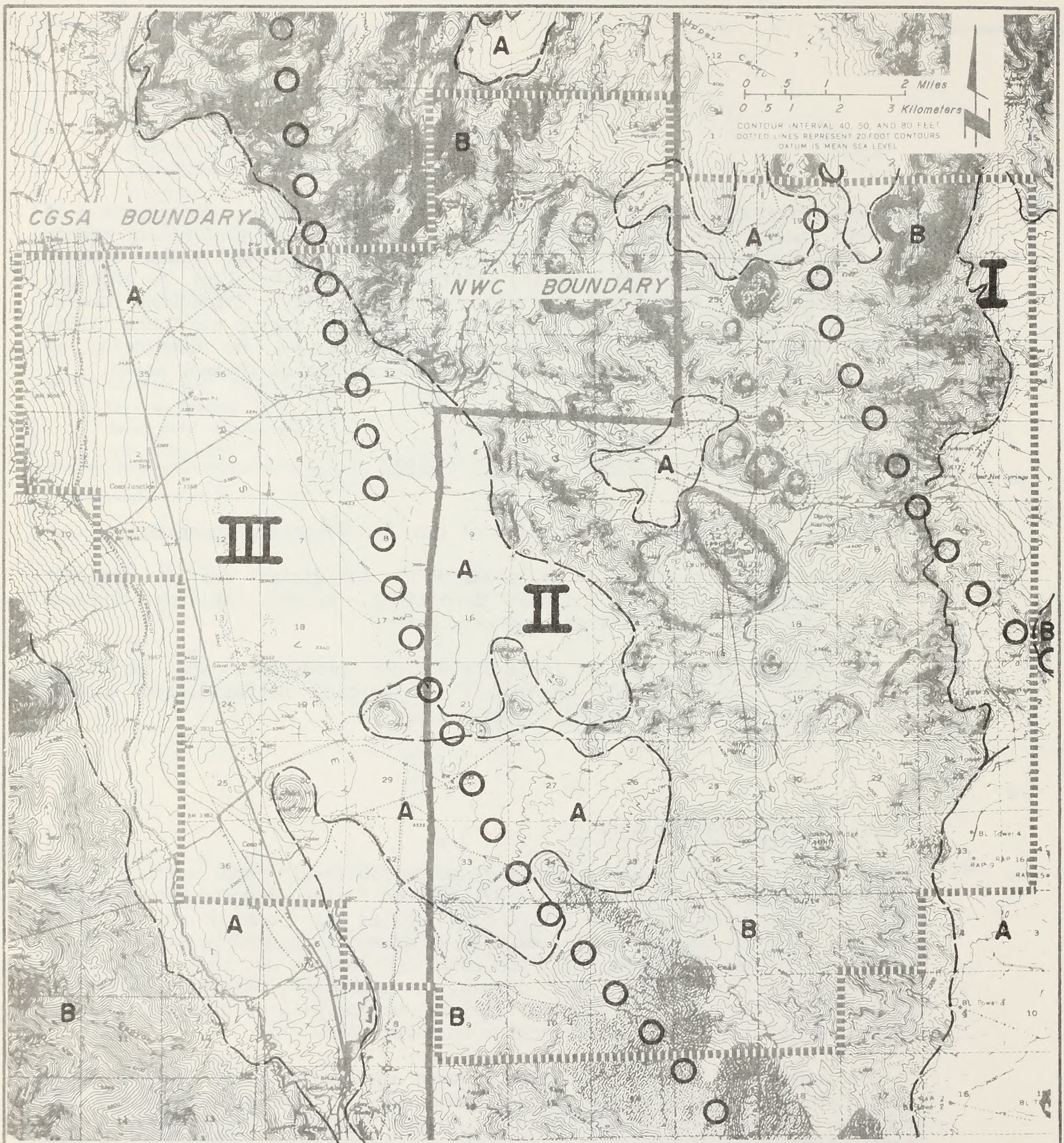
1. Geologic constraints on development activities due to geologic hazards. These include landslides, seismic shaking, surface faulting, ground failure and weak soils.

2. Impacts resulting from large scale fluid production and injection. This could include changes in seismicity patterns, land surface deformation and renewed volcanism.

2.4.2.1 Geologic Constraints

Seismic Hazards.--Earthquake associated damage can result from surface fault rupture, strong ground motion (shaking), ground failure induced by earthquake shaking (landsliding, settlement, liquefaction) or any combination of these effects. The great majority of earthquake damage is caused by strong ground motion and the geologic hazards in the CGSA will largely be those associated with earthquake shaking. Such damage, in improperly designed facilities, would include any type of structural failure such as well or pipeline failure, structural damage to building, cracking in paved roads etc.

The Coso region is seismically active. There are several major active fault zones within 50 miles (Figures 2.4.1-1 and 2.4.2-1). Some are within the CGSA boundary, including the Haiwee Spring, Coso Hot Springs, Airport Lake, and Little Lake. The study area could experience significant ground shaking from a major earthquake on any of these local or regional fault zones. Generalized shaking characteristics of expected earthquakes are presented on Table 2.4.2-1. The seismic zones specified in this table are shown on Figure 2.4.2-1. These ground motion characteristics and seismic zones may be used for general planning purposes. However, to determine specific ground shaking parameters for critical structures, individual site and structure analysis will be required.



EXPLANATION

(See Envicom, 1976 for detailed explanations, limitations and locations)

I O O II Seismic Zone boundary, based on 500 year earthquake and distance to causative fault

A/B Ground shaking zone boundary, generalized and approximately located; A= Alluviul areas, B= Bedrock areas.

Table 2.4.2-1
Generalized Characteristics
Of Expected Earthquakes

Zone	Maximum Ground Acceleration (g's)	Predominant Period (Seconds)	Duration of Strong Shaking (Seconds)
IA	0.13	0.3-0.8	8-15
IB	0.13	0.2-0.4	5-10
IIA	0.26	0.3-0.8	10-25
IIB	0.26	0.2-0.4	8-15
IIIA	0.40	0.3-0.8	15-35
IIIB	0.40	0.2-0.4	10-20
IVA	0.53	0.3-0.8	20-45
IVB	0.53	0.2-0.4	15-25

Source: Envicom, 1976

Landsliding.—Landslides may be initiated by response to strong earthquake shaking and oversteepening by grading. Renewed movement on both active and ancient landslides may occur during earthquakes. Areas of potential slide activity can generally be recognized and avoided when locating facilities.

A rotational slide in soil has been observed on a steep slope north of the Coso Resort Area (see Geology Technical Report for further discussion). Naturally steep slopes are common in the areas where basement rock of the Coso Range crops out. Soil development on these slopes range from moderate to deep. Rockfalls are anticipated on these steep slopes, especially in the areas where bedrock is pervasively shattered, such as the southeast part of the study area. No large-scale landslides (several thousand feet plus in length) like those which plague development at The Geysers, California, have been observed.

Slopes in the pyroclastic debris are gentle, except along rhyolite dome faces. Slopes in these areas are relatively stable.

Surface Faulting.—Several active faults exist in the CGSA. Some of these are associated with the surface thermal manifestations at Coso Hot Springs. While there is always some possibility of future faulting in any locality in a seismicly active region, the historical occurrences of surface faulting have generally closely followed the trace of existing recently active faults.

Therefore, future surface faulting or rupture is most likely to occur on known active traces of faults in the study area.

Other Ground Failure Induced by Shaking--Settlement or densification may occur in sandy soils above the ground water table or earth filled areas during earthquake loading due to rearrangement of particles. A potential for earthquake induced settlement exists in alluvial areas.

Liquefaction occurs only in cohesionless soils where the water table is high. It is not expected in most parts of the CGSA because of deep ground water conditions. However, seasonal perched shallow ground water has been noted in the valley area between Devil's Kitchen and Coso Hot Springs.

2.4.2.2 Land Surface Deformation and Renewed Volcanism

The possibility of triggering earthquakes by geothermal production and injection is of some concern. Although existing producing fields at The Geysers, California, and Wairakei, New Zealand have long been associated with pre-existing earthquake activity, only tenous associations have been drawn between geothermal production and additional induced earthquake activity. (Marks, et al., 1978). One of the main resons for this is inadequate pre-production (i.e., baseline) microseismic monitoring. In any event, the great majority of earthquakes recorded at The Geysers between 1975 and 1977 have been of magnitude 3 or less, with only 2 earthquakes up to magnitude 4 in this period.

Existing oil field and waste well data have yielded clues to the effect of fluid injection on triggering earthquakes. Of the thousands of existing oil fields and waste injection wells, only a few instances of earthquake triggered by fluid injection have been cited in the literature. One of them is at the Rocky Mountain Arsenal waste disposal well near Denver, Colorado and another is at the Rangely Oil Field in northwestern Colorado (Raleigh, et. al. 1976). The largest event registered at Rangely was a magnitude 6 earth quake. Earthquakes are inferred to be caused by an increase in pore pressure that results in shear failure, therefore reducing the normal stress across fracture surfaces. However, regional tectonics, the stress field and rock properties in other areas are different from Rangely, so the Rangely experience may not apply universally to all injection programs.

Withdrawal of geothermal fluids may alter deep ground water flow patterns. The effect of these alterations on the tectonic stress regime is unknown.

Two criteria can be considered useful in detecting induced earthquakes: changes in frequency-magnitude statistic in the area of the geothermal field; and changes in depth and location of events from pre-production activity (Phelps and Anspaugh, 1976). It will require several years of continous monitoring activity, superimposed on the known background seismicity, to understand the possible effects of withdrawal and injection of fluids on seismicity.

Ground subsidence is the most common and obvious type of land surface deformation, although horizontal movements are also possible. It occurs with the withdrawal of large amounts of fluid (oil, gas, steam or water) and subsequent compaction of compressible or poorly consolidated sediments. Since the geothermal resevior rocks at Coso are the strong, fractured, crystalline basement rocks of the Coso Range and spent fluids will be reinjected, subsidence in the producing geothermal field is not anticipated.

Extensive withdrawal of ground water in Rose Valley will cause a drop in the ground water level as discussed in Section 2.5.2. Many ground water basins throughout the world have experienced ground subsidence from extensive, long-term overdraft of the ground water reservoir. (Bouwer, 1978, p. 314). Subsidence could occur in Rose Valley with extensive long-term overdraft of the ground water resevoir. Effects would be minimal due to the sparse development of the field. The Los Angeles Aqueduct is located on the alluvial fans in the western margin of the valley and would most likely be out of the zone of potential subsidence. The Southern Pacific Railroad is similarly located in the northern half of the valley, while in the southern portion the railroad runs along the valley floor. However, ground water pumping, and subsequent possible subsidence would most likely occur in the east-central part of Rose Valley, closer to the development area.

Inyo County Planning Department (1979) considers volcanic activity potentially a very significant hazard, in the Coso Mountains area. Risk of potential volcanic eruption is not presently possible to predict, no less to predict the effects of large-scale geothermal fluid withdrawal on volcanism.

2.5 HYDROLOGY

2.5.1 Present Hydrologic Environment

2.5.1.1 Surface Water

The CGSA is located in the northern Mojave Desert, encompassing Rose Valley, Coso Basin, and several smaller enclosed basins located between Rose Valley and Coso Basin (Figure 2.5.1-1 and Plate 2.5-1 of the Hydrology Technical Report).

Watershed Features.-- The drainage areas of Rose Valley, Coso Basin, and the enclosed basins are shown in Table 2.5.1-1.

Table 2.5.1-1
Areas of Watersheds in the CGSA

Watershed	Area: Acres	Area: Square Miles
Rose Valley	89,640	140.07
Coso Basin	132,750	207.42
Upper Cactus Flat	10,350	16.18
11 Enclosed Basins	6,690	10.45

The Coso Basin encompasses a major portion of the Coso Range. The crest of the range serves as the eastern and northern boundaries of the basin. The enclosed basins are bounded by the lower Coso Range.

The soils and vegetation in the CGSA are significant factors contributing to the high runoff potential of upland watershed areas of Rose Valley, Coso Basin, and the enclosed basins. The principal runoff producing areas are the uplands of the Sierra Nevada and the Coso Range, characterized by shallow soils, exposed bedrock and sparse vegetation with reletively high runoff potential. The soils and vegetation of the CGSA are capable of retaining the moisture from most low-intensity precipitation events.

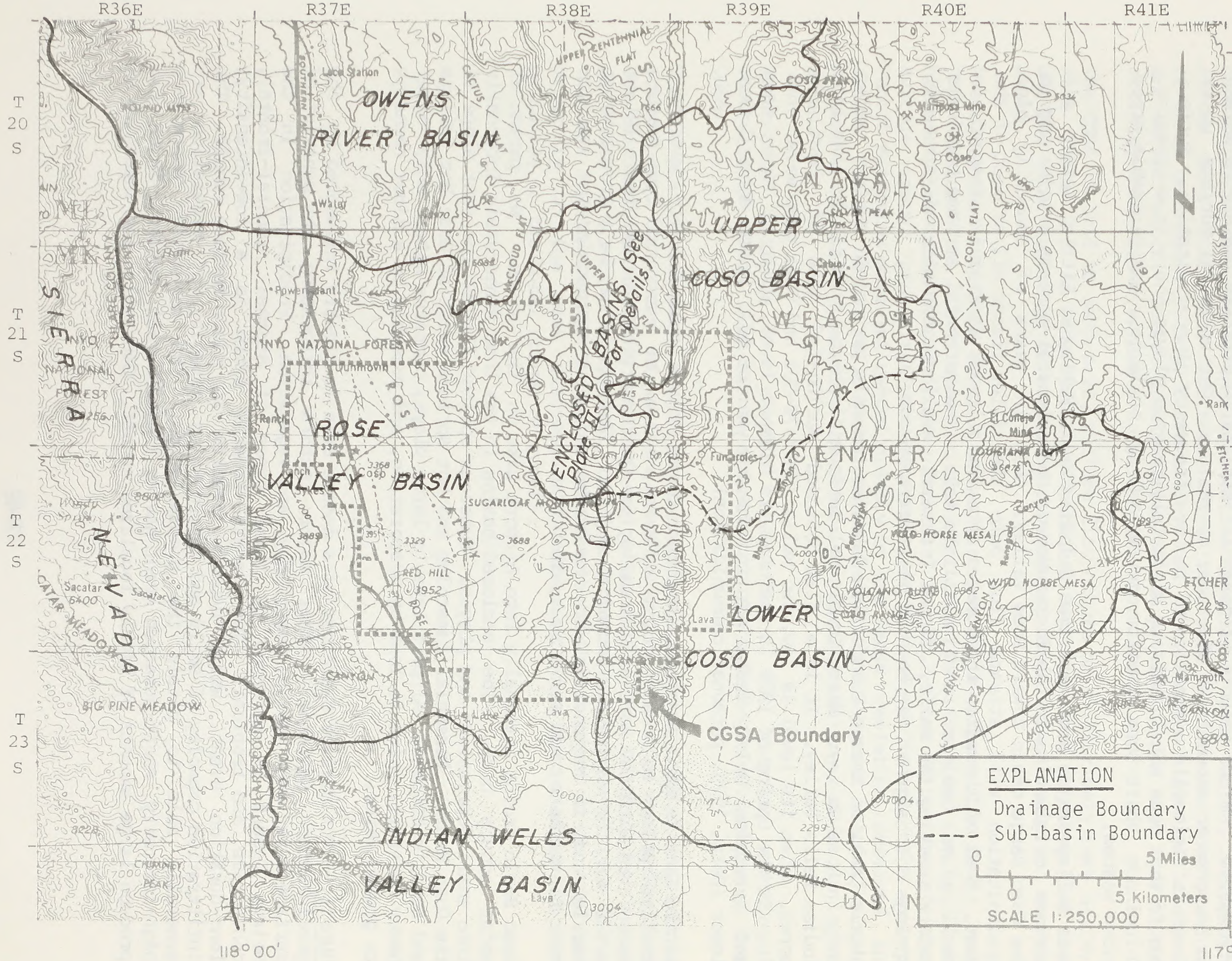


Figure 2.5.1-1 Watershed Boundaries - CGSA

Flow Regime--Surface water flow in the CGSA is predominantly ephemeral streamflow. Minor amounts of perennial streamflow exist in the Sierra Nevada in response to snowmelt at the upper elevations. The ephemeral surface water flow is primarily a function of the low frequency of precipitation. Surface runoff that does not infiltrate ultimately reaches playas where it evaporates. Voluminous short-term runoff occurs mainly on large, less permeable steep sided washes.

Rose Valley drains southward toward Indian Wells Valley at Little Lake. All streams originating in the Sierra Nevada and ephemeral streams originating in the Coso Range drain toward Rose Valley. Only in years of unusually high precipitation will streams flow onto the valley floors all or most of the year. Most of the water infiltrates into the alluvial fans or is trapped in small playas before reaching Little Lake. The perennial streams terminate before reaching the valley floor. Several small perennial and ephemeral springs discharge at the base of the Sierra Nevada.

Little Lake, an emergent underflow lake, is the only perennial surface water body in Rose Valley. There is minimal surface discharge from Little Lake into Indian Wells Valley. It is a flat-bottomed spring-fed lake of about 100 acres. When its level is low, two wells (23S/37E-8D1 and 8D2) pump water into it. In the Spring of 1979 it was near its highest level, up to 5 feet deep and averaging 3-1/2 feet. During the dry year of 1976 it was about 3 feet lower (Bate, 1979, personal communication).

Little Lake is in a remnant of a former Owens River channel. It was much smaller prior to construction of a dam, and may be a sag-pond type feature associated with the northerly trending pre-Quaternary Little Lake fault (Plate 2.5-1 in the Hydrology Technical Report). This fault may be a ground water barrier and, in conjunction with the basement complex approaching the surface near Little Lake, may serve as a water trap.

Coso Basin drains internally into Airport Lake on the south. No perennial water occurs here. The enclosed basins in the Coso Range drain internally into small depressions and playas. Numerous springs flow on the east slope of the Coso Range. Perennial fumaroles and hot springs exist at Coso Hot Springs and Devil's Kitchen. Airport Lake, a large playa, contains water only after heavy rainfall, which is lost by evaporation, and possibly by a minor recharge to ground water.

Runoff.— The surface hydrology of a desert area is greatly influenced by the precipitation patterns. Other major factors influencing the behavior of surface water are: soils, topography, and vegetation. Precipitation in the Mojave Desert is produced by three types of storms: general-frontal, convective, and tropical. The general-frontal storm is a low-intensity, long-duration event, which usually results in minor surface runoff. The infiltration capacity of soils and interception capacity of vegetation are generally able to retain the precipitation. The convective storm is a high-intensity, short-duration event having limited areal extent, which can produce large amounts of highly localized runoff. Generally, the intensity of convective storms exceeds the infiltration capacity of the soils. Tropical storms come from the incursion of moist, warm air from the south, which produces prolonged, steady, torrential rains. They cause high infiltration and severe runoff. Larger precipitation events probably occur when convective activity takes place within a large frontal storm system.

The CGSA is arid to semi-arid, surface flow occurs on a relatively rare basis, (see Table 2.3 in the Hydrology Technical Report). This requires that the surface water hydrology be evaluated on an event basis as well as an annual basis.

Average annual runoff is about 2 inches for Rose Valley, Upper Coso Basin and Upper Cactus Flat. It is somewhat lower for Lower Coso Basin and the enclosed basins. (See Table 2.3, Hydrology Technical Report.) About 70 percent of the average annual precipitation occurs between November and March. The annual runoff estimates were influenced greatly by the large variation observed in annual runoff data. It is questionable whether annual runoff statistics can be used to accurately describe the nature of surface water runoff in arid areas.

Event-based analysis can pinpoint the effects of extreme hydrologic occurrences. Such analysis is essential to the hydrologic evaluation of the CGSA.

The 100-year design storm was chosen for analysis as the extreme precipitation occurrence. Estimates of surface runoff and peak discharge were made using the hydrologic model, HYMO (Williams and Hann, 1972). The results are shown in Table 2.5.1-2. In general, the 6-hour storm produced larger peak flows than the 24-hour storm. The principal effects of the 6-hour storm are due primarily to the peak discharge. The effects of the 24-hour storm are due primarily to the total volume of runoff.

Table 2.5.1-2
Estimates of Runoff from CGSA Watershed
For the 100-year Design Storms

24-Hour Storm

	Precipitation in.	Runoff in.	Runoff AF	Peak Discharge cfs
Upper Rose Valley	5.90	4.22	30730	20051
Lower Rose Valley	5.90	2.07	378	258
Upper Coso Basin	4.50	3.28	11250	7354
Lower Coso Basin	3.80	2.74	20718	32143
Upper Cactus Flat	4.50	3.36	2899	2025
Enclosed Basins				
A	4.50	0.43	26	19
B	4.50	0.09	2	1
C	4.50	2.29	731	532
D	4.50	0.26	6	4
E	4.50	0.62	52	38
F	4.50	0.00	0	1
G	4.50	1.03	117	85

6-Hour Storm

	Precipitation in.	Runoff in.	Runoff AF	Peak Discharge cfs
Upper Rose Valley	2.11	0.88	6391	21095
Lower Rose Valley	2.11	0.88	161	939
Upper Coso Basin	1.90	0.95	3250	12904
Lower Coso Basin	1.46	0.65	4939	14782
Upper Cactus Flat	2.41	1.15	989	5616
Enclosed Basins				
A	2.41	1.08	66	670
B	2.41	0.46	8	80
C	2.41	1.04	334	2315
D	2.41	0.79	17	182
E	2.41	1.07	88	806
F	2.41	0.15	1	12
G	2.41	1.06	120	954

The surface water runoff resulting from the design storms will move through the watersheds as described in Section 2.5.1.1. However, a significant portion of the runoff may be lost as channel infiltration. Runoff from Upper Rose Valley will flow to playas and eventually into Little Lake. Little Lake will behave in a manner similar to a reservoir, storing some water as lake levels increase and Discharging water via the south end. The runoff eventually discharges into Indian Wells Valley, approximately 31,000 AF from the 24-hour storm or 6500 AF from the 6-hour storm. Runoff from Upper Coso Basin will flow down Coso Wash into the Lower Coso Basin and combine with runoff from the Lower Coso Basin. The runoff accumulates in Airport Lake - approximately 32,000 AF from the 24-hour storm or 8,200 AF from the 6-hour storm. The runoff in the enclosed basins terminates in playas.

The existence of Haiwee Reservoir presents an extreme hydrologic condition not normally considered in an event-based analysis. Estimates of the potential inundation of Rose and Indian Wells Valleys due to failure of the dam are shown in Appendix D of the Hydrology Technical Report.

Surface Water Quality and Erosion

The quality of surface water in the CGSA is influenced by the type of runoff. The principal difference in water quality resulting from frontal and convective storms is suspended sediment; convective storms carry more sediment.

Water quality data are difficult to obtain due to the infrequency of runoff events in the CGSA. The locations of surface water sampling points are shown on Plate 2.5-1 in the Hydrology Technical Report. Chemical analyses for typical surface runoff and surface water bodies are presented in Table 2.5.1-3. Chemical characteristics of surface runoff from the Sierra Nevada and Coso Range are consistent. Water from the surface water bodies, Airport Lake and Haiwee Reservoir, has lower specific conductance (is less mineralized) than streamflow water.

Airport Lake is probably representative of the water quality of surface runoff in the Coso Basin. In arid areas, sediment is often the most important water quality parameter. Consequently, the sample from Airport Lake was analyzed for total suspended solids (TSS). A TSS value of 104 mg/l was determined using a 5-10 micron glass fiber filter and a TSS value of 3170 mg/l was determined using a 0.45-micron filter. The value of 3170 mg/l is characteristic of the fine suspended sediment found in the playa waters.

Erosion

Major runoff events can mobilize large amounts of sediment, particularly on steep slopes. However, the principal agent of erosion in the uplands of the Coso Range is wind, as the undisturbed soils in the CGSA are fairly stable and not susceptible to significant amounts of sheet erosion. In the CGSA as a whole, sheet erosion and wind erosion produce only minor sediment yields relative to channel erosion, which takes place particularly in the mid to

Table 2.5.1-3 Chemical Analyses for Typical CGSA Waters

	Nonthermal Wells			Thermal Wells				Surface Waters	
						CGEH-1	Haiwee Spring	Portuguese	Little
Name/Number	21S/37E-2K1	21S/37E-26B1	23S/38E-5N1	22S/39E-4K1	22S/39E-4K2	22S/39E-6G2	21S/37E-10PS1	Canyon	Lake
Date of Sample	1975	12/78	3/60	12/77	9/78	12/77	4/79	2/79	4/79
Source[a]	M	P	M	S	N	F	H	H	H
Units	mg/l	ppm	mg/l	ppm	mg/l	mg/l	mg/l	mg/l	mg/l
Temperature - ^oC	14.0	---	---	91.2	---	---	---	---	---
pH	7.8	7.78	8.0	6.92	2.5	8.14	8.2	8.28	8.8
Specific conductance (mho)	1340	1130	1420	240	---	---	430	446	1600
TDS - sum	878	716	1163[c]	185	1757	5610	285[b]	385	1045[b]
Ca	52	67	49	6.4	42	93.0	38	57.4	52
Mg	28	22	31	0.25	18	2.7	13	10.6	60
Na	220	99	225	33	420	1590.0	29	18.0	200
K	8.0	14	12	5.9	73	126.0	6	5.8	24
HCO_3	150	200[d]	513	12	0	279.0	143	238	497
CO_3	---	---	0	---	0	---	6	---	69
SO_4	370	200	93	83	1000	245	73	23.4	158
Cl	50	66	170	1.7	21	2480.0	16	13	112
SiO_2	40	32	48	42	93	710.0[e]	---	19.0	---
Others	Fe = 0.2 F = 0.9 NO_3 = 1.2 N = 0.03 NO_2 = 0.12 NH_4 = 0.0 PO_4 = 0.60 As = 0.59 B = 1.3	B = 1.4 Li = 0.0 NH_4 = 0.0 NO_3+ NO_2 = 15 F = 0.0	F = 0.7 NO_3 = 9.3 B = 4.0 CO_2 = 8.2	F = 0.4	NH_4 = 73 NO_2 =<0.1 NO_3 = 1.0 F = 0.1 As = < 0.01 B = 0 PO_4 = 65.7 Cu = 0.4 Br = 0.0 Hg =<0.001	F = 3.8 B = 56.0 Li = 10.0 Rb = 0.118 Cs = < 0.01	F = 0.4 B = 0 NH_4 = 0.2 OH = 0 NO_3 = 1		F = 1.4 B = 6 NO_3 = 2 OH = 0 NH_4=0.4
Anions/cations (epm)	0.79	0.91	1.00	0.96	0.95		1.02	0.98	1.00

a M = Moyle, 1977; P = P. Hennis (personal communication, 1979); R = R. Lane (personal communication, 1979); S = Spane, 1978; N = Naval Weapons Center (personal communication, 1979); H = Hydrology Technical Report; F = Fournier, et al., 1978

b TDS residue on evaporation at 180^oC

c Recalculated from original source

d Value is for HCO_3+CO_3

e Silica values include possible colloidal clay dispersed in water lower elevations (Glosser, 1979).

Channel erosion and sediment transport are governed by the amount and duration of runoff and degree of channel development (Water Management Subcommittee, 1968). Frontal storm runoff generally produces minor channel and upland erosion, while convective storm runoff produces relatively great channel and upland erosion. Frontal storms with associated convective activity produce long-duration high flows, necessary for maximum sediment transport. Storms of this nature are characteristic of the CGSA. The amount of runoff and subsequent erosion are greatly reduced by infiltration to the stream-bed. The porous materials in the stream beds in the CGSA are capable of sustaining large stream bed losses during runoff periods.

2.5.1.2 Ground Water

Hydrologic Units

Hydrologic units are traditionally divided into two major categories: (1) non-water-bearing units, and (2) water-bearing units. The major water-bearing unit in the CGSA is the Quaternary alluvial sediment. The fractured granitic and metamorphic areas of the Pre-Tertiary basement complex, the Tertiary and Quaternary volcanic areas and the Tertiary Coso formation are not considered water-bearing units (Dutcher and Moyle, 1973, p.8).

The areal distribution of these units is shown on Plate 2.4.1 in the Geology Technical Report.

Since acquifer test data and ground water basin development are extremely limited to the CGSA, estimates of the hydrologic characteristics are based largely on the characteristics of analogous lithologic units in nearby areas.

Thickness of Alluvial Deposits--There are two types of alluvial sediments in Rose Valley--a Quaternary and Pleistocene alluvium (Qal) and the Coso formation (Tc). Estimated total thickness of both alluvial deposits in Rose Valley was interpreted from gravity data. Maximum valley fill thickness reaches 5600 feet (Healy and Press, 1964) in the north-central part of the valley. It has been suggested that interpretation of additional gravity data may reduce the maximum alluvial thickness estimate to about half of the present estimate (Moyle, 1979, personal communication). Interpretation and inclusion of these additional data would increase the confidence of the present estimate and structural interpretation.

Transmissivity--Transmissivity is an expression of the capacity of the aquifer to transmit water. The coefficient of transmissivity is defined as the quantity of water that will flow through a 1-foot-wide vertical strip including the total thickness of the aquifer under a hydraulic gradient of 1 foot per foot. It is expressed in gallons per day per foot (gpd/ft). In Rose Valley, the Quaternary and Pleistocene alluvium (Qal) has high permeability while the Coso formation has a low permeability. Wells drilled in the Qal have measured specific capacities that range between 4.5 and 13gpm/ft drawdown depending upon depth and well construction. No wells have been tested in the Coso formation in Rose Valley but these would probably be similar to wells drilled in the Pliocene Ricardo formation in Indian Wells Valley (California Department of Water Resources Bulletin 91-9, p. 243 1963). A well drilled in the Ricardo formation has specific capacity of one-third gpm/ft drawdown. In general, there are many basins that show this large difference in specific capacity between wells drilled in Qal and Coso formation. The coefficient of transmissivity of saturated alluvium in Indian Wells Valley ranges from over 300,000 gpd/ft in the central parts of the valley to about zero at the basin margins (Dutcher and Moyle, 1973, p. 11). Transmissivity in Rose Valley can be expected to be similar.

Ground Water Movement

Very few water level data are available for the CGSA. However, compilation, interpretation and extrapolation of all data suggests ground water flows into Rose Valley from the west, with perhaps some component from the north and east.

Two cross-sections were constructed from the geologic and hydrologic data: one trending east-west (Figure 2.5.1-2), the other trending north-south (Figure 2.5.1-3).

Interpretation of these cross-sections imply:

A. The major component of ground water flow is from west to east from the Sierra, and the Sierra Nevada fault zone apparently acts as a ground water barrier.

B. The configuration of schematic ground-water contours (Section 3.2.1, Hydrology Technical Report) suggests an east to west component of flow from the Coso Range into Rose Valley. Subsequent to drawing this figure, Fournier and Thompson (1980) have calculated that the water level difference is due solely to temperture effects on the density of water and, in fact, there is no hydraulic gradient from Coso Range to Rose Valley. However, the degree of hydraulic connection between these two ground water reservoirs is not presently known.

Ground Water Flow in the Coso Range--There are several hypotheses for ground water movement in the Coso Range, particulary with respect to recharge of the geothermal reservoir. Implications that can be drawn from Figure 2.5.1-2 are:

A. CGEH-1 and Coso No. 1 are in hydraulic communication.

B. The water table in the Coso Range is essentially horizontal at 3460 feet.

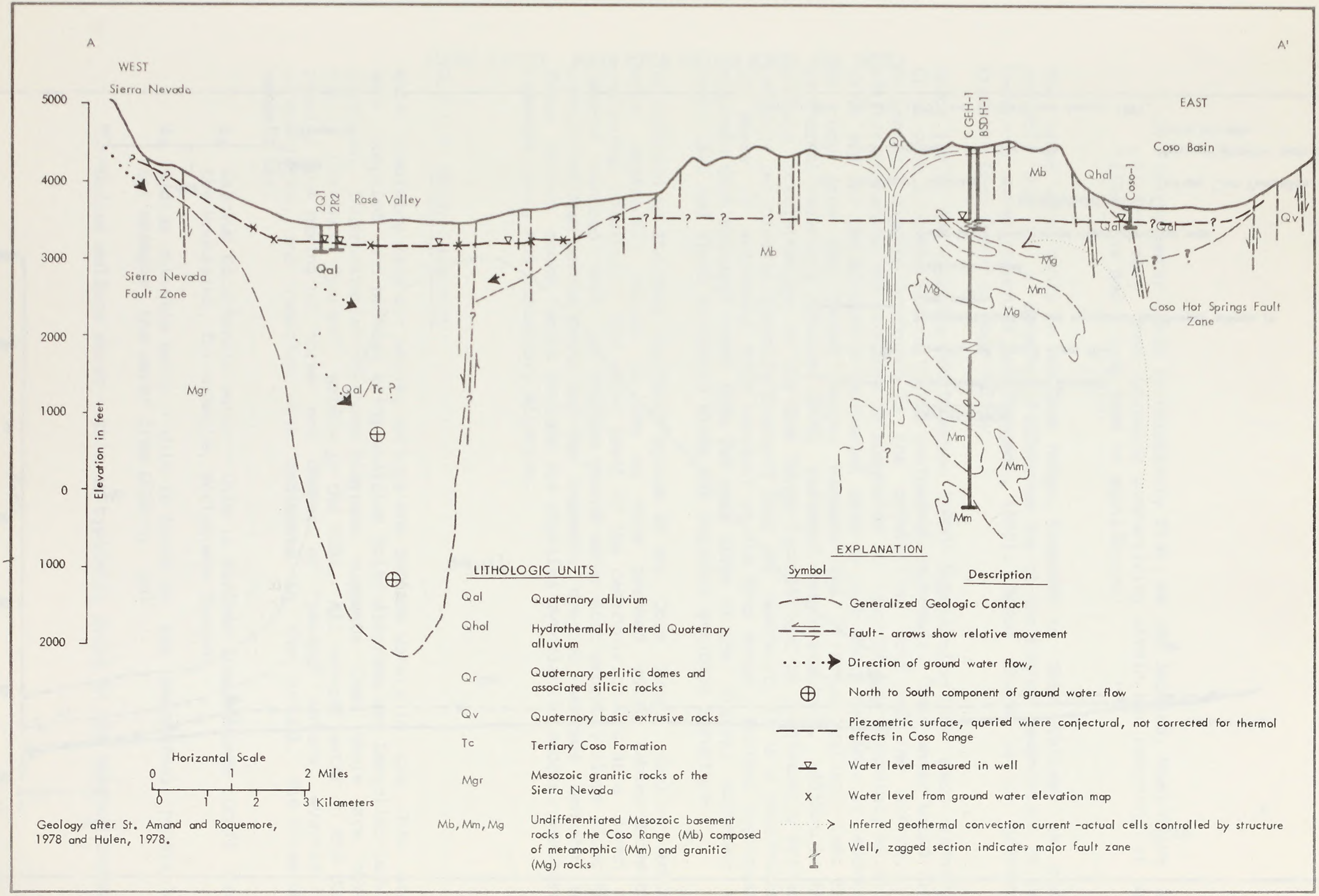


FIGURE 2.5.1-2 EAST-WEST SECTION ACROSS THE CGSA

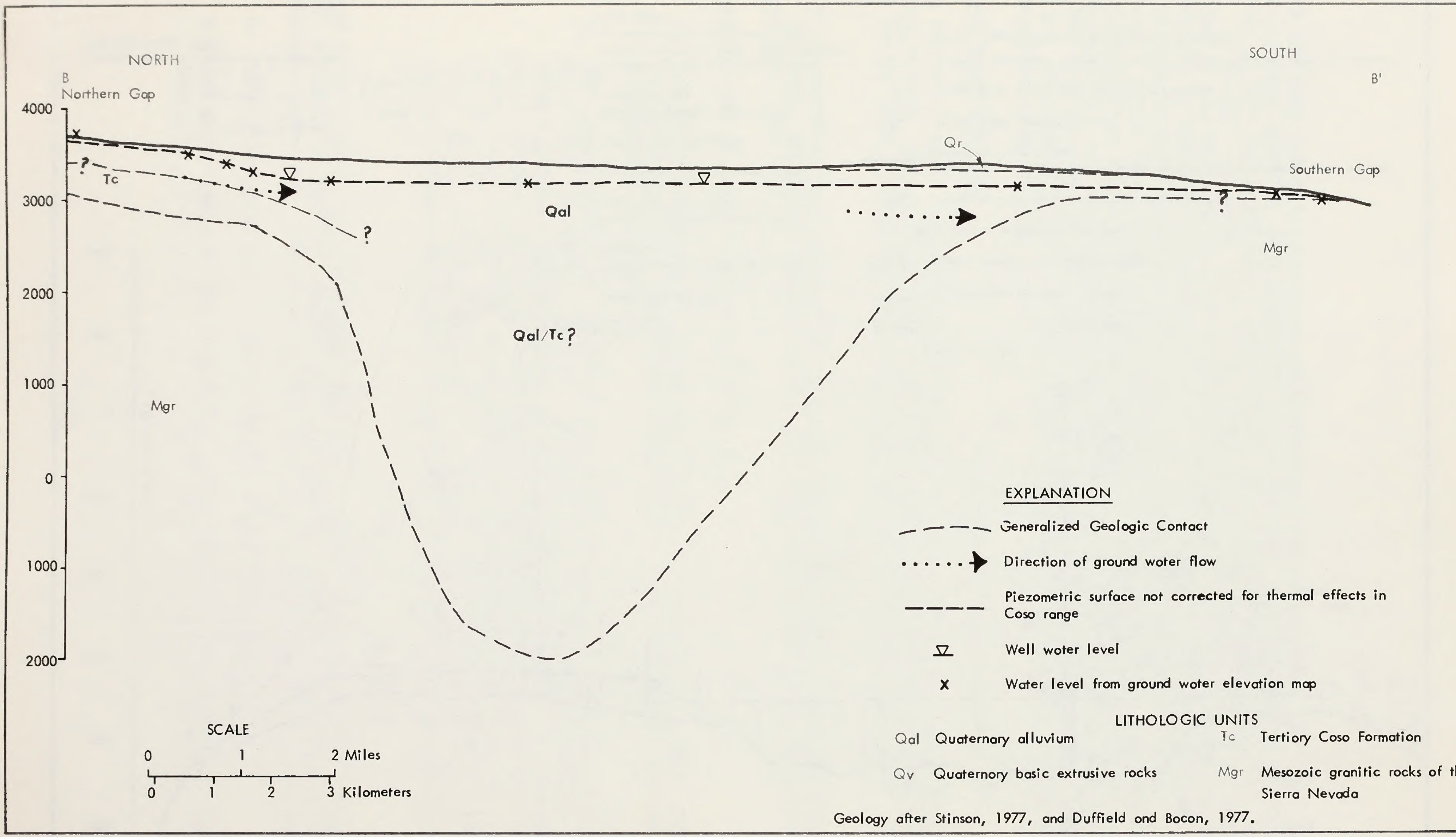


FIGURE 2.5.1-3 NORTH-SOUTH SECTION ACROSS ROSE VALLEY

C. If the water table is relatively flat, as (B) implies, then there is either very good hydraulic conductivity within the reservoir or the fluid has had a long time to equilibrate.

The higher water table in the Coso Range, compared to Rose Valley, is most probably due to a density difference due to the higher temperature of the reservoir water (Fournier and Thompson, 1980). Hence there is no gradient from the Coso Range to Rose Valley.

Spane (1978) and Fournier and Thompson (1980) hypothisize that deep recharge flows east from the Sierra to the geothermal reservoir. This water would flow in easterly dipping fractures in the crystalline rock of the Sierra. A similar mechanism for recharge is suggested for Long Valley (Fournier, et al., 1978) and for the Roosevelt geothermal area in Utah where recharge is reported to come from the Tushar Range, beneath the alluvial valley, into the geothermal reservoir (Whelan, 1979, personal communication). Although the average precipitation on the Coso Range insufficient to consistantly provide recharge percolating directly downward into the reservoir, it is a possibility in years of extremely high rainfall on the Coso Range. Another hypothesis suggests that recharge comes from the east slope of the Sierra, adjacent to Owens Lake and flows southward along the regional geologic structure.

In addition to the deep reservoir system in the Coso range, shallow ground water apparently occurs as one or more perched water tables above the geothermal reservoir. The water level of the reservoir occurs at a depth of several hundred feet and shallow ground water most probably flows along the contact between porous rocks and the basement complex surface beneath it. These porous rocks would include the rhyolite pyroclastic debris, weathered basement rock, and Quaternary alluvium.

2.5.1.3 <u>Water Chemistry</u>

Water chemistry data for wells, springs and surface waters in the Coso area were compiled and plotted using modified Stiff diagrams and Langelier-Ludwig diagrams. Interpretation of these diagrams suggests that there are three fairly distinct "parent" waters in the CGSA. All natural water in the CGSA results from mixing of three end member or "parent" waters, evaporative concentration and reaction with sediments in the ground. The three end members are:

A. Calcium bicarbonate water - this is derived from surface runoff from the mountains, for example, Portuguese Canyon;

B. Sodium chloride water - this is found in the geothermal reservoir; for example, the water from CGEH-1; and

C. Sodium sulfate water - this is typically found in the surface thermal manifestations at Coso; for example, 22S/38E-4K1.

Additional data collection and study will be necessary to further define the relationships of different waters and aquifers. An isotope study is presently being conducted by the USGS (Fournier, 1979, personal communication). The results of this study should provide much information on the origin, movement, and genesis of waters in the CGSA.

Natural or Existing Water Quality--Most known ground and surface water in the CGSA appears suitable for domestic, agricultural and livestock use, except for the thermal waters and somwhat more mineralized waters in the Little Lake area. There are presently no chemical data for water on the east side of Rose Valley or at depth. These data are necessary to define baseline conditions. In addition to spatial variation, the chemical composition of natural waters will vary with time. For example, the several analyses included for surface thermal waters, for Haiwee Spring and Lewis Spring show some variation. In order to determine if natural water is being degraded, some idea of this natural variation must also be established.

The spring and surface waters from the Sierra and the Coso Range are calcium bicarbonate in character. They generally contain about 300 to 500 milligrams per liter TDS. The TDS of this type of water in the ground is generally somewhat greater than that in the surface runoff due to some evaporative concentration and solution of minerals.

Wells and surface water in the Little Lake area have TDS contents up to 1300 milligrams per liter or more. A boron concentration of 6 mg/l for the surface water makes it totally unsuitable for agricultural applications.

The surface thermal manifestations are acid sulfate waters with TDS ranging from less than 200 to more than 2000 milligrams per liter, depending on the contribution from ground water and the degree of evaporative concentration. The several analyses for Wells 22S/39E-4K2, 4K3 and others, show that the composition and concentration of hot spring waters varies with time.

Trace amounts of mercury were found in water samples from the Coso resort area (Austin and Pringle, 1970). Well 21S/37E-2K1, just south of Haiwee Reservoir, contained 0.59 milligrams of arsenic per liter (Moyle, 1977, p.47). The drinking water standard for arsenic is 0.05 milligrams per liter (U.S. EPA, 1976).

The geothermal reservoir fluid is a sodium chloride type water. It has a total dissolved solids content of about 5600 mg/l, and likely high concentrations of toxic constituents. An arsenic content of 7.5 ppm and a boron content of 71.6 ppm have been reported (Austin and Pringle, 1970, p.36).

2.5.1.4 Hydrologic Models

In the resource assessment stage, such as this, data are sufficient only for a simple, qualitative conceptual model of the system. Such conceptual models for the geothermal system and the cooler ground water system are outlined below. A conceptual model for volcanic geothermal systems in general is outlined in Section 3 of the Geology Technical Report.

Conceptual Model of the Geothermal System--The geothermal reservoir at Coso is in fractured granitic and metamorphic rocks. It is essentially a liquid dominated system with a boiling water table (Galbraith, 1978, p.22). The great number of fractures and the complexity of the fracture distribution may compartmentalize the reservoir. Evidence to date suggests that vapor dominated sections occur as steam above the boiling water table. Since there is no evidence of a continuous caprock at Coso there must be a low heat flux, deep water table (Galbraith, 1978, p. 22) and/or channel deposition partially filled by hydrothermal alteration products to account for the limited surface manifestations. The hydraulic properties, temperature and areal extent of the reservoir are described in Appendix B, and in the Geology Technical Report. To summarize, the hydraulic properties of the reservoir are based on the following assumptions:

A. The rock matrix of the reservoir has no primary porosity; no deep primary aquifers have been identified by drilling or geologic mapping (Hulen, 1978, p. 24);

B. All flow and storage is in fractures with direction of flow probably entirely structurally controlled (Hulen, 1978, p. 24);

C. The porosity will vary widely depending on the size and openness of fractures.

Based on heat flow studies (Combs, 1976) the eastern boundary of the reservoir appears to be well defined at the Coso Hot Springs fault. The western boundary appears to be gradational, with cooler parts of the reservoir extending into or under Rose Valley. The northern and southern boundaries extend several miles to the north and south, respectively, of the Devil's Kitchen area.

The fluid in the reservoir may be relatively static, circulating as convection cells, or part of a deep circulation system. It may originate from the Sierra to the west, the Coso Range or the Owens Lake area to the north, or perhaps some combination. below (see Hydrology Technical Report), or some combination.

Test wells Coso No. 1 and CGEH-1 are about 2 miles apart and terminate at depths of 375 feet and 4794 feet, respectively. The marked similarity in composition of the reservoir fluid from these two wells suggests that convective currents within the reservoir may mix and "homogenize" the fluid.

Coso Hot Springs--The acid sulfate waters, such as those found at Coso Hot Springs, are distinctly different from the sodium chloride fluid found in the deeper reservoir. Acid sulfate waters, may be derived from steam condensing into surface waters. Oxidation of hydrogen sulfide to sulfate contributes to the acidity. Other constituents are leached mainly from rocks and sediments surrounding the pools (Ellis and Mahon, 1977, p. 60).

The Coso Hot Springs are not technically springs, but rather areas where steam condensate accumulates over near-surface impermeable clay layers (Austin and Pringle, 1970). The fluid levels, concentration, and temperature of the springs, all vary with precipitation, temperature and quantity of shallow ground water (Spane, 1978; Austin and Pringle, 1970). In the winter, when precipitation is greater, the fluid levels in the mud pots rise and its temperature decreases. In the summer, evaporation increases and contribution from shallow ground water stops. This lowers the fluid levels, allowing the temperature and concentration to increase. Possibly, pure shallow ground water contributes to the hot springs at times. The precise mechanism and relation between all the hydrologic, chemical and climate parameters are not presently known. Better definition and understanding of these relationships may provide more insight into the mechanism of the hot springs and its relationship to the geothermal reservoir.

In the most likely mechanism for the surface thermal manifestations shallow ground water flows from the small alluvial valleys west of the hot springs, and percolates deep enough to be heated and boiled by the hot ground and steam. The steam from the reservoir and ground water then ascends through fractures to the surface, condensing and accumulating on the impermeable clay layer several feet below the surface.

2.5.1.5 Hydrologic Balance

The hydrologic balance is a tally of all water entering and leaving a specified drainage area. The amount of water entering must equal the amount leaving to maintain water resources. If more water enters than leaves, then water in storage is increased. If more water leaves than enters, then water in storage is reduced. Calculation of the hydrologic balance will allow estimation of the practical sustained yield; that is, the amount of water that may be withdrawn from the system without producing undesirable effects. The practical sustained annual yield may exceed the mean annual recharge, particularly in arid regions where there may be large volumes of ground water in storage.

In the CGSA, there has been so little water use, and so few wells have been drilled that, at best, the parameters necessary for a hydrologic balance must be rough estimates, see Plate 2.5-1. These estimates would be based largely on a conceptual model of the general ground water situation in the area, empirical relationships and analogy from other areas and a few points of factual control. As more wells are drilled and more data become available, these estimates can be refined to reflect the added control.

The hydrologic balance (including surface and ground water) for Rose Valley shows total recharge approximately equalling total discharge at about 60,000 AF/YR. That portion which pertains to the ground water regime is summarized on Table 2.5.1-4. Derivation of the individual estimates is presented in Section 4 of the Hydrology Technical Report.

Table 2.5.1-4
SUMMARY OF ESTIMATED GROUND WATER BALANCE FOR ROSE VALLEY

Recharge	Estimated Annual Quantity (acre-feet/year, rounded)
Underflow from Haiwee Reservoir	600
Underflow from alluvial fans west of Haiwee Reservoir	Contribution not Presently Known
From precipitation on Sierra	1900-3000
From precipitation on Coso Range	0
From precipitation on valley floor	0
Imported water	100
Irrigation	900
	3500-4600
Discharge	
Irrigation withdrawal	3100
Little Lake surface evaporation	830
Evapotranspiration, other vegetated areas around Little Lake	40
Underflow to Indian Wells Valley	200-500
Domestic and stock withdrawal	30
Springs	30-190
	4100-4700

Within the roughness of the estimates the Rose Valley ground water basin presently appears to be near hydrologic equilibrium with a ground water recharge of 3500 to 4600 AF/yr and a discharge of 4100 to 4700 AF/yr. Ground water excess or deficiency is not more than several hundred acre-feet per year. This balance may be modified by further studies which would confirm the assumptions these estimates are based on, including:

A. Precipitation on the east slope of the Sierra

B. Precipitation/potential ground water recharge relation

C. Recharge from areas to the north, including underflow through the gorge south of Haiwee Reservoir and possibly through the alluvial fans to the west of the reservoir.

These assumptions are detailed in Sections 4.1 and 4.2 of the Hydrology Technical Report.

Ground water in storage for Rose Valley has been estimated by assuming an average specific yield for the saturated thickness of alluvial material in the valley. Assuming an unconfined aquifer with a 10 to 15 percent specific yield, the total volume of water in storage is 3.3 to 5 million acre-feet. Of this total, 1.4 to 2.2 million acre-feet is within 1000 feet of the surface. Most of the water in storage is believed to be usable but the geothermal reservoir fluid may extend into the alluvial material on the east side of the valley or saline water may occur in other locations.

2.5.1.6 Water Availability and Use

No surface water is available for consumptive use in or near the CGSA. Water is potentially available from several ground water basins. Areas that contain porous materials with water-bearing properties may be considered for ground water extraction. These include the alluvial sediments in Rose Valley, Upper Cactus Flat, McCloud Flat, Upper Coso Basin and Lower Coso Basin (Figure 2.5.1-1). Use of water extracted from the geothermal reservoir is considered in the design of the power plant system for cooling and the 323 acre-feet/year requirement per 50 MW (Section 1.3.5.4) is in excess of that use.

Rose Valley has been emphasized as a prime potential source of cooling water due to its size and potential ground water yield, its status as BLM administered land and its proximity to the primary area of projected development. Compared with Rose Valley, the other drainage basins are quite small, have lower rainfall, and have much less or no data available. Use of ground water from these other basins would require further assessment of ground water resources, most likely including drilling of several observation wells.

Water Use

Current water use is quite limited in Rose Valley and nil in Coso Basin. Rose Valley Ranch is the major water user, pumping about 3130 AF/yr (Hennis, 1979, personal communication). Domestic use is small due to the low population. Water use in Rose Valley is summarized in Table 2.5.1-5.

Table 2.5.1-5
ESTIMATED WATER USE IN ROSE VALLEY

Use and Location	Estimated Annual Quantity (acre-feet/year)
Irrigation	
Rose Valley Ranch	3130
Cal-Trans Rest Stop	14
Domestic & Stock	
Permanent Residents	7
Cal-Trans Rest Stop	14
Stock Watering	3
Transient Residents at Little Lake Hotel	5
Total	3200 (rounded)

2.5.2 Impacts of the Proposed Action on Hydrology

Geothermal development requires cooling water, which could displace other uses or degrade other supplies. It also produces enormous amounts of liquid waste which must disposed of. In the CGSA another hydrologic issue of particular importance is possible alteration of the Coso Hot Springs.

2.5.2.1 Background

Hydrologic impacts are best described by dividing geothermal development in the CGSA into two phases. The first is the preliminary exploration, exploratory well drilling, and construction of the development facilities. These would involve mostly short-term local hydrologic effects, which would consist mainly of impacts from surface erosion and drilling waste disposal.

This could possibly cause alteration of surface runoff and erosion patterns, sediment yield, and ground water degradation.

The second phase is geothermal field development and resources utilization activities. This would involve higher levels of runoff and more long-term regional effects. The impacts would result from geothermal reservoir utilization and injection and ground water withdrawal. The potential impacts may include:

1. Lowering of the water table in Rose Valley;

2. Degradation of natural water;

3. Alteration of surface thermal manifestations, including flow to Coso Hot Springs;

4. Localized cooling, mineral precipitation and/or depletion of the geothermal reservoir.

Precise quantification of these long-term impacts requires geothermal and ground water reservoir development data. Such data are not presently available. Hence, the analysis of the hydrologic impacts is semi-quantitative. It is based on analysis, interpretation and extrapolation of the limited available data. The assumptions, techniques and derivations of numeric estimates are detailed in the Hydrology Technical Report and those most pertinent to the following discussions are summarized.

Preliminary Exploration, Exploratory Well Drilling and Construction Activities

Insignificant impacts from alterations in runoff patterns and increases in erosion would occur from the preliminary exploration. Drilling wastes and test fluids could be produced in fairly large quantities during exploratory well drilling. If toxic, these may have to be trucked to a disposal site for Class I wastes. If not, they may be evaporated and buried in place, the impacts of which would be low.

Increased runoff could occur on disturbed soils. Water erosion potential from drill pads in this stage ranges from slight to high depending upon which soil type the pads are located. Disturbance from drill pads located on highly erosive soils could greatly increase sediment yield and thus create active erosion in drainage channels, see Section 2.6. An approximate total of disturbance of 450 acres could occur in this stage if, as has been calculated, 100 wells are drilled in Zones 1 and 2, and 300 exploratory wells are drilled in Zones 3 and 4.

Geothermal Field Development, Resource Utilization

Well testing in the field development stage would also result in large quantities of waste and test fluids which could be disposed of by burying. In addition, spent geothermal fluids from resource utilization would be produced. As most of these fluids could be reinjected in available wells, impacts would be slight.

As in exploratory well drilling, sediment yield and erosion potential from disturbed sites created during field development would vary with the erosion susceptibility of the soil see Table 2.6.1-2.

Because approximately 800-1000 acres would be disturbed, increased runoff and subsequent erosion could be about double that of the exploratory stages. During periods of heavy rainfall, erosion on disturbed soils could displace large amounts of soils which would cause heavy cutting of downstream channels, and deposition of sediment in the playas. In 100 year storms, sediment could be deposited into Little Lake, and even farther.

2.5.2.2 Lowering the Water Table in Rose Valley

Water Use and Availability— No surface water is available for use in the CGSA. Rose Valley is presently considered the most logical source for geothermal plant cooling water.

Potential combined water use by geothermal and present users may exceed natural recharge. Current and projected water use in Rose Valley is summarized in Tables 2.5.1-5, and 2.5.2-1. Ground water recharge and discharge is summarized in Table 2.5.1-4. Although it is extremely conjectural, if geothermal power production in the CGSA is extrapolated to a total of 550 MW by 2030, geothermal development water requirements would total about 4,300 AF/yr. Details of derivation of these estimates are presented in Sections 5.2 and 5.3 of the Hydrology Technical Report.

Table 2.5.2-1
PROJECTED WATER USE IN ROSE VALLEY

Use and Location	Estimated Annual Quantity (acre-feet/year, rounded)		
		1986[a]	1995
Irrigation			
Rose Valley Ranch	3130[b]		
Lewis Ranch/Coso Junction	1000		
Cal-Trans Rest Stop	14		
Total Irrigation		4100	4100
Domestic and Stock			
Permanent Residents	260		
Other	40		
Total		300	400
Industrial			
Geothermal Power Plant	390		
Geothermal well drilling (assumes 13 wells/year)	210		
Total Industrial		600	1800[c]
Total Use		5000	6500

a Or at completion of first 60 MWe of geothermal generating capacity.
b Irrigation application at Rose Valley Ranch could possibly increase by as much as 4600 AF/yr (See Hydrology Technical Report).
c Assuming 250 MW geothermal development.
Also, about 30 percent of irrigation application is estimated to recharge the ground water table (see Table 2.5.1.5).

The range in the recharge and discharge estimates and the assumptions used in deriving them make it difficult to determine at what point increased water demand in Rose Valley may overdraft the ground water reservoir. In the worst case it is presently overdrafted by about one thousand AF/yr. In the best case recharge presently exceeds discharge by about 500 AF/yr.

Total ground water in storage in Rose Valley is estimated at about 3.3 to 5 million acre-feet. Approximately 1.1 to 2.2 million acre-feet is within 1000 feet of the surface. Most is believed to be usable. The estimates are based on the volume of alluvial sediments in Rose Valley and their average assumed specific yield. The volume of sediments is based on a gravity survey that has some demonstrated inconsistencies. The identified inconsistencies were corrected, but the reliability of the interpretation remains somewhat dubious. Resurvey and reinterpretation of the gravity data would most probably reduce the ground water in storage estimates. The total ground water in storage estimate would be affected much more than the water availability in the upper one thousand feet. These assumptions and derivations are detailed in Section 4.3 and 3.1.2 of the Hydrology Technical Report.

If the water required for geothermal development tilts the hydrologic balance, as a first approximation, an average of 2100 to 3200 acre-feet of ground water in storage will be available per foot of drawdown from the upper one thousand feet of the ground water reservoir in Rose Valley. Naturally the water table will not be lowered evenly throughout the valley. Lowering will be greatest near pumping wells. Formations with adequate transmissivity to supply this water exist in Rose Valley.

Potential Impacts-- Estimated potential average annual water table lowering is summarized for the years 1979, 1986, and 1995 in Table 2.5.2-2. It is divided into two parts; one part assumes the "best case" situation and the other assumes a "worst case" condition. The "best case" is based on maximum recharge and minimum natural discharge from Table 2.5.1-4 and the water yield that would minimize drawdown. The "worst case" is based on minimum recharge, maximum natural discharge and minimum water yield per foot of drawdown. If it is assumed that total field development, from initial startup to final shut-down will take about 70 years, and average water use is at the 250 MW level, then the water table may be lowered a total of about 60 to 150 feet.

Lowering the water table in Rose Valley may:

1. —Reduce the quantity of ground water in storage

2. —Reduce the quantity of underflow into Indian Wells Valley

3. —Lower the water level in Little Lake

4. —Affect surface vegetation

5. —Degrade natural water

Table 2.5.2-2. ESTIMATED POTENTIAL AVERAGE ANNUAL WATER TABLE LOWERING IN ROSE VALLEY*

	BEST CASE					WORST CASE				
Year	Estimated Recharge (AF/yr)	Estimated Natural Discharge (AF/yr)	Estimated Water Use (AF/yr)	Change in Water Supply (AF/yr)	Estimated Water Table Change (ft/yr)	Estimated Recharge (AF/yr)	Estimated Natural Discharge (AF/yr)	Estimated Water Use (AF/yr)	Change in Water Supply (AF/yr)	Estimated Water Table Change (ft/yr)
1979	4600	900	3200	+ 500	+0.2	3500	1600	3200	-1300	-0.6
1986	4600	900	5000	-1300	-0.4	3500	1600	5000	-3100	-1.5
1995	4600	900	6600	-2900	-0.9	3500	1600	6600	-4700	-2.2

*Recharge, discharge and water use rounded to nearest one hundred acre-feet; water table change rounded to nearest 0.1 foot.

The first impact would decrease the amount of water available for future uses from this source. The second impact would result from a reduction in the hydraulic gradient between Rose Valley and Indian Wells Valley. Presently ground water recharge to Indian Wells Valley is estimated at 10,000 to 15,000 acre-feet/year (Bloyd, 1979). The quantity of underflow from Rose Valley, perhaps several hundred AF/YR, woulld represent a few percent of the total ground water recharge to Indian Wells Valley. This is discussed further in Section 4.2.3 of the Hydrology Technical Report. The third impact would occur since Little Lake is fed by ground water from natural springs. The degree of water level lowering in Little Lake is difficult to quantify for several reasons.

1. The flow rates of the springs feeding in the Lake have not been measured.

2. The source and mechanism of these springs has not been identified.

3. The natural variation in the level of the Lake has never been systematically recorded.

4. The Lake level has historically been artificially maintained by ground water pumping.

The fourth impact would affect only natural phreatophytic vegetation which is virtually nonexistent in Rose Valley, except for a small area immediatly adjacent to Little Lake. This effect is discussed in Section 2.8, Flora. The fifth impact, degradation of natural water as a potential impact is discussed in the following subsection.

2.5.2.3 Degradation of Natural Water

Geothermal fluid may be released at the surface via accidental spills, blowouts or leakage from surface facilities. Geothermal fluid may be re leased beneath the surface via well failure or unforeseen structural or stratagraphic pathways. Ground and/or surface water may be degraded by escape of noxious drilling muds from the well, sump or from leaching of drilling mud residues. Septic systems, if not properly designed and installed, may degrade ground or surface waters.

Insufficient data is available to define the present character of water throughout the Rose Valley, the possible locations of water withdrawal, or the details of hydraulic gradients. This also applies to the geothermal reservoir. Hence, location, distribution and quantity of presently nonusable water (nonusable water refers to water of quality too poor to suit its intended use; this generally is water with high salt content, high boron, fluoride or trace metals) in Rose Valley may increase or decrease depending on:

A. The location and extent of nonusable water;

B. The hydraulic relationships between the geothermal reservoir and the ground water reservoir;

C. Geothermal production and injection design;

D. The cooler ground water extraction location in Rose Valley.

For example, under the following set of hypothetical conditions ground water may be induced to flow from Rose Valley towards the geothermal reservoir:

There is some hydraulic communication between the Rose Valley ground water reservoir and the geothermal reservoir, and

The water level in the geothermal reservoir is lowered below the level of the ground water reservoir in Rose Valley.

Although it is premature to define specifics, in general, chemical and thermal pollution of ground water aquifers during injection of waste can result from escape of geothermal fluids via the following mechanisms:

1. Improperly constructed or deteriorated injection well;
2. Improperly constructed, deteriorated or ineffectively abandoned wells nearby;
3. Escape of injected fluid from the receiving formation through structural or stratigraphic pathways;
4. Hydrofracturing of confining formations with high-pressure injection;
5. Accidential spills at the ground surface;
6. Percolation from storage ponds (enhanced by higher temperatures);
7. Percolation from discharge of mineralized fluids through leaks in surface conveyances which are part of the injection system;
8. Chemical migration through confining beds due to osmotic forces.

Escape of fluid by any of these mechanisms would result in mixing of non-geothermal water with geothermal fluid. This would in most cases, result in increased total dissolved solids and trace metal concentrations in the non-geothermal water. (Table 2.5.1-3 has representative analyses of several types of water in the CGSA). In the vicinity of the prospective geothermal development there are many shallow (less than 100 ft. deep) abandoned wells at Coso Hot Springs, and the Devil's Kitchen, Nicol and Wheeler prospects. There are also about 20 heat flow holes drilled in 1975-1976 to maximum depths of about 300 feet in and around the CGSA. None of these wells intercepted usable water, hence this mechanism is unlikely.

Fluid escape along faults, at the surface or by osmotic forces are not anticipated to affect ground water quality in the reservoir development area in the Coso Range itself since there is no known perennial, usable ground water above the reservoir. Fluid flow into or out of the reservoir from Rose Valley or Coso Basin would depend on the existence of a conductive fault and the natural and induced hydraulic relations.

Accidental spills at the surface, percolation from holding ponds, blowouts (see Section 1.3.5.2) or leakage from surface conveyances would each entail similar pathways. The fluids would percolate from the surface downward into the nearer surface aquifers. A spill, if not contained, may also discharge fluids directly into the nearer surface aquifers. Such occurrences would be treated immediately. Pollution due to osmotic migration of chemical constituents is generally anticipated to be minor and insignificant.

Although escape of fluids by any of these mechanisms is of concern, the greatest risk of fluid escape is through the injection well itself (Talbot, 1972). Currently prescribed well construction practices and the large vertical distances between the injection zones and usable aquifers, reduce the probability of contamination of usable aquifers. The nearest used aquifer is in Rose Valley. Alluvial valleys adjacent to the reservoir may be potentially usable. It is not anticipated that any of these used or potential ground water sources would be directly affected by injection in the geothermal reservoir.

Septic Systems-- Assuming local health ordinances are followed, septic systems from potential residential development in Rose Valley are not anticipated to have any adverse impact.

2.5.2.4 Alteration of Surface Thermal Manifestations, Including Flow To Coso Hot Springs National Historic Site

Flow to the hot springs may increase or decrease due to geothermal production depending on reservoir development design and the precise nature of the hydraulic connection between the geothermal reservoir and the hot springs. Lowering of the water table and altering natural flow in the geothermal reservoir may affect the amount of steam condensate reaching the hot springs. This effect cannot be quantified at this time. However, it is anticipated that the effects of geothermal development will be less than if the hot springs were fed directly and solely by geothermal reservoir fluid for two reasons:

A. Steam is much less viscous and dense than water. It will rise above the water table and flow more pervasively than water.

B. Shallow ground water contributes to the hot springs. This contribution of shallow ground water will not be affected by geothermal development.

Construction activities may increase runoff potential upstream from the hot springs. This surface disturbance may produce a minor increase in shallow ground water contribution to the hot springs. The cultural and socio-economic aspects of alteration of flow to the hot springs are discussed in Sections 2.10.2 and 2.12.2.

2.5.2.5 Localized Cooling, Mineral Precipitation and/or Depletion of the Geothermal Reservoir

Injection of spent fluids may cause localized cooling in the geothermal reservoir. Production and injection may cause mineral precipitation (plugging) around wells, thereby reducing productivity and/or injectivity, respectively. The extent or recharge mechanism of the resource is not presently known. Environmental effects of depletion of the resource would depend on the hydraulic relations between the geothermal and other ground water systems.

2.6 SOILS

2.6.1 Present Soils Setting

Twenty-one predominant soils occur in the CGSA. They have been grouped into ten General Soil Map Units (Plate 2.6-1) based upon similar soil and landform characteristics. Table 2.6.1-1 shows how soils are grouped on Plate 2.6-1. Table 2.6.1-2 gives selected properties and qualities of the 21 soils. The soils on granitic uplands and steep sideslopes of rhyolite domes of Map Units 6 and 8 generally have a moderate to high susceptibility to water erosion. Map Units 1, 4, 5, and 7 have a slight to moderate susceptibility to water erosion. Soils of the valley bottoms and playa areas in Map Unit 2 are slightly susceptible to water erosion. The hazard of wind erosion is high on Map Units 1, 2, 3, 4, 6, and 7.

The total of all map units rated as highly susceptible to wind or water erosion covers the bulk of the CGSA. Generally, soils on the more level areas are susceptible to wind erosion, and the soils on the hillsides are susceptible to water erosion. Soils on basaltic uplands, lava flows, cinder cones and deposits, and rhyolite domes are less susceptible to erosion.

TABLE 2.6-1-1*

COMPONENT SOILS OR LANDFORMS OF GENERAL SOIL MAP UNITS

Map Symbol	Soil or Landform
1	Dunmovin, Arizo, Garlock
2	Dunmovin, Lavic, Wasco Variant, River Wash
3	Alko Variant, Joshua Variant, Nebona Variant, Hooten Variant, Arizo
4	Alko Variant, Dunmovin Variant, Nebona Variant
5	Gass Variant, Garlock Variant, Sparkhule
6	Maynard Lake, Stumble, Haybourne
7	Maynard Lake, Stumble
8	Coco, Rock Outcrop, Haiwee, Shoken, Coso Variant, Haiwee Variant
9	Rubble Land, Torriorthents, Rock Outcrop
10	Cinder Land, Lava Flows

*Refer to Section 5.0 of the Soils Technical Report for a more detailed discussion of the General Soil Map Units.

TABLE 2.6-1-2

RATINGS FOR SELECTED SOILS
PROPERTIES AND QUALITIES

Soil Name	Class				Limiting Layer		Precipitation Annual	Erosion Susceptibility	Area Acres	Percent of Soil Series
	Depth Inches	Permeability	Runoff	Drainage	Kind	Thickness Inches				
Alko Variant	8-20	<.06	Medium to Rapid	Well Drained	Hardpan	Not Known	5-6	Moderate to High	2,123	2.8
Arizo	20.0	20.0	Very Slow	Excessive	None	None	5-6	Slight (Water) High (Wind)	695	0.9
Coso	8-20 to Weathered Granite	2.0-6.0	Medium to Rapid	Somewhat Excessive	Weathered Bedrock	--	6-7	High	6,548	8.7
Coso Variant	20-60 to Weathered Granite	0.6-2.0	Medium	Well Drained	Weathered Bedrock	--	6-7	Moderate	1,118	1.5
Dunmovin	More Than 60	6.0-20	Very Slow to Slow	Somewhat Excessive	None	None	5-6	Slight (Water) High (Wind)	15,970	21.3
Dunmovin Variant	>60	0.2-0.6	Slow to Medium	Somewhat Excessive	Weakly Cemented Substra-tum	14	5-6	Slight (Water) High (Wind)	1,643	2.2
Garlock	>60	0.2-0.6	Medium	Well Drained	None	None	5-6	Moderate	96	0.1

TABLE 2.6-1-2 (Cont.)

RATINGS FOR SELECTED SOILS

PROPERTIES AND QUALITIES

Soil Name	Class				Limiting Layer		Precipitation Annual	Erosion Susceptibility	Area Acres	Percent of Soil Series
	Depth Inches	Permeability	Runoff	Drainage	Kind	Thickness Inches				
Garlock Variant	26-40 Over Basalt And Cinders	0.2-0.6	Slow to Medium	Well Drained	26-40" to Basalt And Cinders	--	5-6	Slight to Moderate (Water) High (Wind)	1,614	2.1
Gass Variant	20-40 to Basalt And Cinders	0.06-0.2	Slow to Medium	Well Drained	Bedrock	--	5-6	Slight to Moderate	873	1.2
Haiwee	8-20 to Granite	2.0-6.0	Medium to Rapid	Somewhat Excessive	Bedrock	--	6-7	High	2,134	2.8
Haiwee Variant	10-20 to Andesite	0.6-2.0	Medium to Rapid	Somewhat Excessive	Bedrock	--	7-8	High	308	0.4
Haybourne	>60	2.0-6.0	Slow to Medium	Well Drained	None	None	7-8	Slight to Moderate (Water) High (Wind)	941	1.3
Hooten Variant	8-20 to Hardpan	<.06	Slow to Medium	Well Drained	Hardpan	4	5-6	Slight to Moderate (Water) High (Wind)	450	0.6

TABLE 2.6-1-2 (Cont.)

RATINGS FOR SELECTED SOILS
PROPERTIES AND QUALITIES

Soil Name	Class				Limiting Layer		Precipitation Annual	Erosion Susceptibility	Area Acres	Percent of Soil Series
	Depth Inches	Permeability	Runoff	Drainage	Kind	Thickness Inches				
Joshua Variant	>60	0.6-2.0	Slow	Well Drained	None	None	5-6	Slight (Water) Moderate (Wind)	1,328	1.8
Lavic	>60	0.6-2.0	Very Slow	Well Drained	None	None	5-6	Slight (Water) High (Wind)	2,670	3.6
Maynard Lake	>60	6.0-20	Medium	Somewhat Excessive	None	None	5-6	Moderate (Water) High (Wind)	8,208	10.9
Nebona Variant	8-15	<.06	Slow to Rapid	Well Drained	Hardpan	Not Known	5-6	Slight to Moderate	2,191	2.9
Shoken	3-15 to Granite	6.0-20	Medium to Rapid	Somewhat Excessive	Weathered Bedrock	--	7-8	Moderate to High (Water) Moderate (Wind)	1,686	2.2
Sparkhule	14-20 to Basalt	0.2-0.6	Medium	Well Drained	14-20 to Bedrock	6-14	5-6	Moderate	780	1.0
Stumble	>60	6.0-20	Medium	Somewhat Excessive	None	None	7-8	Moderate (Water) High (Wind)	4,166	5.5
Wasco Variant	>60	0.2-0.6	Very Slow	Well Drained	Weakly Cemented Substra-tum	36	5-6	Slight (Water) Moderate (Wind)	1,016	1.4

2.6.1.1 Paleontology

Fossils are a nonrenewable resource of interest to the general public and the scientific community. Although thought to be rare in the CGSA, fossil vertebrates provide the only information on the terrestrial life that existed in this region during the past 60 million years. Fossil invertebrates are not known or thought to occur in the CGSA. Fossils are found primarily in sedimentary rocks, but their occurrence is unpredictable. In this area they may also be found in volcanic rocks. Generally, finer grained sedimentary rocks represent an environment of deposition more favorable for the preservation of fossils than coarser grained sedimentary rocks, but again, fossils can be found in any rock type. As such, it is not possible to say that any area is barren of fossils. Those areas within the CGSA which have a relatively high potential for containing fossil vertebrates have been identified.

Studies made for the California Desert Plan in the California Desert Conservation Area (CDCA) which includes the CGSA, have designated areas as having a high, medium or low probability of containing fossil vertebrates. These studies are the primary source of information for this discussion of paleontology. The designation of high probability areas is based on the known occurrence of fossils and are so designated because it is quite likely that fossils would be found if careful searches were made. In medium probability areas, experience has shown that diligent searches can occasionally turn up fossil remains. Low probability areas have a low potential, but due to the unpredictability of fossil distribution, these areas should not be ruled out completely.

All vertebrate fossils and specific invertebrate fossils are considered objects of scientific interest and are covered by the Antiquities Act of 1906.

In the CDCA investigation on fossil localities, no fossil localities or areas designated as having any potential of containing fossils have been identified within the CGSA. Based on similar lithology and age, three geologic mapping units are identified here as potentially containing fossil vertebrate sites.

Vertebrate Fossil Sensitivity

The Indian Wells Valley area and the Coso Mountains area are high potential areas adjacent to the CGSA. Airport Lake is a low potential area adjacent to the CGSA. It contains Rancholabrean Age mammal fossils which occur in Quaternary alluvium that may or may not extend into the CGSA. Due to the age and lithology of the deposit, the Old Alluvium geologic unit should be considered to have a moderate sensitivity for vertebrate fossil sites.

The White Hills portion of the Indian Wells Valley area is a high potential area with mammal fossils from the Irvingtonian Age. This area correlates to the sedimentary rock of the White Hills (swh) mapping unit of the CGSA. It consists of interbedded conglomerate, sandstone, siltstone, silty claystone and tufa grading laterally into cobble to boulder fanglomerate deposits. The sedimentary rocks of the White Hills unit in the southeastern portion of the

CGSA should have a high sensitivity to the following Irvingtonian Age vertebrate fossils: _Paramylodon_, _Stegomastadon_, _Mammuthus_, _Equus_, _Camelops_, _Breameryx_.

The Coso Mountains between Rose Valley and Owens Lake contain Blancan Age mammal fossils, early Pleistocene or late Pleistocene, in sandstone and siltstone deposits which correlate to the Coso formation (c) on the CGSA geologic map. The Coso formation crops out in the north central portion of the CGSA, see Table 2.6.1-3. The Coso Formation in the north central portion of the CGSA should have a high sensitivity for the following Blancan Age fossils: _Cosomys primus_, _Hypolagus limnetus_, _Borophagus solus_, _Platygonus_, _Hemiauchenia_, _Plesippus francescana_, _Pliomastadon cosoensis_.

Cenozoic Epoch	Mammal Ages	Time in millions	
PLEISTOCENE*	Rancholabrean	0	QUATER-NARY
	Irvingtonian	1	
PLIOCENE	Blancan	2 – 5	note change in scale here
MIOCENE	Hemphillian	10	TERTIARY
	Clarendonian		
	Barstovian	15	
	Hemingfordian	20	
OLIGOCENE	Aridareean	25	
	Whitneyan	30	
	Orellan		
	Chadronian	35	
EOCENE	Duchesnean	40	
	Uintan	45	
	Bridgerian	50	
	Wasatchian	55	
PALEOCENE	Clarkforkian		
	Tiffanian	60	
	Torrejonian		
	Dragonian-Puercan	65	
NEWER USAGE		70	
		75	

Table 2.6.1-3
Paleontologic Epochs

Invertebrate Fossil Sensitivity

No invertebrate fossil sites have been identified in or adjacent to the CGSA. The closest sites identified in the CDCA studies are in the Argus Range and the Darwin Hills to the northeast in areas underlain by Paleozoic and early Cenozoic marine sedimentary rocks. Marine sedimentary rocks, which represent an environment of deposition favorable for the preservation of invertebrate fossils, don't occur in the CGSA. Thus, invertebrate fossils are not thought to occur in the CGSA.

2.6.2 Impacts of the Proposed Action on Soils

Based upon input from other resources and Chapter 1, Proposed Action , environmental impacts to soil resources resulting from possible implementation of the Proposed Action will be presented and analyzed using data and interpretations derived from the Soils Technical Report.

2.6.2.1 Sensitivity and Limitations of Soils

The soils of the CGSA are quite variable and pose many different kinds of sensitivities and limitations to development. Sensitivities, capabilities, and constraints imposed by soils to various land uses are summarized in tabular form by soil map unit in an appendix to the Soil Technical Report.

Sensitivities and constraints of the soils include the following:

1. Soils of the playa bottoms are subject to soil compaction when wet.

2. The Maynard Lake and Stumble soils developed in cinder and ashfall deposits are highly susceptible to wind and water erosion on slopes greater than 30 percent.

3. Garlock and Garlock Variant soils mapped on old terraces and basalt flows have high soil shrink-swell potential and are less desirable building sites.

4. Coso and Haiwee soils developed on granitic rock occur on steep, rocky slopes and pose difficult conditions for road construction.

5. Alko, Nebona, and Nebona Variant soils are bouldery and shallow to hardpan, and pose difficult road construction conditions. Once disturbed, these areas would be difficult to revegetate.

6. Areas mapped as Arizo soils and Riverwash may be subject to periodic flash flooding.

7. An area of landslides and rockfall was mapped north of Coso Hot Springs and may be reactivated if disturbed.

Sensitive areas have been delineated on Plate 2.6-1 General Soils Map and Sensitivities.

2.6.2.2 Preliminary Exploration

The initial exploratory program will consist predominantly of field geophysical investigations which may require Surface vehicular access to most areas of the CGSA. Off-road travel will be regulated within the Naval Weapons Center (NWC) and on public lands. Impacts to soil resources from off-road vehicular travel include displacement of soils in tire ruts and wheel holes and soil compaction. The degree of localized damage to the soil is a function of soil properties. Tire ruts on slopes can divert surface runoff, and may cause accelerated soil erosion which may persist for long periods of time after soil disturbance. The sandy Maynard Lake and Stumble soils on slopes greater than 30 percent present the most serious potential soil erosion impacts.

Soil compaction may occur when the soil surface is wet/moist. The finer textured soils of the the playas and adjacent areas are the most susceptible to soil compaction (see soils map in Soils Technical Report for soil type). A secondary impact caused by soil compaction is the impedance to revegetation.

A third impact may result from drill cuttings left on the soil surface. This is estimated to be from 0.8 to 1.6 cubic meters of drill cuttings per shallow temperature gradient hole (USFW, 1976). Since cuttings are usually low in fertility and do not support vegetation, they would leave local visual scars. There would also be minor impacts from spills of gasoline and lubricating materials, litter from the crew, parking of personal vehicles, and other associated activities. Impacts from preliminary exploration are considered minor.

2.6.2.3 Exploratory Well Drilling

Estimated acreages of surface disturbance due to exploratory well drilling activities are outlined in Table 1.3-2 of Chapter 1 which shows totals of estimated acreages to be disturbed per 50 MW generation station. An estimated 112.5 acres of land would be disturbed in Zones 1 and 2 by exploratory well drilling. Soils are predominantly the sandy Maynard Lake and Stumble series.

During drilling operations, there is a slight potential for well blowout. The probability of occurrence can be minimized by proper design, installation, supervision, and adherence to the USGS GRO Orders. Mud sumps and reserve pits could also breach or overflow.

Should a blowout occur, impacts include the spreading of sand, gravel, and rock fragments on the soil surface around the drilling platform. If unabated, the soil around the drill hole may erode inward, enlarging the hole to form a crater, into which the drilling rig itself may collapse (Cook and Raschen, 1976). The amount of land disturbed would be related to the nature and duration of a blowout. Geothermal fluids and possibly toxic materials (including drilling mud) may also be released on the surrounding soil surface from blowouts or sump overflows. This could contaminate the soil with dissolved salts. The most probable impact of a release of geothermal fluid under pressure would be erosion and alkalinization of the area affected due to the anticipated high concentration of sodium in the fluid. In addition, boron is expected to be present in high concentration in the geothermal fluid (Appendix B, Geothermal Development Model). Additions of sodium and boron to the soil would restrict plant growth. Boron is generally considered toxic to plants in solution concentrations exceeding 2-3 ppm. The exact nature of the drilling mud and geothermal fluid is unknown.

Existing topsoil would be disturbed in this and subsequent stages of development. Surface disturbances would cause associated losses of soil productivity, expected to occur throughout the life of the project. This loss is considered to be insignificant when viewed within a regional context; however, the loss may be apparent for many years after the project life, as soils in a desert environment do not quickly revegetate. Soil areas most sensitive to disturbance consist of the drier south and southwest facing slopes.

Loss of wildlife habitat, rangeland uses, and agricultural productivity would be secondary impacts related to surface disturbance of soils (refer to Section 2.7, Wildlife, and Section 2.11, Land Uses). Rangeland and agricultural productivity would be minor.

Soil slumping and rock slides may occur in areas of steep slopes due to construction activities. Landslides have been mapped near Sec. 33, T.21S, R.39E, and could possibly be reactivated due to road and drill pad construction. Rockslides may occur on steeply sloping rocky soils and landforms. Map Units 130, 131, and 160 contain 15 to 35 percent rock outcrops or rubble (see Plate 2, Soil Technical Report). Rockslides constitute a safety hazard to construction workers and equipment. Soils occurring extensively in Zones 1 and 2 having engineering limitations for geothermal facilities include the Dunmovin, Maynard Lake, and Stumble soils (Map Units 1, 6, 7, Plate 2.6-1, General Soils Map). These non-cohesive sandy soils have a low bearing strength and a nearly uniform particle size distribution, which renders them poorly suited for mud sump and reserve pit construction. Refer to the Appendix--Soil Technical Report for a detailed assessment of engineering properties, uses, and limitations of soils.

An identified impact due to surface disturbances includes increases in runoff and erosion caused by improved roads and facilities. Water erosion due to runoff channelization of access roads, drill pads, cuts and fills, and mud sumps and reserve pit sidewalls is a potential direct soil impact. This impact would be confined to localized areas of surface disturbance, and may potentially occur throughout the life of the project. As discussed in 2.5.2 the significance depends upon soil vunerability.

2.6.2.4 Field Development

The impacts to soil resources due to field development, are expected to be similar to those associated with exploratory well drilling. The magnitude of the field development operations is generally much larger, and the degree of impacts to soils is correspondingly greater. Some 800 to 1,000 acres of land may be disturbed in this stage. This must be viewed as a significant impact on soil resources.

In addition to well drilling activities, power generation facilities and transmission lines are to be constructed during this stage of development. Impacts associated with these losses of soil productivity are expected to be similar to those described for exploratory well drilling.

The most probable transmission line corridor (shown on Fig. 1.3-11) will cross approximately seven miles of soils Map Unit 180, consisting predominantly of Nebona Variant and Alko Variant soils (see Plate 2.6-1, General Soils Map).

These soils may pose constraints to corridor construction, as they are underlain by a silica cemented hardpan at depths ranging from 8 to 20 inches. Cuts by road building equipment through areas of these soils may create rubble poorly suited for fill material. This rubble may potentially be dumped on the the landscape, and constitute a visual impact. Water erosion of this corridor is a potential insignificant impact occurring throughout the life of the project. Revegetation of soils underlain by hardpan will be particularly difficult.

2.6.2.5 Resource Utilization

Impacts to soils during this stage of development are perceived to be similar to those described above, on a magnitude consistent with the amount of ongoing development.

2.6.2.6 Close-out

This phase includes abandonment of wells, removal of generating facilities, and restoration of the area following requirements of USGS.

Additional disturbance will occur as building pads are regraded and topsoiled.

Wind and water erosion may occur on replaced topsoil prior to its stabilization. This potentially constitutes a significant direct impact, since these occurrences may deplete the total amount of topsoil resources available for revegetation. Because disturbed soils recover slowly in an arid environment, the potential impacts are considered long-term.

2.6.3 Impacts of the Proposed Action on Paleontology

Because they have similar lithology and age to high potential areas in the CDCA, the areas within the CGSA underlaid by the following two geologic units should have a high potential for containing vertebrate fossil sites.

The Coso formation in the north central portion of the CGSA should have a high sensitivity for Blancan Age fossils; and the sedimentary rocks of the White Hills unit in the south eastern portion of the CGSA should have a high sensitivity to Irvingtonian Age vertebrate fossils. Due to the age and lithology of the deposit, the Old Alluvium geologic unit should be considered to have a moderate sensitivity for vertebrate fossil sites. Figure 2.6.2-1 shows potential areas of sensitivity. Impacts to potential fossil deposits in these areas would come from any of the earth moving activities of geothermal development. Such activities may occur during exploratory well drilling and field development. It is not possible at this time to estimate the extent of impact geothermal development could have on fossil deposits.

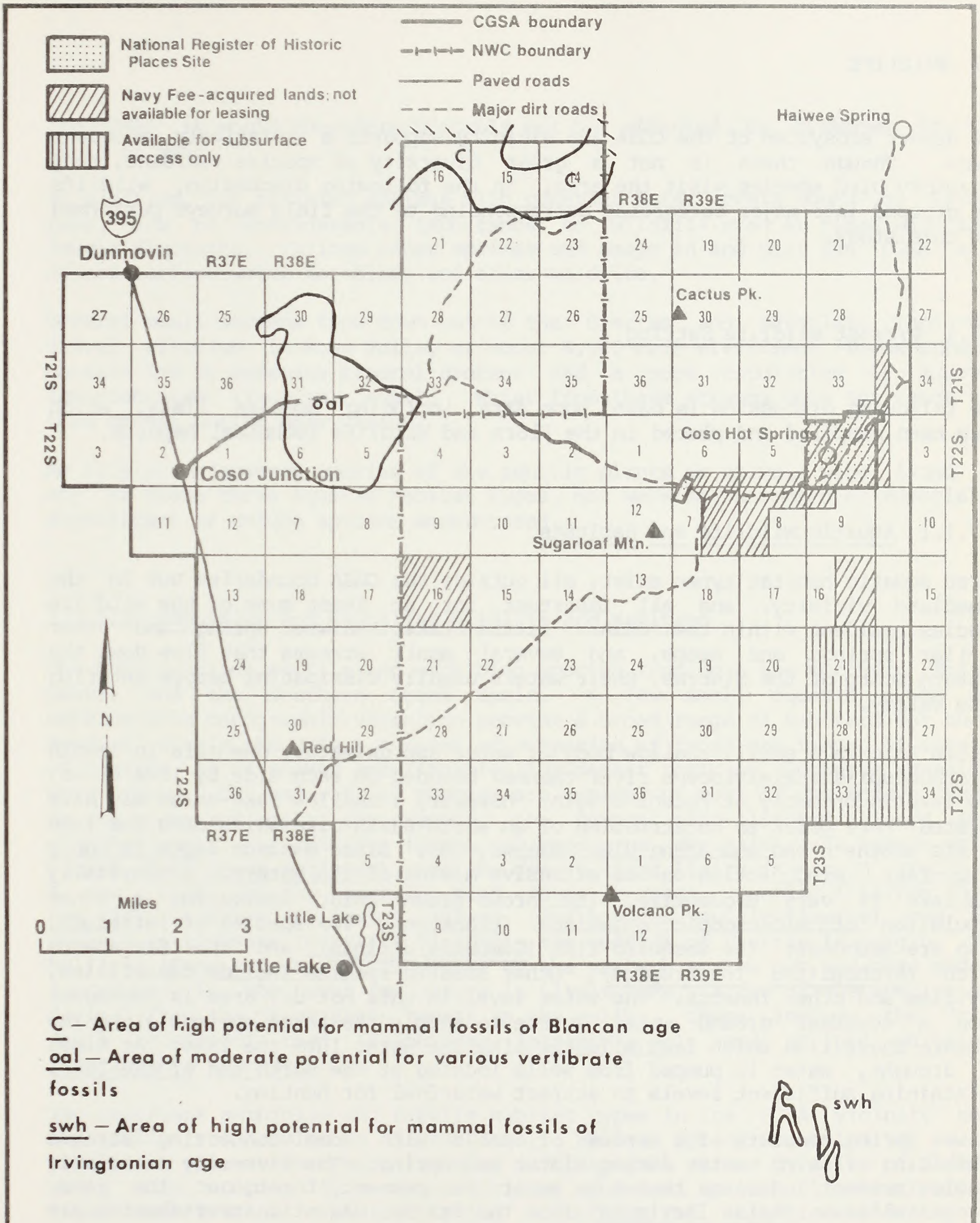


Figure 2.6.2-1

Potentially Sensitive Paleontology Resource Areas

2.7 WILDLIFE

The desert ecosystem of the CGSA and vicinity supports a relatively abundant fauna. Though there is not a great diversity of species resident, many migratory bird species visit the area. In the following discussion, wildlife are grouped into major categories corresponding to the field surveys performed for this study.

2.7.1 Present Wildlife Setting

The following discussion is based upon data, including species lists, which have been compiled and placed in the Flora and Wildlife Technical Reports.

2.7.1.1 Aquatic Wildlife and Habitats

Three aquatic habitat types exist, all outside the CGSA boundaries but in the immediate vicinity, and all important for at least some of the wildlife species resident within the CGSA: Little Lake, Haiwee Spring and other smaller springs and seeps, and several small streams that flow down the eastern scarp of the Sierras, their waters usually dissipating before entering Rose Valley.

Little Lake is a small, shallow body of water approximately one mile in length which occupies a Pleistocene river channel bounded on each side by lava flows. The lake is probably of recent origin; however, a shallow lake-marsh may have existed here prior to construction of an earth earth dike which dams the lake at its southern end and along U.S. Highway 395. Since maximum depth is only five feet, wind action causes extensive mixing of its waters. Biologically the lake is very productive, its brown-green color indicating a dense population of microscopic organisms (plankton). Two species of introduced fish are abundant: the mosquito fish (Gambusia affinis) and the Sacramento perch (Archoplites interruptus). Other aquatic species include damselflies, mayflies and other insects. The water level in this hot dry area is dependent upon a constant ground water source to supply the three springs along the western shore line which feed slightly alkaline water into the lake. At times of drought, water is pumped from wells located at the north end of the lake, maintaining sufficient levels to attract waterfowl for hunting.

Haiwee Spring consists of a series of pools with some connecting streams exhibiting flowing water during winter and spring. The diversity of aquatic species present indicates that some water is present throughout the year. Arroyo willows (Salix laevigata) line the stream. Aquatic invertebrates are numerous, and several aquatic plants are also present. Haiwee Spring water is derived from runoff and subsurface waters in the Coso Range north and east of the CGSA; it would therefore probably not be affected by drawdown to the south or west.

In addition, two artisian springs with constant water levels south of Little Lake, are of considerable importance to wildlife even at times when lake levels fluctuate. Various other springs and seeps in and near the CGSA also afford surface water for birds and other wildlife.

Several small streams flow down out of the Sierras and percolate into the gravel alluvium in Rose Valley at about 4,000 feet elevation. These streams contain low to moderate mineral content and a good population of aquatic invertebrates (insects, e.g.). Water from these streams does not reach the CGSA except during heavy rains.

No rare or endangered species of the aquatic plants or animals were found in any of these three aquatic habitat types, nor were any uncommon or especially significant or unique species encountered.

2.7.1.2 Amphibian and Reptilian Wildlife and Habitats

The CGSA contains reptile and amphibian species from both the northern Mojave Desert and the southern Great Basin. A few small aquatic areas and considerable topographic variation provide a broad range of habitats for these species within the CGSA. A total of 4 species of frogs and toads, 14 species of lizards, 16 of snakes and 1 turtle (the desert tortoise, Gopherus agassizi) were found. The majority of species are typical of most of the Mojave Desert to the south and east; for example, the common side-blotched lizard (Uta stansburiana), the desert iguana (Dipsosaurus dorsalis), the desert spiny lizard (Sceloporus magister), and the desert night lizard (Xantusia vigilis). A few, such as the western toad (Bufo boreas), pacific treefrog (Hyla regilla), southern alligator lizard (Gerrhonotus multicarinatus) and the western rattlesnake (Crotalus viridis), are coastal or Sierran in origin. The bullfrog (Rana catesbiana) is native to the eastern states but has been widely introduced in the west and occurs in Little Lake. A few of the species are derived from the Great Basin Desert to the north; these include the Great Basin spadefoot toad (Scaphiopus intermontanus), and striped whipsnake (Masticophis taeniatus).

Two important amphibian and reptile habitat types in the CGSA vicinity seem especially vulnerable to disturbance. Haiwee Spring contains a relict population of western toads, isolated in this small stream by miles of desert. While this species is a common habitant of desert springs, its distribution within desert areas is limited by the occurrence of suitable habitat. At present the spring receives considerable impact from both cattle and feral burros. If water levels drop, or exotic species such as the bullfrog are introduced from Little Lake, the western toad population could be eliminated at Haiwee Spring. The second sensitive habitat type comprises desert washes. During infrequent rains, water flows along these sandy courses and has produced rich communities of plants; washes are thus good habitat for reptiles and certain amphibians, and their preservation is important for these species. Washes are vulnerable to disturbance by vehicle use, since they often cut through otherwise impassable terrain and are frequently used as a means of access to remote areas.

The only uncommon species, of the 31 encountered, was the desert tortoise, which is fully protected by the State of California, though not included in Federal listings of threatened or endangered species. It occurs in the Mojave Desert as well as the deserts of Utah, Nevada, Arizona and Sonora; the CGSA is presumed to be near the northern limit of its range. One individual, found near the Coso Junction rest stop, may have been a vagrant or a released pet. It is doubtful that any breeding populations occur north of the Ridgecrest area.

2.7.1.3 Avian Wildlife and Habitats

The bird survey of the CGSA was divided into three parts: breeding birds, winter birds, and migratory species. Special attention was paid to raptor use of the area, and to the possible presence of any endangered, threatened, or rare species.

The breeding bird survey was conducted in eight specially selected areas during the spring of 1979. The study plots represent the various habitat types located within the CGSA; see also Section 2.8 and the Flora and Wildlife Technical Reports. The following numbers of species were found to be breeding in the eight plant communities selected; 4 species in the Creosotebush Scrub, 8 in the Joshua Tree Woodland, 4 in Shadscale Scrub, 5 in Desert Scrub, 6 at Haiwee Spring, 5 in the Creosotebush Scrub on Southern Sierra slopes, 5 at Coso Hot Springs, and 18 at Little Lake. The total number of permanent resident bird species found breeding in the area was 33. An additional 22 species breed in the area during migratory periods but are not year-round residents. Some common residents of the area are listed below by plant community.

The Shadscale, Desert, and Creosotebush Scrub habitats (corresponding to Shadscale Scrub, Mixed Desert Scrub and Creosotebush-Burroweed Scrub associations described in Section 2.8) include the following species: sage sparrow (Amphispiza belli), black-throated sparrow (A. bilineata), raven (Corvus corax), rock wren (Salpinctes obsoletus), and horned lark (Eremophila alpestris). The Joshua Tree Woodland community (see Figures 2.8.1-7) contains cactus wren (Campylorhynchus brunneicapillus), sage sparrow, Brewer's sparrow (Spizella breweri), black-throated sparrow and house finch (Carpodacus mexicanus). In the vegetated areas around Little Lake and Haiwee Spring, lesser goldfinch (Spinus psaltria) and house finch were common. Also common at Little Lake are numerous waterfowl species, including the pied-billed grebe (Podilymbus podiceps) and mallard (Anas platyrhynchos).

Migratory birds were also studied in the eight study plots during winter 1978-79 and spring 1979. Sixty-eight migrant species were found on the CGSA. Many of these migrants (23 species) were water birds which nest in the northern states and Canada and winter at the Salton Sea and along the Gulf of California; these included the California gull (Larus californicus), eared grebe (Podiceps nigricollis) and Wilson's phalarope (Steganopus tricolor). As these may settle on any body of water along their migration route, Little Lake, Haiwee Spring and any desert playas that contain water are important habitats for them. Forty-five species of land-bird migrants were noted, including three species of migrant raptors: the short-eared owl (Asio flammeus), osprey (Pandion haliaetus), and Swainson's hawk (Buteo swainsoni). Most land birds migrate at night, settling at daybreak to feed and rest and seeking out trees and water. Desert oases tend to concentrate migrants, and such aggregations were observed in the study area, notably at Little Lake, Haiwee Spring, the Coso Junction rest stop and at Rose Valley Ranch. Raptor migrants (and all raptors) tend to be most numerous along the power lines in Rose Valley where the transmission towers give them roosting spots and the Shadscale Scrub habitat harbors prey (small mammals) for raptors.

Wintering avifauna in the CGSA vicinity (as distinct from the migrants stopping on their way south) can be divided into three groups: water birds, raptors, and other land birds. Water birds congregate at Little Lake, the only suitable habitat for them in the vicinity. Ducks, which are hunted on Little Lake from mid-October to the end of January, reach peak numbers on the lake just after the close of the hunting season, with a maximum of 1,000 sighted in one observation day. (Coot, which are not hunted, numbered up to 1,500 per observation day during the winter of 1978-79.) A number of other water birds spend some of the winter months at Little Lake; the most common are American coot (Fulica americana), canvasback duck (Athya valisineria), pintail duck (Anas acuta), and ruddy duck (Oxyura jamaicensis). Several land birds winter in the CGSA vicinity. These small ground-dwelling birds appear to prefer weedy areas around the developed pastures south of Little Lake and at the Rose Valley Ranch. The most common species of bird wintering on the CGSA is the white crowned sparrow (Zonotrichia leucophrys).

Raptors of the CGSA were also surveyed by Zembal et al. (1978), who made 150 sightings during the winter months of 1977-1978. The present study recorded 203 sightings during the period October 1978 - May 1979. In addition to the migrant raptors mentioned above, 13 other raptor species were observed, most of them in the Rose Valley area. Among the most numerous were the red-tailed hawk (Buteo jamaicensis), rough-legged hawk (B. lagopus), golden eagle (Aquila chrysaetos), and long-eared owl (Asio otus). The prairie falcon (Falco mexicanus) was also sighted. In addition to power lines, a second area of significant use is the mountainous region between Volcano Peak and Sugarloaf Mountain.

The National Audubon Society publishes an annual Blue List of bird species that show decreasing population trends. It is meant to be an "early warning list" for troubled species whose decline may not always be otherwise apparent. The Blue List for 1979 includes 10 species found in the Coso area, mostly as migrants. Only two species, the prairie falcon and burrowing owl (Speotyto cunicularia), are residents of the CGSA. Another three species, canvasback duck, ferruginous hawk (Buteo regalis), and marsh hawk (Circus cyaneus), winter in the study area. No state or Federal rare, threatened or endangered species of birds were sighted during the study.

The only game bird species of significance are the introduced chukar partridge; mourning doves and the Gambel quail are also present.

Several areas within and near the CGSA can be considered sensitive habitats for avifauna. Little Lake and the pasture nearby are important stopping points for many water and land birds. Raptors frequently roost on the high cliffs east of the lake, and at least one pair of prairie falcons was observed nesting there. Other areas used by raptors include the 200 foot high rocky ridges bordering the Joshua Tree Woodland study plot (see Figure 2.7.2-1), the hills near Haiwee Spring, lava cliffs one mile south of Coso Hot Springs and other high points. Their favorite roosts are the power transmission lines running the length of Rose Valley. Of the arid areas, other than Rose Valley, the Joshua Tree Woodland habitat contained the greatest numbers and greatest variety of species. Birds were also sighted at Coso Hot Springs, but the area is disturbed by human use and burro concentrations, and plant cover is quite sparse.

2.7.1.4 Mammalian Wildlife and Habitat: Small Mammals and Carnivores

Study of the mammalian fauna in the CGSA was divided into four parts: bats, rodents, carnivores, and other larger mammals.

Fall and summer studies of bat populations were carried out at seven locations within and adjacent to the CGSA. The permanent bat fauna includes five species, all common and widely distributed throughout the California deserts: California myotis (Myotis californicus), small-footed myotis (M. leibii), western pipistrelle (Pipistrellus hesperus), Townsend's big-eared bat (Plecotus townsendii) and pallid bat (Antrozous pallidus). (Five other species, all common in western states, may also be present though they have not yet been collected in the CGSA. A sixth western species, the spotted bat (Euderma maculatum), was not sighted, though it may be expected to occur in the area. It is relatively rare, though not presently listed by the U.S. Fish and Wildlife Service or the California Fish and Game Commission.) Two additional species, long-legged myotis (M. volans) and silver- haired bat (Lasionycteris noctivagans), taken only in October of 1978, were apparently seasonal transients in the Coso area; both are common elsewhere in western states. The greatest capture success for bats was achieved at Haiwee Spring, where all seven species were collected. No large bat colonies were discovered. Bat populations in the CGSA are almost entirely dependent on natural rock crevices for their daytime roosts. Water sources are essential for them and hence should be considered sensitive areas for these mammals.

The rodent and lagomorph (rabbit and hare) fauna include 16 species. The desert cottontail (Sylvilagus audubonii), and black-tailed jackrabbit (Lepus californicus), are commonly observed in all habitat types. The California ground squirrel (Spermophilus beecheyi), and Botta's pocket gopher (Thomomys bottae), were recorded during this study for the first time in the CGSA. Live-trapping at 5 study sites yielded 2,292 individuals representing 10 species of nocturnal rodents. The trapping sites were similar in total numbers of rodents captured. Live-trapping for ground squirrels was performed at eight sites. Antelope ground squirrels (Ammospermophilus leucurus), were taken in good numbers at all sites. The Mohave ground squirrel (Spermophilus mohavensis), a species designated as rare by the California Department of Fish and Game, was found to be widely distributed through all habitats. A total of 124 individuals were live-captured at seven of the eight sampling areas in June and July 1979; at Cactus Peak (Mixed Desert Scrub), none were taken.

Carnivore presence was determined by sightings and by means of more than 100 scent-posts (stakes covered with an attractant), each surrounded by a circle of fine, brushed clay powder in which tracks were easily identified. No estimates of the numbers, but only of the presence, of species is possible using this method. From observation, coyote (Canis latrans), appeared to be the most abundant carnivores in the region. Four other species were also found. Kit foxes (Vulpes macrotis), occur throughout the CGSA; the bobcat (Lynx rufus), undoubtedly uses all habitats in the study area, though it was only tracked at two stations; gray foxes (Urocyon cinereoargenteus), were recorded at one station near Haiwee Spring and are probably restricted to that riparian habitat and the rocky canyons nearby; and the ringtail cat (Bassariscus astutus) (fully protected under California law) was documented at two stations in the hills on the east side of Rose Valley and are probably distributed throughout in cliffs and rocky hillsides. In addition, Zembal et al. (1978) reported the presence of the longtailed weasel (Mustela frenata), badgers (Taxidea taxus), near Coso Hot Springs, and mountain lions (Felix concolor, in Joshua Tree Woodland on the northern edge of the CGSA.

Mammal habitats sensitive to disturbance include Haiwee Spring, a water source for bats and other mammals. Denning sites for carnivores are sensitive; denning for most species is likely to occur more frequently in the rocky and mountainous areas.

2.7.1.5 Larger Mammals and Habitats

The only large mammals on the CGSA other than domestic cattle (and aside from mountain lions) are feral burros. Counts of burros were made in the winter and spring months of 1979 by driving along permanent roads. A maximum of 52 burros were observed during the January census, mostly males and mainly in the vicinity of Coso Hot Springs and near the stock pond north of Cactus Peak. Burros apparently migrate out of the CGSA in winter, when water is more prevalent and Coso Hot Springs and Haiwee Spring are less important. A maximum of 235 burros were observed during the May census, mainly at Coso Hot

Springs and Haiwee Spring, with lesser use at the stock pond near Cactus Peak. This burro population is part of a larger herd which inhabits the NWC. The significance of Coso Hot Springs as a water source decreases in summer, since the cattle trough at the springs is turned off when cattle are removed in early May and only a trickle of water flows into the tank. However, burros continue to use the area heavily in summer, even queueing up to drink at the tank. Haiwee Spring, located some four miles to the north, is the only important permanent water source in the area in the summer months, and it becomes vital to the survival of many burros, as well as for other wildlife. The valley leading from Coso Hot Springs to Haiwee Spring is also heavily utilized in summer months. The burro population is presently trampling and overbrowsing the area around both these water sources. Most of the palatable plant species are severely hedged or virtually absent.

2.7.1.6 Rare, Endangered, Threatened, and Protected Species

None of the species encountered, known or expected within the CGSA or immediate vicinity is on Federal listings of threatened or endangered species. One species (the Mohave ground squirrel) is listed as rare by the California Fish and Game Commission; this species was found to be relatively abundant, at the time of this study, in virtually all habitat types in the CGSA. The ringtail cat, a carnivore, and the desert tortoise (the state reptile), are fully protected under California law though not included in state or Federal listings of rare, threatened or endangered species. The ringtail probably utilizes all habitats within the CGSA. No estimate was made of its numbers in the area. No other rare or protected wildlife species are known within the study area, though several relatively uncommonly sighted raptors were observed.

2.7.2 Impacts of the Proposed Action on Wildlife

Impacts were estimated on the basis of field survey data, published material on geothermal impacts on wildlife, data from other surveys conducted for this EIS (e.g., noise, soils) and information from Chapter 1.

2.7.2.1 Wildlife Sensitivity to Geothermal Development

Two aspects of geothermal development that would impact wildlife are habitat removal, and disturbance due to noise and human presence. Noise may be continuous (such as the rushing water sound of a cooling tower) or periodic (such as a car door slamming or the operation of a jackhammer). The effect of noise on wildlife is a new field of research and few conclusive data are available. However, recent studies give valuable insight into the probable impacts of noise on animals. Though most of these studies concern species which do not occur within the CGSA, they indicate possible responses of similar vertebrates that do occur in the study area.

Studies by Bondello and Brattstrom (1979a) indicate that motorcycle sounds may stimulate emergence behavior in burrowed Couch's spadefoot toads (Scaphiopus couchi). Toads apparently receive accoustic stimuli from motorcycle noise similar to those received during thunderstorms; they emerge to gather water, and instead encounter the danger of being crushed by vehicles (op. cit.). Dune buggy sounds were demonstrated to cause hearing loss in the Mojave fringe-toed lizard (Uma scoparis) making it unable to sense sound levels similar to those produced by potential predators (op. cit.). The same authors have demonstrated that the desert kangaroo rat (Dipodomys deserti) can also suffer hearing impairment due to recreational and other vehicular traffic sounds, rendering it more vulnerable to nocturnal predation by sidewinders (Crotalus cerastes). Auditory recovery from an exposure to 500 seconds of 95 dBA dune buggy sounds required 21 days.

Brattstrom and Bondello (1978) have also compiled an extensive bibliography (2568 citations) on the effects of noise on non- human vertebrates. Unfortunately, little research has been carried out on birds. The best studies on noise impacts to birds from geothermal development are currently being conducted at the Raft River Test Site in southern Idaho. Here nesting ferruginous hawks were found to be equally sensitive to both noise and human presence. Results indicate that both noise and human activity within one-half mile of the hawks may prevent normal nesting (White, D., 1979, personal communication).

Inventories of the CGSA did not reveal any noticeable noise impact on wildlife as a result of Navy RDT&E activities. The NWC policy of restricted access may have protected wildlife to some extent despite military testing; on the Mohave B portion of the NWC, both flora and fauna are numerous, and some pristine areas exist (Ives, 1980).

The other impact which all wildlife would experience in varying degrees is habitat removal from land clearing and construction activities; for some species habitat loss is expected to present the most severe impact. Water drawdown (e.g., at Little Lake) could reduce or alter vegetative cover. Loss of surface water itself would be a potential impact in this desert area. Construction of fences or other barriers to wildlife movements may affect large mammals. These impacts are summarized by wildlife form below.

Birds. Birds are probably the vertebrates most sensitive to both noise and human presence. Geothermal development within the CGSA could alter roosting, feeding and reproductive patterns for birds in general. The most sensitive would be raptors (hawks and owls), which tend to avoid humans; their behavior would be modified by the presence of workmen and the operation of construction equipment.

Loud construction noise could startle both raptors and smaller birds. Once power generation begins, many of these species may move back into areas surrounding the plant if suitable habitat remains. For example, bluebirds have resumed nesting within 200 feet of a power plant at The Geysers, where noise levels are about 60 dBA (P. Leitner, 1979, personal communication).

Raptors would be negatively affected by disturbance of predator/prey relationships (such as could result from habitat destruction and reduction of rodent populations). Smaller birds would be directly affected by habitat removal, as they are dependent upon the vegetation in a smaller area. They can, of course, move to adjacent habitat if the destruction is not too widespread, and if the disturbance does not occur during their nesting activities. All bird species would be affected if reduction or loss of the few water sources should take place; waterfowl and migrants (both land and water species) would be especially affected.

Mammalian Carnivores. Carnivorous mammals are also sensitive to human presence and noise. These animals will avoid areas near construction and would be deprived of hunting on those portions of the CGSA which are subject to exploration and development activities. However, since carnivores characteristically have very large home ranges, no identification of especially sensitive habitat areas is feasible, except likely denning sites in rocky slopes and cliffs. Like the raptors, carnivorous mammals would suffer from the ecological imbalance that would result if prey populations were reduced. Trapping results indicate large populations of small mammals, whose numbers could be greatly reduced at the loci of operations. Some vegetative recovery would take place at disturbed sites during the life of the project. After closeout and restoration, habitat recovery will eventually allow animal populations to recover to approximately the present levels.

Other Large Mammals. Burros present a special problem in the Coso area in that they are already causing a negative impact on wildlife habitat. At present, burros congregate around water produced by steam condensate from Coso Hot Springs. Because they are large and abundant, burros may well become a nuisance during geothermal development. They may constitute a menace on roads, and they can also destroy light fencing, if it denies them access to water or preferred forage. Burros reportedly damage pipelines, especially if attracted by small leaks. They may bump into sensitive equipment during fights, and their trampling in areas of heavy use causes compaction of soils.

Small Mammals. Perhaps the most severe direct impacts of habitat removal would be experienced by small mammals. Some rodents, if they are not hibernating or aestivating below ground, could move to nearby areas. However, the newly colonized areas may already be at carrying capacity and unable to support the additional populations. These smaller animals depend on relatively small areas of habitat for food and cover as compared to raptors, carnivores and burros, thus are most severely affected by habitat loss. They will also be disturbed by noise, as discussed above.

Herpetofauna. In addition to the impacts of noise, reptiles and amphibians, like small mammals, may be accidentally crushed by vehicular traffic. Amphibians also experience habitat loss from any sustained reduction or loss of surface moisture.

Aquatic Species. Fish and aquatic invertebrate species occur in two localized habitats: Little Lake and Haiwee Spring. These aquatic fauna will be affected if water tables drop due to excessive ground water pumping. As documented in Section 2.5.2 and the Hydrology Technical Report, springs which feed Little Lake may be lowered as a result of the proposed action; see Wildlife discussion on Resource Utilization phase. See also Section 2.8.2.1.

2.7.2.2 Areas of Sensitivity Within CGSA

Figure 2.7.2-1 indicates wildlife habitat areas in and adjacent to the CGSA which are sensitive or unique; these are summarized below.

A. Little Lake, just outside the CGSA, in an area of unknown geothermal potential, is a fresh water habitat nearly unique within the region; the riparian vegetation and the fauna depending on this vegetation are vulnerable to any reduction of water levels. The cliffs along the eastern lake border extend into the CGSA (into a zone of unrated geothermal potential); these cliffs provide likely nesting sites for raptors and possibly some carnivores. At least one pair of prairie falcons was observed nesting there in the spring of 1979.

B. Haiwee Spring is the other significant permanent fresh water source in the immediate vicinity of the study area. Like Little Lake, it provides valuable habitat for many species inhabitating the CGSA. In addition there are various small springs and seeps.

C. Ephemeral playa lakes east and north of Red Hill are occasionally important sources of fresh water (Geothermal Zones 3 and 4), as are desert washes, found throughout the area.

D. The mountains between and including Volcano Peak and Sugarloaf Mountain (Zones 1, 2 and 3) are the loci of raptor sightings (including hawks and golden eagles) and provide probable nesting sites for raptors. These and other mountainous regions within the CGSA also provide likely carnivore denning habitat.

E. Transmission lines and power pylons through Rose Valley provide roosting for raptors (Zones 3 and 4 and unrated geothermal zones).

F. Rocky ridges near Joshua Tree Woodland, at the extreme northern edge of the CGSA in a zone of unrated geothermal potential, provide likely raptor nesting sites.

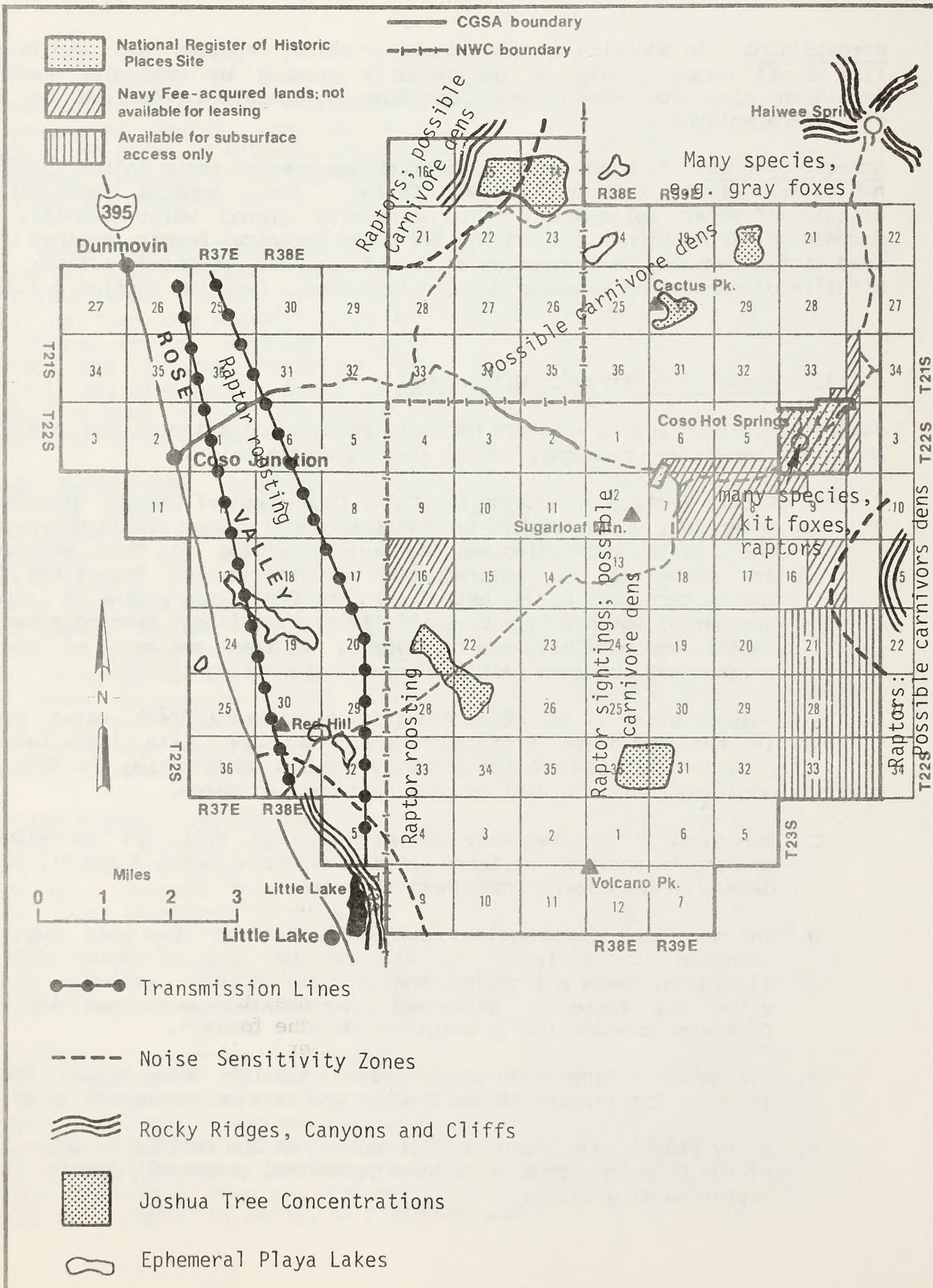


Figure 2.7.2-1. SENSITIVE WILDLIFE HABITAT AREAS OF CGSA

G. Lava cliffs southeast of Coso Hot Springs (Section 15, T22S, R39E) on the eastern border of the CGSA in Zone 3 are likely raptor nesting sites.

H. Joshua Tree Woodland provides good habitat for the Mohave ground squirrel. In addition, birds occur in large numbers and diversity. Although usually not dense, this habitat type exists in many places throughout the study area. It is usually found in alluvial surfaces and seldom on shallow stony-soil slopes. Relatively good stands exist east of Cactus Peak in Zone 3 (Sections 20 and 30, T21S, R39E), northeast of the pumice mine and near the petroglyphs in Zone 3 and an unrated area (Section 14 and 15, T21s, R38E), along the road east of Red Hill in Zones 3 and 4, and in the mountains north

I. Coso Hot Springs in Zone 1 is frequented by many species as a water source. The area is a National Historic Register Site, is NWC fee-owned land and is protected from surface disturbance by current NWC policy. As habitat, the site is poor, partly as a result of trampling and compaction of soil.

Areas not shown on Figure 2.7.2-1 as special habitat features can be considered as moderate to low sensitivity areas, pending further detailed investigation. For example, Mixed Desert Scrub, Creosotebush Scrub and Shadscale Scrub characterize much of Zones 1 and 2, where geothermal development is expected to be concentrated. Such vegetation affords moderately good habitat for many wildlife species. No wildlife species were found to be restricted to these two geothermal zones. The wide distribution of these vegetative associations throughout the CGSA (and the equally wide distribution of the one rare faunal species encountered in Zone 1 and 2, the Mohave ground squirrel) would suggest that this complex could be considered as a relatively low sensitivity habitat. However, detailed site specific studies undertaken later as part of the permitting process may uncover new information on areas not now known to be sensitive.

The remainder of the CGSA is rated to have marginal (Zone 3) or uncertain (Zone 4) potential as a geothermal resource; no wildlife species were found to be restricted to these portions of the CGSA.

One further caution should be entered, concerning the slow recovery rate of all desert habitat, once disturbed. In this sense, the entire CGSA should be considered sensitive, and the features noted on the foregoing map should be regarded simply as more sensitive than other habitats in the study area. Finally, the CGSA as a whole must be perceived in perspective in relation to the surrounding region, which affords many similar habitats, the only exception being oases; thus, Little Lake and Haiwee Spring assume additional importance as areas to be protected. (Coso Hot Springs, as noted, will be excluded from habitat disturbance resulting from the proposed action.)

2.7.2.3 Rare, Threatened and Endangered Species

Probably the most important wildlife issue in the GCSA involves the Mohave ground squirrel which is designated is as "rare" by the California Fish and Game Commission. The species is numerous in every habitat of the CGSA except steep, rocky slopes. The highest densities were observed in Rose Valley and on the Sierra slope west of US Highway 395. Since this species occurs in almost every part of the CGSA, it will be very difficult to carry out geothermal exploration and development without causing some adverse impacts. This is particularly true because the areas of relatively level terrain favored by these animals may also be the best sites for geothermal facilities, e.g., in geothermal Zones 1 and 2. See Chapter 3 (Mitigation Measures) and the Flora and Wildlife Monitoring Plan in Appendix D. The ringtail, a carnivore, protected under California law, probably utilizes all CGSA habitats; denning sites would be expected in rocky hillsides and cliffs. No Blue List bird species are expected to be significantly affected.

2.7.2.4 Impacts During Stages of Geothermal Development

Preliminary Exploration. In the first few years of the program, exploration will be largely confined to Zones 1 and 2.

Microseismicity and resistivity measurements would involve some off-road driving. The extent of this is expected to be minimal in Zone 1, as sufficient data may have been developed by the NWC contractor. Off-road travel will cause some minor destruction of wildlife and habitat; types of surface disturbance include vehicle tracks, tire ruts and wheel holes (Davidson and Fox, 1974). Refer also to Section 2.6.2.1, Soils.

Some wildlife habitat will be lost due to vehicular traffic and drilling of heat flow measurement test holes. However, the area disturbed by actual drilling would be only approximately 10 square meters per drill hole; no drill pad is required. Again, few such measurements are expected to be necessary in Zone 1. The amount of surface disturbance in this zone would probably amount to no more than 10 acres, total, for off-road vehicle tracks, and less than one-half acre for heat flow holes. More extensive exploration activities of all the types described above are anticipated for Zone 2; in these nine square miles, surface disturbance might amount to three or four times as much as described for Zone 1. The major type of habitat lost in both zones would be Mixed Desert Scrub; specific areas disturbed would be small and localized. Wildlife displaced (particularly rodents and herpetofauna) would attempt to reestablish in nearby areas, which may be presently supporting optimum numbers of these species; some temporary reduction of populations would probably occur.

In Zones 3 and 4, far more extensive preliminary exploration may be necessary; the habitats disturbed could include every type encountered within the CGSA.

In addition to habitat removal, vehicular and drill noise and human presence could prevent raptors and mammalian carnivores from foraging in areas being explored. These localized habitat disruptions, though minor, could possibly also interfere with the feeding or nesting activities of many smaller bird species. Heavy vehicular traffic could disturb some terrestrial vertebrates. Rabbits and snakes may be killed by vehicles on roads, and some rodents could be crushed in burrows by off-road traffic.

Exploratory Well Drilling. During this stage, habitat loss and disturbance to wildlife would be increased. Additional access roads would be cut, drill pads cleared, sumps and disposal pits constructed. During the well drilling phase, noise levels will be high (see Table 2.3.2-1, Noise from Construction Equipment). Birds and mammalian carnivores will avoid drilling areas (P. Leitner, 1979, personal communication). Total area temporarily disturbed by noise and human presence may be as much as one-half mile radius around each drill area (D. White, 1979, personal communication).

Both birds and mammals may attempt to drink from water of sumps or disposal areas (reserve pits) which could contain high concentrations of salts or toxic substances when wells are first flowed. The nature and degree of effects are unknown. Birds are often attracted to such open bodies of water (even wet mud) in dry areas and may attempt to land and feed or rest on these toxic wet areas (Clemens, 1954; Land, 1974).

Habitat loss is probably a more serious impact than those described above. Exploratory, production and replacement wells each require approximately 4.5 acres/well pad total surface disturbance. (Subsequently, an average of three additional well-heads may be placed on the same drill pad, using the same sumps, etc.; see Chapter 1.) It is expected that ultimately 600 wells would be drilled in Zones 1 and 2; if 100 of these are drilled in the exploratory period, total disturbance would be 25 x 4.5 acres or 112.5 acres. Animals migrating away from construction sites might not be able to crowd into adjacent areas because the carrying capacity of those areas would be stressed. Loss of habitat means that animal populations would temporarily decline to a new lower level which the remaining vegetation is capable of supporting. Estimates of population reduction for various species would depend upon exact locations of activities and upon habitat type.

In Zones 3 and 4, some 900 wells are ultimately envisioned. If 300 of these are exploratory, disturbance would be 75 x 4.5 acres, or 338 acres. Habitat disturbed/destroyed could include all types encountered in the CGSA.

Field Development. Power plant construction would affect wildlife due to increased noise, human presence and loss of habitat. Construction activity would temporarily displace raptors and mammalian carnivores. Any construction within one-half mile of nests of sensitive species such as prairie falcons would interrupt nesting (D. White, 1979, personal communication).

Field development would involve approximately 800-1000 acres of disturbance. Habitat removal would be approximately double the amount described for Stage 2 above (exploratory well drilling); the types and habitat disturbed would be as above for all geothermal zones.

Construction of transmission lines and maintenance roads along these lines would involve some clearing of habitat. Vasek, et al. (1975b), report that power transmission lines may increase plant growth in some instances and perhaps offset this loss of habitat. There appears to be generalized decrease in plant densities under the pylons while an increase in plant productivity occurs under the wires and along access roads (Johnson, et al. (1975). Increased diversity of species, as well as more luxuriant plants, have frequently been observed along roadsides, due to increased runoff. The species encountered include some non-native weeds but these are generally outnumbered by native plants. Within the CGSA, field studies revealed numerous weedy species in and near disturbed areas (see Section 2.8.1.2).

Resource Utilization. During this stage, the aquatic habitat at Little Lake may be affected if ground water levels are lowered. As mentioned in the hydrology section (see Table 2.5.2-1), projected water use exceeds recharge levels estimated for the Rose Valley area. According to W.R. Moyle of the USGS (1979, personal communication), the level of Little Lake dropped approximately three feet (1 m) below its present level during the drought of 1975-76. Since Little Lake is fed by springs which issue near its water level and since it is a very shallow body of water, lowered ground water levels from water use in excess of recharge volumes could reduce spring flows and return the lake to a marsh. On the basis of estimates produced in this study and past records (level of Little Lake in 1975-76 drought), there is a high probability that the utilization of 6,600 acre-feet of water per year in Rose Valley (see Section 2.5.2) will lower the lake level.

Since Haiwee Spring is higher in elevation than the probable geothermal resource (Zones 1 and 2), it has a low probability of being affected by utilization of that resource (See Hydrology Technical Report).

Additional road construction, exploration, replacement well drilling and additional power plant construction would continue during operation. In all, an additional 600-800 acres may be disturbed as a result of these activities, causing some losses in all habitats throughout the four zones of the CGSA.

Transmission lines can also damage birds. Birds, especially raptors, may be electrocuted, as many species including ravens and golden eagles utilize lines as roosts. Collision of all species with towers or lines may occur, especially night-migrating species (Thompson, 1977).

Close-Out. In the close-out stage, power plant units would be removed, wells capped and sumps and disposal pits returned to natural grade. Noise and increased human presence would be similar to levels during the field development phase. Once facilities are removed, noise and traffic would return to present low levels. Habitat would gradually recover over a period of several decades, and wildlife populations would again increase to approximately their present levels.

2.7.2.5 Cumulative Impacts

All of the impacts described above would also accompany the NWC development program. However, many roads will be shared, and estimated habitat disturbances for the NWC power unit are included in this analysis (see Chapter 1). The greatest cumulative impact would occur during Navy plant construction (assuming active exploration and well drilling are then taking place in BLM-leased lands) and during field development on BLM-leased lands. A total of approximately 2,260 acres of various kinds of habitat could be destroyed as a result of the BLM and NWC development programs; this represents approximately 3 percent of the total acreage of the CGSA. Probably about half of the BLM development as well as most of the NWC development would take place in Zones 1 and 2, which are characterized largely by Mixed Desert Scrub habitat. Additional Scrub will certainly comprise some of the disturbed areas in Zones 3 and 4. It should be noted that habitat removal or disturbance does not necessarily result in total loss of productivity. As noted above, increases in plant production have been observed under transmission lines, as well as plant species diversity along roadsides. New nesting or watering sites for some animal species may also be found along steam lines.

Development is not expected to take place at Little Lake, Haiwee Spring, or Coso Hot Springs; rather, it is the possible lowering of water levels that is of concern in regard to these areas. Remaining habitat types and features, particularly Joshua Tree Woodland and mountainous areas affording raptor and carnivore habitat, can be protected with proper development planning. The status of the Mohave Ground Squirrel will be a matter of continuing concern. The remaining concerns are the potential loss of overall biological productivity of the area and the temporary unbalancing of predator-prey relationships that could result from the loss of even a small percentage of habitat in a fragile desert ecosystem.

2.8 FLORA

2.8.1 Present Floral Setting

The physical and climatic variables within the CGSA combine to form a complex vegetative pattern in which the classic plant communities of the Mojave Desert and the Great Basin grade into each other, with a variety of subdominant species present (for example, Creosotebush Scrub may occur mixed with Shadscale Scrub). Also, in numerous sinks and basins, cold air drainage produces microclimate conditions where plants adapted to the northern desert are found, while surrounding vegetation may be a mixture of Mojave Desert species. In the following description, CGSA vegetation is therefore grouped by major dominant species and associated subdominant plants. Figure 2.8.1-1 shows locations of sample sites used in the study. Where possible, a correlation is made by vegetational association, as for example, Creosotebush and associated species together are comparable to Creosotebush Scrub as described in Munz (1968), although some of the subdominant species are different. A species list of the vascular plants of the CGSA is found in the Flora Technical Report.

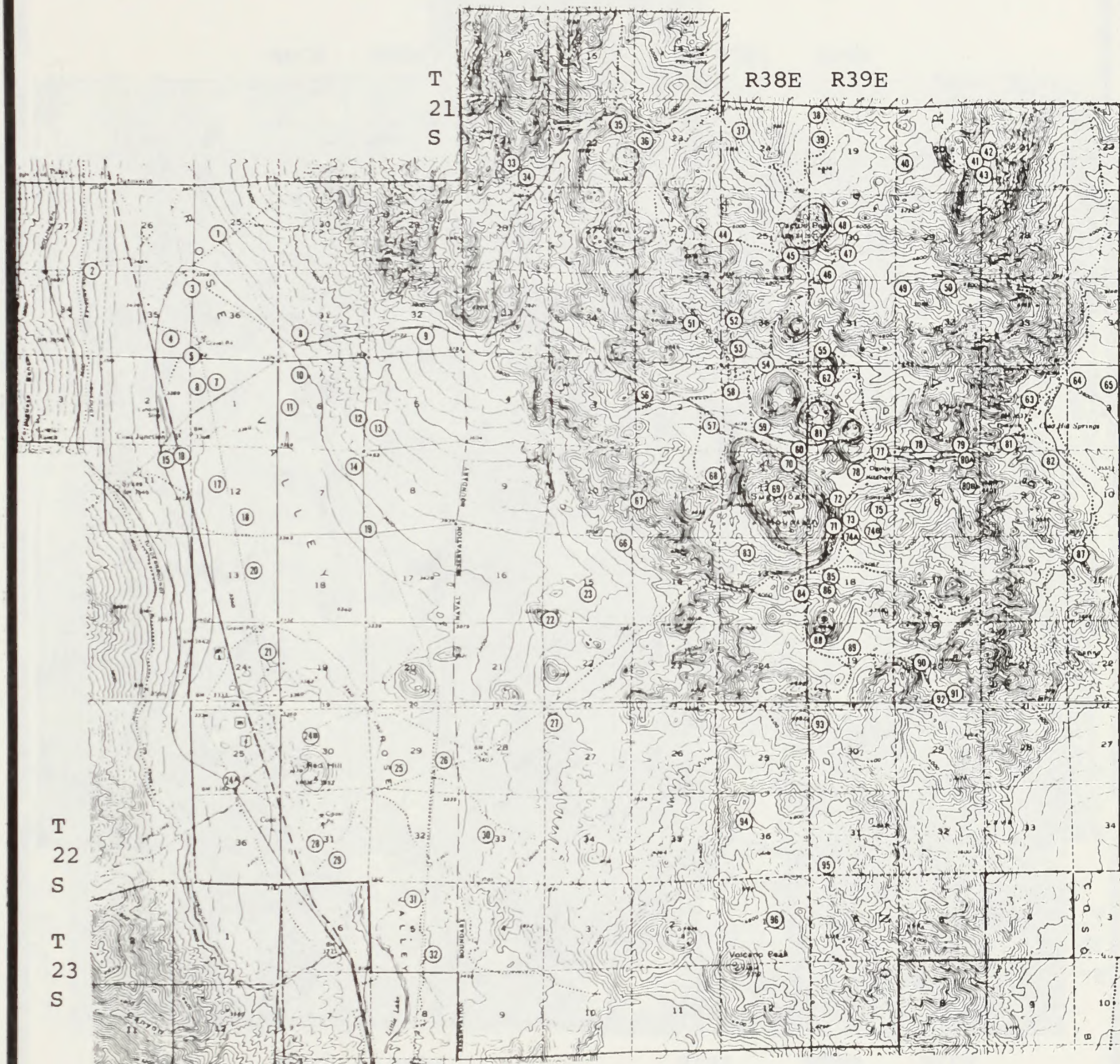
2.8.1.1 Dominant Component Plant Associations

Creosotebush - Burro weed Scrub - The most common plant throughout the Mojave desert is creosotebush (Larrea tridentata), occurring over about 70 percent of its total area (Shreve, 1942). On the CGSA, creosotebush occurs mainly with burro weed (Ambrosia dumosa), and numerous subdominant species; the resulting association is termed Creosotebush - Burro weed Scrub. It is present on the slopes of the Sierra Nevada west of Highway 395, on the east side of Rose Valley up to an elevation of about 4000 feet, and in the southeastern portion of the CGSA. The burro weed component occurs mainly on coarse, sandy soils bordering Rose Valley and in the far southeastern corner of the CGSA. (See Figures 2.8.1-2 and 2.8.1-3.)

Shadscale Scrub - Atriplex confertifolia (shadscale) is common in depressions and in larger basins of the CGSA, including much of the floor of Rose Valley, the area north and east of Sugarloaf Mountain, and open sandy-gravelly slopes and ridges south and north of Cactus Peak. The most commonly associated plants include bud sagebrush (Artemisia spinescens), cheesebush (Hymenoclea salsola), ricegrass (Oryzopsis hymenoides), and box-thorn (Lycium andersoni). The association is comparable to Shadscale Scrub (Munz, 1968), with a difference in some of the subdominant species. On the CGSA, bud sagebrush is found usually with shadscale on the lower flat areas and basins; in some areas it occurs alone. (See Figure 2.8.1-4.)

Allscale Scrub - Atriplex polycarpa (allscale) is the dominant plant in certain sandy arroyos, where it occurs with cheesebush. It also occurs in Rose Valley in clay sink areas; on basaltic domes where sandy soils are present; on lava flows; and along roadsides and other disturbed areas (e.g., along the Owens valley aqueduct), where it develops as a pioneer. The only habitat types from which allscale seems to be excluded are rocky slopes at higher elevations. (See Figure 2.8.1-5.)

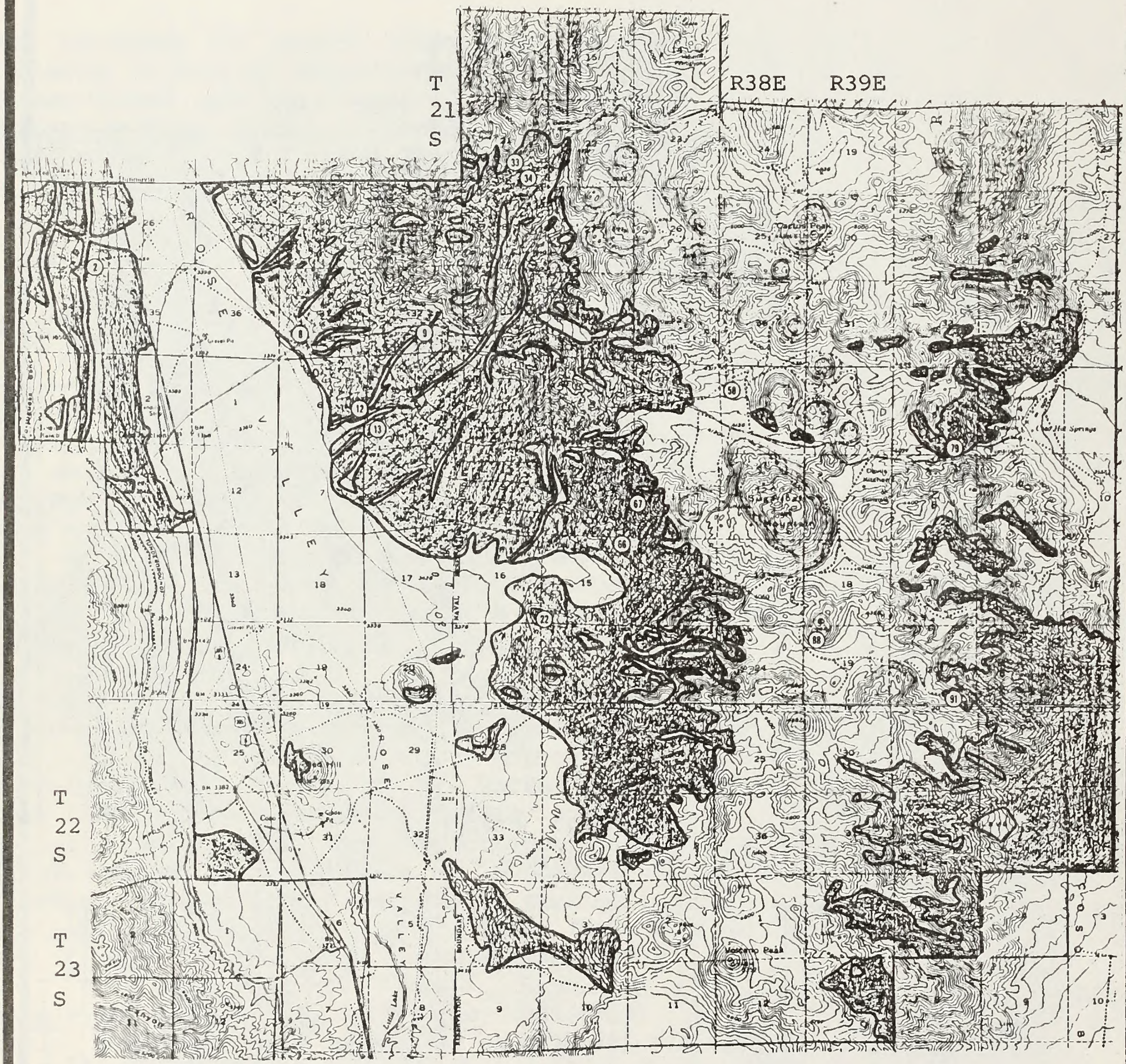
Four-winged Saltbush Scrub - Atriplex canescens (four-winged saltbush) was found to be mostly restricted to depressions at elevations between 4,000 and 5,000 feet where clay soil predominated; it was occasionally found on volcanic slopes. It is thus in scattered locations throughout the CGSA. It is often found with allscale. Both species are considered to be tolerant of slightly saline or alkaline soils. On the CGSA, saltbush often appears alone. It seems to be more cold-resistant, hence able to persist at higher altitudes and in small pockets where cold air accumulates. As shown in Figure 2.8.1-6,



EXPLANATION

Distribution of quantitative sample sites in CGSA. Numbers are arranged from north to south in Rose Valley and north to south in area east of Rose Valley.

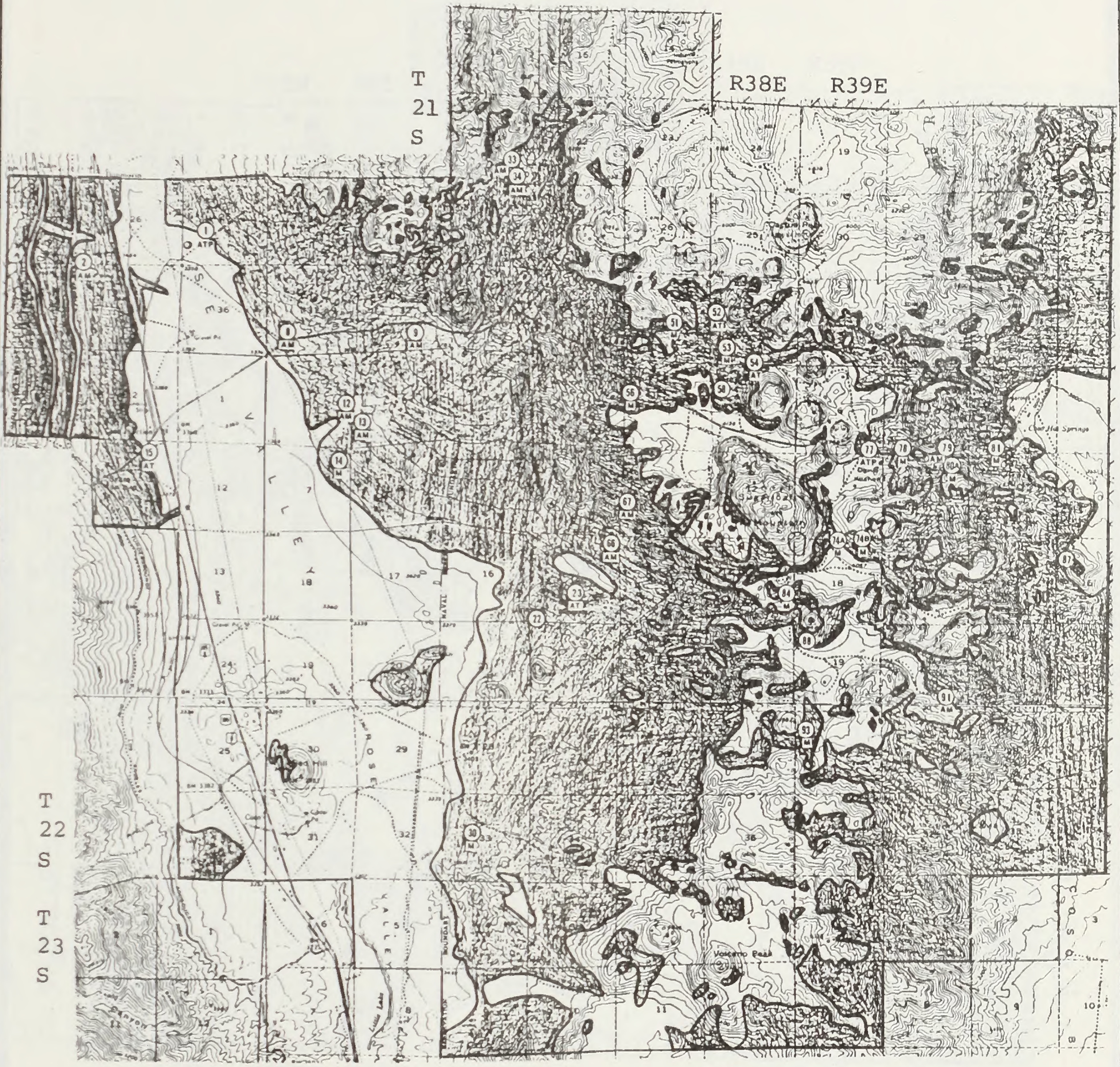
Figure 2.8.1-1 CGSA VEGETATION SAMPLE SITES



EXPLANATION

Distribution of Ambrosia dumosa (burro weed) in the CGSA.
Sample sites are indicated by numbers. See Table 7 for data.

Figure 2.8.1-2 DISTRIBUTION OF BURRO WEED

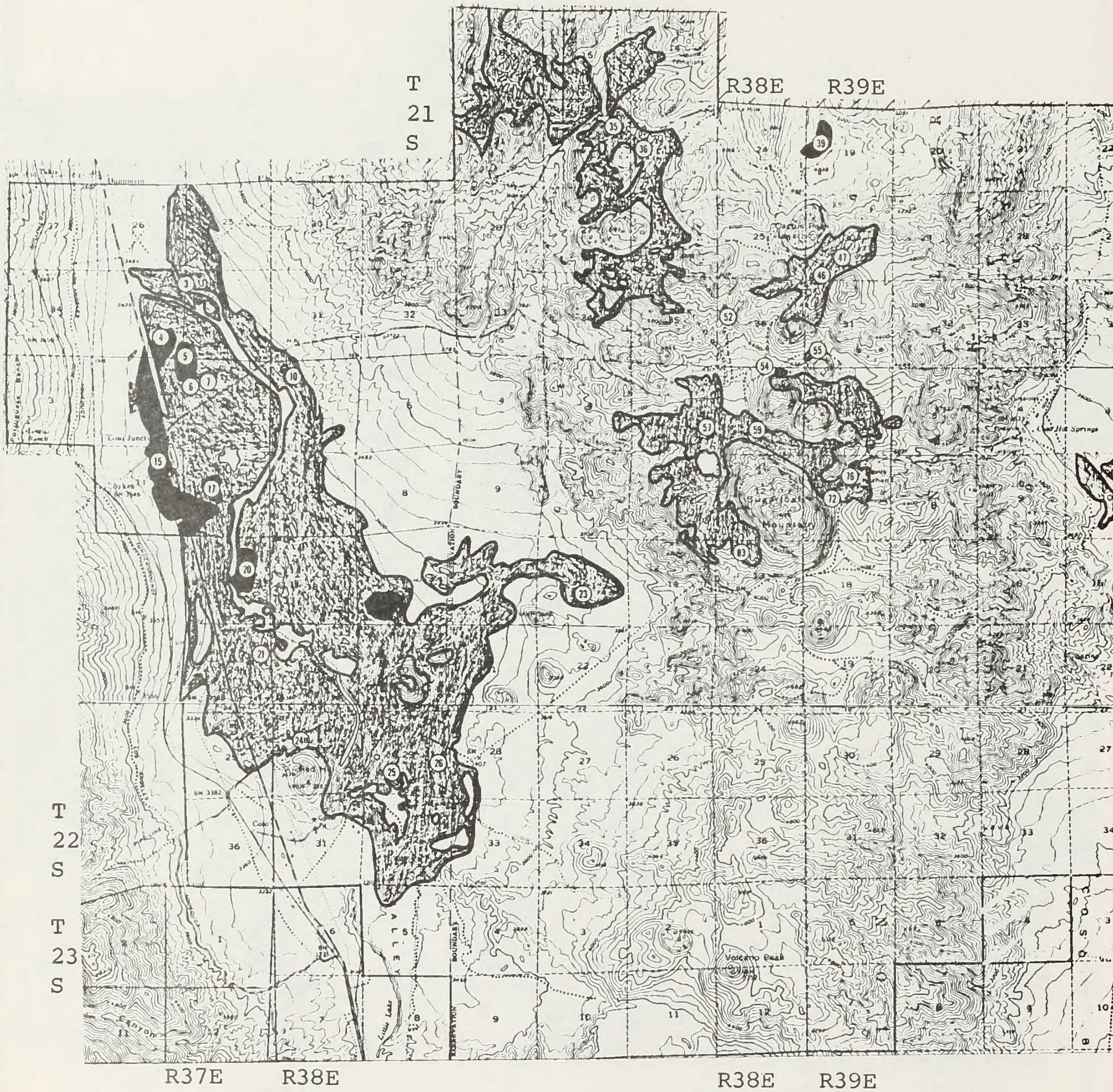


EXPLANATION

Distribution of Larrea tridentata (creosote bush) in the CGSA. Sample sites are indicated by numbers. Subdominant species at each site is indicated by subtending letters. Quantitative data are given with understory species in Tables as indicated.

- M Mixed Desert Scrub (Table 8)
- AM Ambrosia dumosa (Table 7)
- AT Atriplex confertifolia (Table 4)
- ATP Atriplex polycarpa (Table 5)
- --- Larrea exclusive (Table 7)

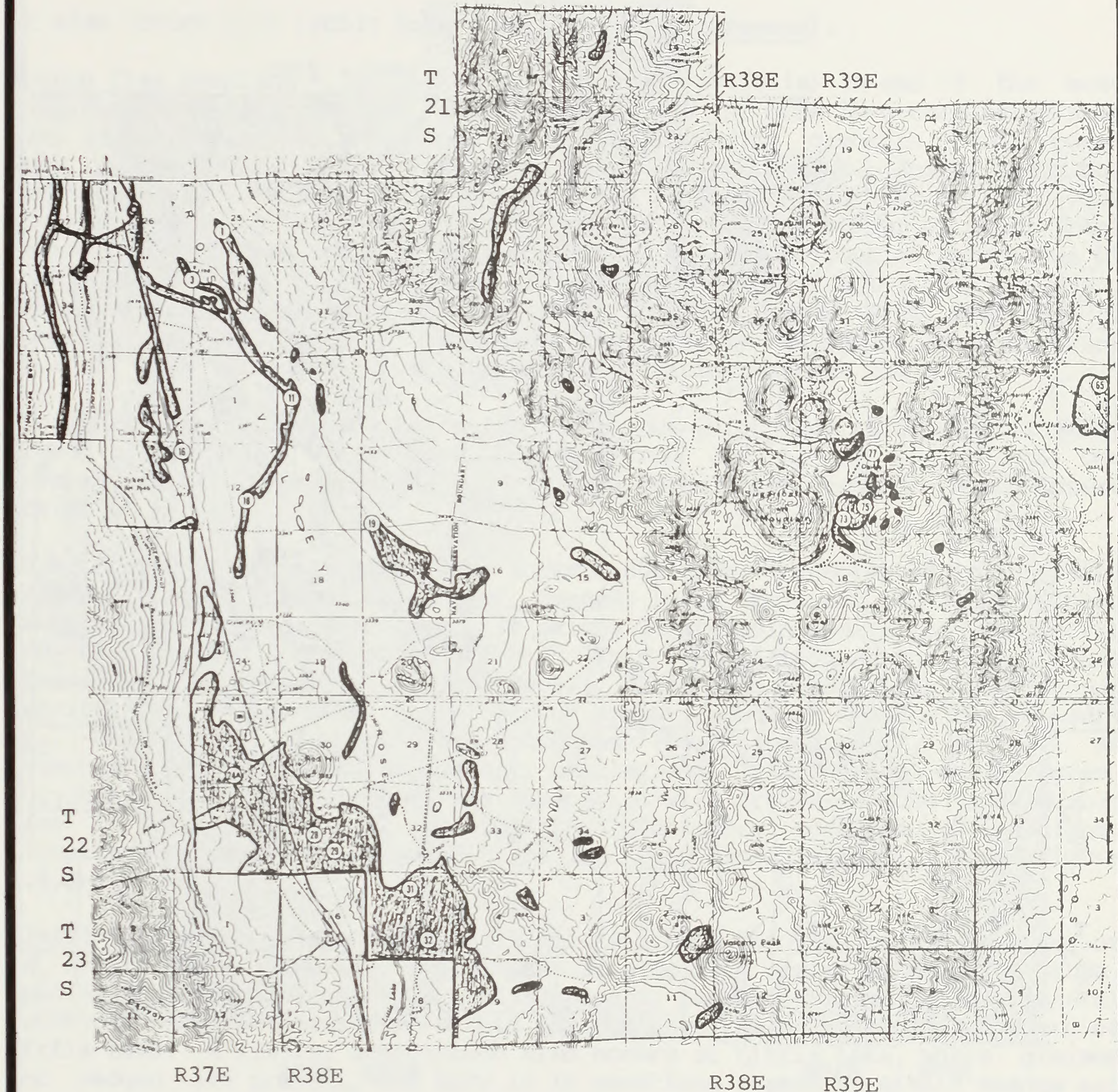
Figure 2.8.1-3 DISTRIBUTION OF CREOSOTE BUSH



EXPLANATION

Distribution of Atriplex confertifolia (shadscale), shaded, and Artemisia spinescens (bud sage), solid, in the CGSA. Sample sites are indicated by numbers. See Table 4 for data.

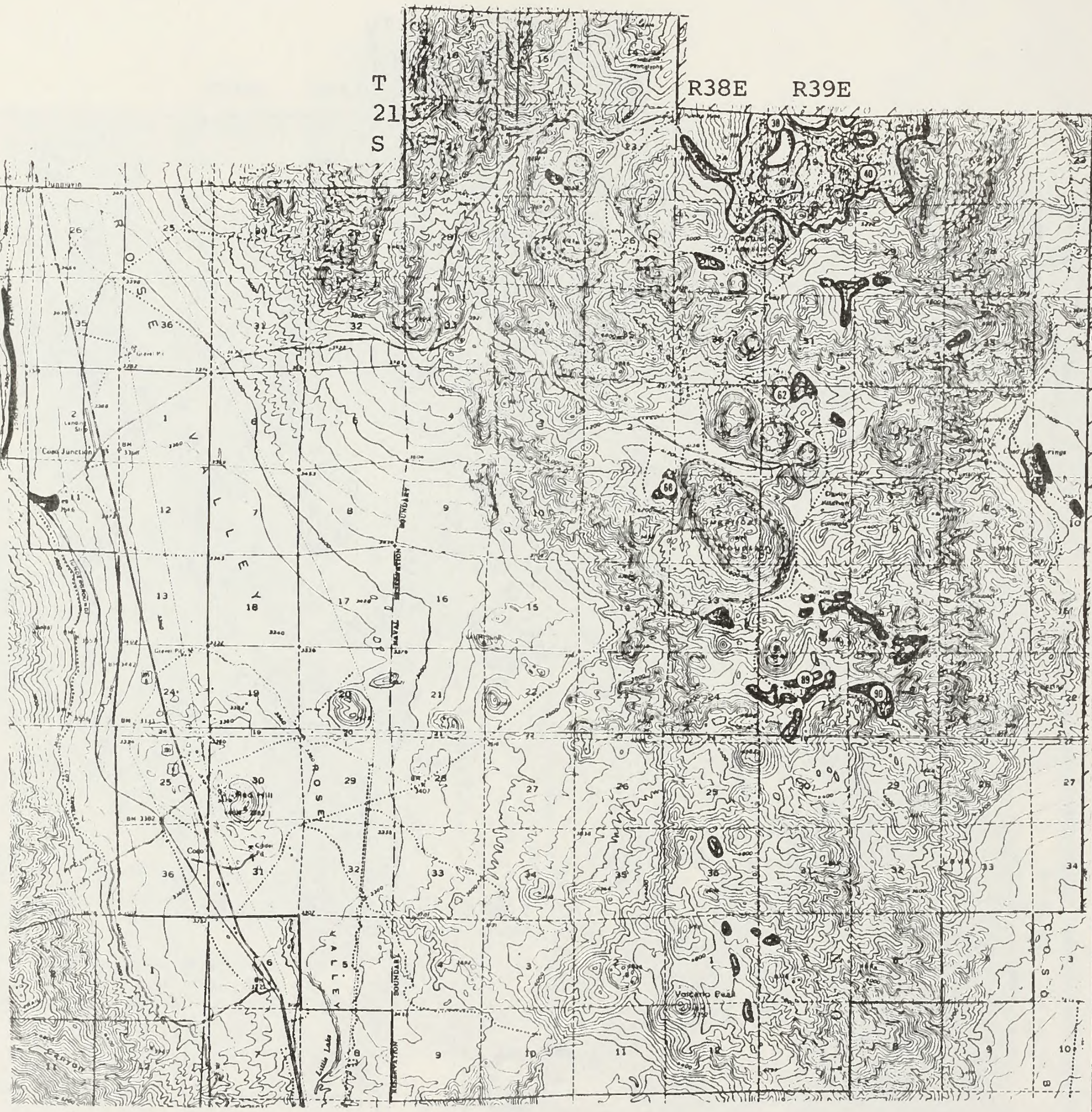
Figure 2.8.1-4 DISTRIBUTION OF SHADSCALE AND BUD SAGE



EXPLANATION

Distribution of Atriplex polycarpa (allscale) in the CGSA.
Sample sites are indicated by numbers. See Table 5 for data.

Figure 2.8.1-5 DISTRIBUTION OF ALLSCALE



EXPLANATION

Distribution of Atriplex canescens (four-winged saltbush), shaded areas, and Chrysothamnus nauseosus (rabbit bush), solid, in the CGSA. Sample sites are indicated for Atriplex canescens by numbers. See Table 6 for data.

Figure 2.8.1-6 DISTRIBUTION OF FOUR-WINGED SALTBUSH AND RABBIT BUSH it also occurs with rabbit bush (Chrysothamnus nauseosus).

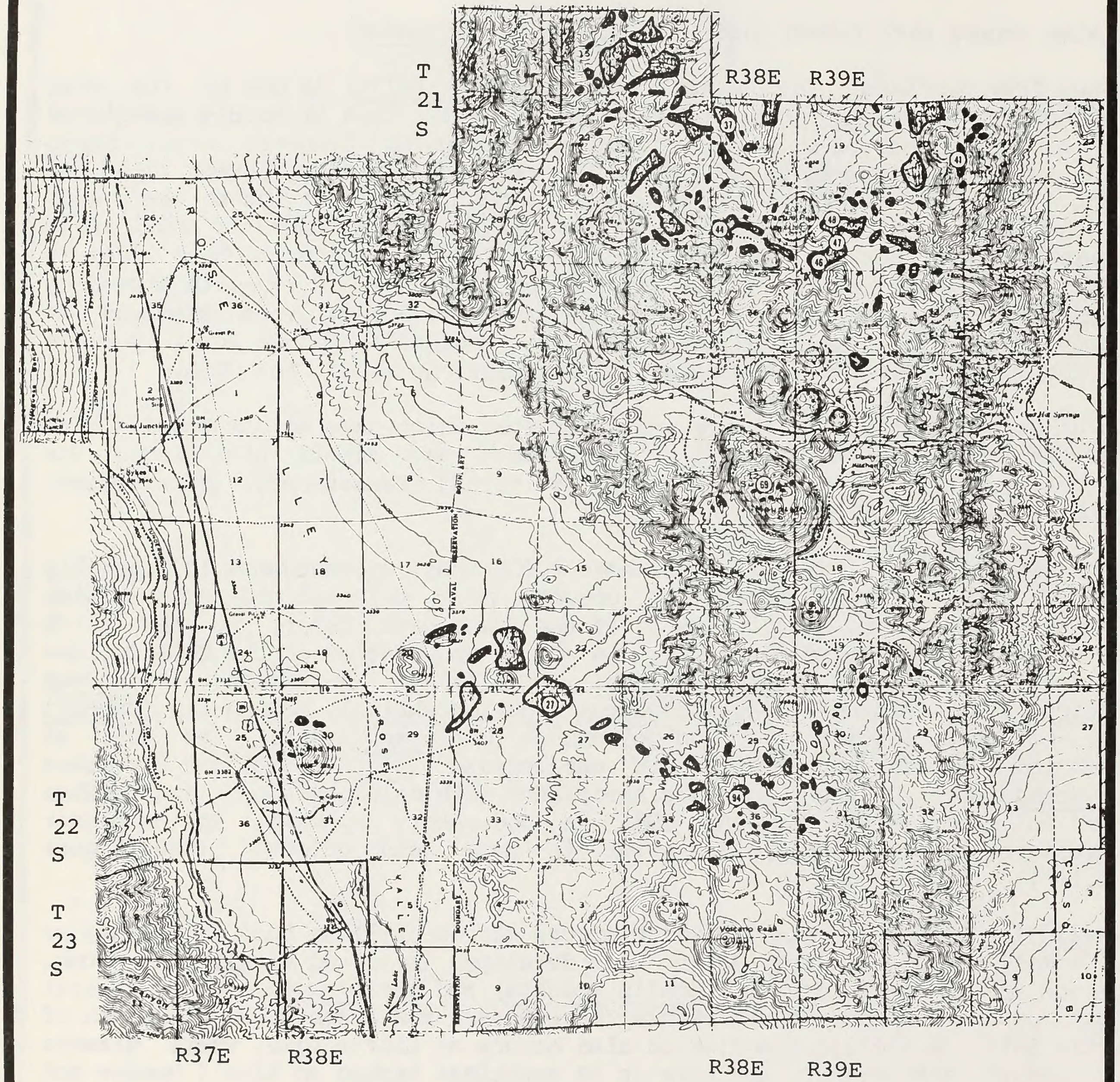
Joshua Tree Woodland - The Joshua tree (Yucca brevifolia) is one of the most distinctive plants in the Mojave Desert. In the CGSA it occurs associated with a wide variety of understory components including creosote bush, burro weed and numerous others (see Mixed Desert Scrub, below). Joshua trees are located in widely scattered patches near the pumice mines at the northern edge of the CGSA, in the vicinity of Cactus Peak, and in a number of small areas between Volcano Peak and Sugarloaf Mountain. They also occur on both sides of Cinder Road east of Red Hill. Comparison of Figure 2.8.1-7 with preceding illustrations will show that Joshua trees (the term Joshua Tree Woodland is commonly applied virtually wherever the species is found) actually occur together with various other species and associations within the CGSA.

Two other associations which are important (but which have no one species that characterizes them) are Mixed Desert Scrub and Alkali Sink Brush. One further, rather complex association is here termed Creosotebush - Mixed Desert Scrub.

Mixed Desert Scrub - At elevations above 4,000 feet, creosotebush is generally replaced by a broad mosaic of species more tolerant of cold winter temperatures and more characteristic of the Great Basin desert to the north and east. The dominant species in this association on the CGSA include cheesebush, hop-sage (Grayia spinosa), California buckwheat (Eriogonum fasciculatum, goldenhead (Acamptopappus sphaerocephalus), Mormon tea (Ephedra sp.), box-thorn (Lycium sp.), and goldenbush (Haplopappus sp.), as well as perennial grasses such as desert needlegrass (Stipa arida) and ricegrass (Oryzopsis sp.). These plants are associated with creosote bush and Joshua tree in other areas of the CGSA as understory species. In the higher elevations, however, the species exist in pure associations. (See Figure 2.8.1-8)

Alkali Sink Brush - Vegetation which occurs around dry lake beds or playas, or in areas where alkaline soils have developed is termed Alkali Sink Brush. Species include saltgrass (Distichlis spicata) and Atriplex sp. The general locations where this occurs within the CGSA are the playa areas and south of Little Lake. A similar association also occurs at Little Lake, where grasses and sedges are present, and here it is sometimes termed an Alkali Meadow and Aquatic association (Thorne, in press). Common species are various bulrushes (Scirpus acutus, S. americanus, S. olneyi), members of the other rush and sedge genera (e.g., Carex and Juncus), and saltgrass. Alkali Meadow also is found in moist areas at the lower end of Haiwee Spring, where other semi-aquatic species include wrinkled rush (Juncus rugulosus), Mexican rush (J. mexicanus), and iris-leaved rush (J. xiphioides).

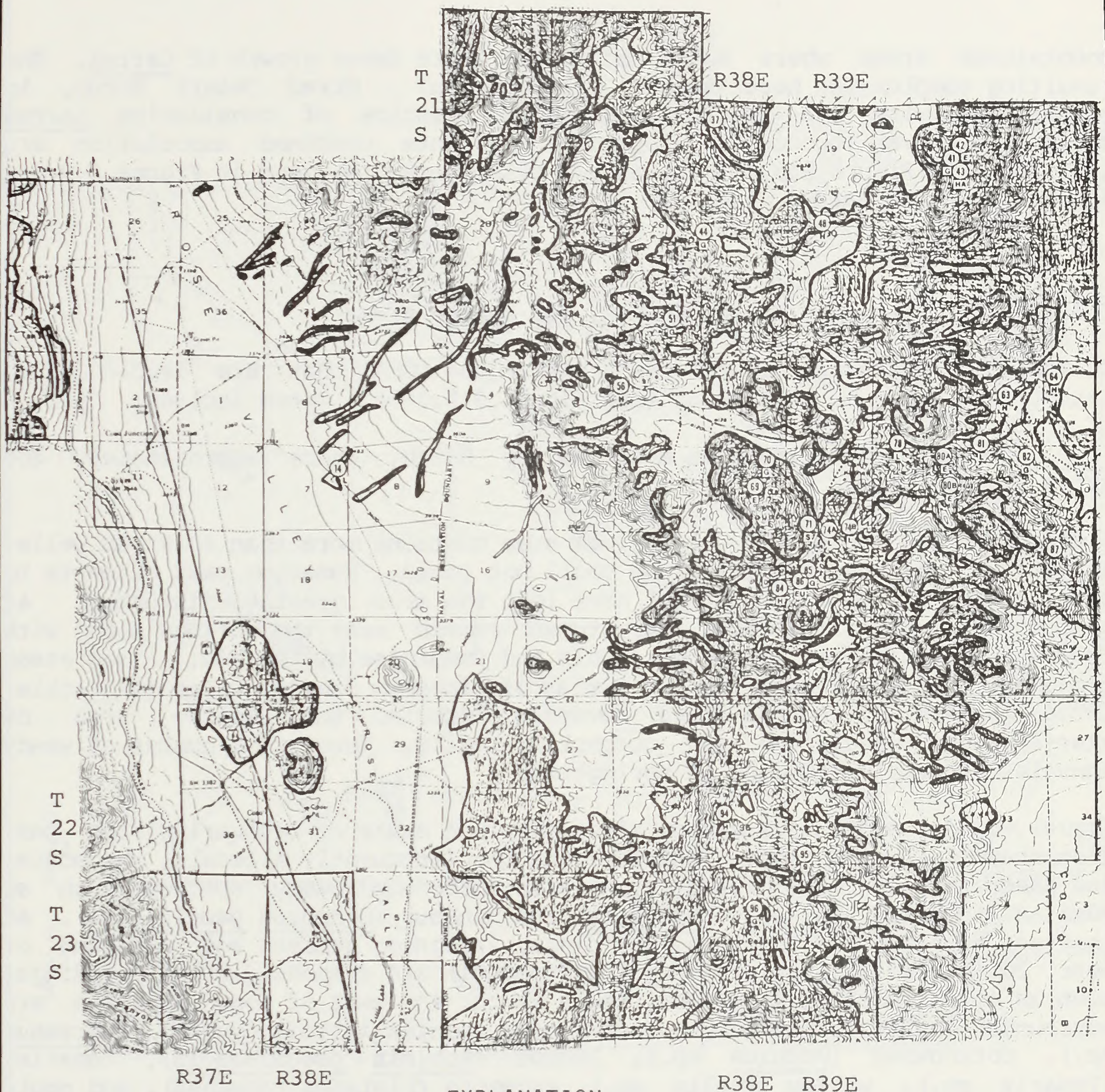
Creosotebush - Mixed Desert Scrub - As the term implies, this is a variation on the association described as Creosotebush - Burro Weed Scrub, in that the subdominant species comprise those listed above for Mixed Desert Scrub. Though the latter association generally replaces Creosotebush at higher elevations, the two are occasionally found together on the CGSA on some



<u>EXPLANATION</u>

Distribution of <u>Yucca brevifolia</u> (Joshua tree) on the CGSA. Sample sites are indicated by numbers. See Table 9 for data.

Figure 2.8.1-7 DISTRIBUTION OF JOSHUA TREE



EXPLANATION

Distribution of Mixed Desert Scrub on the CGSA. Sample sites are indicated by numbers. Dominant species for each site is indicated by the following subtending letters. (See Table 8 for data.)

L	<u>Larrea tridentata</u> (creosote bush)
H	<u>Hymenoclea salsola</u> (cheesebush)
G	<u>Grayia spinosa</u> (hop sage)
E	<u>Eriogonum fasciculatum</u> var. <u>polifolium</u> (California buckwheat)
EU	<u>Eurotia lanata</u> (winter fat)
S	<u>Stipa speciosa</u> (needle grass)
HA	<u>Haplopappus cooperi</u> (Cooper's goldenbush)

Figure 2.8.1-8 DISTRIBUTION OF MIXED DESERT SCRUB

mountainous areas where soil and microclimate favor growth of Larrea. The resulting complex is here termed Creosotebush - Mixed Desert Scrub, in conformance with the generally accepted practice of considering Larrea dominant wherever it occurs. Locations of this combined association are indicated in Figure 2.8.1-3 (at sample sites marked M), and in Figure 2.8.1-8 (at sample sites marked L).

2.8.1.2 Cultivated, Disturbed, Open, and Barren Areas

In addition, there are several areas within the CGSA that are devoid of a natural overstory of vegetation (see Figure 2.8.1-9). These include:

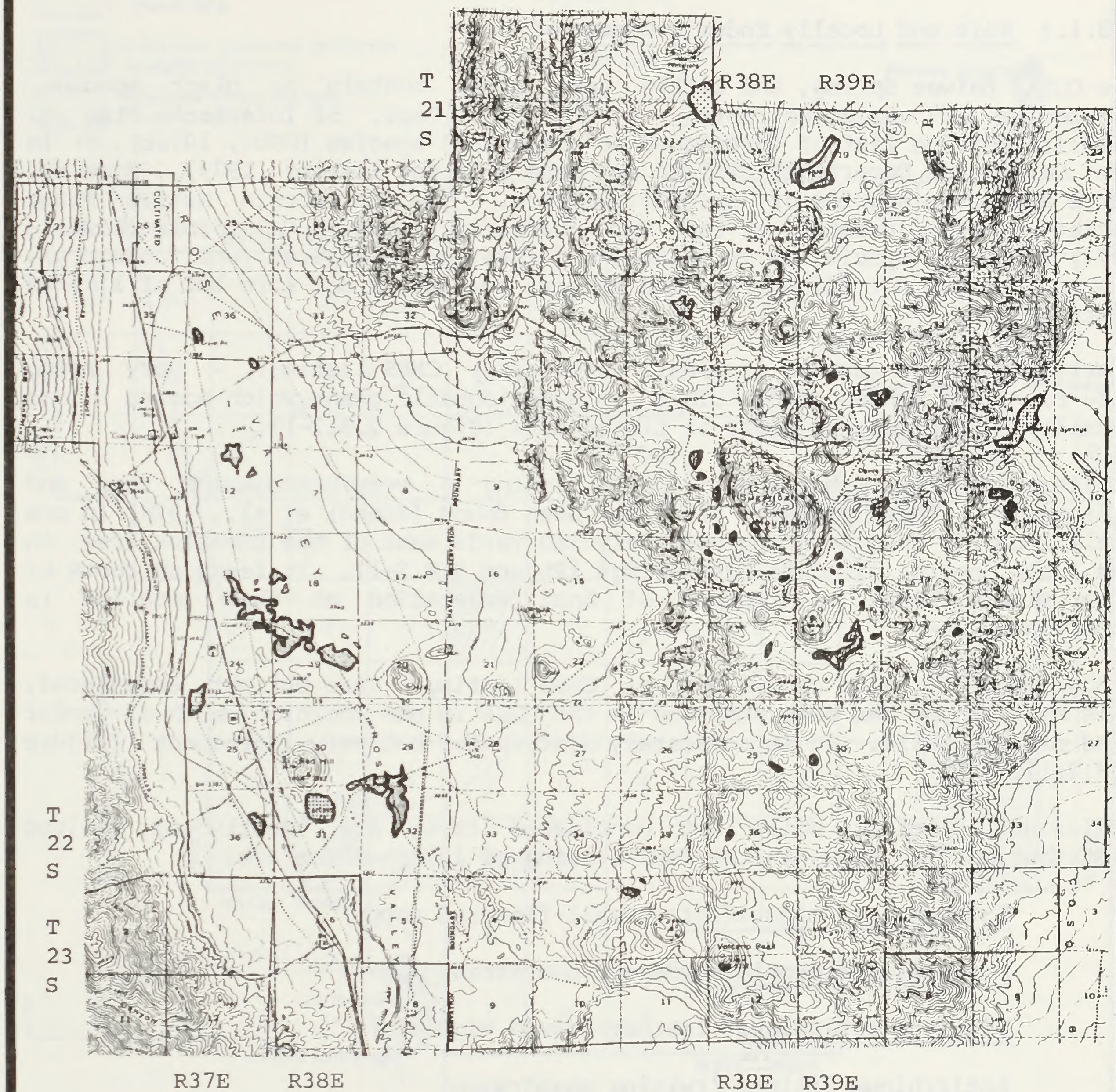
Cropland - Alfalfa is grown at Rose Valley Ranch, where approximately 400 acres are irrigated.

Disturbed Areas - The Coso Hot Springs area contains more than 40 steam wells, as well as mud pots, fumaroles and small hot pools. Numerous past attempts to develop the site (e.g., as a spa) have left the area greatly disturbed. At present various dilapidated structures remain near the springs along with numerous fences placed around hot pools and fumaroles by the NWC. Also, steam condensate is collected by a system of pipes to provide water for cattle. Large numbers of burros have severely impacted the entire area by over-browsing vegetation and compacting soils. However, a number of weedy annuals are fairly abundant in springtime.

Gravel, cinder and pumice mining sites are in a state of recovering from past disturbances; here some native vegetation (frequently allscale, shadscale, and cheesbush) is recolonizing, along with introduced weedy species such as Russian thistle (Salsola pestifera) and sandbur (Cenehrus pauciflorus). At the rest stop at Coso Junction, buildings, irrigated grasses and a stand of over 20 good-sized poplars (Populus fremonti) are present. Other buildings, such as at the Rose Valley Ranch, Lewis Ranch, and west of Coso Junction are surrounded by disturbed areas; introduced species include cypress (Cupressus sp.), cottonwood (Populus sp.), locust (Robinia pseudoacacia), tamarisk (Tamarix sp.), willow (Salix sp.), sycamore (Platanus racemosa), and maple (Acer sp.).

Open flats - There are several local depressions (some less than an acre in extent) among the hills in the eastern half of the CGSA, which are devoid of shrubby species, probably because of soil conditions. Vegetation on these open flats varies, but commonly consists of spring-blossoming annuals such as coreopsis (Coreopsis bigelovii, C. californica), pectocarya (Pectocarya sp.); later, various annual buckwheats (Eriogonum sp.) are prominent.

Barren Areas or Playas - Several of these have developed along the central drainage in Rose Valley; usually playas have a clay surface which cracks when dry. At the periphery of each of these is often a growth of allscale, and less often, shadscale or saltbush. The playas themselves are usually barren.



EXPLANATION

Distribution of disturbed, cultivated, open and barren areas in the CGSA.

Disturbed areas (coarse dots)
Cultivated areas (so noted)
Open flats (shaded)
Barren flats (fine dots)

Some disturbed areas have been heavily revegetated; these are not shown in Figure 1.

Figure 2.8.1-9 DISTURBED, CULTIVATED, OPEN AND BARREN AREAS

2.8.1.3 Rare and Locally Endemic Plants

The CGSA, Haiwee Spring, and Little Lake areas contain no plant species, subspecies or varieties noted in the U.S. Dept. of Interior's Fish and Wildlife Service list of threatened or endangered species (USDI, 1976b), or in the California Department of Fish and Game's latest listing (1979). However, there are seven species of special concern. The California Native Plant Society (CNPS) inventory of rare and endangered plants of California (Powell, 1974) lists two species as very rare, and rare and endangered (one category), one as rare but not endangered, and several species as not rare but of limited distribution.

Spartina gracilis (desert or alkali cordgrass); CNPS listing: - very rare, and rare and endangered. This is a semiaquatic plant which occurs in one locality on the western shore of Little Lake (Figure 2.8.2-1).

Pholisma arenarium (pholisma); CNPS listing - very rare, and rare and endangered. This parasite plant has been found (Zembal *et al*., 1978) in one small locality thus far, approximately 140 yards east of the tamarisk tree on the wash north of Coso Hot Springs (Figure 2.8.2-1). It feeds on roots of other plants, hence maintenance of host vegetation at this locality is important.

Canbya candida (white canbya poppy); CNPS listing - rare but not endangered. This small poppy has been observed in the CGSA in one location south of Cinder Road near Red Hill. It is moderately distributed but very infrequent (Figure 2.8.2-1).

Additional species, while not considered rare, are "mostly of limited distribution," as shown in the CNPS listing of 1974; these are:

Eschscholzia minutiflora (small-flowered poppy)

Stylocline micropides (desert neststraw)

Viguiera reticulata (leather-leaved viguiera)

Antirrhinum filipes (twining snapdragon)

Although these plants do not occur widely throughout southern California deserts, none are limited to one particular area of the CGSA; therefore, specific sensitive areas cannot be identified for them (Zembal, *et al*., 1978). The CNPS status of these plants is such that they warrant population monitoring and possible future reassessment of status (Powell, 1974); see also Flora and Wildlife Monitoring Plan in Appendix D.

Additional species known or expected to occur within the area may be placed on the state's rare list; these, of course, would require site-specific identification and monitoring, as would the rare and limited species listed

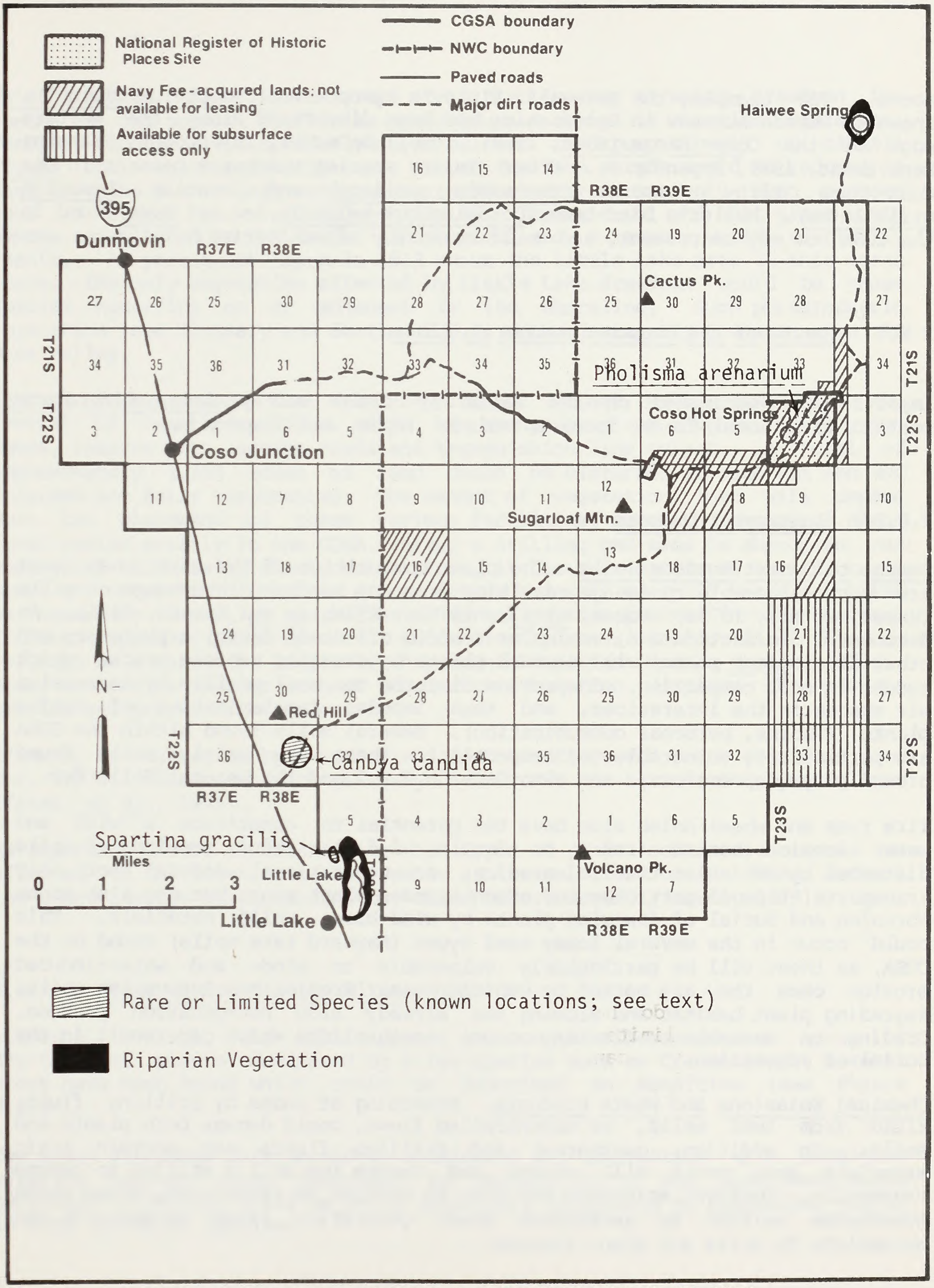


Figure 2.8.2-1. SENSITIVE VEGETATION AREAS IN CGSA

above. For example, the perennial Ripley's cymopterus (Cymopterus ripleyi), known in Nevada but new in California, has been discovered along the western edge of the Coso Range (Munz, 1968: 1030; DeDecker, Inyo County Planning Department, 1979, Appendix O). Other similar species which are present in the CGSA are Kirby's spurge (Euphorbia ocellata) and lomatium (Lomatium utriculatum). Heller's bird-beak (Cordylanthus helleri) has not been found in the CGSA but may be present, and would be worthy of monitoring.

2.8.2 Impacts of the Proposed Action on Flora

Impacts were estimated on the basis of field survey data, literature pertaining to local flora, local botanists' input, and Chapter 1.

2.8.2.1 Summary of Impacts

Damage to Desert Surface Soils. The plant communities of the arid Coso area are very vulnerable to damage resulting from any surface disturbance of soils (Vasek, et al., 1975a; Vasek, et al., 1975b; Wilshire and Nakata, 1976). As documented in Section 2.6, vehicular traffic off roads during exploratory and other development phases will disturb plants by creating vehicle tracks which result in soil compaction. Compaction disturbs the soil profile by decreasing air spaces in the interstices, and thus impedes recolonization of native plants (Thorne, personal communication). Several soils found within the CGSA are particularly vulnerable to compaction. These are mainly soils found around playa depressions; see also Section 2.6.2 and the General Soils Map.

Tire ruts and wheel holes also have the potential to constitute a wind and water erosion hazard (refer to Section 2.6.2). Wind erosion of soils disturbed by vehicular traffic, grading, or vegetational removal not only transports topsoil particles and often exposes plant roots but may also cause abrasion and burial of downwind plants by wind-blown solid materials. This could occur in the several loamy sand types (Maynard Lake soils) found on the CGSA, as these will be particularly vulnerable to wind- and water-induced erosion once they are marked by vehicle ruts. Erosion may impoverish soils, degrading plant habitat and slowing the already slow revegetation process. Grading on unstable soils may cause earth slides which can result in the burial of vegetation.

Chemical Emissions and Waste Products. Breaching of sumps by drilling fluid, fluid from test wells, or uncontrolled flows, could damage both plants and soils. In addition, geothermal and drilling fluids may contain toxic materials that could kill plants and damage the soil's ability to regrow vegetation. Chemical emissions may also be harmful to vegetation, since toxic substances emitted by geothermal power generation (such as mercury) can accumulate in soils and plant tissues.

Water Drawdown. Lower water levels at Little Lake due to water drawdown for geothermal and support facilities would cause a change in riparian vegetation. Emergent aquatic plant species such as bulrush (*Scirpus olneyi*) or cattail (*Typha* sp.) which presently occur around the lake margin would be reduced or lost as these plants only occur where surface water is present. Rush grasses such as *Juncus* sp. and *Heleocharis* sp. (spike rush) and salt grass would become established on the former lake bottom and a marsh would eventually result. A photograph taken in 1913 shows the Little Lake area in this marsh state. The only vegetation affected by Little Lake drawdown would be those species occurring on or adjacent to its shoreline. Such phreatophytic vegetation (see Glossary and Section 2.5.2) occurs naturally nowhere else in Rose Valley.

Removal of Vegetation. The most significant impact would come from the removal of vegetation from sites of the power plant complex, drill pads, sumps, reserve pits, access roads and transmission line pylons. A total of approximately 2,260 acres of land could be disturbed if both BLM and NWC programs are fully implemented. The amount of vegetation lost will depend upon the placement of these various facilities, since the amount of plant cover varies greatly in the CGSA. After a drilling pad area is abandoned and ecological succession slowly takes place, it has been estimated that 30 to 40 years are required in the best circumstances and well over 100 years may often be necessary (Vasek, *et al*., 1975a). Normally, this process involves several different types of plant species. Short-lived pioneer species first appear, followed by a series of longer-lived perennial species (Vasek, *et al*., 1975a). Weedy non-native species such as Russian thistle often displace the pioneer species and prevent succession.

Crushing of vegetation by vehicles and foot traffic would occur (Davidson and Fox, 1974). Effects of trampling by field crews can be seen many years later (Vasek, *et al*., 1975).

An important factor in determining what types of plant communities would be affected is the location of the usable geothermal field on the CGSA. Zones 1 and 2 are largely characterized by "Mixed Desert Scrub" (Thorne, 1979).

2.8.2.2 Areas of Sensitivity Within CGSA

Although, overall, the CGSA appears to contain a monotonous array of dry-tolerant plants dominated by a few species such as Creosotebush, several areas have been found which could be described as sensitive (see Figure 2.8.2-1).

The areas discussed here should be considered in conjunction with sensitive wildlife habitat areas described in Section 2.7.2 and also those soils mentioned in Section 2.6.2 as being especially vulnerable to compaction and/or to wind and water erosion.

Riparian Vegetation. The riparian vegetation which borders Little Lake and Haiwee Spring comprises two very sensitive areas (see Figure 2.8.2-1). As mentioned in Section 2.7.2, there is a high probability that the water level of Little Lake will be lowered if water utilization for the proposed program reaches projected levels. The marsh area surrounding Little Lake supports numerous riparian plant species, including the CNPS-designated rare cord grass (*Spartina gracilis*). Lowering of Little Lake could cause the local loss of this rare plant, as well as the reduction of other species which can only exist in oases in an otherwise arid environment. Haiwee Spring is not likely to be affected (see Hydrology Technical Report).

Other Sensitive Areas. Red Hill is a sensitive area, near the base of which may be found the rare white canbya (*Canbya candida*); in addition, cinder cones have unusual heat- and moisture-retentive qualities which may have a "hothouse effect" on plants growing there (DeDecker, Inyo County Planning Department, 1979, Appendix O: 19; and R. Weiss, 1979, personal communication).

An area on the northern border of the Coso Hot Springs National Register of Historic Places site is the only locality in the CGSA in which the rare parasitic plant, *Pholisma arenarium*, was found. It may exist elsewhere in the CGSA in sandy areas, if host plants are present.

Rocky exposures and areas of thin stony soil are also especially vulnerable; any vegetation disturbed or destroyed in such areas would require many years to recolonize, up to 100 years for some species even if a revegetation plan is implemented (Vasek *et al.*, 1975a).

Areas not shown on Figure 2.7.2-1 or Figure 2.8.2-1, or described as especially vulnerable to compaction or erosion in Section 2.6, may be considered as relatively less sensitive to vegetation damage resulting from the proposed action. This assessment is subject to revision after further site-specific study. In general, it can be stated that vegetation in broad valleys (and on some smaller areas of nearly level terrain) recovers more quickly, once disturbed, than that on steeper slopes. Again, it should be remembered that the entire CGSA, like all desert ecosystems, is a sensitive area where damage to plant life can persist for decades and even up to 100 years, even when a restoration plan is implemented.

2.8.2.3 Rare and Endangered Species and Species of Limited Distribution

Seven plant species of special concern could be impacted by geothermal development.

Spartina gracilis (alkali cord grass). If the level of Little Lake is lowered, this CNPS-listed rare plant could be adversely affected, and could be locally extirpated.

Pholisma arenarium (pholisma). The population of the CNPS-listed rare species is located in Zone 1, on the edge of the NWC fee-owned Coso Hot Springs National Register Site, and is so localized that geothermal development, if ever to occur here, would be able to avoid it. If discovered elsewhere in the CGSA, it should be avoided.

Canbya candida (white canbya poppy). Because canbya is located in a zone of unrated geothermal potential, its habitat may never be proposed for disturbance. If it is disturbed, significance of the loss of this population is moderate.

Four additional species of limited distribution are worthy of monitoring: little gold poppy (Eschscholzia minutiflora); twining snapdragon (Antirrhinum filipes); desert neststraw (Stylocline micropoides); and leather-leaved viguiera (Viguiera reticulata), although they are not likely to be significantly impacted by geothermal development. They are scattered throughout the CGSA, making sensitive habitat identification difficult. The loss of these plants in any one location would be of low significance because they are distributed in other parts of the southern California desert.

2.8.2.4 Impacts During Phases of Geothermal Development

Preliminary Exploration. Impacts would result mainly from off-road vehicle use, and drilling of test wells for heat-flow measurements. Vehicular traffic from this phase would cause compaction and movement of the natural soil surface. Impacts to plants during this stage would be mainly due to trampling of perennials, some soil compaction from vehicles and possibly some wind- or water-induced erosion. The extent of surface disturbance is expected to be as described in Chapter 1; areas disturbed in Zones 1 and 2 would be largely Mixed Desert Scrub. In Zones 3 and 4, any of the flora encountered in the CGSA may suffer some damage.

Exploratory Well Drilling. During this stage, major localized disturbances to flora could occur. As discussed in section 2.7.2.4, an estimated 112.5 acres of Mixed Desert Scrub in Zones 1 and 2 would be removed if 100 exploratory wells are drilled in those zones. No known rare or endangered species would be disturbed, since the immediate vicinity of Coso Hot Springs would not suffer surface disturbance. In Zones 3 and 4, if 300 exploratory wells are drilled, vegetational destruction may amount to 338 acres. This could include any type of common vegetation encountered in the CGSA.

Compaction of soils will also occur, and erosion by wind and occasional heavy rains may be increased, which could impoverish the soils, slow revegetation and allow weedy species to invade. During most of the year the CGSA is extremely dry, and dust would be generated from roads and drill pad areas due to vehicular use. The high winds which occur very frequently in the area may result in abrasion of sensitive plant surfaces as soil particles are blown by winds. Small plants may be buried by wind-blown particles.

It is assumed, however, that the preliminary exploration stage would yield sufficient information regarding well locations and flora on selected sites, and that facilities may be located so as to minimize vegetational impacts during this stage.

Field Development. Destruction of the vegetation at the site of the power plant and ancillary facilities is generally total. Some 800-1000 acres may eventually be disturbed; again, disturbance in Zones 3 and 4 may affect any of the species and vegetative associations within the CGSA.

During full field development, all impacts described for the previous stages would be roughly doubled as a result of the greater number of disturbed acres. Increased plant productivity may be noted along the sides of access roads and transmission lines (Vasek, et al., 1975b; see also Section 2.7.2.

Resource Utilization. During the operations phase there would be additional disturbances to the habitat. Areas cleared of native vegetation could become colonized by weedy plant species. As the species reproduce, they may spread into the disturbed natural plant communities near the power plant complexes. For example, near Victorville red brome, (Bromus rubens) and other Mediterranean grasses have spread into Creosotebush Scrub and Joshua Tree Woodland communities (Henrickson, personal communication). The resulting competition from these introduced species may mean a gradual loss of native vegetation, continuing long after construction is completed. If herbicides are used in weed control, these may be washed or blown onto native vegetation, causing additional impact.

However, as noted in Section 2.7.2.4 and 2.7.2.5 some specialized disturbed areas such as roadsides, and areas under transmission lines or steam lines, may be positively affected, affording fair habitat for wildlife.

During this phase, there is a possible indirect effect of lowering ground water levels near Little Lake. Loss of riparian vegetation would occur along the borders of the lake, and in particular Spartina gracilis, the rare cord grass found at this location, may be reduced or lost. Nonriparian vegetation of Rose Valley would not be affected by Little Lake drawdown; see Section 2.5.2.

Since the geothermal fluid has not been completely characterized, estimates of chemical emissions and their impact may be inaccurate. Chapter 1 indicates that condensed steam will be used as make-up water for the cooling tower. Gases such as carbon dioxide and hydrogen sulfide (H_2S) will be emitted, as will the heavy metal mercury. (Since 95 percent of hydrogen sulfide will be scrubbed, the actual emission rate of this toxic gas will be so low that it should not affect plant or animal life.) Water vapor emissions will be accompanied by mercury at an estimated rate of 10×10^{-8} by weight per unit water (see Section 2.2). The amount of water vapor emitted by the cooling tower of a 50-MW power plant is estimated at 1.1×15^5 g/sec. Hence, mercury emissions will be about 95 g Hg per 50-MW power plant per day; and mercury levels in atmospheric air are estimated to be 0.01 ug/m^3 (Technical Reports:

Air Quality, Chemical Emissions). Schroeder (1971) considers prolonged exposure to atmospheric levels in excess of 0.1 ug/m^3 to be harmful to humans and mammals in general. Since estimates for the atmospheric levels in the CGSA are one-tenth that amount, no immediate health problem is foreseen.

The hazard to both flora and wildlife from mercury accumulation in soils, as well as plant and animal tissues, during geothermal power development and use has been documented in a few preliminary studies (Siegel and Siegel, 1975; Robertson, et al., 1977; Fang, 1978). Mercury is absorbed by dry soils (Fang, 1978) and can be concentrated in plants at levels from 10 to 20 times higher than soil levels (Siegel, et al., 1973). Field studies have shown that mercury is commonly concentrated 10 to 100 times by soil fungi and in invertebrates such as annelids and millipedes (Siegel and Siegel, 1975). Thus, mercury could possibly accumulate, eventually, to harmful levels in soils, and in plant and animal tissues.

Close-Out. In the close-out stage there would be some increase in habitat disturbances: Power plant units would be removed, wells capped, and sumps and reserve pits returned to natural grade.

2.8.2.5 Cumulative Impacts

Cumulative impacts to vegetation as a result of the proposed action and the NWC development together would be generally as described in Section 2.7.2.5. Surface disturbance in Zones 1 and 2 would affect largely such common associations as Creosotebush and Shadscale Scrub and Mixed Desert Scrub. The likelihood of impact to *Pholisma arenarium* seems slight unless host vegetation near Coso Hot Springs is further reduced. Elsewhere in Zones 1 and 2, and throughout the rest of the CGSA, the possibility exists for damage to those species whose distribution is limited; this possibility is increased by the development of additional facilities for the NWC. An additional cumulative impact may be lowering of water tables and consequent alteration of aquatic or semiaquatic habitats, which would probably affect the rare cord grass, *Spartina gracilis*, near Little Lake.

The overall productivity and ecological balance of the CGSA—as a management unit and in relation to its surroundings in the region—would be a matter for ongoing study and care. Displacement and destruction of desert vegetation in its natural physiognomy and structure within this area would leave scars visible for many years.

2.9 VISUAL RESOURCES

2.9.1 Present Visual Setting

2.9.1.1 Landscape Character

All landscapes have a readily identifiable character, regardless of size, location, or land use. Those landscapes that possess or have potential for a greater degree of visual variety are more desirable than those that tend to be monotonous. Each characteristic landscape is determined by the features that are seen and their arrangement in the landscape composition. These landscape features are the landform, vegetation and structures. Each particular feature is defined by the four basic elements of form, line, color and texture. All of the basic elements are present in every landscape, but exert various degrees of visual influence. The more elements that exert a strong visual influence or contrast in the landscape, the stronger or more interesting the landscape character. The degree of variety and harmony among the basic elements determines whether or not a given landscape is pleasant to view.

2.9.1.2 Observer Position

Landscape character is determined by viewing portions of the landscape. The placement and relationship of the viewer to the landscape is the "observer position". From this position the extent or area that can be viewed is normally limited by landform, vegetation, or distance. This is the seen area. Those portions of the landscape which are generally not visible from observer positions, and which are beyond approximately 15 miles are the seldom seen areas. In addition, several variables influence visual perception from these observer positions and determine how well contrasts are seen. These variables are: distance, angle of observation, time, size or scale, season of the year, light, and atmospheric conditions.

As observer positions heavily influence the determination of seen or seldom seen areas these positions are carefully selected to fairly represent the viewed portions of the landscape. One or a series of observer positions on a travel route, such as U.S. 395, or at the use area, such as the National Register Site, become "key observation points," (KOP). Rose Valley has been identified as a State Eligible Scenic Highway by California Department of Transportation. In seldom seen areas, the observer positions are those which appear to be "likely observation points."

The basic elements of form, line, color and texture are used to describe the landscape features of the CGSA from five "key or likely" observation points. (See Appendix E)

2.9.1.3 Scenic Quality

The Coso Range. Although two-thirds of the CGSA is of the strong relief of the Coso Range, the scenic quality is of a generally low quality. The complex but sparse vegetation patterns of creosote bush, Joshua Tree and mixed desert scrub are generally insignificant. Numerous cultural modifications are in evidence on all of the landforms. Graded roads, range targets and testing facilities are instrusions in the HIGH GRANTIC RIDGES AND SLIDE SLOPES. Mining activity with the associated pipes and structures in the Devil's Kitchen area, and the weathered wood and stone buildings of the resort area are cultural modifications to the ENCLOSED BASINS. The stone buildings are National Historic Landmarks listed in the National Register of Historic Places. The hot springs of this desert area is a relative water feature. Another notable feature is the localized color found in the soils of the Devil's Kitchen area. The RHYOLITE DOME FIELD includes Sugarloaf Mountain and is a notable feature (Figure 2.9.1-1). The obsidian and pumice deposits in the rubble land flanks of these upland cinder cones are visually interesting.

Rose Valley Plain. One-third of the CGSA is a broad valley in which the overall visual effect is common to the desert region, with little visual diversity. The vegetation is sparse with little variety to the broad expanse of mixed desert shrubs. The area is heavily intruded with numerous unimproved road, the Gil Station highway rest stop, U.S. 395, transmission corridors, mines and fences, cultivated fields and agricultural buildings. The ALLUVIAL FANS are the most visible areas of the valley. The LOWER VALLEY FLOOR is expansive but not easily viewed in its entirety due to the depressions, sinks, interplaya dunes and flats (Figure 2.9.1-2). The scenic quality is enhanced by the adjacent scenery of the Sierra Nevada Range to the west and the Coso Range to the east.

Lava Flows. The visual quality is generally strong despite being heavily intruded by U.S. 395, transmission corridor roads and towers, pit mining and access roads. Although there is little or no variety in vegetation, the ground plane is of strong visual interest due to the dark LAVA FLOWS (Figure 2.9.1-3). A notable feature of this landform is the Fossil Falls where the basalt flow assumes configurations, textures and scale unique to the area. The upland basalt flows rise from the valley as a mantle cresting over a portion of the Coso Range. Red Hill, a basaltic cinder cone, is a notable landform with mass and configuration unique to the area.

Fig. 2.9.1-1 ENCLOSED BASIN AND RHYOLITE DOMEFIELD

LANDFORM The massive, symmetrical domes dominate the open basins. Steeply rounded flanks converge on the basin floor in a series of powerful undulations which race down one slope to return up to the crest of another. This uninterrupted flowing of lines is characteristic of this landscape. Darker hued reddish browns continue the undulating pattern at the greyish basin edge. The uniformity of the stones and boulders of the rubble land is a notable large scale fine texture.

VEGETATION The sparse, clumping vegetation is open with minimal form. Notable random and jagged patterns occur on the steep slopes. The grey-green coloration and fine, tufted texture bring unity to the landscape.

CULTURAL MODIFICATION Road grading in the basins and cuts and fills on the slopes are minor forms. These modifications become notable where texture and color have been interrupted, and where these interruptions take on strong linear characteristics not consistent with the undulating line quality.

Fig. 2.9.1-2 BROAD VALLEY PLAIN AND ALLUVIAL FANS

LANDFORM The expanding space of the valley floor is flat, with a notable absence of protruding form. At the base of the massive domes and cinder cones along the perimeter of the valley a strong horizontal line emerges. The undulating and complexly furrowed lines of the distant ridgeline are strong compliments to the heavy horizontal lines of the plain. The grey and tan colorations and smooth, rounded textures unify the scene and provide little variety.

VEGETATION The low, open clumping vegetation has minimal form and spreads as a veneer over the valley floor. Faint linear aspects are apparent where the vegetation is interrupted by striations of denuded transmission corridors, and where it has adopted to depressed playas and raised terraces with variations in color and texture. The ochre, grey-green and olive coloration of the fine, tufted texture is uniform with minimal variety.

CULTURAL MODIFICATION Angular steel towers are noticeable although their open fabrication gives their form a semi-transparent quality The faint linear tracery grey color and metal texture are insignificant at this scale.

Fig. 2.9.1-3 LAVA FLOW

LANDFORM The broad void of the valley floor is interrupted by rugged lava flow silhouettes. The overall line quality is irregular, jagged and horizontal. The most striking element is the coloration of the black-brown basalt flow and the red-brown of the cinder cones, which is strong contrast to the mottled greys and tans of the distant ridgeline. The coarse even texture of the lava flow is quite distinct from the roundly furrowed, soft ridgeline texture.

VEGETATION The low, open clumping vegetation has minimal form, and appears like a veneer on the valley floor. The floor is covered by a broad mosaic of irregular bands and distant striations. Although the ochre and grey-green coloration is typical of the area, it contrasts strikingly with the dark basalt colors in this locale.

CULTURAL MODIFICATION Angular steel towers, spaced at regular intervals, are noticeable although their open fabrication gives their form a semi-transparent quality. These towers and sagging connection wires are faint horizontal and vertical line tracings. The grey color and metal texture are insignificant on this scale.

2.9.1.4 Visual Resources Inventory

The visual resources of the CGSA were inventoried and evaluated by a system which identifies scenic quality and sets minimum quality standards for management of these resources. This system depends upon three factors:

1. The inherent quality of the scenery being viewed.

2. The visual sensitivity, expressing viewer attitudes toward change and volume of use, of the scenery being viewed.

3. The distance zones representing perception levels by which the scenery is being used.

These factors are used to classify all lands into one of five Visual Resource Management (VRM) classes. Each of these classes contains a specific management objective for maintaining or enhancing visual resource values.

See Appendix E for a description of the complete methodology utilized for evaluation of the CGSA.

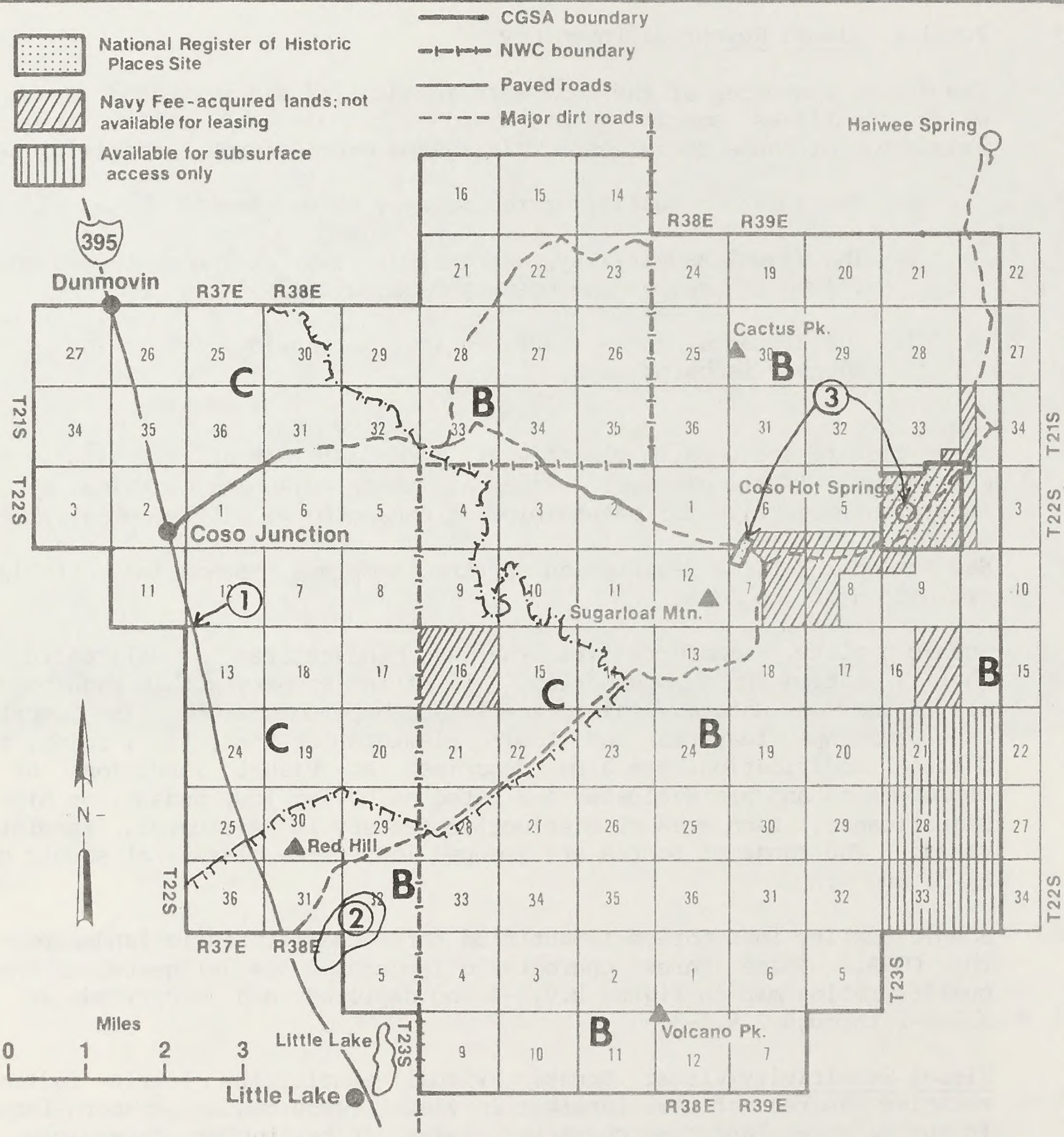
Scenic Quality. Landforms are the key indicators in delineating scenic quality rating unit boundaries. All of the scenery within each boundary is all of the same nature. This overall landscape composition is described by the landscape features and their elements of form, line, color, texture. Cultural modifications are also described as visual intrusions or visual improvements and are evaluated and rated as having low, medium, or high visual significance. Each area of distinctive scenery is evaluated, tabulated and rated. The range of scores are grouped into three classes of scenic quality: A, B, and C.

Scenic quality inventories indentified three characteristic landscapes within the CGSA. These three characteric landscapes are delineated on the scenic quality rating map in Figure 2.9.1-4 and depicted and described in Figures 2.9.1-1 through 2.9.1-3.

Visual Sensitivity/Visual Zones. Visual sensitivity levels indicate the relative degree of user interest in visual resources and concern for changes in the existing landscape character. The criteria for determining visual sensitivity are user volume (both vehicular and pedestrian), and expressed user attitudes toward change. Based upon user volume and user attitude toward change the areas within view of US 395 and the two National Register sites were determined to be highly sensitive to modification.

Distance zones are determined in the field by actually traveling each route and observing the area that can be viewed. The zones are delineated by the following criteria.

Foreground-Middleground Zone. The area seen from a distance of three



Key Observation Points

1. U.S. 395
2. Fossil Falls
3. Coso Hot Springs National Register sites

Scenic Quality Ratings

-·-·-·- division line

Figure 2.9.1-4

to five miles where activities may be viewed in detail. The outer boundary of this zone is defined as the point where the texture and form of individual plants is not longer apparent in the landscape.

Background Zone. This is the remaining area which can be seen from each travel route to approximately 15 miles. Vegetation should be visible at least as patterns of light and dark.

Seldom Seen Zone. These lands are identified as unseen or beyond the approximate 15-mile limit from key observation points.

Visual Resources Management Classes. Visual resources management classes are management objectives which describe the degree of modification allowed in the basic elements of the landscape. The primary character of the landscape should be retained regardless of the degree of modification.

The following is a description of the five VRM class objectives::

Class I. This class provides primarily for natural ecological changes only. It is applied to designated primitive areas, some natural areas, and other similar situations where management activities are to be restricted.

Class II. Changes in any of the basic elements (form, line, color or texture) caused by a management activity should not be evident in the characteristic landscape.

Class III. Changes in the basic elements (form, line, color and texture) caused by a managment activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

Class IV. Changes may subordinate the original composition and character but will reflect some basic elements of the character type.

Class V. Change is needed. This class applies to areas where the natural character has been disturbed to the point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation where the quality class has been reduced because of unacceptable intrusions. It should be considered an interim, short-term classification until one of the other objectives can be reached through rehabilitation or enhancement. The desired visual quality objective should be identified.

The determination of the visual resources management class and therefore the visual sesources management objective for a particular area is based upon consideraton of the various combinations of the three inventory variables, i.e. scenic quality, visual sensitivity, and distance zones. Table 2.9.1-1 shows the matrix used in considering these variables to determine the management class. The lands within the CGSA fall within VRM classes II, III,

Table 2.9.1-1

Visual Resource Management Matrix

VISUAL SENSITIVITY LEVEL

	HIGH			MEDIUM			LOW		
SPECIAL AREAS	I	I	I	I	I	I	I	I	I
SCENIC CLASS A	II	II	II	II	II	II	II	II	II
SCENIC CLASS B	II	III	IV	III	III	IV	III	IV	IV
SCENIC CLASS C	III	IV	IV	IV	IV	IV	IV	I	IV
	FG	BG	SS	FG	BG	SS	FG	BG	SS

DISTANCE ZONES

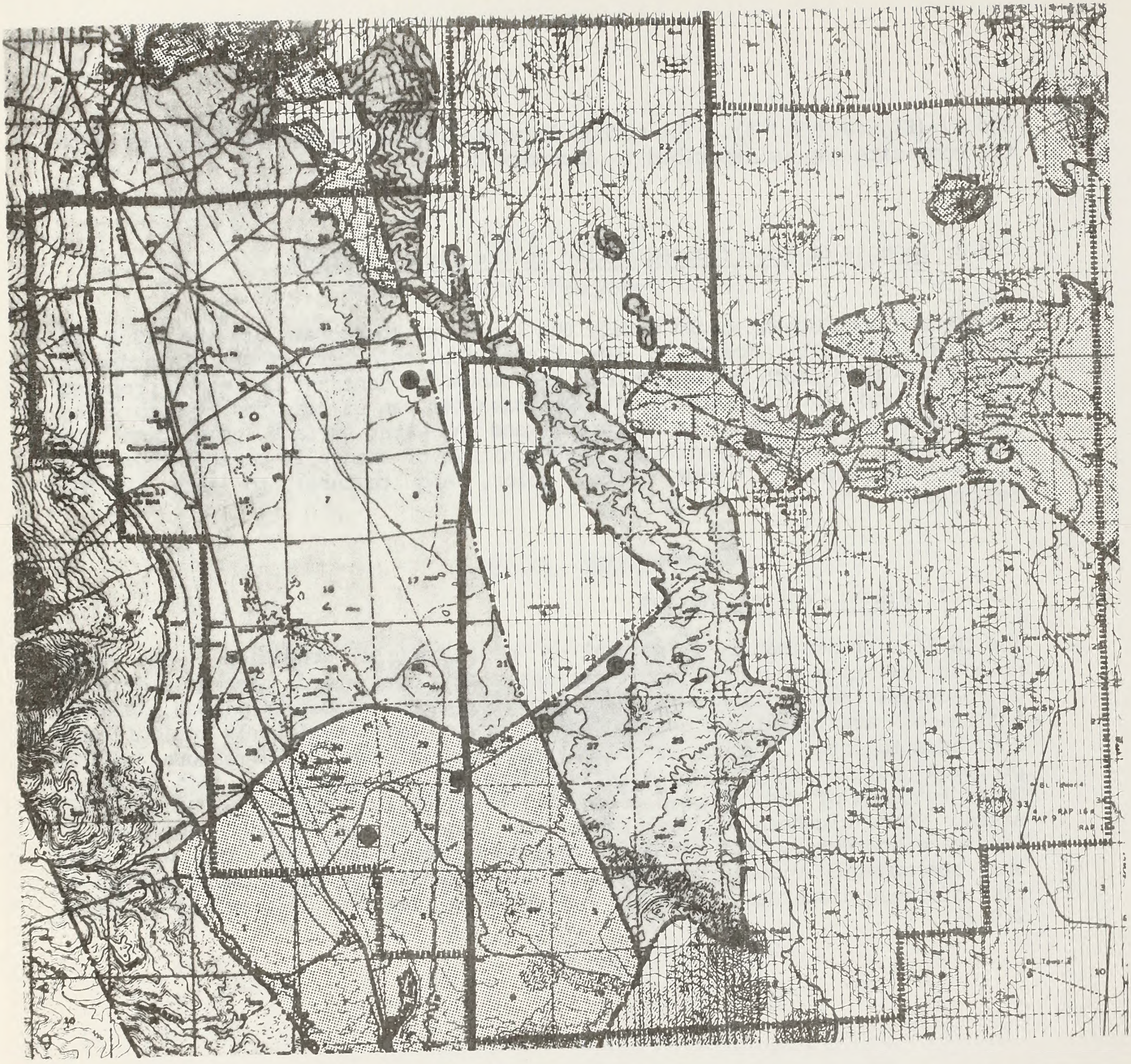
and IV (Figure 2.9.1-5). The methodology use for compiling the data base into the composite map is described in Appendix E.

2.9.2 Impacts of the Proposed Action on the Visual Setting

Geothermal development could modify the landscape character of the CGSA if striking contrasts occur in the form, line, color or texture of landscape features within areas being viewed. The amount of contrast between a proposed activity and the existing landscape character can be measured by separating the landscape into its major features (land and water surface, vegetation and structures), and then predicting the magnitude of change in constrast of each of the basic elements (form, line, color, and texture) to each of the features.

2.9.2.1 Visual Contrast Rating

The CGSA is predominantly in natural or near natural condition. The most notable existing cultural modifications extend over a wide area as a network of roadways, transmission corridors, pipelines and fencing. These lengthy intrusions are lineally dispersed and are rated to be realtively insignficant contrasts to form, line, color or texture. Some of the viewed features of the proposed action will be similarly dispersed and will expand this network. Other features of the proposed acton will be visually concentrated at specific sites. These clusters of development could engender significant constrasts to landscape character. Not rated for constrast significance are the ephemeral and atmospheric visual features which are attendant to field development. A list of these dispersed, clustered and ephemeral features is provided in Table 2.9.2-1.



VISUAL RESOURCE MANAGEMENT CLASSES

= CLASS II

= CLASS III

= CLASS IV

Fig. 2.9.1-5

TABLE 2.9.2-1

Dispersed Features of Development

1. Temporary roads
2. Access and maintenance roads
3. Improved roads
4. Water pipelines
5. Insulated steam lines with expansion loops
6. Transmission towers and lines

Clustered Features of Development

1. Graded pads
2. Sumps and pits
3. Drilling rigs
4. Well heads
5. Cooling towers
6. Turbine generation plant
7. Substation
8. Peripheral scarification
9. Parking and martialing areas

Ephemeral Features of Development
(not rated for contrast)

1. Vehicular movement
2. Dust, Steam and Exhaust
3. Lighting
4. Steam

These visual features of development are contrasted and rated in Appendix E worksheets. This contrast rating reveals the elements and features that would cause the greatest visual impact. Those elements with the highest degree of contrast are the ones that can be most easily identified. Most difficult to identify are the development features which are dispersed over an area. The development features which are most easily identified are those which could be clustered on a site. The contrast rating indicates the significance or insignificance of the visual impacts of geothermal development.

2.9.2.2 Insignificant Impacts

The contrast rating reveals that geothermal development would not significantly affect all three landscape features to the same degree. Due to the variable factors of distance and relative scale, the impact upon the form, line, color or texture of LANDFORM would be insignificant. The extent of change to the existing landforms caused by all grading activity would not significantly affect the major elements of form and line; however, minor affects would be visible in changes in color and texture.

More significant would be the impacts of scarification of VEGETATION which would notably interrupt line, color and texture, while form would remain nearly unchanged. Significant contrasts would be found in the basic elements of STRUCTURES.

2.9.2.3 Significant Impacts

Striking differences in form and line would occur with the introduction of geothermal development STRUCTURES. To a slightly lesser degree, color and texture would also be affected. The contrast in all the basic elements would most notably occur as follows:

FORM - Mass and angular shadows would appear on the floor of basins and valleys where they had not previously occurred. The variable factors of distance, relative scale, period of observation, and light would all diffuse or accent this contrast throughout the daylight cycle.

LINE - Horizontal lines typical of basins and valley floors would be interrupted or made discontinuous altogether. Conversely, much of the intermittent line quality would be overlaid with long, unrelieved linear networks and corridors extending entirely across the area being viewed.

COLOR - Contrasts in color would occur as flecks of contrast interrupting the existing mosaic. In some cases, brightly hued colors would be quite assertive.

TEXTURE - Contrasts in texture would be the least noticeable of the elements, as relative scale prevents surface texture of structure from becoming visually significant. Interruptions in existing patterns and mosaics would be of significance.

2.9.2.4 Simulation of Impacts

Since the location and description of this project is not well defined five situations which were considered to be "typical" for each of the landscape character types were chosen for purpose of impact analysis and evaluated from the most critical location under the most critical viewing conditions. Figures 2.9.2-1 through 2.9.2-5 are visual simulations of these five situations. These evaluations assume full development which would be the worst case and most long term situation. The geothermal development features which are illustrated are a power generating, site a transmission corridor and an electrical substation.

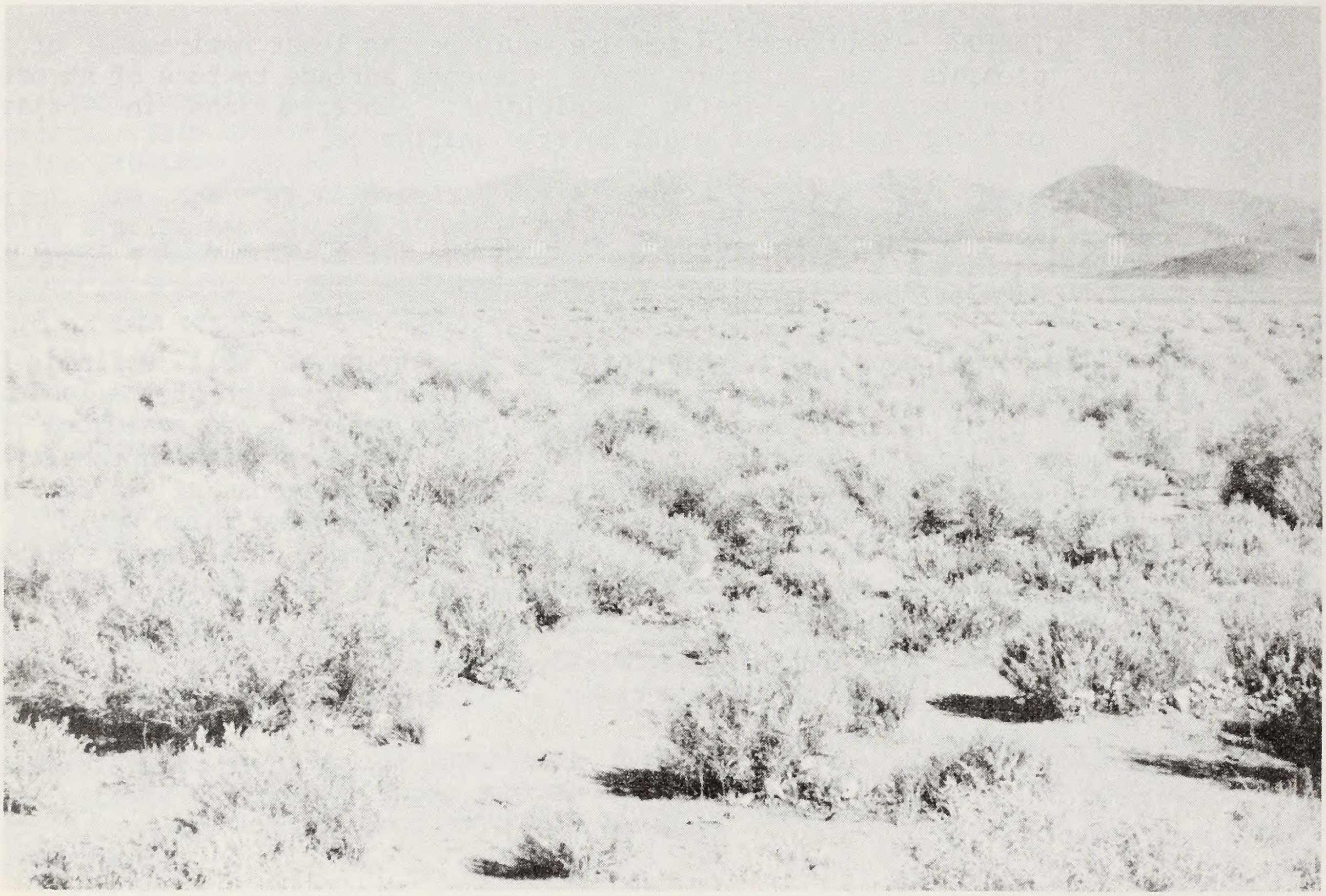


Fig. 2.9.2-1 TRANSMISSION CORRIDOR SIMULATION

VRM CLASS IV REQUIREMENTS:	Contrasts may attract attention and be a dominant feature of the landscape. The change should repeat the basic elements inherent in the characteristic landscape.
CONTRAST RATING:	The contrast can be seen, but does not attract attention. The level of contrasts is acceptable.
FORM:	No impacts upon landform, vegetation or structures.
LINE:	Denudation of service roads would weakly impact vegetation by interrupting striations.
COLOR:	Scarification of service road corridor would weakly impact landform and vegetation by creating flecks of grey-white on the landscape.
TEXTURE:	No impacts upon landform, vegetation or structures.

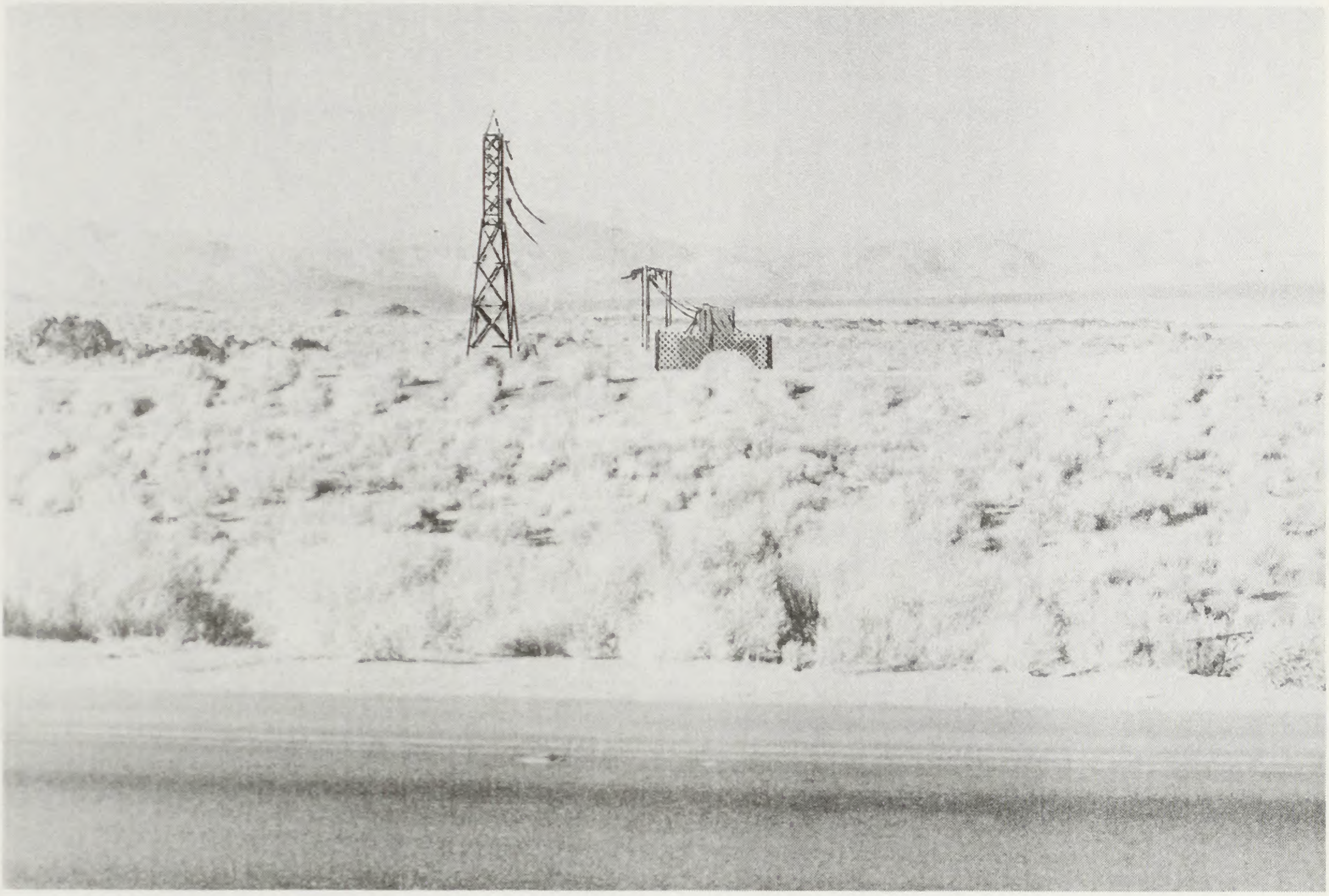


Fig. 2.9.2-2 POWER SUBSTATION SIMULATION

VRM CLASS II REQUIREMENTS: A contrast may be seen but should not attract attention. Changes in any of the basic elements should not be evident in the characteristic landscape.

CONTRAST RATING: The contrast begins to dominate the characteristic landscape and attracts attention. The level of contrasts is unacceptable.

FORM: Earthwork will weakly impact the existing landforms and vegetation as the essential character will remain flat. A cubicle structure will moderately impact an area where form has been notably absent previously.

LINE: Horizontal angularity of ground plane will be weakly impacted. Rigid, rectilinear structures and softly parabolic power lines will be new additions to landscape character with weak impacts.

COLOR: Earthwork will cause moderate impacts of grey to white on the basalt, brown lava covered surface.

TEXTURE: Textural contrasts will be weak impacts on landform, vegetation and structures.

Fig. 2.9.2-3 POWER GENERATING SITE SIMULATION

VRM CLASS III REQUIREMENTS:	Contrasts to the basic elements may be evident and begin to attract attention in the characteristic landscape. However, the changes should remain subordinate to the existing characteristic landscape.
CONTRAST RATING:	The contrast begins to dominate the characteristic landscape and attracts attention. The level of contrasts is unacceptable.
FORM:	Earthwork will be flattened with weak impact on landform. The long, rectilinear shell and towers will moderately impact on area previously devoid of form.
LINE:	The rectilinear and parabolic silhouette of structures will moderately impact an area which previously had been notable for the lack of such lines.
COLOR:	The grey to white of the concrete and metal structure will moderately impact the site.
TEXTURE:	Earthwork will weakly impact landform and vegetation patterns. The smooth to metallic texture of structures will be weak impacts.

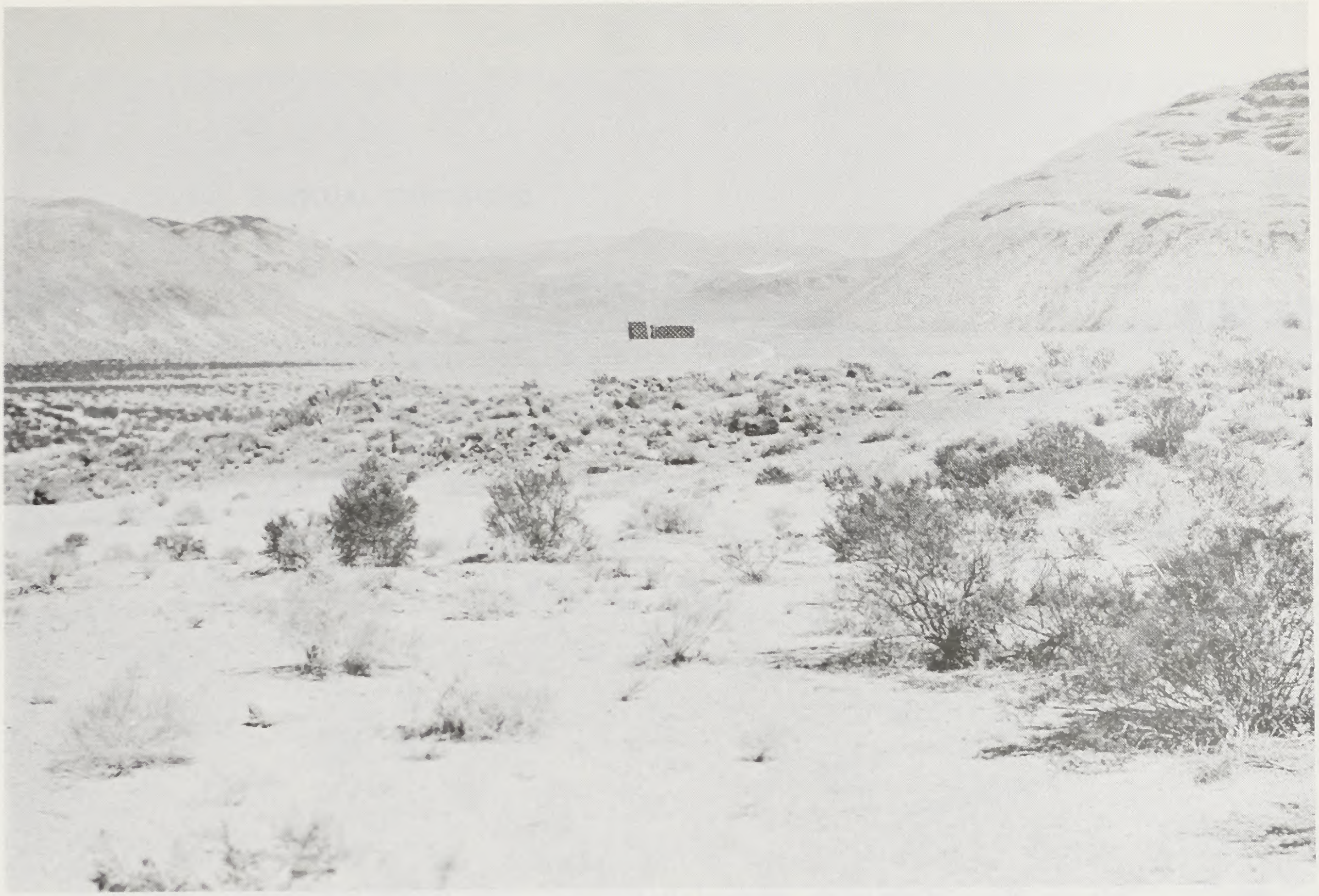


Fig. 2.9.2-4 POWER GENERATING SITE SIMULATION

VRM CLASS II REQUIREMENTS: A contrast may be seen but should not attract attention. Changes in any of the basic elements should not be evident in the characteristic landscape.

CONTRAST RATING: The contrast begins to dominate the characteristic landscape and attracts attention. The level of contrast is unacceptable.

FORM: Earthwork will be flattened and will weakly impact landform and vegetation. The massive, cubicle and horizontal structure with rounded verticals will strongly impact an area previously notable for an absence of such form.

LINE: The parabolic and rectilinear silhouette of the structure is a moderate impact with line characteristics new to the area.

COLOR: The bright grey to white of the metallic and concrete structures are moderate contrasts.

TEXTURE: Earthwork and denudation will cause the texture of landform and vegetation to be uneven. The structure will be smooth to metallic. These impacts are insignificant.

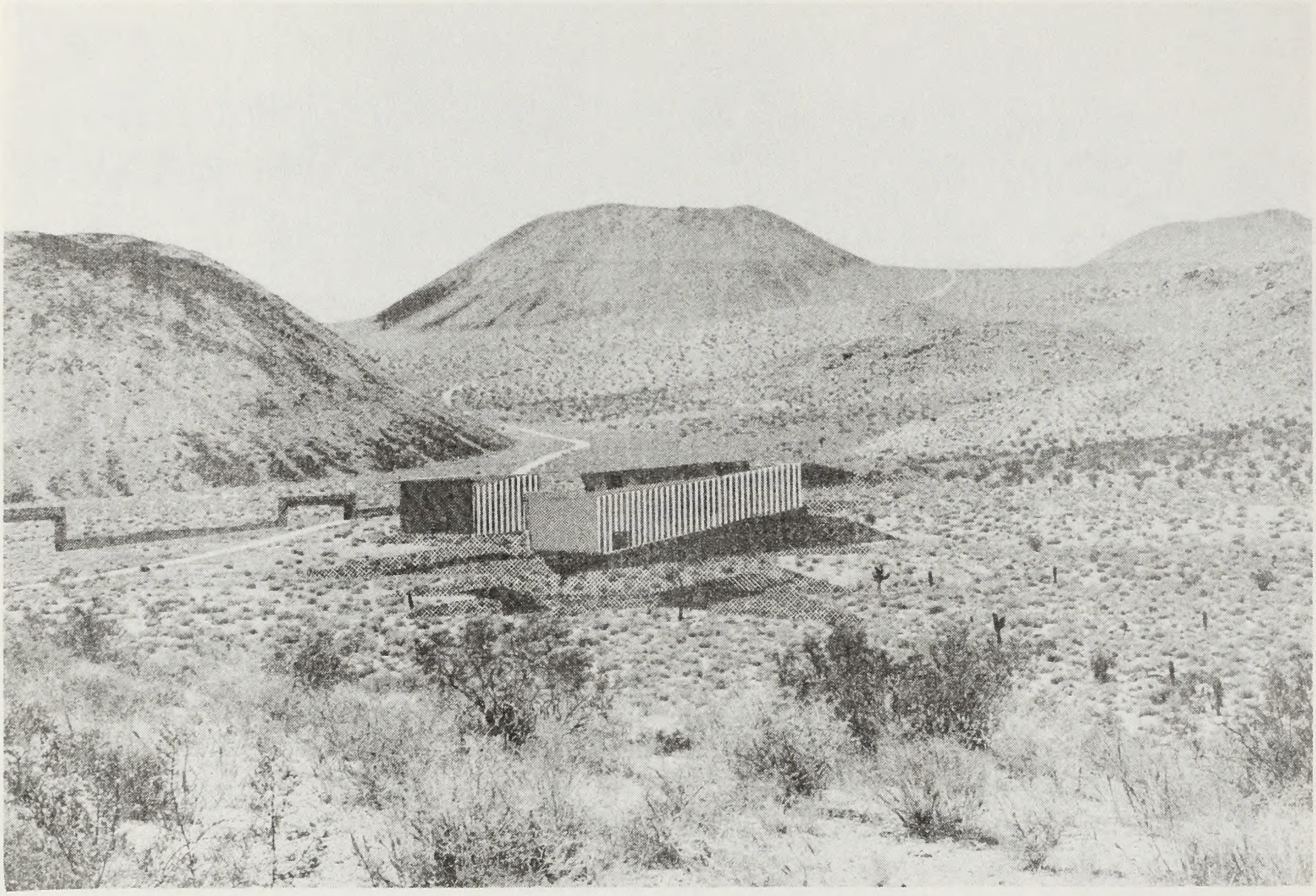


Fig. 2.9.2-5 POWER GENERATING SITE SIMULATION

VRM CLASS IV REQUIREMENTS:	Contrasts may attract attention and be a dominant feature of the landscape. The change should repeat the basic elements inherent in the characteristic landscape.
CONTRAST RATING:	The contrast will not be overlooked and demands attention. The level of contrast is acceptable.
FORM:	Landform will be flattened and mounded with moderate impacts. The long, rectilinear shell of the power plant will strongly impact the site.
LINE:	The angular, discontinuous line of earthwork on the landform and the parabolic to rectilinear line of the structure will moderately impact the site.
COLOR:	Scarification, denudation and new concrete and metal structures moderately impact the site with grey to white.
TEXTURE:	Scarification will cause landform and vegetation to be more uneven. Structure texture will be smooth and metallic.

2.10 CULTURAL RESOURCES

2.10.1 Present Cultural Resources Setting

This section summarizes what is known of the prehistory of the study area (the CGSA) and the ethnography of the peoples inhabiting the region at the time of European contact. The history of the area since 1860, when Anglo-American mining and settlement began, is briefly sketched. The methodology and results of an archaeological survey of approximately 29 percent of the CGSA are summarized, and the overall significance of the findings is discussed; a full discussion of methodology and results is presented in the Cultural Resources Technical Report.

2.10.1.1 Prehistory

Man's use of the region began during the Paleo-Indian period (or more than 10,000 years ago) when aboriginal hunters trapped and killed the now-extinct large Pleistocene mammals along lake beds and in box canyons. No direct evidence for Paleo-Indian use of the CGSA, *per se*, has been found, but evidence at nearby China Lake suggests that these wide-ranging hunters regularly traversed this area (Davis, 1975).

Evidence of human use of the CGSA vicinity has been found at Fossil Falls, at the southwestern corner of the CGSA, and may date to 10,000 years before the present (Harrington, 1952). A hunting and gathering subsistence pattern had evolved, focused on the utilization of stream and lakeshore plant resources and the hunting of large game animals. This period corresponds to what is known as the Western Lakes Pluvial Tradition, a period in which much of California and the Great Basin was characterized by lakes resulting from the run-off from glaciers, and by the generally wet climatic conditions at the end of the Pleistocene Period. These early environmental conditions provided a habitat that was very favorable in terms of human occupation.

Judging from the work of numerous researchers in this area, aboriginal use of the region appears to have been continuous from this period until the arrival of Anglo-Americans in the 19th century (e.g. Harrington, 1957; Lanning, 1963). However, the intensity of use of the area very probably changed as the environment shifted toward the arid regime now characterizing the CGSA; this aridity is emphasized by the rain shadow cast by the Sierra Nevada. Archaeological evidence from the region, in general, indicates an increasing emphasis on the exploitation of plant resources other than those associated with streams and lakeshores. Specifically, pinyon trees were of increasing importance throughout the aboriginal occupation of the area (*c.f.* Bettinger, 1976). While no pinyon forests are presently found within the CGSA, there is a possibility that these were prehistorically present. Other plant communities now found in the CGSA consist of those that were also exploited during the seasonal plant-gathering rounds of the prehistoric population; numerous bedrock grinding slicks indicate that grasses and seeds were gathered and processed in the CGSA.

While opinions of researchers vary, some believe that at some point during the prehistory of the CGSA, the Coso Range may have at some time functioned as the focus of what has been interpreted as a hunting cult, which appeared to emphasize the exploitation of bighorn sheep and which probably was at its apex between 3000 and 1000 B.C. (Grant, Baird and Pringle, 1968). During this period the bow and arrow were introduced, replacing the less accurate throwing board, or atlatl, and dart. The remnants of the hunting magic apparently associated with this cult are the numerous rock art sites, characterized by petroglyphs, or pecked designs, of bighorn sheep and hunters, covering the basalt walls of canyons. While the majority of the known rock art sites are located within the Coso Range to the east of the CGSA, the discovery of isolated petroglyphs and one canyon with considerable rock art in the distinctive Coso style within the study area indicates that portions of the project region were used for the hunting of bighorn sheep. The sites of these petroglyphs may have been sacred; that is, the locations of ceremonial activities relating to the preparation for the hunt. Grant, Baird and Pringle (ibid.) have hypothesized that the introduction of the bow and arrow increased the hunters' efficiency to the point that they over-exploited the bighorn sheep; both the herds of sheep and the hunting cult consequently died out.

Another important factor in the prehistory of the CGSA is the existence of a major obsidian source at Sugarloaf Mountain. Obsidian was the primary (and preferred) material for aboriginal stone tools made in this general region. The obsidian from this location was used in the manufacture of all types of stone tools and implements by various aboriginal groups. Studies on the existence of Coso obsidian in neighboring areas such as Rose Spring and Little Lake indicate that it appears to have been utilized throughout the prehistory of the region, though it is not known at what point this natural resource was first used (Clewlow et al., 1970). Evidently the resource was not claimed exclusively by the immediate inhabitants of the CGSA; rather, the area seems to have been regarded as a "free zone," where peoples from other areas could mine the obsidian as needed. This contributed to an unusual amount of prehistoric traffic into the area. One pictograph (or painted rock art site) within the CGSA appears, on the basis of artistic style, to have been painted by a group from another region. It can be hypothesized that this ceremonial spot, with an associated camp, represents the remains of regular visits to the Coso area by Indians from other areas for the express purpose of exploiting the obsidian resource at Sugarloaf Mountain.

2.10.1.2 Ethnography

The ethnographic period is that period, after the arrival of white settlers, during which the aboriginal inhabitants followed, to some degree, their traditional lifeways. The general region of the CGSA and Owens Valley was studied by the anthropologist Julian Steward (1933; 1938), who provided valuable insights into the ethnographic period. (It should be noted, however, that more than 70 years of Anglo-American contact had substantially influenced and altered traditional lifeways prior to his study.) Steward stated that the study area was inhabited by the Koso or Panamint Shoshone-speaking peoples. Some portions of the CGSA were within the Kuhwiji district, a large subsistence area. That is, finding the resources needed for the inhabitants' subsistence required that they move seasonally throughout a large area which may have included Saline Valley, Owens Lake, the Sierra Nevada and even Death Valley. The vicinity of the CGSA was a unit within that area which was used during the periods of the year when its resources were most abundant; for example, rabbits in winter, and the greens at Haiwee Spring in April. Steward indicates that four major villages were located in the Coso region: at Little Lake, Coso Hot Springs, Cold Springs (five miles south of Darwin), and Olancha (Steward, 1938).

In addition to the use of the CGSA for habitation (at Coso Hot Springs and Little Lake), for ceremonial activities (at rock art sites), for obsidian quarrying (Sugarloaf Mountain) and other seasonal hunting and gathering activities, Coso Hot Springs was apparently the site of aboriginal medicinal and ceremonial rituals at the time of the arrival of white inhabitants in the area. The religious use of the Coso Hot Springs by local Native Americans has continued to the present; the background and significance of this site have been outlined by Theodoratus and Smith-Madsen (1977a). See also Section 2.12 of this EIS.

To summarize the aboriginal prehistory and history of this area, then, it can be stated that the CGSA is characterized by a basic archaeological record analogous to that found throughout the Great Basin. That is, there is evidence of a continuous but changing aboriginal habitation and utilization of the region starting at least by 10,000 B.C. and continuing into the historic period. However, natural and cultural factors within the CGSA, specifically, combine to produce unique archaeological conditions. Sugarloaf Mountain, a major source of obsidian, may have been the impetus for obsidian quarrying and appears to have resulted in an unusual intensity of activity and trade in the area. The discovery of rock art sites within the CGSA indicates the probable existence of hunting cults and ceremonial spots. Finally, it is conjectured that Coso Hot Springs was known and utilized as a medicinal and ceremonial focus for the aboriginal inhabitants of the region (Theodoratus and Smith-Madsen, 1977).

2.10.1.3 Historic Period

The Anglo-American exploitation of the area did not begin until 1860 when Dr. Darwin French made the first major mining discovery in the Coso Mountains. Prior to this time, European interest in the area had been limited largely to occasional penetrations by trappers, prospectors and settlers. Gold and silver mining activities were concentrated around Coso Village, 11 miles northeast of Coso Hot Springs, during the 1860s. When these ore bodies were depleted, the mining focus shifted to other locales, although mining continued at a reduced level into the 20th Century. During World War I sulfur was mined in the Devils' Kitchen area and cinnabar mining began in the 1920s. Some mining continues today within the CGSA, but outside the Naval Weapons Center.

The commercial development of the Coso Hot Springs has been the subject of considerable research and has been reported on by the Iroquois Research Institute (NWC Ad Pub 200, 1979). The area of the main springs was patented in 1905, but development of the resort did not begin until circa 1909 (ibid.). The use of the area continued, with minimal commercial success, until the acquisition of the property by the Navy in 1943. The site is now listed in the National Register of Historic Places and includes historic, prehistoric and present Native American values. Native American concerns regarding the development of the geothermal resource of the CGSA are discussed in Sections 2.12.1.13 and 2.12.2.12.

2.10.1.4 Cultural Resources Inventory

A cultural resources inventory of the CGSA was performed in the winter of 1978-1979. For the first stage of the survey, approximately 10 percent of the CGSA was inspected using stratified random sampling (see Glossary). For this purpose, the CGSA was divided into five areas of approximately equal size. Ten sample units, each, were randomly chosen in three of these areas and all major environmental areas were assured of being sampled. Environmental strata within the CGSA were identifed as terraces, valleys, playa lakes (see Glossary), mountain areas with intermittent stream courses (identified by observation and from USGS 15-minute topographic maps) and mountain areas without such observable stream courses. The 50 sample units consisted of squares 1/2 mile by 1/2 mile (1/4 square mile in area). Six four-person crews were used. Each unit was visually inspected by walking a series of transects across the unit, with crew members spaced 20 to 30 meters apart, in accordance with BLM inventory standards.

At the conclusion of the first sampling stage, results were tabulated and the sample units for the second stage were apportioned. In this stage emphasis was placed on Geothermal strata 1 and 2; in addition all remaining units in the terrace and playa lake environmental strata were sampled, as well as several within the noncompetitive lease area. The remaining units required for a 25 percent sample were distributed within mountain areas containing stream courses. Since time permitted, and it was felt more balanced sampling could result, additional units in eastern Rose Valley were also sampled. Slightly more than 15 percent of the CGSA was sampled in the second stage; the total for both stages was approximately 29 percent. In both stages, if a site was encountered by a team while walking across terrain not selected for sampling, or if a site extended beyond the boundaries of a selected sample unit, such site boundaries were determined and recorded to the extent possible.

Table 2.10.1-1 summarizes the results of both stages of the survey, indicating the number of sites of each type found per environmental stratum (see also Figures 2.10.1-1 and 2.10.1-2). These site types are identified in standard BLM usage as shown below:

Archeological Site Types

Lithic Scatter-A site usually consisting of flakes, cores, (see Glossary) utilized flakes and flaked stone tools; other cultural material is absent. Study findings were classified as large scatters (greater than 50 m^2), small (less than 50 m^2), heavy or high-density (more than 30 flakes or flaked stone tools/10 m^2), and light or low-density (less than 30/ 10 m^2).

Quarry-A site where lithic material has been extracted from a seam, vein or outcrop. The by-products of tool manufacture, including flakes, cores and unfinished tools, are found at quarries.

Cemetery-A location where evidence of human interment is found.

Rock Alignment-Lines or more complex arrangements of cobbles and boulders, sometimes representing hunting blinds.

Petroglyph-A site consisting of pecked figures and/or designs on a boulder, rock outcrop, or shelter wall.

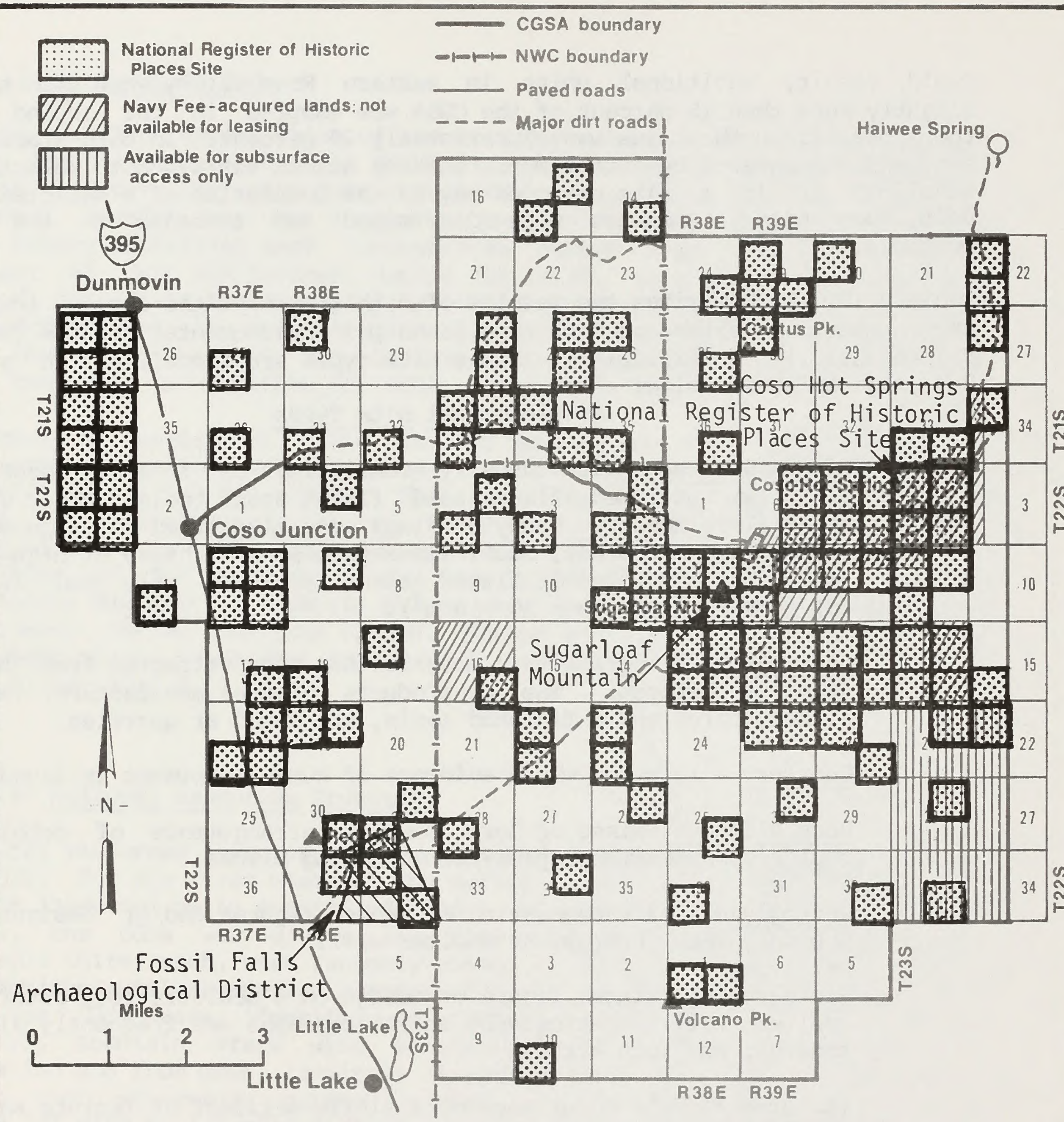
Pictograph-A painted figure or design on a boulder, rock outcrop, or shelter wall; petroglyphs and pictographs are frequently discussed together as "rock art".

Isolated Find-An occurrence of a single artifact or feature which is not included in another site type.

Cairn-A mound of cobbles or boulders that appears to have cultural significance.

Milling Station-A site indicating the procurement and/or processing of seeds and other food items; portable milling tools and/or bedrock milling features may be present.

Temporary Camp-A site that was occupied for a short period of time by a few people. Such an occupation could occur periodically over several hundred years.



Units (½ mi. x ½ mi.; ¼ square mile in area) sampled in both Stages 1 and 2 of the Cultural Resources Inventory. See Figure 2.10.1-2 for distribution of all possible sample units by environmental stratum.

Figure 2.10.1-1. DISTRIBUTION OF CULTURAL RESOURCE INVENTORY UNITS ACTUALLY SAMPLED WITHIN CGSA

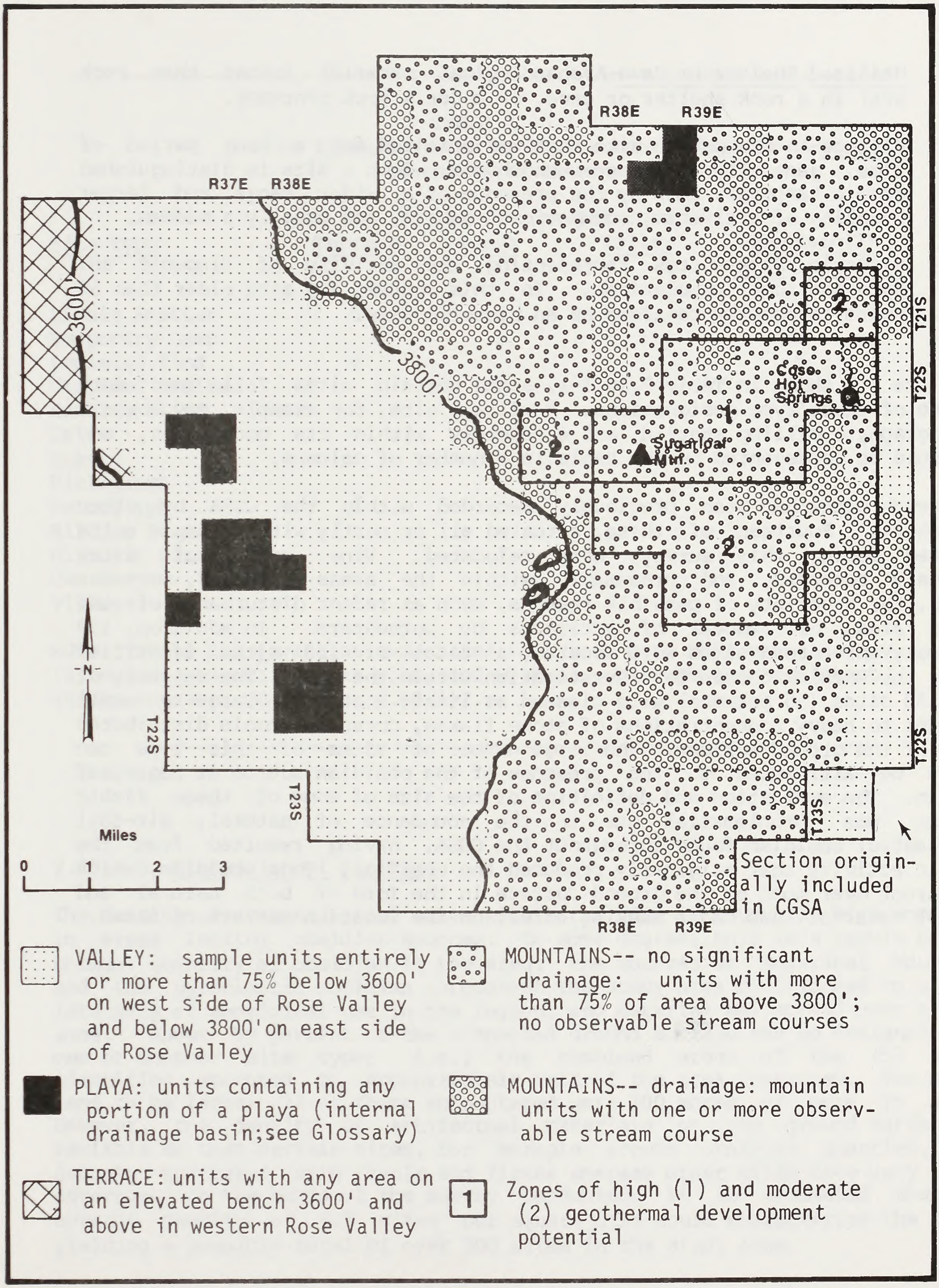


Figure 2.10.1-2. DISTRIBUTION OF ALL POSSIBLE CULTURAL RESOURCE INVENTORY SAMPLE UNITS BY ENVIRONMENTAL ZONE

Utilized Shelter or Cave-Archaeological material (other than rock art) in a rock shelter or cave, or under a rock overhang.

Village-An occupation site that was utilized for a long period of time, generally on a year-round basis. Such a site is distinguished from a temporary camp by the presence of a wider range and larger quantity of artifacts, occupational debris, and usually a midden.

Historic Sites-Sites representing the activity of Hispanic and Euro-American populations. In this context any site older than 50 years is usually regarded as an historic site.

Totals are not shown in Table 2.10.1-1, since certain sites fall into more than one of these type designations. A village site, for example, may contain a pictograph, a milling station, and a cemetery within its boundaries, and thus would be represented on the table in a number of columns.

Fifty-seven sites had been previously recorded within the CGSA by other researchers. Fourteen of these, situated all or partly within sample units inspected during this survey, were relocated. Nine additional sites previously recorded, and presumably within the areas surveyed, were not located, for a variety of possible reasons, such as recent disturbance of the surface area, or removal of artifacts by pothunters. In addition, 139 previously unrecorded sites were located, a total of 153 sites identified within the samples chosen for investigation within the CGSA. The majority of these 153 sites (55 percent) were classed as lithic scatters: large to small and light to heavy concentrations of stone flakes, cores and tools distributed on top of the ground surface. The large number of sites of this type can largely be attributed to the presence of the obsidian source at Sugarloaf Mountain. The evaluation and definition of the size of some of these lithic scatters was problematial due to the abundance of natural, air-fall (pyroclastic) obsidian found throughout the CGSA, having resulted from the volcanic activity that originally produced the obsidian. This obsidian, which is apparent over much of the ground surface in the form of both natural and cultural material, has had a masking effect on the location pattern of sites.

TABLE 2.10.1-1
Site Types/Features by Environmental Stratum
(Both Stages Combined)

Site Type	Terrace	Playa	Valley	Mountain(2)
	Environmental Stratum			
Lithic Scatter	5	11	13	55
Temporary Camp		5	5	26
Isolated Find	4			6
Utilized Shelter		3		2
Hunting Blind				2
Cairn			1	1
Quarry			1	1
Pictograph				1
Petroglyph	1			2
Milling Station				1
Historic Site		1		7
Cemetery	1			1
Village	1			2

NOTE: Totals not given, as some sites fall into more than one category.
(2)Includes mountain units with, and without, observable intermittent stream courses; see Figure 2.10.1-2.

2.10.1.5 Discussion of Findings

The density of archaeological sites within the CGSA is unusually high compared to areas lacking obsidian sources. To some degree, this is a result of the unusual quantity of obsidian in the area: the sources at Sugarloaf Mountain and the pyroclastic obsidian throughout the study area contributed to a high intensity of aboriginal use in the region, and material was spread over a wide zone. About 50 percent of the inspected ground surface can be designated as one or another site type; i.e., the combined areas of the 153 sites identified amounted to approximately half of the area inspected. The sites tend to be large; 23 of those encountered were 100 acres or more in size. However, the density of artifactual materials on the ground surface is variable so that certain sites, for example around obsidian quarries, are densely scattered with tools and flakes whereas other sites have very light coverage. On the basis of the survey conducted, it is estimated that an average density of 4.5 sites per square mile would characterize the CGSA, yielding a possible total of over 500 sites in the study area.

However, a walk-over survey of even 29 percent of the CGSA does not provide sufficient data to fully evaluate all known cultural resource sites within this unique area in terms of the National Register of Historic Places; therefore, further site-specific studies will be required.

It is not possible to provide a complete discussion of each site type here. However, one site type is of particular significance. Four rock art sites have been identified within the CGSA: three of these are petroglyph (carved or pecked) sites and one is a pictograph (painted) site. It has been noted that these sites are possibly the remains of aboriginal ceremonial activities (see also Heizer and Clewlow, 1973). In this sense they can be seen as significant, in terms of religious values, to Native Americans. As cultural resources they have also an important scientific value: rock art sites are thought to be related to prehistoric belief systems (ibid). They have an artistic value beyond the above considerations. The significance of rock art sites in the Coso Range east of CGSA has been recognized on a national level by their designation as National Historic Landmarks. The Coso Hot Springs and Prayer site, within the CGSA, have similarly been included on the National Register of Historic Places (see Glossary). With the exception of the historic remains at Coso Hot Springs, which are a part of the existing National Register site, the historic resources encountered during the survey are sparse and generally lacking in integrity and potential data yield.

The potential scientific value of the findings within the CGSA--as a whole and individually--is believed to be very high. For this reason, the eligibility of all or large portions of the area itself for inclusion in the National Register of Historic Places will be considered. (See Section 3.9 for further discussion.)

A determination of National Register eligibility, and an eventual discontiguous district nomination, would allow the greatest flexibility for future planning, development and scientific investigation. A discontiguous district nomination is similar to a district nomination. However, a discontiguous district comprises individual sites that collectively meet the National Register eligibility criteria (36 CFR 60.6); this type of nomination limits the National Register status to specific geographic loci (i.e., cultural resource sites), rather than designating large geographic zones which may include areas that are devoid of significant sites. Thus, a discontiguous district will provide National Register status to the cultural resource sites and yet not be restrictive of geothermal development beyond the perimeters of those significant sites.

The study area as a whole, with its wide range of sites, long span of aboriginal occupation, and unique resource at Sugarloaf Mountain, has a potential for the investigation of a number of research questions which may be related to broader, regional problems in archaeology. For example, the CGSA can be considered part of two culture areas: Great Basin and California. This area has influenced, and been influenced by, the culture of the Kern River area, the Central Valley and possibly the coast. Thus, the CGSA is an area of contact of several major cultures and has provided a long-used corridor for the movement of people, trade goods and ideas among these areas (cf. Meighan, 1978). A detailed analysis of the archaeology within the CGSA could have implications for the interpretation of the archaeological record in these other areas as well. While all the identified sites are potentially significant as a whole, at least 10 sites, in addition to the Fossil Falls Archaeological District, are believed to have particular scientific value. These are listed below and further discussed in Chapter 3: DA-253, DA-273, DA-340, DA-313, DA-316, DA-373, DA-375, DA-268, DA-380, and DA-381.

In summary, the prehistoric cultural resources of the CGSA are considered worthy of protection and considerable further study for a number of reasons: the high density of archaeological remains in the areas examined; the long span of human occupancy and wide range of site types, including rock art; the generally high integrity of those remains within the NWC withdrawal, which has to a large extent protected them; and the presence of two unique resources which have been conducive to cultural contact between several major prehistoric cultures: the Coso Hot Springs and the major obsidian source (Lanning, 1963; Meighan, 1978).

2.10.2 Impacts of the Proposed Action on Cultural Resources

2.10.2.1 Introduction

The eligibility of the cultural resources of the CGSA for inclusion in the National Register of Historic Places is expected to be determined in consultation with the State Historic Preservation Office (SHPO). (In and of itself, inclusion in the National Register is not a mitigation measure. It does, however, provide a mechanism for developing and implementing such measures, as discussed in Chapter 3 of this EIS.)

A number of recent legislative acts, Presidential directives, and implementing regulations have been designed to protect the nation's cultural resources. These include the National Historic Preservation Act of 1966, Executive Order 11593 of 1971 on Protection and Enhancement of the Cultural Environment, the American Indian Religious Freedom Act of 1978, and portions of the Code of Federal Regulations pertaining to the National Register of Historic Places. Other legislation relevant to geothermal development contains specific clauses relating to protection of cultural resources. A brief description of the most relevant of these laws and regulations can be found in Appendix A. A Memorandum of Agreement (MOA) between the SHPO, the National Advisory Council on Historic Preservation and NWC has been executed by the SHPO and NWC and approved by the National Advisory Council in December of 1979. This MOA addresses management of the existing National Register sites in the study area in compliance with 36 CFR, Chapter VIII, Part 800, as revised in 1978.

A Memorandum of Agreement between USGS and BLM, on cooperative procedures for protection of cultural resources related to geothermal lease operations, was also signed in June 1978 (WO 105); the text of this is included in Appendix C. In brief, this Agreement and subsequent memoranda provide that BLM shall make lease stipulations, which USGS shall enforce, (1) identifying and protecting known cultural resources on all geothermal leases, (2) requiring cultural resource surveys in accordance with BLM standards, and (3) in general providing for avoidance or necessary mitigation.

In addition, a "Memorandum of Understanding Pertaining to Bureau of Land Management, California, Policy for Native American Concerns and Cultural Resource Management" was executed on March 4, 1980 among the Bureau of Land Management, Native American Heritage Commission, and the State Historic Preservation Officer. That document ensures that Native American concerns are considered in all proposed Bureau actions where Native American conflicts can be discerned as a result of project implementation (see SHPO's letter dated May 13, 1980 in Chapter 8).

All of the measures discussed above will be implemented as part of the proposed action. However, even with careful planning of geothermal development to avoid disturbance of cultural resources, there is potential for significant impact because of the high density of archaeological material in the CGSA. Site density is, in fact, so high that severe restriction of the proposed geothermal development might result if all archaeological material were to be avoided. It is expected that an average site density of 4.5 sites per square mile would be found throughout the CGSA, providing a possible total of over 500 sites within the study area as a whole.

While an average site size can be estimated, the figure is not as meaningful as one might wish. Within the 138 sample units (a total of 34.5 square miles examined), 153 sites were identified. It is estimated that these sites cover approximately one-half of the area inspected, or a total of 17.25 square miles. Average site size would thus be approximately 72 acres. However, site boundaries have not been tested. Furthermore, individual cultural manifestations range from isolated finds (e.g., single projectile points) to sites with an areal extent of over 600 acres; it would appear that 23 sites are 100 acres or more in size.

Within Geothermal Zone 1, there are four such sites, one exceeding 600 acres. One extremely high sensitivity area, the Coso Hot Springs National Register Site and Prayer Site, is found within this zone. The Coso Hot Springs area and the Prayer Site (see Figure 2.10.2-1) are both already on the National Register, and the surface of these sites will not be impacted by either the NWC geothermal development or the proposed action because of protection by NWC policy. In addition, no archaeological impact is expected at the Prayer Site, since cultural remains there are sparse, randomly scattered surface lithic materials which are not likely to attract pothunters. Its listing on the Register is due to socio-religious attributes rather than archaeological remains. As a prayer site, however, it may be impacted as discussed in Section 2.3, 2.11, and 2.12. The area has special significance for Native

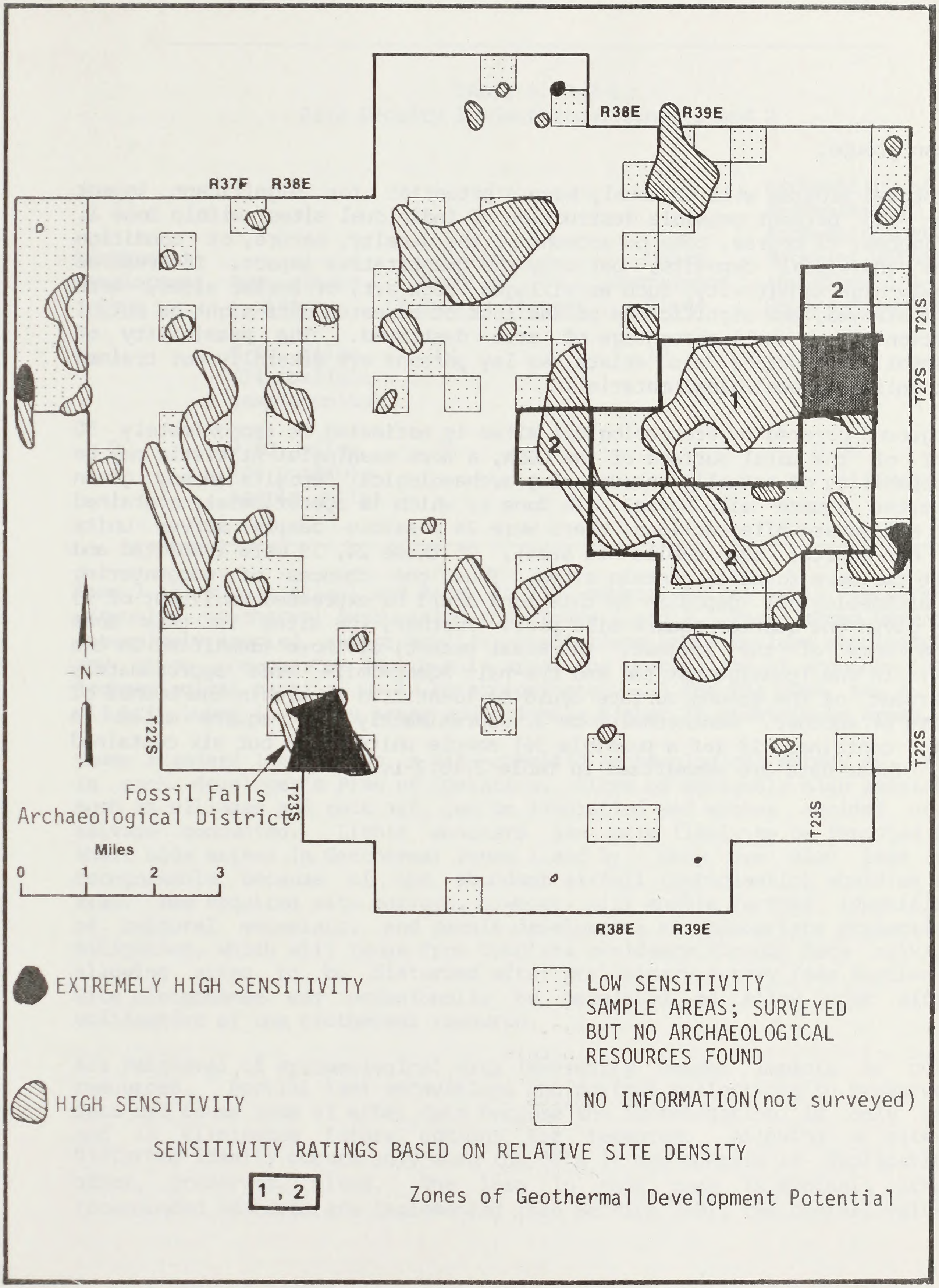


Figure 2.10.2-1. AREAS OF ARCHAEOLOGICAL SENSITIVITY

American groups.

The proposed program will obviously have a potential for significant impact (up to 100 percent possible destruction of individual sites) within Zone 1. Such figures, of course, take no account of the density, nature, or condition of the individual deposits, but only the quantitative impact. If areas of extremely high sensitivity, such as villages, rock art, or burial sites, were to be destroyed, the significance of the loss of research data might be out of proportion to the small percentage of area destroyed. The possibility of accidental destruction also exists, as lay persons are generally not trained to recognize archaeological material.

While ground covered by archaeological sites is estimated at approximately 50 percent of the total surface of the CGSA, a more meaningful statistic may be the probability of actually encountering archaeological deposits in any given one-quarter square mile area. In Zone 1, which is approximately contained within six square mile sections, there were 24 possible sample survey units (each one-quarter square-mile in area). Of these 24, 19 were inspected and all but two were found to contain sites. Thus, the chances of encountering some archaeological deposits in this zone could be expressed as 17 out of 19 in any given one-quarter square mile plot. Further, the sites in this zone include some of the largest, in areal extent, of those identified in the survey; in one (contiguous) two and one-half square mile area approximately 85 percent of the ground surface could be identified as within the bounds of one site or another. Geothermal Zone 2, approximately nine square miles in extent, contained 28 (of a possible 36) sample units; all but six contained sites. These data are summarized in Table 2.10.2-1.

TABLE 2.10.2-1
Site Density in Geothermal Zones 1 and 2

Geothermal Development Zone	Approximate Area	Units Sampled (2-Survey Stages)	Units Containing Sites	Probability of Encountering Archaeological Material Within Any Given 1/4-Square-Mile Area
1	6 sq. miles (24 possible sample units)	19	17	0.89
2	9 sq. miles (36 possible sample units)	28	22	0.79

Zone 3 (31 square miles) and Zone 4 (30 square miles) will require more extensive geothermal exploration than Zones 1 and 2. These zones were not as intensively sampled, and probability predictions would be less meaningful. On any given one-quarter square-mile area, the probability of encountering some archaeological material would be approximately .75 for the CGSA as a whole, slightly lower in valley areas and slightly higher in mountainous areas.

Under standard lease terms, a site-specific archaeological survey is required in each developer's Plan of Operation. Sites of obviously high sensitivity, such as villages and rock art, can be identified and either avoided or data salvage conducted. Lithic scatters are more likely to be impacted due to their wide extent in Geothermal Zones 1 and 2; they are also less easily recognizable because of the abundant airfall (pyroclastic) obsidian in the area. The required site surveys, however, will enable further identification of cultural materials, and permit development of appropriate protection and mitigation, which will range from complete avoidance through data salvage to allowing sites to be disturbed after preliminary survey (see Section 4.9). Site disturbance may occasionally be permitted to allow most efficient utilization of the geothermal resource.

All retrieval of archaeological data inherently causes impacts to cultural resources. Partial test excavations and surface collections to preserve some data can cause loss of other data because the investigation is only partial and it eliminates future options for research. Allowing a site to be disturbed ideally occurs only when the data it may contain is duplicative of other, preserved, sites. The loss in this case is minimal. After all recommended measures are implemented (see Section 3.9), the overall value and unique character of the CGSA cultural resources will be largely unimpaired.

The possible "worst-case" impacts discussed in the following paragraphs should be considered in the context of the above. These impacts will be greatly lessened by the mandated measures discussed, and can be further mitigated by the plan proposed in Chapter 3. In general, these impacts are not likely to occur because of the regulations and lease terms. Their potential seriousness, however, and the resulting loss of data should such impacts occur, must be considered for the purpose of formulating all additional feasible mitigation. In this analysis, emphasis was placed on Geothermal Zones 1 and 2.

2.10.2.2 Preliminary Exploration

Minimal exploratory operations are anticipated for Geothermal Zone 1 prior to drilling; it is assumed that impacts from NWC exploration would have already occurred. Impact would nonetheless result if surface disturbance at a locus of archaeological material removes, displaces or damages that material in proportion to the size of the area disturbed. The extremely high probability (.89) of finding archaeological material in this zone of high geothermal potential could be very restrictive of geothermal exploration if all sites were to be avoided. Zones 2, 3, and 4 are predicted to contain lower densities of archaeological material. Strong pressures could be anticipated from lessees to allow exploration in areas originally proposed if suitable nearby development areas cannot be found.

Gravity and magnetic measurements would not impact archaeological sites if these measurements are taken from aircraft. Impacts to cultural resources would result from off-road vehicle traffic which may occur in connection with measurements of micro-seismicity, and resistivity and magnetic measurements. If a site is located entirely on the surface, as many of the sites appear to be, a large proportion of potential archaeological data may be lost as a result of driving or walking over archaeological remains. If the site includes a subsurface deposit, that portion of the data below the surface may remain undisturbed; hence, the proportion of total data loss would be smaller.

Drilling of holes for temperature gradient measurements in archaeological sites would destroy any surface and subsurface material where the hole is drilled. (No drill pad, however, is required for heat flow measurements unless the ground is steep.) A small, dense lithic scatter could suffer virtual obliteration from such surface disturbance. A larger scatter would obviously experience proportionately less disturbance. In a dense scatter, 100 acres or more in area (several of which occur near Sugarloaf Mountain), the extent of impact from one acre of surface disturbance could be characterized as less than one percent; the significance of the impact would depend on such factors as the density and character of the deposit. Disturbance of an extensive lithic scatter might be confined to an area of light coverage where the scientific value of the findings could be slight in comparison with the value of a particular petroglyph site or village.

2.10.2.3 Exploratory Drilling

The types of surface/subsurface disturbance described for the Preliminary Exploration phase would be magnified in this phase. Access road construction would impact archaeological sites by disturbing both surface and shallow subsurface deposits. Sites adjacent to the route would be disturbed by grading and off-road parking of road construction equipment. New road construction would disturb from 1.7 acres to three acres for each mile of such road (see Chapter 1). An access road constructed through an archaeological site consisting of a surface and shallow subsurface deposit would disturb a small percent of a large lithic scatter but could destroy a very small site. The placement of gravel or cinder on the surface of the road would impact remaining subsurface archaeological deposits slightly by impeding access to the deposits in the future.

Drill site preparation would impact sites by clearing and leveling the land, which would remove both surface and subsurface archaeological deposits. Each drill pad would average 150' x 500' in area, but surface disturbance from pad preparation could amount to much more than this in rough terrain, because of increased cut and fill. The excavation of sumps and reserve pits approximately 150' by 150' and 10 feet deep would further impact archaeological deposits. One hundred percent of a small archaeological site at the locus of excavation could be destroyed. As it is unlikely that an archaeological site in this area extends more than 10 feet below the surface, the excavation of a pit 10 feet deep would probably completely destroy any subsurface archaeological deposit encountered.

Drilling would impact whatever subsurface deposits remain after the leveling of the drill site. If the impact of site preparation has been major, resulting in the total or almost total destruction of the archaeological deposit, then the additional impact of well drilling would be considerably less.

Disposal of waste may impact cultural resources through breaching of sumps. Movement of heavy vehicles to dump or collect other waste in the waste sump may result in the accidental disturbance of adjacent archaeological deposits.

Extensive exploratory drilling prior to production in Zone 1 may not be necessary; more would be expected in Zone 2. In the event that a total of four well pads, eight sumps, four reserve pits, two reinjection wells and one mile of 13.8'-wide maintenance road were required in Zone 1 prior to production, a surface disturbance of at least 18 acres would result; this does not allow for extensive grading due to steep terrain, or for accidental spillage and clean-up. It is expected that approximately 16 of the 18 acres (89 percent) would contain sites or portions of sites, and that these could be impacted, depending on the mitigation measures used.

2.10.2.4 Field Development

Field development would have the most areal-extensive impact on archaeological sites; six well pads per 50-MW plant, together with sumps, etc. would be required. The length of operations and increased waste production will increase the probability of accidentally depositing waste on archaeological sites. The nature of the impacts, however, should be the same as that described for the exploratory drilling phase.

2.10.2.5 Resources Utilization

Some additional impacts to archaeological materials would occur during the operational phase of the program (within a given lease) as a result of the drilling of replacement wells; these impacts would be similar to those described for exploration drilling. In general, however, this phase of development would have less impact on archaeological resources than the preceding phases.

2.10.2.6 Closeout

Abandonment of wells would not impact archaeological resources. Restoration of the area, depending on how it is accomplished, may impact archaeological sites. For example, refilling of sumps and reserve pits, if accomplished by cutting other areas, could have archaeological impact in the area of excavation. If berms are bulldozed to their original grade and this material is used to fill sumps, any deposits contained in the berm would have already been disturbed, and additional data loss would probably be minimal. However, any surface, or shallow subsurface, materials at the original grade would be disturbed when the overburden is removed. Breaching of sumps, which could occur any time from exploratory drilling to closeout, could cause additional surface disturbance from the use of emergency vehicles.

2.10.2.7 Other Impacts

The presence of numbers of workers, engineers and scientists in the CGSA is predicted to impact archaeological sites through an increase in amateur collecting and excavation, and possible vandalism of rock art sites. During the past 30 years since the NWC has restricted access to the area, pothunting has been largely limited to sites outside NWC boundaries. Thanks to NWC policy and monitoring by volunteer escorts, vistors have had access only to narrowly circumscribed areas, and vandalism has been minimized. Even so, due to publicity and heavy vistor traffic, the rock art sites of Little Petroglyph Canyon have been somewhat vandalized, and many of the sites encountered in the survey showed the effects of pothunting. It is difficult to predict the amount of increase in the levels of amateur collecting or vandalism that could result from geothermal development. Little increase would be anticipated during initial exploration when employee numbers would be low. During full field development, it is estimated that increased pothunting would take a toll on the area's cultural resources. However, NWC policy would not permit entry of employees except during regular work shifts, again partly protecting resources in the NWC area. Additional protective measures are discussed in Chapter 3.

2.10.2.8 Summary of Impacts

Of the total of 2,260 acres disturbed in the course of full development (BLM leasing plus NWC), approximately 40 percent or 900 acres (five of the 11 plants and a smaller proportion of the total wells) would probably lie within Zones 1 and 2, an area of 15 square miles. It could be assumed conservatively that 450 acres of this disturbed surface area would constitute archaeological sites. The estimate of disturbed area in these two zones may also be conservative; it could be significantly greater due to the steepness of the terrain.

Given the extremely-high-sensitivity area within Zone 1, the severe topographic conditions (which may constrain plant locations), the relatively small size of this zone (six square miles), and the probable concentration of geothermal development there, the likelihood of impacting archaeological sites in Zone 1 is considered very high. For example, at least one section (640 acres) is required for one 50-MW plant and ancillary facilities, although only a small proportion (71 acres) of land disturbance would occur within that section. The survey data indicated that there is no complete section of 640 acres in Zone 1 without a known cultural resource site. It is clear from reference to the cultural resources site map (on file at the BLM Bakersfield office) that within Zone 1 there is no surface area of one square mile (regardless of section boundaries) without identified archaeological material, and that there are only one or two relatively flat areas of any extent outside of the National Register of Historic Places site. Thus, extreme care would have to be taken to avoid impact to cultural resources in Zone 1.

A few assumptions can be made regarding the placement of facilities; for example, it is conceivable that wellheads or pads might be located on top of rhyolite domes, though not sumps, reserve pits or power plants. However, it is not safe to assume that such locations would be without archaeological sites; in fact, several quarry sites are found on rhyolite domes.

In summary, the prediction is that approximately half of the surface of the CGSA (total 72,640 acres) contains cultural materials. If 2,260 acres were to be disturbed by geothermal development, total disturbed area would equal 3.1 percent of the total area, one-half of which (1.5 percent of the total) could be expected to contain archaeological/historical material. Put another way, half of the disturbed 2,260 acres, or 1,130 acres, could be covered with sites; the total disturbed area would constitute 3.1 percent of the predicted cultural resources in the CGSA.

In a worst possible case (however, statistically and administratively improbable), if every one of the 2,260 disturbed acres were found to be covered with sites, 6.2 percent of the cultural resources within the CGSA would be disturbed and destroyed.

Despite the NWC withdrawal, which has protected parts of the CGSA to a great extent, some pothunting has already taken place; and vandalism has been a significant problem within the region as a whole. However, the extent, variety, and overall condition of the CGSA's cultural resources (together with other known sites within the vicinity such as Petroglyph Canyon) are such as to present extremely valuable data for research into regional archaeological questions.

2.11 LAND USE

2.11.1 Present Land Use Setting

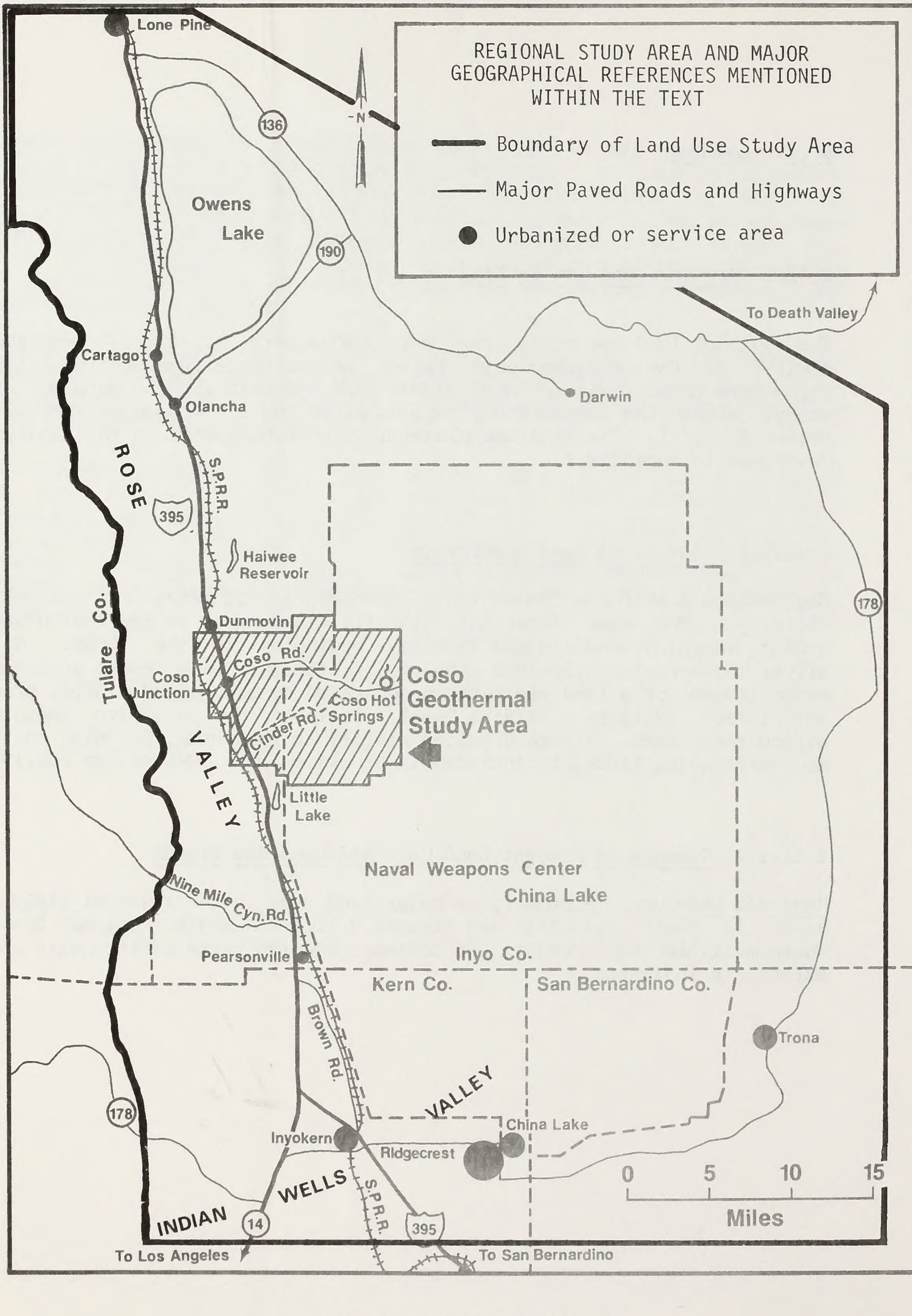
The regional land use study area, some 3250 square miles, is geographically similar to the socioeconomic region of influence (see Section 2.12). The China Lake Complex was included as one land use unit for the purpose of this study. Within the larger study region, attention is focused on the CGSA; see Figure 2.11.1-1. The land use classification scheme used in this analysis is described in Appendix F.

2.11.1.1 Historical Land Use Trends

See Section 2.10 for a discussion of prehistoric occupancy of the CGSA and vicinity. The most important historic land uses in the region have been mining, ranching, and limited farming, beginning in the 1860s. Gold and silver discoveries provided the major impetus to economic growth and the establishment of a land use pattern dominated by mining and mineral processing activities (Miller, 1976; 9-11), followed by extensive ranching and agricultural uses. A more detailed history of land uses, focusing on the CGSA and surrounding lands, is included in Brooks et al. (NWC Ad Pub 200,1979).

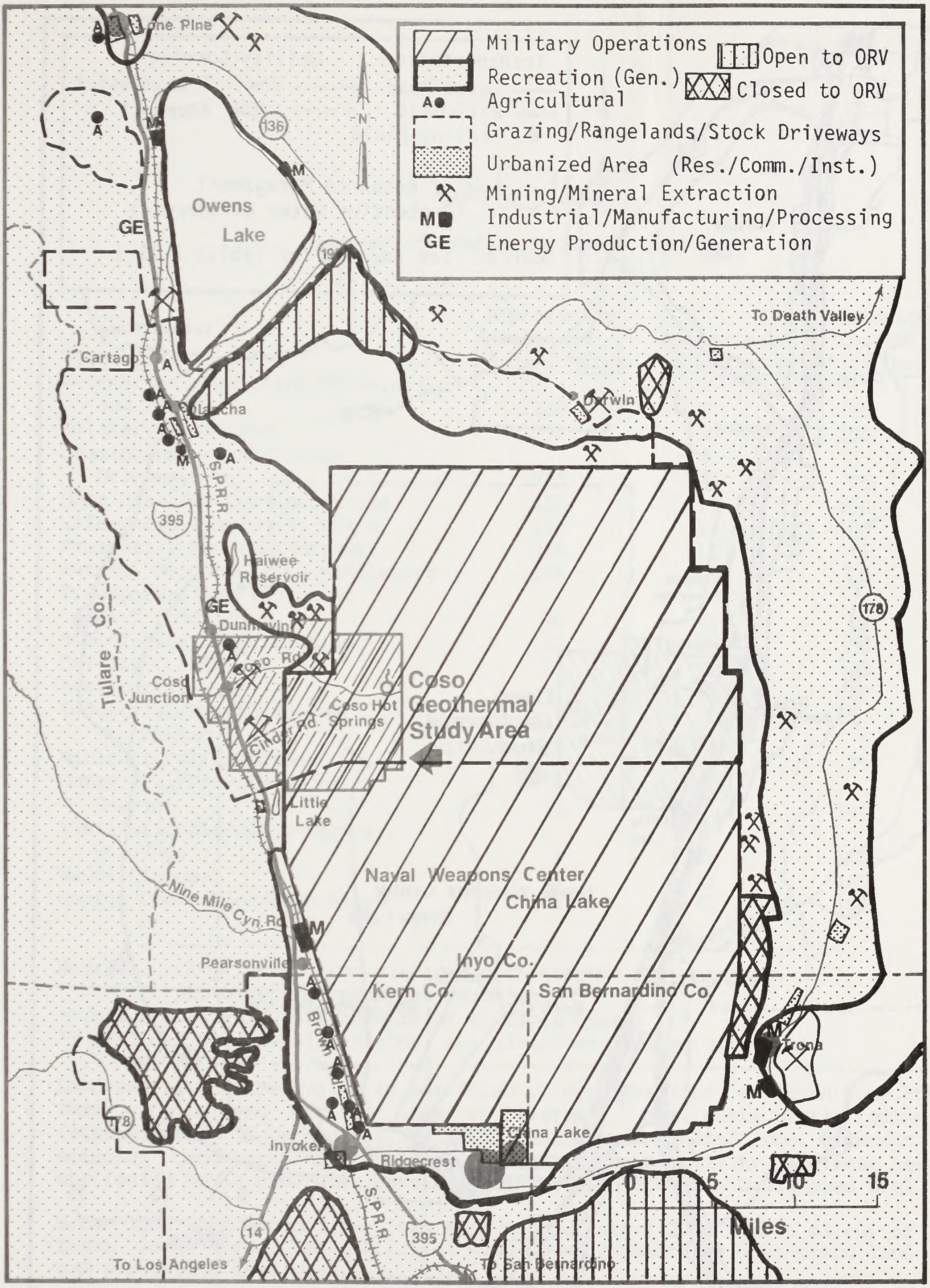
2.11.1.2 Summary of Present Land Uses and Land Use Trends

Regional Land Use. A summary of major land uses in the regional study area is given in Table 2.11.1-1 and Figures 2.11.1-2 A and B (Regional Land Uses). Where multiple uses coexist, the dominant use (in terms of intensity and areal extent) is indicated.



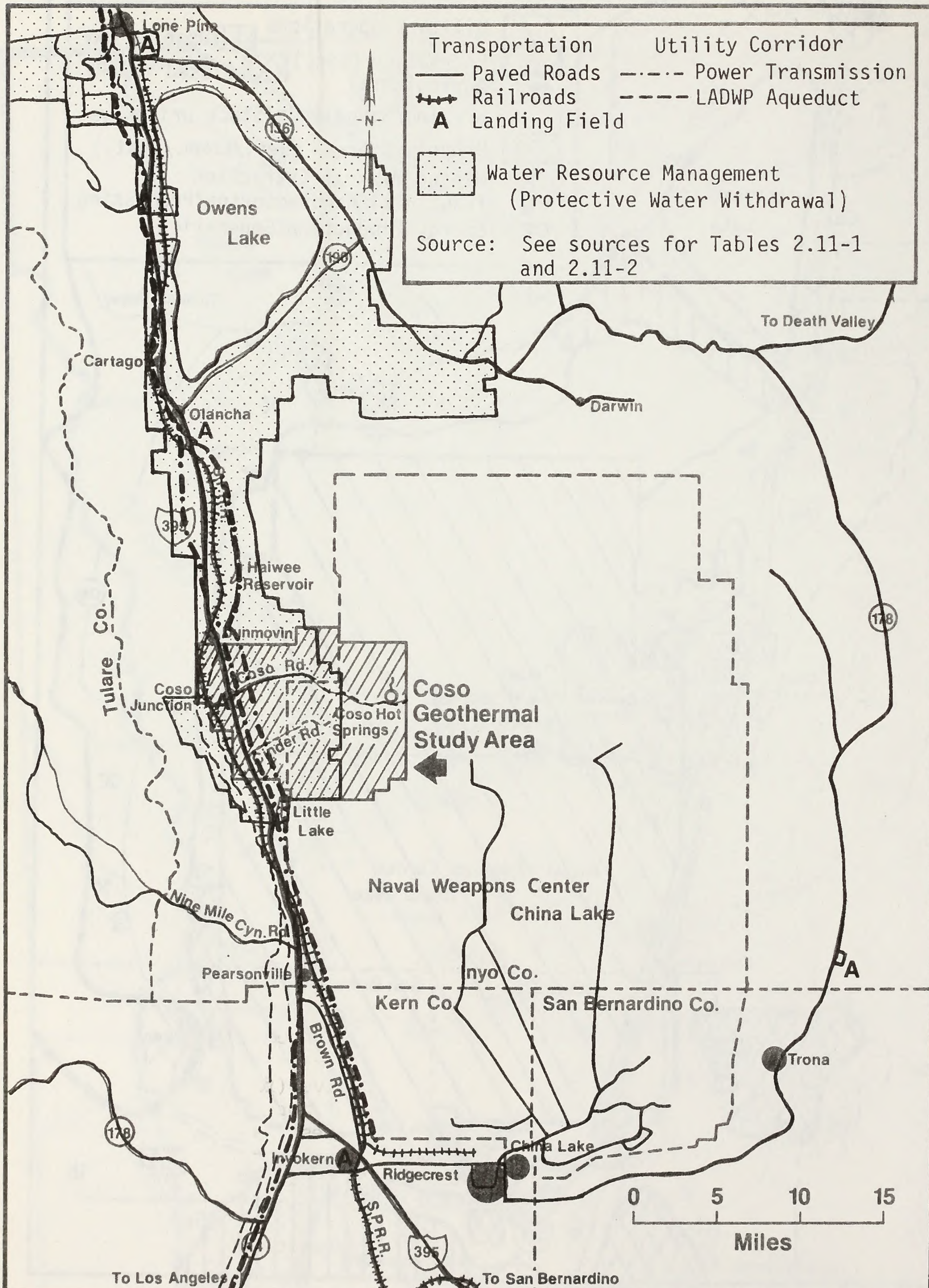
REGIONAL LAND USE STUDY AREA

Figure 2.11.1-1



REGIONAL LAND USE
(Generalized Areal Uses)

Figure 2.11.1-2A



REGIONAL LAND USE
(Generalized Lineal Uses)

Figure 2.11.1-2B

TABLE 2.11.1-1

Summary of Present Regional Land Use

Type of Use	Approximate Number of Square Miles	Approximate % of Region Area*	Estimated Intensity of Use (%)
Recreation (excluding Wilderness and WSA's)	1300	40	<10
Military Operation	950	30	100
Grazing/Rangelands/Stock Driveways	820	25	25
Open Space/No Designated Use	480	15	100
Wilderness (Including WSA's)	405	12	100
Protective Water Withdrawal	358	11	<1
Natural Resource Site Management	155	5	10
Transportation (excluding dirt roads)	20	<1	50
Mining/Mineral Extraction**	12	<1	50
Utility Corridor	11	<1	75
Residential	7	<1	50
Industrial/Manufacturing/ Processing	4	<1	75
Agricultural/Croplands	3	<1	75
Commercial/Private Sector Service	2	<1	100
Institutional/Public Sector Services	1	<1	100
Waste Disposal	<1	<1	100
Energy Production/Generation	<1	<1	100

Sources: Compilation from numerous cartographic, documentary, photographic and survey sources.

* Totals more than 100% because of multiple uses.

** Includes only working sities, not claims or located sites.

Land use within the region is not notably intensive (for a given use, less than 30 percent of the time on average), nor particularly extensive (approximately 15 percent of the land has no designated use. Except for seasonal range grazing and occasional recreational activity, at least half of the region would otherwise be classified as Open Space/No Designated Use).

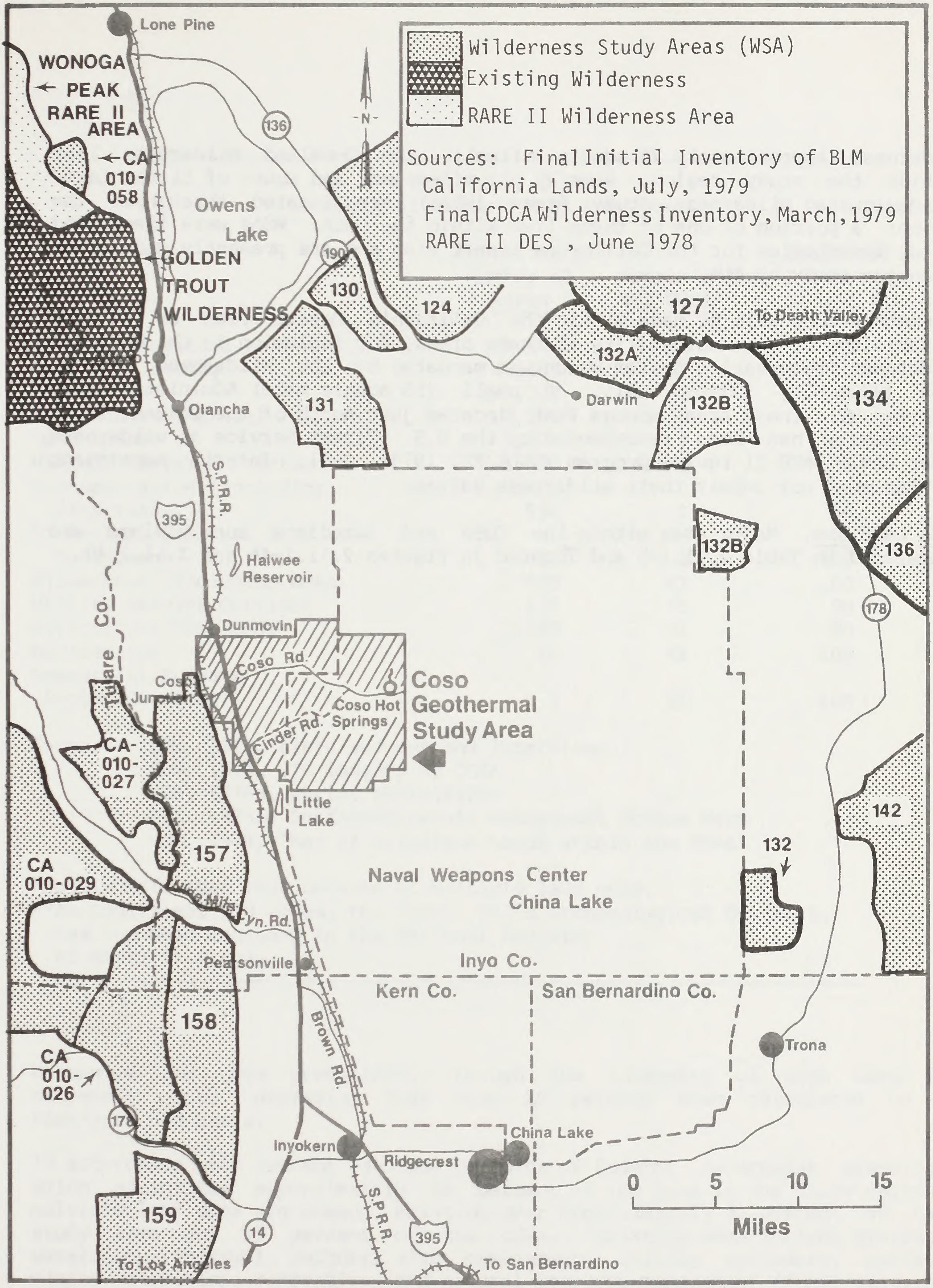
Urban land uses account for less than 0.4 percent (12.25 square miles) of the total land area. Table 2.11.1-2 summarizes present regional urban land uses and per capita land use.

Undisturbed natural areas exist in three categories; see Figure 2.11.1-3. Wilderness Area is represented by the eastern edge of the Golden Trout

Table 2.11.1-2 SUMMARY OF PRESENT REGIONAL URBANIZED AREA LAND USES
(all figures in square miles)

Greater Urbanized Area	Estimated Population (1980)	Urbanized Surface Area	Per Capita Urbanized Land Use	Residential	Commercial/ Institutional	Industrial/ Manufacturing	Transportation
Ridgecrest/China Lake (excluding NWC operations)	21,900	8.0	0.00038	4.8	2.1	0.6	0.5
Trona/Searles Valley	4,460	1.6	0.00036	0.6	0.15	0.7	0.15
Inyokern/Brown-Road (includes Inyokern Airport)	3,200	1.3	0.00041	0.2	0.7	0.03	1.0
Lone Pine (includes Indian Reservation and Airport)	1,750	1.2	0.00068	0.4	0.2	<0.01	0.6
Olancha/Cartago/Grant	550	0.15	0.00029	0.1	<0.01	<0.01	0.05
TOTALS for Urbanized Areas Within Study Region	31,860	12.25	0.00042 (regional average)	6.1	2.55	1.3	2.3
Non-Urban Area TOTALS	2,100	-	-	0.9	0.45	2.7	17.7
Regional TOTALS (Urban and Non-Urban Areas)	33,960	-	-	7.0	3.0	4.0	20.0

Sources: General Plans and Plan Maps for Ridgecrest, Inyo County, Kern County, San Bernardino County.
ERG, 1979, field survey and checking.
BLM, 1976, aerial photography
Section 2.12 of this ES



WILDERNESS AND WILDERNESS STUDY AREAS

Figure 2.11.1-3

Wilderness (approximately 72 square miles); the Domeland Wilderness lies outside the study region, some 20 air miles west and south of Little Lake. BLM-designated Wilderness Study Areas (WSAs) are located throughout the region; a portion of one of these lies within the CGSA. WSAs were identified during inventories for the California Desert Plan and are presently undergoing intensive study by BLM.

Recommendations will be made within the California Desert Plan as to the suitability or non-suitability of these areas, for inclusion in the National Wilderness Preservation System which was mandated by the Wilderness Act of 1964 (USDI/BLM, 1979b: 231). A small (15 square mile) Administratively Endorsed Wilderness Area, Wonoga Peak (located just north of the Golden Trout Wilderness), has been recommended by the U.S. Forest Service as wilderness under their RARE II review program (USDA/FS, 1979: C-3). Interim management of WSAs must not impair their wilderness values.

CGSA Land Use. Major uses within the CGSA and immediate surroundings are summarized in Table 2.11.1-3 and located in Figures 2.11.1-4A and 2.11.1-4B.

TABLE 2.11.1-3
Summary of Present CGSA Land Use

Type of Use	Approximate Number of Acres	Approximate % of CGSA*	Estimated Intensity of Use (%)
Grazing/Rangeland	69,440	96	25
Military Testing	44,480	57	100
Recreation	27,300	38	<5
Watershed Withdrawal	19,250	27	<1
Open Space	3,200	4	100
Mining/Mineral Extraction	1,400	2	35
Transportation (including dirt roads)	850	1	50
Historical/Cultural Site Management	730**	1	100
Wilderness (including WSAs)	500	<1	100
Utility Service Corridor	435	<1	90
Agriculture/Croplands	340	<1	90
Residential	10	<1	100
Commercial/Private Sector Services	1	<1	100

Sources: ERG, 1979, field surveys and interviews
ERG, 1978, CIR imagery of CGSA
BLM, 1976a, aerial photographs
BLM, 1976b, Surface-Minerals Management Status Maps
NWC, 1978, "Map of Withdrawn Lands within the KGRA"

*Totals more than 100% because of multiple land uses.
**An additional 770 acres, the Fossil Falls Archaeological District, has now been included in the National Register of Historic Places.

Extensive land uses predominate, though the intensity of such uses is extremely low, averaging less than 20 percent when calculated on a time/area-use basis.

In accordance with current land use policies of Federal government agencies, which administer approximately 92 percent of the area in the study region, multiple land uses are common, existing over approximately 35 percent of the study area and 95 percent of the CGSA. Existing uses include grazing, watershed withdrawal, cultural site management, utility corridors, surface mining activities, recreation, and natural resource management (management, by a government entity, of wildlife, vegetation or timber resources). These uses

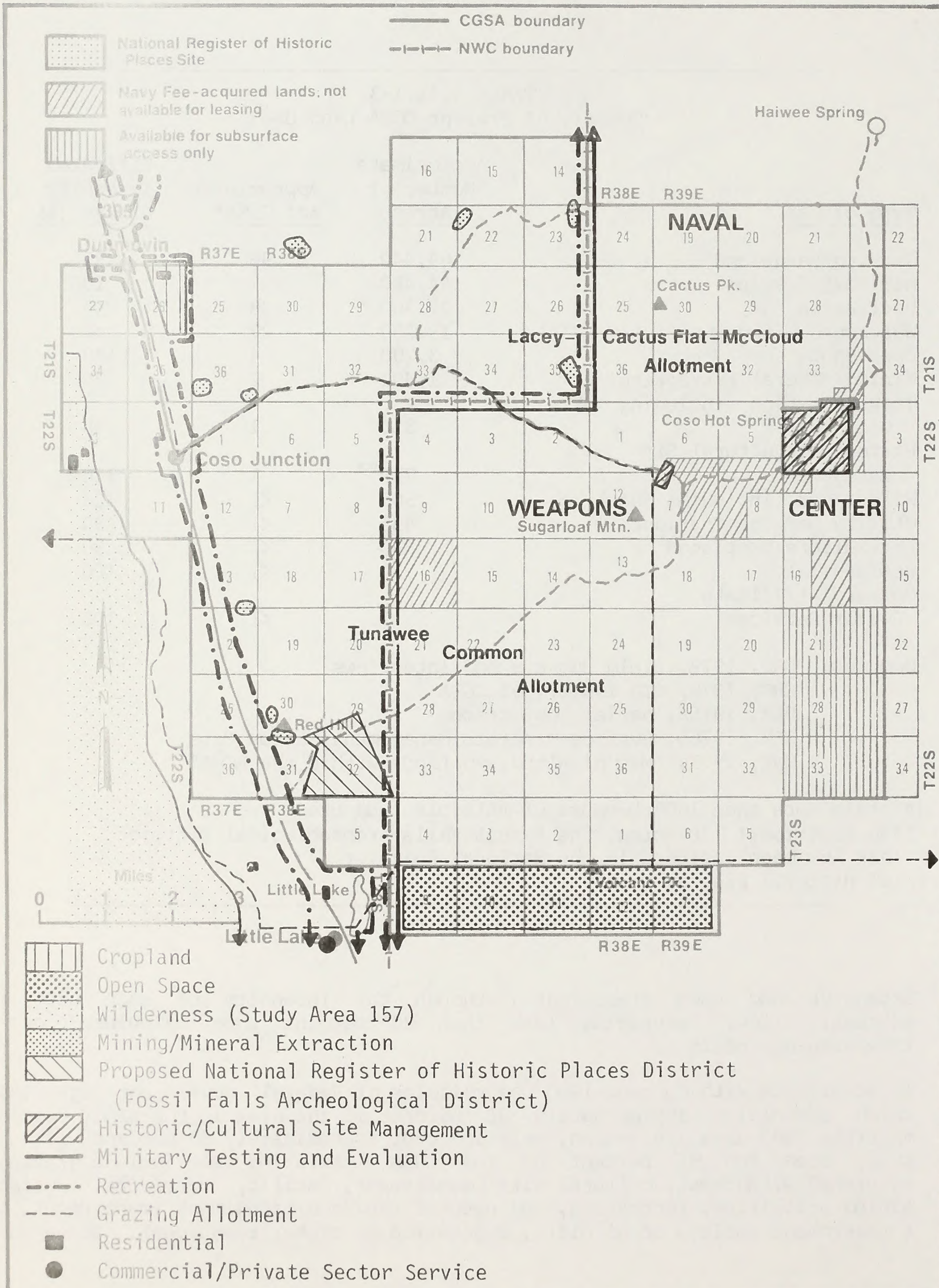


Figure 2.11.1-4A. PRESENT CGSA LAND USE (AREAL USES)

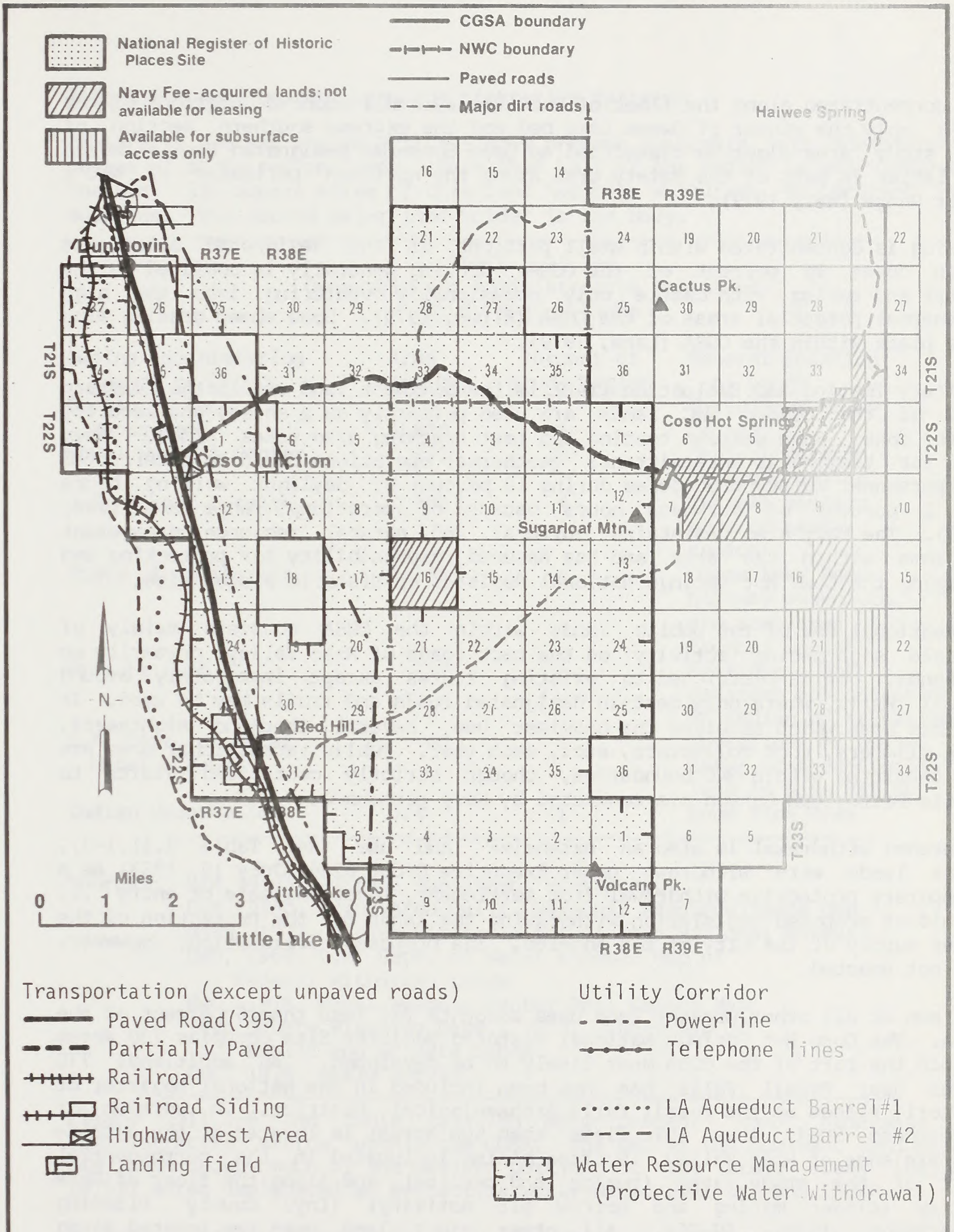


Figure 2.11.1-4B. PRESENT CGSA LAND USE (LINEAL USES AND PROTECTIVE WATER WITHDRAWALS)

are concentrated along the floor of Rose Valley and in non-NWC portions of the CGSA; only the center of Owens Lake bed and the extreme southern section of the study area might be classified as Open Space/No Designated Use, although the latter is part of the safety area along the northern perimeter of NWC's Baker Range (NWC, 1979).

Grazing is concentrated within small portions of the designated allotments which cover 96 percent of the CGSA. Grazing generally is confined to the winter and spring, with cattle only occasionally venturing into the high geothermal potential areas of the CGSA (Elton, 1979). Some sheep grazing also take place within the CGSA (Lane, 1979).

Military Testing and Evaluation (T&E) is the dominant land use in the eastern half of the CGSA. NWC lands are used primarily as a safety and security buffer zone. Some weapons testing and test tracking also takes place. Navy use for testing is intermittent; geothermal operations could be interrupted for personnel safety procedures during 10 percent of daylight working hours and 2 percent of darkness hours because of operational range uses (Ives, 1980). The Navy also maintains cultural and natural resource management programs within the area and has assumed responsibility for protecting and managing the Coso Hot Springs National Register of Historic Places site.

Recreational use of the public lands within the CGSA consists mainly of vehicle sightseeing activity on the back roads of Rose Valley, primarily on weekends. Use is restricted to existing routes except immediately around Fossil Falls, where only certain designated roads and trails may be used. It is this area which receives the heaviest use, several thousand sightseers, rock climbers, rock collectors, etc., each year. Public recreational uses are not permitted within NWC boundaries, though strictly controlled visits to Little Petroglyph Canyon are conducted by Navy personnel.

Watershed withdrawal is also an extensive land use (see Table 2.11.1-3). These lands were withdrawn under Executive Order 6206 (July 16, 1933) as a "temporary protective withdrawal from settlement, location, sale or entry ... in aid of proposed legislation withdrawing the lands for the protection of the water supply of the City of Los Angeles." The proposed legislation, however, was not enacted.

The sum of all other present land uses accounts for less than 6 percent of the CGSA. The Coso Hot Springs National Historic Register Site occupies 730 acres within the part of the CGSA most likely to be developed. An additional 770 acres near Fossil Falls has now been included in the National Register of Historic Places as the Fossil Falls Archaeological District. A portion of Wilderness Study Area 157 (less than 500 acres) is located at the extreme western edge of Rose Valley. Surface mining is located in the north-central part of the study area (pumice and perlite), and along the floor of Rose Valley (cinder mining and borrow pit activity) (Inyo County Planning Department, 1979: 60-66). All other minor land uses are located along Highway 395--transportation, utility service corridor, agriculture, residential, and commercial uses.

2.11.1.3 Land Ownership and Administrative Patterns

Table 2.11.1-4 and Figure 2.11.1-5 show present ownership and administrative status of study region lands. More than half of the region is administered by the BLM; 330 square miles of this land has been withdrawn to protect water supplies. The second major land holder is the Navy.

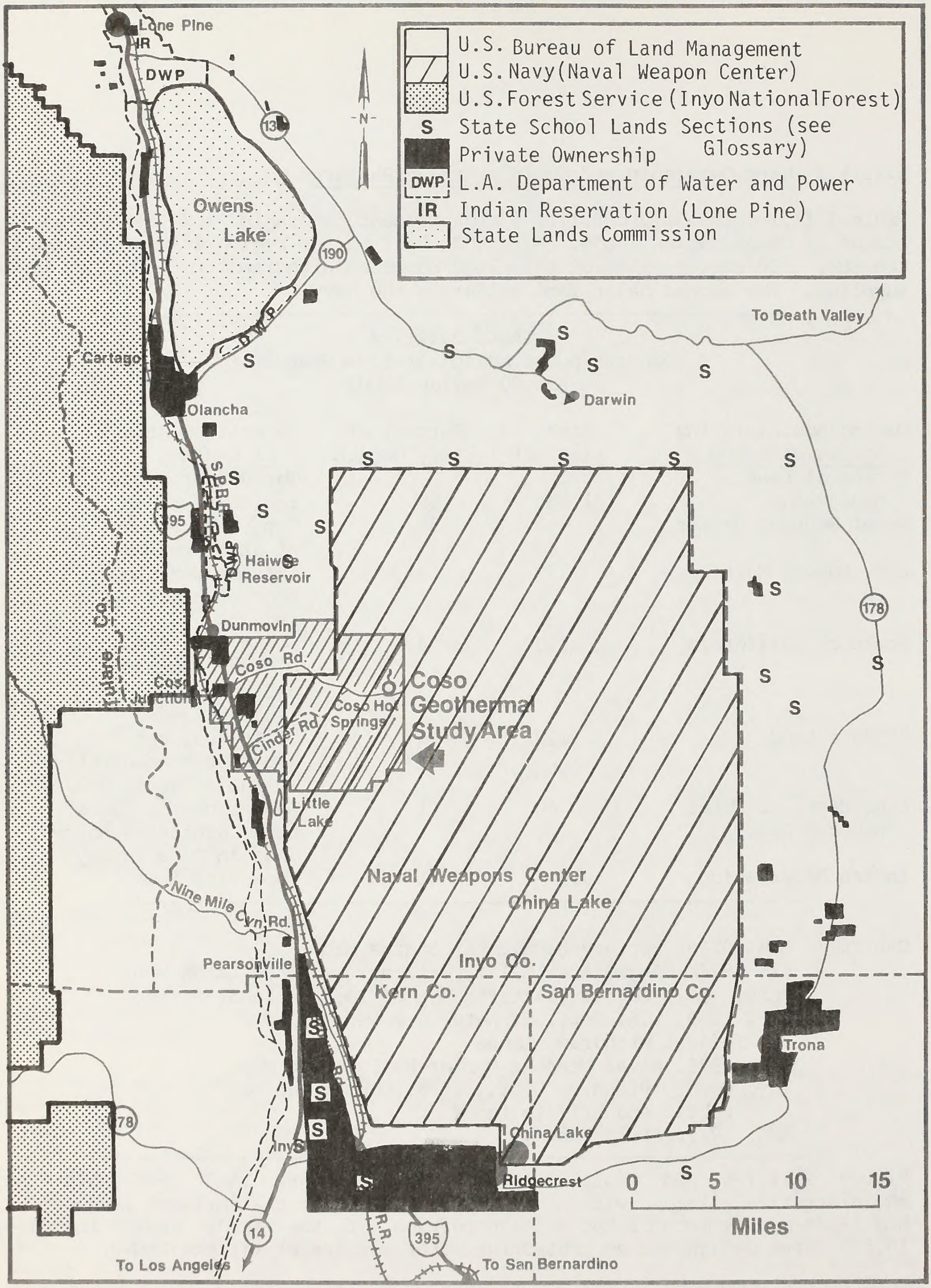
TABLE 2.11.1-4
Ownership and Administrative Status of Study Region Lands

Owning/Administering Agency or Group	Area (sq mi)	Percent of Study Region	General Location of Lands
Bureau of Land Management	1,880	58	Throughout study region
Naval Weapons Center	950	30	Central portion of study region
U.S. Forest Service	130	4	Extreme western edge of study region
State of California	125	4	Owens Lake Bed, highway easements, and scattered "school lands"
Private Land	122	4	Scattered, but greatest concentration in Indian Wells Valley
L.A. Dept. of Water Water & Power	40	1	Shorelines of Owens Lake; scattered holdings in Rose Valley
Indian Reservation	0.4	<1	Lone Pine Area

Sources: BLM 1976a, Surface Management Status Map
BLM 1976b, Argus Area Calif. National Resource Lands Map
USFS, 1972, Forest Visitor's Map of Inyo National Forest
DWP, 1969, L.A. Dept. of Water & Power Map of Federal Withdrawn Lands
NWC, 1978, Naval Weapons Center Real Estate Map
Inyo County Planning Dept., 1978, County Map of Public and Private Lands
ERG, 1979, Field Survey

Figure 2.11.1-6 and Table 2.11.1-5 show present land ownership and administrative status within the CGSA. The NWC is the dominant land holder. BLM lands occupy much of the western portion of the study area, including 19,520 acres designated as protective water withdrawal for the LADWP.

Private ownership accounts for only 1710 acres within the CGSA, although there are an additional 1195 privately owned acres immediately contiguous to the



REGIONAL LAND OWNERSHIP AND ADMINISTRATIVE STATUS

Figure 2.11.1-5

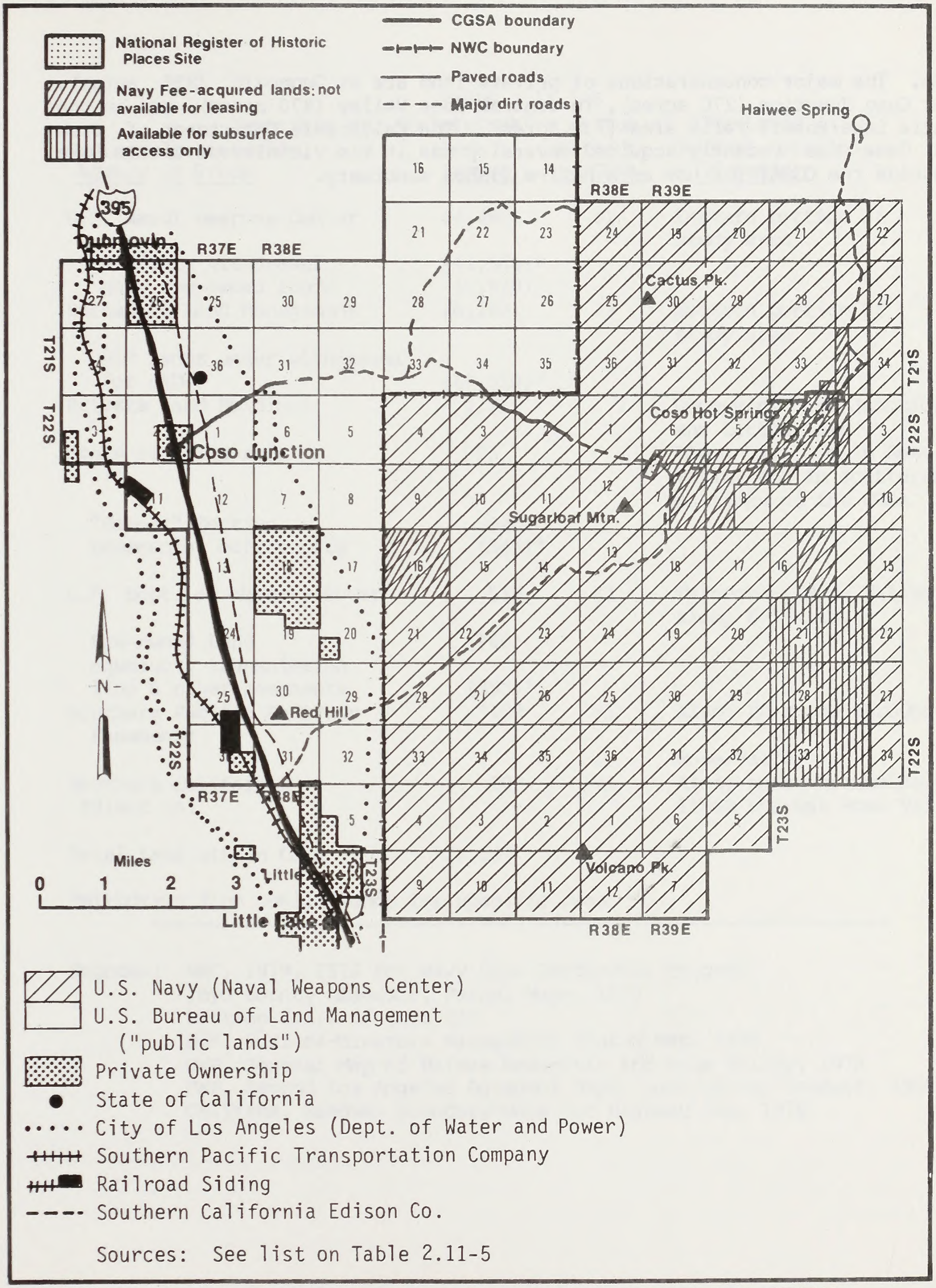


Figure 2.11.1-6. CGSA LAND OWNERSHIP AND ADMINISTRATIVE STATUS

CGSA. The major concentrations of private land are at Dunmovin (855 acres), near Coso Junction (270 acres), in central Rose Valley (970 acres), and in the Little Lake/Fossil Falls area (730 acres). The California Department of Fish and Game has recently acquired several ponds in the vicinity of Little Lake (outside the CGSA) for use as a native fishes sanctuary.

TABLE 2.11.1-5

Ownership and Administrative Status of CGSA Lands

Owning/Administering Agency or Group	Area (acres)	Percent of CGSA	General Location Of Lands
U.S. Naval Weapons Center	44,480	61	Eastern portion of study area
Military Withdrawal	(41,560)*		
Navy Fee-owned lands	(2,920)		
Bureau of Land Management	28,160	33	Western portion of study area
BLM lands under withdrawal for LADWP	(19,520)*		
Private Land Holdings	1,710	2	Dunmovin, Coso Junction and Little Lake
State of California	983	2	Along Hwy. 395 in Rose Valley and in scattered portions of the CGSA
"School" Section	(640)		
Easements, borrow pits	(343)*		
L.A. Dept. of Water & Power	515	<1	Throughout Rose Valley along N-S axis.
Fee-owned Land	(160)		
Aqueduct, transmission line & other easements	(355)*		
Southern Pacific Railroad Easements	310*	<1	Along RR route through Rose Valley
Southern California Edison Co.	20*	<1	Along power transmission lines through Rose Valley
Total Land within CGSA	72,640		

*Withdrawn from public lands for specific uses.

Sources: NWC, 1979, FEIS for Navy Coso Geothermal Program
Inyo County Assessor, Parcel Maps, 1979
Section 1.1.2 of this EIS
BLM, Surface-Minerals Management Status Map, 1976
DWP, General Map of Haiwee Reservoir and Rose Valley, 1978
DWP, Second Los Angeles Aqueduct Maps, Rose Valley Conduit, 1968
CalTrans, Roadway Boundary Maps for Highway 395, 1976

2.11.1.4 Present Land Use Policies, Plans, and Permitted Uses

Public lands within the CGSA are administered under the general provisions of FLPMA, which requires that a master land use plan be prepared for the entire California Desert Conservation Area, including the CGSA. This plan will become the guide to public land use in the area. No other BLM land use plans exist for the area. Geothermal exploration and development is presently considered a permitted use for the CGSA.

NWC portions of the CGSA are subject to the provisions of the NWC Master Plan, which acknowledges the desirability and compatibility of multiple land uses on NWC portions of the CGSA (NWC, 1974: E5-33). At the same time, the Navy is concerned about possible encroachment on their test ranges; NWC policy is to discourage incompatible development activity around the perimeter of the NWC and generally to prohibit non-NWC development or use of base lands (Saxton, 1978, see also NWC 1979a: 168). The Navy also has specific cultural and natural resource management plans for their lands and has executed several land use/management agreements with other federal and state agencies related to grazing, fish and game, and energy resources.

Inyo County's 1990 General Plan is presently being updated and will reflect the possibility of development activities in Rose Valley (Budlong, 1979). The Land Use Element of the new General Plan will not be completed until mid 1980. Presently the CGSA is zoned as Open Space, with all development requiring a Conditional Use Permit (de Hart, 1979). The Inyo Mono Association of Government Entities General Plan designates Rose Valley as a "recreation area" (IMAGE, 1977: 26-30). Inyo County also has a Geothermal Ordinance which would govern certain land development activities of the proposed action.

2.11.2 Impacts of the Proposed Action on Land Use

2.11.2.1 Direct and Indirect Land Use Impacts of Proposed Program

In general, direct land use impacts of the proposed action are expected to be minor or insignificant (see following paragraph for definition of terms) except under certain of the full-development conditions, and most impacts are limited to Zones 1 and 2 of the CGSA. Indirect impacts are also few, becoming severe only under certain "worst case" assumptions; most of these impacts are focused on western portions of the CGSA and study region. See Figure 2.11.2-1 to locate probable impact concentration zones within the CGSA and land uses most likely to be impacted. Table 2.11.2-1 provides a summary of the expected significant land use impacts. In this table, the use of plus and minus signs denotes only the expected additional (or diminished) acreage affected in a given category as a result of the proposed action and does not refer to a "positive" or "negative" impact.

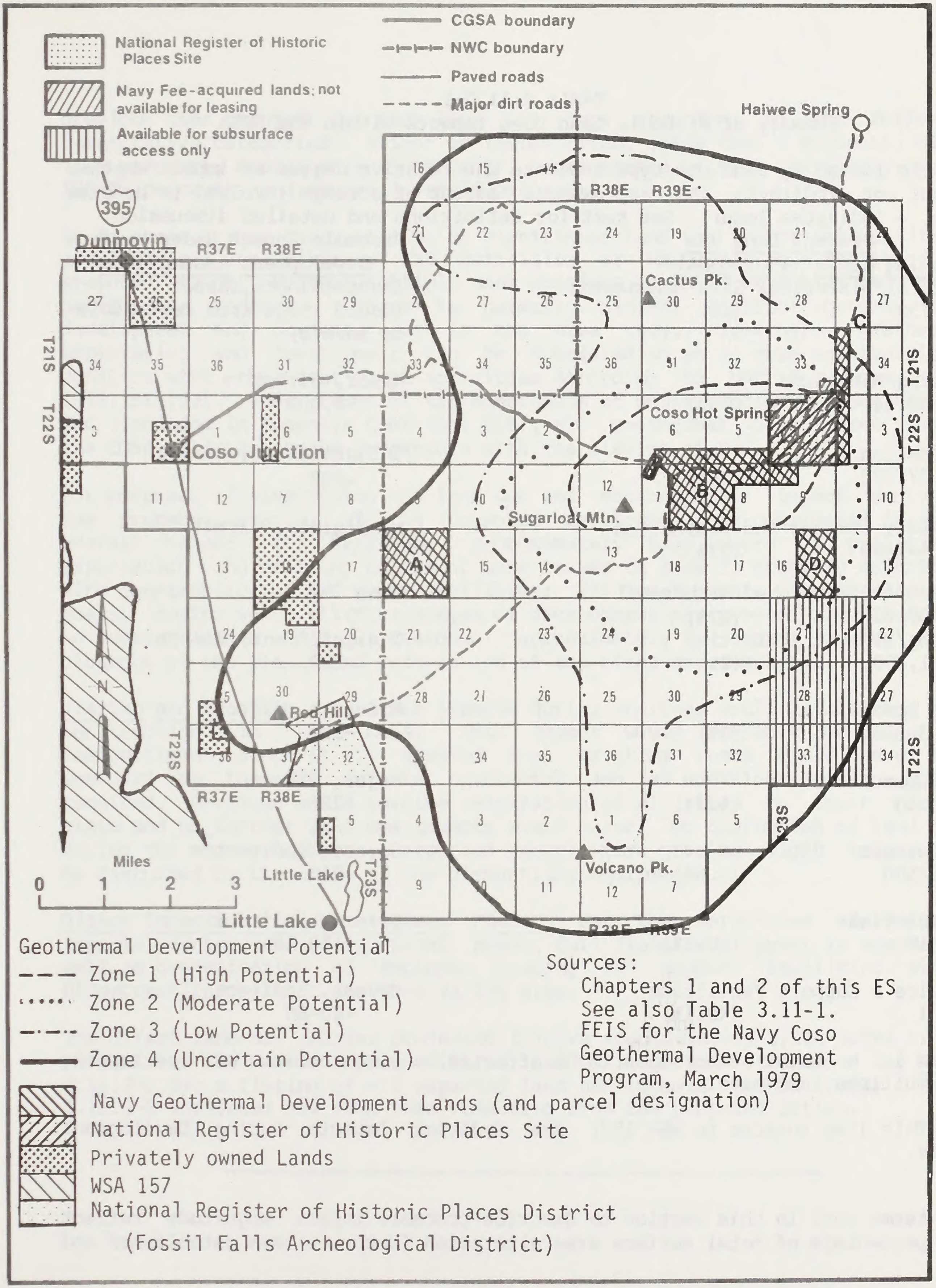


Figure 2.11.2-1. CGSA LAND AREA LIKELY TO BE IMPACTED

TABLE 2.11.2-1
Summary of Probable Land Uses Impacts Within the CGSA

Impacts listed by land use type indicate the relative degree of impact whether direct or indirect, the approximate amount of acreage involved (+ denotes gain, - indicates loss). See text for definitions and detailed discussion.

Present Land Use Existing	Acres (% of CGSA)	Probable Impact Under Maximum Development Assumptions[1]
Cultural/Historical Site Management 730	(1%)	Indeterminate, direct (Could range from negligible to severe)
Grazing/Rangeland 69,440	(96%)	Minor, direct -2,000
Recreation 27,000	(38%)	Insignificant, direct -200
Military Testing and Evaluation 44,480	(57%)	Negligible, direct 0
Protective Watershed Withdrawal 19,520	(27%)	None 0
Mining/Mineral Extraction 1,400	(2%)	Insignificant, direct -150
Open Space 3,200	(4%)	Moderate, direct -300
Transportation 850	(1.2%)	Major, direct +225
Wilderness <500	(0.6%)	Severe, indirect[2] -500
Residential 10	(<0.1%)	Severe, indirect +150-200
Service & Support Facilities 1	(<0.1%)	Severe, indirect +60-80

Notes 1. No total of acreages to be affected is given because of overlapping and multiple land uses.

2. This item relates to WSA 157; see Indirect Impacts During Development Phase.

The terms used in this section to describe probable impact magnitude reflect the percentage of total surface area alteration (both new uses established and previous uses changed) for each land use type according to the following quantitative categories: slight or insignificant (less than 1 percent), minor (1-5 percent), moderate (6-15 percent), considerable (16-25 percent), major (26-50 percent), and severe (over 50 percent).

It is assumed that there will be no significant land use impact (either direct or indirect) on Military T&E activities or NWC lands as a result of the proposed action. Present multiple uses continue, even if extensive geothermal development occurs. There is normally minimal conflict between such development and present uses in the area (e.g., grazing). Geothermal exploration and development can be scheduled so as to pose no significant conflict with other test range activities according to NWC documents (NWC, 1979:151-152). Under terms of the Memorandum of Understanding between BLM and NWC (included in Appendix C of this EIS), all geothermal development within the CGSA will have to be compatible with the mission of NWC.

For purposes of simplifying the land use and socioeconomic impact analyses, the probable staging of the proposed development is considered in three overall phases: (1) Start-up: approximately four years of preliminary exploration and drilling on one or more leases in Zone 1, probably coincident with construction of NWC power facilities; (2) Development: approximately 45 years, during which all five stages of development may proceed simultaneously on several leases; and (3) Shutdown: approximately two years, during which closeout of the plants and restoration of the sites are completed.

Startup and Shutdown. Land use impacts during start-up would result from road construction in the CGSA. This impact would probably be minor or insignificant, since it is assumed that existing roads would have been improved by the NWC or its contractor and few additional roads would be required. Shutdown would involve restoration of all sites to their natural state and no further land use impacts would occur. No disruption of land uses during the shutdown phase is expected except where grazing might temporarily be disturbed by the noise of the dismantling equipment.

Direct Impacts During Development Phase. For the worst-case analysis of impacts during the development phase, full field development is assumed as well as concentration of employee housing and support facilities within Ridgecrest/Inyokern or the Rose Valley area.

The direct land use changes projected involve approximately 2,260 acres or 3.1 percent of the CGSA. Impacts will be insignificant in most cases. See Table 2.11.2-1 for a listing of all expected land use impacts within CGSA; Table 2.11.2-2 indicates new land uses resulting from the proposed action.

TABLE 2.11.2-2 Possible New Land Uses Within the CGSA Resulting from the Proposed Action

New CGSA Land Use (# of Units)	Acreage	%CGSA	Approximate Land Use Intensity (%)	Probable Use Incidence
Sumps and Reserve Pits (1,198)	695	0.96	100	Occasional during project life
Production Wells and Pads	623	0.86	75	Intermittent
Maintenance Roads (229 miles)	377	0.5	100	Frequent
Injection Wells and Pads (216)	217	0.3	75	Intermittent
Access Roads (22 miles)	67	0.09	100	Constant
Power Plant (11)	66	0.09	100	Constant
Abandoned Well Pads (22)	65	0.09	10	Rare
Transmission Lines (19 miles)	29	0.04	20	Constant
Water (makeup) Pipeline (8 miles)	10	0.01	5	Occasional
Transmission Line Road (8 miles)	7	0.01	100	Constant
Rose Valley Substation (1)	2	<0.01	100	Constant
SUBTOTAL	2,258	3.12		
Additional CGSA Land Possibly Developed for Indirect Support Facilities	280	0.38	75	Constant, past field life
TOTAL	2,538	3.5%		

Sources: Chapter 1 of this EIS. USGS 15' Topographic Quadrangles for Haiwee Reservoir (1951) and Little Lake (1954).
Field Survey (1978-1979) conducted by ERG. Chapter 2 of this Environmental Impact Statement.

If 250 miles of roads were needed for geothermal development (assuming that approximately one-half of these roads would use existing rights of way or NWC roads) the total additional road area needed would be approximately 225 acres, a 26 percent increase. Approximately 2,000 acres of existing grazing allotment land might be lost temporarily, including areas fenced off or closed to grazing animals. This impact is considered only minor.

Some 300 acres of existing Open Space uses in Development Zone 4 could possibly be diverted for geothermal development; however, this area is in a remote and presently inaccessible portion of the NWC (south of Volcano Peak). Direct impacts on Recreational land uses will also be minor, resulting from the loss of approximately 200 acres of land presently suitable for such use. There is the likelihood of impacts resulting from increased sightseeing activity within the development area (outside the NWC) by curious tourists, because of the unique nature of this project. This would create additional disturbance of "natural" characteristics of the area for those seeking recreation in remote areas.

Geothermal development is not anticipated to interfere with current or projected mineral production in the area. The only limitations foreseen would be possible coordination of traffic patterns for optimum utilization of access roads, possible limitations on water availability for new mineral production activities, and placement of geothermal facilities not to coincide with any mineral production area.

There is an indeterminate possibility of direct impact on Cultural/Historical Site Management land use at Coso Hot Springs and the Prayer Site, as discussed under Hydrology, and Socioeconomics (Native American Concerns). Direct impact, under full field development of Zones 3 and 4, might also take place near the area of Fossil Falls Archaeological District.

<u>Indirect Impacts During Development Phase</u>. The most significant land use impacts will be indirect, resulting from the need to provide residential and support facilities for 375 to 500 employees and families (see Section 2.12.2). In the "worst case" analysis, the focus of growth and the creation of new support and service facilities is postulated for Rose Valley. Indirect land use impacts would be moderate to severe, requiring a possible 280 acres. Total available privately owned land in Rose Valley comprises 1,710 acres, now mainly used for grazing and alfalfa farming; from 12 to 16 percent of this would be required, resulting in the complete loss of present uses on land designated for development. The intensity of new uses would be high, of long duration, and constant for at least the life of the program.

Geothermal development in those portions of Zones 3 and 4 visible from Highway 395, and any development of support and service facilities within Rose Valley, would slightly lessen the wilderness character of the approximately 500 acres of Wilderness Study Area (WSA) 157 which is located within the CGSA. WSA 157 is presently under intensive study prior to possible recommendation for Congressional designation as a Wilderness Area. In accordance with FLPMA, Section 603, designated Wilderness Study Areas will not be allowed to be impacted by the proposed action.

2.11.2.2 Conflicts with Existing Land Use Plans and Policy

The proposed action poses no significant conflict with relevant existing land use plans and policies of management control agencies, with the possible exception of developing residential and service facilities in Rose Valley under "worst case" assumptions. Such uses may be incompatible with NWC and Inyo County policies.

2.11.2.3 Probable Future Land Use Trends as a Result of the Proposed Action

Since most of the land within the CGSA is administered by Federal agencies, it is unlikely that future land use trends would differ significantly from the present, unless management policies of these agencies are altered as a result of development pressures generated by the proposed action. The limited private land within Rose Valley may experience considerable pressures for change in use as a result of the proposed action however, depending in part upon the extent of geothermal development.

2.11.2.4 Cumulative Land Use Impacts of Navy and BLM Programs

Because many land uses of the two programs would be shared or would involve similar existing land uses in a comparable timeframe, the cumulative impacts would be minimized. The new land use impacts would be similar for both programs, and would be a function of the degree of resource development. The degree of cumulative impact can be calculated by multiplying the full-development proposed action impacts shown in Table 2.11.2-1 by 120 percent. Such cumulative impacts would have little or insignificant total additional effects on land use.

The significant land use impacts identified and discussed in this section are not all necessarily negative or undesirable. For example, it is quite possible that the people of Inyo County and the residents of Rose Valley would encourage and welcome growth, economic stimulus, and resultant land use changes brought about by even the worst-case impacts discussed above.

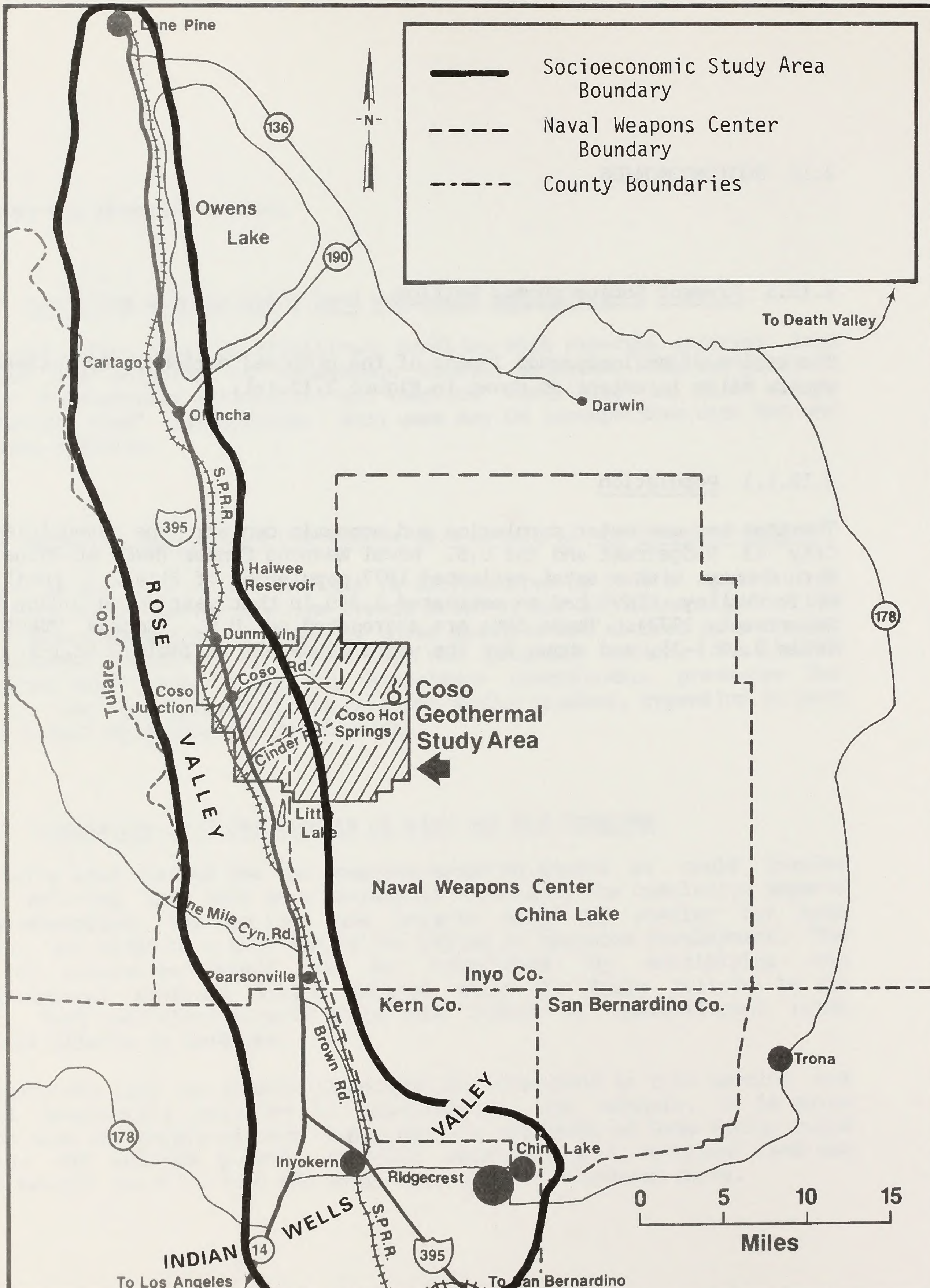
2.12 SOCIOECONOMICS

2.12.1 Present Socioeconomic Setting

The region of socioeconomic impact of the proposed action is approximately 900 square miles in extent as shown in Figure 2.12.1-1.

2.12.1.1 Population

The area has one major population and economic center: the communities of the City of Ridgecrest and the U.S. Naval Weapons Center (NWC) at China Lake in Kern County, with a total estimated 1977 population of 21,402; rural Indian Wells Valley (IWV) had an estimated 3,349 in that year (Kern County Planning Department, 1977). These data are aggregated by U.S. Census Tracts, (see Table 2.12.1-2), and shown for the years 1960-1977 in Table 2.12.1-1.



SOCIOECONOMIC STUDY REGION AND GEOGRAPHIC REFERENCES

Figure 2.12.1-1

TABLE 2.12.1-1
Study Area and Inyo County Population
1960,1970 and 1977

	1960(1)	1970(1)	Rate of Change 1960-70	1977(2)	Rate of Change 1970-77
China Lake (C.T. 53)	11,748	11,105	- 5.5%	6,135	-44.8%
Ridgecrest (C.T. 54)	5,506	8,499	+54.4%	15,267	+79.6%
Subtotal	17,254	19,604	+13.6%	21,402	+ 9.2%
Rural Indian Wells Valley (C.T. 55.01)	716	1,738	+142.7%	3,349	+92.7%
Subtotal: Kern Co.	17,970	21,342	+18.8%	24,751	+16.0%
SW Inyo County(3)	2,467	2,672	+ 8.3%	2,508(4)	-6.1%
Total Study Area	20,437	24,014	+17.5%	27,259	+13.5%
Inyo County(5)	11,684	15,571	33.3%	17,967	15.4%

Notes:

1. Source: U.S. Census of Population (1960 and 1970)

2. Source: Kern County Special Census, July 1, 1977; Kern County Planning Department.

3. Lone Pine Division (corresponds approximately to Special Census Tracts (CT) 16, 17, 18, and CT 12, Area 4).

4. Source:Inyo County Planning Dept., Special Census, 1977.

5. Source:Inyo County Planning Dept., Population Report: Inyo County, California, 1978, Page 4.

Recent Navy policy encouraging personnel to live off base is reflected in the 1970-1977 figures; the area is also experiencing in-migration (City of Ridgecrest, 1977; and U.S. DoD, 1979). Educational levels at China Lake were higher than the state median in 1970 (see Table 2.12.1-2), as was the percent of population under 18; the proportion of those 65 years and older was significantly lower. Of the three percent non-Caucasian population of Ridgecrest in 1970, 44 persons, or 0.6 percent of the total population, were Native American (US Census of Population, 1970).

Inyo County, which contains the balance of the study region, is thinly populated. Its one incorporated city (Bishop, 57 miles north of Lone Pine) accounted for 23 percent of the County's total population of 15,571 in 1970.

Table 2.12.1-2. POPULATION CHARACTERISTICS OF RIDGECREST, CHINA LAKE, INYO COUNTY AND CALIFORNIA 1970

	China Lake (Unincorporated)	Ridgecrest	Inyo Co.	State of California
Total Population	11,114	7,629	15,571	19,953,134
Total Native Population	10,808	7,504	15,161	18,199,314
Percent of Native Population Born in Different	57.9	57.0	42.7	47.4
Total Population 5 Years Old or Older	10,077	6,924	14,462	18,317,974
Percent of Population 5 Years Old or Over Living in Same House in 1965	27.6	38.3	42.1	43. 43.5
Median School Years Completed, Males, 25 Years Old or Over	13.8	12.4	12.3	12.4
Median School Years Completed, Females, 25 Years Old or Over	12.6		12.3	
Percent High School Graduates, Males, 25 Years or Over	76.9	(no data available)	58.4	
Percent High School Graduates, Females, 25 Years or Over	74.9	(no data available)	65.0	62.7
Percent Non-Caucasian	5.5	3.0	8.3	10.6
Percent Under 18 Years	40.1	36.3	32.5	33.3
Percent 18 to 64 Years	59.0	57.6	56.0	57.7
Percent 65 Years and Over	0.9	6.1	11.6	9.0

Source: U.S. Census of Population, 1970

* Persons born in U.S., Puerto Rico, or a possession of the U.S.; or if born ouside these areas, having one parent who was a U.S. citizen.

The southwestern portion of the County is even more sparsely settled than the north. In 1979, aside from perhaps 100-200 persons scattered in small settlements such as Keeler and Darwin and throughout the Panamint Valley, almost all of the residents within the Lone Pine Division lived within the Socioeconomic study area. Lone Pine and Olancha (with 1,800 and 260 persons, respectively, in 1970) comprise the major communities; other settlements or service areas are Cartago, Dunmovin, Little Lake and Pearsonville. An estimate of the 1979 population for the Inyo County portion of the study region is shown in Table 2.12.1-3.

TABLE 2.12.1-3

Estimated 1979 Population:
Inyo County Portion of Socioeconomic Study Area

Community	Population	Source
Lone Pine	1,750	(Farlander, 1979)
Cartago	105	(Benbrook, 1979)
Olancha/Grant	350-400	(Benbrook, 1979)
Total Rose Valley	30	(ERG estimate, May 1979)
Pearsonville	10	(ERG estimate, May 1979)
Scattered Rural	50	(ERG estimate, May 1979)
Approximate Total, Est.	2,300-2,350	

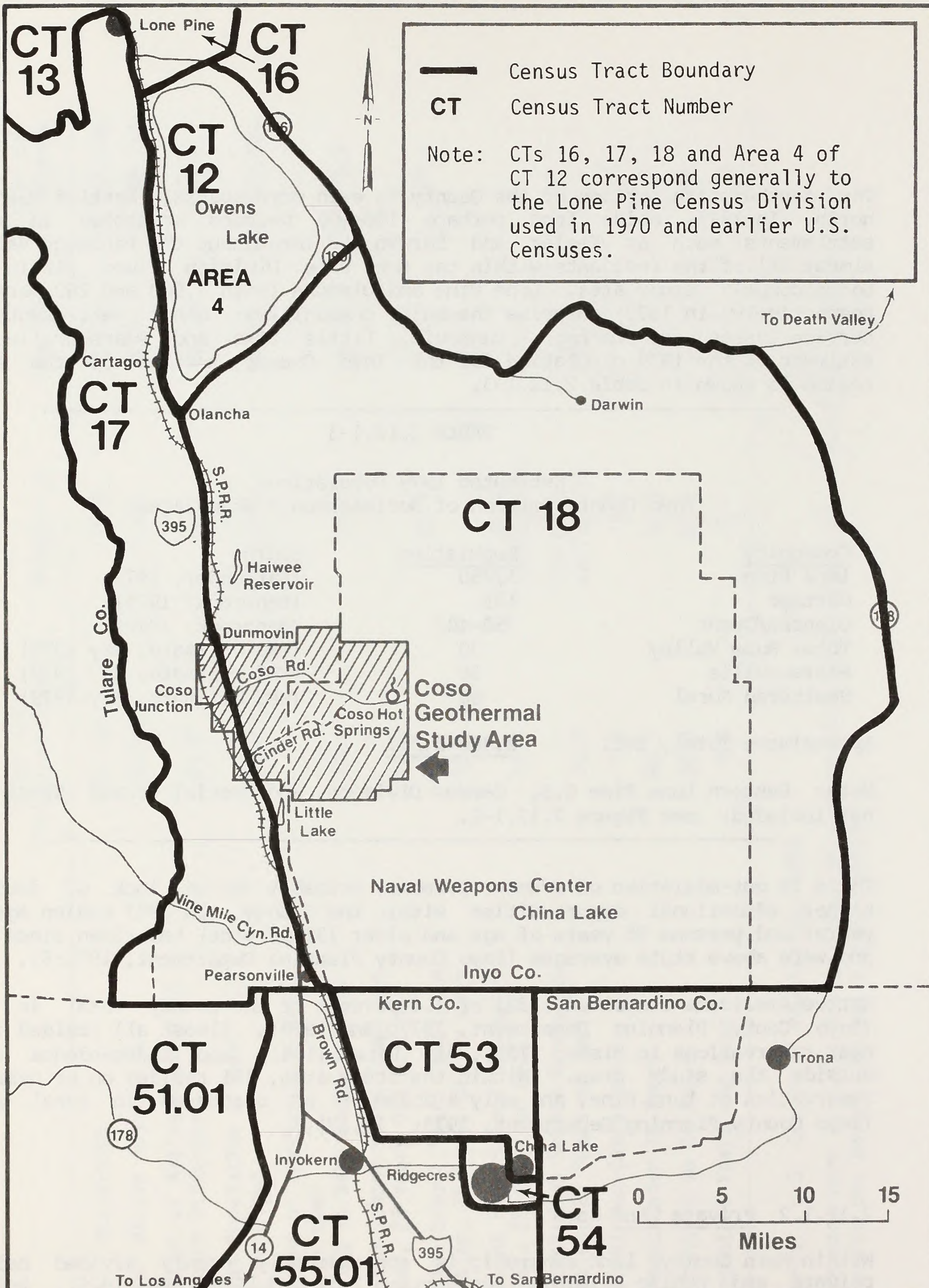
Note: Eastern Lone Pine U.S. Census Division, and Special Census Tract 13, not included; see Figure 2.12.1-2.

There is out-migration of younger persons, probably due to lack of jobs or higher educational opportunities within the County. In 1977 median age (37 years) and persons 55 years of age and older (31 percent) had risen since 1970 and were above state averages (Inyo County Planning Department, 1978:6).

Native Americans comprised 1,321 or 7.4 percent of the county total in 1977 (Inyo Conty Planning Department, 1977b and 1978). Almost all resided in or near reservations in Bishop (722), Big Pine (194), and Independence (26), outside the study area. Within the study area, 151 resided on or near the reservation at Lone Pine, and only a dozen or so scattered in rural areas (Inyo County Planning Department, 1978: 13,17).

2.12.1.2 Private Land Uses

Within Kern County, land ownership is approximately evenly divided between private and public holdings (see Section 2.11 and USDI, BLM, 1976). Private ownerships are centered around Ridgecrest and the Inyokern portion of Indian Wells Valley (IWV). The developed parcels, however, display a prevailing "leap frog" pattern. Brown Road, north of Inyokern, is undergoing



CENSUS TRACTS: SOCIOECONOMIC STUDY AREA

Figure 2.12.1-2

considerable residential development (Ridgecrest, City of, 1977: 27,28; Burns, 1979). In 1977, land zoned in Ridgecrest was estimated at 38 percent residential; 5 percent commercial; 4 percent industrial/manufacturing; 20 percent public facilities, including recreation; and 33 percent urban reserve, for future development (Ridgecrest, City of; 1977: 28). Future proportions are expected to be similar. No comparable data exist for rural IWV.

Inyo County, the state's second largest county (6,490,240 acres), has only 320,000 acres of taxable land, of which only approximately 123,000 (1.9 percent) acres are in private ownership, (IMAGE, 1974a: 24). Most privately owned parcels in the study area are in or near developed areas along Highway 395; south of Lone Pine, most of these represent combined residential and agricultural uses, with grazing incidental. In recent years, there has been little impetus for new private development, and little opportunity for private land acquisition. Future development in the Rose Valley area would depend on Inyo County, BLM, and NWC policies.

2.12.1.3 Housing Stock

The total numbers of housing units in China Lake and the City of Ridgecrest in recent years are shown in Table 2.12.1-4.

TABLE 2.12.1-4
Housing Units: Ridgecrest and China Lake

	1970		1975	
Community	Total Units	Vacant	Total Units	Vacant
NWC-China Lake	3,156	37	2,835	698
Ridgecrest	3,060	274	4,640	252

Source: City of Ridgecrest. Land Use Committee for South Ridgecrest Area: Community Land Use Study. May 1977.

The transfer of several thousand people from the NWC to Ridgecrest has generated considerable pressure for new housing within the City, as well as for increased capacity of local infrastructure, and has stimulated private development. By late 1979 the total available stock in the City was 6,228 units, and the vacancy rate was 14 percent (872 units), largely as a result surplus Navy housing made avialable to the city (Brummett, 1979). Further housing disposal is being considered by NWC as well as 550 acres of NWC land which could be annexed to the city. Inyokern has also experienced considerable housing growth. Total dwelling units for Census Tract 55.01 were 623 in 1970, with a vacancy factor of 11 percent (U.S. Census of Population, 1970). The number of available units has approximately doubled since that time (Cogswell, 1979).

Housing in Inyo County is less plentiful. In 1977, total units available in the study area portion of the County amounted to 1,337 (see Table 2.12.1-5).

Table 2.12.1-5

HOUSING UNITS; INYO COUNTY PORTION OF STUDY AREA, 1977

Special Census Tract	Units Available	Vacant
12 (Area 4)	102 (1)	25 (1)
16	857 (2)	-- (3)
17	163 (2)	24 (1)
18	215 (2)	72 (1)
Total	1,337	

1. Source: State Department of Finance Special Census 1977, cited in NWC, 1979: 143.
2. Source: Inyo County 1978 Population Report: 15.
3. Data not available.

An unknown number of units reported as vacant are probably unsuitable, being remotely located and lacking electricity or sanitary facilities. Of total dwellings in Inyo County in 1960, 41.8 percent were substandard (IMAGE, 1974b: 35 ff). Review of local newspapers confirms the observation that single family homes are placed on the market infrequently, and rentals are even more scarce. Little Lake Hotel and a few motels and mobile home parks in the area have occasional vacancies, some for longer-term occupancy. There are a few locations such as Olancha/Cartago and Pearsonville where additional mobile homes could be sited.

2.12.1.4 Infrastructure

Police Protection. The NWC maintains range security patrol while BLM rangers provide law enforcement on BLM lands (NWC, 1979: 145-146). The California Highway Patrol (CHP) has jurisdiction over all State and U.S. Highways in cooperation with the County Sheriffs' Departments and BLM Rangers. The Inyo County Sheriff's office maintains full time personnel in Lone Pine (7) and Ohancha (2) (Hazelton, 1979). The Kern County Sheriff's Department has 6 officers and 9 reservers in Ridgecrest (Kern County First Supervisorial District, 1978). NWC's China Lake Police Force of 45 members and the Ridgecrest Police Department (20 members plus reserves) provide additional protection.

Fire Protection. Public lands in the area are protected through cooperation between the Navy (on NWC lands), BLM, U.S. Forest Service, and the California Division of Forestry (Peace, 1977: 115). The Los Angeles Department of Water and Power is responsible for fire protection on its lands in Inyo County. Lone Pine and other Inyo County communities have volunteer protection districts (Sherburne, 1979). Indian Wells Valley is covered by the Kern County Fire Department in Ridgecrest and Inyokern.

Electrical Utility. Both Southern California Edison (SCE) and the Los Angeles Department of Water and Power (LADWP) maintain power lines along Highway 395. SCE provides service south of Olancha, while Lone Pine and Owens Valley are served by LADWP.

Fresh Water Supply. No commercial potable water supply is available in the geothermal area. Rose Valley and Olancha residents rely on wells or springs. Domestic and stock consumption in Rose Valley is discussed in Section 2.5.1. LADWP supplies water to Los Angeles-owned and leased lands in Inyo County. Residents in the Lone Pine area are supplied largely by LADWP and the North Lone Pine Water District. Cartago also has a water system (Inyo County Planning Department, 1968: 63). The Indian Wells Valley County Water District (IWVCWD) serves part of the Valley and most of the City of Ridgecrest (Kreiger and Stewart, 1977: I-7); there are also several mutual and private water companies. IWVCWD wells have a total capacity of 8,150,000 gallons per day (gpd); peak demand sometimes exceeds 5,000,000 gallons per day (IWVCWD, 1977; Hamilton, 1979). Water quality is currently good; however, anticipated reversal in the direction of water flow by 1995, due to drawdown, could create problems (Hamilton, 1979; McGuire, 1979). Fire hydrant flow is inadequate in some areas (Brummett, 1979). Most Inyokern residents obtain water from wells.

Gas Utility. Natural gas is supplied to about half the population of Ridgecrest by Pacific Gas and Electric Company (Strayer, 1979). The remainder of the study area population relies on propane.

Flood Control/Storm Drains. LADWP and Inyo County share the responsibility for flood control in Inyo County (Sherburne, 1979; Kuebler, 1979). The Kern County Water Agency is responsible for directing flood control in Indian Wells Valley watershed; however, the only existing facilities are City of Ridgecrest drainage systems (Inman, 1979; Sorenson, 1979; Boyd, 1979).

Sewage/Wastewater Treatment. Most small communities and all of the rural areas use septic tanks. Cartago has no community sewer system. The Lone Pine sewer system has been upgraded by LADWP as a condition of acquiring the Lone Pine water system (Inyo County Board of Supervisors letter, April 29, 1980). Ridgecrest and China Lake have a combined sewer system; the treatment plant has a rated capacity of 820,000 gpd with current usage well below capacity (Boyd, 1979). Inyokern County Sanitation District serves approximately 300 persons with a treatment system designed to handle a maximum of 60,000 gpd; current flow is approximately 30,000 gpd (Webber, 1979).

Solid Waste Disposal. The Class I disposal site closest to the CGSA is located in West Covina, in Los Angeles County. Several Class II-2 sites are located in or near the study area including a private facility east of Lone Pine, with another 28 years' capacity (Goodloe, 1979; Goodman: 1979), and the Kern County-operated Ridgecrest Sanitary Landfill, on BLM lands south of Ridgecrest, which can be used until 1982. BLM approval of expansion for an additional 15-20 years' capacity is being sought (Kennedy, 1979; Colter, 1979). Collection is by private contractors.

Health/Mental Health Systems. Inyo County maintains a medical clinic in Lone Pine (Inyo County Planning Department, 1968: 94). Lone Pine's Southern Inyo Hospital, presently utilized to capacity, serves the southern portion of the county. The Kern County Health Department and the Desert Counseling Clinic maintain offices in the City of Ridgecrest, providing care to northeastern Kern County and portions of Inyo County. Ridgecrest Community Hospital, with 86 beds (not fully utilized at present), and Drummond Outpatient Clinic serve the Ridgecrest/Inyokern area.

Education Systems. The Lone Pine Unified School District serves the southwestern portion of Inyo County. The district has two elementary schools, one in Olancha (enrollment 50, capacity 100) and one in Lone Pine (enrollment 280, capacity 310), and a high school and a continuation high school, both in Lone Pine.

The Sierra Sands Unified School District serves the Indian Wells Valley. Total enrollment for the eight elementary schools, two junior high schools, high school, continuation high school, and adult education program was approximately 5,200 in the autumn of 1979, 1460 below capacity (Saxton, 1979). Declines in enrollment make new construction unlikely, aside from any replacement to meet earthquake safety standards (Brummett, 1979). Higher education is available at Cerro Coso Community College in Ridgecrest and through extension courses taught at the NWC (Ridgecrest Chamber of Commerce, 1978).

Communications. Continental Telephone Company of California provides telephone services to the area. Local newspapers include: the Daily Independent, (Ridgecrest); the Inyokern Inquirer and the Inyokern News Review; the Inyo Register (Bishop), and the Inyo Independent (Lone Pine). There are several local radio stations, and television reception is augmented by cables.

Recreation. Many opportunities for dispersed (as contrasted with urban organized) recreational activities exist in the region's National Parks, Forests, and Monuments. All BLM-administered lands are generally open to the public for recreational use; and some LADWP lands in Inyo County are also available. Opportunities for organized recreation exist at Diaz Lake, two miles south of Lone Pine. A 500-acre State Park is proposed nearby. Urban recreational areas include the county-operated 100-acre Kern Desert Regional Park, Helmer's Park (5.5 acres), the Sgt. John Penney pool, and Navy parks and recreational facilities which are available to Ridgecrest residents. Lack of adequate urban, organized recreational facilities would be a critical problem in Ridgecrest without access to these Navy resources (Brummett, 1979).

Other Community Services. Inyo and Kern Counties provide limited welfare and other social services in the study area. The Inyo County Welfare Department is located in Independence; additional services are provided to Native Americans in the Owens Valley. The Kern County Public Welfare Department has a district office in Ridgecrest (Peace, 1977: 89). Kern and Inyo Counties maintain branch libraries in Ridgecrest and Lone Pine respectively. The NWC China Lake Library and Cerro Coso College Library are also open to the public.

2.12.1.5 Traffic and Transportation Systems

The highway and local road system providing access to the CGSA is shown in Figure 2.12.2-1 (see Section 2.12.2.5) which also shows annual average daily traffic in 1978. U.S. Route 395, the only north-south artery, is a state-eligible scenic highway in the project area. Peak loads of 7,000 vehicles per day or more on Highway 395 were reached during August, 1978, at the height of the tourist traffic. In the study area, the highway is four-lane divided with at-grade intersections; south of the Inyo/Kern County line and north of Dunmovin it is a two-lane undivided roadway.

The local road system in the study area is very limited. The Gill's Station Coso Junction/Sykes Road (here called Coso Road), partially paved east of Highway 395, providing access to the Coso Hot Springs area. Cinder Road, unpaved, branches off Highway 395 south of Red Hill; this is said to be the historical route to Coso Hot Springs. With the exception of a portion of Coso Road, roads in the CGSA are unpaved, and are graded on an as-needed basis. Some are one-way, have steep grades, uneven surfaces, sharp turns, dips and narrow widths. Traffic volume is often less than 20 round trips per day, though Coso Road may be used by as many as 25 vehicles during visits by Native American groups to Coso Hot Springs (NWC, 1979: 148).

Regional highways experience high recreational traffic during May through October, particularly on weekends. In winter months weekend recreational traffic is also very heavy. Truck traffic is heavy, particularly on US 395 and State Route 178. Most truck traffic is interregional, especially through the study area where population is extremely sparse.

Rail Transportation. Southern Pacific Railroad maintains a line from Southern California to Lone Pine, running roughly parallel to Highway 395 and providing transportation for lumber and mineral ores to the south. A siding located at Coso Junction could provide service to the leasing area via truck connections over Sykes Road/Coso Road. Presently there are two or theree round trips per week to Lone Pine (freight service only), during summer; winter service is less frequent. Since the Louisiana Pacific Lumber Mill near Pearsonville may leave the area, the railroad, in March 1979, has indicated that it may abandon the line from Lone Pine to Pearsonville in three years.

Public Transportation. Only limited service is available. Inyo County provides some mini-bus service for the elderly and handicapped. Greyhound Bus has two scheduled round trips daily over U.S. Route 395 and makes stops at Little Lake, Olancha, Lone Pine, Independence, Big Pine, and Bishop.

Air Transportation. The air space over the Naval Weapons Center is controlled by the NWC for testing purposes during normal office hours on weekdays. Outside these periods, air space is controlled by FAA. At present, the only regular, commercial air passenger line operating in Inyo County serves Bishop Airport. Bishop Airport also has two charter services; Lone Pine has one. Scheduled service from Inyokern Airport is provided by Golden West Airlines (to Palmdale and LAX) and C&M Airlines (to LAX).

2.12.1.6 Employment

Employment by sector for Inyo and Kern Counties and Ridgecrest is (shown in Table 2.12.1-6). Resource industries, government, and trade are the dominant sectors. Unemployment (shown in Table 2.12.2-7) has generally been lower in Ridgecrest than in Kern County as a whole, or in Inyo County. Ridgecrest's high government sector employment makes it more directly sensitive to Federal budgetary fluctuations than to business cycle influences. In general, however, the economy of the China Lake/Ridgecrest area has been stable; employment at NWC ranged between 4,000 and 4,600 (approximately) in the years 1970-1976. Further expansion of some RDT&E activities at the base may be anticipated (NWC, 1977b: 45).

TABLE 2.12.1-6
Employment by Sector: 1970 and 1977

	Inyo County 1970(1)	Inyo County 1977(2)	Kern County 1970(1)	Kern County 1977(3)	Ridgecrest 1970(1)
Agriculture, Forestry Mining	891	691	20,565	36,000	250
Construction	593	339	7,121	5,300	163
Manufacturing	235	97	8,353	8,600	145
Transportation, Communication & Utilities	671	672	7,615	6,700	239
Trade	1,345	1,121	23,738	29,200	[illegible]2
Finance, Real Estate & Insurance	158	221	4,210	4,200	271
Services	1,732	1,588	27,877	18,500	562
Government	326	1,439	10,061	31,600	1,004
Other	-----	-----	-----	8,500	-----
TOTAL	5,951	6,168	109,539	148,600	3,276

NOTES:

1. U.S. Census of Population, 1970
2. Inyo County Planning Dept., Population Report, Inyo County, California, 1978: 9.
3. California Employment Development Dept., Annual Planning Information, Bakersfield SMSA, May 1979: 6-7.

TABLE 2.12.1-7
Labor Force and Unemployment

	Inyo County 1970(1)	Inyo County 1977(2)	Kern County 1970(1)	Kern County 1977(3)	Ridgecrest 1970(1)
Civilian Labor Force	6,292	9,225	117,390	163,000	3,435
Unemployment	341	950	7,851	14,400	159
Unemployment Rate	5.4%	10.2%	6.7%	8.8%	4.6%

NOTES

1. U.S. Census of Population, 1970
2. California Employment Development Division, Bishop Office, Aug. 29, 79, personal communication.
3. California Employment Development Dept., Annual Planning. BAkersfield SMSA, May 1979: 6.

2.12.1.7 Income

Income data for California, Inyo and Kern Counties, and Ridgecrest are included in Table 2.12.1-8.

TABLE 2.12.1-8
Study Area Income Levels

		Inyo County	Kern County	Ridgecrest	California
Median Family Income	1969	$ 9,964	$ 8,937	$11,009	$10,732
	1977	$11,687	$10,936	$16,077	-
Per Capita Income	1969	$ 3,436	$ 2,823	$ 3,866	$ 3,614
	1977	$ 4,756(1)	$ 3,732	$ 5,392	$ 5,464(2)

(1) NWC, FEIS for the Navy Coso Geothermical Development Program, 1979: 142).

(2) As of July 1979, the most recent statistics available from the Department of Commerce.

All the areas, including the state, have lost real purchasing power as measured by the National Consumer Price Index, which rose 65 percent in the 1969-1977 period. By contrast, per capita incomes rose by only about 50 percent for the state and 30 to 40 percent for the other three areas.

2.12.1.8 Major Industry

Inyo County Area. The key industrial activities in Inyo County are recreation, mining, and livestock and agriculture. Within the study area are a cinder mine (at Red Hill), stone, sand and gravel, and clay mines, three pumice mines, and some tungsten and uranium exploration.

A shift in Inyo County away from agriculture towards livestock production--largely due to shortages of available land and water-- may be suggested by total production values for 1978: $1.3 million for crops (down 13% from 1977) and $3.8 for livestock (up 81% over 1977; however annual range cattle production figures fluctuate widely, and the shift may be more apparent than real. Grazing activity is discussed in Section 2.11. Future agricultural development will depend on the reliable supply of irrigation water, availability of arable land, and the introduction of less water-intensive and more salt-tolerant crops (USDI, BLM, 1978b: Ch.IV; Inyo-Mono Counties Department of Agriculture, 1979:3).

Recreational resources are extensive, are largly available all year round, and are used by people from throughout California (Angelo, February, 1979). Although Inyo County campgrounds reportedly served approximately 250,000 people in 1978, the County estimates the actual number of visitors at five to ten times the reported figure (Angelo, February 1979). An estimated 80 percent of the County's economy is dependent in some manner on tourism and recreation (Angelo, February 1979); and the annual growth of that industry is projected at 1.5 percent, assuming gasoline availability.

Kern County Area. Industrial activity in the Ridgecrest and Inyokern areas largely supports the NWC's efforts in research, development, testing and evaluation of advanced weaponry. A number of computer and electronics firms are located in Ridgecrest, as well as two complete machine shops. A major national trucking company is locating a large terminal in the Indian Wells Valley (Ridgecrest Daily Independent, March 23, 1979). The area is becoming a regional service center for motorcyclists and other recreational vehicles (Brummett, February 1979), and agriculture is gaining in importance. East of Ridgecrest in San Bernardino County are Stouffer Chemical Company and Kerr-McGee Chemical Company, outside the study area but providing additional stimulus to the economy of northeast Kern County.

2.12.1.9 Public Revenues

A summary of general public revenue sources in Fiscal Year 1977-78 for Inyo and Kern Counties, as well as for the City of Ridgecrest, is presented in Table 2.12.1-9.

Revenues from property taxes are a function of both assessed valuation (25% of full market value) and property tax rate. The Jarvis-Gann Property Tax Reduction initiative, approved by California voters in June 1978, has had a substantial impact upon property tax rates and the tax bases. In effect, it limits property taxes to one percent of the "full cash value", (assessed valuation as recorded by the County Assessor in 1975-76 or, thereafter, the appraised value of the property when purchased or newly constructed), as opposed to previous rates of three to four percent. The value of this tax base may be increased to reflect an annual inflation rate not to exceed 2 percent annually. Net total assessed value in fiscal year 1978-79 was approximately $129.5 million for Inyo County, $2,848.4 million for Kern County, and $42.8 million for the City of Ridgecrest.

California levies a six percent sales tax on local purchases excluding sales of food for home consumption and prescription medicines. One percent (one sixth) is returned to the County or community. The state also levies a six percent use tax on materials purchased out of state, and provides for a one-sixth return to the area which is the point of destination (State of California, Board of Equalization, 1977b). Total taxable sales in 1977 were approximately $87.8 million for Inyo County, $1,933.2 million for Kern County and $6.3 million for the City of Ridgecrest.

Table 2.12.1-9
Summary of General Revenues: Fiscal Year 1977-78
(in thousands)

Area	Taxes	Licences & Licences	Fines/ Penalties	Use of Money/ Properties	From Other Agencies#	Current Service Charges	Other Revenue	Total
Inyo County	4,024.0	129.3	153.2	173.3	4,423.0	1,748.7	154.4	10,805
Kern County	90,104.2	1,453.6	2,111.9	7,170.7	68,778.5	27,657.5	(3,125.7)	194,150
City of Ridgecrest	1,364.2	147.7	45.2	975.5	1,748.7	91.7		4,410

Includes funds received by these counties from BLM under PL 94-565, Payment in Lieu of Taxes Act, of 1976. For FY 1977-78 these payments amounted to approximately $493,000 and $515,000 to Inyo and Kern Counties, respectively.

Sources: State of California, Controllers Office, Annual Report: Financial Transactions of Cities, 1977-78; and, Annual Report: Financial Transactions of Counties, 1977-78.

2.12.1.10 Public Expenditures

A summary of general expenditures for Fiscal Year 1977-78 for Inyo and Kern Counties as well as for the City of Ridgecrest, is presented in Table 2.12.1-10.

2.12.1.11 Electricity Supply and Demand

Prior to the impacts of the 1973 OPEC oil embargo, US electricity demand grew by about 7% annually; in 1974, usage actually declined. It is now increasing and future growth is projected at 4 to 5 percent annually. Recent OPEC price increases may reduce the growth rate to the extent that electricity production depends upon oil.

National trends hold true for California. Pre-embargo rates were 7 to 9 percent; since 1974, rates have been 3 to 5 percent. The study performed for the EIS assumes annual growth rate of 4.1 percent for California electricity sales and 4.0 percent for growth of peak demand (See Appendix G). Such growth in peak demand would require doubling of generating capacity from 38,000 MW in 1977 to 73,200 MW in 1995.

Of the electricity used in California in 1977 (including 17 percent generated outside the state), 72 percent was generated by gas- and oil-powered plants. The remainder was generated from coal (10 percent), and from nuclear, geothermal and hydroelectric plants (5, 6, and 7 percent, respectively). Dependence on oil- and gas-powered generation should decrease due to the cost of these fuels and to legislation requiring that electric utilities phase out gas- and oil-powered generating facilities by 1990 (2000 under certain conditions).

At present, coal, nuclear, and vapor-dominated geothermal power plants all have approximately the same generating costs ($20-30 per MWH including annualized capital costs). Liquid- and brine-dominated geothermal fields have generating costs up to $40 per MWH. Improved technology (as well as costs of other fuels) should make liquid-dominated geothermal operations cost competitive in the 1990s.

2.12.1.12 Public Attitudes

A synopsis of local public opinion concerning regional growth and the proposed development was compiled from local newspapers, informal personal contacts, and review of environmental studies performed for other proposed developments in the region. Opinion surveys were reviewed for social values and attitudes expressed by desert residents (USDI BLM, Bakersfield 1977; Field Research Corporation, 1977; and USDI BLM, 1978a and b). The scope of the present study specifically precluded the use of questionnaires or other formal

Table 2.12.1-10
Summary of General Expenditures: Fiscal Year 1977-78
(in thousands)

Category of Services

Area	General Government	Public Safety	Public Works	Health and Sanitation Services	Culture and Recreation	Public Assistance	Public Education	Debt Service	total
Inyo County	3,262.5	2,110.4	1,591.8	1,908.3	307.3	1,592.8	176.6	--	10,950
Kern County	23,498.3	48,739.3	13,745.3	31,737.6	5,112.5	56,615.5	2,740.3	325.3	182,514
City of Ridgecrest	481.7	950.5	3,073.8	--	195.6	--	--	--	4,701

Sources: State of California Controller's Office, Annual Report: Finanacial Transactions of Cities, 1977-78; and Annual Report: Financial Transactions of Counties, 1977-78.

interview techniques.

Review of these sources confirms that the majority of desert residents over the age of 18 moved to the desert from other regions, many for reasons of health, retirement, job transfer or military assignment, and that the desert environment is perceived as contributing to their well-being. Independence, privacy, recreational opportunities, and aesthetic qualities are all perceived as integral and highly valued aspects of that environment.

In the Ridgecrest/Inyokern area, perception of the proposed development seems generally positive. Those who express any opinion seem to assume that the program will be implemented and that it will generally benefit the region (Bottorff, 1979). However, any additional rapid growth in Ridgecrest is perceived as presenting problems for the city's infrastructure (US DOD, 1979: D-6). Problems with water delivery and a general lack of services are also seen as constraints to further development in the greater IWV area (ibid.: D-4; Inyokern News-Review, April-August 1979).

Residents of the Inyo County portion of the study area generally perceive that region's economy as being static. Population decline is seen as likely to continue (Farlander, 1979); and anxiety has been expressed regarding the future of recreation and tourism--the area's economic staple--as a result of fuel unavailability and high price. Availability of land is an additional concern (Lane, 1979). Opinion in the southern portion of the county generally favors growth (Budlong, 1979), and the proposed development is considered in a positive light. Ambivalence is expressed, however, by residents who treasure the existing qualities of life in the area; for example, the loss of a sense of privacy is seen as a negative though necessary outcome of any major development program (Hennis, 1979). In general, these residents appear to perceive a necessity for some substantial broadening of the economic base, even while they regret the changes this would bring. Opinion within the county as a whole on the subject of growth is divided. In the Bishop area, where a vocal segment of the public has expressed opposition to growth, a local property owners' association obtained a temporary injunction to halt all construction within the county pending the complete revision of the county's General Plan (Inyo Independent and Inyo County Newsletter, June-September 1979).

In general, countywide opinion seems to support a continuation and enrichment of present lifestyles and values. In the southern Inyo study region, this support is no less observable than elsewhere, but here the residents express an acceptance of the need for industrial infusion, as long as environmental values are preserved.

2.12.1.13 Native American Concerns

Approximately 1300 Paiute-Shoshone and Northern Paiute Indians live in Inyo County, most of them in or near one of the four reservations at Bishop, Big Pine, Fort Independence, and Lone Pine. Though all but the Lone Pine reservation are outside the defined socioeconomic study area, these groups have all expressed similar concerns over the proposed development, and for purposes of this study they, and the Kern Valley Indian groups, are considered as one group. Their concerns have been publicized in local and regional news media and have been the specific subject of a study by Johnson (1977). Iroquois Research Instute (1979, NWC Ad Pub 200) and Theodoratus and Smith-Madsen (draft, 1977) also reported on local Native American groups and their traditional use of the Coso Hot Springs area.

The anxieties expressed by local Indian groups have centered around four issues: (1) impacts of geothermal development upon the temperature, flow, and other characteristics of the waters or muds at Coso Hot Springs; (2) disturbance, either deliberate (vandalism) or accidental, of archaeological resources; (3) difficulties with regard to access to the Springs and a nearby Prayer Site for medicinal and religious purposes; and (4) once access may have been gained, the prospect of having their ceremonies interrupted by traffic, noise, or the presence of workmen.

There is evidence that Paiute-Shoshone peoples traditionally frequented the Springs, and that they attributed medicinal values to the waters and muds (Brooks et al., 1979:6). Many local Native Americans attest to this and also to the religious significance of the area for their ancestors, citing creation myths and other folklore connected with the Springs (ibid.: 189, ff.) and giving personal recollections of trips made there for religious rituals and for use of the healing muds (Johnson, 1977: 8-10). Many who were contacted during the present study mentioned these visits.

This traditional use was constrained by development of a commercial spa at Coso Hot Springs in the early 20th Century, and in 1943 by the withdrawal of the area from public use as part of the NWC. In intervening years the Navy has, when possible, accommodated Native American groups wishing to visit the site; however, it is clear that unrestricted access is incompatible with the NWC mission. A Coso Ad Hoc Committee, comprising representatives of the Owens Valley and Kern Valley tribes, was formed in 1977 to provide for communication and negotiation with NWC. Recently, an agreement has been reached between the Navy and Owens Valley Paiute-Shoshone Indians, guaranteeing eight scheduled overnight visits per year (and additional visits on request) during which Indians will have exclusive use of the area immediately surrounding the Springs and Prayer Site (Inyo Independent, August 2, 1979). It should be noted that according to some medicine men, there may be more than one prayer site. Inclusion of the Springs and Prayer Site on the National Register, and listing and nomination of other nearby sites, attest to the cultural significance of the area.

In view of the importance of this issue, and the rich archaeological deposits in the area (see Section 2.10), the archaeological survey performed for this study was undertaken in coordination with local Native Americans. The Coso Ad Hoc Committee was contacted prior to the survey, and three members of the local Indian community acted as monitors during the entire survey. A number of other tribal members from all four reservations were contacted by letter, phone, or personal meeting by members of the Socioeconomics and Land Use study teams. One member of the team was invited to visit the Tribal Elders of the Owens Valley at a luncheon at the Bishop Reservation and heard several elders state their concerns. In addition to these contacts, literature and local newspapers have been reviewed. It is hoped that the following accurately summarizes the feelings expressed.

It is difficult for members of Western civilizations to comprehend the traditional Indian view of the earth as universal life-giver and healer, and equally difficult for traditional Indians to grasp the prevailing civilization's view of land as something that can be bought and sold by private or public entities. This is only one instance of the wide divergence in value systems. Many of today's Native Americans have bridged the gap and can participate in both value systems to some extent; but this is an effort, and they feel it is an effort few Anglo- Americans are willing to make. For most of the elders, Western values are seen as an imposition of the majority upon the minority, which they accept with resignation. Acceptance has frequently led to structural weakness in the traditional fabric, and to ideological conflicts among the younger members of the tribes (USDI BLM, Bakersfield, 1977:112). The recent resurgence of Native American traditions, and the legal recognition beginning to be accorded them (see, for example, the American Indian Religious Freedom Act of 1978, briefly discussed in Appendix A), have not yet healed these divisions.

The anxieties expressed over geothermal development near Coso Hot Springs should be viewed against this background. The Owens Valley elders and spokesmen feel that the Springs, the Prayer Site, the petroglyphs, and perhaps unknown burial sites have already been taken away from them. The guarantee of eight scheduled visits per year (even if crisis visits for healing are permitted on occasion) seems a far cry from their recollections. One member of the Owens Valley tribes believes that several hundred would visit the Springs if freely permitted; another, equally knowledgeable, estimated "a couple of thousand," including Indians from outside Inyo County. The uneasiness over possible alteration of the Springs persists, and in fact not enough is known to predict impact with any certainty (see Section 2.5). The concern over disturbance of burials is accentuated by the fact that locations of interment sites within CGSA are not well known. Tribal elders have agreed to assist NWC personnel in locating any sites known to them so that protective measures may be taken (NWC, 1979a:159). Other measures suggested by the Paiute Warriors' Association and the Elders include protection of petroglyphs in the region by Indian patrols (USDI BLM Bakersfield, 1977: 82). Several Elders have stated that the Prayer Site is on both sides of Coso Road, and that the National Register boundary may not include all of the area used.

These areas of concern are discussed under Hydrology, Land Use, Traffic, Noise, Cultural Resources, and Socioeconomics.

It is the feeling of researchers that many of the Native Americans are resigned to the proposed development. They feel the recent access agreement is not ideal but "it is something." They hope that the government will respect their values as members of a plural society, will give their cultural and archaeological resources all possible protection, and will give their people a prominent voice in planning multiple uses of public lands. These views, however, are not necessarily those of all, or of the younger, members of these tribes.

2.12.2 Impacts of the Proposed Action on Socioeconomics

The following analysis emphasizes full development of 550 MW on BLM-leased lands. However, since the extent of the geothermal resource is not well understood (see Appendix B), and since legal constraints and high costs may deter development, a lower level of development is also analyzed, and is considered the most likely: approximately 250 MW on BLM-leased lands (and 10-15 MW on NWC lands), with development taking place more spasmodically over fewer years than as described in Chapter 1.

Employment Levels. Conservatively high average employment estimates for full development (550 MW) are shown in Chapter 1. NWC-contractor employment is not included. Employment estimates would be lower if economies of scale could be effected through unitization of BLM leases; however, unitization is not assumed here (see Chapter 7). For assessment of greatest potential impact, employees are assumed to come from outside the study area. One 50-MW plant would be coming on line approximately every two years after 1985, and construction employment would be essentially continuous until 2010. There would be active exploration/drilling in all zones. Average employment during development/operation (45 years) is estimated at 375, rising to approximately 500 during a 10-year period (2001-2010). In the lower-level development scenario (250 MW), average employment is estimated at 190, with occasional peaks at about 300. Construction would be intermittent and construction employees would be temporary. Exploration/drilling, operation, plant workover and road maintenance could require essentially full-time employment. During startup (approximately four years), an average work force of 67 is assumed in both scenarios, and during final closeout (two years), a force of 50.

Housing Assumptions. During the start-up years, until the field potential is better known, workers would seek temporary housing, many in the Ridgecrest area but some in southern Inyo, near Olancha or at Little Lake Hotel. The close-out crew of about 50 would probably have a similar residence pattern. For the 45-year development period, the following assumptions apply.

Short-term drilling and construction employment frequently attracts transient workers, content with temporary lodgings of a less than optimal nature. In full field development, with likelihood of essentially permanent, full-time employment over a number of years, the probability of employee relocation to the northeastern Kern/southern Inyo region increases. If an average of 375 employees eventually relocated to the study region with families (conservatively assuming an average family size of three persons), maximum population increase would be 1,050; during the 10-year period when employment could increase to approximately 500, the total new population including families could be 1,500. It is this most extreme case which is examined in the following subsections. It must be emphasized that, even with long-term employment for 375 to 500 workers, certainly not all will be married, have children, and decide to relocate their families; the analysis is performed to determine the capacity of the region to absorb the maximum possible impact.

No developer-supplied housing is assumed in the project description. Families will be assumed to locate mainly in the IWV area but with a scattering throughout southern Inyo as far north as Lone Pine and a few in remote locations. For estimating most severe impact, however, the analysis assumes a concentration of 500 new families in one area, either the Ridgecrest/Inyokern/Brown Road area or, most extreme of all, southern Inyo County (Olancha/Cartago or Rose Valley). This last case is considered highly unlikely, but the possibility is examined. The lower-level development scenario involves approximately half the above number of employees; many of these would be temporary. In this case, permanent employees and families would probably live in the Ridgecrest area at first, with spillover into Inyokern/Brown Road as housing becomes available, and a scattering in southern Inyo County. These housing assumptions are summarized in Table 2.12.2-1.

2.12.2.1 Population

In the maximum development case, with all employees and families living in Ridgecrest, project-related growth could constitute 5.5 percent of the City's total population and 4.2 percent of the total Indian Wells Valley (IWV) population by the year 2000; see Table 2.12.2-2. Concentrations of all employee families in southern Inyo County (in the western portion of Lone Pine Census Division) would account for approximately 20 percent of the entire Division's projected population in the years 1990-2010. Population characteristics of both areas would be altered by this imported population. Employee families would be in their productive years; young children might lower the median age. Impact on ethnic composition, education levels, and life styles would be difficult to estimate at this stage. The average level of education attained by the imported families may more nearly approach the state level than the average in China Lake in 1970. An increasing number of wives of employees may seek employment in the area, in keeping with national and state trends (USDI, BLM, 1978a: III-4); many of these jobs would probably be in the service industries. In addition to employees, approximately 300 indirect jobs would be created in the study area by the

Table 2.12.2-1 EMPLOYMENT/HOUSING SCENARIOS EXAMINED IN SOCIOECONOMIC ANALYSIS

Employment/ Housing Scenario	BLM Leasing Development Scenario	Average/Peak Employment (Maximum new Population)	Residential Pattern Anticipated
Lower Level	Most Likely (250 MW)	190/300 (570)	Ridgecrest at first; eventual spillovers and scattering into Inyo County.
Greatest Impact	Full Field Development (550 MW)	375/500 (1050, growing to possibly 1500 in years 2000-2010)	100% in Ridgecrest/ Inyokern/Brown Road, or 100% in one location in southern Inyo County.

TABLE 2.12.2-2

POPULATION IMPACTS OF PROPOSED ACTION: 1980-2030 (ASSUMING 600-MW DEVELOPMENT AND CONCENTRATION OF EMPLOYEES AND FAMILIES IN ALTERNATE LOCATIONS)

	1980	1990	2000	2010	2020	2030
POSSIBLE MAXIMUM POPULATION RESULTING FROM PROPOSED ACTION (EMPLOYEES AND FAMILIES)		1,060	1,450	1,500	900	350
Ridgecrest/China Lake Population [1]						
Without Project:	21,900	24,200	26,500	29,300	32,300	35,700
With Project:		25,260	27,950	30,800	33,200	36,050
Project Population as % of Total:		4.2%	5.5%	4.7%	2.7%	1.0%
Total Indian Well Valley (IWV) Population [1,2]						
Without Project:	25,700	29,100	33,000	36,500	40,300	44,500
With Project:		30,160	34,450	38,000	41,200	44,850
Project Population as % of Total:		3.5%	4.2%	4.0%	2.2%	0.8%
Lone Pine Census Division Population [3]						
Without Project:	3,300	4,330	5,230	6,100	6,950	7.900
With Project:		5,390	6,680	7,600	7,850	8,250
Project Population as % of Total:		19.7%	21.7%	19.7%	11.5%	4.3%

1. Source: 1980-200 projections from Kern County Planning Department, Population by Census Tract, March 1979; 2010-2030 profections based on Kern County Planning staff population prijections for 2000 using a growth rate of 1% (J. Folpmers, Kern County Planning Department, May 1979)

2. Figures include Ridgecrest/China Lake.

3. Projections for Lone Pine Division estimated as 25% of Inyo County's projected growth 1980-2030; discussed with R. DeHart, Inyo County Planning Department May 1979. (See Figure 2.12.1-1 for boundaries of Lone Pine Census Division.)

proposed action; see Section 2.12.2.6. It is expected these jobs would be filled mainly by local residents, including wives of geothermal employees. In the lower-level development case, approximately half of the maximum employment is expected; and a higher proportion would be temporary, as development would be intermittent.

Temporary employment as a result of NWC geothermal development is estimated at a maximum of 350 during the years 1980-1984 (NWC, 1979). During this period the BLM-proposed program would employ only about 67 persons. Maximum permanent population increase due to the NWC installation would be 175 persons after 1985.

2.12.2.2 Private Land Uses

The program would have an indirect impact in the socioeconomic study area by generating a need for additional private land uses: residential, commercial, public facilities and recreational. A conservatively high estimate of 0.5 acres per permanent worker's family, for all private land uses, is assumed (USDI, BLM, 1978: 1238). Private land use requirements during the start-up and shutdown periods are expected to be minimal. If existing temporary housing is used, there would be virtually no additional requirements.

An influx of 375 families could require approximately 188 acres of private land, more could be required in the years 2000-2010. The Ridgecrest/Inyokern/Brown Road area could probably accommodate this requirement, though land used for this purpose would be unavailable for its present uses (largely grazing, agriculture and open space). Possible future development in southern Inyo County is discussed below and in Section 2.11. In the lower-level development scenario, half (or less) of this requirement would be expected.

No prediction is made concerning private land use requirements for the 55 permanent workers at the NWC geothermal facility (NWC, 1979).

2.12.2.3 Housing Stock

The greatest-impact scenario involves concentration of 375 families, all in Indian Wells Valley (IWV) or all in Rose Valley. The IWV area could probably accommodate all of the new housing requirements. The need would develop over a period of several years. There are presently several hundred vacancies in the total IWV area including Ridgecrest. Available housing in Rose Valley is limited to approximately 25-50 rooms for temporary residence and a few trailer park vacancies. The area would thus require virtually all new housing; 500 units might be required during the period 2000-2010. The lower-level development scenario envisions housing 190 families in IWV with spillover into Inyo County. The private sector could probably accommodate this need. The proposed Kerr-McGee expansion in Trona could create competition in IWV, unless additional housing is constructed in Trona.

During construction of the NWC geothermal facility and startup of the BLM program, 420 temporary dwelling units could be required. Thereafter, the two programs might require a maximum of 550 permanent residences.

2.12.2.4 Infrastructure

Police Protection. Direct impacts involve potential calls for emergency assistance, within the CGSA. The greatest indirect impact would involve housing of 1500 people in Rose Valley or in Olancha/Cartago. Expansion of the Inyo County Sheriff's substation in Olancha (3 additional persons), or establishment of a new substation (5-6 persons) would be required. A similar population increase in IWV could require addition of one officer with equipment and vehicle support.

Fire Protection. Native vegetation on geothermal sites is too sparse to support wildland fires; control rooms would be hardened, with fire suppression equipment on hand. However, if full field development takes place, a fire station may be needed near the CGSA. An added 1500 people living in Rose Valley would require expansion of existing volunteer fire protection in Olancha. The same number of people entering the IWV would cause an increase in the number of calls for fire protection and the possible addition of one person, plus equipment.

Electrical Utility. The only direct electricity requirement would be 8766 mwh/year required for water line pumping. During construction, electricity needs would be met through gasoline-generated power; during operation, power generated through the process would be used. Indirect requirements are estimated at 500 kwh per month per employee family. The greatest impact would occur in Rose Valley, with a possible 500 families using a total of approximately 250,000 kwh/month.

Fresh Water Supply. Consumption by workers and their families is estimated at 220 gpd per person. Present conditions indicate that adequate water will be available although drawdown of groundwater in IWV would be accelerated; the IWV County Water District projects importation of water by the year 2020 (Hamilton, 1979). A water district would be necessary in Rose Valley if population concentration occurred there.

Gas Utility. There will be no project use of natural gas. Domestic consumption is estimated at 5000 cubic feet per month per dwelling unit (or 850 gallons of propane per year per family).

Flood Control/Storm Drains. Runoff and flood hazard within the CGSA are discussed in Section 2.5.2. Indirect impacts are related to population growth, which results in increased runoff as development reduces the amount of ground surface. In addition, homes and buildings often occupy potentially hazardous sites, such as flood plains and canyons.

Sewage/Wastewater Treatment. During early phases of the program portable sanitary facilities would be used on site. When the size of the work force warrants, fixed disposal facilities would be installed. Indirect impacts would be related to total population increases. The average generation factor in Ridgecrest and other local communities with sewer systems is approximately 100 gallons per capita per day (Greenfield, 1979; Webber, 1979). Ridgecrest Sanitation District's facilities could presently accommodate 1500 additional residents; however, by the year 2010 the system could be over capacity (Greenfield, 1979). A similar situation exists in Inyokern (Webber, 1979). A concentration of 1500 persons in Rose Valley would require formation of a sewer district there.

Solid Waste Disposal Facilities. Drilling mud, amounting to perhaps 25,000 ft^3 (708 m^3) per well (based on figures projected for wells in the Brawley Field (Imperial County, 1979: 26)) would contain possibly hazardous additives. During operations, an unknown amount of Group I geothermal solid waste would result from cleaning of pipelines, production lines, etc. (up to 2000 metric tons or 1320 m^3 of waste per year is the figure projected for a 10-MW plant at Brawley (Imperial County, 1979: 274). In addition, sludge from the H_2S abatement system could amount to as much as 2 yd^3 (1.5 m^3) per day per 50-MW station (based on figures projected for a 139-MW plant at the Geysers (PG&E, 1975, App. M:3). All of the above would initially have to be hauled to a Class I or Class II-1 site (see Chapter 1). Rock and cuttings from well drilling, if not permeated with drilling muds, would be disposed of in waste sumps at the sites. Inert construction debris would be disposed of by hauling to a Class II-2 or Class III site; the nearest Class II-2 facility at Ridgecrest could presently accommodate this debris. Office-type paper waste generated at the site and domestic rubbish generated by the increased population could also be accommodated by local facilities. The life of these facilities would be incrementally shortened.

Health/Mental Health Systems. The presence of 1500 additional persons would increase demand for health care and related services, including emergency and out-patient treatment at the Southern Inyo Hospital in Lone Pine and the Ridgecrest Community Hospital, as well as calls for physicians' services. The proposed development may stimulate additional physicians to move into the area.

Education Systems. Approximately 20 percent of any new permanent population due to geothermal development may be children of school age. In the greatest-impact case, 300 additional students might enter either the Sierra Sands Unified School District or the Lone Pine Unified School District. Such an addition in Rose Valley would require expansion of the existing elementary school in Olancha. High school students in Rose Valley would have to be bused to Lone Pine. The additional students could constitute a beneficial impact on the district, as enrollments have been declining in recent years (McCollum, 1979). The Sierra Sands Unified School District is presently below capacity;

enrollment has also been declining there. A significant population increase could, however, affect the District's plans regarding replacement or expansion. Some additional enrollment could be expected at Cerro Coso Community College in Ridgecrest.

Communication. Telephone and radio telephone services at geothermal sites can be provided by Continental Telephone Company. The use of microwave links would minimize land disturbance. The need for two-way radio communication may be increased, along with the potential for emergency services.

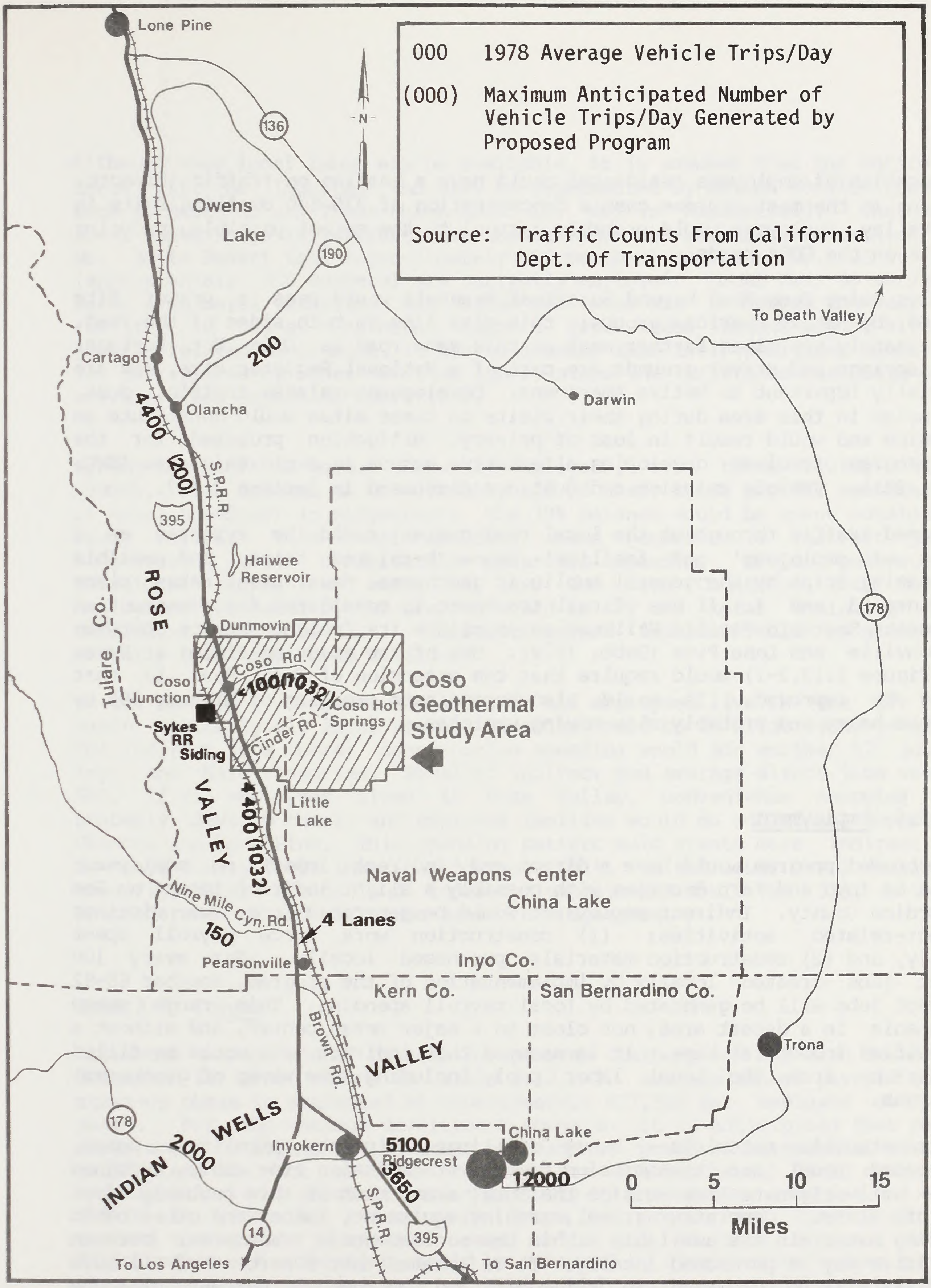
Recreation. With increased population, some undetermined increase in the area generally (for example, in the number of visitors to nearby National Parks, Forests, and Monuments) is expected.

Cumulative Impacts. The cumulative impact on the infrastructure of 350 (maximum, NWC) and 67 (start-up, BLM) temporary workers could be substantial, depending on where those workers reside. After NWC facilities are operational, maximum new permanent population related to that program could be 175, again a potential major impact in a rural area with few existing services.

Geothermal wastes generated by the two programs would be directly related to the extent of geothermal production. The cumulative wastes from other related projects such as the Red Hill and Renegade mines must also be considered. Group 1 wastes from all such projects would eventually necessitate the establishment of a Class I or II-1 site in the vicinity if geothermal development proceeds to the full 600 MW. Siting such a facility would require study and coordination by all parties, including developers, BLM, NWC, RWQCB and other agencies.

2.12.2.5 Transportation and Traffic Systems

Access to the leasing area would be along Highway 395 and Coso Road (see Figure 2.12.2-1). Growth of traffic volumes along Highway 395 could bring the total to three or four times present volumes by the year 2030, still well below capacity (Caltrans, 1979). Further widening is planned. Project-related traffic at maximum employment could amount to slightly over 1,000 vehicles/day (vpd), or 500 round trips, including 200 or more heavy vehicles, an increase of only 23 percent over present levels. No congestion along Highway 395 is anticipated except at Coso Junction rest stop, where slowing and turning of heavy trucks could pose a traffic hazard. In the two-lane segment below Pearsonville, slow-moving trucks may also constitute a hazard. Increase of traffic to several hundred vpd over any of the roads within the CGSA is not possible without considerable improvement and widening. (Parking and storage areas would be provided at work sites.) Traffic impacts of the lower-level development scenario would be approximately half the above estimate.



1978 ANNUAL AVERAGE DAILY TRAFFIC AND PROJECT-RELATED
TRAFFIC ON MAJOR ROADS WITHIN STUDY AREA

Figure 2.12.2-1

The location of employees residences could have a bearing on traffic impacts. Assuming in the most extreme case a concentration of 375-500 dwelling units in Rose Valley, employees would probably carpool to the extent possible, reducing impacts on the CGSA roads.

Vehicles using Coso Road beyond Sugarloaf Mountain would pass a prayer site visited by Native American groups; this site lies on both sides of the road. Approximately two miles farther east on this same road is Coso Hot Springs. Both springs and prayer grounds are part of a National Register site, and are especially important to Native Americans. Development-related traffic, dust, and noise in this area during their visits to these sites would constitute an intrusion and would result in loss of privacy. Mitigation proposed for the NWC program involves developing alternative access to avoid this area (NWC, 1979: 221). Vehicle emission and dust are discussed in Section 2.2.2.

Increased traffic throughout the local road system could be expected as a result of employees' and families' non-work-related trips, and possible sightseeing trips by the general public if geothermal development takes place in Zones 3 and 4. If use of rail transport is considered for construction equipment, Southern Pacific Railroad may continue its freight service between Pearsonville and Lone Pine (Hebb, 1979). Use of the existing siding at Sykes (see Figure 2.12.2-1) would require that the extension of Coso Road to that siding be improved. It would also necessitate crossing of Highway 395 by numerous heavy and probably slow-moving vehicles.

2.12.2.6 Employment

The proposed program would have a direct and indirect impact on employment levels in Inyo and Kern Counties with possibly a slight indirect impact on San Bernardino County. Indirect employment would be generated from two distinct project-related activities: (1) construction work force payroll spent locally, and (2) construction materials purchased locally. For every 100 direct jobs created locally by implementation of the program, another 65-82 indirect jobs will be generated by local payroll spending. This range seems reasonable in a desert area, not close to a major urban center, and without a diversified industrial base. It is assumed that indirect jobs would be filled by persons from the local labor pool, including some wives of geothermal employees.

Most construction materials -- heavy drilling equipment, pipelines, pumps, fabricated steel for transmission towers, transmission line cable, turbines etc.-- will originate from outside the local area, much of this probably from out of state. Concrete, gravel, grading equipment, lumber and other basic building materials are available within the socioeconomic trade area; certain quantities may be purchased locally. It is assumed that 5 percent of all such materials will be purchased in Ridgerest and another 5 percent will be purchased in Inyo County.

Although some local labor may be available, it is assumed that the entire work force will be imported and will be represented by unions outside the area, such as Building and Trade Union Local No. 465 in Bakersfield. The entire local memberships in International Longshoremen and Warehousemen's Union Local No. 30 in Desert Lake (approximately 500 members) and Local No. 35 in Argus (approximately 450 members) are currently employed. Local No. 30 serves the Boron area borax extraction facilities and Local No. 35 serves the Kerr-McGee facility in Trona. Although members from these unions may be hired for program-related employment, it can be assumed that their positions would have to be replaced by other imported labor, since the facilities that both unions serve are now expanding operations.

During the start-up period temporary employees, even those living in Inyo County, are assumed to do virtually all of their local payroll spending (70% of total spending) in Ridgecrest; the 30% balance would be spent outside the study region. This local spending would generate 31 indirect jobs in Ridgecrest. Local construction materials spending would generate an additional eight jobs each, in Inyo and Kern Counties. Total indirect employment generated by the program would be 47, and total including direct employment would be 114. Closeout period impacts would be similar and slightly less, see Table 2.12.2-3.

In the maximum development scenario, if all employees live in the IWV area, again virtually all local payroll spending would be in Ridgecrest, generating 204 indirect jobs there; construction spending would add another 52 jobs in Inyo and Kern Counties. Total of indirect and average direct jobs would be 683. If all employees lived in Rose Valley, convenience shopping would probably develop there, and employee families would do additional shopping in Olancha and Lone Pine. This spending pattern wuld create more indirect jobs in Inyo County (108) than in Ridgecrest (82). In the lower level development scenario, total direct and indirect employment would be 313, with the preponderance of indirect jobs again in Ridgecrest.

2.12.2.7 Income

Estimated average annual payroll for program start-up and for each development scenario is also shown in Table 2.12.2-3. Average annual payroll for the start-up phase is estimated at approximately $27,500 per employee over four years. For the maximum development scenario, it is anticipated that payroll costs would be higher for a number of reasons: proof of substantial resources would tend to act as an incentive for the geothermal field operator to maximize the level of construction activity by encouraging overtime and double shifts in order to reduce work force turnover. Also, Zones 3 and 4 are assumed to require 50 percent more wells per MW than Zones 1 and 2. Efficiencies of operation would be enhanced by discouraging worker turnover through generous overtime pay schemes, and encouraging longer hours per worker.

Table 2.12.2-3 EMPLOYMENT IMPACTS OF PROJECT CONSTRUCTION (In thousands of dollars)

	Development Scenarios			
Assumed MW:	0	250	550	
	Start Up	Lower-Level Impact	Greatest Impact	
(1) Payroll Spending:				
Direct Employment (a)	67	190	375	
Total Direct Labor Cost (b)	$14,727	$455.131	$1,094,846	
Payroll @ 50% of Total Labor (c)	7,364	277,566	547,423	
Average Annual Payroll:				
Startup (4 years)(d)	1,841			
Development (45 years)(e)		5,057	12,165	
Average Payroll Spending @ 75% (f)	1,381	3,793	9,124	
			All Ridgecrest	Inyo/ Ridgecrest
Projected Spending Patterns:				
Ridgecrest:				
Percent of Total Spending (g)	70%	70%	70%	70%
Number of Workers	67	190	375	150
Payroll Spending	$ 967	$ 2,655	$6,387	$2,555
Inyo County:				
Percent of Total Spending (g)				42%
Number of Workers				225
Payroll Spending				$3,832
Indirect Employment Generated:				
Ridgecrest (h)	31	85	204	82
Inyo County (i)				108
SUBTOTAL	31	85	204	190
Average Annual Payroll Per Person (Direct Employment Only)	$27.48	$26.62	$32.44	$32.44

Table 2.12.2-3 EMPLOYMENT IMPACTS OF PROJECT CONSTRUCTION (continued)

	Development Scenarios			
Assumed MW:	0	250	550	
	Start Up	Lower-Level Impact	Greatest Impact	
(2) Construction Material Spending:				
Total Spending (j)	$14,149	$407,373	$989.779	
Annual Spending (k)	3,537	8,147	21,995	
Spending in Ridgecrest @ 5%(l)	177	407	1,100	
Spending in Inyo County @ 5% (2)	177	407	1,100	
Indirect Employment Generated:				
Ridgecrest (m)	8	19	52	
Inyo County (m)	8	19	52	
TOTAL	16	38	104	
			All Ridgecrest	Inyo/ Ridgecrest
(3) Total Indirect Employment Generated:				
Ridgecrest	39	104	256	134
Inyo County	8	19	52	160
TOTAL	47	123	308	294
(Effective Local Mulitplier)(n)	1.70	1.65	1.82	1.78

(a) Average employment over startup period (4 years) and development (45 years); estimates from Chapter 1 (Project Description).

(b) Calculated from Chapter 1 (Project Description).

(c) Assumes 50% of direct labor cost allocated to burden (such as fringe benefits); balance represents actual payroll before taxes.

(d) Average over five-year period.

Table 2.12.2-3 EMPLOYMENT IMPACTS OF PROJECT CONSTRUCTION (continued)

(e) Average over 45-year period; closedown phase of 2 years not included.

(f) Assumes 25% of actual payroll allocated to taxes, savings, investment, and non-local purchases; balance represents local payroll spending.

(g) Percents correspond to proportions of total construction workforce residing in each area, from development scenarios and startup estimate; it is assumed that 30% of Ridgecrest resident payroll spending will occur outside Ridgecrest and Inyo County and that 30% of Inyo County resident payroll spending will occur outside Inyo County and Ridgecrest; this is based on recent conversations with Coldwell Banker (June, 1979).

(h) Assumes that every $31,350 of local payroll spending (all retail items) will generate one indirect job; from U.S. Department of Commerce 1972 Census of Retail Trade: California, adjusted to January, 1979 dollars from U.S. Department of Commerce, Bureau of Labor Statistics, Consumer Price Indices.

(i) Uses same assumptions and data sources as in (h) above, except that ever $35,550 of local payroll spending will generate one indirect job.

(j) Calculated from Chapter 1 (Project Description).

(k) Average over five-year period during startup, 45-year period during subsequent development.

(l) Assumes that Ridgecrest and Inyo County will each contribute 5% of the total value of construction materials, both during startup and subsequent development.

(m) Assumes that every $21,250 of construction materials purchased locally will generate one indirect job; from U.S. Department of Commerce 1972 Census of Wholesale Trade: California, adjusted to January, 1979 dollars from U.S. Department of Commerce, Bureau of Labor Statistics, Consumer Price Indices; local materials spending assumed to largely concentrated in three two-digit Standard Industrial Classification (SIC) Codes: 24 (lumber), 32 (stone, clay, glass - includes gravel), and 35 (machinery).

(n) All direct and secondary employment expressed as a percent of direct employment only.

2.12.2.8 Major Industry

Within the study area, the proposed program would substantially increase the volume of construction activity, construction materials purchased locally, extractive industry, energy production, and recreation/tourism. The direct impacts on major industry, adjusted to January 1979 dollars, for each development scenario are presented in Table 2.12.2-4. These impacts would be more pronounced in Inyo County than in Kern County, with possible slight impact in San Bernardino County.

Materials and payroll spending resulting from the program would also generate indirect impacts on major industry, particularly housing construction in Kern and/or Inyo Counties.

2.12.2.9 Public Revenues

Sales and Use Taxes. Approximately 35 percent of total average annual payroll spending would be taxable, based on historical spending patterns for similar projects in California. The estimated sales and use tax revenues resulting from the proposed program are presented in Table 2.12.2-5.

The maximum impact scenario, assuming that private development is permitted in Rose Valley would result in annual revenues from subventions of approximately $19,900 to Ridgecrest, $5,000 to Kern County, and $85,500 to Inyo County. It should be noted that commercial development in Rose Valley could result in far more retail spending in Inyo County.

Kern County sales and use tax revenues totaled $10.7 million in FY 1977-78. Revenues from the proposed program, in its greatest impact scenario, would represent 0.5 percent of that amount. The City of Ridgecrest received sales and use tax revenues totaling $0.7 million in FY 77-78. Revenues generated by the greatest-impact scenario would represent 2.8 percent. Impact on Inyo County revenues would be substantially greater. In FY 1977-78 that county received sales and use tax revenues totaling $0.5 million. In the greatest-impact scenario, assuming concentration of employees in Rose Valley, the revenues generated by the proposed program would amount to 17.1 percent of the 1977-78 figure.

Property Taxes. The program would have a direct impact on the tax base of the study area (including assessed property valuation from program development improvements and the resource value of geothermal production) and on the sales tax base from local construction materials and payroll spending. The increase in assessed property valuation will be the result of power plant construction, including an electric transmission line, a water pipeline from Rose Valley, and the leasing and development of the geothermal resource. All direct increases in assessed property valuation resulting from the program would be received by Inyo County (see Table 2.12.2-6).

Table 2.12.2-4 ESTIMATED CONSTRUCTION COSTS (In Thousands of Dollars)

Construction Activity	Production Development Scenarios		
	Start Up	Lower-Level Impact	Greatest Impact
(1) Well Construction Costs			
Number of Wells	25	600	1,500
Total Material Cost (49%)	$14,149.1	$339,578.4	$848,946.0
Total Labor Cost (51%)	14,726.6	353,438.7	883,596.8
Total Well Cost (@1,003500/well in 1977 dollars)	28,878.7	693,017.1	1,732,542.8
(2) Water Pipe Construction Costs			
Pump and Equipment			
Materials Cost (40%)		663.0	663.0
Labor Cost (60%)		994.4	994.4
Total Pump and Equipment Cost		1,657.4	1,657.4
(3) Main Pipeline ($50 per foot in 1977 dollars)			
Materials Cost (40%)		972.4	972.4
Labor Cost (60%)		1,458.5	1,458.5
Total Main Pipeline (@ 8 miles)		2,430.9	2,430.9
(4) Power Plant Construction Costs (@ $25 million per 50 MW including access and maintenance roads in 1977 dollars)			
Number of 50 MW Plants		5	11
Materials Costs (40%)		57,550.0	126,610.0
Labor Costs (60%)		86,325.0	189,915.0
Total Power Plant		143,875.0	316,525.0
(5) Transmission Line Costs			
Main line @ 8 miles			
Materials Cost (40%)		5,294.6	5,294.6
Labor Cost (60%)		7,941.9	7.941.9
Total Main Line Cost		13,236.5	13,236.5

(continued)

Table 2.12.2-4 ESTIMATED CONSTRUCTION COSTS (continued)

Construction Activity	Production Development Scenarios		
	Start Up	Lower-Level Impact	Greatest Impact
(6) Connector Lines (1 mile/50 MW plant)			
Materials Cost (40%)		$3,314.9	$7,292.7
Labor Cost (60%)		4,972.2	10,939.2
Total Connector Line Costs		8,287.1	18,231.9
(7) TOTAL CONSTRUCTION COSTS			
Materials Cost	$14,149.1	407,373.3	989,778.7
Labor Cost	14,727.6	455,130.7	1,094,845.8
TOTAL COST	$28,875.7	$862,504.0	$2,084,624.5

2.12.2-5 ESTIMATED SALES TAX REVENUES (In thousands of dollars)

	Production Development Scenarios			
Assumed MW :	0	250		550
	Start Up	Lower-Level Impact		Greatest
(1) Annual Total Materials Spending Start-up (@ 4 years) Development (@ 45 years)	$3,537.0	$8,147.0		$21,995.0
(2) Estimated Annual Materials Spending by Area (from Employment Impact Table)				
(a) Ridgecrest (@ 5% of #1)	176.9	404.4		1,099.8
(b) Inyo County (@ 5% of #1)	176.9	407.4		1,099.8
(c) Rest of California (@ 70% of #1)	2,475.9	5,702.9		15,396.5
(d) Outside California (@ 20% of #1)	707.3	1,629.3		4,398.9
(3) Estimated Annual Sales & Use Tax Revenue From Materials Spending by Area				
(a) Kern County (@ .25% of line #2a)	0.4	1.0		2.8
(b) Ridgecrest (@ 1% of line #2a assuming all spending in Ridgecrest)	1.8	4.1		11.0
(c) Inyo County (@ 1.25% of line #2b, and 1.25% of line #2d assuming all use tax in Inyo	11.0	25.5		68.7
(4) Average Annual Payroll Spending By Area (From Employment Impact Table)			All Ridgecrest	Inyo-Ridgecrest
(a) Ridgecrest	967.0	2,655.0	6,387.0	2,555.0
(b) Inyo County				3,832.0

Table 2.12.2-5 ESTIMATED SALES TAX REVENUES (continued)

	Production Development Scenarios			
Assumed MW:	0	250	550	
	Start Up	Lower-Level Impact	Greatest Impact	
(5) Estimated Annual Average of Taxable Payroll Spending by Area (assuming 35% of line #4 is taxable)			All Ridgecrest	Inyo/ Ridgecrest
(a) Ridgecrest	$ 338.5	$ 929.3	$2,235.5	$ 894.3
(b) Inyo County				1,341.5
(6) Estimated Annual Sales Tax Revenue from Taxable Payroll Spending by Area				
(a) Kern County (@ .25% of line #5a)	0.9	2.3	5.6	2.2
(b) Ridgecrest (@ 1% of line # 5a)	3.4	9.3	22.4	8.9
(c) Inyo County (@ 1.25% of line #5b)				16.8
(7) Estimated Total Annual Sales Tax Revenue from Taxable Materials and Payroll Spending by Area				
(a) Kern County (Lines #3a & 6a)	1.3	3.3	8.4	5.0
(b) Ridgecrest (Lines #3b & 6B)	5.2	13.4	33.4	19.9
(c) Inyo County (Lines #3c & 6c)	11.0	25.5	68.7	85.5
TOTAL LOCAL REVENUE	$17.5	$42.2	$110.5	$110.4

Table 2.12.2-6 ESTIMATED PROGRAM-RELATED MARKET VALUATIONS IN 2010
(Thousands of 1979 dollars)

	DEVELOPMENT SCENARIO	
	Lower-level development	Greatest Impact
Power Plant Construction[1] (Including Transmission Line)	$ 69,827	$ 172,457
Water Line Construction[2]	4,088	4,088
Fair Market Value of Geothermal Resource ($320,000/MW	80,000	176,000
Total Market Value	153,915	352,545
Assessed Value (25% of Market Value)	38,478	88,136
Percent of 1979 Inyo County Assessed Valuation ($121,509)	31.7%	72.5%
Percent of 2010 Inyo County Assessed Valuation ($224,222)	17.2%	39.3%

1. Construction costs from Table 2.12.2-4. Values are depreciated using a 30-year facility life.

2. Table 2.12.2-4.

3. The current market value for Sonoma County geothermal steam is $20 per pound of pressure (Mr. Ken Cory, Senior Appraisor Sonoma County Assessor's Office). Based on the project description estimate of 800,000 pounds of steam for a 50 MW power plant, the per MW steam value is $320,000.

Valuation of geothermal resource in Sonoma County, the California County with the most geothermal experience, is determined on the basis of the both possessory interest (market value of leasehold) and the value of the resource. This method assigns possessory interest to successful exploratory wells ($20,000-$30,000 per well in 1977). As portions of a field go into production, the possessory interest of the producing portion is removed from the assessment roll and replaced by a geothermal resource value ($20 per pound of produced steam in 1979).

Public utilities are valued by the State Board of Equalization, based on the market value of the stock, the rate base, and other factors. The physical facilities are valued at their location based on the historical cost of the facility less accumulated depreciation. The statewide assessed value for each utility is allocated back to each taxing jurisdiction based on the replacement value less depreciation for each facility in the taxing jurisdiction. Attempts to assign the Coso facilities to a public utility (DWP or SCE) and to estimate replacement costs, rate bases, corporate stock values and debt are beyond the scope of this report. Therefore, the assessed valuations presented in Table 2.12.2-6 do not reflect Board of Equalization assessment practices, but only historical cost less accumulated depreciation. The power plants are depreciated over a 30-year period from the plant's first year of operation. The first year of operation of the initial and final power plants for each development scenario are: lower-level (1986-2000), and greatest-impact (1985-2010).

The proposed program would have a significant impact on Inyo County's projected assessed valuation for the year 2010. Over the period 1968-1978, real assessed valuations increased by an average of 1.76 percent per year. The statewide 2 percent limit on annual increases in assessed valuation will have a small effect on this trend (should it continue), since many properties will change hands and be reassessed at real market values, as will new construction. The lower-level development scenario would increase projected Inyo County 2010 assessed valuations by 17 percent. The greatest impact scenario would increase 2010 assessed valuations by 39 percent.

Revenues from Geothermal Leasing. Under the provisions of FLPMA (see Appendix A), Section 317 (a), 50 percent of all revenues received from the proposed program would be returned to the State of California "to be used by such State and its subdivisions, as the legislature of the State may direct, giving priority to those subdivisions of the State socially or economically impacted by the development of minerals leased under this Act." Revenues that fall under this provision are the bonus bid, rental, and royalty revenues.

The bonus bid represents the purchase price of the right to develop the geothermal resource and to assume the lease. This is a one-time cost to the developer prior to award of lease. Before bidding on the lease, however, potential bidders are informed of the rental and royalty rates. Under current BLM practices, the rental rate is set at $2 per acre and the royalty rate is 10 percent of the annual production value of the geothermal resource as determined by the USGS. In general, rental on federally administered land is paid to the BLM until the resource is brought into production; thereafter payment is continued in the form of royalties, paid to USGS. (Rates may be readjusted later according to a general formula given in 43 CFR 3205.) Geothermal leases on Federally administered lands in California have recently begun production in the Geysers area; however the amounts of royalities to be paid from these leases have not yet been determined (White, M., 1980).

The Roosevelt Hot Springs KGRA in Utah, probably the geothermal area most comparable to the Coso area, was first leased in 1974; accepted bonus bids ranged from $5 to $128 per acre (or $7 to $188 in 1979 dollars). Development of the CGSA could yield significant annual royalty revenues. In the year 2010, under the greatest-impact scenario, approximately $2 million in royalties would be divided between Federal and state governments (see Table 2.12.2-7).

Table 2.12.2-7
ESTIMATED PROGRAM-RELATED ROYALTY PAYMENT IN 2010
(In Thousands of 1979 Dollars)

	Development Scenario	
	Lower-Level Development	Full Development
Assumed MW (BLM Leases)1	250	550
Annualized Value of Resource (at $36,800/MW)[1]	9,200	20,240
Royalty at 10%	920	2,024
California Share	460	1,012

1. Fair market value annualized over 30 years at 11%.

At present there is no legislation in the State of California to provide for the distribution of such geothermal revenues between the state and counties or other local jurisdictions.

Other Public Revenues. The proposed project would also result in a direct increase in a number of one-time revenues in Inyo County, for example, revenues from planning, building, and inspection fees associated with program development.

2.12.2.10 Public Expenditures

Direct increase in the marginal work loads of public employees (e.g., general government, fire, and police) as a direct result of the geothermal development, would be relatively insignificant and would not require any increase in public expenditures. However, the program could generate an indirect (population growth-related) need for additional public expenditures.

In the maximum impact case, with all employees living in IWV, Kern county would incur the costs of adding one or two employees and associated equipment to the existing fire/ police protection systems, a possible total of $60,000 per year plus a one-time purchase of equipment. At the same time, however, the County would experience the economic stimulus of payroll spending as discussed above; essentially no payroll spending would be expected to occur in Inyo County under this scenario. On the other hand, regardless of the residential pattern established, the public revenues from geothermal development would accrue to Inyo County.

Assuming development is permitted in Rose Valley, the greatest-impact scenario would require approximately three to six additional sheriff's department personnel, at a total cost of approximately $100,000-$200,000 a year; one or two support vehicles at a cost of approximately $10,000 each, plus maintenance and gas; and possible construction of a new substation in Olancha. The Inyo County Sheriff's station in Olancha recently completed a jail addition at a cost of approximately $750,000; construction of a new substation would probably bear a capital cost in excess of this amount. This scenario would also require expansion of volunteer fire protection in Olancha or formation of a new district and acquisition of equipment. A new fire station would probably bear a capital cost similar to that of the sheriff's substation. A new pumping truck, a hook-and-ladder truck and one automobile would require approximately $275,000. Though no payroll would be involved in a volunteer district, equipment maintenance and fuel costs would be incurred.

It is assumed that the Lone Pine Unified School District could accommodate any additional requirements without additional costs. It is unlikely that the Sierra Sands Unified School District would need additional facilities as a result of the proposed development.

It is assumed that the cost of increasing other utility capacity (gas, electricity, etc.) would be borne by user fees and hookup charges. No other public service costs are anticipated as a result of the proposed program.

In the lower-level development case, the indirect impacts would be approximately half of those described above. The effect of temporary NWC employment must also be considered; this would involve increase in the work loads of public employees but probably no increase in public expenditures during the five years of construction.

2.12.2.11 Public Attitudes

A discussion of the public opinions, expectations, and expressions of perceived well-being can be found in Section 2.12.1.12.

2.12.2.12 Native American Concerns

Native American conerns regarding the proposed action are described in Section 2.12.1.13.

Noise impacts are discussed in Section 2.3.2, where noise contour maps for the Prayer Site and Coso Hot Springs are shown (assuming a power plant within one mile of each site). Development or operational noises that are at background levels would not interfere with ordinary activities. However, the concern of the Native American groups is that, for persons engaged in prayer and meditation, any non-natural auditory intrusion may be distracting (for example, even a distant, constant, low-level sound of machinery, they feel, might be obtrusive whereas a nearby birdcall might not). This is a statement of concern, as perceived by researchers, and not necessarily a potential impact. Intermittent traffic noises (see Section 2.12.2.5) would also be a source of disturbance during visits to these sites.

The possibility of altering the flow or character of the springs is discussed in Section 2.5.2, and careful monitoring and reinjection are suggested as mitigation (see Chapter 3); but at this preliminary stage of analysis no certain reassurance can be given to the Native Americans. The healing qualities attributed to the Springs and the traditional interrelationship between religion and healing, give Coso Hot Springs great significance for them. In general, as suggested in the preceding paragraph, they appear to feel that any man-made alteration in the existing conditions would be a negative impact.

Local groups have been assured of the general (and official Federal) concern for protection of archaeological sites, but they are also aware of the possibility of increased vandalism or accidental destruction. See Sections 2.10 and 3.9 for further discussion of cultural resources impacts and mitigation.

Recent apprehension over access to the Prayer Site and Hot Springs has partially abated due to the access agreement signed with NWC guaranteeing eight scheduled visits per year. The unscheduled visits (on request due to special need on the part of some person or group) will undoubtedly have to be worked out by accommodations and compromises on both sides, due to the special nature of the requests and the special mission of the NWC.

Other impacts which may affect visiting Native American groups, and which are also of general public interest, include visual (discussed in Section 2.9) and air quality (see Section 2.2).

2.12.2.13 Summary of Impact by Geographical Area

Kern County. The Ridgecrest/Inyokern/Brown Road area could probably absorb the maximum impact of full field development, including the possible eventual in-migration of 375-500 families, without too severe a strain. There would be sufficient private land, and probably sufficient housing by the year 2000, when 500 workers might be employed at the leasing sites, assuming future housing starts at the currently projected rates. In the interim, however, it is assumed Ridgecrest and Kern County (for rural Indian Wells Valley) would have solved present problems with regard to infrastructure capacity which have been aggravated by rapid absorption of population from China Lake. Even in the maximum-impact case examined in the foregoing discussion, the project-related population of 1,500 people would constitute only 4 percent of the area's expected total in the year 2010. The additional burden on local support systems would be offset to a great extent by the economic stimulus provided by the proposed program. This would include the creation of indirect employment for some 200 local residents as a result of payroll spending by project employees, and the generation of additional annual sales tax revenues of approximately $42,000 for Ridgecrest and Kern County.

The lower-level development scenario envisions approximately half the above number of employees, only 570 new permanent residents, and concentration of employee housing at first in Ridgecrest/Indian Wells Valley but with a "ripple" of spillovers into southern Inyo County. Impacts on Ridgecrest and IWV--both the burdens on infrastructure and the economic benefits--would be accordingly diluted.

Inyo County. The impact of the proposed development upon Inyo County would be more pronounced and complex, due to the lack of infrastructure systems in this thinly populated area. During start-up, estimated at 3 or 4 years, approximately 67 persons would be employed. It is assumed they would seek temporary housing, probably in Ridgecrest/Inyokern; NWC temporary personnel would probably have filled any temporary accommodations in southern Inyo County. However, developer-furnished temporary housing is suggested for NWC geothermal development (NWC, 1979); if this is provided, some existing temporary facilities may be locally available for employees of BLM-sponsored development.

In the lower-level scenario, an average of 190 essentially full-time employees is assumed, with most of these living in Indian Wells Valley at first; over time, some would probably move to southern Inyo if County and other policies permit construction there. Even if policy discourages development, some would probably elect to move into available housing in Lone Pine or Olancha; some may choose mobile homes in existing parks if long-term tenancy is permitted, or in remote locations. The impact of this in-migration, even in small numbers over time, would be noticeable in such a sparsely populated area with a paucity of support systems. (Any substantial population increase in Lone Pine may require upgrading of existing sewer systems.) The program's economic benefits to Inyo County would compensate in part for the costs involved in incremental improvements to infrastructure capacity. Some 85 indirect jobs would be created by local payroll spending, and largely filled by local residents. Approximately $25,500 yearly in sales and use tax revenues would accrue to Inyo County; and increases in assessed values would amount to some 17 percent more than the projected 2010 total valuation for the county.

Analysis of the maximum-impact scenario is conjectural. The assumptions are 550-MW development on several leases simultaneously by several contractors, no unitization, no developer-supplied housing, and concentration of 375-500 employee families (in this case, in Rose Valley or Olancha). The economic benefits would accrue largely to Inyo County, although without considerable expansion of commercial development in southern Inyo, a sizeable proportion of payroll spending would still occur in Ridgecrest. Approximately 110 indirect jobs would still be created locally by payroll spending, as well as $85,500 in annual county revenues for sales tax subventions; assessed valuation would increase by 39 percent over projected 2010 county valuation.

However, the uncertainties regarding county, BLM and NWC policies and plans for the region make such a housing scenario--at Dunmovin, for example--highly speculative. Even if such a development were permitted, there would be many difficulties and expenses surrounding a development of this magnitude in a rural area, together with necessary support systems. These expenses, furthermore, would be incurred prior to the time when public revenues would be realized from the project.

If appropriate solutions can be found for the problems posed by housing and infrastructure, policymakers may decide that the benefits of a well-planned housing and commercial development in northern Rose Valley outweigh the disadvantages. On the one hand, the program's economic benefits--including diversifying and stabilizing the County's economy--would be enhanced by the encouragement of greater local payroll spending. On the other hand, even the best-designed housing and satellite development accommodating up to several hundred families would alter the character of this rural area. Many local residents may be unwilling to accept this change toward urbanization.

At whatever level of geothermal development, and regardless of the residential patterns established, the program would have potential impact upon Coso Hot Springs and the Prayer Site. Both are National Register sites, and both are of great importance to local Native American groups. Their concerns are discussed in Section 2.12.1.13; possible impacts are addressed under Air Quality, Noise, Land Use, Traffic, Hydrology, and Socioeconomics.

3.0 MITIGATION MEASURES

The material in this chapter presents measures, which if implemented, would mitigate the impacts of the proposed action as described in Chapter 2. The proposed action of the BLM is to lease parcels of land for the purpose of developing the known geothermal resource. Some of the mitigation measures proposed are amenable for inclusion in the leases as stipulations. After leasing, supervision of the development and enforcement of the lease conditions becomes the responsibility of the USGS. Federal Regulations (*) require that geothermal lessees and operators to submit a plan of operation for production which includes:

> "A requirement for the collection of data concerning the existing air and water quality, noise, seismic, and land subsidence activities, and ecological systems of the leased lands covering a period of at least one year prior to the submission of a plan of production."

The USGS normally requires five types of submissions or plans for approval in addition to the baseline studies. These are:

1. Notice of Intent for Exploration - For initial study purposes prior to intensive exploration.
2. Plan of Operation - Including development drilling and deep exploration drilling.
3. Plan of Development - Including development drilling, permanent roads, pipelines, and other facilities.
4. Plan of Utilization -Describes proposed use of the resource and siting plans for surface structures.
5. Plan for Production - Including operation of wells and facilities for production and use of the geothermal energy.

The lessees and operators must follow the directions of USGS as given in the

---

* Code of Federal Regulations, Part 30, Par. 270.34(k).

"Geothermal Resources Operational Orders" (GRO) issued by this agency. These orders cover various specific details of exploration and development. The enforcement of these GROs effectively mitigates many of the impacts described in Chapter 2. The GROs issued to date include:

1. Exploratory Operations

2. Drilling, Completion, and Spacing of Geothermal Wells

3. Plugging and Abandonment of Wells

4. General Environmental Protection Requirements

5. Plans of Operation, Permits, Reports, and Forms (Draft)

6. Pipelines and Surface Production Facilities

7. Production and Royalty Measurement, Equipment, and Testing Procedures

In addition the NWC will review all such plans to insure that any development does not interfere with the mission of Navy.

Thus, although the impacts and the mitigation measures described in this EIS are quite general, there is provision to insure that site-specific impacts can be mitigated.

3.1 AIR QUALITY MITIGATION MEASURES

Air quality impacts may result from exceedances of both hydrogen sulfide (H_2S) and suspended particulate standards. Mitigation measures for both species are presented here.

Exceedance of the state H_2S standard is not predicted under most meteorological and emissions conditions. However, such exceedances are projected under special conditions. Therefore:

1. A monitoring program will be implemented by the developer whenever flow testing is initiated at a site which is downwind of a producing power plant. Such monitoring, and cessation of activities contributing to these emissions, if necessary, should avoid the problem of excessive H_2S levels.

More extensive mitigation measures will be required for fugitive dust than have been presented for hydrogen sulfide. All State of California and Federal standards for total suspended particulate (TSP) are projected to be exceeded during the exploration and field development stages. Proposed mitigation measures for TSP are:

1. Water roads and exposed areas undergoing activity utilizing dust suppressing additives.

2. The operators submit a dust abatement plan along with the Plan of Operations which may include water, gravel, etc.

3. Operators will provide transport for employees traveling in groups of 6 or more by bus from U.S. 395 in order to reduce the number of vehicle trips.

Discussions

If watering, using effective dust suppressant additives, is employed, it is estimated that 600 to 2,600 liters per acre per application will be used. Assuming that there will be six applications per year (Armbrust et.al, 1971) this will require from .25 to 1.0 acre foot of water in 1986 and from about 1 to 4 acre feet by 1995. The application rate assumed is 0.025 inches per application which will not be sufficient to promote the growth of introduced plant species.

3.2 NOISE MITIGATION MEASURES

The siting of wells and power plants is critical in considering noise mitigation measures. If it is determined that a proposed geothermal activity will occur a mile and a half or more from a sensitive receptor (see Section 2.3.2), then the resulting noise will be inaudible at the receptor and no mitigation will be necessary. If the source-receptor distance is less than one and a half miles, the following mitigation measures will be applied:

1. Truck deliveries and geothermal operations will be reduced at night whenever technically feasible in order to reduce the noise impact, which is greater at night. This mitigation measure will be applied to all sensitive receptors which are used for sleeping or for nighttime religious observances and which lie within one and a half miles of a power plant or within one mile of a plant access road. The list of such receptors includes Rose Valley Ranch, Coso Hot Springs and the Prayer Site (see also 2A, below).

2. The following mitigation measures will be applied to all leases which lie within one and a half miles of Coso Hot Springs or the Prayer Site, or which require access along any road which passes within one mile of Coso Hot Springs or the Prayer Site:

A. During periods of Native American use of the Prayer Site or Coso Hot Springs, eliminate truck deliveries which must use roads passing these sites, especially at night. Specific authorization to bypass this mitigation may be given by the Area Supervisor after consultation with BLM on a case-by-case basis.

B. Avoid well testing within one and a half miles of the Prayer Site and Coso Hot Springs during periods of Native American religious observances. To implement this mitigation, Native Americans will notify the USGS Area Geothermal Supervisor of their entrance schedule at least 10 days beforehand.

3. The Lessee will monitor sound levels, pursuant to GRO #4 section 11.G specifications, of any permanent operations which may be later proposed for areas within 1.5 miles of sensitive receptors. Using these data the lessee or power plant proponent shall perform a noise attenuation study which considers topographical barriers for noise sources proposed to be placed within a 1.5 mile radius of a sensitive receptor. Lessees will be required to demonstrate that such facilities will not impact the sensitive areas (L_{eq} less than 28 dBA with no wind).

3.3 GEOLOGY MITIGATION MEASURES

1. All structures will be designed to meet the applicable State of California and/or Inyo County earthquake standards, and of the USGS Area Geothermal Supervisor standards.

2. Engineering geologic site investigation may be required, including location of active fault traces.

3.3.1 Seismicity and Subsidence

1. Lessees will be required to meet the USGS monitoring requirements of GRO #4. This GRO requires surveying of land surface prior to and during geothermal resources production to determine any change in elevation of leased lands. If subsidence is determined to present a significant hazard to operations or adjoining land use, then remedial action may be required. Installation of seismographs or other like instruments may be required to detect potential induced seismicity. If induced seismicity is determined to represent a significant

hazard, remedial action may be required.

2. To ensure stability of all geothermal facility construction sites, the lessee will be required to conduct site-specific geotechnical investigations unless waived in writing by the Authorized Officer and Supervisor. The Supervisor and Authorized Officer may require that these investigations be conducted by a civil engineer knowledgeable in the practice of soil mechanics and/or a qualified engineering geologist; results of such studies will be submitted with and incorporated in the design. When any geothermal facility is to be sited on an identified landslide, a slope monitoring program acceptable to the Authorized Officer and the Supervisor will be required which will detect any slope movement that may occur. The installed slope monitoring devices may require monitoring throughout the life of the project, with the cost of installation and monitoring to be borne by the lessee.

3.4 HYDROLOGY MITIGATION MEASURES

1. The Hydrology Monitoring Plan in Appendix D, or an approved modification which meets the same data needs, will be implemented by the lessees jointly. Such monitoring shall be implemented by the lessee no later than one year before Plans for Production are implemented. Monitoring will be subject to review by USGS. Such a Plan will include monitoring the following mitigation measures if they are implemented.

   A. Importation of water from nearby sources,

   B. Injection of spent geothermal fluid at depth, beneath fresh water in Rose Valley,

   C. Artificial recharge and monitoring of Little Lake.

3.4.1 <u>Lowering of the Water Table in Rose Valley</u>

The amount of acceptable water table lowering would be determined by the BLM, USGS, Lahotan Water Quality Board, Inyo County, and Los Angeles Department of Water and Power policy and local economics. The following mitigation measures will be applied:

1. Lessees will submit a water management plan as part of the Plan for Production. This plan could include the following mitigation measures and/or other measures determined to be appropriate:

   A. Importation of water or obtaining water from aquifers other than Rose Valley.

   B. Monitoring and artificial recharge of Little Lake. The proper level for Little Lake will be determined jointly by the BLM, CDFG, USFWS, and USGS.

   C. Injection of spent geothermal fluid at depth beneath fresh water in Rose Valley. A comprehensive ground water basin survey and modeling would have to precede implementation. This measure would be only in the event that lowering the level of the Rose Valley water table in unacceptable.

2. Springs used by wildlife which appear to be drying as a result of impacts from development of geothermal resources (e.g., lowering of Rose Valley water table) will be replenished by artificial means, the costs to be borne by the lessees using the water in Rose Valley or otherwise creating the cause for drying. See also Hydrology Monitoring Plan.

3. The Hydrology Monitoring Plan will be implemented to record the potential lowering of Little Lake water levels and to determine actual ground water recharge in Rose Valley. Lessees will be responsible for implementation of the monitoring plan, and subsequent design of mitigation to ensure integrity of Little Lake. Little Lake will be maintained at levels within the current (1975-1980) annual and seasonal variations. However, the decision on appropriate lake levels will be reviewed and possibly modified in a joint meeting of BLM, USGS, USFWS, CDFG, Inyo County, Lahotan Water Quality Control Board, and LADWP.

Discussion

The nearby alluvial valleys do not contain nearly as much water or have as much recharge as Rose Valley. However, they may be able to supply some of the required cooling water and thereby reduce the amount extracted from Rose Valley. For example, recharge into Upper Coso Basin is estimated at 390 acre-feet/year. If most of this water could be captured it could supply enough cooling water for one 50 MW power plant. Ground water extraction from Upper Coso Basin would reduce underflow to Indian Wells Valley as would extraction from Rose Valley.

Injection of spent geothermal fluid beneath or at the bottom of the fresh water aquifer in Rose Valley would raise the water table. Although the geothermal fluid and the fresh ground water are miscible, the density difference between them would tend to keep the geothermal fluid beneath the fresh water. A comprehensive ground water basin survey and modeling would have to be conducted prior to implementation of such a plan. Even though this scheme would keep the water table up, the amount of usable ground water in storage would still be reduced.

Monitoring as specified in the monitoring plan, will aid in determining the proper level for Little Lake. It will then be maintained, as it has been in the past, by feed from wells just north of the lake. Keeping this water level up should also maintain underflow to Indian Wells Valley.

3.4.2 Degradation of Natural Water

Mitigation for degradation of natural water can be divided into four categories:

A. Design of surface facilities

B. Blowout prevention devices, and

C. Ground water and geothermal reservoir monitoring

D. Injection well design

Discussion

Spent geothermal fluid, other than condensed steam, shall be reinjected into the geothermal reservoir for maintaining fluid pressure and recharging the reservoir. If the geologic structure does not allow for reinjection, fluids can be injected into an aquifer demonstrated not to be connected with any fresh water aquifer.

GRO No. 4 specifies that, in areas where there is a possibility of contamination of surface or ground water containing less than 10,000 mg/l total dissolved solids, pits and sumps shall be lined with impervious materials to prevent escape of contaminated fluids into ground or surface water.

GRO's No. 2, 4, and 6 specify mitigation measures for these categories. Within the constraints of current technology, the GRO's are formulated to mitigate all known potential impacts. Surface facilities, including all conveyances and sumps, must be designed to safely contain anticipated capacities, temperatures and chemical composition. GRO No. 6 specifies requirements for pipelines and surface production facilities. It states that they must be designed to withstand thermal stresses and two phase flow. They must be designed with safety control devices such as automatic shut-off valves. The facilities must be tested and monitored regularly.

GRO No. 4 specifies that pits and sumps shall be lined with impervious materials to prevent escape of contained fluids into ground or surface water. All potentially harmful materials shall be removed before backfilling and disposal areas should be restored to natural appearances. Fencing during use to protect wildlife, livestock and public may be required if needed.

GRO No. 2 specifies use of blowout prevention equipment and procedures. This includes installation and testing of blowout preventers with high temperature and pressure capacity components. The system shall have manual and hydraulically actuated valves and dual control stations.

GRO No. 6 discusses injection facility regulations. It specifies that injection facilities must:

A. Be designed to withstand anticipated pressures.

B. Have an automatic pressure actuated shut-in device or pressure relief valve, and

C. Check valves to prevent backflow.

D. Not to be operated in excess of 75 percent of hydrofracture pressure as tested with fresh water.

3.4.3 Alteration of Flow to Coso Hot Springs

1. The Hydrology Monitoring Plan (Appendix D), to be implemented by the lessees, will include monitoring of Coso Hot Springs. If monitoring shows that the flow to Coso Hot Springs is altered by geothermal production, the lessees will develop and implement a strategy to restore the flow by selective placement and regulation of injection and production wells. USGS, BLM and NWC will approve such strategy prior to implementation. Monitoring will be continued by the lessees to determine the effectiveness of the mitigation strategy. If the mitigation strategy is determined to be ineffective, the lessees, BLM, NWC, and USGS will develop procedures, to be implemented by the lessees, to mitigate impacts to the flow to Coso Hot Springs.

3.4.4 Localized Cooling, Mineral Precipitation and/or Depletion

Discussion

Localized cooling around injection wells could be mitigated by halting injection. However, with proper design and reservoir engineering, this should not be a problem. In fact, recirculation of cooler water in hot rocks can contribute to increased resource recovery. Mineral precipitation and resource depletion can be minimized by proper well management practices. Site specific mitigation may be required as the need arises.

3.4.5 Flood Hazard

Discussion

Flood hazards can be mitigated by proper siting of facilities and proper engineering to protect facilities from flood. Areas subject to periodic flash floods are delineated on Plate 2.6-1, General Soils Map and Soil Sensitivities.

Hazard due to inundation by failure of South Haiwee Dam can be avoided by not siting facilities in the inundation area outlined in Appendix D of the Hydrology Technical Report.

No specific mitigation is necessary at this time because facility siting procedures will incorporate good engineering practice for this concern.

3.5 SOILS MITIGATION MEASURES

1. A soils monitoring plan based upon the Soils Monitoring Plan in Appendix D.1 will be developed jointly by the lessees and appropriate regulatory agencies, and used to satisfy requirements for impact monitoring. Periodic reports resulting from the monitoring activities will be submitted to the USGS who will send copies to Federal, state, and local agencies, including the California Department of Fish and Game.

Utilization of vehicles and construction equipment during exploratory operations and subsequent development shall be subject to the following mitigation measures:

1. The Plan of Operations for geophysical explorations shall include

proposed routes of travel where departure from roads is required. Routes shall be chosen to create the least disturbance to soil and vegetation. Soil maps and tables should be consulted in planning all routes.

2. Vehicle travel off of roads shall be restricted when the soil surface is wet or moist in order to reduce soil compaction and the potential for generating ruts and wheel holes, as directed by the Area Supervisor.

3. Vehicle speed of all vehicles on roads and trails shall be minimized to reduce dust generation.

4. If lessees propose any material sites within the lease acreage, it will be shown in the plan of operation submitted in accordance with 30 CFR 270.34(e). New material sites will be allowed only when existing sites are not within a reasonable distance. Use of sites off lease must be under appropriate permits from the land managing agency.

5. All areas which have been temporarily disturbed or which are being reclaimed after long-term disturbance will be stabilized. Stockpiled soil will be replaced, if available. The disturbed areas will be recontoured to a natural contour, seeded, and irrigated until the seeding becomes established. Irrigation efforts will be monitored to determine degree of revegetation success. If vegetation becomes established and receive pressure from cattle or burros, fencing shall be required until sensitivity to heavy grazing decreases. Seeds of native plants which have high food value for mammals, and the ability to become established will be used if obtainable; these include Amsinckia tessellata, Coreopsis sp. and Lycium Cooperi. The BLM and NWC will help to determine the proper species.

6. Topsoil stockpiling. When determined by the BLM soil scientist to be present in sufficient quantities to warrant protection, topsoil will be stockpiled, seeded, stabilized, and irrigated until the seeding becomes established and the pile becomes stabilized. Procedures outlined in Surface Restoration above will be followed. Topsoil suitability of soil types is presented in the Soils Technical Report, Table 7-5, Interpretive Ratings for Soil Uses.

7. Sections 9110 and 9111 of the Bureau of Land Management manual shall be used as guidelines in all construction activities with case-by-case modifications of such recommendations as are presented below. Standard specifications for Construction of Roads and Bridges on Federal Highway Projects (USDOT, FP-74) can also be used as guidelines. All roads will also meet the State, Local and NWC specifications.

3.5.1 Paleontology

During the surface and soil removal in areas containing outcrops of Old Alluvium (OAL), Coso Formation (C), or Sedimentary Rock of White Hills (SWH), as shown in Figure 2.6.2-1, a qualified professional paleontologist will be present at the expense of the lessees or developers, to collect representative paleontological resources.

3.6 MITIGATION OF IMPACTS ON WILDLIFE

1. See Soils measure 6 and 7, in Section 3.5 for mitigation to wildlife from surface disturbance.

2. Prior to surface disturbance in an area inhabited by Mohave ground squirrel, a population study to determine density of the squirrel for the particular habitat type to be disturbed will be performed by the lessee to form part of the USGS EA on the submitted Plan of Operations. From this information, the number of squirrels lost per power generating unit will be calculated and necessary mitigation levels (revegetation and habitat improvement) will be established by the surface managing agency.

3. Temporary fencing around the unattended pits and sumps will be required to protect wildlife.

4. Aquatic Habitats. See mitigation in Section 3.4 for protection of aquatic habitats; Little Lake and springs.

5. Raptor and Mammal Habitat.

   A. Where possible, exploration and construction activities will be timed to avoid the period between March 1 and June 30 (the period when birds are nesting and small-mammals activity is greatest) in those areas which have been identified as sensitive; see Section 2.7.2 and Figure 2.7.2-1. Exceptions must be approved by the Area Geothermal Supervisor after consultation with BLM.

   B. A noise/disturbance buffer zone of one-half mile or more (depending on the noise levels of the proposed activity --see Section 2.3.2 and following paragraph) shall be maintained during each spring around such areas, if possible, until demonstrated to the satisfaction of the Supervisor that the operations will not disturb the nesting/breeding activities. These areas include:

      1. Raptor nesting habitats in cliffs east of Little Lake, in the lava cliffs southeast of Coso Hot Springs, in the rocky

ridges near Haiwee Spring and northwest of Cactus Peak (Sections 15, 16 and 21 in T21S R38E), and other cliffs/rocky ridges between Volcano Peak and Sugarloaf Mountain; and any other raptor habitats subsequently identified.

2. Nesting bird habitats in areas of Joshua Tree concentration (see Section 2.7.2).

3. Probable carnivore denning sites, i.e., the areas mentioned in (a) above, additional possible sites northeast of Cactus Peak and south of Sugarloaf Mountain. The ringtail, protected under California law, is likely to den in these areas.

C. In addition to the above general stipulations, USGS EAs on Plans of Operations will include data collected by a qualified biologist on any current nesting or denning sites or other sensitive areas to be avoided and shall specify size of noise/disturbance buffer zones to be maintained around these sites or areas.

6. Feral Burros. The lessee should notify the Area Supervisor of any damage to facilities caused by burros. BLM and the NWC will then determine appropriate modifications to their individual Burro Management Plans to reduce incompatibilities.

7. Transmission Line Construction. Construction of transmission lines will follow guidelines established by the Raptor Research Foundation in 1975, so that electrocution of large birds does not occur.

8. Wildlife and Flora Monitoring Plan. The Monitoring Plan for flora and wildlife (see Appendix D.2) will be used, together with data in the Flora and Wildlife Technical Reports, as a basis to build upon when collecting data for monitoring impacts. Periodic reports of monitoring activities will be furnished to the USGS who will distribute copies to appropriate regulatory agencies.

9. In the event that geothermal development activities result in wildlife becoming deprived access to an accustomed watering place, such as a seep or spring, a guzzler line will be installed in an accessible location, cost to be borne by the lessee.

3.7 MITIGATION OF IMPACTS ON FLORA

1. See Soils Section 3.5, Nos. 6 and 7 for measures concerning topsoil protection and revegetation.

2. Where vegetative control is necessary, mechanical rather than chemical methods will be employed.

3. Surface disturbance will not occur on the localized habitats (see Figure 2.8.2-1) for the CNPS-listed Pholisma arenarium and Spartina gracilis. All vegetative surveys shall include a specific search for Pholisma arenarium, and Canbya candida. If possible, surface-disturbing activities should not occur on the habitats of Canbya candida.

4. See measures outlined in Section 3.4.1 for maintaining water levels in Rose Valley and Little Lake, therefore, aquatic habitats. implemented.

5. See Section 3.6 regarding wildlife and flora monitoring activities.

3.8 VISUAL RESOURCES MITIGATION MEASURES

The mitigation of impacts of the proposed project is divided into two categories:

1. Those mitigation measures which will be applied to sensitive (Class II) lands within the CGSA, and

2. Those mitigation measures which will be applied to less sensitive areas.

3.8.1 Mitigation Measures for Class II Areas

1. No permanent visible structures will be permitted on Class II lands except those which meet requirements of blending in with the background in terms of form, line, color and textures. Such structures will be limited to pipelines, transmission lines, roads, and similiar lineal elements.

2. The design and routing of each of these facilities will be planned

and approved by the USGS and BLM prior to implementation to insure that they minimize visual impacts and maintain the overall esthetic pattern of the area. Expansion loops will be horizontal except where crossing roads or other facilities which need high clearance. Facilities will be nonreflective and colored to blend with the background.

3.8.2 Mitigation Measures for Other Areas

1. All required land scarification will be revegetated as soon as practicable. Power generation stations will be located in areas such that they minimize impacts from sensitive viewing points and such that they are unobtrusive to the eye. Since each power plant will be covered by a layer of earth for protective hardening the structures will blend into the natural background.

3.9 CULTURAL RESOURCES MITIGATION MEASURES

Discussion

In compliance with 36 CFR 800.4, the State Historic Preservation Officer (SHPO) and the National Advisory Council on Historic Preservation are being consulted to obtain concurrence on all proposed mitigation measures for cultural resources within the CGSA that may be impacted as a result of geothermal development. In addition, all proposed mitigation of impacts to sites determined to be eligible for inclusion on the National Register of Historic Places will be approved and implemented by concurrence of the BLM (and NWC on withdrawn lands). The following mitigation measures specifically address prehistoric and historic cultural resource sites. Mitigation of impacts to Native American values are addressed in Sections 3.2, 3.10 and 3.11. The California Native American Heritage Commission and the local Native American community will be afforded the opportunity to review proposed mitigation measures, in accordance with the Memorandum of Understanding between the BLM, Native American Heritage Commission, and the State Historic Preservation Officer (see Appendix C.4).

As discussed in Chapter 2, the cultural resources inventory completed for this EIS provided important data concerning the density, distribution, and overall significance of cultural resource sites within the CGSA. Several site types were encountered and recorded during the course of the inventory; 55 percent of all sites were classified as lithic scatters.

The BLM has concluded that, collectively, the known cultural resource sites within the CGSA constitute a significant array of data that appear to qualify for inclusion on the National Register (see Section 2.10). However, the "masking effect" of the airfall (pyroclastic) obsidian from Sugarloaf Mountain precludes a clear definition of the research potential of the lithic scatters within the context of the other site types. No single set of measures could presently be implemented to adequately mitigate impacts to every site type recorded. Therefore, in addition to mandated measures discussed in Section 2.10.2, the recommended strategy provides for three kinds of evaluation, protection, and mitigation (as appropriate) to solve the problem:

Development and implementation of a strategy to evaluate lithic scatters within the CGSA through a program of limited surface collection and subsurface testing;

Cultural resource site avoidance when feasible; and

Site-specific data recovery (mitigation), when necessary.

Only by implementing such a plan can appropriate mitigation measures be developed to include areas and sites yet to be inventoried during the course of geothermal development.

There are three assumptions guiding the proposed evaluation and mitigation plan:

1. The cultural resource sites within the CGSA are collectively considered by the BLM to meet the eligibility criteria for inclusion on the National Register of Historic Places.

2. The obsidian source at Sugarloaf Mountain, which was greatly utilized by aboriginal populations, has created a "masking effect" (discussed in Chapter 2), which partially obscures the significance of one cultural resource type within the CGSA, the lithic scatter.

3. This evaluation and mitigation plan, in addition to the mandated measures discussed in Section 2.10.2, will provide the guidelines to facilitate compliance with the requirements of Federal historic preservation legislation through appropriate levels of cultural resources site avoidance and data recovery.

In accordance with the cooperative agreement between BLM and USGS, "Protection of Cultural Resources Related to Geothermal Lease Operations (WO-105) (see Appendix C.3), the lessees are responsible for identification and mitigation costs for impacts to cultural resource sites on lands they propose to disturb in their approved plans of operation.

Any cultural resource work, required of the lessee by the lessor, shall be undertaken under the authority of a current Antiquities Permit applicable to the area to be inventoried, investigated, or salvaged. The archaeologist must be approved by the BLM and must have an adequate research inventory design approved prior to commencing field work.

3.9.1 Evaluation, Protection, and Mitigation Measures

The following evaluation, protection, and mitigation measures will be implemented to encompass all public and withdrawn lands within the CGSA that are proposed for geothermal leasing and development. Responsibility is delineated following the measure number.

Surface disturbances will be allowed without further cultural resource inventories within those areas already examined preparatory to this EIS and found to contain no cultural resources (see Figure 2.10.2-1). Pursuant to Section 18 of the Standard Geothermal Lease Form, in the event of a discovery of previously unknown cultural resources during operational activities conducted under an approved plan or permit, the lessee or operator will stop operations in the immediate area of the discovery and shall immediately notify USGS, or BLM if unable to contact USGS, of the cultural resource discovery. The procedures outlined in the cooperative agreement (see Appendix C) between the USGS and BLM shall be closely followed in order to allow adequate evaluation of the cultural resource site, and to facilitate the development of appropriate site avoidance or impact mitigation.

1. Lessee: No surface entry by lessees for any purposes associated with geothermal leases will be permitted on cultural resource sites known to be of extremely high sensitivity (see Figure 2.10.2-1 and Section 2.10), including properties already listed on (or pending nomination to) the National Register of Historic Places. These sites and properties include the Fossil Falls Archaeological District; Coso Hot Springs National Register Site; DA-253, 268, 273, 313, 316, 340, 373, 380, and 381. (Permanent numbers are forthcoming.) These include rock art sites, certain rock shelters with associated occupational midden, and any village or temporary campsite with cultural deposit (due to the possibility that they may include human burials). Pursuant to Mitigation Measure 6 below, monitoring by the BLM and NWC (as appropriate) will be required at all cultural resource properties of extremely high sensitivity.

2. BLM: Cultural resource sites discovered in the future which appear to be of extremely high sensitivity will be evaluated by the BLM, NWC (as appropriate), and the SHPO in order to determine National Register eligibility and to develop and implement adequate site-specific project avoidance or mitigation measures.

3. Lessee: No surface disturbances related to geothermal exploration and development will be permitted on all other cultural resource

sites not listed in Mitigation Measure 1 that are determined eligible for inclusion on the National Register until the National Advisory Council on Historic Preservation has been afforded a reasonable opportunity to comment and until concurrence on appropriate site avoidance and mitigation measures has been obtained from the SHPO.

4. BLM: After leasing, the BLM will fully develop and implement the following Cultural Resources Assessment Strategy (CRAS), in consultation with the SHPO and NWC. The CRAS is anticipated to take less than one year to implement. It will be implemented during the latter part of preliminary exploration after the lessees have indicated a serious interest in deep well exploration and field development. It will be completed no later than the beginning stages of production well drilling of field development. The lessees will each be requested to help fund this project to ensure timely completion.

   The primary objective of the CRAS is to establish evaluation criteria to determine the National Register eligibility and potential data yield of lithic scatters and the lithic components of quarry sites, rock shelters and temporary campsites.

   An overall understanding of sites that contain lithics can then be established. This lack of understanding currently hampers the BLM and SHPO's ability to determine what sort of mitigation is necessary. Thus, during the course of approval of the various plans required by GRO Order #5, when these site types are proposed for disturbance, they can be quickly evaluated with less data collection and analysis. Site avoidance and/or mitigation can then be developed and implemented in accordance with historic preservation mandates. To sum up, the intent is to increase understanding at the forefront in order to be less restrictive of development in the future.

   A. The Cultural Resources Assessment Strategy will be fully developed and implemented to address, at a minimum, the following research problems:

      1. define the local chronology of the CGSA within the regional sequence of the western Mojave Desert, based on inter-site and intra-site analysis of flaked stone artifacts, obsidian hydration studies, and other appropriate relative and absolute dating techniques;

      2. define the relative importance of the CGSA, specifically Sugarloaf Mountain, to the local and regional lithic technology and exchange systems, based upon comparative literature studies and, if appropriate, ethnohistoric research. Studies of exchange systems should emphasize the Great Basin-Coso, Kern River-Coso, and South/Central Coast-Coso trade relationships;

3. define inter- and intra-site relationships within the CGSA and with adjacent areas that have been previously investigated.

Fifteen sites that are believed to represent the known lithic scatters and types of lithic technology within the CGSA were selected by the BLM, in consultation with the NWC and the SHPO, for limited data collection and analysis. The sites were selected on the basis of site type, site components or features, overall site integrity, distance from Sugarloaf Mountain, and direction from Sugarloaf Mountain. Table 3.9.1-1 below lists the sites selected for limited data collection and analysis.

B. The Cultural Resources Assessment Strategy will be developed and implemented in the following steps:

1. develop a detailed research design to incorporate and address at a minimum, the research problems outlined in A.1, A.2, and A.3 above within the constraints of the limited data recovery and analysis at the fifteen sites specified in Table 3.9.1-1;

2. develop a field strategy to implement the research design in B.1 above. The field strategy will include the systematic surface collection of a limited percentage of each site specified in Table 3.9.1-1 and subsurface testing of those sites, as appropriate. Location mapping of diagnostic artifacts and features discovered during data collection will be required in addition to the presentation of professionally acceptable contour maps for each of the fifteen sites.

C. Lithic analysis will be conducted on representative samples of each site and shall include, but not be limited to, the following analyses, as appropriate:

1. lithic reduction studies (i.e. flake/core ratios, etc.);

2. lithic use wear analysis;

3. obsidian sourcing;

4. obsidian hydration;

5. lithic analysis of human use versus natural wear patterns;

6. descriptions and explanations of lithic tool kits and the range of tool forms discovered;

7. projectile point analysis.

TABLE 3.9.1-1

SITES SELECTED FOR LIMITED CULTURAL RESOURCE DATA COLLECTION AND ANALYSIS

Site Number	Site Type*	Miles From Sugarloaf Mountain	Direction From Sugarloaf Mountain
DA-367 (or)	LS	0	---
DA-368 (or)	Q	0	---
DA-369	LS	0	---
DA-392	TC	1.24	SW
DA-270	Q	1.52	SE
DA-303	LS	1.90	N-NW
DA-264	Q	1.90	NE
DA-344	LS	3.24	S-SW
DA-374	TC	3.43	E-SE
DA-316	RS	3.52	W-SW
DA-315	LS	4.10	SW
DA-285	LS	4.29	NW
DA-335	LS	4.95	NE
DA-252	Q	5.14	N-NW
DA-259	LS	5.33	W-NW
DA-389	LS	7.81	W
DA-370	LS	9.24	NW

* LS = Lithic Scatter

Q = Quarry

RS = Rock Shelter

TC = Temporary Campsite

D. Corollary studies of data recovered from subsurface testing will be conducted and will include, but not be limited to, the following studies, as appropriate:

1. limited microanalysis of midden constituents;

2. radiocarbon analysis;

3. soil analysis;

4. pollen analysis;

5. faunal analysis.

The research design and field strategy will be subject to the final approval of the SHPO and the Advisory Council on Historic Preservation. The concurrence of the NWC and the local Native American community will also be solicited by the BLM prior to approval and implementation of the research design and field strategy.

Following completion of fieldwork and data analysis, a professionally acceptable report of publishable quality will be written which presents the results of data analysis. The report will be furnished by the BLM to the NWC, SHPO, and the Advisory Council on Historic Preservation for review and comment in order to assure that the requirements of Section 106 of the National Historic Preservation Act of 1966 are fulfilled. The report results will provide the necessary evaluation criteria to determine the National Register eligibility, including potential data yield of lithic sites. The BLM, NWC, and SHPO, in consultation with one another, will then develop and implement any further necessary mitigation measures for those lithic scatters determined to be eligible for inclusion on the National Register and which may be impacted by geothermal development.

E. The cultural resource inventories and reports prepared by the lessee's archaeologist(s) as part of the Plans of Operation submitted to the USGS must conform to BLM standards and incorporate the objectives of the Cultural Resources Assessment Strategy.

It is anticipated that implementation of the Cultural Resources Assessment Strategy will provide for the protection of significant cultural resource data, and yet will not be overly restrictive of geothermal development in the CGSA. For example, as lessee-funded archaeologists discover lithic scatters while conducting required inventories for proposed Plans of Operation, results obtained from the Cultural Resources Assessment Strategy could guide future mitigation of impacts to lithic scatter sites. The research parameters established by the Cultural Resources Assessment Strategy, as outlined above, would limit the range and quantity of necessary data gathering during mitigation, rather than requiring exhaustive studies of every lithic scatter encountered. On the basis of the results of the Cultural Resources Assessment Strategy, it should be possible to state that a specific lithic scatter (located at an area proposed for geothermal development) appears typical of others of its type and distance from the obsidian source, already examined. In such a case, it is possible that sufficient data from similar sites and/or site types within the CGSA have been previously recorded and studied; therefore, site recordation, mapping, and minimal data collection may be the only necessary mitigation.

Not only will the Cultural Resources Assessment Strategy upgrade the present knowledge of the cultural resources within the CGSA in order to facilitate compliance with Section 106 of the National Historic Preservation Act of 1966, but it will also provide a mechanism to prevent unacceptable data loss which may result from separate surveys, piecemeal excavations, and dispersed sampling of site-specific areas proposed for development by various lessees.

The results of analyses of cultural resource sites investigated during the field work phase of the Cultural Resources Assessment Strategy could also enable the BLM and the NWC (as appropriate) to recommend that the SHPO reevaluate specific sites previously recommended to the National Register of Historic Places. Such reevaluation would help assure that only those sites which meet the National Register criteria are determined to be eligible, based upon the more intensive data analyses.

5. BLM, NWC: Periodic monitoring by site inspection and photo documentation of selected cultural resource sites will be conducted by the BLM and NWC authorized personnel. If degradation of the cultural resources is found to occur as a result of geothermal development activities, the lessees will develop appropriate monitoring and mitigation in consultation with the BLM, NWC, and SHPO.

6. BLM, NWC: A cultural resources educational program, sponsored jointly by the BLM and NWC, will periodically be presented to the lessees and their personnel. Such a program will be designed to inform the geothermal lessees and their personnel of the fragile nature of cultural resources, the local mitigation measures that are being implemented, and the legislative protection of cultural materials. Input by the local Native American community to the educational program will be solicited during its preparation. This

program should help reduce vandalism.

7. BLM: BLM resource management personnel will increase patrol of the public lands, as funding and manpower permit, to help prevent vandalism. NWC also maintains patrol of the range.

3.10 MITIGATION OF LAND USE IMPACTS

1. Coso Road, which presently passes through the Prayer Site, should be rerouted to the south, as suggested in the NWC Final EIS, 1979. The responsibility for this should lie with those lessees who must use this road segment for access. This should include the NWC geothermal development contractor. This issue must be resolved by USGS, BLM and NWC when development begins and impacts to Native American values are discerned.

   Indirect land use impacts caused by pressure to develop support and service facilities in the event of extensive development in Rose Valley would also have to be mitigated; see 3.11 below.

2. Any leases which include portions of Wilderness Study Area 157 will include the protective stipulaton in the USDI, BLM publication of Dec. 12, 1979, entitled "Interim Management Policy and Guidelines for Lands under Wilderness Review".

   This stipulation requires that activities may be permitted so long as the BLM determines that they will not impair eventual wilderness suitability. Activities considered suitable must:

   1. Be temporary

   2. Permit reclamation

   3. Assure that the area's wilderness suitability is not impaired upon termination of the activity.

3. No residence on leases within the NWC will be allowed. All other residence proposals will be approved by the BLM and must meet appropriate county, state and Federal standards.

3.11 MITIGATION OF SOCIOECONOMIC IMPACTS

1. Developers will be required by USGS to supply employee transportation to and from work sites. This mitigation is discussed in other sections of this chapter. It is anticipated that the measure would reduce disturbance experienced by Native Americans during ritual and religious activities at Coso Hot Springs and the Prayer Site.

2. If hazardous wastes are allowed in drilling muds and regular transportation to a Class I or II-I site begins, siting of a Class I or Class II-I disposal site in the vicinity of the CGSA should be required. This would reduce cost, transportation impacts, and potental for accidential spills during long hauls involved in hazardous waste disposal at Covina, Elk Hills, or Taft.

3. If congestion occurs at Coso Junction due to turning of slow moving, heavy vehicles, the lessees, BLM, USGS, and NWC should petition Caltrans to change the roadway geometry.

4. See Section 3.2 for mitigation of noise impacts on users of Coso Hot Springs and the Prayer Site.

5. See Section 3.4 for mitigation of flow alterations at Coso Hot Springs.

6. See Section 3.9 for mitigation of impacts on cultural resources.

4.0 UNAVOIDABLE ADVERSE IMPACTS

The material in this chapter describes those impacts which would remain after mitigation if the proposed action described in Chapter 1 is implemented. A table summarizing these impacts is presented at the end of this chapter.

4.1 AIR QUALITY

Ambient fugitive dust concentrations will be increased above current levels by geothermal development. The principal emission sources will be vehicle traffic on unpaved roads, grading and construction activities, and wind erosion of exposed areas. The impacts will, for the most part, be localized to the development area. The magnitude of the ambient dust level increase will be determined by the degree of mitigation. Appropriate application of mitigation measures, particularly watering of unpaved roads, should make it possible to maintain 24 hour average ambient levels below 100 ug/m^3, which is within all government TSP standards.

Ambient gaseous pollutant levels will be increased, primarily by power plant operation and well testing, but also by vehicular activity. The most significant increase will be in the concentration of hydrogen sulfide. Ambient levels of hydrogen sulfide in the vicinity of geothermal development may increase up to, but probably not exceed, the state one-hour average standard of 30 ppb.

The local visual range will be decreased by elevated ambient dust levels, the amount of decrease being determined by the degree of mitigation applied. Under worst-case conditions the visual range as observed from the CGSA would be expected to decrease from its present annual mean of 61 miles to approximately 51 miles. With appropriate mitigation (such as watering) visual range should not decrease perceptibly (only one or two miles at the most). Visibility degradation due to fugitive dust from the CGSA should not interfere with the NWC mission because particle deposition will tend to confine elevated TSP levels to the immediate area. Regional visibility will decrease no more than 10 percent in the worst case if hydrogen sulfide emissions are at the levels projected and if mitigation measures are applied as necessary.

Infrared visibility should not be significantly impacted by the predicted upper level ambient level increases of 0.2 percent and 2.0 percent for carbon dioxide and water, respectively. The NWC mission should not be affected by this increase.

4.2 NOISE

Noise levels in some sections of the CGSA will increase as a result of geothermal development. Increases occurring along access roads and near power plants which result from electrical power production will be permanent thoughout the productive life of the geothermal field. Maximum instantaneous noise levels adjacent to roadways will be approximately 90 dBA, and near power plants will be about 70 dBA. Temporary noise level increases resulting in ambient levels of up to about 80 dBA will occur in the vicinity of construction sites. The degree of increase will depend upon the distance of the receptor from the noise sources, the presence of noise barriers (e.g. mountains or ridges) between source and receptor, and the amount of mitigation imposed. Certain mitigation measures (e.g., elimination of truck traffic at night) would reduce L_{dn} and CNEL levels, while having no effect upon L_{eq} levels.

Specific residual impacts can be addressed in terms of sensitive receptors. Power plant construction and operation workers will be exposed to highly elevated noise levels during their work hours, up to around 100 dBA for the operation of heavy equipment such as tractors and pile drivers. These levels can be mitigated so as to meet health and safety standards, but many activities will still be audible to nearby workers. Coso Junction Rest Area users will be subject to vehicle noise up to 90 dBA from the Coso Junction access road which intersects U.S. 395 adjacent to the rest area. There should be no unavoidable adverse impacts upon other sensitive receptors in Rose Valley (e.g. Rose Valley Ranch) unless a power plant is constructed within 1.5 miles of the receptor. When mitigation measures are strictly imposed, there will be no residual noise impacts to Native American religious observances at Coso Hot Springs and the Prayer Site, so the present background level of approximately 40 dBA should be preserved during scheduled religious usage periods. Finally, geothermal activities will be audible to wildlife no matter where the power plants are located because various species live in all sections of the CGSA. Mitigation measures can reduce the noise impacts upon particularly sensitive wildlife areas such as raptor nesting sites.

4.3 GEOLOGY

Although it is considered highly unlikely, the only unavoidable engineering geologic hazard is possible well damage due to subsurface fault movement or ground shaking. If such damage does occur, the impact to soils and vegetation due to salt buildup could be moderate to severe and would include leakage from ruptured well casings to total blowout.

As there is no statistical basis for prediction of such events, further quantification of such impacts is not possible.

4.4 HYDROLOGY

The identified unavoidable impacts in this resource area are:

1. Lowering the water table in Rose Valley. This will occur if long-term ground water withdrawal exceeds natural and artificial recharge. The quantity of usable ground water in storage and underflow to Indian Wells Valley will be reduced. The underflow is a very small percentage of the total Indian Wells Valley recharge, and should not impact users of the Indian Wells Valley ground water. The spatial distribution of water types may be altered to an indeterminate degree.

2. Degradation of natural ground and surface water. This would most probably occur only as a result of an accident, such as a well blowout or leak in a surface facility. Degradation due to most accidents would be short-term and local. Blowouts may be more difficult to control and could contaminate larger areas.

3. Alteration of flow to Coso Hot Springs. Mitigation measures that would totally reproduce typical flow may be unacceptable to Native Americans. It is not known whether the alteration would be permanent or temporary. Mitigation developed in the event of flow alteration will be presented to the Native American Council for comment and review, prior to implimentation.

As indicated in Chapter 2 and in the Hydrology Technical Report studies are presently being conducted by USGS to identify the aquifer flow patterns in order to obtain a better understanding of the recharge in the area. Until such data becomes available, quantification of the residual impacts is not possible.

4.5 SOILS

Some adverse increases in soil erosion and sedimentation will occur due to soil disturbance associated with all stages of geothermal development before soil stabilization has been achieved. Such construction impacts are generally considered short term.

Although unlikely, blowouts, mud sump, or reserve pit failure or overflow may occur. Assuming a best-case scenario a blowout may occur but is quickly brought under control with no resultant damage to the sumps and minimal amount of geothermal effluent spills on the soil surface. The impact of such an accident would be localized and insignificant provided the proper mitigation actions are rapidly implemented. In a worst-case scenario, a blowout may occur and continue unabated, the duration of the incident being dependent on a number of factors, such as depth of the blowout in the well casing. Impacts to soil resources should this even happen are described in Section 2.6.2. A blowout may spread fragments on the soil surface around the drilling pad, and geothermal fluid may escape to the soil surface and possibly contaminate the soil with its constituents. The degree of soil contamination is dependent on the exact composition of the geothermal effluent, but a build-up of salts would occur. A severe blowout may possibly cause sump failure, which could result in further contamination of the soil with drilling muds and geothermal fluids. Sump failure may also occur independently of a blowout. The uncontrolled release of the full blow of geothermal fluids may also result in erosion of the drill site. These impacts are considered to be significant and localized, and the degree to which they occur will depend on the nature and duration of the incident.

Surface disturbance and the direct occupation of the land by geothermal related structures, facilities, and roads constitutes an unavoidable adverse impact, even if all mitigation measures recommended are implemented.

4.6 WILDLIFE

Habitat Disturbance and Loss - During the exploratory, drilling and construction phases, wildlife habitat will be lost even though such activities are carefully located on each lease tract. Mitigating measures to supplement the lost vegetation by replanting roadside cuts and other areas will offset a portion of the significant loss of habitat needed for foraging, nesting, and cover by wildlife species. It is impossible to predict the numbers of lizards, birds, or mammals which may no longer be able to inhabit the CGSA, since population density measurements were not made. However, to obtain an idea of the numbers of animals affected by a habitat loss of say 20 acres, the following figures are presented. In the five trapping areas (approximately 20 acres each), using 333 regularly spaced live traps for three nights (1000 trap-nights total), from 483 to 516 nocturnal rodents were captured per trapping area. Evenly spaced trapping samples only a small portion of the total population. The site-specific EA required for each lessee's Plan of Operations will provide additional population data; particular emphasis will be placed on the rare Mohave ground squirrel, as proposed in the Mitigation Chapter.

The wildlife community structure will be adversely affected by losses of vegetation. Animals most likely to be affected will be small mammals, herpetofauna, and small birds, which depend upon more restricted foraging areas than larger species. The species affected, and the amount and significance of their reduction, will depend upon exact facility siting, exploration, etc. Some 2,260 acres of vegetation would be lost (See Section 4.7), from the proposed action and the Navy Geothermal Program. A small amount of natural revegetation should take place on disturbed areas during the life of the proposed action, permitting partial recovery of wildlife populations.

After closeout, restoration would allow decompaction of soils and seed bed preparation to encourage plan succession (pioneer invading species, gradually replaced by long-lived climax plant species) on the bare soil and thus bring about general habitat improvement. Vasek, et al., (1975a), in a study on construction projects in the Mojave Desert, found that 30 to 40 years were required in the most optimal areas; they estimate at least 100 years would be necessary for Creosotebush Scrub communities to recover. However, since plant species recovery will be aided by implementation of restoration activities, recovery rates should be increased over those due to natural succession, and the numbers of invading weedy species could be kept relatively low. As plant habitat slowly reclaims the disturbed areas, wildlife populations would return to original levels.

Human Presence and Noise - Considerable noise will be generated by well drilling. If sensitive roosting and nesting areas are avoided, the principal impact will be that raptors, mammalian carnivores and probably other bird species will not use habitat within one-half mile of the drilling area. During the operations period, some species may return to the vicinity of the power plant.

Ground Water Lowering - If ground water is used in the quantities projected, Little Lake has a high probability of decreasing in volume and hence a valuable habitat for waterfowl and other wildlife species may be endangered.

Pipelines - Steam pipelines may impede some large animal movements, depending on location of lines, height above ground, and configuration of expansion bends, e.g., whether vertical or horizontal.

4.7 FLORA

Devegetation - During the construction process, 2,260 acres of bare and/or level ground will be required and thus the vegetation will be lost. Types of vegetation lost would depend on location of exploration and development activities, but all vegetative associations in the study area are relatively common. Joshua Tree Woodland is of higher value for wildlife habitat and scenic qualities, but its distribution is not in the areas most likely to be disturbed. Because of its value as wildlife habitat, it will be protected by mitigation. Unique plant species and CNPS species will be protected by mitigation.

Trampling - Vegetation will be disturbed and trampled by field crews and off-road vehicles during the exploratory phase and during construction of transmission lines. Vasek et al. (1975) found that 13 years after construction of a transmission line in the Mojave desert, vegetation disturbances due to trampling were still evident beneath pylons.

Introduced Weedy Species - There will be some invasion of weedy species such as Russian Thistle into disturbed soil areas. These will be controlled by mechanical means and revegetated with native species undertaken, to the extent possible. However, these invading species will constitute an unavoidable adverse impact.

Erosion - Topsoil erosion is discussed in Section 4.5.

4.8 VISUAL RESOURCES

If mitigation for VRM Class II areas recommended in Chapter 3 is implemented only structures which meet the Management Class restrictions will be allowed. These include pipelines, transmission lines, and the main switching yards. These will be visible in the Class II area, but if well designed, will maintain the overall esthetic pattern of the area.

4.9 CULTURAL RESOURCES

This section addresses only archaeological cultural resource sites in the CGSA; unavoidable adverse impacts to Native American values are presented in Sections 4.2, 4.4, 4.10, and 4.11.

The known cultural resource sites within the CGSA are considered by the BLM to collectively meet the eligibility criteria for inclusion on the National Register of Historic Places. Two properties in the CGSA area have already been listed on the National Register: the Fossil Falls Archaeological District and Coso Hot Springs National Register Site. In compliance with 36 CFR 800.4, the BLM has initiated consultation with the SHPO and the National Advisory Council on Historic Preservation. The SHPO has determined that the proposed action will have an adverse effect on the cultural resources of the CGSA (see SHPO letter of May 30, 1980 in Chapter 8).

A plan for site evaluation, impact avoidance, and impact mitigation for known cultural resource sites and those yet to be discovered within the CGSA is presented in Chapter 3. Cultural resource sites of extremely high sensitivity (see Figure 2.10.2-1 and Section 2.10) will be protected through site avoidance and monitoring. These sites and properties include Fossil Falls Archaeological District; Coso Hot Springs National Register Site; DA-253, 268, 273, 313, 316, 340, 373, 380, and 381 (permanent numbers forthcoming). The site types represented include rock art sites, certain rock shelters with associated occupational midden, and any village or temporary campsite with cultural deposit (due to the possibility that they may include human burials). Appropriate measures will be taken by the BLM and NWC (as appropriate), in consultation with the SHPO, to avoid or mitigate the impacts to highly sensitive sites that are discovered after leasing. All other sites that may later be determined eligible to the National Register will not be disturbed by geothermal exploration and development until the National Advisory Council on Historic Preservation has had a reasonable opportunity to comment on the proposed action and until concurrence on appropriate site avoidance and mitigation measures has been obtained from the SHPO.

A Cultural Resources Assessment Strategy is presented in Chapter 3 that will provide an evaluation standard for assisting the BLM, NWC, and the SHPO in determining the National Register eligibility and potential data yield of lithic scatters and the lithic components of quarry sites, rock shelters, and temporary campsites in the CGSA.

Despite all proposed protection and mitigation efforts outlined in Chapter 3, accidental disturbance of some archaeological deposits by geothermal personnel will probably occur. Geothermal program personnel will generally not be experienced in recognizing archaeological material and may unknowingly disturb or destroy deposits in sites near development areas by accidentally driving over them. If full development of the geothermal resource occurs under the BLM leasing program, a total of 2,150 acres of surface disturbance could result. It is estimated that the probability of encountering a cultural resource site within Geothermal Zone 1 is .89, within Zone 2 it is .79, and for the CGSA as a whole, .75 (see Section 2.10.2). Certain site types will be protected through site avoidance; others may require data collection and analysis as a means to mitigate adverse effects. It is likely, however, that some lithic scatters (which comprise 55 percent of the known cultural resource sites in the CGSA) will be disturbed by the proposed action through accidental disturbance. Disturbance or destruction of even a peripheral portion of a whole site, however carefully the cultural material is removed and studied, affects the site as a whole, especially in an area as archaeologically rich as the CGSA. It is critical, therefore, that parameters for determining site significance are established, as well as achieving concurrence of the BLM, NWC, SHPO, Advisory Council on Historic Preservation, Native American Heritage Commission, and the local Native American community on acceptable levels of data loss. Implementation of the proposal in Chapter 3 for site evaluation and impact avoidance or mitigation provides the necessary framework to achieve those comprehensive objectives of cultural resource management in the CGSA.

Periodic monitoring of selected sites, a cultural resources education program, and increased patrol of sensitive areas by BLM resource management personnel and NWC patrols, will be implemented to reduce potential vandalism of cultural resource sites in the CGSA. However, it seems realistic to assume that some additional pothunting and general deterioration of sites beyond present levels would be unavoidable with increased personnel in the CGSA as a result of geothermal development.

In summary, some degradation of cultural resources sites is anticipated as a result of the proposed action. Levels of site disturbance through accidents or vandalism cannot be accurately predicted at this time; realistically, however, the cumulative unavoidable adverse impacts will not be disproportionate to the increased personnel activity in the CGSA.

4.10 LAND USE

The only unavoidable adverse public land use impact of significance likely to accrue as a result of the proposed program is possible interference with Native American uses of the Coso Hot Springs and Prayer Site. While mitigation measures have been recommended, and an access agreement with NWC has been signed, occasional additional impediment to their usage of the sites due to geothermal development may be unavoidable. For example, religious observances at the Prayer Site may occasionally be disturbed by nearby development even if Coso Road is relocated, as suggested. A new land use would be added to the CGSA as a result of 2,150 acres of land diverted from present uses to geothermal development. The NWC mission should not be substantially interfered with, because the development activities will be required to work around the NWC activities.

4.11 SOCIOECONOMIC

Housing and Infrastructure - Population increases will create additional demands on all facilities and services of southern Inyo county and northeast Kern County. Zoning in these areas is designed to accommodate some change in private land use, e.g. from agriculture/grazing to residential/urban uses. However, influx of both temporary and permanent workers may pose the need for acceleration of these changes beyond the rate presently provided, necessitating policy decisions by both Counties.

Public Fiscal Impacts - Although revenues from the proposed program, including sales tax subventions and sharing of geothermal revenues with the State, should eventually mitigate the public fiscal burdens imposed by the need for additional infrastructure, these revenues may not accrue sufficiently early in the development program. Floating of bonds may then become necessary. This bonding, if it approached the limits of the jurisdictions' bonding capacity, might then preclude the implementation of other necessary capital improvement projects.

Fresh Water Availability - Additional drawdown of water in Rose Valley for geothermal and domestic uses, and in Indian Wells Valley for domestic uses occur.

Vehicular Traffic - Even with mitigation, increase in vehicular traffic up to a possible 1,000 additional vehicle trips per day on Highway 395 and within the CGSA will inevitably accompany geothermal development, with consequent potential for congestion at Coso Junction.

Native Americans - The potentially unavoidable adverse impacts on Native Americans wishing to preserve and utilize these areas are addressed in a number of sections above. These impacts themselves, in the aggregate--noise, impediment to Coso Hot Springs/Prayer Site access, and possible alteration of the Springs--may entail impact on the sociocultural and religious values which the Springs and Prayer Site have for local Native American groups.

4.12 SUMMARY OF UNAVOIDABLE IMPACTS

Impact	Degree of Unavoidable Impact
	AIR QUALITY
Increased fugitive dust concentrations	Localized, should be able to maintain Federal and State standards.
Increase in H_2S concentrations	Localized increases below state standards
Decrease in visual range	Projected maximum 10% decrease in regional visibility (average)
	NOISE
Increase in background, increase to sensitive receptors.	Barely perceptible after initial construction activities are completed. May affect sensitive wildlife. Sensitive human receptors protected.
Disturbance of Native American ceremonies	Low
	GEOLOGY
Well damage due to ground shaking	Low probability of occurrence. Moderate to severe impacts on soils and vegetation if event occurs.
	HYDROLOGY
Lowering of Rose Valley water table	Moderate impacts on vegetation and wildlife if mitigation measures are fully implemented.
Degradation of natural ground and surface water	Only if accident occurs. Moderate short term except for blowouts.
Alteration of flow to Coso Hot Springs	Potentially severe. Insufficient data to predict at this stage of project development.
	SOILS
Surface disturbance due to roads, well pads and sumps.	Localized and relatively minor.
Blowouts and sump failures	Moderate to severe, although these have low probability of occurrence.

Impact	Degree of Unavoidable Impact
	WILDLIFE
Surface disturbance; habitat loss	Moderate in extent, eventual recovery
Damage to Mohave Ground Squirrel	Low; eventual recovery
Loss of aquatic habitat and watering areas	Low to moderate depending of level of development
Noise disturbance to raptors and mammals	Temporarily moderate; long-term low; eventual recovery
Electrocution of birds on transmission wires	Low to none
Impedance of wildlife movement by pipelines	Low
	FLORA
Devegetation/trampling soil compaction	Moderate in extent; moderate locally; eventual recovery
Erosion	Low to moderate locally; some permanent effects
Damage to rare *Pholisma arenarium*	Low to none
Damage to rare *Spartina gracilis*	Low to moderate, depending on development level
Damage to rare *Canbya candida*	Low
Introduction of weedy species	Moderate locally
	VISUAL RESOURCES
Degradation of natural scenery	Low, locally moderate

Impact	Degree of Unavoidable Impact
	CULTURAL RESOURCES
Vandalism, pothunting	Moderate locally
Destruction resulting from development	Low to moderate in extremely high sensitivity; moderate to low in remainder of CGSA
	LAND USE
Impact to Native Americans use of Prayer Site and Coso Hot Springs	Low to Moderate
Impact to WSA 157	None if declared a wilderness area
	SOCIOECONOMICS
Increased traffic volume and related impacts	Moderate locally, low regionally
Congestion at Coso junction	Moderate to low
Housing/infrastructure impacts	Moderate to low
Public Fiscal	Moderate at first; eventual net gain in public income
Fresh water availability	Moderate to low
Native American values	Low if mitigation measures are successful; impacts on Coso Hot Springs are unpredictable
Access for Native Americans to Coso Hot Prayer Site	Low to no impact ascribable to geothermal development; is a NWC policy. Springs and

5.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE AND MAINTENANCE ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Implementation of the program would result in some lowering of wildlife populations by direct (fatalities) and indirect (habitat loss) impact as discussed in Chapter 2. The lowered productivity of the CGSA as a whole, and the disturbance of ecological relationships -- as for example, predator-prey balance and changes in habitat due to introduction of exotic plant species -- would result in long-lasting effects, persisting beyond the assumed 50-year span of the program. Wildlife species of particular concern during this period would be the rare Mohave Ground Squirrel, raptors such as the prairie falcon and golden eagle, and carnivores. However, within a few decades after close-out, with proper mitigation, monitoring and restoration, wildlife populations, including the species mentioned, could recover to their preconstruction levels. Without such measures, recovery would take hundreds of years (Vasek, et al., 1975a).

In the short term, i.e., for the assumed 50-year life of the program, biological productivity of the CGSA would undoubtedly be lowered by the loss of some 2200 vegetated acres. Most of the perennials in the CGSA are long-lived, very slow-growing plants. The rare cord grass (Spartina gracilis) (rare, CNPS) could become locally extirpated if the water level of Little Lake is lowered by depletion of the water table. The rare poppy (Canbya candida) and pholisma (Pholisma arenarium) (rare, CNPS) are restricted to very small areas and could be also lost if care is not taken to avoid their habitat areas. Without restoration efforts, plant communities damaged would take centuries to recover. With proper mitigation measures, discussed in Chapter 3, the general level of vegetational productivity could probably be partially restored within a few decades (Vasek, et al., 1975a), though rare or limited-distribution species may be irreparably damaged or lost. Changes in soil structure, discussed in Section 2.6, would alter plant habitats. Another long-term vegetational change can be expected as a result of the accidental introduction and spreading of exotic weedy species such as Russian thistle. Such changes -- loss of species, modification of soils, and addition of new species -- would persist indefinitely, though their extent may be limited by careful planning.

One possible long-term beneficial change, mentioned in Section 2.7.2, is the occasional enrichment of vegetational communities, under transmission lines and along unpaved access roads (Johnson, et al., 1975); Vasek, et al., 1975b).

Combined NWC and BLM development activities may have some adverse impacts on archaeological resources, as discussed in previous chapters, despite site avoidance and/or data collection proposed in Chapter 3. All adverse impacts to cultural resource sites are considered to be permanent. Once a site is disturbed or destroyed, its original setting and integrity have been lost; data from disturbed sites can rarely be as comprehensively analyzed and interpreted as data from undisturbed sites.

A short-term commitment of approximately 2.9 percent of the present CGSA area (2150 acres for 50 years) would be required for implementation of the proposed leasing and development program. Most of the present multiple uses -- grazing, wildlife habitat, watershed, mineral resources reserve, and use as a safety and periodic testing area for the NWC testing program -- could continue in general as at present on undisturbed portions of the CGSA. Present usage, by Native American groups, of the National Historic Register Site, including the prayer site, may be subject to interruption or disturbance unless appropriate mitigation is implemented.

Assuming eventual closeout and restoration (and assuming that appropriate mitigation and monitoring plans have been in effect), disturbed portions of the land within the CGSA could be returned to their present uses after about 50 years, with the possible exception of some roads. Where road construction has involved extensive cut-and-fill operations and/or blacktopping or other hard surfacing, effects could persist for, conceivably, hundreds of years (or require considerable regrading and removal of surfacing). Any additional roads left in place after closeout of the program would not substantially interfere with any of the above listed multiple uses; however, they would constitute an added attraction for sightseers, pothunters, and others.

Indirect land use changes (outside the CGSA) involving any residential or infra-structure construction in areas now devoted to agriculture, grazing or other uses would represent an opportunity loss, in that those land resources would not be available for their present uses. Some such changes (e.g., shopping and service facilities and residential developments) would probably have been incorporated into the general growth patterns of the region by the year 2030, with or without the proposed geothermal program.

In the short term, the program would require the commitment of large amounts of labor (building up to a maximum of possibly 500 employees over a period of several years), materials and funds (an estimated $2 billion, in 1977 dollars, for total payroll and materials over 50 years). The benefits accruing from the program would include the production of 550 MW of electricity at full development; this would result in the sale of approximately 3.85 million MWh/year at an average adjusted retail cost (for all uses) of $40 per MWh, or total sales of $154 million per year at full production in 1977 dollars (California Energy Commission, 1978). This assumes 80 percent capacity.

Other economic benefits of the program in the short term include the generation of direct and indirect employment and stimulation of the regional economy in terms of payroll spending, sales tax subventions, new housing construction and new service industries.

The future of the region would thus be affected during the life of the program and beyond. The overall long-term effect would be to accelerate ongoing regional development. Some inevitable changes in life style would accompany the economic changes -- local population increases, land use changes, and some loss of the sense of remoteness and privacy heretofore highly valued by many of the region's residents.

In particular, some loss of privacy may be experienced by Native American groups wishing to visit the Coso Hot Springs and prayer site areas within the CGSA during the life of the program. Any alteration in the flow, temperature or characteristics of the Springs and muds, as addressed in Section 2.5.2, would be a long-term loss.

6.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible or irretrievable resource commitments are presently not possible to define. It is likely that the geothermal resource will be irretrievably depleted, but the extent is not known. It is possible that the Coso Hot Springs may be irreversibly altered, but it is also possible that, if they are altered, they may recover after production ceases. Ground water may or may not be irreversibly degraded. As long as total ground water use continues in excess of recharge the use will be an irretrievable commitment of this resource. Any time recharge exceeds use, ground water in storage will increase.

Commitment of biotic resources to the program is not entirely irreversible. Some loss of wildlife would be inevitable if the program is implemented, but populations would eventually return to original levels, as discussed in Chapter 5. Change in habitat, however, may be permanent.

Some vegetational changes resulting from the program, while not completely irreversible, would persist for perhaps hundreds of years even with careful restoration measures. Modification of soils (with inescapable consequences for plant life) is one such change: the rates of soil formation in desert areas are very slow, measured in centuries, and impoverishment of soils by wind and water erosion, spilled toxic materials, grading and compacting could leave soils and vegetational scars persisting long after the closeout period. Introduction of weedy species may result in additional permanent ecological change. Local extirpation of rare or limited-distribution plant species could be irreversible; attempts at re-establishing such species from other areas may not be successful.

To the extent that archaeological resources are disturbed or destroyed, such impact represents an irreversible and irretrievable loss. Cultural resource sites are nonrenewable resources; once the data are lost, they cannot be replaced.

As presently defined, the proposed action should create no irreversible or irretrievable loss or commitment of land resources, with one possible exception. In the event that the steam and thermal water flow of Coso Hot Springs were significantly and permanently altered as a result of geothermal fluid extraction , the significance of this area as a cultural/historical resource management site and as a religious/traditional healing site for Native Americans would be irreversibly and irretrievably lost.

Commitment of industrial resources is generally irretrievable, with the exception of capital investment recovery through sales and depreciation. In view of the current and increasing emphasis on conservation and resource recovery, some substantial salvage of construction materials after closeout may be made possible by technological advances during the 50-year life of the program. Labor commitment is irrecoverable.

Changes, if any, in the characteristics of the Coso Hot Springs and muds would be long-term and perhaps permanent.

7.0 ALTERNATIVES TO THE PROPOSED ACTION

The proposed action is to lease the CGSA for the purpose of geothermal development. Chapters 1 through 6 discuss the impacts of such development utilizing a specific model which assumes that a total of 12 electrical generation stations (including NWC development), each of approximately 50 MW capacity will be constructed. The material in this section describes alternative to the proposed action.

The specific alternatives considered are:

1. Offer no leases. This is the "no-action" alternative.

2. Lease all lands except those with significant surface conflicts.

3. Conduct partially deferred leasing in order to protect the cultural resources of the CGSA.

4. Lease with no surface disturbance on areas with sensitive resources.

5. Defer leasing until a comprehensive geotechnical testing program can be carried out under the supervision of an appropriate Federal agency.

6. Conduct a staged leasing program by zone of geothermal potential.

7. Require that all lessees enter into a "unitization" agreement wherein a single operator is responsible for the development of the field.

7.1 NO LEASING ALTERNATIVE

The consequences of taking no action with respect to leasing of the CGSA are:

1. The potential geothermal resource will remain undeveloped, with the exception of the NWC geothermal project.

2. The lands will not be disturbed by exploration or development.

3. Data and information concerning the nature of the resource will be forgone unless the government sponsors separate exploratory activities.

4. The lands would remain available for leasing at a later date.

5. The existing uses would continue, undisturbed.

Impacts of not leasing include potential increases in the degradation of air quality in various basins in the southwest United States due to combustion of fossil fuel for the generation of electrical energy which might have been generated with the Coso geothermal resource.

The CGSA, without implementation of the proposed geothermal development, is expected to remain much as it is at present with regard to wildlife. Two changes which would alter the existing environment to some extent are increased alfalfa farming at the Rose Valley Ranch, and hence increased pumping of ground water (see Hydrology, Section 2.5), and the proposed NWC geothermal facility on lands to which the Navy holds fee title near Coso Hot Springs.

Both these developments may lower ground water levels in Rose Valley and could affect the riparian habitat and aquatic species at Little Lake (NWC 1979). Haiwee Spring, which derives water from the north and east of the CGSA, probably will not suffer from lower flow as a result of the NWC geothermal development.

Some terrestrial habitat loss will occur in the vicinity of the Navy fee-owned lands, as a result of disturbance for drill pads, sumps, reserve pits, and power plant construction. A total of approximately 110 acres may be required for the NWC facility. Some wildlife habitat will thus be lost, and burrowing animal populations may be reduced in particular; but since vegetative cover is sparse in the Coso Hot Springs area, near which NWC development is expected, the impact to reptiles, birds and non-burrowing mammals due to habitat loss will probably be minimal (NWC, 1979: 188 pp.).

The presence of exploration and drilling crews and construction personnel will also affect wildlife. The noise of vehicles and equipment, and the presence of large work crews, will disturb foraging activities of raptors and mammalian carnivores. Once power plant operation begins, these disturbances should decrease, although some noise and human presence will continue and will displace certain wildlife species. If the proposed action is not implemented, the vegetative cover of much of the CGSA will remain essentially as it is at present.

As remarked in Section 2.7.2, future drawdown of groundwater in Rose Valley for increased agricultural acreage and for the NWC geothermal installation could seriously affect Little Lake by lowering water levels. The effect might be to increase marshland vegetation at the expense of water surface, and, hence, habitat for aquatic species and waterfowl; eventually if deficit drawdown continues, the marshland might also be lost.

Even if leasing does not occur, approximately 110 acres of Navy fee-owned land, mostly in Geothermal zones 1 and 2, will be disturbed for exploration, drilling, and construction of geothermal plants and associated facilities. The areas within Zones 1 and 2 which may be disturbed are largely covered with creosote bush associated with burro weed and mixed desert scrub, all of which are common throughout the CGSA; therefore these cannot be considered as sensitive areas with regard to vegetation.

Even if the proposed development is not initiated, it cannot be assumed that archaeological resources within the CGSA will remain at the state in which they were discovered in 1978. Such resources are by their nature very fragile, and subject to deterioration from natural environmental conditions. Rainfall, water run-off, wind, freezing and thawing, erosion, and animal and human traffic contribute to disturb and disrupt the integrity of archaeological deposits. In 50 years it can be assumed that these natural factors will erode and deflate portions of midden deposits, relocate surface artifacts, and destroy and alter certain archaeological materials. If development is restricted solely to NWC lands these natural disturbances, of course, will not be halted. Further impacts, in such a case, will be restricted to the direct impacts resulting from increased human traffic in the area. The degree of indirect negative impacts resulting from the construction of the NWC facility will be contingent upon the amount of cultural resources education and supervision given to exploration, plant construction and maintenance personnel. It is very possible that, even with some educational program emphasizing the significance of cultural resources, in 50 years the archaeological sites within the immediate vicinity of the geothermal plant will be stripped of all identifiable surface artifacts. Thus, it can be conjectured that in 50 years those archaeological sites surrounding locations of geothermal development will be seriously impacted unless steps are initiated to mitigate these impacts prior to exploration and construction.

Unless there are significant changes in present land management policies and plans on the part of agencies governing land use within the CGSA (most notably BLM and NWC), future uses over the probable life of the proposed action (50 years) are not expected to be appreciably different from those found at present. Completion of the CDCA Master Plan by September 30, 1980, will provide some indication of the probable and permitted future uses, both for the CGSA and the surrounding region (BLM, 1977: 1-3). Because the California Desert Plan is only in preliminary draft stages at this time and presents three vastly different land use alterntives for the CDCA, it is difficult to speculate on the most likely ultimate plan (Pfulb, 1979). NWC land uses within the CGSA are not likely to change in the foreseeable future (NWC, 1977) with the notable exception of the Navy's proposed Coso Geothermal Development Program; this project is described in detail in the Navy's Programmatic Final Environmental Impact Statement (NWC, 1979). There is also a possibility that additional cultural resources may be nominated or determined eligible for inclusion in the National Register of Historic Places as a result of discovery and evaluation of sensitive archaeological areas throughout the CGSA (see Section 2.10). Although the CGSA is in proximity to the Los Angeles metropolitan area, no increase for recreation purposes is anticipated as long the the NWC and LADWP withdrawals remain.

Probably most land use changes which take place during the next 50 years will occur on the limited (1710 acres) privately owned land within Rose Valley. Among the more likely changes and developments are: expansion of agricultural lands to include greater alfalfa and field crop acreage (Hennis, 1979; Lane, 1979); possible development of geothermal resources, especially those from low-temperature fluids (Minor, 1979; Hennis, 1979); possible abandonment of the Lone Pine Branch rail line by Southern Pacific (Hebb, 1978); the draining of Lower Haiwee Reservoir and reallocation of DWP land uses in the area (Kuebler, 1978); the possibility of residential or commercial development at Dunmovin (Cooper, 1979); and the immediate expansion but ultimate abandonment of pumice mining operations at the Donna and Gill deposits at the North end of the CSGA (Paul, 1979).

Population projections to the year 2030 for Inyo County, Lone Pine Census Division, Lone Pine (unincorporated), Indian Wells Valley and the China Lake/Ridgecrest area are shown in Table 7.1-1. Within

TABLE 7.1-1
Population Projections for the Study Area: 1980 - 2030

Year	Inyo County	Lone Pine Division(3)	Lone Pine(4)	Indian Wells Valley	China Lake/ Ridgecrest (C.T.53&54)	Rural Indian Wells Valley (C.T.55.01)
1980	18,100(1)	3,300	1,745	25,700(5)	21,900(5)	3,900(5)
1990	22,200(1)	4,330	1,690	29,100(5)	24,200(5)	5,200(5)
2000	25,800(1)	5,230	1,640	33,000(5)	26,500(5)	6,500(5)
2010	29,300(1)	6,100	1,590	36,500(6)	29,300(6)	7,200(6)
2020	32,700(1)	6,950	1,540	40,300(6)	32,300(6)	8,000(6)
2030	36,500(2)	7,900	1,495	44,500(6)	35,700(6)	8,800(6)

Notes:

1. California State Department of Finance, Population Projections for California Counties, 1975-2020, Series E-150, Report 77-P-3, Sacramento, California, Dec. 1977.

2. ERG projection, based on same grwoth rate as used by California State Dept. of Finanace for 2020 projection.

3. Projections for Lone Pine Division estimated as 25% of Inyo County's projected growth, 1980-2030; discussed with R. DeHar, Inyo County Planning Dept. May 1979.

4. Lone Pine population projected on the basis of the -3.1% population loss experienced between 1975 and 1979 and discussion with P. Farlander, Executive Director, Lone Pine Chamber of Commerce, May 1979.

5. Kern County Planning Dept., Population by Census Tract, 1960-1979-1977-1980-1990-2000, March 1979.

6. Based on Kern County Planning Staff population projections for 2000; uses growth rate of 1% for IWV (C.T.'s 53 and 55.01) and C.T.'s 53+54 combined; Inyokern is included in C.T. 55.01. Discussed with J. Folpmers, Kern County Planning Dept., May 1979.

the Kern County subregion, 2030 population is expected to be approximately double the 1977 figure, with increasing decentralization from Ridgecrest into currently unincorporated areas. Inyo County population is also expected to double, largely due to net in-migration (Inyo County Planning Department, 1978: 11). Greater growth is expected in Lone Pine Census Division, which may triple in population even without the proposed action, although Lone Pine itself is seen as declining without further economic stimulus. The NWC geothermal program would add a temporary stimulus of some 350 construction employees within southwestern Inyo County, and a permanent population of 150-175 persons (NWC, 1979: 215).

The Land Use Element of the Kern County General Plan, in conformity with state law requiring comprehensive long-range community planning, provides for a more orderly development of the northeastern portion of the County in the near future. Further expansion in Inyokern and Brown Road is expected (Kern County Planning Commission, 1973; City of Ridgecrest, 1977; Burns, 1979). Inyo County's General Plan is being revised and updated, with the Land Use Element expected in early 1980 (Budlong, 1979). If County and State population projections for the Inyo County portion of the study area are correct, comprehensive planning will be essential to accommodate the increase. Additional private land acquisition and development may be required. The expectation of 150-175 additional permanent residents as a result of the NWC geothermal program would act as a stimulus for such development.

Pending revision of the Inyo County General Plan, it is difficult to predict the future availability of housing within the Inyo study area. However, to accommodate the expected population growth (and the NWC personnel), more residential construction seems likely. This will presumably be located in or near existing settlements to take advantage of services and utilities. The trend toward construction expansion in the Kern County portion of the study area is expected to continue; in the near future, a new-housing completion rate of 250 per year is expected in Ridgecrest (Brummett, 1979).

Infrastructure would expand incrementally to meet the requirements of the growing population. Fresh water supply systems and wastewater treatment facilities would be the most critical areas for adjustments, particularly in Inyokern, Cartago, and Lone Pine. Expansion of solid waste disposal facilities in the study area is currently proposed by both Kern and Inyo Counties. With present enrollment in Sierra Sands Unified School District well below capacity, no need for new facilities is anticipated in the near to medium-term future, except for replacement facilities or additional neighborhood classrooms. Development of additional parks and recreational facilities in Ridgecrest will be necessary, with or without continued access to NWC facilities.

Assuming that recreational traffic will continue to increase, Caltrans has projected annual increases of 4.5 percent in average daily volumes on Highway 395 in the vicinity of the study area (California Department of Transportation, 1979: 4). The Department plans to upgrade additional sections of the road to four-lane divided expressway, both north of Dunmovin and south of Pearsonville. The continuance of railway service north of Pearsonville is now in question, and may depend on whether the Inyo County portion of the study region receives some economic stimulus. Improvements are planned for the region's airports at Inyokern, Lone Pine and Bishop.

Some economic projections for portions of the study area have been provided by SRI International for the California Desert Planning Program (USDI BLM 1978). According to these analyses, the desert area in general will neither acquire major sources of new water nor lose those it now has. It will, however, be difficult (even with the exercise of conservation and recycling of water) for the region to provide for expected growth. Military activities in the area are expected to remain at approximately their present levels, while recreational activities are expected to continue to grow and to pose management problems-- always assuming the availability of fuel. Agricultural expansion will depend largely upon introduction of new species of plants.

Personal income in the desert portion of Kern County in 1990, according to SRI (USDI BLM 1978: III-3_3), is expected to total $440 million, up from $335 million in 1980; by the year 2000 it is seen as $620 million or approximately double the figure in the late 1970s. In the desert portion of Inyo County, income is predicted to rise from a total of $19 million in 1980 to $30 million in the year 2000.

Employment throughout the area is expected to rise faster than population, as the proportion of working age persons will be greater, and the percentage of women working will continue to rise (ibid.: III-4).

7.2 LEASE ALL LANDS EXCEPT THOSE WITH SIGNIFICANT SURFACE CONFLICT

This alternative would open all lands to leasing and development except those areas which have been identified as having resources extremely sensitive to development, see Figure 7.2-1. These lands include a compilation of sensitive habitat for wildlife, (Figure 2.7.2-1), rare plants, (Figure 2.8.2-1), and the cultural resources of extremely high sensitivity as shown in Section 2.10 (Figure 2.10.2-1).

Soils which are sensitive to disturbance have also been identified in this document. However, sensitive soils are not included in the leasing limitations under this alternative because protection of soils by avoidance is not necessary; mitigation can be effectively implemented prior to and during development.

The total acreage which would not be offered for lease under this alternative is low, approximately 5720 acres; the bulk is in areas outside of geothermal zones 1 and 2. The impacts to the known sensitive wildlife resources would be less than those which would occur as a result of the Proposed Action in that

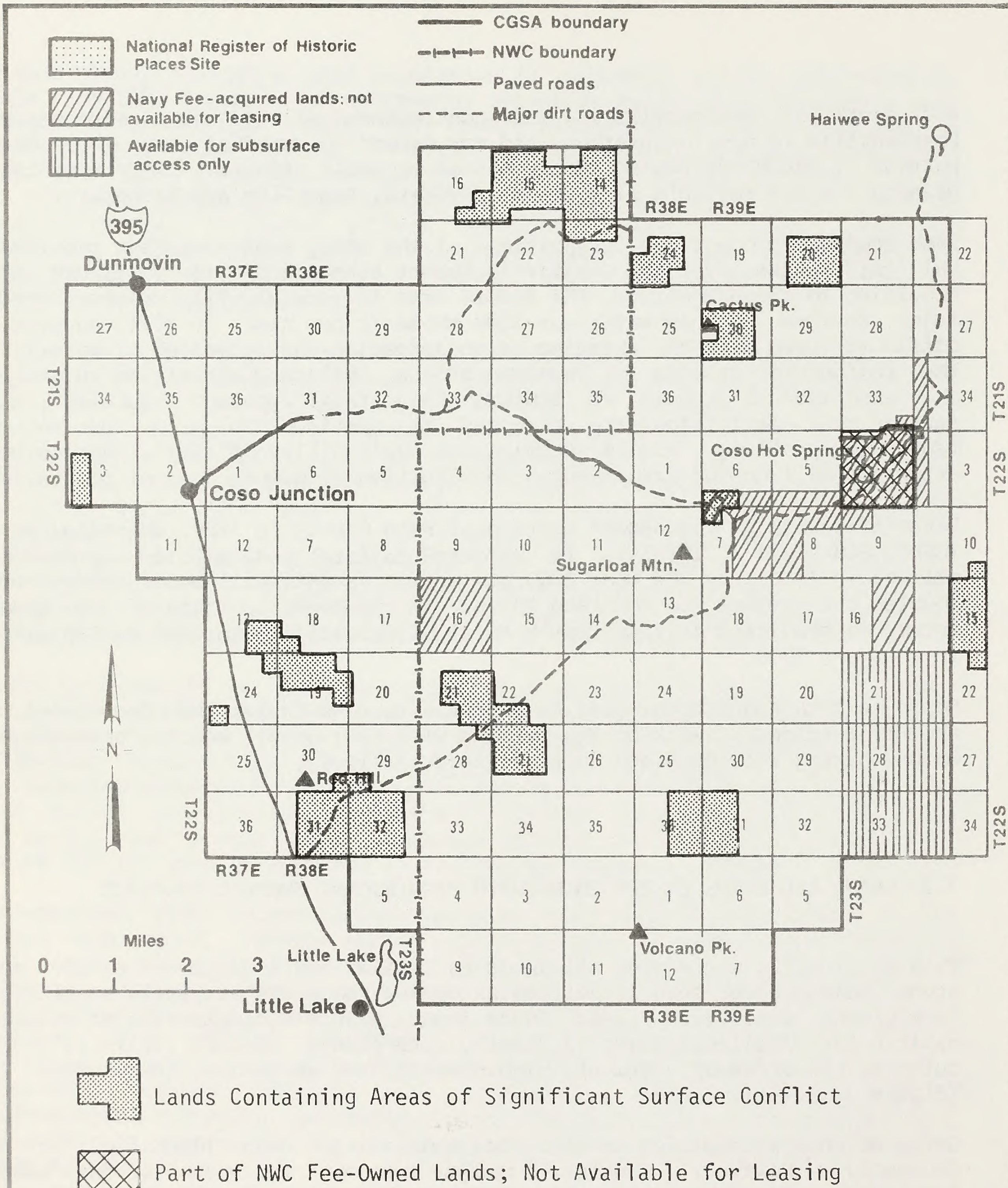


Figure 7.2-1. ALTERNATIVE 2: LEASE ALL LANDS EXCEPT THOSE WITH SIGNIFICANT SURFACE CONFLICTS

only carefully controlled surface entry would be permitted on those acreages not leased. However, the carnivore denning areas and adjacent high potential areas for raptor nesting on the rocky ridges would still be susceptible to noise, so a noise disturbance buffer zone of one-half mile would be needed for mitigation. It should be maintained around such areas until demonstrated to the satisfaction of the Supervisor that the operations would not disturb nesting/breeding activities. Impacts to the known sensitive flora species and cultural resources of extremely high sensitivity identified in Sections 2.8 and 2.10 would not occur under this alternative because they would not be disturbed. All other impacts predicted (and not mitigated) under the proposed action would occur under this alternative.

7.3 PARTIAL DEFERRED LEASING TO PROTECT CULTURAL RESOURCES

This alternative would include the concept of partial deferred leasing in order to permit collection of sufficient data on cultural resources to determine optimal mitigation measures. Lands that would be open for leasing immediately would be those areas of the CGSA which have been inventoried and found to contain no cultural resources, roughly 6 percent of the CGSA (see Figure 2.10.2-1, areas labeled as "low sensitivity sample units"). The additional information which is necessary to collect and analyze is contained in Section 3.9 as the Cultural Resources Assessment Strategy. The deferral of the rest of the lands for leasing would probably be for a year or two, if the data collection was implemented concurrently with the initial lease sale.

The impacts of this alternative would be to limit the area leased; therefore the exploration to define the resource would be curtailed. Commitment of financial resources by the lessees for serious exploration might occur more slowly, because the area open for the initial lease sale may not give them sufficient geothermal resource potential to warrant large investments.

This effect on the initial availability of the geothermal resource would be large because it would defer the leasing of large portions of Zones 1 and 2. However, this would only be for a year or two, and then most of the CGSA could be leased with optimal cultural resources mitigation.

This alternative would protect the integrity of the cultural resources sites to the degree that no disturbance of sites would occur until after the addtitional data is collected and analyzed, and optimal mitigation is designed and concurred with by the State Historic Preservation Officer. Since the proposed mitigation which has been designed for the Proposed Action should protect cultural resources in a similar way, the degree of impacts from this alternative should be slightly less than those predicted to occur from the Proposed Action. Accidental disturbance would not occur, as it might under the Proposed Action if the proposed mitigation was not implemented immediately upon lease. Impacts of other resources would remain the same as in the Proposed Action.

7.4 LEASE WITH NO SURFACE DISTURBANCE ON LANDS WITH SIGNIFICANT SURFACE CONFLICTS

This alternative (Figure 7.4-1) would open to leasing all lands, but would require no surface disturbance of lands identified on Figures 2.7.2-1 and 2.8.2-1, and cultural resources identified as having extremely high sensitivity as shown in Figure 2.10.2-1.

The impacts to the identified sensitive resources would not differ from those predicted for the proposed action if the mitigation measures recommended in Chapter 3 are fully implemented. This alternative is, in a sense, the Proposed Action with mitigation applied.

The consequences of implementing this alternative are similar to those described in Section 7.2 with the primary difference being the potential to fully develop the field by utilization of slant drilling and careful selection of plant sites with respect to the sensitive resources. The primary impact of this alternative would be to marginally increase the cost of the electrical energy produced due to the requirement of more slant drilling. It would not, however, make unavailable any of the geothermal resource.

7.5 DEFER LEASING UNTIL COMPLETION OF FEDERAL TESTING OF THE GEOTHERMAL RESERVOIR

This alternative would result in essentially all of the impacts described for the unitization alternative. Such action would result in a more orderly exploration phase for the CGSA. A comprehensive exploratory program considering the geothermal resource as a complete entity would be designed and only the necessary surface disturbance would occur. There would be no incentive to perform exploratory activities on acreages not considered as being prime. This alternative would permit ready implementation of unitization as described below.

7.6 STAGED LEASING BY GEOTHERMAL POTENTIAL ZONE

The impacts of this alternative would be similar to those described for the Proposed Action. The principal advantage would be that only the "hot" zone would be initially explored and developed and there would, therefore, be less disturbance. Implementation would result in a longer period of development for the CGSA as a whole.

The first lease offering would be of Geothermal Zones 1 and 2 and make approximately 10,240 acres available. The size of the second and subsequent

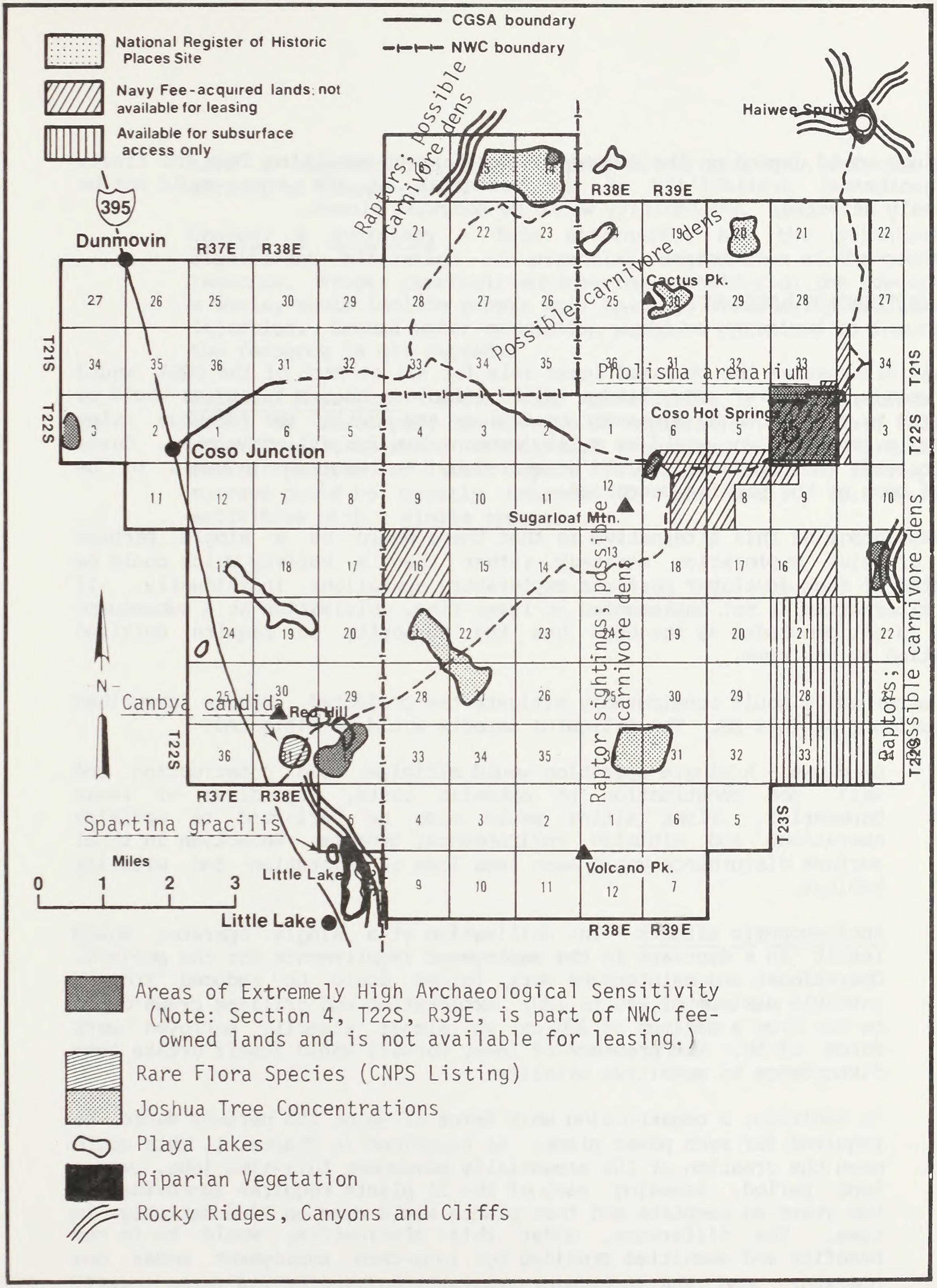


Figure 7.4-1. ALTERNATIVE 4: LEASE WITH NO SURFACE DISTURBANCE ON LANDS WITH SIGNIFICANT SURFACE CONFLICTS

offerings would depend on the success of development resulting from the first. The geothermal availability of the potential of the area would not be adversely affected; availability would be somewhat slowed.

7.7 UNITIZATION ALTERNATIVE

In this alternative the proposed lease sale for all or part of the CGSA would take place. However the leases would stipulate that all lessees would be required to enter into an agreement to explore and develop the resource using a single operator who would be solely responsible for all activities. Costs and proceeds from operations would be shared by the lessees on a basis to be agreed upon by the parties concerned.

A disadvantage of this alternative is that there would be a single perhaps less creative exploration strategy rather than a variety which could be expected if each developer performs exploratory operations individually. If this alternative is not implemented at lease time, unitization at a subsequent stage is not precluded as the USGS has the authority to require unitized operation at any time.

This alternative would considerably mitigate the projected impacts described in Section 2 of this ES. The following impacts would be mitigated:

> Land Use - A single operation would minimize road construction and well pad construction to optimize costs, regardless of lease boundaries. Plant siting would also be performed to optimize operations and minimize environmental impacts. Reduction in total surface disturbance would mean less loss of vegetation and wildlife habitat.
>
> Socioeconomic effects - The utilization of a single operator would result in a decrease in the employment requirements for the project. Operational and maintenance work forces could be reduced from a possible maximum of 240 to 120; exploration and drilling crews could be cut from a maximum of 220 to an almost steadily employed work force of 50. The presence of fewer workers would itself create less disturbance to sensitive wildlife.
>
> In addition, a construction work force of about 150 persons would be required for each power plant. As described in Chapter 1, this could mean the creation of 150 essentially permanent full-time jobs, over a long period, assuming each of the 11 plants requires approximately two years to complete and that plants would come on line serially in time. The difference, under this alternative, would be in the benefits and amenities provided by long-term employment under one operator, and the consequent greater stability of the force itself. The more gradual planned influx of about 300 total employees would

have a significantly lesser impact on the area than the more random arrival of larger crews.

Geology & Hydrology - This alternative has the potential for significant mitigation of potential degradation of the geothermal resource. Proper reservoir engineering, considering the resource as a whole, would include proper well spacing, drilling, production, and injection. Ground water extraction would be optimized to insure that the resource is not degraded.

Cultural Resources - Under this alternative a comprehensive plan could be developed, in advance of exploration, to locate roads and other facilities where artifactual deposits are not located. A staged program of direct impact mitigation, including site-specific surveys could be greatly enhanced by the ability to coordinate activities with a single operator.

8.0 CONSULTATION

The BLM decided to prepare an Environmental Statement (ES) by contract in late 1977. Coordination with the China Lake Naval Weapons Center, U.S. Geological Survey and other Federal, state and local agencies began during this time on both the geothermal program and preparation of the ES. Major participants in the coordination and information exchange process for the ES were the NWC, U.S. Geological Survey, California Energy Commission, and the State of California Coso Geothermal Advisory Committee, which is made up of most of the resource-related state agencies.

Concurrently, the Department of Energy awarded a contract to Lawrence Livermore Labs to prepare Overview Reports on the high priority Known Geothermal Resource Areas (KGRAs), including the Coso KGRA. The contract was sublet to the China Lake NWC. As a result, the NWC convened the Coso Advisory Committee in June 1978, including BLM, U.S. Fish and Wildlife Service, U.S. Geological Survey, California Energy Commission, Inyo and Kern Counties, the State Air Resources Board, Water Pollution Control District, and California Department of Fish and Game. The committee held three issue/impact scoping and planning meetings and then chaired a two-day public Coso Overview Workshop on August 17-18, 1978. The workshop was a multi-resource consideration and scoping of issues and impacts likely to occur from geothermal resource development at the Coso KGRA. It was very well attended and received by the public. Concerns brought up at this workshop covered a range of resources and have been addressed in this document.

Two public meetings were held by BLM and Rockwell November 15, 16, 1978 to acquaint the public with the proposed leasing program and upcoming ES preparation effort, and to receive any resource information which they could provide. These meetings were very poorly attended, although the attendees were receptive to the concept of geothermal development. The concerns expressed by the attendees at the Ridgecrest meeting centered on hydrology, while at the Lone Pine meeting concerns centered on Native American access to Coso Hot Springs, potential degradation of the springs, and whether leasing would restrict access.

During preparation of the ES, Rockwell and BLM conferred with various agencies and groups about methodologies of data gathering and impacts of the proposed leasing program. These included:

BLM/Owens Valley Paiute Shoshone Band of Indians - April 1978, covering Native American concerns.

BLM/Environmental Protection Agency/NWC/ Rockwell - November 1978, concerning air quality monitoring, modeling, impacts.

BLM/Air Resources Board/Rockwell - January 1979, concerning air quality monitoring, modeling, impacts.

BLM/Rockwell/Sequoia National Forest - April 1979, concerning schedule, and air quality impacts to the Forest.

BLM/Rockwell/Sequoia and Kings Canyon National Park - March, 1979, concerning schedule and air quality impacts to the Parks.

BLM/NWC/U.S. Geological Survey/Los Angeles Department of Water & Power/Rockwell - April 1979, concerning hydrology, existing environment, impacts.

Environmental Resources Group (subcontractor to Rockwell)/California Indian Legal Services, Owens Valley, Bishop, and Pauite Shoshone Tribe elders - June, 1979, covering Native American concerns about potential impacts to Coso Hot Springs and the Prayer Site.

BLM/U.S. Geological Survey/Rockwell - October 1979, concerning mitigation measures.

Other briefings on the project which were held included:

BLM's California Desert Advisory Committee - progress, schedule.

Inyo County - general, schedule, plans.

California Energy Commission - general, schedule.

California Coso Geothermal Advisory Committee - general, schedule.

Several unofficial coordination efforts were initiated with the State Historic Preservation Officer to receive interim guidance in development of proposed mitigation measures.

During preparation of this document, many agencies and individuals were contacted for information. Other general public affairs activities which have been carried out have been various special BLM District news publications, newspaper articles, and radio interviews to inform the public of the program and solicit information.

Reviews were made during preparation of this EIS and the supporting Technical Reports by various entities. The Coso Technical review team and other staff from the BLM, U.S. Geological Survey, the Naval Weapons Center, and certain experts on resource fields reviewed one or more of the draft Technical Reports. The interim draft submissions from Rockwell all were reviewed and approved by the BLM Coso Project Manager and the Technical Review Team.

The Draft EIS was released for a public review period of 45 days, ending May 12, 1980. One public meeting was held in Lone Pine May 1,1979. The public meeting was attended by about 35 persons of various backgrounds. Sixteen comments were received (see comments and responses 1-16). Written comments were received by 34 reviewers, including agencies, interest groups and individuals. See Table 8-1.

Table 8-1. LOG OF OFFICIAL COMMENTS RECEIVED ON DRAFT EIS

No.	Date Received	Agency, Organization or Individual
1	3-28-80	Bureau of Reclamation-Lower Colorado Regional Office (no comments)
2	4-10-80	Kern County Planning Department (no comments)
3	4-18-80	Rural Electrification Administration
4	4-18-80	Advisory Council on Historic Preservation
5	4-23-80	U.S. Department of Transportation - Federal Highway Administration, Region 9 (no comments)
6	4-24-80	Ridge-riders; C.K. Hollingsworth - Trail Club, Ventura
7	5-2-80	Carol Panlaqui, Ridgecrest
8	4-30-80	Department of the Army, Army Corps of Engineers, Los Angeles District (no comments)
9	5-1-80	George A Bridges, Sacramento, California
10	5-5-80	Ron Guenther, Fort Bragg, California
11	5-7-80	Marguerite Christoph, San Diego, California
12	5-8-80	Ronald A. Henry, Ridgecrest, California
13	5-9-80	USDI, Heritage Conservation and Recreation Service, Pacific Southwest Region
14	5-9-80	Chris Brewer, Kern County Museum
15	5-12-80	Mark A. Roeder, Scientific Resource Surveys, Inc.
16	5-12-80	Dr. Robert D. Berry, Maturango Museum
17	5-12-80	Sierra Club, Hamilton Hess
18	5-12-80	Katharine G. Connable, Independence, California
19	5-12-80	Irene Cuffe, Lone Pine, California
20	5-12-80	USDI, Bureau of Mines, Washington
21	5-14-80	Enid A. Larson, Big Pine, California
22	5-14-80	Environmental Protection Agency, Region IX
23	5-15-80	California Wilderness Coalition
24	5-15-80	Inyo County Board of Supervisors
25	5-16-80	Elizabeth Fontaine, Tehachapi, California
26	5-16-80	USDI, Bureau of Indian Affairs (no comments)
27	5-19-80	Department of the Navy, Naval Weapons Center
28	5-19-80	Resources Agency, Department of Conservation, State of California
29	5-23-80	USDI, Geological Survey, Reston, Virginia
30	5-23-80	Department of Housing and Urban Development, Los Angeles Area Office (no comments)
31	5-28-80	USDA, Forest Service Region
32	5-29-80	Department of Housing and Urban Development, San Francisco Regional Office
33	6-2-80	California Department of Transportation, Bishop
34	6-2-80	Resources Agency of California
35	6-2-80	Department of Parks and Recreation, State of California
36	6-16-80	California Energy Commission

Coso Geothermal Leasing
May 1, 1980 Lone Pine, California
Public Meeting

#1 Phil Hennis

- Why does this particular geothermal development design use so much water?

#2 Phil Hennis

- How does the water utilization at Cerro Prieta compare with the Coso model of utilization?

#3 Neddeen Naylor

- How will cultural resources be restored after disturbance? Will cultural resources sites be disturbed by geothermal development activities? Do we have a guarantee that the workers will not disturb cultural resources? Does the Native American have a guarantee that geothermal testing and development will not impact Coso Hot Springs?

#4 Captain Ives - NWC

- Statement: From all the chemical analysis the NWC has performed on the water of the springs, the conclusions point toward the springs being hid by ground water rather than the geothermal resource itself. (Point of clarification for Neddeen Naylor's question #3).

#5 Phil Hennis

- Will the county be able to tax the improvements which the geothermal lessees and the opwer companies put on the federal lease? Both on fee lands and withdrawn lands.

#6 Captain Ives - NWC

- Statement: Clarification that geothermal operations could be interrupted for personnel safety procedures 10% of day light working hours and 2% of darkness hours, because the range is in use 100% of the time.

#7 Phil Hennis

- Will the BLM resurrect the Small Tract Development in southern Inyo County to help provide housing for potential employees of the geothermal industry?

#8 Walter Wilson, M.D.

- Our tax base in Inyo County is just over 1/2 billion. Will geothermal development increase the tax base? How much?

#9 Captain Ives - NWC

- He is not sure what the tax basis is for NWC situations and will check into it. (Alan Barnie).

#10 Phil Hennis

- Utah and Texas receive severence tax for their respective coal and oil Will there be such a tax on geothermal energy?

#11 Neddeen Naylor

- In your proposed mitigation for vandalism to cultural resources, you have proposed to provide periodic educational sessions for the employees of the geothermal industry. Won't these educational sessions just show then what to look for?

#12 Dr. Walter Wilson

- Has the NWC activities already caused noise pollution which disturbed wildlife? (What is the present noise environment?)

#13 Captain Ives - NWC

- Because NWC restricts access on the Mohave B range, the flora and fauna are greater than originally expected - many pristine areas.

#14 Dr. Walter Wilson

- If there is a water supply problem, why can't you use a binary cycle heat exchange system? Couldn' this be required if Coso Hot Springs begins to be impacted?

#15 Phil Hennis

- Now that the cadastral survey is completed, are the state sections finally going to be transferred to the state? Will the state assume full title to Sections 16 and 36? What about mineral estate and geothermal resources?

#16 Phil Hennis

- Will Dr. Fournier's latest isotope study affect the hydrology analyses in the Technical Report and the DEIS? Will it be addressed the the FEIS?

1 - The geothermal design used in the EIS is based on the best available data for the geothermal reservoir. The design incorporates only best current engineering practice and is not dependent on radical improvements in technology. The principal basis for the anticipated water use is the fact that all of the geothermal fluid not utilized for steam will be reinjected to preserve the reservoir itself. The design does incorporate condensation of the steam and use of the recovered water for cooling purposes and in the H_2S abatement system. The full basis for the development model is given in Appendix B of the EIS.

2 - Reinjection of the aqueous component of the withdrawn geothermal fluid is not utilized at Cerro Pietro. Therefore this water can be utilized for cooling purposes.

3 - The Bureau of Land Management considers cultural properties to be nonrenewable resources. Once cultural resource sites are destroyed, they cannot be restored. As discussed in Section 2.10.2, there is the potential for geothermal development to significantly impact cultural resource sites within the CGSA, due to the high site density (4.5 sites per square mile expected). Within Zone 1, up to 100 percent possible destruction of individual sites could occur; the chances of encountering a cultural resource site within Zone 1 are predicted to be 17 out of 19 (89 percent). Within Zone 2, the chances of encountering sites are 22 out of 28 (79 percent). Zones 3 and 4 were less intensively inventoried; however, it is estimated that there is a 75 percent chance of encountering a cultural resource site within any given one-quarter section (160 acres) in the CGSA as a whole (see Section 2.10.2.1).

Within Section 3.9 the mitigation of adverse impacts to cultural resources is addressed in detail. Please refer to that section for a discussion of proposed mitigation measures.

Section 4.9 discusses unavoidable impacts of the proposed action on cultural resources. A possible total of 2260 acres of surface disturbance would result from full development of the CGSA; approximately half of that area is predicted to contain cultural resource sites, predominantly lithic scatters. The proposed mitigation measures require avoidance of all sites of extremely high sensitivity, including properties already listed on the National Register of Historic Places, villages, rock art sites, temporary campsites with cultural deposit, and certain rock shelters with associated midden. Additional data collection prior to geothermal development is required at selected archaeological sites (primarily lithic scatters) to determine whether specific site avoidance or mitigation is appropriate. It is anticipated that mitigation would include data collection and partial disturbance of less sensitive sites. However, disturbance or destruction of even a peripheral portion of a site, however carefully the removed material is studied, is a loss of data concerning the whole site. Thus, some loss of cultural resources is anticipated and considered to be an unavoidable impact resulting from the proposed action.

In reference to the Coso Hot Springs, Section 2.5.2.4 states that "flow to the hot springs may increase or decrease due to geothermal production depending on reservoir development design and the precise nature of the hydraluic connection between the geothermal reservoir and the hot spring."

There is no guarantee that the flow to Coso Hot Springs will not be altered. However, the Hydrology Monitoring Plan (Appendix D) includes monitoring of Coso Hot Springs. Section 3.4.3 states that any alteration of flow will be restored by "selective placement and regulation of injection and production wells." Monitoring will be continued to determine the effectiveness of the mitigation strategy. It must be emphasized that the surface of the Coso Hot Springs area and Prayer Site will not be directly impacted by either the NWC geothermal development or the proposed action because of protection by NWC policy (see Section 2.10.2.1).

Vandalism to cultural resource sites is recognized as a potential adverse effect to the proposed action (see Section 2.10.2.7). Neither the BLM nor NWC can guarantee that vandalism will not occur; however, an educational program will be developed by the BLM and NWC (in consultation with the Native American community) to inform the geothermal lessees and their personnel of the fragile nature of the cultural resources within the CGSA, the mitigative measures that are being implemented, and the legislative restrictions and prohibitions concerning collecting cultural resource materials (see Section 3.9.1). It does seem realistic, however, to anticipate that some additional pothunting and general deterioration of cultural resources beyond present levels would be unavoidable with increased use of the area (see Section 4.9).

4 - Thank you for the information. This subject has been discussed in Section 2.5.1.4 of the EIS.

5 - A discussion of tax revenues expected from the development of the geothermal resource is presented in Section 2.12.2.9. To summarize, private activities that take place on public lands are generally taxable. Both the possessory interest in the geothermal resource and the physical facilities developed on the BLM-leased lands (including those lands within the NWC) would be subject to property taxation by Inyo County as long as the developer is a private firm. However, if the City of Los Angeles Department of Water and Power were to build a power plant to utilize the geothermal steam, the power plant would not be taxable. Development that takes place on the Navy fee lands may or may not be taxable. In the Navy's development program, the geothermal resource will be owned by the Federal government and, as such, would not be subject to property taxation. The Navy's contractor will own the power plant and related facilities and will be required to sell electricity to the Navy. The taxability of these facilities has not been determined.

6 - The comment has been noted and incorporated in Section 2.11.1.2.

7 - The Small Tract Act of June 1, 1938, as amended, was repealed by the Federal Land Policy and Management Act of October 21, 1976, and will not be "resurrected." The Federal Land Policy and Management Act of 1976 gives disposal authority to BLM for community expansion or development.

8 - A range of potential increases in Inyo County's assessed valuation resulting from geothermal development is presented in Table 2.12.2-6 (Section 2.12.2.9). The anticipated change in assessed valuation in the year 2010, directly attributable to geothermal development, would represent an increase of between 31 and 72 percent of 1979 assessed valuation, depending on the development scenario used. However, since assessed valuations in Inyo County might double by 2010 without the proposed action, geothermal development is also shown in Table 2.12.2-6 as a percent (17 percent to 39 percent) of potential 2010 assessed valuations. See Section 2.12.2.9 for further discussion.

9 - See response to Comment 5.

10 - At the present time there is no severance tax on the use of the geothermal resource. As discussed in section 2.12.2.9, however, there will be rental and royalty payments made to BLM and USGS. Based on current regulations, 50 percent of the revenues received by BLM and USGS from the Coso leasing program would be returned to California for distribution in part to the areas impacted. Geothermal leases on Federal lands have recently begun production in the Geysers area; however, the amount of royalties to be paid from these leases has not been finally determined (White, M. 1980).

11 - The education program proposed in Section 3.9.1 will not be designed to instruct the geothermal personnel how to identify cultural resource sites or artifacts. The BLM and NWC will solicit input from the Native American Community to help ensure that the education program addresses only the fragile nature of the sites and artifacts, and the legislation prohibiting unauthorized collection of archaeological materials. It is anticipated that such a program will not require any instruction in site or artifact identification.

12 - General background noise levels (including those generated by the NWC activities) are discussed in Section 2.3.1, Existing Noise Setting. The ecology field studies did not reveal any particular differences between the wildlife populations in the CGSA and other parts of the desert.

13 - Thank you for the additional information.

14 - Utilization of a binary cycle heat exchange system does not affect the cooling requirements. The working fluid (isobutane) must be cooled; this would require significantly more water as the condensed steam from the resource would not be available for this purpose. The binary cycle, including cooling is described in Section B.3.2.3.

15 - The indemnification to the State for the townships within the Coso Geothermal Area has been satisfied. There will not be any additional lands going to the State within these townships.

16 - A report was prepared to determine the effects that Dr. Robert Fournier's isotope study would have on the hydrology analyses in the Coso Environmental Impact Statement. This report concluded that Dr. Fournier's findings would not affect the recharge estimates for Rose Valley, nor could it help quantify the amount of recharge to the geothermal reservoir. The study still leaves the recharge source for the geothermal reservoir ambiguous.

United States
Department
of Agriculture

Rural
Electrification
Administration

Washington
D.C.
20250

APR 11 1980

SUBJECT: Coso Known Geothermal Resource Area
Draft Environmental Impact Statement

TO: District Manager
Bureau of Land Management
U. S. Department of the Interior
Bakersfield, California 93301

The Rural Electrification Administration (REA) has reviewed the Draft Environmental Impact Statement (EIS) for the proposed leasing within the Coso Known Geothermal Resource Area (KGRA) in California and offers the following comments.

No REA-financed cooperative is directly involved or expected to participate in the Coso KGRA proposed leasing project because the nearest cooperative is about 175 miles away from that area. Therefore, the
#17 intensity of our review of this document has been limited. In general, the document fails to discuss some important resources such as wetlands and floodplains (Executive Order 11990 and 11988, respectively) and prime or unique farmlands. These features may have little significance in the Coso KGRA, but should nevertheless be discussed in the Final EIS.

Thank you for the opportunity to comment on the Draft EIS.

Charles T. Crowley

CHARLES T. CROWLEY
Chief, Environmental Services Branch
Environmental and Energy Requirements
Division

17 - The wetlands within the area are discussed under Section 2.5.1. Agricultural areas within Rose Valley are discussed in Section 2.11.1. The flood plain Executive Order merely discusses the fact that all Federal agencies must provide flood plain management. the policy of the Bureau is that public lands be retained within the base flood plain except for the following:

1. If Federal, state and private institutions and parties have demonstrated the ability to maintain, restore and protect the flood plain on a continuous basis.

2. If the transfer of public lands, minerals and subsurface estates is mandated by legislation or presidential order.

Advisory
Council On
Historic
Preservation

ADVISORY COUNCIL ON HISTORIC PRESERVATION
LAKE PLAZA SOUTH, SUITE 616
44 UNION BOULEVARD
LAKEWOOD, COLORADO 80228

1522 K Street NW.
Washington D.C.
20005

This response does not constitute Council comment pursuant to Section 106 of the National Historic Preservation Act, nor Section 2(b) of Executive Order 11593.

April 14, 1980

Mr. Louis A. Boll
District Manager
Bureau of Land Management
800 Truxtun Avenue, Room 302
Bakersfield, California 93301

Dear Mr. Boll:

We have reviewed the draft environmental statement (DES) for Proposed Leasing Within the Coso Known Geothermal Area per your request for comments received March 21, 1980. Pursuant to Section 102(2)(C) of the National Environmental Policy Act of 1969, we have determined that the Bureau of Land Management's DES appears procedurally adequate concerning Council's area of interest with regard to NEPA.

With regard to compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, we note that the BLM's cultural resource inventory has established the existence of a relatively high density of archeological sites within the proposed project area (p. 2-147) with a potential for yielding scientific data (p. 2-148). In addition, there also exists within the proposed project area Coso Hot Springs, a National Register of Historic Places site. It appears that a potentially large number of archeological sites within the project area are likely to be determined eligible for inclusion on the National Register.

#18 Because geothermal exploration and leasing, as proposed " . . . will obviously have a potential for significant impact . . ." upon cultural resources (p. 2-150) Section 106 and Section 2(b) of Executive Order 11593 appear to be applicable. These sections require the Council be afforded an opportunity to comment prior to approval of the undertaking. This is to be done in accordance with the Council's regulations, "Protection of Historic and Cultural Properties" (36 CFR Part 800). (Copy enclosed for your convenience.)

Page 2
Mr. Louis A. Boll
Coso Hot Springs
April 14, 1980

#18 In order for the final environmental statement to contain Council comment in accordance with Section 800.9 of the regulations it is suggested that BLM consult with the California State Historic Preservation Officer and the Council to develop an agreement that will ensure proper protection of the extant cultural properties. Such an agreement can be developed pursuant to Section 800.8 of the regulations. However, in this situation it may be more appropriate to develop the agreement in accordance with Section 800.6. For your information, enclosed is a copy of a similar agreement with the Navy for the exploration and development of its geothermal resources at Coso Hot Springs.

For assistance in completing this process, please contact Robert Fink of this office at (303) 234-4946, an FTS number.

Your continued cooperation is appreciated.

Sincerely,

Louis S. Wall
Chief, Western Division
of Project Review

Enclosures

Response to Comments from Advisory Council on Historic Preservation

18 - As discussed in Section 3.9.1, the Bureau of Land Management is following the procedures established in 36 CFR 800.4 to ensure that the Advisory Council on Historic Preservation is afforded the opportunity to comment prior to approval of the proposed action. The Bureau is developing an agreement in consultation with the State Historic Preservation Officer, Naval Weapons Center, and Advisory Council on Historic Preservation to protect the extant significant cultural properties; the procedures established in 36 CFR 800.6 or 36 CFR 800.8, whichever is appropriate, are being followed.

RIDGE-RIDERS TRAIL CLUB INC.
POST OFFICE BOX 835
VENTURA, CALIFORNIA 93001

April 21, 1980

Mr. Louis A. Boll, District Manager
U.S.D.I. Bureau of Land Management
800 Truxtum Avenue, Room 311
Bakersfield, CA 93301

RE: Draft E.I.S. for Proposed Leasing within C.O.S.O.

Dear Mr. Boll:

It would seem that the actual decision of whether or not to allow, on a large scale, leasing of the properties within COSO should be based on known facts, rather than possible facts; however this can be circumvented to a degree with a positive monitoring program.

#19 The current restrictions of all the agencies involved on such a project are seemingly way out of proportion and should be streamlined to meet, and not exceed, the actual requirements of such an undertaking, and all agencies involved should work toward a well-defined, mutual goal of progress.

I have found in the past that all E.I.R.s are questionable in the area of conservation, in that the baseline or preliminary studies and reports are very biased, and that they do not conform to a rational basis of thought or current trend of a positive land use concept and management possibilities.

It is my opinion that with a positive and progressive land management program we can develop our natural resources, provide for and enhance the multiple use concept and at the same time provide for and enhance our environment.

#20 I believe the leasing within COSO should be allowed and encouraged with a positive approach, and a well-defined monitoring program that would involve all areas of concern. It would seem appropriate that all of the proposed routes with regards to roads, power line installations be considered with multiple use (facilities used by all leases) a prominent factor.

Mr. Louis A. Boll, District Manager
April 21, 1980
Page Two

#21 The visual aspect of the proposed installation could be enhanced by the placement of false fronts around permanent installations that would have the appearance of a deserted or ghost town.

Sincerely yours,

C. K. Hollingsworth

C. K. Hollingsworth
1155 Mariano Drive
Ojai, CA 93023

Response to Comments from the Ridge-Riders
Trail Club, Inc.

19 - The Federal agencies directly participating on the proposed leasing within the Coso Geothermal Study Area are required to analyze the potential environmental impacts under the National Environmental Policy Act of 1969 (P.L. 91-190). Restrictions applied to the proposed leasing activities stem from implementation of Geothermal Steam Act of 1970 (P.L. 91-581) and the Federal Land Policy and Management Act of 1976 (P.L. 94-579). All agencies involved are coordinating to ensure efficient processing of the leasing proposal.

20 - Thank you for your indication of preference. It will be considered in the decision making process. Site-specific applications for roads, powerlines, etc. will be analyzed by US Geological Survey and BLM. Potential for use of these facilities by many lessees will be one of the considerations in the assessments.

21 - It is the policy of the Bureau of Land Management to manage the public lands "......in a manner that will protect the quality of the scenic values......that where appropriate, will preserve and protect certain public lands in their natural condition......" The placement of false fronts that would give the appearance of a deserted or ghost town would not be in keeping with this policy. Assuming that the mitigation proposed in Section 3.8 is implemented, false fronts, as recommended, may actually cause a greater visual contrast.

229 N. Brady
Ridgecrest, CA 93555
April 30, 1980

Lou Boll, District Manager
800 Truxtun
Bakersfield, CA 93301

SUBJECT: Proposed Leasing within the Coso Known Geothermal Resource Area, Draft Environmental Impact Statement

I am concerned about several areas discussed in your EIS . Most of the objections to the report revolve around the lack of sufficient baseline information on the hydrology and geothermal potential of the area and its implications for the leasing program. On the basis of this lack, I think this leasing program a bit premature. A corollary to this is that the Naval Wapons Center plans for development of these geothermal resources is also premature as it has been based on even skimpier baseline data mixed with an overly healthy dose of wishful thinking.

#22 Thus, my recommendation is the alternative proposal of deferring leasing until a comprehensive geotechnical and hydrological testing program can be carried out under an appropriate Federal agency (not NWC) to better assess the well-field potential and the hydrological effects of the development. #23 Furthermore, if the decision is made to proceed with leasing, a single operator should be made responsible for the development of the field and a single archeological firm (if possible) be made responsible for surveys and studies. #24 Furthermore, it should be a condition of the lease agreement, that the leasee be required to help mitigate socioeconomic impacts on Indian Wells Valley and Rose Valley insofar as it is possible and with good faith intentions and to make reasonable efforts to preserve Little Lake and its associated flora and fauna.

GEOTHERMAL RESOURCES

#25 I know that the NWC assessment of resources was limited because of time and money constraints. I also gather from this report that there was considerable difference in assessment of resources by USGS and NWC. I also know that the only deep test hole was not particularly positive and this report didn't present much new or more positive data. Because of this, I question the adequacy of the data on the geothermal resource potential and the underlying rationale for proceeding with leasing at this point in time.

HYDROLOGY

#26 More specifically, unavoidable impacts on the hydrology have not been adequately assessed. I am concerned about the total water consumption from the underground water storage basin in Rose Valley. In addition to the half million acre feet of water potentially needed with full development of the geothermal field, farming and household consumption will have a significant impact. If alfalfa growing in the Valley increases (alfalfa is a heavy water user - up to 10 acrefoot of water per acre of land per year) and substantial numbers of employees move into the

#26 Valley because of geothermal development, the water table drop would betremendous and the probability of reaching non-potable water would increase. All this is in addition to the potential unknown effect of this drawdown on the geothermal well yields and the probable elimination of the spring waters feeding Little Lake.

WILDLIFE

#27 The probable lowering of Little Lake and the subsequent effect on wildfowl and wildlife has not been adequately treated or adequate mitigation measures proposed. They are simply written off as a negative effect.

FLORA

#28 The effect on the flora of the lowering of Little Lake and subsequent changes and losses was not adequately assessed nor were suggested mitigation measure very feasible.

CULTURAL RESOURCES

#29 The probable loss of activity at Coso Hot Springs and its loss as a sacred site to local indians is not adequately discussed. In my opinion, this problem is more important and has ramifications beyond those presented in the EIS.

#30 In view of the National Register significance of the CKGRA and the extremely high archeological and religious significance of the area and the unavoidable adverse impacts to these features, I would suggest a moratorium on leasing until a comprehensive geotechnical testing program can be carried out by an appropriate objective agency to determine the "richness" of the resource and the need to partially destroy such a rich resource for a very short term gain. #31 The effects of pot-hunting and casual impacts were probably underassessed. This area has always been a pot-hunters paradise and development of the area will only increase these impacts.

SOCIOECONOMIC

#32 The impacts of the proposed action on the this aspect has been underestimated, in my opinion. This applies, in particular, to the already decreasing water supplies and to the housing availability in both Rose and Indian Wells Valleys. Mitigation measures (3.11) for these factors are barely discussed and then listed on page 4-7 as unavoidable impacts.

SPECIFIC COMMENTS

#33 p. 2-149, last ¶, lines 6&7. The specific clauses relating to protection of cultural resources, referred to here, should be presented so assessment of them in relation to this project can be made.

#34 Figure 2.10.2-1 This map does not show those areas surveyed and found to have no values (if any). A later note indicates there are no 1 sq mi areas which did not have sites.

#35 p. 3-13, section 3.9.2.1, ¶2. High sensitivity sites yet undiscovered should be completely avoided as per previous ¶.

#36 p. 3-14, section 3.9.2.3.C. Why would it not be possible to allow future archeological assessments to be made by the original company, providing they were satisfactory to ensure continuity and familiarity with the area and its problems?

#37 p. 3-15, section 3.9.2. C.6. Before implementing the plan to educate personnel and the public about high archeological values in the CKGRA, I suggest the idea be reassessed in order to discover whether this might have a substantial negative impact; i.e., it is a form of advertisement, particularly to the general public.

#38 p. 3-6, section 3.4.4. It would behoove BLM and NWC to do more research on the alteration of water flow to Coso Hot Springs <u>before</u> leasing and implementation of a production strategy.

Sincerely,

Carol Panlaqui

Carol Panlaqui

22 - Thank you for your indication of preference. It will be considered in the decision making process.

23 - The concept of unitization is discussed in Section 7.7. Thank you for your recommendation; it will be considered in the decision making process. The BLM anticipates that the Cultural Resources Assessment Strategy outlined in Section 3.9.1 will be developed and implemented either through in-house capabilities or by an individual contractor. However, the BLM cannot require the lessee(s) to employ a single consulting firm to conduct necessary cultural resource inventories or data recovery.

24 - Please see Chapter 3, Section 3.11 for mitigation of socioeconomic impacts, and Sections 3.6 and 3.7 for mitigation of impacts on flora and fauna. See also Appendix D.2 for Wildlife and Flora Monitoring Plan.

25 - The estimates of geothermal potential have ranged from about 4500 MW to a possible lack of geothermal potential. Generally, for the Coso KGRA, as for many other KGRA's, the first estimates of potential were very high. As technology has been refined, and more geophysical information has been collected, estimates have dropped over the years. The 600 MW potential that is used in this document is a moderate estimate and stems from the latest USGS research, Circular 790, and other sources (see Appendix B). The one deep test hole , CEGH-1, apparently did not flow partially because of technical problems stemming from the DOE and NWC sponsored drilling procedures, rather than from presence or absence of geothermal resource. The Bureau's policy is to make available, if environmentally acceptable, geothermal resources for leasing to help alleviate the Nation's dependence on petroleum energy resources.

26 - The unavoidable impacts on hydrology addressed in Section 4.4 were based on the best estimates of projected population and water use.

27 - The effects on wildlife of possible lowering of Little Lake are addressed in Section 2.7.2.1, Paragraph 4 and under <u>Birds, Herpetofauna</u>, and <u>Aquatic Species</u>; in Section 2.7.2.2, Paragraph A and final paragraph; in Section 2.7.2.4 under <u>Resource Utilization</u>, and in Section 2.7.2.5, <u>Cumulative Impacts</u>. These sections discuss the significance of Little Lake for wildfowl and other wildlife, the importance of maintaining water levels, and the geothermal activities which could cause drawdown. See Sections 3.4 and 3.6 for proposed mitigation; see also response to Comment No. 24. The monitoring plans for Wildlife and Flora and for Hydrology (Appendices D.2 and D.4) are designed in part to ensure careful observation of Little Lake levels and the impacts of any habitat loss due to drawdown. It should also be noted that the water level in the lake is artificially maintained; see Appendix D.4, section on Water Level Monitoring.

28 - Sections 2.8.2.1, 2.8.2.2, 2.8.2.3, and 2.8.2.4 all address the possible impacts to flora if Little Lake levels are lowered. These sections describe what vegetational changes are expected, at which stage of development they are expected, the unique or rare plant species recognized by the CNPS and the possible impacts to those. The plan for monitoring water levels, discussed in Sections 3.4.1 and 3.6, will be implemented. See also response to Comment No. 27 regarding artificial maintenance of Little Lake levels.

29 - Please see responses to Comments 18, 56, 57 and 95. Native American concerns regarding use of the Springs as a sacred site are discussed in Sections 2.12.1.13 and 2.12.2.12.

30 - Thank you for your suggestion of a leasing moratorium. Your recommendation will be considered in the final decision-making process. It is definitely an option that we will weigh carefully.

31 - The effect of pothunting and vandalism of rock art sites is admittedly a potential indirect adverse impact of the proposed action. The level of anticipated impacts is difficult to assess prior to development of the geothermal resource; however, increased patrols by BLM resource personnel and a carefully designed educational program will be implemented, as discussed in Section 3.9.1, in order to alleviate pothunting and vandalism (also see response to Comments 3 and 11). Some additional vandalism is inevitable, however, despite any feasible mitigation measure (see Section 4.9).

32 - The present unavailability of housing in lower Inyo County is discussed in Section 2.12.1.3. The maximum potential impact of full field development on housing, and on all related infrastructure, including water availability, is discussed in Sections 2.12.2 (introductory paragraphs), 2.12.2.3, 2.12.1.4, and 2.12.2.13. The impacts of the proposed action on water availability are further addressed in Section 2.5.2. It is the policy of the BLM to propose only those mitigation measures which are enforceable by the Bureau or by USGS. The action on the local housing industry, and/or developer-supplied housing, could fill this recognized need, which would develop over a period of time. (Developer-provided housing is not enforceable by BLM or by USGS.) Implementation of proper water conservation measures is a function of the Lahontan Regional Water Quality Control Board and would be coordinated with that agency.

33 - The clauses referenced in Section 2.10.2.1, relating to the protection of cultural resources, are presented in Appendix A.

34 - Figure 2.10.2-1 has been clarified to better indicate those sample units that were inventoried and found to contain no cultural resource sites. Section 2.10.2.8 refers to the fact that survey data indicated no complete section of 640 acres without a known cultural resource site <u>within Geothermal Development Zone 1</u>.

35 - Please refer to Section 3.9 for discussion of mitigation measures for high-sensitivity sites as yet undiscovered. This section has been further clarified in the Final EIS.

36 - The lessee(s) will be responsible for selecting qualified consulting firms to conduct cultural resources inventories. The BLM cannot legally require the lessee(s) to employ specific consulting firms.

37 - Please see response to Comment 11.

38 - A requirement which is placed on lessees is that baseline data collection and monitoring must be carried out for a year prior to beginning geothermal exploration wells (Geothermal Operational Order No. 4, Paragraphs 5 and 6). Pursuant to this requirement, the Hydrology Monitoring Plan in Appendix D.4 will be required to be implemented by the lessees (see Secttion 3.4.3). This will occur prior to and concurrently with exploration wells, and therefore, before production. Geothermal exploration wells are one of the most effective ways of implementing research on the hydrologic mechanisms of Coso Hot Springs. The BLM does not have the funds or the mandate to conduct such research.

George A. Bridges
3124 Brophy Drive
Sacramento, CA 95821

April 30, 1980

Mr. Louis A. Boll
District Manager
Bureau of Land Management,
800 Truxtun Avenue, Room 302
Bakersfield, CA 93301

Dear Sir:

We are writing in connection with the EIS released in April by the Bakersfield District Office for the proposed geothermal leasing developpment in the Coso Hot Springs region of Inyo County.

#39 We urge for your favorable consideration that if any geothermal leasing is to take place, a combination of Alternative 2 (lease all lands <u>except</u> those with significant surface conflicts) and Alternative 7 (utilization) be adopted. Taken in addition to full implementation of mitigation measures suggested in the EIS, we believe this would allow utilization of the energy resource while minimizing <u>some</u> of the adverse impacts.

We believe that utilization would require all lesees to agree to explore and develop the area using a single operator and that this should significantly lessen impacts because road construction and well pad construction would be minimized to reduce costs.

Sincerely,

George A. Bridges

Response to Comments from George A. Bridges

39 - Thank you for your expression of preference. It will be considered in the decision making process.

May 1, 1980

29900 Highway 20
Fort Bragg, California 95437

Louis A. Boll, District Manager
Bureau of Land Management
800 Truxton Avenue
Bakersfield, California 93301

For the Record

RE: Proposed Coso Geothermal Study Area.

Dear Mr. Boll:

Please include these comments as part of the public hearing record on the proposed Coso Geothermal Study Area.

While recognizing the national need for clean, nonpolluting energy sources, I believe that the impacts of the proposed Coso geothermal development should receive at least equal consideration.

Impacts would include loss of visibility, increased noise levels, ground and surface water depletion, elimination of open space, destruction of archeological sites, and degradation of Coso Hot Springs, important to Native Americans and others. Other problems with the proposal are substantial adverse impacts on soils, vegetation, including rare and endangered plant species, on an abundant wildlife resource, viewshed, and air quality.

#40

Of particular concern are the cumulative impacts of the proposal on nearby wilderness areas which include Golden Trout and Domeland.

I would urge here a "go slow" approach to the proposed geothermal leasing, with every possible mitigation measure for environmental impact.

Lands exhibiting significant surface conflicts should not be leased; road and well pad construction should be minimized through the unitization technique; all possible environmental mitigation measures should be employed.

I appreciate the role of BLM in meeting our energy needs, and invite your reply to these suggestions.

Thank you for your consideration.

Ron Guenther

40 - Thank you. See response to No. 39.

4435 Brindisi St
San Diego, CA. 92107
May 4, 1980

Louis A. Boll
District Manager Bureau of Land Management
Dear Sir

#41 Leasing in the Coso Geothermal Study Area will have considerable impact on the desert unless the leasing is carefully controlled. I hope Little Lake and the riparian vegetation around it will not be permitted to dry up, and that the welfare of the wildlife population there will be protected. Of the seven Alternatives offered in the Environmental Impact Statement, I feel a combination of Alternative 2 (lease all lands except those with significant surface conflicts) and Alternative 7 (unitization) with the addition of mitigating measures would result in the least damaging approach. Unitization using single operators would lessen the impact of road construction, workers, noise, etc. on this area.

Sincerely,

Marguerite Christoph

Response to Comments from Marguerite Christoph

41 - Thank you. See response to No. 39.

609 Saratoga
China Lake, Calif. 93555
May 2, 1980

Louis A. Boll, District Manager
U.S. Bureau of Land Management
800 Truxton Avenue, Room 302
Bakersfield, Calif. 93301

Dear Mr. Boll:

I have examined the Draft EIS for proposed leasing within the Coso KGRA and have the following comments:

General

#42 I would prefer to see the leasing delayed until the potential of the area has been revealed both by the results of the current effort on the Navy fee land and by a Federal geothermal testing program (Alternative E) on the Public lands. In other words, that alternative, which will minimize all the negative impacts until the questions about the potential of the field are answered or better understood, is the one which should be adopted initially.

#43 A benefits/cost ratio has not been attempted. Will the total of both direct and indirect cost exceed the value of the electrical energy produced over the life of the field? (Direct costs would include leasing fees, royalties, exploratory drilling, well development, site preparation, roads, power plants, transmission lines, waste disposal, etc, etc.; indirect costs would include environmental impacts and degradation, cultural resource loss, various socioeconomic effects, etc.) For the same expenditure of funds could other alternative energy sources (solar, wind power, etc.) be developed, which might have a better benefits/cost ratio and which might be environmentally less degrading? Shouldn't these alternatives be considered in the final assessment?

Hydrology

#44 1. The figure of 60,000AF/YR in first paragraph, page 2-64, does not agree with the numbers in Table 2.5.1-4, page 2-65.

#45 2. Although the projected water use in Rose Valley for both 1986 and 1995 already exceeds the recharge rate, these projections do not include the worst possible scenario, namely, that there might be 1500 new residents in Rose Valley because of the development, that the City of Burbank might build a power plant in Rose Valley (page1-39), and that the Rose Valley Ranch might increase its water pumping by 1500 AF/ YR. How much would the water table be lowered over 70 years in this situation? How long can we continue to consume stored fossil water and not begin to have serious consequences?

#46 3. A projected lowering of the water table by 150 feet (page 2-71) will cause how much land subsidence? What will this subsidence do to roads, buildings, wellpipes, drainage patterns, playas, etc. in Rose Valley? Will massive cracks develop throughout Rose Valley as has happened in the Cantil area because of excessive draw-down? What permanent damage to porosity, transmissivity, and storage capacity of the aquifer will result? Some of these issues are briefly outlined on page 2-48, but are not adequately discussed or analyzed in terms of their long time environmental effects.

#47 4. Although the concern about the effect of a lowered water table on Little Lake is important, equally important or perhaps even more so, is the effect of a lowered water table on the native vegetation in Rose Valley. If most of the surface plants should die off, the potential for the development of a large dust bowl becomes very real and very high. This new source of dust could degrade visibility and air quality many times more than that estimated from the fugitive dust and sulfate aerosol production from the project. Citizens on the east side of the Sierra Nevada Mountains are already greatly concerned by excessive dust off Owens Lake. Increased dust, as a result of the desertification of Rose Valley, could interfere with the mission of the Naval Weapons Center.

#48 5. Page 3-5. What is the advantage of pumping spent geothermal fluid beneath the fresh water aquifer in Rose Valley when one is pumping fresh water off the top? Why not just reinject this geothermal fluid into the Coso geothermal formation, pump less fresh water from Rose Valley, and save on pumping costs? What is the density of the spent geothermal fluid? What will its temperature be at the point of injection? If the density of spent geothermal fluid is only slightly greater than that of the water in Rose Valley (both measured at the same temperature), but if the temperature of the former is significantly higher at injection than that of the Rose Valley aquifer, the spent fluids will rise and admix with the fresh water in the aquifer.

<u>Flora</u>

#49 1. Page 2-116, Section 2.8.2.2. The statement that "Coso Hot Springs .....is also the <u>only locality</u> in the CGSA in which the rare parasitic plant, <u>Pholisma arenarium</u>, <u>is found</u>" (emphasis added) is probably not true. It is the only locality in which this plant <u>has been found so far</u>. Its discovery at Coso Hot Springs was just a matter of being in the right place at the right time.

#50 2. Pages 2-118, through 2-120, Sections 2.8.2.4 and 2.8.2.5. Shouldn't there be carefully drawn plans to close off and re-vegetate access roads, test-site areas, etc. resulting from the preliminary exploration and exploratory well drilling phases if these tests indicate that the geothermal potential of the site is marginal or inadequate?

#50 Shouldn't there be restoration and re-vegetation plans for the whole Coso KGRA if the latter should prove uneconomical to develop? Decisions should be made now as to who will do this restoration and who will pay for this effort so that it is accomplished in an environmentally acceptable manner. Similarly, if and when the Coso KGRA is fully exploited, who sets the standards and monitors the restoration effort at close-out?

Mitigation Measures

#51 1. Page 3-2. The term...."after the proposed action"... in the paragraph beginning: "Thus, although....," is vague and too general. What action? The granting of a lease? A geotechnical testing program? The actual drilling /development phase? Let's be sure all site-specific impacts are thoroughly mitigated before any machine moves.

#52 2. Pages 3-2 and 3-3. Where will the water come from to sprinkle roads and exposed areas in order to reduce the dust problem? Rose Valley? Has this extra demand been included in the projected water use in Rose Valley (Table 2.5.2-1)? Watering will just encourage growth of introduced, noxious, disturbed-soil-loving plants, such as Russian Thistle. Who is going to water the surface of Rose Valley to keep the dust from blowing after the protective, native plants die off due to the lowered water-table?

#53 3. Page 3-8. All sumps or disposal areas containing high concentrations of salts or toxic substances should be screened over to prevent access by birds, mammals and reptiles.

#54 4. Page 3-10, Section 3.7, paragraph 1. How can topsoils be stockpiled for up to 30 years, then spread over disturbed areas at project close-out? Wind and rain will erode the piles over such a long period: they will also be fertile areas for new growth, especially noxious plants, like Salsola.

#55 Page 3-10, Section 3.7, paragraph 2. Since all surface disturbance increases the amount and distribution of Salsola, mechanical vegetative control will greatly exacerbate the problem. Although there is an awareness of a problem with Salsola and other opportunistic, noxious weeds on disturbed surfaces, the report does not emphasize the extreme severity of the problem nor the tragic consequences which follow. Numerous areas in Inyo County which were essentially free of Salsola 10 - 15 years ago now have vast spreads of the plant due to ORV activity. Regrading of the shoulders on some Inyo County roads has lead to the introduction of Salsola into regions which were once free of the plant and ~~the plant~~ is now intruding vigorously to adjacent, undisturbed areas.

5. Page 4-5, Section 4.7. The introduction of Salsola

#55 and other noxious, non-native plants on disturbed surfaces will lead to their intrusion into surrounding areas. These hardy intruders, competing for limited moisture and nutrients, could have a devastating effect on the kind and quantity of remaining native vegetation.

Sincerely yours,

Ronald A. Henry

Ronald A. Henry

42 - Thank you. See response to No. 39.

43 - The National Environmental Policy Act (P.L. 91-190) does not include a requirement for a benefit/cost ratio; rather, its intent is to consider the environmental impacts separately from economics to ensure that economic benefits do not outweigh environmental impacts which cannot be quantified in economic terms. The decision on whether to lease will consider costs of both socioeconomic and environmental considerations. If the direct costs of production of electricity outweigh the economic gains, it is doubtful that the lessees would propose to enter the serious exploration or production phases.

The BLM Manual, Section 1792, Environmental Statements, defines alternatives to be "alternate ways or locations to achieve the objectives of the proposal, with the exception of the no action alternative." The proposal of leasing geothermal resources was developed in response to non-competitive geothermal leasing applications, designation by USGS of the area as a Known Geothermal Resource Area, and industry interest in the geothermal resources of the area. Development of renewable energy resources on the same land is not precluded by the proposed action, and could occur sometime in the future if applications are made.

44 - The figure of 60,000 AF/YR in the first paragraph refers to total hydrologic balance, including surface and ground water. Table 2.5.1-4 refers <u>only</u> to the ground-water portion of the hydrologic balance.

45 - A total of 1,500 new residents living in Rose Valley as a result of the proposed action as identified in the FEIS (Section 2.12.2) is unlikely though possible. If such a population center did develop, their water consumption would be estimated at 220 gpd per person (see Section 2.12.2.4), or approximately 370 acre feet per year. Table 2.5.2-1 (Section 2.5.2, Hydrology) has assumed a consumption rate of 260 acre feet per year for approximately 1,050 permanent residents in the year 1986, and 360 acre feet per year for 1,450 residents in 1995 (see Hydrology Technical Report, Paragraph 5.3.2, and Section 2.5.2.2 of FEIS). Since there are approximately 30 permanent residents in Rose Valley now, the figures in Table 2.4.2-1 account for virtually all of the population in the "worst-case" assumption.

The worst case analysis is included in Table 2.5.2-2 of the DEIS. As stated, the worst case is based on minimum recharge, maximum natural discharge, and minimum water yield per foot of drawdown. For this analysis it was assumed that Rose Valley Ranch would not significantly increase its water supply. As stated in the Related Projects section, the City of Burbank power plant is still in a feasibility study stage and will undoubtedly be influenced by any development in the Coso lease area. To answer the specific question, "How long can we continue to consume stored fossil water and not begin to have serious consequences?"--these consequences are outlined as explicity as data allows in the Hydrology Sections 2.5.1 and 2.5.2.

46 - Subsidence due to fluid withdrawal in the Rose Valley is discussed as thoughly as available data allows (see Section 2.4.2.2). Any attempt to quantify this without even a well in the area, not to mention permeabilities, porosities, water levels, compaction coefficients, pumping rates, etc., is not possible.

47 - The impact of lowering the water table in Rose Valley is addressed in Section 2.5.2.2 under the heading of "Potential Impacts," in reference to effects on surface vegetation. Because of the type of vegetation found in Rose Valley, a dust bowl effect is not anticipated. This is unlike Owens Valley, which originally had much riparian vegetation. Plant associations in Rose Valley include Creosote Bush, Scrub and Shadscale Scrub, the species of which are not dependent upon ground water, but rather upon rainfall. Reference to phreatophytic vegetation (the only type of vegetation in Rose Valley that would be affected if Little Lake levels were lowered) has been added to Section 2.8.2.1.

48 - The suggestion is made as a basis for raising the ground water table. Implementation of such suggestion would require the studies described in Section 3.4.1.

49 - Thank you for your comment. Section 2.8.2.2 has been clarified.

50 - The US Geological Survey administers geothermal leases. Pursuant to such administration, they have promulgated Geothermal Resources Operational Orders 1-7 which instruct lessees and operators as to what procedures are required in the geothermal industry. GRO No. 4, General Environmental Protection Requirements, designates procedures on reclamation. In the plans of operation required to be submitted, the lessee must describe the reclamation and revegetation plans for all disturbed lands. These plans will be approved by USGS and the appropriate surface management agency; in this case, the BLM, and on the NWC, both the BLM and the NWC. (See Section 4.2, Land Use and Reclamation, GRO No. 4.)

51 - Thank you for your comment; the text has been corrected. The proposed action includes granting of leases through development of geothermal resources and closeout of the development when it becomes no longer viable.

52 - The presence of noxious weeds will to some extent be an unavoidable adverse impact. In those areas where topsoil has been replaced and revegetated, however, sprinkling will assist in the rehabilitation of native species. See also responses to the following 3 comments. Application of water for dust control is considered to be insignificant compared to water use for power plant cooling and well drilling. It is felt that water use for dust control would fall within the round-off range of the water use estimates. In an arid area such as the CGSA, we would assume that soil stabilizing additives would be used to reduce the amount of water required for dust suppression. There are many commercially available materials that will stabilize soil or control erosion while allowing plant germination.

53 - GRO 4 (see Appendix A) generally describes the environmental protection measures required to be implemented by lessees under the monitoring of the USGS Area Supervisor. The measures for the protection of wildlife address disposal of toxic substances, construction of sumps and possible fencing of unattended pits and sumps. The site-specific environmental process surrounding geothermal operations, and the USGS implementation of the GRO Orders, provide considerable environmental review and opportunity for public input. Prior to any exploratory activities, lessees must obtain permits from USGS, and prior to any surface disturbance such as deep exploratory drilling, lessee must submit and have approved a Plan of Operations which among other things must state the additives to be used with drilling mud (the drilling mud itself is usually nontoxic). During the review of the Plan of Operations, (1) public comment is invited on the Plan, and public site inspection may be arranged, and (2) a site-specific Environmental Assessment is conducted by USGS, again with ample opportunity for public expression. If concern regarding fencing, for example, is expressed during the review of the Plan and the EA--which review usually lasts 3 to 6 months--the USGS Supervisor may require fencing and monitoring of the first deep well exploratory operation. (This operation, of course, may not take place until both the Plan of Operations and the site-specific EA are approved by USGS, BLM and, in this case, NWC). If such monitoring reveals either thermal pollution or injurious substances to a degree expected to be harmful to wildlife, and/or if sufficient concern was expressed over fences during public review, the Supervisor may include a stipulation for fencing of all such sumps. Beyond these precautions, it should be noted that on the military withdrawal of geothermal operations in sensitive areas in California, a further review of the EA is conducted by the Geothermal Environmental Advisory Panel, comprising numerous state and Federal agencies. (Source: Conversation with Roger Witham, Staff Geologist, Office of Deputy Conservation Manager--Geothermal, USGS, Menlo Park, CA.)

In accordance with the Resource Conservation and Recovery Act (RCRA), 1980 amendments, interim status standards, part 261, geothermal drilling muds are listed under the category of oil and gas drilling muds within Subtitle C - Special Wastes. Subtitle C standards have been temporarily deferred until further studies can be performed by EPA. Also, part 261 defers the effective date of the regulations for the hazardous portions of the proposed oil and gas and utility special wastes. Until regulations for drilling muds are promulgated by the EPA, they are not considered hazardous wastes unless specific additives are applied which are listed in the RCRA hazardous waste list found in Section 261.30 (Ref. Fed. Reg. 5/19/80).

54 - Sections 3.5 and 3.7 have been clarified to reflect your concern. Topsoils disturbed for many types of operations will be stockpiled only temporarily; once the geothermal development activity in question (road grading or well pad construction, e.g.) is completed, the topsoils would be replaced as evenly as possible in the disturbed area and revegetated. Please refer to Section 3.5, 3.7

and 4.7 of the FEIS. Also, stockpiles are commonly seeded to reduce wind and water erosion. Height of stockpiles is limited to reduce effects of compaction and activity of anaerobic organisms.

55 - Surface disturbances caused by permanent roads will continue. Other sites, once closed out, will be prepared and reseeded to assist revegetation of native plants and minimize the establishment of invader plant communities. The weedy plants will be, though, an unavoidable adverse impact. See also response to Comment No. 54.

United States Department of the Interior

HERITAGE CONSERVATION AND RECREATION SERVICE
PACIFIC SOUTHWEST REGION
SAN FRANCISCO, CALIFORNIA 94102
450 Golden Gate Avenue Box 36062

IN REPLY REFER TO:

PSW 200

MAY 6 1980

MEMORANDUM

To: District Manager, Bureau of Land Management, Bakersfield, California

From: Assistant Regional Director; Grants Assistance & Federal Coordination and Landmarks Divisions

Subject: Review of Draft Environmental Statement for the proposed Leasing within the COSO Known Geothermal Resource Area (DES 80/12)

We have reviewed the subject document and offer the following comments.

General Comments

Overall, we find the discussion of cultural resources to be quite good. However, several of the proposed mitigation measures are inadequate to protect Native American religious values and National Register of Historic Places sites.

We question the concession, made by the Bureau of Land Management and the China Lake Naval Weapons Center,to permit only eight (8) visits per year to the Indian Prayer Site by Native American groups.

#56 Restricting Native American access to the Indian Prayer Site while providing nearly unlimited access to the lessee for geothermal development may not comply with the provisions of the Native American Religious Freedom Act. Increased Native American access, or limited lessee access to prevent vandalism and Prayer Site desecration, is suggested.

#57 Furthermore, careful, monitoring and reinjection (Appendix D-Section 30) proposed for the Prayer Site and Hot Springs as mitigation measures may not be in line with Native American wishes.

#58 Project abandonment may be appropriate, should geothermal development or testing indicate significant and permanent alternation of the Coso Hot Springs.

cc: Interagency Archeological Services

KERN COUNTY MUSEUM

RICHARD C. BAILEY, Director

3801 Chester Avenue
Bakersfield, California-93301
Telephone 861-2132

May 7, 1980

Ms. Janis Bowles
Bureau of Land Management
Bakersfield District Office
800 Truxtun Avenue
Bakersfield, Ca 93301

Dear Ms. Bowles:

In reviewing the Environmental Impact Statement for Proposed Leasing within the Coso Known Geothermal Resource Area, I have found the information provided to be most interesting. The statements on cultural resources and land use appear to be well thought out. Of special value to this report is the technical report on cultural resources which was prepared under the supervision of C.W. Clewlow, Jr. This report appears to be quite well prepared.

#59

It is a firm belief of the museum staff that the cultural resources in this area should be left undisturbed if possible. The resources in the Coso area, as you know, have long been known as some of the finest examples of Native American existence in California. It appears as if an attempt will be made by the Bureau of Land Management to avoid archeological or cultural destruction in this area. If the presently designed proposed action is followed, it appears as if very little damage will occur to the cultural resources in the area. As it was noted in the report, the damage caused due to vandalism would always be a possibility, especially due to the increased activity in the area. If, indeed, the BLM personnel and/or rangers patrol the area with increased frequency, perhaps a portion of this vandalism can be avoided.

It is regrettable that our energy resources appear to have dwindled to a point that may be sacrificing our heritage. The geothermal resources in the Coso area have great potential as energy sources. It is hoped that a final plan for the protection of the cultural and environmental resources, as well as use of the geothermal energy, will be produced.

Very truly yours,

Christopher D. Brewer
Museum Technician

CDB:el

56 - Access to Coso Hot Springs and the Prayer Site by Native Americans as discussed in Section 2.12.1.13 and 2.12.2.12, is guaranteed by the NWC. A minimum of eight scheduled visits will be permitted, however, more visits could be allowed, upon request by the Native Americans to the NWC. Access to lands under NWC jurisdiction has been restricted for all persons since 1947, including geothermal personnel, due to the mission of the NWC to develop and test air warfare systems (see Section 1.3.9). The proposed action of geothermal leasing does not deny the Native Americans the right to practice their religious observances or traditional lifeways. Restricted access to the NWC would continue despite any proposed BLM geothermal development.

57 - The BLM and NWC recognize the concerns of the Native Americans regarding the potential flow reduction of Coso Hot Springs due to geothermal development (see Section 2.12.1.13). As stated in Section 2.5.1.4, "the precise mechanism and relation between all the hydrologic, chemical, and climate parameters are not presently known," despite several research studies. Therefore, the only feasible course of action is to implement a Hydrology Monitoring Plan (see Appendix D) to determine the effect of geothermal development on Coso Hot Springs. If the monitoring determines that the flow has diminished, reinjection may be appropriate (see Section 3.4.3). If this strategy proves ineffective in restoring Coso Hot Springs to its original character, the BLM, NWC, and USGS will develop and implement procedures to mitigate impacts to the flow of Coso Hot Springs. Any such plan should ensure that Native American use of the Springs is not impaired. Please also see response to Comment 38.

58 - In the event that mitigation as described in response to comment 57 was not successful, project abandonment would be one of the options carefully considered by the lessees and regulatory agencies.

59 - Thank you for your comments. The final EIS provides mitigation measures for conversion into lease tract stipulations. In addition, site-specific Environmental Assessments will be prepared by USGS to ensure that cultural and environmental resources are protected during development. These procedures will serve as a "final plan" for protection of the environment.

Scientific Resource Surveys, Inc.

LAND BRANCH: 2770-F South Harbor Blvd., Santa Ana, CA 92704 714/979-3981
UNDERWATER BRANCH: 21 Balboa Coves, Newport Bch., CA 92663 714/979-3983

May 6, 1980

Mr. Louis A. Boll, District Manager
U.S. Bureau of Land Management
800 Truxtun Ave. - Room 302
Bakersfield, CA 93301

Dear Mr. Boll,

#60

I am writing to comment on the Coso Geothermal Draft EIS. As with most BLM projects, the impacts to the paleontology of the Coso Area were not addressed in the Technical Appendices. Portions of the Coso Mountains are rich in paleontological resources. It is quite possible that no known paleontological localities exist in the project area, but a records and literature search should be made at the following institutions: Dr. Donald Savage, Museum of Paleontology, University of California, Berkeley; Dr. Michael Woodburne, Department of Geological Sciences, University of California, Riverside; Dr. David P. Whistler, Natural History Museum of Los Angeles County.

There are several papers which were written by Dr. Chester Stock (in the 1930's), of Cal-Tech, Pasadena, on the mammalian fauna from geological deposits in the Coso Range. A collection of the material described in these papers is currently housed at the Natural History Museum of Los Angeles County.

Because most of the impacts will occur in volcanic rocks (basalts), the likelihood of fossil localities and/or remains in the project area is low. There should be a section in the Draft EIS that addresses paleontology, even if only a negative statement. Paleontology should be included in every BLM EIS along with archaeology and history.

I am available if you need assistance in this matter. Please feel free to call anytime. Thank you for your attention to this important matter.

Sincerely,

Mark A. Roeder

Mark A. Roeder
Paleontologist

60 - Thank you for your comment. The information requested has been added in Section 2.6.1.1, 2.6.3, and 3.5.

Maturango Museum

OF THE INDIAN WELLS VALLEY FOUNDED 1962

P.O. BOX 1776 / RIDGECREST, CALIFORNIA 93555

PHONE (714) 446-6900

7 May 1980

Mr. Lou Boll, Bakersfield Area Manager
Bureau of Land Managemant
800 Truxton Avenue
Bakersfield, CA 93301

Subject: EIR for Coso Known Geothermal Area

Dear Mr. Boll:

#61 In order to prevent damage or loss of the vast cultural resources in the Coso area, it is recommended as a first choice that (1) there be no leasing of Public Lands until the potential of the KGRA has been thoroughly documented, based on the development currently proceeding on Navy Fee Lands; and that (2) the BLM initiate promptly a thorough, integrated, professional archeological investigation, including complete surface surveys, mapping, delineating significant sites, collecting and cataloging surface artifacts, etc. of all Zone 1 and 2 lands. This latter action would prevent much loss of information through vandalism and would permit more expeditious geothermal site selection and subsurface archeological work or salvage if and when development begins on a more extensive scale.

#62 A second choice selected to minimize destruction or loss of cultural resources until thorough archeological investigations can be completed is Alternative "E" (defer leasing until a Federal geothermal testing program can be implemented). The latter is preferrable to the remaining four Alternatives which have been proposed.

#63 Page 3-15, paragraph 7. Patrol by BLM rangers to protect other resources on the California deserts appears to be largely ineffective to date--it seems to be lots of talk and publicity but not much action. Hence, we hold out little hope of their protecting the cultural resources in the Coso area.

Sincerely,

Robert D. Berry

ROBERT D. BERRY, PhD.
President, Board of Trustees

61 - The estimate of potential of the KGRA is based upon a geothermal development model that has employed the best estimates of experts as to the physical characteristics as well as the energy potential of the field (see response to Comment 41, Section 1.3.3 and Appendix B). Since geothermal enery is an attractive alternate to the use of fossil fuels and since the BLM has received applications for geothermal leases within the CGSA, the Bureau believes at this time that the national interest would best be served if we did not wait many years for the NWC to fully develop the resource of Navy fee lands. However, your recommendation will be considered during the decision making process. Recommendation No. 2 meets the intent of Alternative 7.3.

The initial survey of cultural resources within the CGSA covered 29 percent of the 72,640 acres within the CGSA (see Section 2.10). The significance of the known cultural resource sites will be determined by the Keeper of the National Register of Historic Places, based upon the recommendations of the BLM and State Historic Preservation Officer. In addition, the mitigation measures discussed in Section 3.9 will prevent the loss of significant cultural resource sites (also see response to Comments 18 and 95).

62 - Thank you for your indication of preference. It will be taken into consideration in the decision-making process.

63 - The Bureau readily admits that the BLM Ranger program is not as effective as we would hope; however, we feel that any ineffectiveness is due to funding and manpower limitations and not to the capability or concern of the rangers. The NWC security staff will patrol withdrawn lands.

SIERRA CLUB 530 Bush Street San Francisco, California 94108 (415) 981-8634

8 May 1980

District Manager
Bureau of Land Management
Bakersfield District Office
800 Truxton Avenue
Bakersfield, CA 93301

Dear Sir:

The Sierra Club appreciates an opporunity to comment on the draft Environmental Impact Statement on Proposed Leasing within the Coso Known Geothermal Resource Area, and upon the geothermal leasing proposal which it presents.

We believe that the information contained in the EIS, including its admission of a lack of available information on certain topics of consideration, makes inappropriate the selection of any single alternative among the seven offered in relation to the leasing proposal. A combination of resources and values is present in the Coso geothermal resource area, and it is clear from the EIS that geothermal operations in this region, unless closely restricted, would have detrimental effects on some of these resources and values and unknown effects upon others.

#64

As the EIS attests (pp. 2-56 to 60), too little information is available on the relationship of the geothermal reservoir to ground water aquifers and on the consequent questions of the liklihood of ground water draw-down if geothermal fluids are withdrawn and of ground water contamination if geothermal fluids are reinjected. Either or both of these events could have substantial effects upon the quantity and quality of ground water and regional ecology. The lack of information regarding the availability of cooling water for geothermal power plants is a matter of further concern. We believe that it is inappropriate to implement the proposed leasing with these questions substantially unanswered. A decision to lease or not to lease must take such major effects into account, and they must be reasonably predictable before the decision is made. We suggest in view of these uncertainties that the procedure outlined in alternative number six be followed; that is that leasing should be deferred until a geotechnical and hydrological testing program is carried out under the supervision of an appropriate federal agency.

#65 As the EIS also attests, little information is available regarding the character and quantity of the geothermal resource within the KGRA. Any development proposal will therefore be speculative, and it does not seem appropriate to lease 28,160 acres of public land for a speculative venture which will adversely impact the land and its fragile desert ecosystem with a road building and exploratory drilling program that may well be abandoned as unsuccessful.

#66 The EIS provides ample testimony regarding the extremely high archaelogical value of the region proposed for leasing, and acknowledges that a walk-over survey of "29 percent of the CGSA does not provide sufficient data to fully evaluate this unique area". We reject as specious the assertion on page 2-153 of the EIS that "in some cases, when cultural resource values are compared to national energy needs, it may be necessary to sacrifice some archaeological material after feasible mitigation." If this is indeed a "unique" archaeological area as the EIS attests, its cultural, scientific and outdoor classroom value may well be greater than its estimated energy value at a modest 600 MW (field estimate, p. 1-14) for thirty to fifty years. The cultural values, if protected as a resource, will be available to posterity, but the geothermal resource value would be restricted to a generation. At the very least, we would urge the partially deferred leasing suggested by alternative number three to preserve the cultural resources in this region. If development takes place, we would urge continuous monitoring for

#67 compliance with the Antiquities Act and other pertinent law to be undertaken by an independent authority, as is being done, for example, in connection with the New Melones Dam project.

#68 The Sierra Club shares the urgent concern of the Native American community for the preservation of the undiminished flow of Coso Hot Springs. Not only are the springs of religious and cultural value to the native American people, but they are representative of a class of natural phenomena increasingly threatened by geothermal operations which have inherent value by their very existence. We propose that the presently contracted geothermal development on the Naval Weapons Center withdrawn lands be allowed to serve as a pilot project to determine the relationship of the hydrothermal system in the KGRA to Coso Hot Springs.

#69 The location of Wilderness Study Area 157 within the Coso Geothermal Study Area precludes geothermal development within visual or audial contact of the WSA, at least during the wilderness study period, and will do so permanently if the WSA is declared a Wilderness Area. Exclusions from geothermal leasing should be made accordingly.

#70 Finally, we believe that the present geothermal leasing proposal is premature in view of the fact that the Draft California Desert Conservation Area Plan Alternatives and Environmental Impact Statement is still under review and final decisions are yet to be made regarding relative resource values and the management of the California desert region as a whole. Under the Protection Alternative proposed in this study, the Coso KGRA would not be leased for geothemal development, and under the Balanced Alternative only half of it would be leased (Desert Plan and EIS, p. 262). These alternatives must be weighed in accordance with the multiple resource consideration of the Desert Plan and EIS, and overall desert management decisions must be made before geothermal leasing decisions are reached in the Coso Area or any other California desert area.

#71 If the desert management decision designates the Coso Area for geothermal development, the Sierra Club requests that the policies

#71 and objectives embodied in Alternatives 3, 4, 6 and 7 be combined. Leasing should thereby be deferred until needful information is gained regarding ground water hydrology, the hydrothermal system, and their interrelation. If, after these studies, leasing is undertaken, localities of exemplary cultural value should be protected from disturbance, areas of natural sensitivity (cf. Figure 2.7.2-1) should be protected from surface occupation and should be provided with buffer zones as appropriate (e.g. in prime habitat of the Mojave Ground Squirrel and in raptor nesting areas), and development should be unitized to provide a unified geothermal resource development and utilization plan.

#72

#73

We offer the following comments specific to the content of the EIS.

#74 page 2-16 It is stated that hydrogen sulfide emissions from the proposed development would "be scrubbed with 95 percent efficiency". Given the difficulties of hydrogen sulfide abatement in The Geysers geothermal field and the lower efficiencies attained, this claim seems gratuitous.

#75 page 2-47 Contrary to the assertion that " no associations have been drawn between geothermal production and induced earthquake activity", tentative conclusions have been reached by USGS geologists that "much of the seismicity at The Geysers steam field is induced by steam withdrawal or condensate injection or both". (Neil B. Crow, An Environmental Overview of Geothermal Development: The Geysers-Calistoga KGRA, Volume 4. Environmental Geology, Lawrence Livermore Laboratory, 1979).

#76 page 2-69 In connection with the proposal that geothermal fluids produced for heat extraction could be reinjected, it should be noted that this would be dependent on permeability in the receiving formation.

Again, we are grateful for this opportunity to comment and will appreciate attention being given to the issues that we have raised.

Yours sincerely,

Hamilton Hess
Geothermal Coordinator

255 Ursuline Road
Santa Rosa, CA 95401

64 - Thank you for your expression of preference. It will be considered in the decision making process.

65 - Please see response to Comment No. 25. Geothermal development on leased Federal land proceeds under a careful step-by-step process which is administered by the US Geological Survey in consultation with the BLM. As lessees decide what exploration (and road building) and development is necessary, they submit to USGS a series of plans; plans of exploration, plans of baseline data collection, plans of development, plans of injection, plans of utilization, and plans for production. Each plan is reviewed and approved by USGS. Except for the plan of baseline data collection, each plan is analyzed in an Environmental Assessment prepared by USGS and reviewed by BLM and within the withdrawal, the NWC. These procedures are outlined in Geothermal Resource Operational Order No. 5 which is operational but is still being refined as a draft. In addition, GRO Order No. 3 and No. 4 specify abandonment and other environmental protection measures which help to insure that geothermal activities will create little residual impact should the exploratory drilling result in abandonment of the drilling program. Because the Coso Geothermal Study Area is laced with roads for use by the Navy, it is probable that the bulk of the residual impacts at this stage would be reclaimed drill pads along existing roads.

The proposed action considers for leasing about 69,000 acres (excluding the private lands and NWC fee lands); rather than 28,160 acres.

66 - By stating that the cultural resources survey of 29 percent of the CGSA was not sufficient to "fully evaluate this unique area." we are collectively speaking of the exhaustive surveys of every recorded site required in terms of qualifying for National Register of Historic Places nomination. The final EIS will include the necessary changes to clarify this point (see Sections 2.10.1.5 and 3.9).

The signficance of some cultural resource sites (or portions thereof) will, as required by historic preservation law, be subject to the terms of a Memorandum of Agreement (MOA) between the BLM, USGS, NWC, State Historic Preservation Officer, and the Advisory Council on Historic Preservation (see responses to Comments 18 and 95). The provisions of the MOA will incorporate the mitigation measures addressed in Section 3.9. Thus, the overall value and unique character of the cultural resources within the CGSA will not be compromised by the proposed action, assuming that all recommended measures are implemented. However, your recommendation to defer leasing will be considered in the final decision making process.

67 - Compliance with the Antiquities Act to reduce pothunting and vandalism within the CGSA will be an ongoing responsibility of the BLM, NWC, USGS, and geothermal personnel. Increased patrols by BLM resource personnel, photo documentation, site inspection, and a cultural resources eductional program sponsored by the BLM and NWC are proposed in Section 3.9.1. All land managing agencies are

required to comply with historic preservation laws. The Office of Historic Preservation and the Advisory Council on Historic Preservation are responsible for ensuring that the agencies comply with the law. The BLM feels that compliance will therefore be adequately assured.

68 - The Bureau also shares the concern for the preservation of the undiminished flow of Coso Hot Springs. Because of this concern a hydrologic monitoring plan of Coso Hot Springs (see Appendix D.4) will be implemented as a condition of lease.

If the NWC contracted geothermal development on their fee (not withdrawn) lands continues as scheduled, it will, in effect, serve as a pilot project to determine the hydrothermal system in the KGRA to Coso Hot Springs. See Section 1.3.5 for the anticipated sequence of events. Also see response to Comment 56.

69 - The location of a Wilderness Study Area within the Coso Geothermal Study Area does not preclude geothermal leasing and <u>may</u> not preclude development within the Wilderness Study Area. The Interim Management Policy and Guidelines for Lands Under Wilderness Review, December 12, 1979 states on Page 24, that "New leases may be issued provided the special stipulation (Appendix A) is attached. Activities may occur under these leases so long as the BLM determines that they satisfy the non-impairment criteria." Once leased, specific development proposals will be evaluated in separate Environmental Assessments to determine if they meet the non-impairment criteria. This policy is restated as a mitigation measure in Section 3.10.

70 - The Coso Known Geothermal Resource Area has attracted a large amount of interest in industry because it has a high potential of being a developable geothermal field. The President's energy policy, as interpreted by the BLM, is to make available alternate energy resources as rapidly as possible under the constraints of NEPA and FLPMA. Because the Coso KGRA appears to have good potential, it was decided in 1977 to analyze the environment and land use impacts independently of the Desert Plan Program. All data collected in the EIS and Technical Reports were collected using Desert Plan standards and were fed into the Desert Plan data inventory to be used in the compilation of the plan alternatives. Existing Desert Plan data was also utilized for this EIS.

The California Desert Advisory Committee was briefed in 1977 on the proposed EIS for Coso. They advised the Bureau to proceed with the EIS to analyse leasing alternatives and to keep them briefed on the project. They have been briefed periodically throughout the process and have expressed no concern with the schedule for proposed leasing, if the decision results in leasing.

Data collected for the EIS are much more site-specific than most of the data collected on the rest of the land designated as CDCA. A decision on which lands within the Coso Geothermal Study Area are environmentally suitable for leasing will consider these data and the configuration of surrounding land use designations in the proposed final Desert Plan.

71 - Thank you for your expression of preference. It will be considered in the decision making process.

72 - If and when leasing is undertaken, the mitigation proposed in Chapter 3 would satisfy the concerns you have expressed.

73 - Thank you for your recommendation. Unitization is certainly one of the alternatives being carefully considered; see Section 7.7.

74 - The current Best Available Control Technology (BACT) applied to the Geysers geothermal operations Units 3, 4, 5, 6, and 11, for H_2S scrubbing has achieved a 90-95 percent abatement status. The BACT method utilized is the Stretford process with an additional hydrogen peroxide (or iron/hydrogen peroxide) supplemental abatement system. (Reference PG&E AFC, Geysers Unit 18, 4/19/79). The use of the Stretford process with hydrogen peroxide is part of the Proposed Action described in Chapter 1 of the EIS.

75 - The report entitled An Environmental Overview of Geothermal Development: The Geysers-Calistoga KGRA, Volume 4, Environmental Geology, Lawrence Livermore Laboratory, 1979, reports the available information (page 9): "Seismic data have been collected for the past three years from a seismograph network covering The Geysers field and its vicinity. Marks et al. (1978) conclude tentatively that an increased level of microearthquakes, with Richter magnitudes less than 2, has resulted at production areas in the steam field from production or injection of geothermal vapor or condensate, or both."

Listed under Data Gaps it reports: "The seismicity of The Geysers field has not been monitored long enough to characterize definitively the relationship between production and induced microearthquakes. For instance, it is not known if the present level and magnitude of induced earthquakes are increasing as production continues. Continued monitoring of the dense network will provide the data necessary for resolving these problems Coverage is too sparse north and east of The Geysers for proper characterization of the seismicity of that region.

"The information about fault geology is not everywhere sufficient to evaluate earthquake potential; more detailed mapping is needed. A strong-motion seismograph network, with instruments at large geothermal installations, is needed to generate data to relate earthquake magnitude to seismic shaking forces at each major facility. There is also a need for site-specific studies to assess potential damage."

Therefore, the mitigation measure to determine seismicity effects of geothermal development is to monitor the area as is stipulated in USGSGRO #4.

76 - It is assumed that the receiving formation will have the same permeability as the formation from which the energy is extracted.

Bureau of Land Management
800 Truxton Avenue - Room 302
Bakersfield, California - 93301

Subject: Geothermal Development, Coso Hot Springs

Attention: Janis Bowler, BLM Coordinator for Environmental Studies of the CKGRA in Inyo County -

The Public Hearing which you conducted in Lone Pine, Tuesday evening, May 1 was carried off very peacefully. No opposition in the audience. Not even from me - tho' I may have been the only person there who objects to the destruction of the Coso Hot Springs area by Geothermal development.

No alternatives for energy have really been explored since the sudden enthusiasm for geothermal began during Nixon's "energy crisis" - and the Navy realized they have something big on the land they acquired by condemnation from the BLM, ranchers and miners to use as a Test Range for missiles during WW II.

#77 An obvious alternate energy source for this area is Wind Power. The Navy should put its brains to work to use a renewable non-polluting energy instead of a non-renewable energy source. The production potential of Geothermal is only about 30 years.

Your Draft EIS discusses the detrimental impact on the environment of this project. I do not want to add "a little more noise, a little more haze - a little more air pollution, a little less prettiness" to our Eastern Sierra Valley when there is the alternative of wind power that would not damage the land.

Sincerely

Katharine G. Connable
Box 487
Independence Calif. 93526

5-9-80

77 - Please see response to Comment 43.

Cuffe Guest Ranch

of Movie Fame

P.O. Box 153 (4½ Miles W. on Whitney Portal Road)
Lone Pine, Calif. 93545
'Phone (714) 876-4161

Irene Cuffe
Actress of 1000 Faces
Owner-Manager

May 8, 1980

Mr. Louis A. Boll, District Manager
U. S. Dept. of the Interior,
Bureau of Land Management,
800 Truxton Ave. Room 302,
Bakersfield, Ca. 93301

Dear Mr. Boll: Re: Coso Geothermal, Naval Weapons Center

This is to let you know that I am protesting the Geothermal Project as well as the EIS in its entirety as it does not spell out anything definite.

#78 I signed your record at the public hearing that was held at the Lone Pine Town Hall on May 1st at 7:30 PM, that I was protesting the project and also the EIS.

Please make this of record in your documents.

Sincerely,

Irene Cuffe

Irene Cuffe

78 - Thank you for your expression of preference. It will be considered in the decision making process.

OFFICE OF THE DIRECTOR

United States Department of the Interior

BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

May 7, 1980

Memorandum

To: District Manager, Bureau of Land Management, Bakersfield, California

From: Director, Bureau of Mines

Subject: Draft environmental impact statement (DEIS), proposed leasing within the Coso Known Geothermal Resource Area (KGRA), Inyo County, California

Thank you for the opportunity to review the DEIS for proposed leasing within the Coso, California, KGRA. Our comments are confined mainly to geology and mineral resources.

General Comments

The DEIS is generally well-written and comprehensive, with excellent maps, tables, and illustrations. Geothermal leasing and subsequent development of geothermal energy in the Coso area should be beneficial to local and regional minerals-related industries.

Specific Comments

#79 Page 1-3, Location and ES Area. We question the exclusion of the northwest portion of the KGRA from the Coso study area. If this portion is environmentally sensitive, any special environmental conditions should be discussed in detail in the DEIS. The criteria by which the excluded area and adjacent parts of the study area have been rated as "low potential" (page 1-10 and figure 1.3-1) are not clearly stated. The excluded area evidently exhibits sufficient potential to attract applications from private industry for noncompetitive leases, hence the establishment of the KGRA. Dismissal of the area as "less likely to contain an economic geothermal resource" should be withheld pending further exploration.

MAY 1980
RECEIVED
U.S. DEPT. INTERIOR
BUREAU LAND MGMT.
BAKERSFIELD

#80 Pages 2-34 to 2-48, Geology. The discussions of regional and local geology, and geological hazards are clear and concise. This section would be enhanced, however, by a brief discussion of other mineral resources. A search of the Bureau of Mines Mineral Industries Location System automated data file (MILS) shows a number of scattered claims and prospects within and peripheral to the Coso study area. Mineral commodities represented include mercury, tungsten, uranium, stone, and pumice. Some of these are briefly acknowledged under "Related Projects" (page 1-39). Geothermal leasing and subsequent activities need not interfere with mineral entry and exploration for locatable minerals on Federal lands not previously withdrawn for other purposes. A statement to this effect should also be included under a subheading of "Mineral Resources."

Director

79 - The northwest portion of the KGRA was excluded from the study area based on several considerations; budget, apparent geothermal potential based on heat flow data, and environmental and political considerations. Also, the NWC reduced the area which they would allow BLM to consider for leasing.

80 - A discussion of mineral resources in the CGSA can be found in Section 2.11.1, Present Land Use Setting, as well as Section 2.12.1.8, Major Industry and Section 2.10.1.3, Historic Period. Also found in Section 2.11.2, Impact of the Proposed Action on Land Use, is a discussion of the effects of the Proposed Action upon the current mineral resource development. As is discussed in these sections, geothermal leasing and subsequent activities is not anticipated to interfere with mineral entry and exploration for locatable minerals on Federal lands not previously withdrawn for other purposes.

Big Pine, California

May 11, 1980

District Manager
Bureau of Land Management
Bakersfield, California

Dear Sir: In re: Coso Geothermal Draft E.I.S.

I am deeply concerned over the problem which this DRAFT reports: namely, the sources of water to be drawn upon if the leasing plan is placed in operation.

#81 1. LITTLE LAKE is suggested as one source. This lake provides food and resting sites for a multitude of migratory birds as they pass through Inyo County. The drawdown will limit and can place undue stress on these birds if the level of water is lowered appreciably. Please answer this concern of mine and state just exactly your proposal for migitating this impact.

#82 2. Haiwee Reservoir along the DWP Aqueduct: The water impounded in this reservoir is INYO-MONO water taken from our counties for the express purpose of providing water for the residents of L.A. If DWP is allowing water to be taken for Coso from this Reservoir, then DWP has sufficient water to cease its diversions in Mono County and return the streams in their natural channels to Mono Lake. I oppose any deal to exchange Haiwee Reservoir (Inyo-Mono waters for Kilowatts from any geothermal development that may take place in the future.

3. Ground Water Pumping in the Coso region: I strongly oppose any ground water extraction that will obviously draw down the water level and dry up the natural springs in Coso areas. ~~This~~ These are isolated oases that are used by countless numbers of wildlife species and without these sources of free water their numbers will be seriously and irrepairably disrupted.

4. Until BLM can and will incorporate into its planning an ethic for land use that gives recognition (not lip service) to the needs of other forms of wildlife, both plants and animals, that are established in an area, I cannot endorse any plan that considers man's exclusive use of a biological necessity of life.

5. I am also concerned with the probable destruction of an area that is of religious significance to the Native Americans and the cultural values that are of importance to the Paiute and Shoshone Indians of Inyo County.

Please make this letter a part of your permanent record.

Respectfully,

(Ms) Enid A. Larson

From: Enid A. Larson

81 - Please refer to Sections 2.7.2, 3.4 and 3.6 for a discussion of both impacts and mitigation measures concerning possible drawdown of Little Lake. The use of groundwater, and not the Lake itself, is suggested as a source of water for geothermal operations; see Section 2.5.2. A hydrology monitoring plan (Appendix D) is proposed for protection of lake water levels; also please see response to Comment 27, regarding artificial maintenance of water levels in the lake.

82 - Make-up water for the proposed Coso geothermal development is assumed to be taken from Rose Valley, not from the Hawiee Reservoir. Section 2.5.2 of the EIS discusses Impacts of the Proposed Action on Hydrology and the source for needed water.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Fremont Street
San Francisco, Ca. 94105

Project #D-BLM-K09002-CA

Louis A. Boll, District Manager
Bureau of Land Management
Bakersfield District Office
800 Truxton Avenue
Bakersfield, CA 93301

12 MAY 1980

Dear Mr. Boll:

The Environmental Protection Agency (EPA) has received and reviewed the Draft Environmental Impact Statement (DEIS) titled PROPOSED LEASING WITHIN THE COSO KNOWN GEOTHERMAL RESOURCE AREA.

The EPA's comments on the DEIS have been classified as Category ER-2. Definitions of the categories are provided by the enclosure. The classification and the date of the EPA's comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed Federal Actions under Section 309 of the Clean Air Act. Our procedure is to categorize our comments on both the environmental consequences of the proposed action and the adequacy of the environmental statement.

The EPA appreciates the opportunity to comment on this DEIS and requests three copies of the Final Environmental Impact Statement when available.

If you have any questions regarding our comments, please contact Susan Sakaki, EIS Coordinator, at (415)556-6925.

Sincerely yours,

Sheila M. Prindiville

for Paul De Falco, Jr.
Regional Administrator

Enclosure

WATER QUALITY COMMENTS

Groundwater Degradation

#83 The DEIS includes discussion of potential contamination of the Rose Valley aquifer with the geothermal reservoir fluid. "The major component of ground water flow is from west to east from the Sierra...The configuration of schematic ground water contours suggests an east to west component of flow from the Coso Range into Rose Valley. If this is true, then there is a hydraulic connection between the geothermal reservoir and the ground water in Rose Valley...Presently there is not enough water level elevation data to determine which of these interpretations is correct." (Page 2-57). The FEIS should include data on the water chemistry of the eastern portion of the Rose Valley aquifer including an analysis of concentrations of boron, arsenic, mercury, and total dissolved solids. The FEIS should also contain a comprehensive analysis of the water chemistry of the Rose Valley aquifer with the geothermal reservoir fluid to determine if there is a hydraulic connection and the extent of ground water exchange. If there is evidence of such an exchange, the FEIS should contain mitigation measures to eliminate possible degradation of the Rose Valley aquifer.

Beneficial Uses

#84 The beneficial uses established in the Water Quality Control Plan, South Lahontan Basin (6B) were approved by the State Water Resources Control Board on May 15, 1975 for the Rose Hydraulic Ground Water Unit. Those beneficial uses were designated as municipal, agricultural, industrial, and freshwater replenishment. As stated in the Water Quality Control Plan, "Groundwaters designated for use as agricultural supply shall not contain concentrations of chemical constituents in amounts that adversely affect such beneficial uses." Therefore, the FEIS should contain mitigation measures to ensure that significant degradation of the Rose Valley aquifer does not occur.

Water Supply

#85 1. The DEIS includes a discussion of possible lowering of the Rose Valley water table. "Potential combined water use by geothermal and present users may exceed natural recharge." (Page 2-69). The mitigation measure as stated on page 3-5 of the DEIS to raise the water table proposes to inject the "spent geothermal fluid beneath or at the bottom of the freshwater aquifer in Rose Valley." The high level of

#85 ground water extraction during the production phase may create more mixing, causing faster degradation of the Rose Valley aquifer. The FEIS should include the results of the complete basin survey and modeling indicated on page 3-5, with the modeling to be conducted for low and high levels of ground water extraction. The FEIS should include

#86 alternative mitigation measures for the potential lowering of the water table in Rose Valley.

#87 2. The FEIS should include a discussion of future competing water uses with respect to present water use and those which will result from this project. The FEIS should project increases in water use associated with geothermal development.

#88 3. The DEIS proposes to import water from nearby sources as a possible mitigation measure (page 3-5). The FEIS should identify the potential sources of imported water and the total environmental impact of the importation of such water.

General Comments

#89 1. The DEIS includes a discussion of reinjection wells for the spent geothermal fluid. It is not clear whether the fluid will be reinjected immediately upon cycling through the system or whether it will be temporarily held in storage ponds. If the latter is the case, the FEIS should address the possibility of storage pond leakage or leachate contaminating the surface or groundwater and appropriate mitigation measures should be discussed. The FEIS should indicate the locations of the reinjection wells.

#90 2. The control methodology required for compliance with the environmental laws and regulations that will apply to this project and future development is not fully described. Of specific concern to EPA is that the Safe Drinking Water Act section on page A-6 be expanded to discuss in more detail the Underground Injection Control (UIC) Program. The proposed technical criteria and standards for that program were published in the Federal Register on April 20, 1979 and will be codified as Part 146, Title 40, Code of Federal Regulations. Subpart D of Part 146, "Criteria and Standards Applicable to Class III Wells," sets forth the requirements for geothermal activities under the UIC program. The FEIS should describe how the project will address the proposed requirements under the UIC program.

#91 3. The DEIS indicates that the Bureau of Land Management, Inyo County, and the Los Angeles Department of Water and

Power would determine the acceptable level of water table lowering based on policy and economics (page 3-4). The California State Water Resources Control Board should be
#91 included as one of the coordinating agencies involved in this decision. As required by Section 313 of the Clean Water Act, the project must comply with both State and Federal regulations.

AIR COMMENTS

1. The DEIS states that hydrogen sulfide emissions from power plants will be scrubbed with 95 per cent efficiency
#92 (page 2-16). The FEIS should indicate if this degree of hydrogen sulfide control is to be a condition for the leasing of geothermal lands at Coso.

2. The DEIS states, "Easterly, up-slope winds extending to the Sierra Nevada crest are extremely rare. Thus, it can be estimated that there will be no impact upon the Prevention of Significant Deterioration (PSD) increments allowed for
#93 Class I areas." (page 2-21). This brief discussion of geothermal development in this area and its impact on PSD increments allowed for Class I areas are inadequate. The FEIS should include a detailed analysis of the impact of the proposed project on PSD increments in adjacent or surrounding Class I areas.

EIS CATEGORY CODES

<u>Environmental Impact of the Action</u>

LO—Lack of Objections

EPA has no objection to the proposed action as described in the draft impact statement; or suggests only minor changes in the proposed action.

ER—Environmental Reservations

EPA has reservations concerning the environmental effects of certain aspects of the proposed action. EPA believes that further study of suggested alternatives or modifications is required and has asked the originating Federal agency to reassess these aspects.

EU—Environmentally Unsatisfactory

EPA believes that the proposed action is unsatisfactory because of its potentially harmful effect on the environment. Furthermore, the Agency believes that the potential safeguards which might be utilized may not adequately protect the environment from hazards arising from this action. The Agency recommends that alternatives to the action be analyzed further (including the possibility of no action at all).

<u>Adequacy of the Impact Statement</u>

Category 1—Adequate

The draft impact statement adequately sets forth the environmental impact of the proposed project or action as well as alternatives reasonably available to the project or action.

Category 2—Insufficient Information

EPA believes that the draft impact statement does not contain sufficient information to assess fully the environmental impact of the proposed project or action. However, from the information submitted, the Agency is able to make a preliminary determination of the impact on the environment. EPA has requested that the originator provide the information that was not included in the draft statement.

Category 3—Inadequate

EPA believes that the draft impact statement does not adequately assess the environmental impact of the proposed project or action, or that the statement inadequately analyzes reasonably available alternatives. The Agency has requested more information and analysis concerning the potential environmental hazards and has asked that substantial revision be made to the impact statement.

If a draft impact statement is assigned a Category 3, no rating will be made of the project or action, since a basis does not generally exist on which to make such a determination.

83 - The idea of inferring hydraulic connection between aquifers based on water chemistry and concentrations of distinctive parameters is a good concept. However, no water chemistry data, nor wells, exist in the eastern portion of Rose Valley.

The hydrology monitoring plan suggests chemical constituents to be analyzed for in geothermal and nongeothermal fluids in the CGSA (see Appendix D). Specific locations for monitoring wells are not specified in the monitoring plan. If there is any development in the eastern part of Rose Valley, monitoring wells should be drilled.

Fournier and Thompson (1980) calculate that the difference in water level elevations between the geothermal reservoir and Rose Valley is due entirely to density difference between hot and cold ground water. Hence, although water levels appear to be higher in the geothermal reservoir, they would not induce a gradient, or flow, from the reservoir to Rose Valley.

84 - The hydrology monitoring plan specifies a complete baseline water chemistry survey for all existing wells in the CGSA, including those in Rose Valley. Periodic monitoring would be conducted subsequently to detect any potential water degradation. Unfortunately, no wells exist on the eastern portion of Rose Valley which could help define either baseline conditions and/or hydraulic communication with the geothermal reservoir.

85 - The discussion of possible mitigation in Section 3.4.1 in the DEIS was not meant to imply that the injection of spent geothermal fluid beneath Rose Valley is to be imposed at this stage, or that "comprehensive ground-water basin survey and modeling" would be conducted now or is being conducted. The mitigation proposed is that the lessees will submit a Water Management Plan as part of the plan of production. This plan <u>could</u> include, among other possibilities, injection of spent geothermal fluid beneath the fresh water aquifer in Rose Valley. If it does include such a method a comprehensive ground-water basin survey and modeling would be necessary prior to implementation of such injection.

86 - Additional mitigation measures for the potential lowering of the water table in Rose Valley have been developed in Section 3.4.

87 - The DEIS does include a discussion of future competing water uses with respect to present water use and those which result from this project. It projects increases in water use specifically associated with geothermal development, as outlined in Table 2.5.1-5 and Table 2.5.2-1. Detailed explanation of the derivation of the estimated water use and projected water use is in the Hydrology Technical Report.

88 - Section 3.4.1 has been corrected to clarify that the nearby alluvial valleys are possible sources for imported water.

89 - As described in Section B.3.3 the spent geothermal fluid will be reinjected immediately after flashing.

90 - Additional information concerning the Safe Drinking Water Act Public Law (AW93-523) Underground Injection Control (UIC) program has been added to the EIS, Appendix A.

91 - The text will be changed to indicate that the California State Water Resources Control Board (Lahotan) will be one of the coordinating agencies involved in this decision.

92 - The 95 percent efficiency of hydrogen sulfide emissions abatement will not occur as a condition of leasing. However, in the application and permitting process of power plants, the power plant operators will be required (under existing statutes and laws including the Clean Air Act) to use "lowest achievable emission rates" (LAER) because they will be within range of the Class 1 areas. This will in effect be a "condition of leasing", if indirectly.

93 - In order to properly quantify the impacts, if any, on the class I areas it would be necessary to have a detailed meteorological data base for each of the potential air mass trajectories. Such data would then be input into a suitable long-range air quality simulation model. This necessary data is not available. However the fact that the short range model predicts SO_x concentrations near the power plants which do not exceed the PSD increments is indicative of the lack of impact projected. The rarity of the winds in the direction of the areas further supports this conclusion. A detailed analysis such as suggested is not warranted at this stage of development. When actual plant construction is contemplated, the EPA (or the Air Resources Board of the State of California) will review the construction plans in conjunction with the appropriate Federal Land Manager(s). At that time the necessity of such detailed evaluation can be reconsidered.

California Wilderness Coalition

POST OFFICE BOX 429 • DAVIS, CALIFORNIA 95616 • (916) 758-0380

May 12, 1980

Louis A. Boll, District Manager
U.S. Bureau of Land Management
800 Truxtun Ave.--Room 302
Bakersfield, CA 93301

Dear Mr. Boll:

Thank you for the opportunity to comment on the Draft EIS for "Proposed Leasing within the Coso Known Geothermal Resource Area." We have reviewed this document and have the following concerns. We feel that no leasing should actually take place until an EIS is prepared which addresses the following issues:

#94 (1) An integrated study of the geothermal resource and leasing program by both the BLM and China Lake Naval Weapons Center.

#95 (2) An adequate survey is made of cultural resources within the CKGRA and impacts of exploration and development are specifically determined and made available for evaluation by the public. The inadequacy of the cultural resource impact assessment of the draft EIS violates the spirit and letter of national historic laws and policies.

#96 (3) The relative value of archeological resources to be damaged and the geothermal resource is evaluated. Is immediate development of the geothermal resource justified after considering the nonrenewable and fragile nature of the archeological/cultural resources of the KGRA?

#97 (4) Adequate environmental safeguards should be developed to protects soils, wildlife, vegetation and cultural resources. Also, no activities should be permitted which would exceed state or federal standards for total suspended particulates (TSP).

After these issues are addressed in the EIS, and if geothermal development does indeed proceed in the CKGRA in the near future, we also propose that the following measures be taken:

#98 (1) A combination of alternative 2 (lease all lands except those of significant surface conflict), alternative 3 (partial deferred leasing to protect cultural resources) and alternative 7 (unitization at time of leasing) be adopted.

#99 (2) All mitigation measures for all resources mentioned in the Draft EIS be implemented.

#100 (3) New "geothermal operating orders" for use during the post leasing phase be developed. The existing operating orders are antiquated and are not in conformance with environmental laws and regulations. An independent monitoring and review authority should be established.

#101 (4) Groundwater should not be extracted from Rose Valley if this might lead to drying of Little Lake. No lowering of the water table supplying this lake should be allowed because riparian habitat is rare in this arid region an a rare and endangered plant--*Spartina gracilis*--may be extirpated.

Thank you for considering these comments.

Sincerely,

Dennis Coules
Project Coordinator

94 - The Naval Weapons Center prepared an EIS on their proposed geothermal development program in 1979. See list of references, under U.S. Naval Weapons Center, 1979. The Bureau EIS has attempted to address the accumulation of impacts from both the BLM leasing program and the NWC development program. The inconsistency between the discussion of MW potential in the two documents stems mostly from the difference in estimates of MW production per geothermal well. Also, the NWC document takes a more optimistic view of the potential of the area for energy production.

95 - The State Historic Preservation Officer (SHPO) has reviewed the DEIS. The BLM, NWC and SHPO are developing a procedural and specific agreement to protect the known cultural resource sites and those sites yet to be discovered withing the CGSA that qualify for inclusion on the National Register of Historic Places. Such agreement will ensure compliance with the National Environmental Policy Act of 1969, the National Historic Preservation Act of 1966, and Executive Order 11593 of 1971.

96 - It is the policy of the BLM to make available geothermal resources, if environmentally feasible, to help alleviate the Nation's dependence on petroleum energy resources (see response to Comment 25). The mitigation of adverse impacts, as addressed in Section 3.9, is believed to provide adequate protection to significant cultural resource sites (see response to Comment 95).

97 - See the mitigation measures chapter. The measures in Chapter 3 of the FEIS will be applied as stipulations on the appropriate lease tracts. Other safeguards are included in the standard lease form, the USGS Geothermal Resources Operational Orders 1-7 and various state and local permitting procedures which will be required.

98 - Thank you for your indication of preference. It will be used in the decision making process.

99 - See response to Comment 97.

100 - The US Geological Survey has the responsibility for the promulgation of the Geothermal Resource Operating Orders, and of their implementation. These Orders are guidelines for geothermal developers. Site specific analysis is performed for each lease. Environmental considerations are not limited to the guidence given in the GRO Orders.

101 - Thank for your expression of interest. Little Lake will be given appropriate protection because of its importance to both flora and fauna. See the mitigation measures, Chapter 3, Sections 3.4.1 and 3.6. See also Hydrology and Wildlife/Flora Monitoring Plans (Appendix D).

COUNTY OF INYO

BOARD OF SUPERVISORS

COURTHOUSE

INDEPENDENCE, CALIFORNIA 93526

April 29, 1980

Bureau of Land Management
Mr. Louis A. Boll
District Manager
800 Truxtun Avenue
Bakersfield, CA 93301

Dear Mr. Boll:

Inyo County has reviewed the "Proposed Leasing Within The Coso Known Geothermal Resource Area Draft EIR". We would like to bring to your attention the apparent technical inconsistencies between the above EIS and the "Final EIS for the Navy Coso Geothermal Development Program" and subsequent past presentations of the Navy before the Board of Supervisors.

We do not have the technical geothermal expertise on our staff to comment on the technical aspects. We therefore listed the inconsistencies without presenting any conclusions:

#102 1. The BLM estimates the geothermal potential at 600 Megawatts (MWe). The Navy estimates it between 1,000 to 4,000 MWe.

#103 2. The BLM estimates the life of the Coso field at 50 years. The Navy estimates are up to 1,000 years or more.

#104 3. The BLM has stated they need cooling water from the Rose Valley Groundwater Basin to supplement geothermal fluids. The Navy states that water will only be needed to drill wells and start up the electric generating stations. They contend that the geothermal electric stations will create their own cooling water from geothermal fluids and still end up with a surplus of water. It is further stated that it would take 3,500 acre feet of water per 50 MWe for cooling water if geothermal fluid is not used.

#105 4. The BLM has estimated the size of the Navy geothermal generating station at 10 MWe. They estimate up to 50 MWe capacity. The Navy has stated 10 MWe is the minimum size, 110 MWe as maximum capacity and ultimately there could be as much as 300 MWe.

In the Rooms of the Board of Supervisors

County of Inyo, State of California

AUDITOR'S
PAGE
NO.

I HEREBY CERTIFY, That at a meeting of the Board of Supervisors of the County of Inyo, State of California, held in their rooms at the Court House in Independence on the 6th day of May, 1980, an order was duly made and entered as follows:

EIS COSO GEOTHERMAL LEASING PROPOSAL -- RESPONSE

Moved by Supervisor McDonald, seconded by Supervisor Engel to approve Inyo County's letter of response to the Draft EIS Coso Geothermal Leasing Proposal to be sent to the U.S. Bureau of Land management, Mr. Louis A. Boll, District Manager; and authorize the Chairman to sign the letter on behalf of the County.

Motion carried unanimously.

WITNESS my hand and the seal of said Board as the same appears of record in my office. this 6th day of May, 1980

APPROVED FOR ENTRY

MARGARET BROMLEY
County Clerk and ex-Officio Clerk of said Board.

Auditor. By *Margaret Vaughn* Deputy

BOARD OF SUPERVISORS
Referred *Copies*
CAO *✓*
DA
Other *Aud, Planning, BLM*
Date *5-12-80*

We also present the following comments for your review and comment:

#106 1. California Desert Plan Protection Alternate would prohibit geothermal development outside of N.W.C. boundaries.

#107 2. The planned phased development of a 50 MWe power source would create less of an impact on Southern Inyo County than a short boom construction period followed by the exodus of the construction workers that a non-phased development would cause. However, such a phased development may not be possible with the energy shortage and a national policy to develop alternative energy sources.

#108 3. If the BLM's estimate of field potential turned out to be incorrect and the Navy estimate of 1000-4000 MWe was correct wouldn't there be pressure from the President, Congress and the public to create more geothermal energy to help the energy crisis? Therefore, shouldn't there be a contingent alternative based upon a larger potential geothermal field?

#109 4. On Table 1.3-1 why is noise level measured at 700 feet for generator and other noise sources from 10 to 50 feet? (excluding Jet at 200 feet).

#110 5. Apparently, the authors of the EIS misunderstood the county's position stated in the Seismic Safety Element of the County General Plan. The County is aware that volcanism could occur again in the future. However, since the locations of possible volcanic eruption are not within populated areas, the county's position is to seek research help on other geologic hazards such as earthquake faults, which do have the potential of infliction, damage to property and injury to human life as a higher priority. The County welcomes all research on all geologic hazards when the opportunity is available including volcanism.

#111 6. Page 2-48 How much subsidence would occur in Rose Valley from groundwater pumping? What are the estimated impacts from subsidence? What will the future water tables be during and after pumping?

#112 7. Is it possible to buy cooling water from the Los Angeles Department of Water and Power rather than pump Rose Valley groundwater?

#113 8. Page 2-121-U.S. 395 is not a designated scenic corridor by the State of California.

#114 9. Page 2-122 the stone buildings at Coso are National Historical Landmarks registered in the National Register of Historic Places.

#114 The county does not consider them an intrusion on the landscape.

#115 10. Figure 2.11.1-5 shown the delineation of Los Angeles Department of Water and Power and Private Property incorrectly.

#116 11. Page 2-190-Cartago has a water system and no sewer system; individual septic systems are used. The Lone Pine sewer system was upgraded by Los Angeles Department of Water and Power as a condition of acquiring the Lone Pine water system.

The Board of Supervisors would like to thank BLM Bakersfield District for the opportunity for us to comment on the proposed Coso project.

Sincerely,

Vernon "Johnny" Johnson
Chairman

102 - Please see the response to Comment 25. The Bureau estimate of 600 MW is based on the opinion of experts in the geothermal field (see Appendix B), and upon the latest USGS information, Circular 790. Over the years, estimates have ranged from about 4,500 MW down to little or no potential. Generally, in this KGRA, as in most, the first estimates were high (4000 MW). As more research has been carried out over the years, these estimates have dropped. The Bureau has chosen a moderate estimate and recent research as a basis for the geothermal development model in Appendix B.

103 - The BLM's estimate of the life of the field is moderate. Only in one field, Larderello, Italy, has geothermal development continued for over 30 years. The NWC has reached its own conclusions.

104 - The differences lie in the differences between the geothermal development model contained in the BLM EIS and the model adopted by the Navy. The BLM model does, however, assume that the stations will create their own cooling water; however engineering calculations using the model indicate that make up water totaling 323 acre feet per year per 50 MWe station will be required. Please refer to our answer to comment 1 as well as to the description of the system in Section 1.3.5.4 of the EIS.

105 - It is assumed that the first generation station will be a "demonstration" plant. The differences lie in the fundamental differences in the estimates of the energy available from the resource. See also response to comment 94.

106 - Please see response to question No. 70.

107 - Thank you for your comment. The discussion of unitized development of the geothermal resource (in Section 7.7) also suggests that a planned and coordinated approach would involve less socioeconomic impact.

108 - Rather than an alternative based on a larger field potential, when or if the development of the field approaches 600 MW, the Bureau will prepare a supplement to the present EIS to analyze the accumulation of impacts of increased MW production. At this time, we feel that 1000-4000 MW potential is unrealistic.

109 - Table 1.3-1 represents typical noise levels measured at the fence line surrounding the various noise sources.

110 - Thank you for your comment. Section 2.4.2.2 has been changed to reflect the Inyo County policy on renewed volcanism.

111 - Insufficient data exists on ground-water levels, physical properties of materials and aquifers in Rose Valley to predict how much subsidence would occur in Rose Valley from ground-water pumping. However, estimated impacts from subsidence are not anticipated to be significant due to the sparse population and few structures in the area. Best and worse case analyses for lowering of the water table in Rose Valley is given in Table 2.5.2-2.

112 - Los Angeles Department of Water and Power aqueduct water is currently committed for use in Southern California.

113 - The correct designation has been noted. The section of US 395 from Little Lake to Coleville has been identified as a State Eligible Scenic Highway in the Transportation Agency's publication _The Scenic Route - A Guide for the Designation of an Official Scenic Highway,_ 1964, revised 1975.

114 - Correction has been noted. The stone buildings at Coso are National Historical Landmarks registered in the National Register of Historic Places. In the BLM visual resource management system, man made objects or cultural modifications are considered to be intrusions upon the naturalness of the landscape. This is not intended to indicate that they are unattractive, just that they are in contrast to the natural features.

115 - Thank you for the comment. Figure 2.11.1-5 has been amended accordingly.

116 - Thank you for your comment. Section 2.12.1.4 has been amended to include this information.

Star Rte 2, Box 1142
Tehachapi, CA 93561
May 12, 1980

Mr. Lou Boll, District Ranger
U. S. Bureau of Land Management
800 Truxtun Avenue
Bakersfield, CA 93301

RE: Coso Known Geothermal DEIS

Dear Mr. Boll:

I have reviewed the Draft EIS for the Coso Geothermal Study Area and would like the following comments recorded in the public record.

#117 As a general comment I would like to support the phased development as proposed in the Draft. In that manner, if a significant impact appears it would be possible to forego the rest of the project. #118 There are several impacts that would appear to be significant before the first phase is even commenced. The most serious would be the impact on air quality. Without our mountains and deserts to act as cleansing areas our quality of life in California would deteriorate even further. The decrease in visibility could be very serious for the test program at the Naval Weapons Center.

#119 Another serious impact could occur in regards to archaeological values. These cultural resources are priceless and need to be more adequately studied before large scale leasing occurs. Within each tract of 2,560 acres a careful inventory must be made before any impacting exploration begins (drlling, road construction, and the like).

#120 I would certainly like to support Alternative 7 which requires unitization. This sems like a prudent way in which to minimize soil, wildlife, and vegetation impacts. This Alternative should be implemented in connection with the various mitigation measures listed in the DEIS.

#121 I finally would suggest that Alternative 7 should not stand alone. There should be acombination alternative wherein Alternatives 3 and 5 could be utilized. If the first phase of exploratory well drilling proceeds with out major impacts then it might be poissible to go from the combination of Alternatives 3-5-7 to an Alternative comprised of 7-2.

Thank you for this opportunity to comment.

Sincerely,

Elizabeth Fontaine

Elizabeth Fontaine

117 - Thank you for your comment. It will be considered in the decision making process.

118 - Thank you for your comment.

119 - Please see the mitigation section of the FEIS. In addition to procedures outlined there, US Geological Survey, as part of their lease administration responsibilities, prepares a site-specific Environmental Assessment on each lessee-submitted Plan of Operations. These EAs include cultural resource inventories of all areas proposed for disturbance. See also response to Comment 65.

120 - Thank you for your expression of preference. It will be considered in the decision making process.

121 - Thank you for your expression of preference. It will be considered in the decision making process.

DEPARTMENT OF THE NAVY
NAVAL WEAPONS CENTER
CHINA LAKE, CALIFORNIA 93555

IN REPLY REFER TO:

26305/TMD:gtl
Serial 3875
19 May 1980

Mr. Louis Boll
Bureau of Land Management
800 Truxtun Avenue, Room 302
Bakersfield, California 93301

Dear Mr. Boll:

The Naval Weapons Center has reviewed the Bakersfield District's Draft Environmental Impact Statement (DEIS) for your proposed leasing program within the Coso Known Geothermal Resource Area. Our detailed comments are contained in enclosure (1) and we will look forwarded to receiving the District's responses to them in your Final EIS. On the whole, this document makes a substantial contribution to the body of knowledge for the region and should provide a good foundation for both the Navy and BLM geothermal programs to move forward.

Overall, the Center feels the DEIS has no major deficiencies in its baseline data and technical analyses. Our geothermal experts do question the validity of several assumptions contained in the geothermal development model and it is our opinion that relying on the model results in underestimates of certain impacts and overestimates of others, such as cooling water requirements. We do realize that, as the geothermal reservoir is characterized in greater detail, estimates of impacts can be updated by U.S.G.S., BLM and ourselves in evaluating site or project specific impacts in the future.

#122 One feature the DEIS lacked was an assessment of the relative importance or severity of identified impacts. Each impact discussed appeared to be given equal weight without ranking them in terms of importance. Also, the term "impact" was used throughout the report without adequate qualification regarding its degree or type, i.e., adverse or beneficial.

We appreciated the opportunity to review and comment on the Coso Leasing DEIS and we believe our comments will contribute to making the Final EIS a sound decision-making document for leasing. If you have any questions regarding our comments, the point of contact is Mr. Tom Dodson, the Center's Environmental Protection Officer. He can be reached at (714) 939-3411.

Sincerely,

J. R. IVES
CAPT, CEC, USN
Public Works Officer
By direction of the Commander

Enclosure
(1) Comments on Coso
BLM Leasing DEIS

Specific Comments
on the
Coso BLM Leasing DEIS

* *

Comments are provided in the order that the issue appears in the DEIS rather than in the relative order of their importance.

#123 Pages 1-1 and 1-2: The list of alternatives should be qualified by a statement that indicates the final alternative adopted by BLM must include measures deemed necessary by NWC to insure that we will be able to accomplish our mission.

#124 Page 1-5, Paragraph 2: This paragraph implies that BLM leasing authority extends to public domain lands withdrawn under PLO 431. The Engle Act [43 U.S.C., Sections 155-158] is cited as the basis for this authority. The Engle Act actually authorizes the Secretary of the Interior to lease public lands withdrawn for use of DOD agencies as otherwise provided by law. The Geothermal Steam Act of 1970 [30 U.S.C. Par 1002 _et seq_.] is the sole authority for leasing geothermal steam and associated resources. DOD withdrawn lands do not fit within any of the categories of lands subject to leasing under the Steam Act. NWC has reservations concerning whether the Engle Act can be used to provide leasing authority not provided by the Steam Act. It should be noted that pending legislation in Congress that will provide express leasing authority on all withdrawn lands may resolve this question in the near future.

#125 Page 1-5: The discussion of agency authorities and roles does not address the November 1977 Memorandum of Understanding and Constraints that control the leasing of withdrawn land within the NWC boundary. A description and reference to these two documents should be included in this section on this page, between paragraphs 2 and 3.

#126 Page 1-6, Bottom of Page: The NWC constraints contained in Appendix C should be added to this list of applicable regulations.

#127 Page 1-7, Line 7: Following the sentence ending "appropriate land management agency", a sentence should be added to indicate that within the NWC boundary, the appropriate land management agency is NWC.

#128 Page 1-10, Paragraph 1: The BLM has made a number of assumptions in their geothermal development model which NWC believes are invalid. As a result, several of the resource evaluations contained in this DEIS, although technically consistent with BLM assumptions, either under- or over-estimate the degree of impact. The two major assumptions in question are the size of the resource, and the requirement for cooling water. The assumption of a 600 megawatt "most probable" generation scenario is lower than NWC estimates and results, we believe, in an underestimation of all resource impacts by approximately a factor of 1.5.

#129 On the other hand, NWC experts, as noted in detail below, feel the assumption that cooling water will be required for generation of electricity is incorrect and that estimates of geothermal development impacts on Rose Valley groundwater resources are significantly overstated.

Enclosure (1)

Page 1-10, Paragraph 2: This paragraph describes four zones of "diminishing potential" and concludes that the two "best" zones will provide enough power for five 50 MW power plants plus the 10-15 MW plant on NWC acquired lands. Each well in Zone 1 is estimated to have 2.25 MW potential, while each well in Zone 2 is estimated at 1.67 MW. Since there
#130 are 6 sections of Zone 1 land and 9 sections of Zone 2 land, and wells are estimated on 40 acre spacing (16 wells per section), we calculate Zones 1 and 2 should represent 456 MW rather than 250 MW. These numbers are conflicting and need to be rectified in this section of the report as well as at other points in the report where the numbers do not track properly.

Page 1-20, Paragraph 2: It is understood that the assumption to drill 4 wells from each well pad is being implemented to reduce the amount of area disturbed by geothermal development. However, it should also be
#131 recognized that directional drilling substantially raises costs of well drilling and also increases the probability of down-hole problems in the future. Since terrain considerations that dictated the 4-well array at Geysers do not exist at Coso, geothermal lessees may request BLM to permit one pad-one well normal, straight drilling techniques. What policy does BLM intend to carry out if this situation arises?

Pages 1-21 and 1-25: NWC feels that the assumption that additional make-up water (beyond that condensed from the flashed steam) will be required for cooling during power generation is invalid. This assumption has led to the conclusion that a pipeline from Rose Valley will be required to provide cooling water. Our investigation reveals that
#132 flash or dry steam systems (e.g., Geysers, Baca, Krafla and Cerro Prieto) require no additional make-up water. Rather, these facilities generate a net surface surplus of water from the condensation of produced steam. The book "Geothermal Energy", published by the Stanford Press, states that "Dry steam and flashed steam power plants supply their own cooling water, and are therefore independent of the sources of condenser cooling water that are needed by other types of thermal plants." If this assumption is eliminated from the DEIS, a major environmental impact to regional water resources will not occur. As a related issue, incorporation of Figure 1.3-7 (Page 1-23) is an apparent error. The text on Page 1-21 describes this figure as a typical flash-type system, and it
#133 illustrates a binary system. A binary generation system may require additional make-up water, whereas, as noted above, a flash system is independent of external water sources.

Page 2-19, Paragraphs 2 and 3: The projections for fugitive dust impacts within the local area substantially exceed the pertinent TSP standards. What does BLM intend to do with regard to continuing development if the standard is exceeded locally in the early stages of field
#134 development? What if proposed mitigation measures are unsuccessful? A point to keep in mind is that NWC has retained the right to impose standards stricter than provided in existing regulations in order to protect our operational capability.

Enclsoure (1)

#135 Page 2-20, Paragraph 3: The comment in the last sentence regarding acceptability of a 10 percent decrease in visual range to NWC is not accurate. NWC has presented evidence to the California Energy Commission (Docket No. 78-NOI-1) that we require a minimum average visual range of 50 miles for our optical data gathering operations. It is correct that the 10% projected degradation from present average visual range (approximately 60 miles) would maintain that standard. However, our average visibility may decrease in the future due to proposed power plants and other major stationary sources within our airshed. NWC will evaluate cumulative visual range degradation as future geothermal power plants come on line and, if they pose no potential for reduction of average visual range below 50 miles, we will be able to accept them. We do reserve the right to require more stringent emission controls or to seek emission offsets in our airshed if our minimal operational visual range is impaired.

#136 Page 2-30, Paragraph 2: The description of noise impact from a power plant is somewhat misleading. The current background noise level is a result of an extremely quiet natural setting (25 dB(A) or less) and highly intermittent aircraft overflights. A power plant is a continuous noise source which, even at a distance where the projected value (L_{dn}) is equal to the existing noise level, will create a distinct new background noise environment. Even though not considered adverse by community noise standards, the degree of adverse impact from the changed noise setting might be perceived as adverse by Native Americans using the Hot Springs or Prayer Site.

#137 Page 2-33: It should be pointed out that use of Coso Hot Springs by Native Americans is infrequent (8 scheduled times per year) and generally of short duration (weekends).

#138 Page 2-43, Section 2.4.2: This section does not list one of the major geologic impacts, topographic alterations, and this impact was not addressed in detail in any other section of the DEIS. Such an analysis should evaluate how much of each zone has slopes of certain categories and then calculate the type and degree of topographic alteration (including access roads) that will be required to develop that zone.

#139 Pages 2-45 and 2-47, Surface Faulting: The DEIS indicates that "surface faulting or rupture is most likely to occur on known active traces of faults in the study area." However, these active faults were not clearly identified or referenced, especially those most active ones. Also, no attempt was made to analyze the impact on siting of facilities or on well drilling locations, or to describe necessary mitigation measures to prevent or reduce adverse impacts due to surface rupture. The FEIS should address these issues.

#140 Page 2-48, Paragraph 1: As noted in our comments on the geothermal model, we feel the potential for groundwater utilization is low and, as a result, potential subsidence impacts should be negligible.

Enclosure (1)

#141 Page 2-54, Paragraph 1: The comment regarding runoff discharging into Indian Wells Valley, particularly in the volumes mentioned, needs to be clarified. Our experience in this region does not support this contention.

#142 Page 2-54, Paragraph 6: Comments regarding wind erosion impacts in the second and fourth sentences appear contradictory. Also, if the soils are stable and not subject to sheet erosion as claimed, then wind erosion should be even less effective. These statements and conclusions need to be re-evaluated.

#143 Page 2-56, Paragraph 1: What is implied by use of the term "non-vegetative period of the year"? Many plants are perennials within the CGSA and the implication of this comment needs to be explained.

Page 2-68, Paragraph 2: Questions regarding groundwater impacts in Rose Valley have already been raised.

#144 Page 2-69, Paragraph 2: Additional data regarding 100-year flood events are requested. If, as indicated, these flows will reach Little Lake and perhaps beyond, then the sediment impacts on Fossil Falls should be evaluated in greater detail. This potential impact to Fossil Falls indicates that mitigation measures for erosion impacts within Rose Valley should perhaps be more effective than in other areas.

Page 2-69, Section 2.5.2.2: The potential impacts described in this section are questioned as noted above.

#145 Page 2-71, Paragraph 5: Except for the limited area of phreatophytes around Little Lake, none of the native vegetation in the CGSA is directly dependent upon groundwater. The area of impact, if it were to occur, would be small but, as noted in the Vegetation Section, significant.

#146 Page 2-84, Section 2.6.2.5: Analysis provided in this section is extremely limited. We suggest quantifying the amount of soil removed and discussion of secondary impacts in a manner similar to all other resource evaluations in the DEIS.

#147 Page 2-86, Paragraph 4: As an item of interest, how would geothermal development increase the potential of the bullfrog being introduced to Haiwee Spring from Little Lake?

#148 Page 2-87: We suggest a table be prepared using both scientific and common names opposite their normal habitat in order to better characterize the data for the lay reader.

#149 Page 2-95: This and all other maps should show the National Register Site as fee-acquired land, in addition to its Register status. The land ownership is not changed by its listing on the National Register.

#150 Page 2-96, Lines 3 and 4: The habitat quality of the area immediately adjacent to the Old Resort is also poor because of human use of the area since 1893 and due to the chemical nature of the soils.

Enclosure (1)

#151 Page 2-96, Paragraph 4: The Mojave ground squirrel exists around China Lake and Ridgecrest in numbers sufficient to be considered common to this area. While some population surveys of this rodent should be conducted on a site-specific basis during the development phases, it is not believed that the CGSA contains a habitat critical to the existence of this species.

#152 Page 2-98, Last sentence on page: This statement minimizes the presence of Salsola iberica (Russian thistle) in disturbed soil areas. The comment "generally outnumbered by native plants" is an inaccurate and misleading observation when Russian thistle and cheatgrass (Bromus sp.) are considered.

#153 Page 2-100, Section 2.8: As a general comment, the vegetation maps, Figures 2.8.1-2 through 2.8.1-8, are valuable sources of information, but are virtually illegible at this size. These maps should be enlarged for the FEIS, as they would enhance this section substantially.

#154 Page 2-112, Paragraph 1: As previously noted, the limited vegetation around the Old Resort is not solely due to compacted soils. Soil chemistry also inhibits plant growth.

#155 Page 2-116 and 2-117: Pholisma Arenarium was found just outside the National Register Site Boundary (Section 3), but still on Navy fee-acquired land. See NWC Ad Pub 202, map, page 154. This species can occur in sandy areas throughout the distribution of its host plants.

#156 Pages 2-118 and 2-119: The discussion of habitat losses fails to take into account the fact that a total loss does not occur. The habitats will be altered rather than subtracted from production. Some species may flourish on winter grasses under steam lines and find additional watering, burrowing and nesting sites in disturbed area. Other positive effects to the habitat should also be identified.

#157 Page 2-119: It is already established that mercury exists naturally in soils adjacent to Devil's Kitchen and Coso Hot Springs. Evidently, certain plant and animal life can tolerate some degree of mercury concentrations. How do the natural concentrations of mercury compare with that predicted for areas impacted by geothermal power plant plumes?

#158 Page 2-127, Figure 2.9.1-4: The description of scenic quality on Page 2-126 does not appear to correlate to the figure. This should be revised and/or redrawn to allow interpretation.

#159 Page 2-132, Sections 2.9.2.2 and 2.9.2.3: Both of these sections describe impacts too abstractly to be valuable in interpreting where visual impacts are most likely to occur and how significant an impact will be. They need to be revised to apply more specifically to the KGRA.

#160 Page 2-139, Section 2.10: General Comment - All references to the Iroquois Research Institute's report on Coso Hot Springs should be cited as NWC Ad Pub 200.

Enclosure (1)

#161 Page 2-150, Paragraph 2, First sentence: How will resources be implemented as part of the proposed action? This comment is unclear.

#162 Page 2-156, Paragraph 2.10.2.7: This paragraph implies there has been extensive vandalism/damage to rock art sites in Renegade Canyon. Only one section (known as Little Petroglyph Canyon) may be visited by the public on a strictly controlled basis. Although this area receives relatively heavy visitor use, vandalism is minimal due to monitoring efforts of volunteer escorts and to NWC resource management policies.

#163 Page 2-159, Paragraph 1, Line 3: "entire NWC" add "China Lake Complex, not Mohave B - Randsburg Wash test ranges".

#164 Page 2-163, Table 2.11.1-1: Military operation use intensity is shown as 50%. What is this figure based upon? As we discuss below, our assumed use factor is somewhat higher.

#165 Page 2-170, Paragraph 2: The statement regarding T&E operation use intensity is erroneous and gives a false impression of our utilization of the area. In fact, we use the area in one way or another essentially on a full-time basis. The 10% and 2% statistics refer only to the proportion of our operations which would require exclusion or sheltering of personnel in the Coso area for safety reasons.

#166 Page 2-170, Paragraph 3: Recreational uses are not permitted within the NWC boundary.

#167 Page 2-213, Paragraph 3, Last line: Is the 900 geothermal employee figure, cited here, an error? What should the figure be? If it is not an error, please relate it to previous estimates for clarification?

#168 Page 3-1: General Comment - Many of the proposed mitigation measures appear to be unrealistic or economically infeasible, in particular, the Cultural Resources Assessment Strategy, CRAS. Perhaps a description of who will fund and implement mitigation measures can be provided.

#169 General Comment - When predicting fairly specific impacts as in this document (air quality, hydrology, cultural resources), it is generally considered appropriate to indicate to what degree the mitigation measure is expected to reduce impacts, i.e., totally, partially, or minimally. We believe some indication of effectiveness of proposed mitigation measures should be provided in the FEIS.

#170 Page 3-2, Section 3.1: NWC requests that visibility monitoring be added to the general air quality monitoring requirements for all future air monitoring programs within the Coso Hot Springs KGRA. Such monitoring should be consistent with the minimum programs to be presented to Congress this year by the Environmental Protection Agency.

#171 Also, NWC requests that, once the geothermal resource is defined, and successful development of electrical power generation is assured, lessees

Enclosure (1)

#171 be required to contribute to a detailed evaluation of local dynamics of visibility degradation, i.e., study of H_2S to SO_2 to SO_4 conversion rates in the local area.

#172 Page 3-3: Fugitive dust control may require a more stringent set of mitigation measures and background data, since it appears to have the highest possibility of exceeding standards in the future. We suggest that baseline TSP studies be designed, coordinated and implemented with Great Basin Unified Air Pollution Control District subsequent to successful lease sale. Also, in the future as the resource is developed, if the TSP standard begins to be consistently exceeded, lessees should be required to control local fugitive dust emissions at an offset rate equivalent to or greater than estimated emissions.

#173 Page 3-4: Geologic impact mitigation measures are insufficient. This section should contain measures guiding siting of geothermal facilities, including wells on or near active young faults and suggested measures to control topographic alteration on steep slopes.

Pages 3-8, 9 and 10: Please refer to NWC comments on Pages 2-69 through 2-119.

#174 Page 4-1, Paragraph 2: Did BLM calculate the volume of water required to water unpaved roads at various levels of development? This could turn into a significant water use and energy consumption component of geothermal development, and some impact estimates should be provided.

#175 Page 4-1, Paragraph 4: Our comments regarding impact of geothermal development in the air quality section are applicable in this instance. The acceptability of a 10% visual range degradation is dependent on the average visibility context at that time.

#176 Page 4-2, Section 4.3: The impacts of topographic alteration and related scars will be unavoidable.

#177 Page 7-1: General Comment - As noted in our first comment on the DEIS, any alternative developed must contain measures to protect NWC's ability to perform its military mission as it exists at the time of development. The types of measures are described in the MOU and attendant constraints.

#178 Page 7-2, Paragraphs 3 and 6: NWC has indicated it does not concur with BLM's model requiring the use of groundwater for cooling water purposes. We also do not concur that Navy development of fee-acquired land will lower groundwater levels in Rose Valley as indicated in this paragraph.

#179 Appendix C: We simply note that this constraint package is in draft form at present and is subject to change prior to final adoption by both BLM and Navy.

Enclosure (1)

Response to Comments from
Department of the Navy, Naval Weapons Center

122 - The relative importance of an impact is most often in the eyes of the beholder. The destruction of a single archaeological site would be of major import to individuals concerned with cultural resources, whereas the lowering of the ground water table by as much as one foot in the Rose Valley could be of greater importance to individuals directly concerned with water availability. Wherever possible, we have quantified impacts and related them to such standards as may exist.

123 - The text has been changed to indicate that measures deemed necessary by NWC to avoid conflicts with the mission will be included in any alternative choosen.

124 - The Bureau of Land Management authority to lease geothermal resources on lands including public lands, DoD withdrawn lands and private lands is provided by the Geothermal Steam Act of 1970, P.L. 91-581 85 Stat. 1577, 30 U.S.C. Paragraph 1002 et. seq.

125 - Thank you for the comment. The text has been corrected.

126 - The NWC constraints package contained in Appendix C has been listed in Section 1.1.3.1, Applicable Regulations.

127 - Section 1.1.3.1 has been modified.

128 - Thank you for your expression of preference. The geothermal development model uses a moderate estimate stemming from USGS and other sources (see Appendix B).

129 - Additional cooling water is believed to be necessary because the geothermal reservoir is located within geologic substrata of low porosity and permeability. Good reservoir management practices to conserve the fluid indicate the need for reinjection. See also the response to comments 1 and 132.

130- The development scenario for zones 1 & 2 calls for 250 MW development prior to exploitation of the other zones. The remainder is assummed to be developed during the later development stages.

131 - Industry has indicated that directional drilling is more expensive but not prohibitive. Using common drill pads, sumps and roads cuts surface development costs considerably, partially offsetting the increased cost of actual drilling. The terrain within the Coso Geothermal Study Area is generally similar to that within the Geysers area. Although there are relatively level valleys, the bulk of the CGSA within the zones most likely to produce is of very high relief as is the case in The Geysers Area. See the CGSA map for topographic lines.

The multiple well pads were based upon the above considerations, are considered to be most likely to occur, but will not be required by stipulation in the leases. Where necessary for resource protection, multiple well pads will be required as stipulations stemming from the site-specific EA's on the Plans of Operations.

132 - The question of whether a geothermal plant will produce enough water from the condensers to adequately supply the cooling towers and abatement equipment cannot be definitively answered at this time. It is highly dependent on the thermodynamic efficiency of the plant which is a function of the steam temperature and of the condenser temperature. For the particular conditions described in the EIS, it is estimated that make-up water will be necessary. The statements

from the book referenced are ambigous. The statement that geothermal plants do not need a supplementary source of cooling water is to be found on page 211 in a section by R.G. Bowen on Environmental Impact of Geothermal Development; no supporting basis for the statement is given. On the other hand on page 169 in a section by J.H. Anderson it is stated that:

> "To compound the problem, many geothermal areas occur where there is an inadequate supply of cheap cooling water. Thus, one of the most serious problems in large-scale geothermal power development is cooling."

It should be noted that even in dry steam field stations require some make-up water. For example Unit 18 of the Geysers Field is projected to require up to 320 gallons per day (See "Final Environmental Impact Report for PG&E Geysers Unit 18" published by the California Energy Commission, P700-80-004).

133 - Thank you for noting the error. The correct drawing has been inserted into the text.

134 - If TSP standards are exceeded locally during field development, additional mitigation measures will be applied. The situation will be handled appropriately as it arises. As discussed in the first paragraph in Section 2.2.2.2, models do not provide exact predictions, and carry uncertainties of $\pm$ 50 percent. Air quality monitoring will be carried out as described in Appendix D.3 or as further refined at the time of implementation.

135 - The text has been modified to reflect your comment.

136 - The text has been modified to take such possibility into account.

137 - Thank you for your comment. The frequency of visits was noted in Section 2.12.1.13 and 2.12.2.12; an additional mention has been made in Section 2.3.2.

138 - Grading plans for construction are developed to minimize earth moving. This is standard engineering practice for both slope and soil stability, and economic incentives. The analysis requested is only possible on a site-specific basis.

139 - Known active faults were identified in Section 2.4.1.2 and referenced under the subheading, Faults. These are discussed in more detail in the Geology Technical Report and their locations are shown on Plates I-1 and I-2 of the report. Prior to building any structures in this area, a detailed structure and site-specific

engineering geologic study would be done. This would include detailed mapping of active faults for a specific site. Steps in engineering geologic analysis were included in an earlier version of the EIS but had been deleted to reduce the length of the EIS. The rationale for this was that an engineering geologic study, or active fault study, are fairly routine activities described and prescribed in guidelines published by the California Division of Mines and Geology and others. An additional mitigation measure has been added to prevent or reduce adverse impacts due to surface rupture.

140 - Subsidence due to fluid withdrawal in Rose Valley is discussed. Quantification is not possible at this time or until well data are available.

141 - The quantities of runoff discussed in the EIS are based on 100-year design storm. We appreciate the input from the NWC regarding their experience in this region.

142 - Thank you for your comment. The text has been changed for clarification.

143 - Thank you for your comment. The text has been changed for clarification.

144- The data requested is not, to the best of our knowledge available. However, potential sediment increases which would reach Fossil Falls should not be significantly more than the amount of sediment carried in 100-year storms currently.

145 - Thank you for your comment.

146 - Mitigation measures have been developed concerning soil removal (see Section 3.5). Detailed studies for quantification of soil removal may be performed prior to resource development.

147 - Section 2.7.1.2 (paragraph 2) was not intended to suggest that introduction of the bullfrog to Haiwee Spring would be a likely result of geothermal development, but rather to emphasize the vulnerability of the relict population of western toads at the spring. In fact, the accidental or purposeful introduction of exotic species at the spring as an indirect impact of the proposed action would not be surprising; the bullfrog was cited as an example. Historically, whenever human usage has increased in given area, hardy, aggressive exotics have tended to be introduced, causing elimination of some native species.

148 - Thank you for your comment. More detailed data are provided, in the form you suggest, in the various Field Ecology Technical Reports.

149 - Thank you; CGSA base maps have been clarified to show the Coso Hot Springs National Register Site as also being Navy fee-aquired land.

150 - Thank you for your comment.

151 - Thank you; our findings concur with your comment.

152 - The paragraph in question refers to studies by Vasek, Johnson and other concerning disturbed areas in general. A clarifying comment has now been added to Section 2.7.2.4. Our studies indicate that Bromus sp. may indeed be observed widely, in disturbed locations and also throughout the area; see Flora Technical Report, species lists. The appearance of Salsola sp. in disturbed areas is mentioned in Section 2.8.2.1.

153 - Larger originals (1:24,000) of the vegetation maps are available for viewing at the BLM District Office in Bakersfield.

154 - Thank you for your comment.

155 - Thank you for your comment; this information has been added to Section 2.8.2.2.

156 - Thank you for your comment; this information was noted in Section 2.7.2.4. Reference to that section has now been added to Section 2.8.2.4.

157 - It should be noted that there is virtually no vegetation at present in the immediate vicinity of Devil's Kitchen and the Nicol prospect. As noted, the habitat quality around Coso Hot Springs is also poor, in part due to soil chemistry. It is difficult to say whether the mercury in the soils at these locations results from man's activity in the area.

158 - Thank you for the comment. The text has been corrected.

159 - The impact discussion is general in nature by necessity since the level of impact will depend on the exact location of facilities as to the visibility and observability of the facilities. Impacts were derived through evaluation of typical developments in the most likely locations within the CGSA.

160 - The citation (NWC Ad Pub 200) has been added to all references to the Iroquois Report.

161 - The word "measures" should be substituted for "resources." The text has been corrected.

162 - Thank you for your comment; the text in Section 2.10.2.7 has been clarified.

163 - Thank you for your comment. It has been noted and incorporated in Section 2.11.1.

164 - The figure of 100 percent for military testing would indicate that no other land use is permitted, whereas multiple uses to exist within NWC, such as grazing, and natural and historic/cultural resources management. In response to your comment, however, Table 2.11.1-1 is being modified to show "greater than 50 percent" usage for military testing. The text of Section 2.11.1.2 seems consistent with such a designation.

165 - See response to Comment No. 6.

166 - In Section 2.11.1.2, paragraph 10, the phrase "and none within NWC" has been deleted and a clarifying statement added.

167 - The figure "900" should be deleted completely; the text has been corrected.

168 - As discussed in Section 3.9.1, all proposed mitigation of impacts to sites determined eligible to the National Register of Historic Places will be approved and implemented in consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation; and upon concurrence of the BLM and NWC on withdrawn lands. All mitigation measures will be in compliance with 36 CFR 800 (see response to Comments 3, 11, 18, 56, 57, 95 et al.).

The BLM has the responsibility of implementing the CRAS; however, the lessees will be requested to assist in the funding. The EIS has been reworded (Section 3.9.1) to clarify this. Lessees will be responsible for funding the identification and mitigation costs for impacts to cultural resources on the lands they propose to disturb in their approved Plans of Exploration, Operation, and Production.

169 - Thank you for the suggestion. A table summarizing the residual impacts has been prepared and inserted at Section 4.12.

170- It is our understanding that the National Park Service, or the appropriate Federal Land Manager, will have the responsibility for monitoring visibility. Insofar as the NWC is concerned the most appropriate monitoring location for visibility as it concerns the Naval mission would be on the China Lake range itself.

171 - The study recommended could be of some value in the future. It is our understanding that such study, if deemed necessary, could be required of powerplant licensees.

172 - Thank you for the suggestion. Lessees will be required to design baseline TSP studies. The standard procedure is to coordinate with the local Air Pollution Control District. See also Appendix D for a monitoring plan upon which the lessees may build as necessary.

173 - Suitable mitigation measures for geothermal power plants will be addressed in the power plant siting process. Mitigation of geologic hazards associated with geothermal well locations is addressed in GRO Order Nos. 2 and 3. This concern is addressed in

the industry by design features of the wells rather than locational mitigation. In addition, design features required by the NWC will cause the wells to be more secure. Topographic measures to reduce erosion, etc. will be addressed in the plan of operation approval process.

174 - The quantity of water which may be required has been calculated and is presented in Section 3.1. The relative impact is low.

175 - See response to Comment 172.

176 - Grading plans for construction are developed to minimize earthmoving. This is standard engineering practice for both slope and soil stability, and economical incentives.

177 - Thank you for the comment. The text has been corrected to include the information.

178- Thank you. As indicated above, this reflects a difference in the evaluation of the field and in the geothermal model developed.

179 - Comment accepted.

State of California THE RESOURCES AGENCY OF CALIFORNIA

Memorandum

To : Jim Burns
Assistant to the Secretary
Resources Agency

James B. Ruch, Director
Bureau of Land Management
2800 Cottage Way
Sacramento, CA 95825

Date : MAY 08 1980

Subject: Draft EIS for the Proposed Leasing Within the Coso KGRA
SCH Number: 80040216

From : Department of Conservation—Office of the Director

#180 We reviewed the subject document and found sections addressing the impact of the project on geology, hydrology, and soils to be adequately addressed. However, we are concerned that the potential of the geothermal resource zone at the Coso Hot Springs is very speculative as indicated several times in the Environmental Impact Statement (EIS). The proposed project appears to be based almost exclusively on observations from other fields and not on hard sub-surface data collected at the Coso fields. The only deep exploratory well at this field (CGEH number 1, 4,845 feet, TD) proved unsuccessful.

#181 In addition, the magnitudes of geophysical anomalies presented here are not well defined in relation to regional trends. Neither are individual magnitudes of each geophysical anomaly defined. Only "boundaries" of anomalies are presented (figure 2.4.1-2, p. 2-38). It would be instructive to see the above relationships in order to determine the significance of the anomalies. Also, how does one know that the low production encountered in exploratory well CGEH No. 1 is not due to the fact that there may be little or no fluids in the potential reservoir?

#182 We appreciate the expeditious manner in which BLM has prepared and processed the EIS. However, it is premature to proceed with the leasing program until exploratory geothermal data is obtained from the China Lake Naval Weapons Center's geothermal development program. The data should indicate whether an adequate resource is present. If the data is favorable, the bidding will reflect increased interest and commitment to explore the Coso area.

Priscilla C. Grew

Priscilla C. Grew
Director

Response to Comments from Resources Agency of California

180 - Thank you for your comment. The possibility of further study is being considered.

181 - The EIS is not intended to detail geophysical exploration at Coso. For this type of geophysical analysis, the commentor should refer to the Geology Technical Report and the references cited therein.

182 - Thank you for your expression of preference. It will be taken into consideration in the decision making process. The alternative actions discussed in Section 7 address this issue.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
SAN FRANCISCO REGIONAL OFFICE
450 GOLDEN GATE AVENUE, P.O. BOX 36003
SAN FRANCISCO, CALIFORNIA 94102

May 27, 1980

REGION IX
Office of Community Planning and Development

IN REPLY REFER TO:
9CE

District Manager
U.S. Department of the Interior
Bureau of Land Management
Bakersfield, California 93301

Dear Sir:

#183 HUD's Office of Indian Programs, Region IX, has reviewed the subject Draft EIS and recommends that the BLM and the China Lake Navel Weapons Center (NWC) reach satisfactory agreement with Native American Indians concerning access to the use of the COSO Hot Springs and Prayer Site. This agreement should be addressed in the Final EIS.

Sincerely,

Arthur Kontura

Arthur Kontura
Regional Environmental Clearance
Officer

AREA OFFICES
HONOLULU, HAWAII LOS ANGELES, CALIFORNIA SAN FRANCISCO, CALIFORNIA

183 - An agreement for access to the Coso Hot Springs and Prayer Site by Native American gruops has been developed between the NWC (surface managers) and the Native American groups, see Section 2.12.1.13 in the EIS. The BLM leasing program will not interfere with access.

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

Memorandum

To: District Manager, Bureau of Land Management
Bakersfield, California

Through: Assistant Secretary--Energy and Minerals

From: Director, Geological Survey

Subject: Review of draft environmental statement for proposed leasing within the Coso Known Geothermal Resource Area, Inyo County, California

We have reviewed the draft statement as requested in a letter from the State Director.

We suggest that consideration be given to preparation of supplements to the environmental statement as more information about the ground-water system becomes known, and we have several specific comments that are presented in the enclosure.

George H Davis
for H. William Menard

Enclosure

General Comment

#184 Because of the potential for impacts which can not be accurately evaluated at this stage in the development, we recommend the preparation of one or more supplements as additional information on the geothermal reservoir, the ground-water resources, and the interrelationships between the two become available. This approach would be similar to that proposed in the draft statement of the Navy Coso Geothermal Program (vol. 1, p. 7-8).

Specific Comments

#185 Page 1-16, sec. 1.3.5.2. Federal geothermal lessee exploratory well drilling is reviewed, regulated, monitored, and controlled by the U.S. Geological Survey. Normally, toxic additives are not permitted in drilling muds except for neutralization of produced effluents. Use of any toxic materials on Federal geothermal leases requires prior approval by the Survey' Area Geothermal Supervisor.

#186 Page 1-18, par. 2. Noncandensible gases may include carbon dioxide, hydrogen, carbon monoxide, methane, and hydrogen sulfide. If hydrogen sulfide is known or anticipated to be present so that measurable amounts may be emitted during drilling or testing, strict monitoring and safety measures and control equipment will be utilized to minimize the possibility of ejection of dangerous quantities.

#187 Page 1-18, sec. 1.3.5.2. Resevoir drainage and efficient bottomhole spacing are dependent upon various reservoir characteristics (permeability, porosity, fracture patterns, heat content, formation materials, structure, pressures, and temperatures). Determination of these parameters requires drilling of wells and producing geothermal resources. Based on past experience in other areas, one well should efficiently drain approximately 40 acres.

#188 Page 1-20, sec. 1.3.5.4. Experiments are currently underway in the California Imperial Valley, Utah, New Mexico, and other areas exploring the technical and economic feasibility of using binary systems (transferring heat from hot water to other expansible fluids through indirect heat exchange to generate electric power), single well downhole turbine generators, and cycling fluids through dry hot rock zones.

#189 Page 2-3. Figure 2.1.1-1 does not show the time period used to draw the isohyetal lines. More information is available in "Mean Annual Precipitation in the California Region" by Saul Rantz (USGS Basic Data Compilation 1020-01, 1969) which is more detailed and is based on a 50-year record.

#190 Page 2-56. The section on thickness of alluvial deposits needs some elaboration. There are two types of alluvial sediments in Rose Valley. There is a Quaternary and Pleistocene alluvium (Qal in text) with high permeability and the Coso Formation (Tc in text) with a low permeability. Wells drilled

#190 in the Qal have measured specific capacities that range between 4.5 and 13 gpd/ft dd depending upon depth and well construction. No wells have been tested in the Tc in Rose Valley but would probably be similar to wells drilled in the Pliocene Ricardo Formation in Indian Wells Valley (California Department of Water Resources Bulletin 91-9, p. 243, 1963). A well drilled in the Ricardo Formation has a specific capacity of .33 gpm/ft dd. In general, there are many basins that show this large difference in specific capacity between wells drilled in Qal and Tc.

#191 Page 2-57, Ground Water Movement. A recent USGS open-file Report 80-454 (The recharge area for the Coso, California, geothermal system deduced from SD and $S^{18}O$ in thermal and non-thermal waters in the region, by R. O. Fournier and J. M. Thompson) suggests that recharge is from the Sierra Nevada on the west.

#192 Pages 2-58, 2-59. The cross sections give the impression that the Rose Valley basin is composed of 5,000 feet of Qal, although the deepest wells with data are less than 1,000 feet deep. There may be Tertiary Coso Formation sediments beneath the Qal where well data is lacking.

#193 The north-south cross section should show the depth of wells similar to the east-west cross section for a better evaluation of the geologic data.

The shallow wells between the Devils's Kithchen and Coso Hot Springs should be added to the east-west cross section. These shallow wells have water levels about 1,000 feet higher in altitude than the water level in well CGEH-1. This shallow water may be a source of recharge to the geothermal resevoir tapped by CGEH-1. USGS Open-file Report 77-485 gives data on the shallow wells.

#194 Page 2-118, sec. 2.6.2.4. We recommend, in order to properly understand the distrubance factors of exploratory drilling that the number of drill pads be used in the text instead of the number of wells. Several wells can be drilled from one drill pad, unless the lessee proposed to drill only one well per pad.

#195 Page 2-190, Flood Control/Storm Drains. The Ridgecrest drainage system was inefficient during heavy rains which occurred a few years ago, resulting in substantial flooding. If the problem has not been remedied, future floods could pose a transportation problem in the city, especially if the population is increased by the project.

#196 Page 3-2, sec. 3.0. We suggest that reviewing agencies may not have regulatory authority and, therefore, may be unable to require implementation of proposed mitigation measures.

#197 Page 3-3, sec. 3.1. Where will the water be obtained to control road dust? How much water will be needed, and what impact will the removal of this water have on the source?

#198 Page 3-4, sec. 3.3.1. The report should describe what GRO Order #4 requires a lessee to do as mitigator. In addition, BLM should add additional stipulations if GRO Order #4 will not provide adequate protection.

#199 Page 3-5, sec. 3.4.1. Reference is made to maintaining the level of Little Lake by "feed" (overflow?) from wells north of the lake. Elsewhere it is indicated that Little Lake is fed by ground water from natural springs but that historically the lake level has been artificially maintained by ground-water pumping (p. 2-72). This situation should be more clearly explained to provide a basis for impact evaluation. Is the ground-water pumping deliberate and used in time of need, or does the lake regularly receive merely overflow and waste water from ground-water pumping and use? What is the meaning of mitigation measure "Artificial recharge or monitoring in Little Lake?" If geothermal development affects the water surface of Little Lake, other water must be used to maintain a permanent water level.

#200 Monitoring will be required to determine possible lowering of the water table. Therefore, the or should be changed to and.

#201 No hydrologic data are presented to support the statement that injection of geothermal fluids beneath the fresh water aquifer in Rose Valley would raise the water table. If this is a supposition, then it should be stated as one. It is just as possbile that injection of geothermal fluids into Rose Valley will do nothing to the water table.

#202 In the last paragraph of this section, mention is made of a monitoring plan being used to determine proper water level for Little Lake. Who will be making that determination? This is a very critical issue, especially in regard to the biological resources in and around the lake. We recommend that any water level determination be a joint one between the Geological Survey, the Fish and Wildlife Service, and the Bureau of Land Management.

#203 Page 4-5, sec. 4.6. The report makes a supposition that wildlife population will return to original levels after closeout and restoration. If geothermal exploration activities confirm the presence of a commercial geothermal reservoir and one or more power plants are constructed, power production could go on for an indefinite time.

#204 Page H-1. The definition of aquifer should be made more explicit and exact by the inclusion of the criterion that an aquifer is capable of yielding economically significant quantities of water to wells and springs.

#205 The glossary should include a definition of geothermal fluid and a definition of groung water. A distinction is suggested in the text (e.g., p. 2-72); and one of the principal needs for impact analysis involves this distinction and the possible interrelationships of the two types of fluid.

184 - Thank you for your comment. There is a possibility that such supplements to the EIS could be prepared as more information becomes available. These supplements could be prepared by USGS in the lease administration stage as well as by BLM. Decisions and budget commitments would have to be made as the need arises.

185 - USGS regulatory authority in regard to geothermal well drilling has been noted.

186 - Thank you for the comment.

187 - Thank you for your comment.

188 - Thank you for the comment.

189 - Thank you for the comment.

190 - Thank you for your comment. The additional information has been added to the text.

191 - A report was prepared to determine the effects that Dr. Robert Fournier's isotope study would have on the hydrology analyses in the Coso Environmental Impact Statement. This report concluded that Dr. Fournier's findings would not affect the recharge estimates for Rose Valley, nor could it help quantify the amount of recharge to the geothermal reservoir. The study still leaves the recharge source for the geothermal reservoir ambiguous.

192 - Thank you for your comment. The additional information has been added to the text.

193 - Thank you for the comment. The additional information has been added to the text.

194 - Section 2.7.2.4, Wildlife Impacts, discusses disturbance in terms of the acreage required for drill pads. A reference to the specific section has been added to Section 2.8.2.4. Thank you for your comment.

195 - Thank you for the information. See also Section 2.12.2.13, which refers to the limited infrastructure capacity in Indian Wells Valley and Ridgecrest.

196 - Thank you for the comment, the text has been changed to reflect the comment.

197 - It is anticipated that water to control dust would be obtained in Rose Valley. An estimate of the amount of water which might be used has been added at Section 3.1.

198 - Section 8 of GRO No. 4 discusses mitigation measures a lessee must consider with respect to geologic impact. Section 8 is cited below for review:

"Subsidence and Seismicity. Surveying of the land surface prior to and during geothermal resources production will be required for determining any changes in elevation of the leasted lands. Lessees shall make such resurveys as required by the Supervisor to ascertain if subsidence is occurring. Production data, pressures, reinjection rates, and volumes shall be accurately recorded and filed monthly with the Supervisor as provided in 30 CFR 270.37. In the event subsidence activity results from the production of geothermal resources, as determined by surveys by the lessee or a governmental body, the lessee shall take such mitigating actions as are required by the lease terms and by the Supervisor.

"If subsidence is determined by the Supervisor to present a significant hazard to operations or adjoining land use, then the Supervisor may require remedial action including, but not limited to, reduced production rates, increased injection of waste or ther fluids, or a suspension of production.

"A. Surveys. All required surveys shall be second order or better and shall be conducted under the direct supervision of a registered civil engineer or licensed land surveyor using equipment acceptable by the National Ocean Survey for second order surveys. All such work shall be coordinated with the county surveyor of the county in which the surveys and benchmarks are to be established. Level lines and networks shall be tied to the available regional networks.

"Adjusted survey data shall be filed with the supervisor within 60 days after leveling is completed. Any lessee having a commercially productive geothermal well or wells shall participate in cooperative County/State subsidence detection programs. All survey data filed with the Supervisor shall be available to the public.

"B. Bench Marks. One or more wellsite bench marks shall be required at each completed well prior to prolonged production and said bench marks shall be located in a manner such that there is a minimal probability of destruction or damage to said bench marks. Wellsite bench marks shall be tied to existing regional networks. Additional bench marks between the wellsites and the regional network shall be at 0.8-km (one-half mile) intervals or as otherwise specified by the Supervisor. These bench marks shall be resurveyed during well production operations on a periodic basis as determined by the Supervisor.

"Acceptable bench marks include, but are not limited to, a brass rod driven to refusal or 9 metres (about 30 feet) and fitted with an acceptable brass plate or a permanent structure with an installed acceptable brass plate.

"C. Reservoir Data. Initial reservoir pressure and temperature shall be reported to the Supervisor in duplicate on Well Completion or Recompletion Report (Form 9-330C) for all completed wells within 30 days after the completion of measurements or tests conducted for the purpose of obtaining such data. Initial production test data including steamwater ratio, surface pressure and temperature, quality and quantity of well effluent shall also be filed with the Supervisor on Form 9-330C within 30 days after a well is completed.

"D. Seismicity. The installation of seismographs or other like instruments in producing geothermal areas for the purpose of detecting potential seismic activity may be initiated from time to time by appropriate public agencies. Lessees shall cooperate ith the appropriate public agencies in this regard. The lessee and the appropriate public agency should take care not to unreasonably intefere with or endanger each other's respective operations. The Supervisor shall coordinate such detection programs between the appropriate public agency conducting the program and the lessee.

"Where induced seismicity caused by the production of geothermal fluids is determined to exist by the Supervisor, then the Supervisor may require the lessee to install such monitoring devices as necessary to adequately quantify the effects thereof. If induced seismicity is determined to represent a significant hazard, the Supervisor may required remedial actions inluding, but not limited to, reduced production rates, increased injection of waste or other fluids, or suspension of production."

199 - Levels in Little Lake have been maintained artificially through pumping, by the Little Lake Hunt Club, to maintain water levels for water fowl. The mitigation measure which discusses "Artifical Recharge" refers to continuing the current pumping intermittently which maintains lake levels when lowered. Since little historical data can be found on flucuations of water levels in the lake, a monitoring program would help to establish the natural level variations. Therefore, any effect of geothermal development in the CGSA can be measured.

200 - Thank you for your comment. The text has been corrected.

201 - Thank you for the comment. The statement that injection of geothermal fluids beneath the fresh water aquifer in Rose Valley would raise the water table, is indeed a supposition based upon industry's previous experience. Verification of this theory, specific to the Coso and Rose Valley area, will require detailed research.

202 - The proper level for Little Lake will be determined jointly by the BLM, CDFG, USFWS, USGS, Lahotan Water Quality Control Board, LADWP, and Inyo County. The text has been changed to include this addition.

203 - A percentage of the wildlife population will return during commercial geothermal production, as has been seen in the Geysers KGRA. Estimates of Coso KGRA field life are 30 years. Estimates of wildlife population cannot realisticly be projected for an indefinite geothermal field life.

204 - Aquifer - A permeable material through which ground water moves. A water bearing formation, commonly used in reference to a formation that is capable of yielding economically significant quantities of ground water.

205 - Ground water - Subsurface water, especially that contained in a saturated zone or aquifer, including underground streams.

Geothermal Fluid - Subsurface water and/or steam heated by internal process within the earth.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
630 Sansome Street
San Francisco, California 94111

1950
May 22, 1980

Ms. Janet Bowles
District Manager
Bureau of Land Management
Bakersfield, Ca. 93301

Dear Ms. Bowles:

We have received the draft environmental impact statement for the Proposed Leasing within the COSO Known Geothermal Resource Area in Inyo County, California, and the supporting Air Quality Technical Report (AQTR) by Rockwell International.

We request the opportunity to review and comment on any further environmental documents prepared for the developmental and/or operational phases of the program. Our concern is focused on air quality in the vicinity of the Domelands Wilderness on the Sequoia National Forest. The Domelands Wilderness is a Class I air quality area (as defined by the Clean Air Act as amended August 7, 1977). This area may be influenced by the Coso development.

#206 Visibility is a major concern for nearly all Class I wilderness areas, including Domeland. Because of the ridge which separates the Domeland from the Owens Valley/China Lake area, there are no significant vistas to or from this wilderness which are likely to be affected by the Coso project.

Another consideration is the Clean Air Act's requirement for Prevention of Significant Deterioration (PSD) of air quality. Very limited increases in SO_2 and Total Suspended Particulates (TSP) are allowed in Class I areas under the PSD provisions. The levels of both of these pollutants will certainly rise in the vicinity of the geothermal development. However, we concur with the AQTR's conclusion on page 5 - 46 that the overall meteorology and topography will preclude any significant increase in SO_2 or TSP in the Domeland area.

We support Rockwell's recommendations for a monitoring system to check whether actual particulate and gaseous emissions are within the levels predicted by the RAMR dispersion model. A periodic report of the monitoring results and how they correlate with predicted values will be of interest to us when such a system becomes operational.

6200-11 (1/69)

The opportunity to comment on this proposed project is appreciated. We are grateful for the cooperation and timely information provided us by you. Please forward a copy of the final environmental impact report to the Forest Supervisors of the Inyo and Sequoia National Forests, as well as to me.

Sincerely,

for John Chaffin

ZANE G. SMITH, JR.
Regional Forester

Response to Comments from the U.S. Department of Agriculture

206 - Thank you for your comments. Periodic reports of the air quality monitoring results will be forwarded to the Sequoia and Inyo National Forests and to the Regional Office.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
SAN FRANCISCO REGIONAL OFFICE
450 GOLDEN GATE AVENUE, P.O. BOX 36003
SAN FRANCISCO, CALIFORNIA 94102

May 27, 1980

REGION IX
Office of Community Planning and Development

IN REPLY REFER TO:
9CE

District Manager
U.S. Department of the Interior
Bureau of Land Management
Bakersfield, California 93301

Dear Sir:

#207 HUD's Office of Indian Programs, Region IX, has reviewed the subject Draft EIS and recommends that the BLM and the China Lake Navel Weapons Center (NWC) reach satisfactory agreement with Native American Indians concerning access to the use of the COSO Hot Springs and Prayer Site. This agreement should be addressed in the Final EIS.

Sincerely,

Arthur Kontura
Regional Environmental Clearance
Officer

AREA OFFICES
HONOLULU, HAWAII LOS ANGELES, CALIFORNIA SAN FRANCISCO, CALIFORNIA

Response to Comments from the Department of Housing and Urban Development, San Francisco Regional Office, Office of Community Planning and Development

207 - The BLM geothermal leasing program will not interfere with the use of the Coso Hot Springs and Prayer Site by the Native Americans. The access by the Native Americans to these areas is a policy matter between the NWC and Native Americans. The NWC has been closed to free access by all members of the public since 1947. See also responses to Comment No. 56.

STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY EDMUND G. BROWN JR., Governor

DEPARTMENT OF TRANSPORTATION
500 SOUTH MAIN
P. O. BOX 847
BISHOP, CALIFORNIA 93514
(714) 873-8411

Date: April 30, 1980

File: Inter-Agency Doc. Review

Bureau of Land Management
State Office
Federal Office Building
2800 Cottage Way
Sacramento, CA 95825

Re: Proposed Leasing within the Coso known Geothermal Resource Area

We have reviewed the above-referenced document and have the following comments.

( ) We have no comments.

( ) CALTRANS is not a Responsible Agency.

(✓) CALTRANS is a Responsible Agency pursuant to the California Environmental Quality Act, since Encroachment Permits will be required to install driveways, utilities, or other facilities within the right of way for State Highway Route 395. As a Responsible Agency, CALTRANS will rely on the Lead Agency's environmental document for CEQA clearance of any such Encroachment Permits.

( ) In accordance with Section 15161.5(2) of the State Environmental Impact Report Guidelines, the environmental document should be submitted to the State Clearinghouse for review by State agencies.

( ) The environmental document appears to be adequate with respect to any areas of concern where CALTRANS has jurisdiction by law or has special expertise.

(✓) See attached sheet for additional comments.

James C. Jelinek

James C. Jelinek
CALTRANS District 09
Environmental Planning Unit

NR:cam

STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY EDMUND G. BROWN JR., Governor

DEPARTMENT OF TRANSPORTATION
500 SOUTH MAIN
P. O. BOX 847
BISHOP, CALIFORNIA 93514
(714) 873-8411

ATTACHMENT

RE: Coso Geothermal Resource Area

Comments: D. Oldenburg - Environmental Testing Engineer
J. Edell - Environmental Planner (Natural Sciences)

We have reviewed the Draft Environmental Impact Statement for the Coso Geothermal Resource Area, and offer the following comments:

AIR QUALITY

#208 On Page 2-13, Table 2.2.1-1, it would appear that the various constituents should be reported with the same comparative values, instead of ppm, pphm, and ppb. Also if CO was monitored, it should be included in the table. The column "Average Concentration" should be written "Average Hourly Concentration".

#209 On Page 2-15, Table 2.2.1-2, the emission rates for Route 395 seem high. A Caltrans report for a 1.3 mile passing lane project at Dunmovin calculated 0.077 Tons/day CO emissions predicted in 1977. This is approximately 28 Tons/year for 1.3 miles. If 10 miles of Route 395 traverse through the KGRA, then $\frac{28}{1.3} = \frac{215}{10}$, or 215 Tons/year of CO for 10 miles of Route 395. The table should specify what year the predictions are made for and by what methods were the emission rates calculated.

#210 On Page 2-17, Table 2.2.2-1, it should be pointed out that the vehicle exhaust emissions from Route 395 would be averaging 5$\pm$ miles distance from the construction and operation sites, therefore allowing for a wide dispersal of air pollutant emissions. It would be difficult to conceive that the combined emissions in Tons/year would have much impact considering wind dispersal as well as distances involved. Also, for what year(s) is the prediction being made?

#211 On Page 2-18, Table 2.2.2-2, the air pollutant concentrations are not clear. What are the "micrograms per cubic meter" averaging time frames? i.e., per hour, per 8 hour, 12 hour, 24 hour or per year? Currently the National Standards for CO are, 10 mg/m^3 for 8 hour average and 40 mg/m^3, (40,000 $\mu g/m^3$) for one hour, and the State Standard is 11 mg/m^3 for 12 hour average and 46 mg/m^3 (46,000 $\mu g/m^3$) for one hour. If "Oxides of Nitrogen" means Nitrogen Dioxide then the Federal Standards are 100 $\mu g/m^3$ average annual and State Standards are 470 $\mu g/m^3$ for one hour. No figure is given for on site "Oxides of Nitrogen" found in the Coso area. "Oxides of Sulfur" or Sulfur Dioxide Federal Standards are 80 $\mu g/m^3$ annual average and 365 $\mu g/m^3$ for a 24 hour average, and State Standards are 131 $\mu g/m^3$ for 24 hours and 1310 $\mu g/m^3$ for 1 hour.

ENERGY

#212 It seems like the report should include an in-depth discussion of the energy trade-offs relative to how much energy will be produced compared to how much energy must now be imported to the area. Also, future uses of energy produced and how this energy would replace fossil fuel energy. A comparison of energy consumption for construction and operation should also be discussed. The energy production and consumption aspect is the very central focal point of this particular project which would directly affect the environment in so many ways.

WILDLIFE

#213 The loss of 2260 acres of wildlife habitat will be considerable and almost impossible to mitigate. I think you are doing everything you can and the monitoring should provide information that will be useful to many agencies. One thing might be worth further thought - In Section 2.6, Page 3-9, construction will be avoided between March and June to protect nesting raptors. This would lead to construction during most of the time that the Mohave Groundsquirrel is underground (August to March). It is the population, of course, not specimens that is important but maybe some of the critters could escape construction equipment in use while they are active.

208 - The column heading has been changed to reflect that these are hourly readings. To the best of our knowledge carbon monoxide was not monitored. The units employed are those most suited for the species in question. The concentration values between species are not comparable.

209 - Emission rates were calculated using 1978 vehicle counts and emission factors from EPA Publication AP-42.

210 - The table was included to show the relative impact of the proposed action on a regional scale. It is a well accepted fact that automotive emissions are precursors to air pollutants which must be treated on a regional basis (ozone and NO_x).

211 - Thank you. No oxides of nitrogen (taken as NO_2) due to the geothermal facilities are anticipated. The errors noted have been changed in the table.

212 - The question of energy import/export was not addressed as it is assummed that the geothermal energy would be utilized in the overall service net of the various utilities which would generate the power. Even in a non-growth economic situation any energy produced would lessen the fossil fuel requirements of the utilities.

213 - Thank you for your comment. The avoidance of construction in spring months to protect nesting raptors will only affect limited portions of the CGSA (see Figure 2.7.2-1); only a few of these are within or near areas of high geothermal potential. Fortunately the Mohave Ground Squirrel is abundant in other areas as well.

Resources Building
1416 Ninth Street
95814

(916) 445-5656

Department of Conservation
Department of Fish and Game
Department of Forestry
Department of Boating and Waterways
Department of Parks and Recreation
Department of Water Resources

EDMUND G. BROWN JR.
GOVERNOR OF
CALIFORNIA

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

To	Initial	Date
2 SD		
Ret 1 ASD		
MS		
4 RES		
3 TS		5-29
PA		
POS		
DES		
EEO		

Action by 3/4
Surname by
Return to

Air Resources Board
California Coastal Commission
California Conservation Corps
Colorado River Board
Energy Resources Conservation and Development Commission
Regional Water Quality Control Boards
San Francisco Bay Conservation and Development Commission
Solid Waste Management Board
State Coastal Conservancy
State Lands Commission
State Reclamation Board
State Water Resources Control Board

Mr. James B. Ruch
State Director
Department of Interior
Bureau of Land Management
2800 Cottage Way
Sacramento, CA 95825

1980 MAY 16

Dear Mr. Ruch:

The State of California has reviewed the report, Proposed Leasing Within the COSO Known Geothermal Area, submitted through the Office of Planning and Research in the Governor's Office.

The State review, in accordance with the requirements of Part II of Office of Management and Budget Circular A-95 and the National Environmental Policy Act of 1969, was coordinated with the Departments of Conservation, Fish and Game, Parks and Recreation, Water Resources, and Health; the Air Resources, Solid Waste Management, and State Water Resources Control Boards; and the Energy, Public Utilities, and State Lands Commissions.

DEPARTMENT OF FISH AND GAME

#214 DFG comments that the report does not provide sufficient assurances that the level of Little Lake or other critically important desert water sources (such as springs and seeps) would be maintained. The report does not consider the value of these springs and seeps to wildlife, nor mitigative actions to maintain that value.

#215 DFG recommends that BLM consider, as a minimum project requirement, doing a complete survey and documentation of all wildlife watering sources and establishing a program to monitor them periodically for project-induced changes. If adverse changes occur, the project should replace those sources with piped water or other artificial recharge methods.

#216 Little Lake is of considerable importance as habitat for waterfowl and marsh-associated birds and mammals. In addition, DFG has recently purchased several ponds on adjoining property for use as a native fishes sanctuary. The Owens pupfish (Federally classified as endangered) will soon be reintroduced there.

#217 The monitoring program should provide for frequent reports to appropriate agencies, including DFG, so that any necessary mitigation can be implemented before the ecosystems are damaged.

#218 Although the report mentions some expected impacts of the influx of 1,500 persons during project construction, it does not mention their impact on the area's wildlife habitat or fish and wildlife resources. Construction workers often live in trailers when they move into a project area; they often select trailer sites which adversely affect the environment. Impacts on birds, reptiles, and mammals frequently are significant, particularly in close proximity to the residences. Such wildlife losses are unacceptable, and since DFG considers them project-induced, they require mitigation. Adequate mitigation of this problem should require that: (1) All short-term, construction-phase employees must live either in existing housing or in a "company" established and controlled housing facility at a site selected to avoid substantial adverse impacts to wildlife resources and habitat, and (2) the project will provide for the hiring of additional appropriate patrol personnel to control hunting on lands under military jurisdiction.

#219 DFG would also like to meet with the U.S. Bureau of Land Management to discuss and agree on the monitoring program, the reporting schedule, and appropriate mitigation if water lowering is detected in Little Lake or any springs or seeps in the project area.

DEPARTMENT OF CONSERVATION

#220 The Department finds that the report adequately addresses the project's impact on geology, hydrology, and soils. However, the potential of the geothermal resource zone at the Coso Hot Springs is speculative, as indicated several times in the report. The proposed project appears to be based almost exclusively on observations from other fields and not on hard subsurface data collected at the Coso Fields. The only deep exploratory well at this field (CGEH number 1, 4845 feet, TD) proved unsuccessful.

#221 In addition, the report does not adequately define either the individual magnitudes of each geophysical anomaly or how these relate to regional trends. Only "boundaries" of anomalies are presented (figure 2.4.1-2, pg. 2-38). It would be instructive to see the above relationships in order to determine the significance of the anomalies. Also, how does one know that the low production encountered in exploratory well CGEH No. 1 is not due to the fact that there may be little or no fluids in the potential reservoir?

#222 The Department appreciates the expeditious manner in which BLM has prepared and processed the report. It is premature, however, to proceed with the leasing program until exploratory geothermal data is obtained from the China Lake Naval Weapons Center's geothermal development program. The data should indicate whether an adequate resource is present. If it is, the bidding will reflect increased interest and commitment to explore the Coso area.

STATE WATER RESOURCES CONTROL BOARD

#223 The report indicates that there is insufficient technical data to determine if there is a hydraulic barrier separating the groundwater of the Rose Valley basin from the geothermal reservoir in the Coso Range. The Board believes that this question should be adequately answered before any geothermal program begins. If no hydraulic barrier exists, groundwater degradation is likely in Rose Valley. Chemical analyses of groundwater samples from the east side of the basin could provide insight for answering this question.

#224 Reinjection of spent geothermal fluid beneath or at the bottom of the freshwater aquifer in Rose Valley is a mitigation measure discussed in Section 3.4.1 of the report. This measure may degrade the existing groundwater quality. The high groundwater pumping rates proposed for Rose Valley will create pressure gradients within the groundwater basin which could lead to geothermal fluids being drawn into the good quality groundwater. Decreasing the quantity of good quality water decreases the ability to maintain a hydrostatic equilibrium between the geothermal fluid and "freshwater". In addition, any leakage from a reinjection well would lead directly to water quality degradation.

#225 Section 3.4.2, Item GRO No. 4, which states that pits and sumps will be lined with impervious materials, should indicate that this will be required only in those areas where there is a possibility of contamination of surface or groundwater containing less than 10,000 mg/l total dissolved solids.

#226 Section 3.4.2, Item GRO No. 6, should add the following to conform to California regulations: "D. Not be operated in excess of 75 percent of hydrofracture pressure as tested with freshwater."

#227 The final report should indicate that wastewater from the China Lake Weapons Center or the City of Ridgecrest could be an alternative source of cooling water to reduce groundwater pumping in Rose Valley.

Sincerely,

James W Burns

JAMES W. BURNS
Assistant Secretary for Resources

cc: Office of Planning and Research
1400 Tenth Street
Sacramento, CA 95814
(SCH 80040216)

214 - A complete hydrological survey was performed in the course of preparing the EIS (see Appendix B Section B.2.1.1). A Hydrology Monitoring Plan has been prepared (Appendix D), which includes monitoring Little Lake, Coso Hot Springs, and "all accessible surface and ground water features" (Appendix D.4, Section 2, Page D-21), including regular, ongoing monitoring of "selected natural, cool springs and wells that may be affected by lowering water levels in Rose Valley" (ibid., Page D-22). Additional mention of springs and seeps, and their importance to wildlife, has been included in Section 2.7.1.1. Specific mention of these water sources and their maintenance has been added in the chapter on mitigation, Sections 3.4 and 3.6.

215 - Please see response to Comment 214.

216 - Thank you for the information; it has been added to Section 2.11.1.3.

217 - Periodic reports of all monitoring activities will be furnished to USGS who will provide copies to Federal, state and local agencies, including CDFG.

218 - No residency by workers will be allowed within the NWC. No residency will be allowed on BLM administered land without appropriate application and specific environmental assessment procedures. It is more likely that private land within the Rose Valley region would be used for occupancy.

The NWC patrol force would be able to handle additional patrols necessary to control hunting. NWC policy will not allow geothermal development employees to spend time on the NWC other than that needed for ingress, egress, and work. Consequently, casual hunting should not be a problem.

219 - A meeting between CDFG and BLM personnel to discuss the monitoring program is an excellent suggestion and is being carried out in August 1980.

220 - See responses to comments 180-182.

221 - See response to comments 180-182.

222 - See response to comments 180-182.

223 - Thank you for your expression of preference. It will be considered in the decision making process.

224 - The reinjection of spent geothermal fluid would be implemented only after the recommended study had been completed and only if it is shown that it will have a beneficial impact.

225 - Thank you for your comment. The additional information has been added to the text.

226 - Thank you for your comment. The additional information has been added to the text.

227 - Thank you for your comment. Although use of wastewater is not precluded it was not considered based on economic considerations for construction of a pipeline of the required length.

STATE OF CALIFORNIA—THE RESOURCES AGENCY EDMUND G. BROWN JR., Governor

DEPARTMENT OF PARKS AND RECREATION
P.O. BOX 2390
SACRAMENTO 95811

May 30, 1980

Mr. Louis A. Boll, District Manager
U.S. Bureau of Land Management
800 Truxtun Avenue
Room 302
Bakersfield, CA 93301

RE: Draft EIS- Proposed Leasing within the Coso Known Geothermal Resources Area

Dear Mr. Boll:

My staff has reviewed the Draft Environmental Impact Statement for Proposed Leasing within the Coso Known Geothermal Resource Area and we have the following comments.

#228 The BLM's geothermal leasing program in the Coso KGRA must meet the requirements of the National Historic Preservation Act of 1966 and Executive Order 11593. The cultural resources study (Cultural Resources Technical Report) which was undertaken for this project constitutes your Agency's initial compliance with 36 CFR Part 800.

The BLM's responsibilities for this project under the historic preservation laws were discussed in a meeting between my staff and representatives of your Agency on May 20-21, 1980 in Bakersfield. It was agreed that the BLM would prepare and submit a Request for Determination of National Register Eligibility for the identified cultural resources within the project area.

In lieu of detailed resource evaluations and impact analyses, it was also determined that implementation of the leasing program could have an adverse effect on properties eligible for inclusion in the National Register of Historic Places. Hence, the BLM will prepare a Preliminary Case Report for a Memorandum of Agreement with this Office and the Advisory Council On Historic Preservation.

Considering the Draft EIS, I offer the following specific comments (based on our May 20-21 consultation):

#229 The proposal to develop a thematic nomination of the Coso KGRA archeological sites to the National Register may be inappropriate. I recommend that we explore the feasibility of a discontiguous archeological district for these sites.

#230 The proposed "Mitigative Measures" (Section 3.9.2) includes an extensive plan for additional site reconnaissance (the Cultural Resources Assessment Strategy). I submit that this procedure constitutes a cultural resource

Mr. Louis A. Boll
May 30, 1980
Page 2

survey and not an impact mitigation measure.

#231 It is stated that cultural resource sites yet to be discovered will be evaluated by the SHPO in order to develop and implement mitigation measures. This procedure must be expanded to include a provision for determinations of National Register eligibility for newly discovered sites, prior to developing mitigation measures.

#232 As my staff has recommended, the proposed Cultural Resources Assessment Strategy (CRAS) should be modified to exclude the reconnaissance of eight transects and include a detailed data recordation and recovery plan for selected (representative) archeological sites.

#233 The assumption that on the basis of the results from the CRAS it should be possible to avoid further data recovery on certain site types must be clarified. Data recovery tasks such as mapping and collection of interpretive specimens should always be considered.

#234 There is also a need for ethnographic work to be accomplished in the Coso study area. This task would assist the identification of socio cultural values within the study area, as well as aid the understanding of cultural resources found in the area. Native Americans should be consulted
#235 to determine their feelings regarding data recovery (excavation) on archeological sites. Those sections in the Draft EIS addressing Native American values (i.e. socio economics, noise, etc.) should also be cross referenced
#236 in the cultural resources section. Finally, it should be explained how the BLM's program to protect or mitigate the impacts to Native American values will be coordinated with the Navy's program.

Again, we appreciated the opportunity to meet with your staff to discuss the proposed Coso KGRA leasing program. Should you require any further assistance, please do not hesitate to contact Jeffery Bingham, Staff Archeologist, at (916) 322-8701.

Sincerely,

Marion Mitchell-Wilson for

Dr. Knox Mellon
State Historic Preservation Officer
Office of Historic Preservation

cc: Mr. William Olsen
BLM

Mr. Jim Burns
State Resources Agency

228 - The Preliminary Case Report for a Memorandum of Agreement with the State Historic Preservation office and the Advisory Council on Historic Preservation is being completed; and close communication with your office is being maintained. Thank you for your letter, which is acknowledged as an outline of our compliance.

229 - The BLM has determined, in consultation with the SHPO and the Keeper of the National Register's staff, that a discontiguous archaeological district is preferable to a thematic district for the cultural resource sites in the CGSA. The Bureau is pursuing a discontiguous nomination.

230 - Section 3.9 is being extensively revised to specify a sample of the lithic components of various site types (primarily lithic scatters). The revised Cultural Resources Assessment Strategy (CRAS) proposes to surface collect and test excavate (as appropriate) representative samples of 15 selected cultural resource sites which appear to represent the full range of lithic sites in the CGSA. The primary objective of the CRAS will be to establish evaluation criteria to determine National Register eligibility and potential data yield of lithic scatters and the lithic components of quarry sites, rock shelters, and temporary campsites. These site types, both known and yet to be discovered, then may be evaluated in terms of National Register eligibility criteria, minimal data collection and analysis at selected cultural resource sites in the CGSA. In that way, site avoidance and mitigation, as appropriate, can then be developed and implemented in accordance with historic preservation mandates.

231 - Please see response to Comment 230.

232 - Please see response to Comment 230.

233 - The revised Section 3.9 will state that "it is possible that sufficient data from similar sites and/or site types within the CGSA have been previously recorded and studied, therefore, site recordation, mapping, and minimal data collection may be the only necessary mitigation" at lithic sites yet to be discovered. Thus, mapping and collection of interpretive specimens will be considered by the BLM, in consultation with the SHPO and the Advisory Council on Historic Preservation, on a site-specific basis.

234 - One objective of the revised Cultural Resources Assessment Strategy in Section 3.9 will be to define the relative importance of the CGSA, specifically Sugarloaf Mountain, to the local and regional lithic technology and exchange systems, based upon comparative literature studies and, if appropriate, ethnohistoric research. Ethnohistoric research would be conducted on a limited scale, in order to obtain the most data from a small number of knowledgeable Native American informants; this data would then be directly incorporated into the research in order to help answer the questions posed in the Cultural Resources Assessment Strategy.

In accordance with our Memorandum of Understanding with the Native Americans (see Appendix C-4), the BLM will solicit the opinions of the Native American community concerning proposed excavations in the CGSA. Their wishes will be followed whenever possible.

235 - The discussions of Native American concerns have now been cross-referenced in the FEIS sections on cultural resources.

236 - The BLM will coordinate the monitoring of Coso Hot Springs with the NWC. Coordination for completing and implimenting the Memorandum of Aggreement will be required to ensure that the respective agency responsibilities are defined. Initial evaluation and protection or mitigation measures for cultural resources will be primarily a BLM responsibility.

State of California | The Resources Agency of California

Memorandum

To : Mr. James Burns
Assistant Secretary
Resources Agency

District Manager
Bureau of Land Management
Bakersfield, CA 93301

Date: June 11, 1980

Telephone: ATSS ( )
( ) 920-6103

RECEIVED JUN 1980 U.S. DEPT. INTERIOR BUREAU LAND MGMNT. BAKERSFIELD, CALIF.

From : California Energy Commission - John L. Geesman
1111 Howe Avenue Executive Director
Sacramento, 95525

Subject: DRAFT EIS FOR PROPOSED LEASING WITHIN THE COSO KNOWN GEOTHERMAL RESOURCE AREA

Introduction

The U.S. Bureau of Land Management (BLM) proposes to offer geothermal leases in portions of the Coso Geothermal Study Area (CGSA), which covers 72,640 acres of the Coso Known Geothermal Resources Area (KGRA). The geothermal resources of the area are not well characterized at present. Although the Department of Energy has drilled one test well, to date the well has not been successfully flow tested and sufficient information is not available to properly describe the geothermal reservoir.

BLM's Draft Environmental Impact Statement (EIS) assesses the potential cumulative effects resulting from full field development of the proposed Coso leasehold. This estimate is based on an assumed geothermal potential of 600 MW within the study area developed as twelve 50 MW generating stations. As required by Section 150.22 of the Council on Environmental Quality Regulations, BLM has indicated that gaps exist in relevant information needed to describe the geothermal resource, and that scientific uncertainty regarding the impacts of the project exist.

CEC Staff Review and Comment

The staff of the California Energy Commission (CEC) has reviewed BLM's Draft EIS and has developed comments that consider Commission policy as it relates to the proposed project, and the technical areas covered in the Draft EIS.

Policy Considerations

The CEC's preferred energy supply scenario, as described in its 1979 Biennial Report, emphasizes geothermal energy resource production. Where environmental standards are met, and identified impacts are mitigable, the CEC will continue to certify the maximum number of geothermal sites available.

With respect to BLM's proposed project, the Commission is concerned with: (1) the pace of exploration required of the leaseholders by BLM; (2) the timing of the lease sales; and (3) the promotion of direct heat applications as a viable alternative to electric power generation.

The Commission wishes to assure maximum diligence in the exploration for and development of geothermal resources. In support of this policy, BLM's proposed geothermal lease sale is an important step towards the development of energy resources in the Coso KGRA. However, to further expedite resource development, it is recommended that BLM require that lease holders perform
#237 exploratory drilling (deep well drilling) on the leaseholds within three years from the lease's commencement, as is currently required in State geothermal leases.

The California Energy Company is currently conducting drilling operations on U.S. Navy-owned lands (not available for lease) within the Coso KGRA to provide electrical power to the Navy. The Commission would like to see the drilling activities of the California Energy Company remain on schedule so that the success of their drilling operations will encourage additional interest in BLS's scheduled lease sale and promote further exploratory activity.

As part of its policy of promoting the diligent development of available geothermal resources within the State, the CEC encourages the development and application of alternative technologies such as direct heat applications of geothermal energy. Direct heat applications of the geothermal resource should be considered in the EIS as an alternative or adjunct to the proposed electric
#238 generation action. Depending on the nature of the geothermal resource and the economics of direct heat applications, this alternative may be preferable in certain areas of the CGSA. Given the lack of data on resource characteristics, it is premature to exclude consideration of space heating, food processing, agriculture and other direct heat applications. Impacts associated with direct heat applications would differ significantly from those occurring from the electric power scenario. The EIS should determine and assess these potential impacts.

Technical Comments

The CEC staff's review of the Draft EIS has produced the following comments:

Geology

1. The failure of project structures due to the occurrence of geologic hazards may have adverse effects on the surrounding environment. Steam and/or hot water released from broken well pads, casings or transport pipelines may degrade air quality and increase soil erosion. No discussion of geologic hazard mitigation is provided
#239 in the Draft EIS other than to briefly state that "all structures will be designed to meet the applicable State of California and/or Inyo County codes and earthquake standards, and of the USGS Area Geothermal Supervisor." The Draft EIS would be enhanced by the addition of a qualitative discussion of earthquake shaking mitigation, surface fault rupture mitigation, landslide and slope instability mitigation, etc. The EIS should discuss geologic hazard mitigation.

#240 2. The Draft MLS (Section 2.5.2.2) discusses effects from the probable lowering of the groundwater table. The subsidence issue should be included in this discussion.

#241 3. All well pads and sumps should be constructed to withstand shocks which may be occurring during weapons or missile testing.

#242 4. The EIS should discuss the depth of good vs. poor quality groundwater in the project area and in Rose Valley (the point of water extraction).

#243 5. Drilling pad and sump sites should either avoid potential "flash-flood" zones or be constructed in such a menner which would preclude inundation or excessive storm runoff.

#244 6. All construction areas should be stabilized to minimize erosion, and efforts towards revegetation of those disturbed areas should be implemented.

#245 7. The EIS should estimate and discuss the amount of traffic bearing toxic or hazardous materials and wastes into, through, and out of the area. The increase in truck traffic per drilling operation and eventual power plant construction will increase the opportunity of mishaps, accidents, spills, etc. as the field is developed.

Biology

#246 1. Rare, threatened, endangered species, and species of special concern should not be disturbed. Their habitats should be avoided. These areas should be mapped completely prior to leasing and stipulation should be included in the lease requiring the lessees to avoid the areas.

#247 Further, BLM has an opportunity to plan the development of these leasehold areas so that all areas of concern are avoided. This should include constructing roads that would be used by a maximum number of leaseholds, developing tranmission line corridors for maximum efficiency, and planning well pads and other disturbances to reduce impacts on biological resources. The EIS should discuss these concerns.

#248 2. In addition to proper planning, enhancement and compensation measures should be implemented in order to mitigate the loss of wildlife habitat. Measures which should be considered as appropriate include:

a. installing guzzlers to increase water availability,

b. developing watering areas for riparian type vegetation,

c. creating artificial nesting sites,

d. installing exits along fences and streamlines to permit migration of large mammals and,

#248 e. using irrigation during revegetation attempts on disturbed areas to avoid long-term erosion by speeding stabilization.

Any measures which are implemented should be monitored for effectiveness.

Cultural Resources

#249 1. The EIS should discuss the impacts from the proposed development of the Coso KGRA on contemporary Native American values.

#250 2. The EIS should discuss the mitigation measure of prohibiting development in areas of significance to Native Americans. Further, buffer zones which may vary depending on the value of the resource, should be established around these sites.

#251 3. Areas containing significant archaeological resources should be avoided and not permitted to be developes.

Air Quality/Health

#252 The Draft EIS estimates the potential for exceeding the State hydrogen sulfide (H_2S) ambient air quality standard as a result of the operation and well flow testing associated with only one power plant. The EIS should assess potential cumulative air quality and health impacts associated with operation of several plants in close proximity to one another.

Conclusion

The Commission is very supportive of the proposed project and commends BLM on the overall high quality of the Draft EIS. Considering the limited amount of information available on the Coso GSA, BLM has designed a good development model as the basis of a "worst case" analysis of full field development. At the same time BLM has pointed out the limits of such a predictive model, and the fact that new environmental and geotechnical data, as well as changes in technology and regulatory policy may cause deviations from the forecase presented in the Draft EIS.

The staff of the California Energy Commission appreciates the opportunity to comment on this phase of development in the Coso KGRA. If you have any questions contact David Maul, Senior Environmental Planner, Engineering and Environmental Divisions at (916) 920-7501.

Sincerely,

JOHN L. GEESMAN
Executive Director

cc: State Clearinghouse,
Office of Planning and Research

237 - Exploration of leases is covered in 43 CFR Subpart 3203.5. It requires diligent exploration as defined in the regulations. Failure to perform such exploration may subject the lease to termination.

238 - Direct heat applications are not precluded. Although the proposed action is to lease the land for geothermal development for the primary purpose of generation of electrical energy, non-electric purposes are allowed. In the event that lessees proposed non-electric uses, the environmental effects of such action would be evaluated by U.S. Geological Survey at that time (see Section 1.1 in the FEIS).

239 - Thank you for the comment. Additional information has been added to Section 3.3 of the text.

240 - Thank you for the comment. It is not anticipated at this time, that geothermal development of the Coso KGRA will induce ground subsidence.

241 - Regulations governing the construction and operation of well pads and sumps are provided in GRO #4, item 9A(4). Mitigation measures for hydrology and wildlife discuss mud sumps and well pad stabilities. Also in Sections 1.3.5.1 and 1.3.5.3 geothermal facilities are discussed.

242 - The data requested is not available in the literature.

243 - A mitigation measure has been developed for flash flood zones in Section 3.4.5, Flood Hazard, in the EIS.

244 - Mitigation measures have been developed to minimize erosion and revegetate disturbed areas, are covered in GRO No. 4, and are discussed in Section 3.7 of the EIS.

245 - Drilling muds are not considered hazardous materials unless compounds are added that are listed as hazardous. The amount of toxic materials, if any, are likely to be insignificant. All precautions to avoid accidents and spills will be considered. See mitigation section in the EIS.

246 - Rare, threatened, and endangered species, as well as other species of special concern, are discussed in Sections 2.7, 2.8, 3.6 and 3.7. In addition, a Wildlife and Flora Monitoring Plan will be implemented to determine whether impacts addressed in the FEIS were correctly assessed and whether mitigative/protective measures are proving effective.

247 - The concerns you raise are all important. They can be most effectively handled by USGS during the lease administration stage.

248 - Thank you for your suggestions. While we do not believe that measures b), c) and d) are needed at this time, we have incorporated measures a) and e) in Sections 3.6 and 3.7, respectively.

249 - Please refer to Section 2.12.1.13 which discusses Native American concerns regarding the proposed action; Section 2.12.2.12, which further addresses the impacts on Native American values; and Sections 2.3.2, 2.5.2, 2.10.2, and 2.12.2.5, which discuss specific impacts. Mitigation measures are discussed in Section 3.9 and elsewhere in Chapter 3.

250 - Please see response to Comment 249.

251 - Mitigation of impacts to archaeological resources is discussed in Section 3.9.

252 - The air quality simulation modeling performed considered the full complement of power generation stations, not just one plant. For further details concerning this subject please see the Air Quality Technical Report. The exceedance predicted would occur only under rare circumstances when the meteorological conditions are not favorable and a well in the vicinity of a power plant is being tested.

9.0 REFERENCES

Allen, C.R., P. St. Amand, C.F. Richter and J.M. Nordquist. "Relationship Between Seismicity and Geologic Structure in the Southern California Region." Bulletin of the Seismological Society of America, Vol. 55, No. 4, 1965, pp. 753-798.

AAUW. Indian Wells Valley Handbook, Third Edition. China Lake, CA, American Association of University Women, Inyokern Branch, 1967, 121 pp.

Anderson, J.R., et al. "A Land Use and Land Cover Classification System for Use With Remote Sensor Data," USGS Professional Paper 964. Washington: U.S. Government Printing Office, 1976, 28 pp.

Angelo, J., Director, Inyo County Department of Parks and Recreation, Independence, CA, personal communication, February 1979.

Armbrust, D.V., and J.D. Dickerson, "Temporary Wind Erosion Control: Cost and Effectiveness of 34 Commercial Materials", Journal of Soil and Water Conservation, Volume 26, No. 4, pp.154-157, 1971.

Austin, C.F., and J.K. Pringle. "Geologic Investigations at the Coso Thermal Area." U.S. Naval Weapons Center Tech. Publ. 4878, 1970.

Babcock, J.W. The Late Cenozoic Coso Volcanic Field, Inyo County, California. Unpublished Ph.D. Thesis, University of California, Santa Barbara, 1977.

Barling, T.C. Environmental Analysis Report, Phase I of Coso Geothermal Project. See U.S. NWC, 1977b.

Barling, T.C., NWC Natural Resources Specialist, China Lake, CA, personal communication, October 1978, and April 1979.

Bate R. President, Little Lake Duck Club, personal communication, February 1979.

Baumhoff, Martin A. and R.F. Heizer. "Post-Glacial Climate and Archaeology in the Desert West," in The Quaternary in the United States, H. E. Wright, Jr. and D.G. Frey, eds. Princeton: Princeton University Press, 1965, 697-707.

Beck, W.A. Historical Atlas of California. Norman, OK: University of Oklahoma Press, 1974, 216 pp.

Benbrook, P., Postmistress, Olancha, CA, personal communication, April 1979.

Bettinger, R.L. The Development of Pinyon Exploitation in Central Eastern California," Journal of California Anthropology 3(1), 1976:81-95.

Bloyd, R.M. Jr. and S.G. Robson. "Mathematical Ground Water Model of Indian Wells Valley, California," USGS Open File Report (No Number), USGS, Water Resources Division, Menlo Park, California, 1971.

Boeker, E.L. and T.D. Ray. "The Golden Eagle Population in the Southwest," Condor 73:, 1971 463-467.

Boh, Russel, Thomas Cuscino, Jr., and Chatten Cowherd, Jr. "Fugitive Emissions from Integrated Iron and Steel Plants," EPA Report 600/2-78-050, 1978.

Bradford, G.R. "Boron Toxicity, Indicator Plants," in Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. University of California, Division of Agriculture Science. Berkeley, CA., 1966, 33 pp.

Bondello, Michael C. and Bayard H. Brattstrom. The Experimental Effects of Offroad Vehicle Sounds on Three Species of Desert Vertebrates. Part I: Couch's Spadefoot Toad (Scaphiopus couchi); Part II: Mojave Fringe-toed Lizard (Uma scoparis); Part III: Desert Kangaroo Rat (Dipodomys deserti). Report to the Bureau of Land Management. Final Report of Contract CA-060-CT7-2737, 1979a, 125 pp.

Bondello, M.C. and B.H. Brattstrom. "Ambient Sound Pressure Levels in the California Desert". Report to the Bureau of Land Management as part of Contract CA-060-CT7-2737, 1979b, 135pp.

Bottorff, Sarah, Ridgecrest Daily Independent staff writer, personal communication, March 1979.

Bouwer, H. Groundwater Hydrology, McGraw-Hill Book Company, New York, 1978, 480 pp.

Boyd, A., City Engineer, City of Ridgecrest, CA, personal communication, April 1979.

Brattstrom, B.H. and M.C. Bondello. "Bibliography on the Effect of Noise on Non-Human Vertebrates," Report to the Bureau of Land Management as Part of Contract CA-060-CT7-2737, 2568 Citations, 1978.

Brooks, C.R., W.M. Clements, J.A. Kantner and G.Y. Poirier. A Land Use History of Coso Hot Springs. Prepared for NWC China Lake by the Iroquois Research Institute. China Lake, CA: Naval Weapons Center Public Works Dept., NWC Ad Pub 200, 1979, 233 pp.

Brown, C.R., W.A. Duffield and K. Nokumura. "Distribution of Quaternary Rhyolite Domes of the Coso Range, California: Implications for Extent of the Geothermal Anomaly." Geophysics Research, in press.

Brummett, R.E., Director, Planning Department, City of Ridgecrest, CA, personal communication, August 1979.

Budlong, G., Inyo County Planning Department, Independence, CA, personal communication, April-August 1979.

Burns, P., President, Inyokern Chamber of Commerce, Inyokern, CA, personal communication, March-April 1979.

California Administrative Code, Title 8, Article 105.

California, State of, Department of Transportation (CalTrans), "Supplemental Report for the Environmental Considerations of Air-Noise-Water-Energy on the Dunmovin Project, District 9 Report," 1978.

California, State of, Board of Equalization, Annual Report, 1976-1977, Sacramento, CA, 1977a.

California, State of, Board of Equalization, California Sales and Use Tax Law, Sacramento, CA, 1977b.

California, State of, Department of Finance, Special Census for Inyo County, Sacramento, CA, 1977.

California Division of Mines. Mineral Resources of California. California Division of Mines Bulletin 191, 1966, 450 pp.

California, State of, Department of Fish and Game. Fish, Wildlife and Plant Species Designated as Endangered or Rare by the California Fish and Game Commission. Sacramento, 1979.

California, State of, Department of Transportation (CalTrans). "Initial Study and Negative Declaration on Proposed Highway Improvement Project on Route 395 in Inyo County". Bishop, CA, 1979, 17 pp plus exhibits.

California, State of, Employment Development Department, Annual Planning Information, Bakersfield SMSA, Sacramento, CA, 1979.

California Energy Commission, Natural Gas Supply and Demand for California, 1978-1995. Sacramento, CA, March 1978.

California Resources Agency, Department of Parks and Recreation, Office of Historic Preservation: see also Theodoratus and Madsen, 1977.

California Resources Agency, Department of Parks and Recreation. What's Happening, Newsletter, September 1978.

California Resources Agency, Department of Parks and Recreation, Office of Historic Preservation: see also Johnson, V., 1979.

Chalfant, W.A. The Story of Inyo, Revised Edition, Bishop, CA: The Chalfant Press, 1933, 291 pp.

Chesterman, C.W. "Pumice, Pumicite and Volcanic Cinders in California," California Division of Mines Bulletin 174, 1965, 119 pp.

Christman, A.B. History of the Naval Weapons Center, China Lake, California, Vol. I. Washington: U.S. Government Printing Office, 1971, 303 pp.

Clemens, H.P. and W.H. Jones. "Toxicity of Brine Water from Oil Wells", Trans. Amer. Fish Society, 1954, 84:97-109.

Clewlow, C.W., Jr., R.F. Heizer and R. Berger. "An Assessment of Radiocarbon Dates for the Rose Spring Site (CA-INY-372), Inyo County, California." Contributions of the University of California Archaeological Research Facility, 7: 64-73, Berkeley, 1970.

Coffman, S.L., and C.A. von Hake. "Earthquake History of the United States," Revised Edition. National Oceanic and Atmospheric Administration Publication 41-1, 1973, 208 pp.

Cogswell, M. Kern County Building Inspection Department, Bakersfield. Personal communication, August 1979.

Colter, P., Administrative Assistant, Kern County Supervisor's Office, District 1, Ridgecrest, CA, personal communication, April-July 1979.

Combs, J. "Heat Flow and Microearthquake Studies, Coso Geothermal Area, China Lake, California," Advanced Research Projects Agency, Contract No. N00123-74C-2099, Final Report, 1975.

Combs, J. "Heat Flow Determination in the Coso Geothermal Area, California," The Coso Geothermal Project Technical Report No. 3, U.S. Energy Research and Development Administration, Contract E(45-1)-1830, 1976, 24 pp.

Combs, J. "Heat Flow in the Coso Geothermal Area, Inyo County, California," Jour. Geophys. Res, in press.

Combs, J., and D. Jarzabek. Seismic Evidence for a Deep Heat Source Associated with the Coso Geothermal Area, California," The Coso Geothermal Technical Report No. 4, U.S.Energy Research and Development Administration, Contract E(45-1)-1830, 1977, 13 pp.

Cook, W.S., and Rashen, R. "Exploration and Development of Geothermal Resources (with Emphasis on Surface Disturbance)," U.S. Geological Survey, Menlo Park, CA, 1976.

Cooper, R., land owner and former resident, Dunmovin, CA, personal communication, March 1979.

E.A. Crecelius, D.E. Robertson, J.S. Fruchter, and J.D. Ludwick. "Chemical Forms of Mercury and Arsenic Emitted by a Geothermal Power Plant," Trace Substances in Environmental Health, 10, 1976, 287.

Cunniff, P.F. Environmental Noise Pollution. John Wiley and sons. Santa Barbara, CA, 1977, 210 pp.

Davis, E.L. (ed.). The Ancient Californians: Rancholabrean Hunters of the Mojave Lakes Country, Science Series Publication No. 29. Los Angeles: Natural History Museum of Los Angeles County, 1978, 193 pp.

Davidson, D., Superintendent, Lone Pine Unified School District, Lone Pine, CA, personal communication, February 1979.

Davidson, E. and M. Fox. "Effects of Off-Road Motorcycle Activity on Mohave Desert Vegetation and Soil." Madrono, 1974, 22:381-390.

Davis, E.L. "The Exposed Archaeology of China Lake, California." Amer. Antiquity, 1975, 40, No. 1:39-53.

deHart, R., Acting Director, Inyo County Planning Department, Independence, CA, personal communication, June 1979.

Dodds, R., Lahonton Regional Water Quality Control Board, Victorville, CA, personal communication, March 1979.

Duffield, W.A. "Late Cenozoic Ring Faulting in the Coso Range Area of California". Geology, Vol. 3, 1975, pp. 335-338.

Duffield, W.A., and C.R. Bacon. Preliminary Geology Map of the Coso Volcanic Field and Adjacent Areas, Inyo County, California. U.S. Geological Survey Open-File Map 77-311, 1977.

Duffield, W.A., C.R. Bacon, and G.B. Dalrymple. "Late Cenozoic Volcanism, Geochronology, and Structure of the Coso Range, Inyo County, California." Jour. Geophys. Res., in press.

Dupuy, L.W.. "Bucket Drilling in Coso Mercury Deposit, Inyo County, California." U.S. Bureau of Mines, Report Investigation 4201, 1948, 45 pp.

Dutcher, L.C., and W.R. Moyle, Jr. "Geologic and Hydrologic Features of Indian Wells Valley, California." USGS Water Supply Paper 2007, 1973, 30 pp.

Ellis, A.J. and W.A.J. Mahon. Chemistry and Geothermal Systems, Academic Press, New York, 1977, 392 pp.

Ellis, M.Y. (ed.), Coastal Mapping Handbook. Washington, U.S. Government Printing Office, 1978.

Elton, B., Rancher/cattle Owner, Olancha, CA, personal communication, April 1979.

Evernden, J.F., and R.W. Kistler. "Chronology of Emplacement of Mesozoic Batholithic Complexes in California and Western Nevada." U.S. Geological Survey Professional Paper 623, 1970.

Fang, S. "Sorption and Transformation of Mercury Vapor by Dry Soil," Environmental Science & Technology, Vol. 12, No. 3, 1978, 285-288.

Farlander, P., Director, Long Pine Chamber of Commerce, Lone Pine, CA, personal communication, April 1979.

Field Research Corporation. California Public Opinion and Behavior Regarding the California Desert. Survey conducted for the Bureau of Land Management, 1977.

Fletcher, J.L. "Effects of Noise on Wildlife and Other Animals," EPA, Washington, D.C. NTID 300.5, 1971, 74 pp.

Fletcher, J.L. and R.G. Busnel. Effects of Noise on Wildlife. Academic Press, 1978.

Fournier, R., personal communication, 1979.

Fournier, R., et al. J. Volc. and Geothermal Research, Vol. 5, 1978, p. 17-34.

Galbraith, R.M. "A Geological and Geophysical Analysis of Coso Geothermal Exploration Hole No. 1, Coso Hot Springs CGSA, Inyo County, California." U.S. Department of Energy, Department of Geothermal Development, Contract 78-C-07-1701, 1978.

Galbraith, R.M. "Geological and Geophysical Analysis of Coso Geothermal Exploration Hole No. 1 (CGEH-1), Coso Hot Springs, CGSA, California." Earth Science Laboratory, University of Utah, Salt Lake City, 1978, 39 pp.

Garfinkel, A.P. "A Cultural Resource Management Plan for the Fossil Falls/Little Lake Locality." Bakersfield, CA, BLM District Office, 1976, 68 pp.

Garfinkel, A.P. "'Coso' Style Pictographs of the Southern Sierra Nevada." California Anthroplogy, 5 (1), 1978, 95-100.

Glosser, J., Soil Conservation Service, Bishop, CA, personal communication, 1979.

Goodloe, J., Division of Environmental Health, Inyo County Health Department, Independence, CA, personal communication, April 1979.

Goodman, M., Inyo County Health Department, Bishop CA, personal communication, April 1979.

Grant, C., J.W. Baird and J.K. Pringle. Rock Drawings of the Coso Range, Inyo County, California. Maturango Museum Publication 4, China Lake, CA, 1968.

Hamilton, D.R., General Manager, Indian Wells Valley County Water District, Inyoker, CA, personal communication, February and June 1979.

Harrington, M.R. "The Fossil Falls Site." Southwest Museum Masterkey, 26: 191-195, Los Angeles, 1952.

Harrington, M.R. A Pinto Site at Little Lake, California. Southwest Museum Paper 17. Los Angeles, 1957.

Harris, G., Grazing Specialist, Bureau of Land Management, Ridgecrest, CA, personal communication, May 1979.

Hayes, K., Bureau of Land Management, Area Manager, Ridgecrest, CA, personal communication, March 1979.

Hazelton, J. (Deputy), Inyo County Sheriff's Office, Independence, CA, personal communication, April 1979.

Healy, J.H. and F. Press. "Geophysical Studies of Basin Structures Along the Eastern Front of the Sierra Nevada, California," Geophysics, Vol. 14, No. 3, 1974, pp. 337-359.

Heb, G., District Engineer, Southern Pacific Transportation Company, Bakersfield, CA, personnal communication, April 1979.

Heizer, R.F. and C.W. Clewlow, Jr. Prehistoric Rock Art of California. Ballena Press, Ramona, California, 1973.

Hem, J.D. "Study and Interpretation of the Chemical Characteristics of Natural Water," Second Edition. USGS Water Supply Paper 1473, 1970, 363 pp.

Hennis, P. and B. Hennis, Owners, Rose Valley Ranch, Dunmovin, CA, personal communication, September 1978-July 1979.

Hileman, J.A., C. R. Allen and J.M. Nordquist. "Seismicity of the Southern California Region, 1 January 1932 to 31 December 72." Seismological Laboratory, California Institute of Technology, 1973, 560 pp.

Housner, G.W. "Intensity of Earthquake Ground Shaking Near the Causitive Fault." Proceedings, Third World Conference on Earthquake Engineering, New

Zealand, Vol. 1, 1965.

Hulen, J.B. "Geology and Alteration of the Coso Geothermal Area, Inyo County, California." U.S. Department of Energy, Report IDO-1701-1, 1978, 28 pp.

Imperial County Board of Supervisors. Geothermal Element of the General Plan. 1977.

Imperial County Planning Department. "North Brawley Ten Megawatt Geothermal Demonstration Facility: Final EIR." Prepared by WESTEC, Inc. 1979.

Indian Wells Valley County Water District (IWVCWD). Brief Report on the Progress, Expansion, and Improvements to the District. Compiled by H. Suzuki and A. Freeland, April 1975, updated November 1977.

Inman, L., Director, Kern County Water Agency, Bakersfield, CA, personal communication, April 1979.

Inyo, County of, Board of Supervisors. Comments on City of Los Angeles Department of Water and Power: August 1978 Draft EIR on Increased Pumping of the Owens Valley Groundwater Basin. 1978, 194 pp and Appendices.

Inyo County Planning Department, Inyo County Population Data, Independence, CA, 1977a.

Inyo County Planning Department, 1990 General Plan for Development, Inyo County, Independence, CA, 1977b (revision of 1968 edition), 123 pp.

Inyo County Planning Department, Population Report, 1978, 21 pp.

Inyo County Planning Department, Final Environmental Impact Report on the Red Hill Cinder Mining Project, Independence, CA. Prepared by VTN Consolidated, 1979, 179 pp plus Appendices.

Inyo County News-Letter, Independence, CA, June 29, 1979.

Inyo Independent, Lone Pine, CA. Various issues, January-August 1979.

Inyokern News-Review, Inyokern, CA. Various issues, March-August 1979.

Inyo-Mono Association of Government Entities (IMAGE), Land Use Element, Bridgeport, CA, 1974a.

Inyo-Mono Association of Government Entities (IMAGE), Housing Element, Bridgeport, CA, 1974b.

Inyo-Mono Counties Department of Agriculture, 1978 Annual Crop and Livestock Report, Bishop, CA, 1979, 5 pp.

Iroquois Research Institute. A Land Use History of Coso Hot Springs, Inyo County, California, Naval Weapons Center, China Lake, California, NWC Ad Pub 200, 1979, 233 pp.

Jackson, D. and Lindberg, S. "Atmospheric Emission and Plant Uptake of Mercury from Agricultural Soils Near the Almaden Mercury Mine," Agronomy Abstracts, Am. Soc. Agronomy, Madison, WI, 1978, p. 30.

Jennings, C.W. Geologic Map of California. California Division of Mines and Geology, California Geologic Data Map Series, 1977.

Ives, J.R., Captain, CEC, Public Works Officer, US Naval Weapons Center, China Lake, CA, personal communication, May 1980.

Johnson, H.B., F. C. Vasek, and T. Yonkers. "Productivity, Density and Stability Relationships in Mohave Desert Roadside Vegetation," Bull. Torrey Bot. Club, 1975, 102: 106-115.

Johnson, V. Report on Coso Hot Springs Project: Cultural Heritage Restraints on Development of Coso Hot Springs Geothermal Power. Prepared for the Office of Historic Preservation, Departments of Parks and Recreation, California Resources Agency, Sacramento, CA, 1977.

Keeler, J.M. "Mining Map of Inyo County," published by the San Francisco Daily Report, 1883; reprinted 1977 by Eastern California Museum, Independence, CA.

Kennedy, J., Environmental Engineer, Kern County Public Works Department, Bakersfield, CA, personal communication, March 1979.

Kern County First Supervisorial District, The Services of the County of Kern in the Indian Wells Valley, Randsburg, and Johannesbury. Prepared by the Office of Kern County Supervisor G. Tackett, Ridgecrest, CA, September 1978.

Kern County Planning Department, Special Census, 1977, Bakersfield, CA, 1977.

Kern County Planning Department. Population by Census Tract. Bakersfield, CA, March 1979.

Koenig, J.B., GeothermEx, Inc., Berkeley, California. Draft report on Geology and Geothermal Potential of the Coso Environmental Statement Area, personal communication, 1978.

Krieger and Steward, Engineering Consultants, Indian Wells Valley County Water District General Plan for Water Supply and Water Distribution, Riverside, CA, 1977, 146 pp.

Kuebler, B., Senior Hydrologic Engineer, City of Los Angeles, Department of Water and Power, personal communication, November 1978-April 1979.

Land, B. "The Toxicity of Drilling Fluid Components to Aquatic Biological Systems: A Literature Review." Fisheries and Marine Services of Canada. Technical Report No. 487, 1974.

Lane, R., Ranch Owner and Resident, Rose Valley, Dunmovin, CA, personal communication, March 1979.

Lanning, E.P. "Archaeology of the Rose Spring Site, Inyo 372." University of California. Publications in American Archaeology and Ethnology, 49(3): 237-336. University of California Press, Berkeley and Los Angeles, 1963.

Lanphere, M.A., G.B. Dalrymple, and R.L. Smith. "K-Ar Ages of Pleistocene Rhyolitic Volcanism in the Coso Range, California." Geology, Vol. 3, 1975, pp. 339-341.

Leitner, Philip, Department of Biology, St. Mary's College, Moraga, CA, personal communication, May-October 1979.

Lester, Peter F. and Richard L. Simon. "Fluxes of Air Pollutants into the California Desert from the Los Angeles Basin," Global Weather Consultants, 1978.

Lipscomb, D.M. and A.C. Taylor. Noise Control: Handbook of Principles and Practices. Van Nostrand Reinhold, N.Y., 1978, 375 pp.

Macy, J., NWC Long-Range Planning Office, China Lake, CA, personal communication, December 1979.

Mansfield, T.A. ed. Effects of air Pollution on Plants. Cambridge University Press, New York, 1976, 209 pp.

Marks, S. M., Ludwin, R. S., Louie, K. B., and Bufe, C. G., 1978, Seismic Monitoring at The Geysers Geothermal Field, California: US Geologic Survey Open File Report 78-798, 26 pp.

May, D.M. Handbook of Noise Assessment. Van Nostrand Reinhold, New York, 1978, 400 pp.

McCollum, J., Coordinator of Business Services, Inyo County Office of Education, Independence, CA, personal communication, February 1979.

McGuire, C.H., President, Board of Directors, Indian Wells Valley County Water District, Ridgecrest, CA, personal communication, February 1979.

Meigan, C.W. "California." In Chronologies in New World Archaelogy, edited by R.E. Taylor and C.W. Meighan. Academic Press, New York, 1978.

Middleton, W.E.K. "Vision Through the Atmosphere," University of Toronto Press, 1952.

Miller, R.D. Mines of the Mojave, Los Angeles: La Siesta Press, 1976, 133 pp.

Minor, J., President, GRID (Geothermal Research and International Development Corporation), Santa Monia, CA, personal communication, August 1979.

Moyle, W.R., Jr. "Summary of Basic Hydrologic Data Collected at Coso Hot Springs, Inyo County, California." USGS Open File Report 77-485, 1977, 93 pp.

Moyle, W.R., Jr. Hydrologist, USGS, Laguna Niguel, California. Phone conversation March 1, 20, 1979; review meeting and field trip for Coso ES hydrology study, April 10 and 11, 1979.

Munz, P.A. A California Flora and Supplement, University of California Press, Berkeley and Los Angeles, California, 1968.

Murphy, M. A.; California Desert Conservation Area Invertebrate Paleontological Resources Study.

Nadeau, R.A. The Water Seekers. Santa Barbara: Peregrine Smith, 1974, 278 pp.

Nielson, D.L, B.S. Sibbett, D.B. McKinney, J.B. Hulen, J.N. Moore and S.M. Samberg. "Geology of the Roosevelt Hot Springs CGSA, Beaver County, Utah. Department of Energy, Division of Geothermal Energy, Contract No. EG-78-C-07-1701, 1978, 120 pp.

Noh, M., Sierra Sands Unified School District, Ridgecrest, CA, personal communication, April 1979.

Ouimette, J.R. "Survey and Evaluation of the Environmental Impact of Naval Weapons Center Activities," China Lake NWC Technical Memorandum 2426, 1974.

Pacific Gas and Electric Company. Amended Environmental Data Statement: Geysers Unit 13. San Francisco, CA, 1975.

Pacific Gas and Electric Company. "Application for Certification, Geysers Unit 18," 1979.

Paul, A., President, American Pumice Products, Inc., Santa Ana, CA, personal communication, March 1979.

Peace, N. Social Profile of the Bakersfield District. See USDI, BLM, Bakersfield, 1977a.

Peters, J., WESCO, San Rafael, California, personal communication, 1978 and 1979.

Pfulb, N., Director, Desert Planning Staff, Bureau of Land Management, Riverside, CA, personal communication, August 1979.

Phelps, P.L. and L.R. Anspaugh. "Imperial Valley Environmental Project: Progress Report." Lawrence Livermore Laboratory UCRL-50044-76-1, 1976, 214 pp.

Powell, W.R. (ed.). "Inventory of Rare and Endangered Vascular Plants in California," Cal. Native Plant Society Special Publication No. 1, 1974.

Raleigh, C.B., J.H. Healy and J.D. Bredehoeft. "An Experiment in Earthquake Control at Rangely, Colorado," Science, Vol. 191, 1976, pp. 1230-1236.

Real, C.R., T.R. Toppozada, and D.L. Parke. Earthquake Epicenter Map of California, 1900 through 1974. California Division of Mines and Geology, Map Sheet 39, 1978.

Reasenbert, et al. Paper to be published in Fall 1979 issue of Jour. Geophys. Res.

Reichard, V., Director, Environmental Health, Kern County Health Department, Bakersfield, CA, personal communication, April 1979.

Reinking, R.F., L.A. Mathew, and P. St.Amand. "Dust Storms Due to Dessication of Owens Lake," International Conference on Environmental Sesing and Assessment, Las Vegas, 1975.

Renner, J.L., D.E. White and D.L. Williams. "Hydrothermal Convection Systems," in Assessment of Geothermal Resources of the United States. D.E. White and D.L. Williams, eds., U.S. Geological Survey Circular 726, 1975.

Ridgecrest Daily Independent, Ridgecrest, CA. Various issues September 1978-August 1979.

Ridgecrest Chamber of Commerce, "Director of Schools, Indian Wells Valley," Ridgecrest, CA, August 1979.

Ridgecrest, City of, Land Use Committee for South Ridgecrest Area: Community Land Use Study, Ridgecrest, CA, May 1977.

Robertson, D.E., J.S. Fruchter, J.D. Ludwick, C.L. Wilkerson, E.A. Crecelius, and J.C. Evans, "Chemical Characterization of Gases and Volatile Heavy Metals in Geothermal Effluents," Transactions of the Geothermal Resources Council, 2, 1978, 579.

Rockwell International, written communication of Hydrosearch, Inc., from B.D. Winkler, Environmental & Energy Systems Division, Creve, Coeur, Missour, 1979a.

Rockwell International, letter dated February 2, 1979, from G. Lauer, Coso Program Manager, Rockwell International, Newbury Park, California to C. Tulloss, COAR, Bureau of Land Management, Bakersfield District Office, outlining results of meeting, 1979b.

Roquemore, G.R. "Active Faults and Related Seismicity of the Coso Mountains, Inyo County, California," Seismological Society of American Earthquake Notes, Vol. 49, No. 1, 1978a, p. 24.

Roquemore, G.R. "Evidence of Basin and Range/Sierra Nevada Transitional Zone Structures in the Coso Mountains, California," (abs.). Geological Society of American Abstracts with Program, Vol. 10, No. 3, 1978b, p. 144.

Roquemore, G., University of Nevada, Reno, personal communication, 1979.

Saxton, L., Coso Coordinator, NWC Public Works Department, China Lake, CA, personal communication, October 1978.

Schnabel, P.B. and H.B. Seed. "Accelerations in Rock for Earthquakes in the Western United States," Earthquake Engineering Research Center, College of Engineering, University of California, Berkeley, Report No. EERC 72-2, 1972, 15 pp.

Seed, H.B., I.M. Idress and F.W. Kiefer. "Characteristics of Rock Motion During Earthquakes," Journal of Soil Mechanics and Foundations Division, American Society of Civil Engineers, Vol. 95, 1969, pp. 1199-1218.

Sherburne, D., former Director, Inyo County Planning Department, Independence, CA, personnal communication, April-June 1979.

Siegel, B. and S. Siegal. "Geothermal Hazards, Mercury Emissions," Environmental Science & Technology, Vol. 9, No. 5., 1975, pp. 473-474.

Smithsonian Institution, "Endangered and Threatened Plants of the United States," Washington Smithsonain Institution and World Wildlife Fund, 1978.

Snow, R.C. "The Prairie Falcon Habitat Management Series for Unique or Endangered Species," Report No. 7, BLM, U.S. Department of the Interior, Technical Note, 1974.

"Soil Conservation Society of America. Soil Erosion: Prediction and Control," Proceedings of a National Conference on Soil Erosion, May 24-26, 1976, Purdue University, West Lafayette, Indiana. Special Publication No. 21, 1976, 393 pp.

Sorenson, D., Kern County Water Agency, Ridgecrest, CA, personal communication, April 1979.

Spane, F.A., Jr. Hydrogeologic Investigation of Coso Hot Springs, Inyo County, California, Naval Weapons Center, NWC TP 6025, 1978, 42 pp.

St.Amand, P. and G. Roquemore. "Preliminary Structural Interpretation of the Coso Area," unpublished U.S. Naval Weapons Center Map, 1978.

Steward, J.H. Ethnography of the Owens Valley Paiute. University of California Publications in American Archaeology and Ethnography, 33(3): 233-350, Berkeley, 1933.

Steward, J.H. "Basin-Plateau Aboriginal Sociopolitical Groups," Bureau of American Ethnology Bulletin 120, Washington, DC. 1938.

Stinson, M.C. Geology of the Haiwee Reservoir 15' Quadrangle, Inyo County, California. California Division of Mines and Geology Map Sheet 37, 1977.

Strayer, J., Manager, Pacific Gas and Electric Company, Ridgecrest, CA, personal communication, April 1979.

Teledyne Geotech. "Geothermal Noise Survey of the Coso Hot Springs Area, Naval Weapons Center, China Lake, California," Office of Historic Preservation, Department of Parks and Recreation, State of California, Sacramento, 1977.

Theodoratus, D. and C. Smith-Madsen. Preliminary Ethnographic Report on Coso Hot Springs, Inyo County, California. Prepared for the Office of Historic Preservation, Department of Parks and Recreation, California Resources Agency, Sacramento, 1977.

Thomann,J., Resident, Rose Valley (Dunmovin, CA), personal communication, April 1979.

Thompson, L.S. "Overhead Transmission Line Impact on Wildlife." Montana Department of Natural Resources and Conservation, Energy Planning Division, 1977.

Thorne, Robert F. "Alkali Meadows and Aquatic Vegetation Associations." In press.

Townley, S.D. and M.W. Allen. "Descriptive Catalogue of Earthquakes of the Pacific Coast of the United States 1769 to 1928," Bulletin of the Seismological Society of America, Vol. 29, No. 1, 1939, 297 pp.

U.S. Bureau of the Census, U.S. Census of Population, 1970.

USFS (United States Forest Service, U.S. Department of Agriculture). Roadless Area Review and Evaluation (RARE II) Final Environmental Statement. Washington, D.C., 1979, 733 pp.

U.S. Department of Commerce, Federal and State Indian Reservations, Washington, D.C. 1974, 604 pp.

U.S. Department of Defense (DOD), Office of Economic Adjustment, Economic Adjustment Program: Ridgecrest, California. Prepared by the President's Economic Adjustment Committee, Washington, D.C., 1979, 99 pp and Appendices.

U.S. Department of the Interior (DOI), Bureau of Land Management, Argus Area National Resources Lands Map, prepared by Bakersfield and Riverside Districts of the BLM, 1976a.

U.S. Department of the Interior (DOI), Bureau of Land Management, Final Environmental Analysis Record for Proposed Leasing in the Randsburg-Spangler Hills - South Searles Lake Area, Riverside, CA, BLM District Office, 1976b, 370 pp and Appendices.

U.S. Department of the Interior (DOI), Bureau of Land Management, An Economic Profile: Bureau of Land Management Bakersfield District, Bakersfield, CA, 1976c, 126 pp.

U.S. Department of the Interior (DOI), Bureau of Land Management, California Public Opinion and Behavior Regarding the California Desert, see Field Research Corporation, 1977a.

U.S. Department of the Interior (DOI), Bureau of Land Management, "Desert Plan to Encompass One-Fourth of California," BLM Newsbeat, Sacramento, CA, BLM, May 1977b, 4 pp.

U.S. Department of the Interior (DOI), Bureau of Land Management, Social Profile of the Bakersfield District (First Draft). Prepared by N. Peace, Bakersfield, CA, 1977c, 126 pp.

U.S. Department of the Interior (DOI), Bureau of Land Management, Future Technology in the California Desert, Final Report. Prepared by SRI International for the California Desert Planning Program, Riverside, CA, 1978a, 98 pp.

U.S. Department of the Interior (DOI), Bureau of Land Management, Future Demographic and Economic Trends in the California Desert, prepared by SRI International for the California Desert Planning Program, Riverside, CA, 1978b, 57 pp and Appendices.

U.S. Department of the Interior (DOI), Bureau of Land Management, Survey of Residents of the California Desert, Final Report. Prepared by SRI International for the California Desert Planning Program, Riverside, CA, 1978c, 93 pp and Appendices.

U.S. Department of the Interior (DOI), Bureau of Land Management, "Interim Management Policy and Guidelines for Wilderness Study Areas," Washington, D.C., BLM, 1979a, 31 pp.

U.S. Department of the Interior (DOI), Bureau of Land Management, Final Wilderness Inventory for the California Desert Conservation Area, Sacramento, BLM, 1979b, 262 pp.

U.S. Department of the Interior (DOI), Bureau of Land Management, Final Environmental Statement: OCS Sale 48, 1979c, 5 Volumes.

U.S. Department of the Interior (DOI), Fish and Wildlife Service, Proposed List of Federally Protected, Endangered and Threatened Species, Washington, D.C., 1976a.

U.S. Department of the Interior (DOI), Fish and Wildlife Service, "Impact Prediction Manual for Geothermal Development," FWS-OBS-78-79, 1978.

U.S. Department of the Interior (DOI), Fish and Wildlife Service, Geothermal Handbook NP-21172, 1976.

U.S. Department of the Interior (DOI), Geological Survey (USGS), Geothermal Resources Operational Orders, Washington, D.C., 1976.

U.S. Environmental Protection Agency, "Noise from Construction Equipment and Operations," EPA Report PB-206-717, 1971.

U.S. Environmental Protection Agency, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," Washington, D.C., 1974.

U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations, Office of Water Supply, EPA-570-/9-76-003, 1976, 159 pp.

U.S. Environmental Protection Agency, "Compilation of Air Pollutant Emission Factors," Publication AP-42, 1977.

U.S. Naval Weapons Center (NWC), Project 21: A Long Range Modernization Plan for the NWC Ranges, NWC Administrative Publication 170, Volume 1, China Lake, CA, 1977.

U.S. Naval Weapons Center (NWC), Environmental Analysis Report Phase 1 of the Coso Geothermal Project, NWC Administrative Publication 184 (by T.C. Barling) China Lake, CA, Public Works Department, 1977b, 227 pp.

U.S. Naval Weapons Center (NWC), "A Preliminary Coso Geothermal Development Study—Impact on NWC T&E Operations," NWC Internal Distribution Publication 3513 (China Lake: NWC Test and Evaluation Directorate), 1978, 94 pp.

U.S. Naval Weapons Center (NWC), Final Environmental Impact Statement for the Navy Coso Geothermal Development Program, China Lake, CA, NWC Public Works Department, 1979, 2 Volumes.

U.S. Naval Weapons Center (NWC), A Land Use History of Coso Hot Springs, NWC Ad Pub 200. See Brooks, et al., 1979.

Vasek, F.C., H.B. Johnson and D.H. Eslinger. "Effects of Pipeline Construction on Creosote Bush Scrub Vegetation in the Mohave Desert," Madrono, 1975a, 23: 1-13.

Vasek, F.C., H.B. Johnson and G.D. Brum. "Effects of Power Transmission Lines on Vegetation of the Mohave Desert," Madrono, 1975b, 23: 114-130.

Volpe, K., District Range Resource Manager, Bureau of Land Management, Bakersfield, CA, personal communication, April 1979.

Weaver, C.S. and A.W. Walter. "Upper Crustal Structure Studies in the Coso Range, California," Jour. Geophys. Res., in press.

Weaver, C.S. and D.P. Hill. "Earthquake swarms and local crustal spreading along major strike-slip faults in California," Pure and Applied Geophysics, Vol. 177, 1978/79, pp. 51-64.

Webber, D., Kern County Public Works Department, Ridgecrest, CA, personal communication, June 1979.

Weiss, R.B., T.O. Coffey and T.L. Williams. "Ground Water Monitoring-Guidelines for Geothermal Development," U.S. EPA, Las Vegas, Nevada, and Cincinnati, Ohio, in press.

WESTEC, A History of Land Use in the California Desert, San Diego: WESTEC Services, Inc., 1978, 134 pp.

Whelan, J.A., Head, Geothermal Technology Branch, Naval Weapons Center, China Lake, CA, Code 2661, personal communication, 1979.

White, D.E. "Thermal Waters of Volcanic Origin," Geological Society of American, Bulletin, Vol. 68, 1957a, pp. 1637-1658.

White, D.E. "Magmatic Connate and Metamorphic Waters," Geological Society of America, Bulletin, Vol. 68, 1957b, pp. 1059-1682.

White D., Study in progress, Raft River Geothermal Test Site, Idaho, personal communication, 1979.

Williams, J.R. and R.W. Hann, Jr. "HYMO: Problem-Oriented Computer Language for Hydrologic Modeling, User Manual," Agricultural Research Service, ARS-S-9, 1972, 76 pp.

Winkler, B.D., written communication, Rockwell International, Environmental & Energy Systems Division, Creve Coeur, MO, 1979.

Wilshire, H.G. and J.K. Nakata. "Offroad Vehicle Effects of California's Mohave Desert," USGS, Menlo Park, California, California Geology, Vol. 29, No. 6, 1976, pp 123-132.

Witham, Roger, Staff Geologist, Office of Deputy Conservation Manager--Geothermal, USGS Menlo Park, CA, personal communication. June 1980.

Woodburne, M. O.; Fossil Vertebrate In the CDCA; Riverside, California.

Yarcho, R., Postmaster, Darwin, CA, personal communication, May 1979.

Zembal, R., B.W. Massey and T.E.LacRocque, "Winter Season Bird Population Studies in the Coso Geothermal Area of Inyo County, California." Report to the U.S. Department of the Interior, Bureau of Land Management, Bakersfield District, 1978, 32 pp. (Also in American Birds, 33:1).

The referenced Technical Reports prepared for this EIS are listed, by author, below.

Clewlow, C.W., D. Whitley, H. Wells. "Cultural Resources Technical Report on the Coso Geothermal Study Area," April, 1980.

Feldmeth, R., J. Henrickson, P. Leitner, D. Guthrie, T. Brown, S. Woodward, J. McDonald. "Field Ecology Technical Report on the Coso Geothermal Study Area," April, 1980.

McDade,C. "Air Quality Technical Report on the Coso Geothermal Study Area," April, 1980.

Mcdade, C., D. Holcomb. "Noise Technical Report on the Coso Geothermal Study Area," April, 1980.

Peters, J., G. Andrews, G. Borst, R. Ulrich, K. O'Loughlin, C. Patterson. "Soils Technical Report on the Coso Geothermal Study Area," April, 1980.

Weiss, R., T. Coffey, J. Koenig, M. Bergstrom, J. Sharp. "Geology - Hydrology Technical Report on the Coso Geothermal Study Area," April, 1980.

APPENDIX A

REGULATORY CONSTRAINTS

A.1 INTRODUCTION

The influence of regulatory and institutional constraints is a major factor in the development of geothermal resources. Major consideration is given to land use policy and environmental protection. In addition, the development of the Coso Geothermal Resource is constrained by the requirement that development of lands presently withdrawn by the U.S. Navy does not significantly interfere with the mission of the Naval Weapons Center (NWC); see APPENDIX C. Although the leasing of public lands is strictly a Federal action, the actual development of the geothermal resource is regulated by Federal, state and local agencies. This section provides a compilation of those constraints which have been identified.

A.2 Federal Statutes

The Bureau of Land Management is responsible for the leasing of the geothermal lands and the U.S. Geologic Survey is charged with regulating operations on the leased lands. Additionally, USGS assesses the nature of the resource and classifies lands as, Known Geothermal Resource Areas (KGRAs). The BLM is the primary contractor with the USGS as a third party who has the conditional power to modify the lease. USGS also has the power to suspend operations and recommend termination of the lease. In other words, USGS controls the technical aspects of geothermal leasing, while BLM controls the administrative aspects of the lease. The BLM is responsible for monitoring for compliance with environmental protection requirements outside the operating area and the USGS examines operations to insure compliance. Both the BLM and the USGS regulations require submission of annual reports on the measures taken to comply with environmental requirements. The following is a list of Federal laws which potentially regulate and/or constrain the full development of the Coso Geothermal Resource.

The Federal Land Policy and Management Act of 1976 (FLPMA) (Public Law 94-579). This act establishes Federal policy with respect to the utilization of Federal lands, their disposal, and the exploitation of resources contained on or under them. It designates the Bureau of Land Management as the agency with primary responsibility for managing the public lands under the principles of multiple use and sustained yield, in accordance with the land use plans developed by the Bureau. This act joins the Wilderness Act (16 USC 1131-1136) and the Mining and Minerals Policy Act of 1970 (30 USC 21a). Proction of cultural resources in the California Desert Conservation Area is mandated in Section 601.

National Environmental Policy Act of 1969 (Public Law 91-190). The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promota efforts which will prevent or eliminate damage to the envoronment and boisphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

The Taylor Grazing Act of 1934 (Public Law 73-865). This act authorizes the BLM to prevent injury to any public grazing land. It specifically calls for the prevention of overgrazing and soil deterioration, and directs the BLM to provide for the orderly use, improvement, development and stabilization of the livestock industry which may be dependent upon the public ranges. 43 CFR 4100. This regulation updates livestock grazing regulations for public lands, and adds provisions required by FLPMA of 1976. Essentially, this allows for management flexibility to achieve multiple use, sustained yield, and environmental as well as economic objectives.

The Geothermal Steam Act of 1970 (Public Law 91-581). This act provides for the leasing of lands containing geothermal resources. The law provides the Secretary of the Interior with authority to protect environmental qualities as well as promulgate leasing regulations. The regulations and related Geothermal Resource Operational Orders (GRO) mandate that Federal geothermal leases comply with all applicable Federal, state, and local environmental standards as well as any more stringent standards which the USGS Area Geothermal Supervisor may impose. This directive includes control of all forms of air, land, water and noise pollution, including but not limited to the control of erosion and the disposal of solid, liquid and gaseous wastes.

43 CFR 3200 - Definition of Terms.

43 CFR 3201 - Specifies lands available for leasing, limitations on leasing, and permits the establishment of unit operations. The section specifically waives the maximum acreage which any entity may control in a single state if leased lands are part of unit operations.

43 CFR 3203 - Specifies Leasing Terms.

43 CFR 3204 - Sets specific surface management requirements and sets limits on royalties and fees to be paid.

43 CFR 3206 - Specifies type of lease bonds required.

43 CFR 3209 - Establishes procedures for Geothermal Resources Exploration Operations on lands not specifically leased for geothermal development.

43 CFR 3210 - Establishes regulations for non-competitive leasing of land for geothermal development. Such lands are those which are not within a Known Geothermal Resource Area as defined in 43 CFR 3200.0-5.

43 CFR 3211 - Establishes procedures for release of formerly leased lands.

43 CFR 3220 - Establishes the procedures to be followed for competitive leasing of public land for geothermal development purposes.

43 CFR 3230 - Defines the rights to conversion of geothermal leases which have been issued under the Mineral Leasing Act of 1920 or subject to existing mining claims located on or prior to September 7, 1965.

43 CFR 3240 - This group of regulations establishes the rules governing geothermal leases. Included are rules pertaining to:

A. Assignments and transfers of lease rights.

B. Production and use of byproducts.

C. Establishment of cooperative or unit plans (unitization).

D. Terminations and expirations.

43 CFR 3250 - Provides the basis for the utilization of geothermal resources for the generation of electricity, by establishing a procedure for licensing electric power sites on geothermal resource leases under provisions of the Geothermal Steam Act of 1970.

30 CFR 270 - Establishes the authority of the U.S. Geological Survey (USGS) to regulate the development of geothermal resources on leased lands and to require compliance with the terms of the leases.

Establishes requirements for lessees (including operators). Requires the submission of drilling and producing plans as well as of well records and energy production records.

30 CFR 271 - Establishes regulations for unit operations.

<u>Geothermal Resources Operations Orders</u>

Geothermal resource operations orders are formal orders issued by the USGS to supplement the general regulations found in 30 CFR 270 by detailing the procedures and operations which must follow in a given area or region. The purpose of this arrangement is to allow consideration of more area-specific operating and environmental conditions.

GRO Order No. 1 - Exploratory Operations

GRO Order No. 2 - Drilling, Completion, and Spacing of Geothermal Wells

GRO Order No. 3 - Plugging and Abandonment of Wells

GRO Order No. 4 - Gneral Environmental Protection Requirements; Section 7 requires protective measures for cultural resources.

GRO Order No. 5 - Proposed Report and Forms

GRO Order No. 6 - Pipelines and Surface Production Facilities

GRO Order No. 7 - Production and Royalty Measurement, Equipment and Testing Procedures

Federal Geothermal Leases

The Federal laws which are applicable to geothermal leases are two-fold because compliance with many of them is a condition of the lease. For example, the Federal geothermal leases require the lessee to dispose of toxic drilling muds and the containers in which mud additives are received in a manner approved by a USGS Area Geothermal Supervisor and in conformance with applicable Federal, state and regional standards. Also, the Federal Water Pollution Control Act (PL92-500) does not give EPA direct authority to regulate erosion/sedimentation control, but it is a function of the lease. Federal leases are limited in noise levels not to exceed 65dB at a distance of 660 ft. (201M). Note: these standards are higher than the currently enforced noise levels of the State of California. In general, the BLM/USGS regulations for geothermal leasing limits the amount of land surface a lease may utilize for geothermal production and disposal area.

Resource Conservation and Recovery Act of 1976 (Public Law 94-58). This act establishes the criteria for management of solid waste and waste products. It requires the promulgation of regulations which implements a permit system for the disposal of solid wastes. Initial regulations have been published in 40 CFR 240-247. The EPA has proposed rules under Sections 3001, 3002, and 3004 which, together with Sections 3003, 3006, 3008, and 3010, will constitute the hazardous waste regulatory program. It is the EPA's goal to integrate the regulations with the National Pollutant Discharge Elimination System required by the Clean Water Act, and the Underground Injection Control Program of the Safe Drinking Water Act. Specific guidelines are to be adopted in late 1979.

Clean Water Act (Public Law 92-500 as amended by Public law 95-217). This act establishes the national policy of protection of the nation's ground or surface water resources. It explicitly calls for the elimination of discharge of toxic pollutants.

A. 40 CFR 116 - Designates hazardous substances as defined in the Clean Water Act. In a recent suit (Manufacturing Chemists Association, et al. vs. Costle), it was decided by the U.S. District Court (Western District of Louisiana) which held that certain sections of the regulations are invalid. The status of this regulation is, therefore, in considerable doubt at this time.

B. 40 CFR 117-119 - States that the EPA no longer determines the 1) removability 2) harmful quantities 3) penalties imposed on the discharge of toxic pollutants.

C. 40 CFR 123 - Which requires state certification of activities requiring a Federal License or Permit.

D. 40 CFR 124 - Establishes the regulations on state program elements necessary for participation in the National Pollutant Discharge Elimination System.

E. 40 CFR 125 - Establishes the regulations on Federal programs similar to the NPDES program; however, geothermal development is not included. Control of new source pollution, in this case, is vested in NEPA, a carry over from the Water Pollution Control Act.

F. 40 CFR 149 - Establishes regulations on Review of Projects Affecting Sole Source Aquifers.

Archaeological and Historic Preservation Act of 1974 (Public Law 93 - 291). This act empowers the Secretary of the Interior to provide for the preservation of historical and archaeological data which may be lost or destroyed as a result of Federal action.

A. 36 CFR 60 - Establishes the National Register of Historic Places

B. 36 CFR 800 - Specifies procedures for the Protection of Historic and Cultural Properties

National Historic Preservation Act of October 15, 1966 (Public Law 89-665). This act enlarges the National Register to include districts, sites, buildings, structures and objects significant in American history, architecture, archeology, and culture. It permits nomination of such historic sites for inclusion into the National Register by the various states. Incorporated into this act is Executive Order 11593, which appoints and delegates responsibilities to the State Historic Preservation Officer, and provides for the State Historic Preservation Plan, and procedures for notification and nominations of sites.

American Indian Religious Freedom Act (Public Law 95-341). This act establishes the national policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express and exercise the traditional religions of the American Indian, Eskimo, Alent, and Native Hawaiians including but not limited to access to sites, use and possession of sacred objects and the freedom to worship through ceremonials and traditional rites.

The Clean Air Act (Public Law 91-604 and amendments). This act, as amended, establishes the Federal policy for protection of the quality of air and sets forth specific methods by which such protection shall be carried out. The law requires that each state prepare an Implementation Plan which clearly describes how that state will insure that National Ambient Air Quality Standards (NAAQS) are achieved and the significant deterioration of ambient air quality will be prevented.

The regulations designed to prevent significant air quality deterioration in areas where the air pollution levels are currently below the NAAQS (source-specific) do not presently include geothermal operations. No new source performance standards (NSPS) have been established for geothermal exploration or development up to this time. If geothermal NSPS are promulgated, it would affect all future geothermal development as well as existing operations.

Fish and Wildlife Coordination Act (Public Law 85-624). Requires baseline studies of the wildlife in areas to be leased, and the establishment of measures to mitigate harm prior to leasing. These requirements are met through the NEPA and California CEQA processes.

Safe Drinking Water Act (Public Law 93-523 as amended by Public Law 95-190). This act establishes the framework for promulgation of regulations to insure that the sources of drinking water are safe for use by the public. It includes provisions for regulation of injection of substances into underground aquifers which constitute the sole or principal sources of supply for communities.

> 40 CFR 146 - gives the state primary enforcement authority over underground injection.
>
> Regulations are currently being proposed under 40 CFR, Parts 122, 123, and 124 which will consolidate the procedural requirements for the EPA's major permit programs.

Under Section 1422 of the Act, each state may submit an Underground Injection Control (UIC) program to establish state authority and control. California Department of Conservation, Division of Oil and Gas (DOG) has begun to develop such a program, estimated to be completed by August 1981. Until California has an EPA certified UIC program, the EPA regulations will pertain. However, on Federal leases, the regulatory agency for UIC is the US Geologic Survey. The regulations which pertain to UIC are found in the draft GRO No. 5. The final GRO No. 5 is due to be published in July 1980.

Noise Control Act of 1972 (Public Law 92-574 as amended by Public Law 94-301). This act vested primary control of noise with state and local government, but retained Federal regulatory authority over the production of four categories of low noise level products; construction, transportation equipment, motors or engines, and electrical or electronic equipment. Until EPA promulgates regulations on a product, the states are free to set their own regulations, When EPA does issue regulations, state standards must meet Federal regulations. This Noise Control Act, along with the requirements of the Federal geothermal lease, provides noise control for geothermal operations.

Endangered Species Act of 1973 (Public Law 93-205 as amended by Public Law 94-32 and 94-539). This act has the purpose of providing a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and of providing a program for the conservation of such endangered or threatened species. Section seven of this act requires all Federal departments and agencies to avoid actions authorized, funded, or carried out by them from destroying or adversely modifying critical habitats.

Soil and Water Resources Convervation Act of 1977 (Public Law 95-192). This act establishes the policy that Federal programs shall be responsive to the long term needs of the nation and that conservation of land and water resources is a long term requirement. It provides for the establishment of a Federal water and soil conservation program.

Toxic Substances Control Act (Public Law 94-469). This act establishes the authority to regulate chemical substances which may present an unreasonable risk of injury to health or the environment. This act, together with the requirements of the Federal geothermal lease, provides controls for toxic substances.

Executive Order 11514 - "Protection and Enhancement of Environmental Quality" March 5, 1970. To further the purpose and policy of NEPA of 1969, the Federal government shall provide leadership in protecting and enhancing the quality of the nation's environment to sustain and enrich human life. This order designates responsibility to Federal agencies to develop procedures to insure timely public information and develop programs to monitor and evaluate 1) pollution control, and 2) enhancement of environmental quality.

Executive Order 11593 - "Protection and Enhancement of the Cultural Environment" (36 FR 8921) May 13, 1971. This order directs the Federal government (primarily the Department of the Interior), to provide leadership in preserving, restoring, and maintaining the historical and cultural environment of the nation. Agencies must list in the National Register of Historic Places, all sites or nominations as of July 1, 1973, and provide documentation before any destruction can take place.

Executive Order 11870 - "Environmental Safeguards on Activities for Animal Damage Control on Federal lands". This order directs that it is the Federal policy to manage all public lands to protect all animal resources thereon in the manner most consistent with the public trust in which such lands are held.

Executive Order 6206 (Signed 16 July 1933). This order withdraws a significant amount of land in the area proposed for leasing for the purposes of protection of the water supply of the City of Los Angeles. According to the language of the order, the withdrawal is temporary in aid of proposed legislation. However, there is no record that said legislation was ever passed by the Congress. The land is withdrawn "from settlement, location, sale or entry....". The current legal status of this withdrawal can pose a serious contraint on the development of the Coso Geothermal Resource. According to the Withdrawal Act of June 25, 1910, (sometimes referred to as the Picket Act), the President may, at any time at his discretion, temporarily withdraw from settlement, location, sale, or entry any of the public lands of the U.S. ".... and reserve the same for the public purpose specified in the orders of withdrawals, and such withdrawals shall remain in force until revoked by him or by an Act of Congress." Public Law 94-579, see above, on the other hand, specifies that withdrawals may not be for a duration of greater than 20 years.

Executive Order 12088 (Signed October 13, 1978). This order re-emphasizes that Federal agencies obey "most pollution abatement regulations" and adds that they also comply with state, interstate, and local procedural regulations "just as any private industry must do."

Tripartite Memo of Understanding. This MOU is a joint agreement between the USGS, BLM, USF&WS, establishing Cooperative Procedures in the Geothermal Program, signed 1976. The W.O. 105 addendum to the MOU specifically addresses protection of Cultural Resources from surface disturbing activities related to the Federal Geothermal Lease operations. The W.O. 105 addendum to the MOU and proposed NWC constraints package can be found in Appendix C.

A.3 State and Local Regulatory Constraints

The regulatory agencies throughout California concerned with the development of geothermal energy at Coso, have been contacted by the California State Energy Commission Geothermal Advisory Committee. The Committee subsequently developed a document identifying the concerns and constraints of these regulatory agencies. This document is available through the BLM Bakersfield Office, as well as the California State Energy Commission. Inyo County has a Geothermal Element included in the County's General Plan which gives guidelines for the exploration, development, and eventual shutdown of geothermal operations. This document is available through the Inyo Planning Commission.

APPENDIX B

GEOTHERMAL DEVELOPMENT MODEL

Please see the Draft Environmental Impact Statement
for this Appendix.

Appendix C

C.1 MEMORANDUM OF UNDERSTANDING
Between
Naval Weapons Center, Department of Navy
Bureau of Land Management, Department of Interior

GEOTHERMAL LEASES IN COSO GEOTHERMAL AREA

It appearing that the Secretary of the Interior, acting through the California State Director, Bureau of Land Management (BLM) and the Department of the Navy, acting through the Commander, Naval Weapons Center (NWC), China Lake, California, have a mutual interest in certain real estate involving both acquired and/or withdrawn lands lying within and without the boundaries of NWC, and being generally within the subsurface to a circular surface area of a diameter of approximately forty-two (42) kilometers and centered at approximately 36° 05' latitude and 117° 50' W. longitude for the production of geothermal steam and associated geothermal resources. This area is depicted on the attached plat;

And it further appearing that although approximately the eastern sixty percent of this area lies within the boundaries of the NWC and, therefore, the surface of the area is under control and administration of the Department of the Navy, through the Commander, Naval Weapons Center; and that approximately the western forty percent of this area lies outside the boundaries of the NWC and, therefore, under the administration of the Department of the Interior, through BLM;

And it appearing that expeditious development and exploitation of geothermal steam and associated geothermal resources is of great importance to the United States, its agencies and its people;

And it also appearing that such development can be accomplished only with the highest degree of cooperation between the two governmental agencies which are parties hereto;

And it appearing that the NWC is an irreplaceable facility essential to the Navy in fulfilling its National Defense responsibilities;

And it appearing that it is in the National interest that there be orderly, optimum and expeditious development and expolitation of geothermal resources in the Coso area in such a manner that the NWC may continue to perform, fully, its National defense functions;

Therefore, it is deemed appropriate that this Memorandum of Understanding be entered into between the parties and their designated officials;

This Memorandum records the understanding of the parties as follows:

1. Public lands withdrawn for the purpose of the NWC defense mission shall be available for geothermal leasing upon NWC's written consent thereto with those stipulations determined necessary to make geothermal operations compatible with the mission of NWC. BLM will, to the extent authorized by applicable law, commit withdrawn lands within NWC to leases in accordance with mutually agreeable schedules.

2. NWC will proceed with its geothermal exploration and development program on acquired lands in the above-described area to provide a secure power supply for the Navy and to gain Navy expertise and experience in employment of this new energy source for support of military missions.

3. NWC and BLM shall cooperate in obtaining modifications to the applicable Public Land Orders to permit the leasing and development of geothermal resources on those lands described above. Jurisdiction over the subsurface and surface of NWC lands covered by this Memorandum necessary to permit development and exploration of the geothermal resources will be vested in the Secretary of the Interior, subject to such surface use controls and/or contraints as may be stipulated by NWC.

4. BLM agrees to coordinate lease stipulations for the public lands in proximity to the NWC lands with the Navy in consideration of the Navy's mission at NWC.

5. The parties agree to immediately take steps to determine methods under which NWC lands can legally be leased and to set forth schedules and programs for completing environmental analyses, leasing schedules, and methods of lease supervision and management of NWC lands, together with mutually acceptable lease conditions on adjacent public lands. Control of access, supervision of operations and handling of data shall be developed as part of lease terms and future agreements between the involved agencies. Lands within the NWC withdrawn area will be withheld from leasing until appropriate terms for development, utilization, or management are approved by the Navy.

6. In general, BLM and NWC agree to fully support each other in this mutual effort, and specifically, to support each other as necessary to accomplish the fullest development of the resource. BLM and NWC agree to cooperate in the development of terms and conditions which will enable lessee operations and NWC operations for exploration and production of geothermal resources in a compatible manner, including but not limited to, utilization, procedures and/or joint development.

7. It is mutually understood by BLM and NWC that the Commander, Naval Weapons Center does not have quthority to fully implement this agreement and that NWC will expeditiously request that authority.

8. It is mutually understood by BLM and NWC that the surface use controls and/or constraints will be identified per paragraph 3, within approximately 60 days of the the execution of this agreement. Those stipulations will then be made a part of this MOU by amendment. It is further understood

that after the initial 60 day period, any emerging control/constraint necessary to prevent an adverse impact on the NWC mission will be incorporated into the BLM leases.

DATED: Dec. 6, 1977 W. L. Harris

Commander, Naval Weapons Center
China Lake, California
DEPARTMENT OF THE NAVY

DATED: Nov. 30, 1977 Ed Hastey

State Director, Bureau of Land Management
California
DEPARTMENT OF THE INTERIOR

Pursuant to the MOU is an addendum regarding constraints on geothermal operations on NWC lands. This constraints package is in draft form and subject to change.

AMENDMENT TO
MEMORANDUM OF UNDERSTANDING
Between
Naval Weapons Center, Department of Navy
and
Bureau of Land Management, Department of Interior

GEOTHERMAL LEASES IN COSO GEOTHERMAL AREA

Pursuant to paragraphs three and eight of the Memorandum of Understanding between the Naval Weapons Center, Department of Navy, and the Bureau of Land Management, Department of Interior, executed on 6 December 1977, it is jointly agreed by the undersigned that the following Navy constraints of geothermal operations on Naval Weapons Center lands will be incorporated into the Memorandum of Understanding.

1. General.

Constraints will be placed on geothermal operations within the boundaries of the Naval Weapons Center to ensure the safe and economical development and production of those geothermal resources within the NWC boundary and to ensure that any leasing, development or production does not conflict with the mission of NWC. In addition to the lease terms and requirements contained in the lease form, the lessee shall comply with the following special stipulations unless they are jointly modified by the Commander, NWC and the State Director, Bureau of Land Management, with concurrence of the USGS Area Geothermal Supervisor.

2. Administrative Responsibility.

The Commander, NWC, is the responsible agent of the Federal Government for the utilization of the land surface and airspace of NWC. As such, the Commander, NWC, is responsible for the protection of the health and safety of all personnel, military and civilian, within the confines of NWC, and is responsible for the continuing preservation of the ability of NWC to perform its mission of air delivered weapons research, development, test, and evaluation.

3. Access.

Access to the NWC is a privilege granted by the Commander, NWC. Exercise of this privilege requires adherence to NWC traffic regulations, check in/check out procedures, radiation control measures, environmental controls, area access limitations, and electronic emission controls and such other published administrative regulations as appropriate. Access shall be on a not-to-interfere basis with NWC test schedules, and shall be limited to that specific lease block or area being explored, developed or produced. Access schedules shall be established on a weekly basis with NWC. NWC shall provide uninterrupted short term access for reasons of geothermal safety or other drilling incidents requiring access to a specific site for geothermal operations. Experience to date shows that in any given month, scheduled and unscheduled daylight downtime will not regularly exceed 10% and nightime downtime will not regularly exceed 2%. Access shall require that for each lease holder, one responsible contact point shall at all times know who is present on NWC lands, and this contact point shall be reachable at all times in event evacuation is ordered.

4. Security.

The mission of the NWC is such that visitors cannot be granted access to NWC lands without going through NWC security procedures. All non-citizen visits must be arranged through NWC with a minimum notice of 96 hours for non-communist-bloc visitors. The latter will be considered on a case-by-case basis. Accessible areas visitors use will be delineated by NWC.

5. Environmental.

NWC retains the right to suspend any operation judged by the Center to present an imminent threat to the environment. During all operations, all federal, state and local environmental standards shall be rigorously observed. No components of the environment shall be unnecessarily disturbed. NWC shall have the right to impose those emission standards required to protect the Center's mission.

6. Sites and Routes.

All vehicular traffic shall be limited to routes approved by NWC. Power plant sites, drill pad sites, and pipe line routes will be selected subject to NWC approval to ensure that such sites will have a minimum impact on NWC range operations. All site plans shall be submitted to NWC for review and approval. Routes to and from work areas within lease blocks shall be approved by NWC.

7. Shelters.

Lease operators shall have the option of either moving employees outside NWC boundaries upon request of the designated representatives of the Commander, NWC, or retiring to NWC approved personnel shelters provided by the lessee during those times when the NWC operations require personnel protection at the work site.

8. Radioactive Sources.

No radioactive sources shall be brought into NWC until appropriate Navy permits have been obtained. These permits will be issued after NWC has verified the license of the operator to be valid for the proposed effort and has approved written standard procedures for use and for handling lost or damaged sources.

9. Injuries and Accidents.

All disabling injuries occurring within NWC boundaries will be reported within 24 hours to NWC. NWC will have the right to suspend any operation judged by NWC to present an imminent danger to any personnel on NWC property or to government property.

10. Electronic Radiation.

Electronic emissions will not be permitted without prior review and authorization by the NWC. Periods of emission will be coordinated with the Center and, at times, the Center may require electronic emission silence for periods of up to four hours.

11. Plant Protection.

All well-heads shall be revetted to a degree acceptable to NWC; all wells so designated by NWC shall be fitted with an approved below ground or revetted flow limiter; all pipe lines shall be fitted with automatic flow limiters as approved by NWC and all power plants shall be equipped with a hardened control room approved for continuous occupancy during NWC tests.

12. Information.

All information on incidents involving both NWC equipment and/or personnel and the geothermal operators will be released to the public jointly by NWC and the Department of Interior. Particular attention will be given to information concerning incidents that have the potential for high public interest. Any serious injury or fatality and any geothermal blowout will be reported at once to NWC.

13. Military/Government Property.

All military and government property found on the land surface or embedded in the land shall be left in place. NWC shall be informed of the presence of all suspected or potentially hazardous material immediately and NWC personnel will inspect and remove such material in a timely manner. In case of doubt, NWC is to be called for an inspection.

14. Data Exchange.

Data on flow, chemistry of fluids and reservoir conditions and structure shall be provided to NWC with such data to remain proprietary in accordance with current practices and procedures as developed by the Area Geothermal Supervisor and set forth in 30 CFR 270.

15. Legal Jurisdiction.

Law enforcement on NWC lands will remain the responsibility of NWC. The use of geothermal operator employees in a guard function or the contracting by the geothermal operator for security guards on NWC lands will be subject to review and approval by NWC.

16. Right of Inspection.

NWC shall have the right of inspection at all times to ensure and verify compliance with these constraints.

Dated: 8 July 1980 W. B. Haff

Commander, Naval Weapons Center
China Lake, California
DEPARTMENT OF THE NAVY

Dated: 8 July 1980

State Director, Bureau of Land Management
Sacramento, California
DEPARTMENT OF INTERIOR

APPENDIX C

C.2 NAVY CONSTRAINTS ON GEOTHERMAL OPERATIONS ON NWC LANDS

.1 General

Constraints will be placed on geothermal operations, within the boundaries of the Naval Weapons Center, to ensure the safe and economical development and production of those geothermal resources within the NWC boundary, and ensure that any leasing, development, or production does not conflict with the mission of the NWC.

.2 Administrative Responsibility

The Commander, NWC, is the responsible agent of the Federal Government for the utilization of the land and airspace of the NWC. As such, the Commander, NWC, is responsible for the protection of the health and safety of all personnel, military and civilian, within the confines of NWC, and is responsible for the continuing preservation of the ability of NWC to perform its mission of Air Weapons RDT&E.

.3 Access

Access to the NWC is a privilege granted by the Commander, NWC. Exercise of this privilege requires adherence to the NWC traffic regulations, check in/check out procedures, radiation control measures, environmental controls, area access limitations, electronic emission controls, and such other published administrative regulations as appropriate. Access shall be on a not-to-interfere basis with NWC test schedules, and shall be limited to that specific lease block or area being explored, developed or produced. Access schedules shall be established on a weekly basis with NWC. NWC shall provide for emergency access, for reasons of geothermal safety or other drilling incidents requiring uninterrupted short term access, to a specific site or geothermal operation. Experience to date shows, in any given month, unscheduled daylight downtime will not regularly exceed 10%, and unscheduled nighttime downtime will not regularly exceed 2%. Access shall require that for each leaseholder, one responsible contact point shall at all times know who is present on NWC lands, and this contact point shall be reachable at all times in the event an evacuation is ordered.

.4 Security

The mission of the NWC is such that visitors cannot be granted access to NWC lands without going through NWC security procedures. All non-citizen visits must be arranged through NWC with a minimum notice of 48 hours for non-communist-bloc visitors. The latter will be considered on a case-by-case basis. The accessible areas and routes to and from work areas within lease blocks shall be approved by NWC.

.5 Vehicular Usage

All vehicular traffic shall be limited to routes approved by NWC. NWC retains the right to suspend any operation that, judged by the Center, presents an imminent threat to the environment. During all operations, all Federal, state and local environmental requirements shall be rigorously observed. No components of the environment shall be unnecessarily disturbed. NWC shall have the right to impose those emission standards requried to protect the Center`s mission.

.6 Sites and Routes

Power plant sites, drill pad sites, and pipeline routes will be selected subject to NWC approval to ensure such sites will have a minimum impact on NWC range operations. All site plans shall be submitted to NWC for review and approval.

.7 Shelters

Lease operators shall have the option of either removing their employees from NWC upon request or retiring to NWC approved personnel shelters provided by the contractor during those times when the NWC mission requires personnel protection at the work site.

.8 Radioactive Sources

No radioactive sources shall be brought onto NWC until appropriate Navy permits have been obtained. These permits will be issued once NWC has verified the license of the operator to be valid for the proposed effort, and approved written standard procedures for use and for handling lost or damaged sources.

.9 Injuries and Accidents

All disabling injuries occurring on NWC land will be reported within 24 hours to NWC. NWC will retain the right to suspend any operation judged by NWC to present an imminent danger to any personnel on NWC property or to government property.

.10 Electronic Radiation

Electronic emissions will not be permitted without prior review and authorization by the NWC. Periods of emission will be coordinated with the Center and, at times, the Center may require electronic emission silence for periods of up to four hours.

.11 Plant Protection

All well heads shall be revetted to a degree acceptable to NWC; all wells shall be fitted with an approved below ground flow limiter; all pipe lines shall have automatic flow limiters as approved by NWC, and all power plants shall be equipped with a hardened control room approved for continuous occupancy during NWC tests.

.12 Information

All information on incidents involving NWC equipment and/or personnel associated with the geothermal operations will be released to the public by NWC or jointly by NWC and the geothermal operator. Particular attention will be given to information concerning incidents that have the potential for high public interest. Any serious injury or fatality and any geothermal blowout will be reported at once to NWC.

.13 Military/Government Property

All military and government property found on the land surface or embedded in the land shall be left in place. NWC shall be informed of the presence of all suspected or potentially hazardous material immediately and NWC personnel will inspect and remove such material in a timely manner. In case of doubt, NWC is to be called for an inspection.

.14 Data Exchange

Data on flow, chemistry of fluids, and reservoir conditions and structure shall be provided to NWC with such data to remain proprietary for a mutually agreed time, and in no case to exceed 10 years.

.15 Legal Jurisdiction

Law enforcement on NWC lands will remain the responsibility of NWC. The use of geothermal operator employees in a guard function or the contracting by the geothermal operator for security guards on NWC lands will be subject to review and approval by NWC.

.16 Right of Inspection

NWC shall have the right of inspection at all times to ensure and verify compliance with these constraints.

.17 Resource Production

All production plans including reinjection schedules shall be submitted to NAVWPNCEN for the record and any such activities that show a reasonable probability of damaging or decreasing the productivity of NAVWPNCEN fee lands shall be prohibited unless such operations and the NAVWPNCEN fee lands involved are both covered by and operated under the same producing unit agreement.

The procedures outlined in the agreement are intended to supplement the cooperative procedures between BLM, GS, and the U.S. Fish and Wildlife Service (FWS) as formally established in June 1976. The provisions of this cultural resource protection agreement will be reviewed at least annually and revised as necessary to improve their workability and will be incorporated into any revision of the BLM, GS, and FWS Cooperative Procedures Agreement of June 1976.

The cultural resource protection procedures as outlined in this agreement are intended to increase cooperation between the Bureaus, avoid duplication of work, and promoted more efficient use of field personnel. It is essential that supervisors of both agencies take the lead in assuring that the procedures of this agreement are carried out. To facilitate the annual review of this agreement supervisors should, after an appropriate period of operating experience under the term of the agreement, notify the co-chairman of desirable changes or additions.

C.3 COOPERATIVE PROCEDURES

U.S. Geological Survey and Bureau of Land Management

Protection of Cultural Resources Related to Geothermal Lease Operations

Introduction and Purpose

This agreement establishes cooperative procedures between the Bureau of Land Management (BLM) and the U.S. Geological Survey (GS) for the protection of cultural resources from surface disturbing activities related to Federal geothermal lease operations. This agreement sets forth the respective functions and responsibilities of the two agencies on public lands where BLM is the responsible surface management agency and on private surface where Federal reserved minerals are involved.

BLM and GS have concluded the following:

1. Compliance with the National Historic Preservation Act of 1966 (NHPA), as amended, and Executive Order 11593 is mandatory for both agencies.

2. There is a need to consider cultural resources in the earliest planning stages of development in order to minimize delays in the exploration and development of geothermal resources.

3. Long-term management continuity for cultural resources should be addressed in all aspects of planning and policy decisions.

4. There is a need to ensure that cultural resources are not inadvertently injured or destroyed by geothermal operations and related activities.

5. There is a need to achieve and maintain consistency in the application of cultural resource management requirements and stipulations related to geothermal lease operations.

6. There is a need for interface procedures between BLM and GS that will permit the timely processing of applications to conduct geothermal operations.

7. There is a need, in the consideration of applications to conduct operations, to integrate the data collection requirements of the National Environmental Policy Act of 1969 (NEPA), as amended, and section 106 of NHPA of 1966, as amended, to avoid delay and duplication of effort in cultural resource protection.

Definitions

Avoidance is the partial or complete redesign or relocation of a project or action to eliminate the potential of impact to a cultural resource. If avoidance cannot be insured, then appropriate mitigation must be undertaken. (See mitigation.)

BLM/GS Program Coordination Committee is an intradepartmental committee established to provide a formal vehicle for program coordination between BLM and GS. Co-chaired by the Associate Director, BLM, and the Associate Director, GS, the committe consists of directorate level representatives from the two Bureaus; plus appropriate subcommittees. The committee meets monthly in Washington, D.C.

Cultural resources are those fragile and nonrenewable remains of human activity, occupation, and endeavor as reflected in districts, sites, and natural features that were of importance in human events. These resources consist of (a) physical remains, (b) areas where significant human events occurred--even though physical evidence of the event no longer remains, and (c) the environment surrounding the actual resource. Cultural resources include both prehistoric and historic remains.

Data recovery is the systematic gathering of the scientific, prehistoric, historic, and/or archeological data that provide a cultural resource property with its research and data value.

Mitigation is the alleviation or lessening of possible adverse effects of the action upon a cultural resource by application of appropriate protection measures. Mitigation may include detailed recordation and documentation, surface collection, subsurface sampling, salvage, and/or relocation of the resource. The nature of the mitigation is dependent upon the impact and the scientific and sociocultural value of the cultural resource involved.

Scientific value is the importance attributed to a cultural resource by scientists and historians because of the information it contains, which will contribute to the understanding of human behavior.

Sociocultural value is the importance attributed to an object, structure, place, living thing, lifestyle, or belief by a group based on the group's perception of the object's role in maintaining their heritage or their existence as a group. Sociocultural values are usually expressed in qualitative, rather than quantitative, terms.

Principles of Agreements

Therefore, BLM and GS mutually agree to the following:

1. The procedures outlined herein supplement the cooperative procedures between BLM, GS and the U.S. Fish and Wildlife Service (FWS) as formally established in June 1976; however, in case of any conflict or inconsistency with regard to cultural resources, the provisions of this agreement shall prevail.

2. A memorandum of Understanding between BLM, GS, and the Advisory Council on Historic Preservation (ACHP), pursuant to section 106 of NHPA, as amended, will be developed based, in part, on the procedures outlined herein.

3. Since the compliance process of both NEPA and section 106 of NHPA, requires similar data, these two requirements will be integrated, whenever possible, so that data generated may be used as documentation for both.

4. Impacts on cultural resources shall be avoided or mitigated.

5. Because BLM has cultural resource expertise, GS will rely on BLM to provide the cultural resource protection requirements related to geothermal lease operations and to coordinate cultural resource compliance responsibilities, including National Register of Historic Places eligibility determinations, consultation with the State Historic Preservation Officer (SHPO), and completion of section 106 of NHPA compliance. This will be superseded by any Memorandum of Understanding developed pursuant to item 2, above.

6. On leases where BLM is the surface management agency or where Federal reserved minerals are involved, GS is responsible for enforcement of compliance with the BLM's cultural resource protection requirements within the area of operations. Accordingly, BLM may make field examinations and report infractions to the Area Geothermal Supervisor and otherwise aid GS in carrying out its enforcement responsibilities in this regard. If the Authorized Officer, BLM, or his designee, discovers that an operator is conductiong activities which are not in compliance with cultural resource protection requirements of the lease terms, the approved permit to drill, applicable geothermal operating regulations and orders, or the approved Plan of Operation, and that such activities pose a threat to the preservation and integrity of the cultural resources, and a representative of the Area Geothermal Supervisor is not timely available, the Authorized Officer, BLM, may order the immediate cessation of such activities and shall promptly notify the Area Geothermal Supervisor.

7. If BLM and GS encounter difficulties at the field level in achieving agreement as to the necessary requirements for the protection of cultural resources, the problems will be referred to the BLM-GS Program Coordination Committee for resolution.

8. The provisions of this agreement shall be reviewed by the BLM-GS Program Coordination Committee at least annually and revised, as necessary, to improve their workability and shall be incorporated into any revision of the cooperative procedures between GLM, GS, and FWS, as formally established in June 1976.

Procedures

In furtherance of the general concepts listed above, BLM and GS agree to the following procedures to ensure cultural resource protection for geothermal leasing and operations over which BLM and GS exercise joint responsibilities.

1. BLM will include a special stipulation for the identification and protection of cultural resources in all new and renewed geothermal leases, specifying the following points:

a. The certified statement required by section 18 of the lease form must be completed by a qualified cultural resource specialist acceptable to the Authorized Officer, BLM; and

b. When necessary, additional special cultural resource stipulations and/or restrictions may be imposed by BLM and GS.

2. GS will not grant relief to the lessee or operator from any part of these stipulations without approval by the Authorized Officer, BLM.

3. Through the use of a Notice to Lessee (NTL) or other means, GS will do the following:

a. Inform the lessee or operator that a cultural resource inventory of the area(s) to be disturbed must be performed and that the cost of the cultural resource inventory and report will be borne by the lessee;

b. Instruct the lessee or operator that the boundaries of the areas to be disturbed must be staked prior to conductiong the cultural resource inventory; and

c. Refer the lessee or operator to the Authorized Officer, BLM, for specific information regarding cultural resource inventory and report standards.

4. GS will insure that the cultural resource inventory report will be included as part of the Plan of Operation submitted to the Area Geothermal Supervisor, and forward a copy of the Plan of Operation and the cultural resource inventory report to the Authorized Officer, BLM.

5. Upon receipt of the Plan of Operation, BLM will do the following:

a. Review the report for acceptability; and

b. Advise GS within 10 working days that-

(1) The report is acceptable, or

(2) The report must be supplemented.

6. Upon receipt of comment from BLM regarding the adequacy of the cultural resource inventory report, GS will notify the lessee or operator of the following:

a. The report is acceptable; or

b. The lessee or operator, at its own expense, is required to perform additional work to supplement the cultural resource inventory report.

7. Upon receipt of an acceptable cultural resource inventory report and after reviewing the Plan of Operation, GLM will do the following:

a. Determine avoidance requirements and necessary mitigation, and prepare special stipulations designed to ensure compliance with Federal Cultural resource protection regulations, including consulting with the SHPO and completion of section 106 of NHPA compliance; and

b. Provide GS with the determined avoidance requirements, necessary mitigations, and special stipulations within 30 days of BLM's receipt of the acceptable cultural resource inventory report, unless an extension is requested by BLM.

8. Although BLM is the lead agency in matters pertaining to section 106 of NHPA compliance, when time is of great importance, GS, with BLM concurrence, may provide assistance in the consultation process.

9. GS will inform the lessee or operator of avoidance requirements, necessary mitigations, and special stipulations identified in item 7 above, and incorporate them in the approved Plan of Operation. Mitigation of impacts to known cultural resources must be completed before surface disturbance begins in the immediate area of such resources. All mitigation costs associated with the protection of cultural resources identified prior to the commencement of operations will be borne by the lessee or operator.

10. GS will refer the lessee or operator to an appropriate BLM officer for clarification of questions regarding mitigation of impacts to cultural resouces.

11. In the event of a discovery of previously unknown cultural resources during operational activities conducted under an approved plan or permit the following actions shall occur:

a. The lessee or operator will stop operations in the immediate area of the discovery and shall immediately notify GS, or BLM if unable to contact GS, of the cultural resource discovery;

b. GS will instruct the operator to suspend operational activities in the immediate area of the cultural resource and will immediately notify the Authorized Officer, BLM, of the discovery. If GS is not immediately available, BLM may direct a suspension of operations and immediately notify GS of such an action; and

c. The Authorized Officer, BLM, will evaluate, or have evaluated, all previously unknown cultural resources brought to his attention and will advise GS, within 48 hours of being notified, of any action that may be required to protect or preserve each discovery. GS will immediately notify the operator of any actions that must be taken prior to the resumption of operations in the discovery area. Responsibility for, and cost of, data recovery of such cultural values discovered during operations will be borne by the lessee.

Arnold E. Petty 6/22/78

Acting Director, Bureau of Land Management Date
Arnold E. Petty

W. A. Radlinski 6/22/78

Acting Director, U.S. Geological Survey Date
W. A. Radlinski

APPENDIX D

MONITORING PLANS

D.1 SOILS

A soils monitoring program is presented to provide a means of assessing changes over time in the soil resources of the Coso Geothermal Study Area.

To provide a check of ongoing soil erosion which has resulted from geothermal activities, photographic documentation of actively eroding soil areas should be carried out on an annual basis. This documentation may be implemented by the lease field developer or the BLM at the end of the rainy season. Actual measurement of depth, width, and length of rills and gullies should be carried out to determine if changes in size are occurring over time. Photo documentation is applicable to all stages of the proposed action, and shall also serve as a means of monitoring the effectiveness of implemented soil mitigation measures.

To monitor the effects of cooling tower emissions on soils, a sampling scheme is presented as follows:

1. Soils should be sampled annually by the lease field developer or the BLM at the end of the rainy season.

2. Permanent marker pins should be located every 1,000 feet along a transect extending in the same compass direction and located in coordination with the air quality monitoring devices. This transect will extend approximately one to three miles downwind from a power plant The transect sampling scheme should be implemented prior to the field development stage as described in the proposed action.

3. Method of Sampling

   A. Ten individual soil samples should be taken within a 10-meter radius of each marker pin.

   B. Samples should be taken with an Oakfield stainless steel soil sampling tube (or equivalent) of the surface A horizon of the soil regardless of soil type.

   C. The 10 satellite samples should be composited and mixed thoroughly, then stored in double thickness one-gallon zip-loc bags. An approximately 500-gram subsampler per marker pin should be collected.

D. An additional samples should be taken at each marker pin for mercury analysis. This soil sample should be collected at a depth of four to six inches. If the soil sample is dry, it should be sieved to -80 mesh in the field, using a stainless steel sieve, and stored in an air-tight screw top glass vial. Wet samples should be dried at room temperature or in the shade before sieving. A small quantity of soil is adequate.

4. Soil samples should be transported carefully and submitted for analysis within five days of collection. Laboratory analysis of the soil samples should be undertaken for the following constituents:

   A. Boron

   B. Chlorides

   C. Sulfur

   D. Mercury, using a Jerome Instrument Corporation, Gold Film Mercury Detector (or equivalent).

In addition, the soil samples should be characterized for pH, electrical conductivity, and sodium absorption ratio.

D.2 MONITORING PLAN: WILDLIFE AND FLORA

A comprehensive plan for ecosystem monitoring is essential for proper mitigation of impacts to both wildlife and flora. (These two resources have been grouped together for efficiency as suggested in the Request for Proposal.) The plan is designed to determine whether the impacts of the proposed action were accurately assessed in the FES, and whether mitigation measures proposed are proving effective, including the rehabilitation efforts at the site. This plan should include the following components:

1. The amount of habitat lost for each lease tract should be checked by comparing aerial photographs taken upon completion of each power plant with those used in preparation for the Flora Technical Report or by counting acreage of the mapped areas disturbance. The former method would provide the most accurate information but it would also be more expensive. Either method will allow a determination of the type and amount of habitat lost and will aid in mitigation. The amount of revegetation of road cuts and other disturbed areas needed to compensate for lost wildlife habitat can thus be determined from these before-and-after floral analyses.

2. Population monitoring is required on a regular basis when a phased project of this magnitude is carried out. Also, the rare Mohave ground squirrel appears to be particularly abundant on almost every part of the CGSA. More Mohave ground squirrels have been caught in this study than in all previous field studies combined (see Wildlife Technical Report: Rodents). It is therefore essential to determine accurate population density measurements for this rare species, particularly in the areas of high and medium geothermal potential (Zones 1 and 2). After construction is completed, a second population study will allow success of the mitigation program for the species to be evaluated.

3. A careful census of current raptor nesting sites and carnivore denning areas would be necessary as a part of the required site-specific analyses for each Plan of Operation. Location of noise-producing equipment should be at least one-half mile from these highly sensitive wildlife species.

4. An analysis of the geothermal fluid must be made to determine if toxic substances are presents (see 5, below). Measurements of cooling tower emissions for mercury and hydrogen sulfide must be made at appropriate downwind locations. Vegetation and animal life (both invertebrates such as millipedes and vertebrates such as rodents) should be sampled and examined for toxic substances before operations begin; this activity should be coordinated with the Soils Monitoring Plan to determine baseline concentrations of mercury, sulfur and possibly other elements that may occur in the geothermal fluid. These concentrations should be monitored every one to two years during the first 10 years of operation in order to detect

accumulations that might be related to cooling tower emissions. Analyses of both plants and animals are necessary, since organisms have been found to concentrate mercury from 10 to 100 times the levels found in the soils.

5. When analyses in item 4 are carried out, the physiological condition of the vegetation near power plants and at some distance downwind should be assessed visually or with aerial photography with false-color film. This assessment will allow areas of stressed vegetation to be detected and should be repeated each season when photosynthetic activity is highest.

6. Water levels for Little Lake, Haiwee Spring and Coso Hot Springs as well as chemical analyses of both geothermal and non-geothermal waters are included in the Hydrology Monitoring Plan. If change in water level or the chemistry of aquatic habitats occurs, vegetation as well as aquatic invertebrates and fish may be affected. Since baseline data of aquatic flora and fauna are known (Wildlife and Flora Technical Reports), spot checks can be carried out at appropriate times to determine if these populations have been affected.

D.3 AIR QUALITY MONITORING PLAN

1.0 INTRODUCTION

The ambient pollutant concentrations predicted in the Air Quality Technical Report are all based upon dispersion modeling results obtained using the emissions estimates described Chapter 1 of the ES as inputs. There is uncertainty in these predicted concentrations from two sources.

First, the simulation models are inherently imprecise, providing only an approximate mathematical description of the pollutant dispersion processess.

Second, the inputs to the models used in the Coso study are estimate values. The meteorological inputs had to be partially extrapolated from China Lake data because a complete meteorological data base has not been compiled for the Coso area. Furthermore, the emissions inputs are estimates based upon data from other geothermal fields and upon limited field testing data taken in the Coso KGRA. Also, the total production capacity of the field has been estimated conservatively and may be significantly greater than projected in Chapter 1 of the ES.

Because of these multiple uncertainties, it will be necessary to maintain a constant check on ambient pollutant levels as geothermal development proceeds in order to determine whether or not further mitigation will be required to meet applicable air quality standards and avoid impact on other environmental resources.

2.0 METEOROLOGICAL MONITORING

The placement of ambient pollutant monitoring instruments is dictated largely by meteorological parameters. The lack of a complete meteorological data base, however, makes it difficult to choose such monitoring sites effectively in the Coso KGRA. Therefore, a high priority in the overall monitoring plan should be the installation of a meteorological data collection system. A basic system would, at minimum, consist of wind speed, wind direction and temperature sensors along with the associated data acquisition equipment. These to be placed at locations where high ambient pollutant concentrations might be expected due to frequent inversions or other prevailing stable conditions. Depending on actual power plant sites chosen, such locations might include Rose Valley, Devil's Kitchen, and Coso Basin. Two or three additional wind stations can be included to cover the the KGRA uniformly. The China Lake NWC staff presently operates winds stations at Rose Valley Ranch, Coso Basin, and Haiwee Dam, and it may be possible to include these data into the overall database.

Inversion height data in the KGRA are extremely rare. The only data available are acoustic sounder data collected Rose Valley Ranch during January, February, and March, 1979. Only the lowest inversion was analyzed, the instrument maximum height being 1,000 meters. The nearest rawinsonde data available were collected intermittently during 1964 and 1965 at Tower 8 in Indian Wells Valley, approximately 20 miles from Coso Hot Springs. Because mixing height is an important input to the dispersion models, acoustic sounders should be operated continuously for at least one year at Coso Basin and in Rose Valley. These sites are chosen because they should be particularly susceptible to strong inversions, especially during the winter months.

3.0 POLLUTANT MONITORING

The dispersion modeling effort described in the Air Quality Technical Report has predicted ambient levels of hydrogen sulfide and fugitive dust to exceed Federal and/or State standards under certain meteorological conditions and during certain stages of geothermal development. Commercial hydrogen sulfide sensors are available for continuous monitoring of this species. As the power plants are expected to be the largest continuous source of hydrogen sulfide, monitoring stations should initially be placed near each power plant as it is brought on line. It should not be necessary to purchase a complete monitoring system for each power plant; if a year or two of monitoring data shows that hydrogen sulfide standards are not being exceeded near the plant, then the monitors can be moved to the next new plant in the development and the process can be repeated. It is critical, however, that the monitoring stations be placed in the areas of most probable maximum concentration. Considering the predominant wind directions in the Coso area, one station should be placed to the north-northwest, and one to the south-southwest of each source. For H_2S emitted from power plants under most meteorological conditions, the stations should be placed approximately 0.5 km from each plant.

Monitoring total suspended particulate (TSP) concentration should be a good approximation of fugitive dust levels, as dust will be the largest constituent by weight of TSP. High-volume samplers for TSP monitoring are available commercially and are described in the Code of Federal Regulations (40 CFR 50). Construction areas and heavily traveled unpaved roads will be the greatest dust emission sources, so monitors should be placed nearby. The monitoring system can be moved as the zones of construction and heavy traffic shift during the staged geothermal development. As with H_2S, the TSP monitors should be placed to the north-northwest and south-southwest of major emission sources, but here the distance should be approximately one kilometer from the center of the disturbed area.

In addition to the hydrogen sulfide and TSP sensors placed near emission sources to monitor local concentration maxima, several monitoring stations should also be located throughout the KGRA to characterize mesoscale concentration patterns. These monitors should be placed in areas subject to meteorological conditions (such as strong inversions) which can lead to adverse air pollution episodes. Probable locations include Rose Valley and Coso Basin. The placement of these monitors should be correlated with the results of the meteorological monitoring program.

The exact placement of all of the monitoring devices discussed here will have to be decided on a case-by-case basis. Local topography, meteorology, and availability of electrical power can all affect the decision. Useful guidelines are available in the Federal Air Quality Surveillance Regulations (EPA, 1979)

The monitoring results should all be considered in terms of the State of California and Federal ambient air quality standards listed in the Air Quality Technical Report (*). Hydrogen sulfide data should be compiled as one-hour averages to conform to the California State standards. Stronger mitigation measures than those currently required should be considered if any of the standards are violated.

4.0 TRACE ELEMENT MONITORING

Trace amounts of various elements have been found in previously developed geothermal fields. Monitoring of ambient trace element levels may be advisable at Coso, but this should be decided on a case-by-case basis due to the wide variability of concentrations both within a given field and among seperate fields. Tests of the geothermal fluid should reveal the predominant trace elements present, and monitoring plans can be developed accordingly, if found necessary. If mercury (Hg) in the geothermal fluid is consistently found to be greater than 10^{-7} of the total weight then, according to dispersion model estimates, it is possible that the ambient mercury levels will exceed 0.1 ug/m^3. This exposure is believed to cause damage to plants and animals (including humans), so a monitoring program should be implemented. As with other monitoring devices, trace element monitors should be placed near the emission sources as well as in areas such as Rose Valley and Coso Basin which are subject to adverse meteorological conditions and concurrent high pollutant concentrations.

---

* It should be noted that the regulations concerning the monitoring are under litigation. Recent court decisions indicate that other species may require monitoring.

5.0 VISIBILITY MONITORING

Maintenance of good visibility in the Coso Area is of prime concern to the NWC with respect to its mission. In addition, the proximity of the CGSA to Class I areas suggests that visibility be monitored to insure that this resource is not significantly degraded. Neither the State of California or the EPA have promulgated guidelines or regulations concerning how visibility shall be quantified.

As the primary concern in the area is long range visibility (greater than 40 kilometers) it is recommended that a monitoring program using the telephotometric technique be established. It is recommended that one telephotometer site be located in the Indian Wells valley and that another site be established at location to be agreed upon with the National Park Service. This program should commence at least one year prior to initiation of development to provide a good baseline against which to measure the impact of the geothermal development.

Reference

Environmental Protection Agency Ambient Air Quality Surveillance Regulations (40 CFR 58; 44 FR 27571, May 10, 1979).

COSO ENVIRONMENTAL STATEMENT

D.4 HYDROLOGY MONITORING PLAN

TABLE OF CONTENTS

Monitoring plans to enable assessment of potential hydrologic impacts in the Coso Geothermal Study Area (CGSA) fall into four categories:

1. Water quality monitoring
2. Water level monitoring, and
3. Coso Hot Springs monitoring
4. Geothermal reservoir monitoring

Each of these monitoring plans must begin with a viable baseline established prior to development. The leasees, either individually or jointly, will be responsible for implementation of the plan and baseline survey. The baseline and outlines for subsequent monitoring for each of the above categories is discussed below.

1.0 WATER QUALITY

For ground or surface water degradation assessment, the natural or current characteristics of the water must be defined and potential degradation sources should be identified. It is important to establish reliable and representative baseline water quality data since adverse changes in water chemistry provide the prima facie evidence of degradation. This often requires collection and analysis of several water samples at representative locations over a period of time. Future analyses would be compared with the baseline data to determine if any changes have occurred. When potential degradation sources have been identified, mitigation measures should be taken.

To monitor for changes in ground water characteristics that may occur during geothermal development and injection the baseline conditions that must be established include:

a. chemical characteristics of nongeothermal ground water, geothermal ground water, and surface waters;

b. geology and hydrology of the area;

c. location, well use and well completion data for all wells in and around the geothermal site; and

d. mechanics and characteristics of the geothermal system.

These data have been compiled and interpreted for the CGSA, to the degree that available information allows, in the geology and hydrology technical reports. Well and spring data appear in Hydrology Technical Report Appendix B and chemical analyses appear in Appendix C.

Current chemical data must also be collected for all waters in the area, including geothermal and nongeothermal ground water, surface water, and any other disposed water to augment existing data and provide a reliable, consistent baseline. The goal of this data collection is to establish for each water type (including industrial and agricultural releases):

1) chemical characteristics;

2) three-dimensional (spatial) distribution;

3) natural temporal variations or cycles;

4) in conjunction with the geologic data, chemical reactions and changes as the water flows through subsurface materials; and

5) mixing relationships, if any, of these waters, and where mixing occurs.

The consistency and accuracy of chemical sampling plays a critical role and is discussed in Section 1.2.

1.1 Regulations

Under the Federal Water Pollution Control Act (1972 Amendments) no degradation of natural water quality is allowed. The Safe Drinking Water Act of 1974 authorizes the U.S. EPA to protect ground as well as surface water. Standards are set by states and must be approved by the U.S. EPA. In California, the State Water Resources Control Board sets such standards. The Lahontan Regional Water Quality Control Board, a state agency within the California State Water Resources Control Board, is the local agency responsible for enforcing the California Water Code (Porter-Cologne Act, adopted 1972 and amended) in the CGSA. Waste discharge permits must be applied for at least 120 days prior to commencement of discharge (Attachment 1A). Waste discharge and monitoring requirements will then be established for each particular discharge source, such as geothermal test or injection wells. Samples of such regulations for CGEH-1 test well and other geothermal operations in the Lahontan Region are presented in Attachments 1B and 1C.

The Geothermal Environmental Advisory Panel (GEAP, 1977) (Attachment 2) outlines water quality baseline data acquisition guidelines to be implemented by the USGS. The U.S. Energy Research and Development Administration (ERDA, 1977), (Attachment 3) discusses geothermal water quality monitoring programs applicable to Department of Energy (DOE) funded projects. Geothermal Resource Operational Order (GRO) No. 4 (ES Appendix A) defers water quality regulation to state and U.S. EPA requirements.

Table 1 lists the specific chemical parameters recommended for analysis by GEAP (1977), ERDA (1977) and this plan. The chemical analyses recommended in the GEAP (1977) and ERDA (1977) differ in the parameters they specify. To resolve these discrepancies and to take the individual environment at Coso into consideration, a synthesized set of analyses is suggested specifically for the CGSA. For example, boron, iron, and mercury have been added to the GEAP (1977) nongeothermal analysis list. Boron and iron were added due to their occurrence in the CGSA in some nonthermal waters at levels approaching or above safe limits. Mercury was added due to the mercury prospects in the Coso Mountains. Methane was dropped from the geothermal analysis since no methane is known to be dissolved in the geothermal fluid at Coso. However, it is beyond the scope of this monitoring plan to specify that the set

Table 1. Guidelines for Chemical Analyses of Geothermal and Nongeothermal Waters[a]

	ERDA (1977)	GEAP (1977)			Suggested for CGSA[b]	
	Geothermal	Geothermal	Surface	Ground	Geothermal	Nongeothermal
General Characteristics						
pH (lab)	x	x	x	x	x	x
TDS	x	x	x	x	x	x
Specific conductance (lab)		x	x	x	x	x
Suspended solids	x				x	
Turbidity	x				x	
Taste	x					
Odor	x				x	
Color	x					
Major Anions & Cations						
Alkalinity	x[c]	x	x	x	x[c]	x[c]
Chloride	x	x	x	x	x	x
Sulfate	x	x	x	x	x	x
Calcium	x	x	x	x	x	x
Sodium	x	x	x	x	x	x
Potassium	x	x	x	x	x	x
Magnesium	x	x	x	x	x	x
Gases						
Radon-222		x			x	
Hydrogen sulfide	x	x			x	
Carbon dioxide	x	x			x	
Methane	x					
Ammonia		x			x	
Sulphur dioxide		x			x	

Table 1 (continued)

	ERDA (1977)	GEAP (1977)			Suggested for CGSA[b]	
	Geothermal	Geothermal	Surface	Ground	Geothermal	Nongeothermal
Minor and Trace Constituents						
Arsenic	x	x			x	
Barium	x	x			x	
Boron	x	x			x	x
Bromide	x					
Cadmium		x			x[d]	
Cesium	x					
Copper	x	x			x	
Chromium		x			x[d]	
Fluoride	x	x	x	x	x	x
Iodide	x					
Iron	x	x			x	x
Lead	x	x			x	
Lithium	x				x	
Manganese	x	x			x	
Mercury	x	x			x	x
Molybdenum		x				
Rubidium	x					
Selenium		x			x[d]	
Silver	x	x			x	
Strontium		x				
Zinc	x	x			x	
Other						
BOD	x					
COD	X					
Nitrate			x	x		x
Ammonium	x	x			x	
Radioactivity (gross &)	x	x		x	x	x
Atmospheric reaction rate	x					
Evaporation rate	x					
Total phosphorus			x	x		x
Silica	x	x	x	x	x	x

Table 1 (continued)

	ERDA (1977)	GEAP (1977)			Suggested for CGSA[b]	
	Geothermal	Geothermal	Surface	Ground	Geothermal	Nongeothermal
Field						
pH		x	x	x	x	x
Specific conductance		x	x	x	x	x
Temperature		x	x	x	x	x
Discharge		x	x	x	x	x
DO	x	x	x	x	x	x
Sulfide					x	x[d]
Alkalinity					x	x

a These complete analyses are recommended only for the initial stages of baseline data acquisition. After the character of each water type is known less extensive continuing analyses may be employed. In some cases this may consist only of measurement of the "field" parameters if all indicators appear consistent with past measurements. However, complete analyses at selected critical locations should be repeated periodically during reservoir development and exploitation.

b These are suggestions only, not binding recommendations.

c Also reported as carbonate and bicarbonate.

d Optional analysis.

of analyses suggested for the CGSA shall supersede the ERDA (1977) or GEAP (1977) guidelines.

Table 2 lists inorganic chemical water standards for several typical uses specified by the U.S. EPA.

1.2 The Monitoring Plan

A consistently controlled and well documented baseline water chemistry survey of the CGSA should be conducted prior to development. Since accessible ground and surface water sources are limited (as shown on Plate 2.5-1) all should be sampled and analyzed according to accepted professional chemical sampling and analysis procedures. One complete survey, with analyses as specified in Table 1, should suffice to establish a baseline for well waters. Streams and springs should be sampled at high and low flows. Frequency of ongoing monitoring would depend on the location and extent of development.

Sample Collection and Chemical Analysis--

Sampling and analysis of waters and geothermal effluents is a specialized field. Some of the more relevant references are: Brown, et al. (1970); Wood (1976); Reed, (1975); Ellis, et al. (1968); Presser and Barnes (1974); U.S. EPA (1974, 1976b, 1978); American Public Health Association (1977); and Watson (1978). These works detail step-by-step procedures that should be

Table 2 Inorganic Chemical Water Standards

Substance	Drinking Water	Irrigating Water [a] (ppm) Threshold [e]	Irrigating Water [a] (ppm) Limiting [f]	Livestock Feeding Water [a] (ppm) Threshold [e]	Livestock Feeding Water [a] (ppm) Limiting [f]
Arsenic	0.05[b]	1.0	5.0	1	--
Barium	1.0[b]	--	--	--	--
Bicarbonate	--	--	--	500	500
Boron	--	--	0.5	--	--
Cadmium	0.01[c]	--	--	5	--
Calcium	--	--	--	500	1000
Chloride	250[c]	100	350	1500	3000
Chromium	0.05[b]	--	--	--	--
Copper	1.0[c]	0.1	1.0	--	--
Fluoride	1.4-2.4[b,d]	--	--	1	6
Hydrogen sulfide	0.5[c]	--	--	--	--
Iron	0.3[c]	--	--	--	--
Lead	0.05[b]	--	--	--	--
Magnesium	--	--	--	250	500
Manganese	0.05[c]	--	--	--	--
Mercury	0.002[b]	--	--	--	--
Nitrate	10[b]	--	--	200	400
Selenium	0.01[b]	--	--	--	--
Silver	0.05[b]	--	--	--	--
Sodium	--	--	--	1000	2000
Sulfate	250[c]	200	1000	500	1000
Zinc	5[c]	--	--	--	--
TDS	500[c]	500	1500	2500	5000
pH	6.5-8.5[c]	7.0-8.5	6.0-9.0	6.0-8.5	5.6-9.0

a Todd, 1970
b Maximum contaminant level specified in National Interim Primary Drinking Water Regulations (U.S. EPA, 1976)
c Maximum contaminant level specified in National Secondary Drinking Water Regulations (U.S. EPA, 1977)
d Maximum recommended concentration is temperature dependent
e Threshold--a concentration at which a given beneficial use is not damaged to any measurable degree
f Limiting--a concentration at which the beneficial use is severely inhibited

followed in collecting and analyzing water and geothermal effluent samples. The document by Watson (1978) is a standard methods manual specifically for sampling and analysis of geothermal fluids.

Sample collection procedures must be specified and consistently applied. These are fairly straightforward for most nongeothermal surface and ground water and are well outlined in several of the previously cited references. With geothermal fluids, a problem arises in collecting a representative sample. To obtain a representative sample from a superheated geothermal source, most investigators recommend collecting both liquid and vapor samples. Techniques used for such sampling are discussed in detail in Ellis, et al. (1968); Truesdale and Pering (1974); Giggenbach (1976); Hill and Morris (1975); U.S. EPA (1976b, 1978); Finlayson (1970); and Watson (1978).

In sampling hot springs, geysers, etc. use of a small hand or battery-operated pump with a long tube that can be inserted in the hot water is often convenient. This procedure will allow the sampler better access to the part of the manifestation that would provide the most appropriate sample.

For most of the historical data used in the baseline data acquisition it will be impossible to determine the sampling and analysis procedures used. Therefore, even though the data can be used in attempting to decipher temporal and spatial patterns, it would be desirable to start collecting baseline chemical data as soon as possible in a consistent, prescribed, reproducible manner. This would allow direct comparisons between consistent sets of chemical data collected before development begins and after development has commenced.

2.0 WATER LEVEL MONITORING

Water levels should be monitored for all accessible surface and ground water features (as shown on Plate 2.5-1) for a minimum period of one year prior to geothermal development. Water level measurements of the Coso Hot Springs are discussed separately in Section 3.

The historic natural variation in water levels in Little Lake would be difficult to determine since it is artifically filled during low water periods. In 1976 it was 3 feet lower than its present level (Hydrology Technical Report Section 2.1.1) Measurements of the water level in Little Lake may be made by installing a staff gauge in the lake and reading it periodically. This may be on the order of once a month until seasonal patterns are established. This monitoring should be coordinated with the owner of the lake to adjust artificial recharge into the lake or take that into account in analyzing the data.

Monitoring of ground water levels, including flow rates of springs, should initially be conducted at least four times a year to establish natural seasonal patterns prior to development. Long-term water level or spring flow rate fluctuations may not be determinable prior to development.

Aquifer tests should be conducted in wells to be used in conjunction with the geothermal operations to determine the safe perennial yield. Monitoring of water levels in these wells would be conducted frequently during the beginning of operations. When the water level stabilizes measurements may be taken less frequently. The pattern may start with measurements every week for several weeks, then each month for several months, then every three months for a year, then every 6 months for 2 years, then once a year.

Selected natural cool springs and wells that may be affected by lowering water levels in Rose Valley should be monitored regularly. These would include the spring or springs feeding Little Lake (e.g., 23S/38E-8DS1, 8DS2 and 8MS1, ES Plate 2.5-1), nearby wells (e.g., 23S/38E-8D1, 8D2, 5N1) as well as wells near ground water extraction areas.

3.0 COSO HOT SPRINGS

To determine if the hot springs would be disturbed by geothermal production, the baseline parameters must be quantified. There is considerable natural variation in the temperature, flow rate and chemical composition of the fluid at the springs. This range is a function of:

a) the source mechanism for the hot springs

b) the properties of hydraulic connection between the geothermal reservoir, shallow ground water and the hot springs, and

c) local climatic factors.

There are several possibilities for the source mechanism for the surface thermal manifestations at Coso Hot Springs. It is agreed that the "springs" are not in fact springs, but areas where steam condensate accumulates (Austin and Pringle, 1970). The working hypothesis model of the hot "spring" system is one where the top of the geothermal reservoir is essentially unconfined and boiling at about 150 feet beneath the surface thermal manifestations. The steam released from this boiling water table rises through fractures and mixes with local, shallow ground water. Portions of many fractures have become sealed by hydrothermal alteration of the rocks and/or deposition of silica. This sealing mechanism results in a circuitous path for the steam and limited surface manifestations above the reservoir.

The water level in the mud pots at the hot springs varies naturally with the seasons. They are higher in the winter and lower or almost dry in the summer. This variation is thought to be a function of varying mixture with shallow ground water, i.e. in the winter during periods of high rainfall more shallow ground water mixes with the steam condensate. (Austin and Pringle, 1970). The controlling mechanisms for mud pot water levels involve variations in steam condensate and shallow ground water contributions and variation of evaporation rates.

3.1 The Monitoring Plan

The properties of the springs must be quantified prior to development and monitored during development. A detailed water chemistry, temperature, evaporation, precipitation and water level analysis program at the hot springs is recommended for this purpose. Certain types of studies, such as diverting hot springs discharge to one flume, would be desirable but not permissible since the hot springs are a National Historic Site and no alteration of its natural state would be allowed. Studies and apparatus that we feel would cause negligible disturbance of the site and provide valuable clues to the spring mechanism include:

1. Continuous or frequent water temperature recording
2. Continuing operation of meteorological stations including precipitation, air temperature and wind measurements in the vicinity of the springs and in the Coso Range to the west
3. Pan evaporation measurements
4. Scale photographs of the mud pots (as required)
5. Continuous or frequent water level recording
6. Frequent water sampling and chemical analysis, including gas sampling and analysis (initially once or twice a month and then adjusted to a greater or lesser frequency as required)

7. Peak runoff gages on major ephemeral stream channels near the hot springs

8. Drilling a small observation well in the alluvium to the west of the surface manifestations

9. Drilling a data heat flow / water level and water chemistry hole in the alluvium to the east of the Coso Hot Springs fault

Items 1, 2, 3 and 4 will help define actual evaporation rates in the mud pots, thereby establishing quantity of inflow to the hot springs. Item 5 will define the water level changes. We may find that minute diurnal changes in mud pot temperatures or water level will provide clues to the hot spring mechanism. The water level data and size of the mud pots can provide an idea of the volumes of water in the pots at any given time. Item 6 will provide a detailed record of changes in chemistry with time. If shallow ground water does in fact contribute to the mud pots, a detailed series of chemical analyses should be able to establish that. Records from the peak runoff gauges, Item 7, would provide knowledge of when the precipitation exceeds the surface soil infiltration capacity. Item 8 would provide de facto evidence of the existence of a shallow ground water table in the alluvium to the west of the hot springs and a sample of such water for chemical analysis. Item 9 could provide information for several baseline tasks as well as help to better define the geothermal reservoir. For the hot springs monitoring it may indicate whether some contribution to the hot springs is possibly originating to the east of the

Hot Springs fault--perhaps from some depth and contributing to the hot springs effluent or to the geothermal reservoir itself. For water availability and quality, it would provide baseline water level and water chemistry characteristics in Coso Valley. For geothermal reservoir definition it would provide clues to the reason why the heat flow drops so sharply on the west side of Coso Valley.

The USGS is currently conducting an isotope study which is expected to provide valuable clues to the origin of geothermal and hot spring fluids, age of waters and source mechanisms. It is anticipated that the USGS will continue its isotope work where it is necessary, hence isotope studies are not discussed further. The NWC is currently monitoring the hot springs. A comparison of their monitoring program with the one proposed here is included as Attachment 4.

The results of the proposed studies, the USGS isotope study and the NWC monitoring will provide baseline hot springs characteristics and perhaps some insight into the connection between the hot springs and the geothermal reservoir.

4.0 GEOTHERMAL RESERVOIR

Monitoring of the geothermal reservoir will be conducted under the supervision of a geothermal reservoir engineer. Mass flow rate (or volume), temperature, pressure and chemical composition for each geothermal well will be monitored continuously or on a regular basis. The flow rate, wellhead pressure and annulus fluid pressure in all injection wells must be monitored continuously to provide the necessary data for reservoir management, well maintenance and pollution control. Chemistry of the injected fluid and annulus fluid should also be monitored regularly.

4.0.1 Injection Well Monitoring

Annulus fluid pressures and chemistry are monitored to detect leakage in the system. Depending on the composition of the fluid, adequate chemical monitoring may be accomplished by placing conductivity probes in the annulus, or by analyzing return flow for contamination in continuous cycling annulus fluid.

Corrosion rate can be determined by placing sample strips of the tubing and casing material in the well, and checking them periodically for weight loss.

Where injecting chemically active fluid, it is important that the well be shut down periodically for inspection and testing. Inspection methods for casing, tubing, cement and well bore include: (1) pulling the tubing and inspecting it visually or instrumentally; (2) electromagnetic caliper or televiewer logging of tubing or casing in the hole; (3) pressure testing of casing; (4) bond logging of casing cement; and (5) inspection of casing cement or well bore with injectivity or temperature profiles (Warner, 1975). Downhole geophysical methods are described in detail by Weiss, et al. (1979a).

REFERENCES

American Public Health Association. 1977. Standard Methods for the Examination of Water and Wastewater. 14th edition. American Public Health Association, Washington, D.C.

Brown, E., M. W. Skougstad and M. J. Fishman. 1970. Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. U.S. Geological Survey Techniques of Water Resources Investigations. Book 5, Chapter A-1. 160 pp.

Ellis, A. J., W. A. J. Mahon and J. A. Ritchie. 1968. Methods of Collection and Analysis of Geothermal Fluids. 2nd edition. Chemistry Division, New Zealand Department of Science and Industry Research Report CD 2013. 51 pp.

Finlayson, J. B. 1970. The Collection and Analysis of Volcanic and Hydrothermal Gases. Geothermics. Special Issue 2, Vol. 2, Pt. 2. pp. 1344-1354.

Geothermal Environmental Advisory Panel. January 1977. Guidelines for Acquiring Environmental Baseline Data on Federal Geothermal Leases. USGS, Menlo Park. 26 pp.

Giggenbach, W. F. 1976. A Simple Method for the Collection and Analysis of Volcanic Gas Samples. Bulletin Volcanology.

Harding-Lawson Associates (in press). Ground Water Monitoring Guidelines for Geothermal Development, report prepared by R. B. Weiss, T. O. Coffey and T. L. Williams for U.S. EPA, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 215 pp.

Hill, J. H., and C. J. Morris. December 1975. Sampling a Two-Phase Geothermal Brine Flow for Chemical Analysis. Lawrence Livermore Laboratory, UCRL-77544.

Presser, T. S., and I Barnes. 1974. Special Techniques for Determining Chemical Properties of Geothermal Water. U.S. Geological Survey Water Resources Investigations 22-74. 11 pp.

Reed, M. J. 1975. The Collection of Geothermal Fluid Samples for Chemical Analysis. in Geothermal Professional Papers. July 1975. California Division of Oil and Gas Report No. TR14.

Todd, D. K. 1970. The Water Encyclopedia. Water Information Center, Port Washington, New York. 559 pp.

Truesdell, A. H., and K. L. Pering. 1974. Geothermal Gas Sampling Methods. USGS Open File Report 74-361. 6 pp.

U.S. EPA. 1974. Methods for Chemical Analysis of Water and Wastes. Environmental Monitoring and Support Laboratory, Cincinnati, Ohio. EAP-625/6-74-003a.

U.S. EPA. 1976a. National Interim Primary Drinking Water Regulations. Office of Water Supply, EPA-570/9-76-003. 159 pp.

U.S. EPA. 1976b. Proceedings of the First Workshop on Sampling Geothermal Effluents, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. EPA-600/9-76-011.

U.S. EPA. 1977. National Secondary Drinking Water Regulations. 40 CFR Part 143, Federal Register. Vol. 42, No. 62. pp. 17143-17146. Thursday, March 31, 1977.

U.S. EPA. 1978. Proceedings of the Second Workshop on Sampling and Analysis of Geothermal Effluents. Prepared by Geonomics, Inc. for EPA, Las Vegas, Nevada.

U.S. Energy Research and Development Administration. February 1977. Guidelines to the Preparation of Environmental Reports for Geothermal Development Projects, Division of Geothermal Energy, ERHQ-0001. 70 pp.

Warner, D. L., 1975, Monitoring Disposal Well Systems, U.S. EPA Report No. EPA-680/4-74-008. 109 pp.

Watson, J. C. 1978. Sampling and Analysis Methods for Geothermal Fluids and Gases. Batelle Pacific Northwest Laboratory, Materials Department. PNL-MA-572.

Weiss, R. B., T. O. Coffey and T. L. Williams, 1979, Ground Water Monitoring Guidelines for Geothermal Development, U.S. EPA, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, EPA 600/7-79, 230 pp.

Wood, W. W. 1976. Guidelines for Collection and Field Analysis of Groundwater Samples for Selected Unstable Constituents. in Techniques of Water Resources Investigations of the USGS. Book 1, Chapter D2. 24 pp.

ATTACHMENT 1

SAMPLE WASTE DISCHARGE REQUIREMENTS AND MONITORING PLANS FOR GEOTHERMAL TEST WELLS ISSUED BY THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD - LAHONTAN REGION

A) REPORT OF WASTE DISCHARGE FORM

B) REGULATIONS AND MONITORING PLAN FOR CLEANOUT AND TESTING OF CGEH-1

C) REGULATIONS AND MONITORING PLANS FOR DISPOSAL OF GEOTHERMAL BRINES AND DRILLING WASTES FROM TWO GEOTHERMAL TEST WELLS IN LONG VALLEY

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

REPORT OF WASTE DISCHARGE
Pursuant to Division 7 of the State Water Code

FOR USE OF REGIONAL BOARD
WRCB Form 200 Rec'd: ______
Duty Fee: ______
Letter to Discharger: ______
Report Rec'd: ______
Effective Date: ______

(A) REPORT FROM:

Discharger ______________________
(Owner of Facility, Municipality, County, District, Firm or Individual)

Mailing Address ______________________ Zip Code

Telephone No. ______________

Name of Facility ______________________

(B) DESCRIPTION:

I. WASTE DISCHARGE: (check)
1. New discharge ---------------------- ( )
2. Existing discharge ---------------------- ( )
3. increase in quantity of discharge ---------------------- ( )
4. Change in character of waste ---------------------- ( )
5. Change in place or method of disposal ---------------------- ( )

II. LOCATION OF POINT OF DISPOSAL OR OPERATION (describe and attach map, sketch or locate on USGS Quadrangle map, 7.5 minute series.) List distances or bearing and distance from section corner or quarter corner, Section, Township, Range and Base and Meridian.)

____

____

III. WASTE TREATMENT OR DISPOSAL FACILITIES: (check)
1. Construction of entirely new facilities ---------------------- ( )
2. Enlargement of existing facilities ---------------------- ( )
3. Other (explain) ______________________

____

(C) TYPE OF WASTE DISCHARGE: (check)
1. Sewage only ---------------------- ( )
2. Industrial wastes only ---------------------- ( )
3. Mixed sewage and industrial wastes ---------------------- ( )
4. Solid wastes ---------------------- ( )

5. Cattle wastes ---------------------- ( )
6. Soil, silt, clay, etc. ---------------------- ( )

7. Other wastes ---------------------- ( )

(D) QUANTITY OF WASTES:
1. Present or proposed flow (in mgd) ______________
2. Design flow (in mgd) ______________
3. Present population ______________
4. Design population ______________
5. Solid waste disposal site (in cubic yards) ______________
6. Area in which soil will be disturbed (in acres) ______________

(E) SOURCE OF WATER SUPPLY:
1. Municipal or utility service ( )
2. Individual wells ( )
3. Surface supply: (a) Name of Stream ______________
(b) Type of Water Rights: Riparian ( ) Appropriation ( )
(c) Water Rights Permit or License Number ______________

(F) AMOUNT OF FILING FEES – (See attached Fee Schedule)
Amount of fee accompanying this report $ ______________

ALL OF THE STATEMENTS CONTAINED HEREIN ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF AND ARE SUBMITTED UNDER PENALTY OF PERJURY.

SIGNATURE OF AUTHORIZED PERSON ______________________

Title ______________________
(Manager, Clerk, Engineer, Consultant, etc.)

Date ______________________

You will be notified of the correctness of filing fee and submittal of any additional information deemed necessary to complete your Report of Waste Discharge pursuant to Division 7, Section 13260 of the State Water Code.

WRCB Form 200(2-72)

(Rev. 6 - 5/15/72)

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

FACT SHEET

ITEM NO. 4 BOARD ORDER NO. 6-78-37

NAME: China Lake Naval Weapons Center - Exploratory Geothermal Well

LOCATION: 8.0 miles (12.88 km) east of Coso Junction

TYPES OF WASTES: Geothermal groundwater and drilling fluids

TYPE OF OPERATION PRODUCING WASTES: The cleanout and testing of the geothermal exploratory well

TREATMENT: TYPE: None

DISCHARGE TO: A dry lake bed, unlined pond, and reinjection into the geothermal well

NEW CASE: Yes

RECEIVING WATERS: Groundwaters of the Coso Subunit of the Coso Hydrologic Unit

BENEFICIAL USES: Municipal and domestic supply

FISH, BIRDS OR ANIMALS, TYPES, DEGREE: Typical high desert habitat. Rodents, reptiles and non-game birds.

WATER QUALITY CONTROL PLAN OR LONG-RANGE POLICY: Contained in the Water Quality Control Plan for the South Lahontan Basin.

QUALITY OF RECEIVING WATERS: Geothermal groundwater underlies the proposed disposal site. The quality of this groundwater is unknown at this time.

QUANTITY OF WASTES: A maximum volume of 50 acre ft. (61 megaliters) will be discharged.

DISCHARGE ON LAND OWNED BY: Department of the Navy

CONTROLLED BY: Department of the Navy

NEAREST HOME, OTHER BUILDING AND TYPE: Distant

NEAREST WATERWELL: Distant

NATURE OF AREA: High desert, mountainous

QUALITY OF WASTES: Quality of the geothermal groundwater that will be discharged to the disposal site is not known.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

BOARD ORDER NO. 6-78-37

WASTE DISCHARGE REQUIREMENTS
FOR

DEPARTMENT OF THE NAVY
CHINA LAKE NAVAL WEAPONS CENTER
EXPLORATORY GEOTHERMAL WELL
Inyo County

The California Regional Water Quality Control Board, Lahontan Region, finds:

1. Captain R.B. Wilson on behalf of the China Lake Naval Weapons Center, Department of the Navy, submitted the information necessary to make up a report of waste discharge dated November 22, 1977 for an existing exploratory geothermal well.

2. The Department of the Navy plans to dispose of a maximum of 50 acre feet (61 megaliters) of wastewater that will be generated by the cleanout and testing of an existing exploratory geothermal well. The wastewater will consist of geothermal groundwater and drilling fluids remaining in the well. Chemical analyses to determine the quality of the geothermal groundwater have been postponed until after the cleanout operation has been completed.

3. The Department of the Navy plans to discharge the wastewater pumped from the geothermal well to a proposed unlined pond. The capacity of this pond may not be able to handle the entire amount of wastewater that will need to be pumped from the well. If this occurs, a nearby small dry lake bed will be utilized as a disposal site. If the wastewater is found to be toxic to animal life, it will be contained temporarily on-site in the pond and then reinjected back into the geothermal well.

4. The dry lake bed, existing geothermal well and the proposed pond are located approximately 8.0 miles (12.88 km) east of Coso Junction, as shown on Attachment "A" which is made a part of this order. The lake bed, geothermal well, and pond are the only designated disposal sites.

5. The disposal facilities are located in the Coso Súbunit of the Coso Hydrologic Unit within the NE/4, Section 6 and the NW/4, Section 5, T22S, R39E, MDB&M.

6. The disposal facilities are located in a shallow closed basin in soils consisting of pumice with scattered lenses of clay. Due to the lack of fresh groundwater underlying the disposal sites and the reported geological conditions underlying the area, it appears that the wastewater may be discharged to unlined ponds and a dry lake bed without creating a threat to groundwater quality in the area.

7. The designated disposal sites are located on land owned by the U. S. Government, Department of the Navy.

8. The Board adopted the Water Quality Control Plan for the South Lahontan Basin on May 8, 1975.

9. The potential beneficial uses of the groundwaters of the Coso Subunit of the Coso Hydrologic Unit as set forth and defined in the plan are:

   a. municipal and domestic supply

10. The Board has notified the discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for this discharge.

11. The U. S. Department of Energy has prepared an environmental analysis and has concluded that mitigation measures presently exist which address the impacts of the project and that an Environmental Impact Statement is not necessary. The Department of Energy has therefore adopted the equivalent of a negative declaration in accordance with the California Environmental Quality Act.

12. The Board, in a public meeting, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED, that the U. S. Department of the Navy, China Lake Naval Weapons Center shall comply with the following:

A. <u>DISCHARGE SPECIFICATIONS</u>

   1. The total volume of wastewater discharged to the disposal facilities shall not exceed 50 acre feet (61 megaliters).

   2. The discharge of wastewater except to the designated disposal sites is prohibited.

   3. Wastewater shall not be injected into any groundwater containing a total dissolved solids content which is less than that of the wastewater being discharged.

4. The waste discharge shall not result in any perceptible color, odor, taste or foaming in surface or ground waters of the Coso Subunit of the Coso Hydrologic Unit.

5. Surface flow or visible discharge of wastewater from the designated disposal sites to adjacent land areas or surface waters is prohibited.

6. All facilities used for collection, transport, treatment or disposal of waste shall be adequately protected against overflow, washout or inundation from a storm or flood having a recurrence interval of once in 100 years.

7. The vertical distance between the water surface elevation and the lowest point of a pond dike or the invert of an overflow structure shall not be less than 1.5 feet (0.46 m).

8. The discharge shall not cause a pollution.

9. Neither the treatment nor the discharge shall cause a nuisance.

B. PROVISIONS

1. Wastes left on-site may be required to be transported to an approved solid waste disposal site in the area if such a site is established sometime in the future.

2. At least 30 days in advance of the cessation of discharge at the site, the discharger shall send a report to the Regional Board that accurately describes the exact location of any wastes remaining at the site, with surveyed references from a monument of known location.

3. Adequate protective works and maintenance shall be provided to assure that ponds will not become eroded or otherwise damaged.

4. A sample of the geothermal groundwater shall be collected after the geothermal well cleanout operation has been completed. A complete chemical analyses shall be conducted on this sample. Further discharge of wastewater after the cleanout operation shall not occur until the Executive Officer has reviewed the chemical analyses and approved the continuation of the discharge.

5. Contingency plans shall be established and shall contain plans for implementing the immediate termination of a wastewater discharge resulting from an equipment failure. Contingency plans shall be submitted to the Regional Board at least 30 days in advance of initiating a discharge at the site.

6. The discharger shall comply with Monitoring and Reporting Program No. 78-37 and with the "General Provisions for Monitoring and Reporting" as specified by the Executive Officer.

7. The discharger shall immediately notify the Regional Board by telephone whenever an adverse condition occurs as a result of this discharge; written confirmation shall follow.

8. Any proposed material change in the character of the waste, manner or method of treatment or disposal, increase of discharge, or location of dischacge shall be reported to this Regional Board at least ninety (90) days in advance of implementation of any such proposal.

9. The California Regional Water Quality Control Board, Lahontan Region, hereby reserves the privilege of changing all or any portion of this order upon legal notice to and after opportunity to be heard is given to all concerned parties.

10. The owner of property subject to waste discharge requirements shall be considered to have a continuing responsibility for ensuring compliance with applicable waste discharge requirements in the operation or use of the owned property. Any change in the ownership and/or operation of property subject to waste discharge requirements shall be reported to this Regional Board. Notification of applicable waste discharge requirements shall be furnished the new owner(s) and/or operator(s). A copy of such notification shall be sent to this Regional Board.

I, Roy C. Hampson, Executive Officer, do hereby certify that the foregoing is a full, true and correct copy of an order adopted by the California Regional Water Quality Control Board, Lahontan Region, on June 8, 1978.

Roy C. Hampson

ROY C. HAMPSON
EXECUTIVE OFFICER

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

MONITORING AND REPORTING PROGRAM NO. 78-37
FOR

DEPARTMENT OF THE NAVY
CHINA LAKE NAVAL WEAPONS CENTER
EXPLORATORY GEOTHERMAL WELL
Inyo County

MONITORING

When a discharge to a location other than the designated disposal sites occurs, the following shall be included in a detailed technical report:

1. When the discharge occurred
2. Volume of wastewater discharged
3. Why the discharge occurred
4. A description of the total area that the discharge came in contact with
5. A plan of action for preventing further discharges and a timetable for implementing this plan of action

The following shall be recorded monthly:

1. The volume of wastes discharged during the reporting period
2. The total volume of wastes contained in the ponds and the dry lake bed disposal area
3. The total filterable residue (in mg/l) of the water contained at each disposal site

At least 30 days prior to the cessation of the operation of the test well, a special report shall be submitted to the Regional Board outlining the procedures for closing down the site and a time schedule for their implementation. This report shall include at least the following:

1. Map showing the exact well location and its relative location to all onsite disposal locations
2. The legal point of disposal for any materials to be deposited offsite

3. The name and license number of any liquid waste hauler handling waste materials from this operation
4. A description of the sealing procedures to be used for all facilities at this site.

Quarterly monitoring reports including the preceding information shall be submitted to the Regional Board by the 15th day following each quarterly reporting period. The first report will be due July 15, 1978.

Ordered by: [signature] ROY C. HAMPSON, EXECUTIVE OFFICER

Dated: June 12, 1978

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

FACT SHEET

ITEM NO. 8 BOARD ORDER NO. 6-77-122

NAME: Union Oil Company of California

LOCATION:: $6\frac{1}{2}$ and 9 miles northeast of Mammoth Lakes, in Long Valley, Mono County

TYPE OF WASTES: Geothermal brines, drilling wastes and drilling mud

TYPE OF OPERATIONS PRODUCING WASTES: Two Geothermal Test Wells

TREATMENT: TYPE: None - wastes confined to lined evaporation ponds CAPACITY: 0.5 million gallons (1.9 megaliters)

DISCHARGE TO: Clay-lined evaporation ponds

NEW CASE: Yes

RECEIVING WATERS: Groundwaters and surface waters of the Upper Owens Subunit of the Owens Hydrologic Unit

BENEFICIAL USES OF GROUNDWATERS: Municipal and domestic supply; agricultural supply; industrial service; freshwater replenishment

BENEFICIAL USES OF SURFACEWATERS: Agricultural supply; industrial and municipal supply; water-contact recreation; noncontact-water recreation; wildlife habitat; cold freshwater habitat; groundwater recharge.

FISH, BIRDS OR ANIMALS, TYPES, DEGREE: Coniferous forest located in high desert, Sierra-Nevada transition zone. Forest and sagebrush communities include small rodents, sage hen and deer.

WATER QUALITY CONTROL PLAN OR LONG-RANGE POLICY: Contained in the Water Quality Control Plan for the South Lahontan Basin

QUALITY OF RECEIVING WATERS: Excellent for all beneficial uses

QUANTITY OF WASTES: Not to exceed 0.5 million gallons (1.9 megaliters) at each site

DISCHARGE ON LAND OWNED BY: R. A. Cashbaugh, Et Al, and Standard Industrial Minerals, Inc.

CONTROLLED BY: Union Oil Company of California

NEAREST HOME, OTHER BUILDING & TYPE: Cashbaugh site; One dwelling is about 1,000 feet north
Clay Pit site; no structures nearby

NEAREST WATER WELL: Not known

NATURE OF AREA: Range land transition to coniferous forest

QUALITY OF WASTES: High in dissolved solids and high pH

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

BOARD ORDER NO. 6-77-122
FOR

UNION OIL COMPANY OF CALIFORNIA
CASHBAUGH RANCH AND CLAY PIT GEOTHERMAL TEST WELLS
Mono County

The California Regional Water Quality Control Board, Lahontan Region, finds:

1. Mr. Vane R. Suter, on behalf of the Union Oil Company of California, Geothermal Division, submitted a complete report of waste discharge dated August 12, 1977 for two proposed geothermal test wells.

2. The Union Oil Company of California, Geothermal Division, is proposing to drill two deep test wells in the Long Valley Area at the sites shown on Attachment "A" which is made a part of this Order. The Cashbaugh Ranch Well Site is approximately four miles (6.4 km) northeast of Highway 395 and the Mammoth Airport in the SE/4, Section 18, T3S, R29E, MDB&M. The Clay Pit Well Site is located approximately five miles (8 km) east of Highway 395 in Little Antelope Valley, in the NE/4, Section 15, T3S, R28E, MDB&M.

3. The proposed drilling site for the Cashbaugh Well is located on land owned by R.A. Cashbaugh, et al. The proposed drilling site for the Clay Pit Well is located on land owned by Standard Industrial Minerals, Inc. Both sites are leased by the Union Oil Company, Geothermal Division.

4. Wastes produced from the drilling and testing of the proposed wells include drilling cuttings, drilling mud, water, cement, and geothermal brines. It is estimated that less than 0.5 million gallons (1.9 mega liters) total of waste material will be discharged to each evaporation pond. The designated discharge sites for the drilling wastes, mud, and fluids from the well operations will be clay-lined evaporation ponds adjacent to the wells. Wastes from either of the wells may be discharged to either of the evaporation pond sites.

5. Both proposed test well sites are located in the Long Hydrologic Subunit of the Owens Hydrologic Unit. The Cashbaugh Ranch Well Site is located in a small sand and gravel pit surrounded by sagebrush covered terrain. Hot Creek is located approximately 1,000 feet (305 m) from the drilling site. The Clay Pit Well Site is located within a commercial open pit clay mine surrounded by forested terrain. There are no surface waters adjacent to the site.

6. The beneficial uses of the groundwaters of the Long Subunit of the Owens Hydrologic Unit as set forth and defined in the Plan are:

   a. municipal and domestic supply
   b. agricultural supply
   c. industrial service
   d. freshwater replenishment

7. The beneficial uses of the waters of Hot Creek as set forth and defined in the Plan are:

   a. agricultural supply
   b. industrial service
   c. water-contact recreation
   d. non-water-contact recreation
   e. wildlife habitat
   f. cold freshwater habitat
   g. groundwater recharge

8. The Board has notified the discharger and interested agencies and persons of its intent to adopt waste discharge requirements for this discharge.

9. The County of Mono has prepared a negative declaration in accordance with the California Environmental Quality Act (Public Resources Code Section 21000 et seq.) and the State Guidelines.

10. The Regional Board has reviewed the negative declaration and determined there will be no substantial adverse changes in the environment as a result of the project.

11. The Board, in a public meeting, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED, the Union Oil Company of California shall comply with the following:

A. DISCHARGE SPECIFICATIONS

1. Any above-ground discharge and/or storage of wastewater except in ponds effectively sealed[a/] to prevent the exfiltration of wastes is prohibited.

2. The discharge of wastes except to the designated disposal site is prohibited.

a/ Effectively sealed in this case is equivalent to a 1.5 foot (0.46 m) thick clay-liner having a permeability of 1×10^{-3} cm/sec or less for the Cashbaugh Ranch Well site and a 1.0 foot (.31 m) thick clay-liner having a permeability of 1×10^{-6} cm/sec or less for the Clay Pit Well site.

3. There shall be no surface flow or visible discharge of wastewater from the designated disposal sites to adjacent land areas or surface waters.

4. Wastewater that is not discharged to the designated disposal sites due to equipment failure shall be collected and contained to prevent contact with other surface waters and to prevent percolation to useable groundwaters.

5. All facilities used for storage, transport, treatment or disposal of waste shall be adequately protected against overflow, washout or inundation from a storm or flood having a recurrence interval of once in 100 years.

6. During the period that liquids are contained in the wastewater ponds, a minimum freeboard of at least 1.5 feet (0.5 m) shall be maintained.

7. The liquid portion of all brines shall be removed from the pond 90 days after the operation ceases.

8. All pond and/or drilling materials not hauled to a legal point of disposal shall be located within the evaporation pond and covered by a minimum of two feet (0.6 m) of material having a permeability of less than 10^{-6} cm/sec. The cover materials shall be placed to promote runoff of any onsite precipitation.

9. The waste discharge shall not result in any perceptible color, odor, taste or foaming in surface or ground waters of the Owens Hydrologic Unit.

10. The discharge shall not cause a pollution.

11. Neither the treatment nor the discharge shall cause a nuisance.

B. PROVISIONS

1. Contingency plans shall be established and shall contain plans for implementing the immediate termination of a wastewater discharge resulting from an equipment failure. Contingency plans shall be submitted to the Regional Board at least 30 days prior to the initiation of work at the sites and must be approved by the Executive Officer before work begins.

2. Wastes left onsite may be required to be transported to an approved solid waste disposal site in the area if such a site is established sometime in the future.

3. At least 30 days in advance of completion of work at the site, the discharger shall send a report to the Regional Board that accurately describes the exact location of any wastes remaining at the site, with surveyed references from a monument of known location.

4. Adequate protective works and maintenance shall be provided to assure that the ponds will not become eroded or otherwise damaged.

5. The discharger shall immediately notify the Regional Board by telephone when drilling has begun and whenever an adverse condition occurs as a result of this work; written confirmation shall follow.

6. Prior to the discharge of any geothermal materials into the ponds, the discharger shall submit a certificate, signed by a Civil Engineer registered in the State of California, stating that the ponds and attendant facilities comply with the requirements of this Order.

7. The discharger shall comply with the Monitoring and Reporting Program No.77-122 and with the "General Provisions for Monitoring and Reporting" as specified by the Executive Officer.

8. Any proposed material change in the character of the waste, method of disposal, increase of discharge, or location of discharge, shall be reported to this Regional Board at least ninety (90) days in advance of implementation of any such proposal.

9. Surface waters, as used in this Order, include, but are not limited to, live streams, either perennial or ephemeral, which flow in natural or artificial watercourses and natural lakes and artificial impoundments of waters within the State of California.

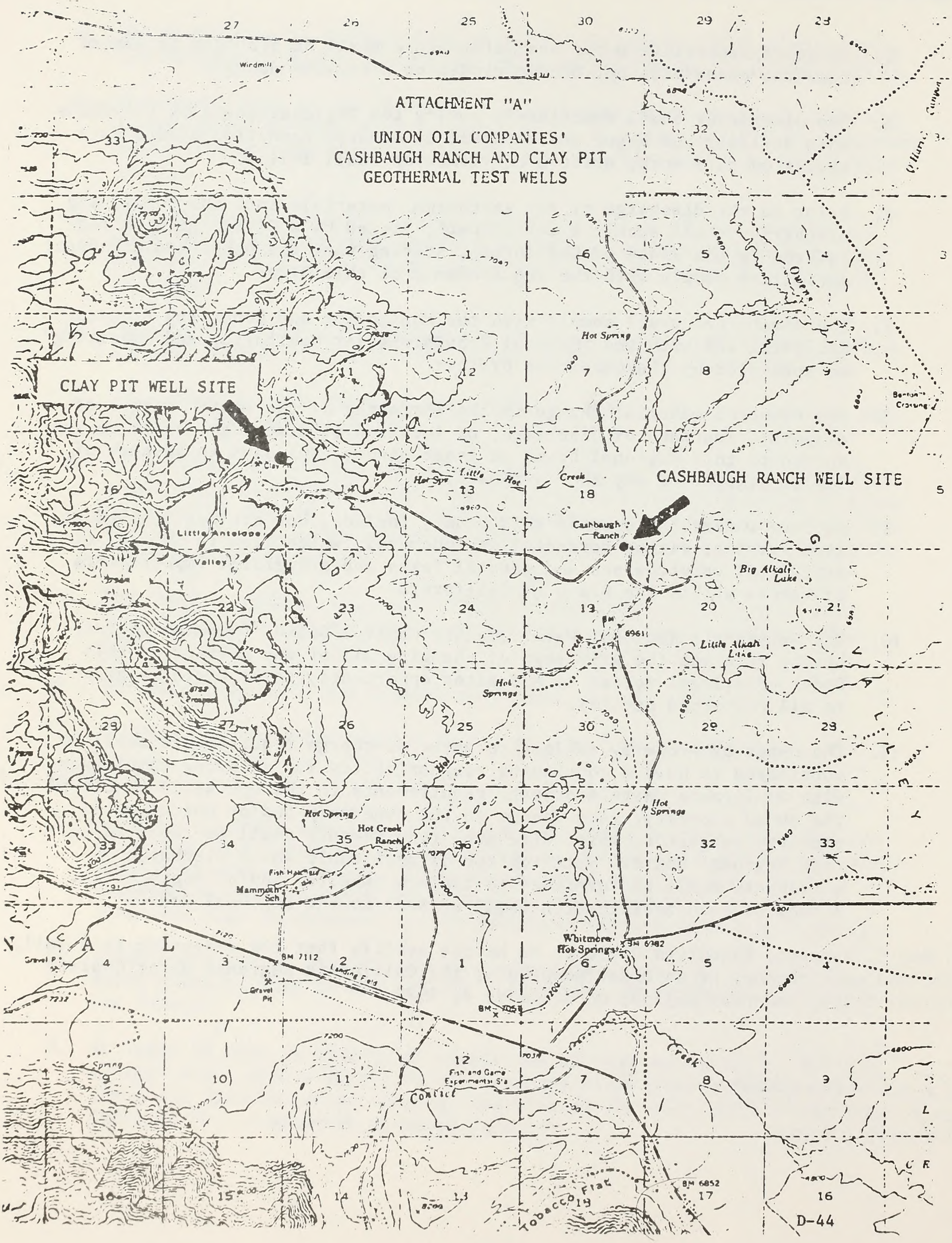
10. The California Regional Water Quality Control Board, Lahontan Region, hereby reserves the privilege of changing all or any portion of this Order upon legal notice to and after opportunity to be heard is given to all concerned parties.

11. The owner of property subject to waste discharge requirements shall be considered to have a continuing responsibility for ensuring compliance with applicable waste discharge requirements in the operation or use of the owned property. Any change in the ownership and/or operation of property subject to waste discharge requirements shall be reported to this Regional Board. Notification of applicable waste discharge requirements shall be furnished to the new owner(s) and/or operator(s). A copy of such notification shall be sent to the Regional Board.

I, Roy C. Hampson, Executive Officer, do hereby certify that the foregoing is a full, true and correct copy of an Order adopted by the California Regional Water Quality Control Board, Lahontan Region, on December 8, 1977.

Roy C. Hampson

ROY C. HAMPSON
EXECUTIVE OFFICER


ATTACHMENT "A"
UNION OIL COMPANIES'
CASHBAUGH RANCH AND CLAY PIT
GEOTHERMAL TEST WELLS
CLAY PIT WELL SITE
CASHBAUGH RANCH WELL SITE
Cashbaugh Ranch
Little Antelope Valley
Big Alkali Lake
Little Alkali Lake
Hot Spring
Hot Springs
Hot Creek Ranch
Whitmore Hot Springs
Mammoth Sch
Fish and Game Experimental Sta
Tobacco Flat
Little Hot Creek
BM 7112
BM 6852
Windmill
Gravel Pit
D-44

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

MONITORING AND REPORTING PROGRAM NO. 77-122
FOR

UNION OIL COMPANY OF CALIFORNIA
CASHBAUGH RANCH AND CLAY PIT GEOTHERMAL TEST WELLS
Mono County

MONITORING

When a discharge to a location other than the designated disposal sites occurs, the following shall be included in a detailed technical report:

1. When the discharge occurred.
2. Volume of wastewater discharged.
3. Why the discharge occurred.
4. A description of the total area that the discharge came in contact with.
5. A plan of action for preventing further discharges and a timetable for implementing this plan of action.

The following shall be recorded monthly:

1. The volume of wastes discharged during the reporting period.
2. The total volume of wastes contained in the ponds.
3. The total filterable residue (in mg/l) of the water contained in each pond.

At least 30 days prior to the cessation of the operation of any test well, a special report shall be submitted to the Regional Board outlining the procedures for closing down the site and a time schedule for their implementation. This report shall include at least the following:

1. Map showing the exact well location and its relative location to all onsite disposal locations.
2. The legal point of disposal for any materials to be deposited offsite.
3. The name and license number of any liquid waste hauler handling waste materials from this operation.
4. A description of the sealing procedures to be used for all facilities at this site.

REPORTING

A technical report shall be submitted immediately after a discharge occurs at a location other than the designated disposal site.

Information recorded monthly shall be submitted quarterly to the Regional Board by the 15th day of the following month. The first monitoring report is due January 15, 1978.

ORDERED BY: Roy C. Hampson
ROY C. HAMPSON
EXECUTIVE OFFICER

DATED: December 15, 1977

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

TRANSMITTAL OF COMMENTS AND RECOMMENDATIONS OF OTHER GOVERNMENTAL AGENCIES
FOR

UNION OIL COMPANY OF CALIFORNIA
CASHBAUGH RANCH AND CLAY PIT
GEOTHERMAL TEST WELLS
Mono County

Other governmental agencies have requested the inclusion of the following additional requirements and recommendations which are not directly related to water quality:

STATE DEPARTMENT OF HEALTH, VECTOR AND WASTE MANAGEMENT SECTION

The discharger should be advised that he will be required to comply with the health-related minimum standards for solid waste handling and disposal as set forth in Section 17200 et seq., Title 14, and this Department's hazardous waste regulations, Sections 60100 et seq., Title 22, California Administrative Code. Compliance with those standards and with the proposed waste discharge requirements should protect the public health, domestic livestock and wildlife.

ATTACHMENT 2

WATER QUALITY BASELINE DATA ACQUISITION GUIDELINES
(SECTION 4.0 FROM
GEOTHERMAL ENVIRONMENTAL ADVISORY PANEL,
1977, pp. 13-17)

4.0 WATER QUALITY

4.1 Introduction

Procedures recommended for establishing a water-quality baseline on geothermal leases and units are divided into two categories, 1) general, and 2) site specific. These recommendations stem from the principle that detailed knowledge of water quality in the environment and of the geothermal fluid(s) is needed early in any operation, to establish baseline concentrations and to determine which potentially harmful constituents are present. Later, measurements may be limited to those constituents that may adversely affect the environment.

4.2 General sampling requirements

To provide an adequate body of baseline data on water quality, the following procedures and principles are generally recommended for all leases or units:

4.21 Standards

Collection and analysis of water samples should be done according to current methods published by EPA, USGS, "Standard Methods" as summarized in "Recommended Methods for Water-Data Acquisition" (3). Analyses by State-certified laboratories are preferred.

4.22 Sources to be sampled

A. Surface water

Where present, perennial streams and significant intermittent streams should be sampled at or near the upstream and downstream boundaries of the lease or unit. Ponds, lakes, canals and drains, if present, should also be sampled. In areas of complex ownership or development lessees should be encouraged to develop sampling programs on a cooperative basis (1.4 above) taking into consideration differences in topography, geology, land use and access.

B. Ground water

Where present, ground-water sources (springs, seeps, and water wells) on the leasehold should be sampled for analysis as prescribed by the Supervisor. If the leasehold overlies and is upgradient from parts of an aquifer from which water is used for domestic, irrigation, stock, or wildlife supply, the Supervisor may require the lessee to obtain water samples for analysis from that aquifer during the drilling of geothermal wells, even though no wells on the lease hold produce from that aquifer.

C. Geothermal fluids

Geothermal fluids produced under the lease should be sampled for analysis according to provisions of GRO Order No. 4, and as specified below. (see 4.31).

4.23 Frequency and duration of sampling

A. The Supervisor should have wide latitude in determining frequency and duration of sampling during the baseline period.

B. The size, nature, intensity of development, and use of the geothermal resources should be important determining factors.

C. Frequency of sampling of streams should be selected with regard to the regimen and environment of the stream. Quarterly samples may define basic conditions in areas where streamflow is fairly uniform. In areas of significant seasonal variation, times of sampling should be adjusted to determine quality of typical high and low flows and/or of extreme events.

D. Ground-water sources upgradient of lessee's structures should be sampled at least once. Downgradient sources should be sampled at frequencies determined by the Supervisor in light of the chemical quality of geothermal fluids and other conditions and events peculiar to the lease.

E. Natural discharges of geothermal fluids (as from hot springs) should be sampled at least once prior to commencement of exploration drilling, and at least once more during the baseline data period.

F. Artificially produced geothermal fluids should be sampled for analysis when encountered and after there has been enough discharge to assure that the sample is representative of fluid(s) in the producing zone. Thereafter, samples may be required by the Supervisor after any major modification to the well or change in flow characteristics.

4.24 Parameters to be measured

A. Physical

1. Discharge of streams, wells, and springs should be measured each time a sample is taken.

2. Temperature should be determined each time a water source is sampled. Precision should be:

   $0.2^{\circ}C$ in the range 0° to $30^{\circ}C$
   $1.0^{\circ}C$ in the range 31° to $100^{\circ}C$
   5.0° above $100^{\circ}C$

3. pH should be determined each time a water source is sampled. For the range 6.0 to 9.0 a precision of about 0.5 pH unit will be accepted. Outside of this range more precise measurements should be obtained.

4. Specific conductance should be determined each time a water source is sampled.

5. Turbidity should be measured on surface-water samples where eutrophication exists or is threatened.

B. Chemical

1. Surface waters

   The first surface water sample from each site should receive a standard analysis. Standard analyses include DO, SiO_2, Ca, Mg, Na, K, alkalinity, SO_4, Cl, NO_3, F, dissolved solids, total P. Thereafter, where specific conductance does not increase by more than 10 percent, repeat analyses may not be required.

2. Ground water

   Ground-water samples from each sampling site should be given standard analysis as required for surface water at least once. Analysis of the first sample from each ground-water source shall include an assay for gross radioactivity.

4.3 Site Specific sampling requirements

The following requirements are to be within the province of the Supervisor and should become part of the required environmental baseline for surface and ground waters when toxic substances have been determined to exist in natural discharges of geothermal fluids or in fluids from geothermal wells, or if the Supervisor has reason to expect that toxic substances exist owing to geologic or other conditions. If the lessee in his plan of operation indicates he intends to use toxic substances, a baseline for such substances should be established prior to their introduction on the lease.

4.31 Geothermal fluids

A. All pre-lease thermal wells and hot springs should be sampled in accordance with 4.23 E above. In addition to the standard analysis the following components are to be quantified by accepted laboratory methods (reference 4)

1. Gases: CO_2, H_2S, SO_2, NH_3, and Rn-222

2. Water: As, Ag, B, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Mo, NH_4, Pb, Se, Sr, and Zn.

B. Analysis of produced geothermal fluids is required under provisions of GRO Order No. 4, section 10, within 30 days of completion of any geothermal well.

C. Analyses of geothermal fluids should include determination of gross radioactivity. If radioactivity exceeds the following values (gross ∞ > 10 ρCi/ℓ, gross β > 50 ρCi/ℓ) the Supervisor may require specific radionuclide assays of these and other water sources on the lease.

4.32 If water pollution is threatened from sources on the lease other than geothermal fluids the Supervisor should require sampling and analysis of those sources and of the water bodies (surface or subsurface) threatened. Potential sources of pollution include, but are not restricted to, effluent or drainage streams including road culverts, mud pits or other sumps, sanitary facilities, and waste-disposal leachates.

4.33 Biochemical, bacteriological, and organic quality of streams, canals and drains should be determined at the discretion of the Supervisor. In general, stations upstream and downstream from construction sites will be of principal interest. Parameters that may be called for include: BOD_5, TOC, COD, fecal coliform bacteria, and fecal streptococcus bacteria. Pesticide analysis should be required if pesticides have been used extensively on the leasehold.

Leachates of any origin originating on the leasehold should be analyzed for deleterious organic constituents and characteristics.

The Supervisor may require biochemical, bacteriological, and organic quality determinations on runoff from construction sites such as roads and drilling pads if that runoff reaches a body of surface water.

4.34 Samples for determination of suspended sediment may be taken from surface sources at discretion of the Supervisor. The load of any component absorbed on suspended sediment may require quantification.

4.35 Standing surface-water bodies (such as ponds, lakes, or reservoirs) on the leasehold or within the realm of influence from operations on the leasehold should be sampled for analysis to determine water quality prior to operations by the lessee. Dissolved oxygen, BOD_5, pH, specific conductance, temperature, and fecal bacteria may be determined monthly or seasonally.

ATTACHMENT 3

SURFACE AND GROUND WATER SECTIONS
FROM SECTION 5. EFFLUENT AND
ENVIRONMENTAL MEASUREMENT AND
MONITORING PROGRAMS
(ERDA, 1977, pp. 34-37)

5. EFFLUENT AND ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

In this chapter the user should describe the procedures for collection of the baseline data presented in other chapters and discuss any plans or programs for environmental monitoring to detect impacts of the proposed activity.

This chapter is not required for those activities that belong to the Systems Development or Exploration categories; it is optional for activities classified as Production Testing (see Table 2 in Part A). However, if there are measurement or monitoring programs for a proposed activity from one of these categories, the user is encouraged to report them. Environmental reports for all other activities should contain a description of relevant measurement and monitoring programs. In each case the user should supply information only to the extent that it is pertinent to environmental characterization and environmental effects described in Chapters 3 and 4.

5.1 PROGRAM UNDERTAKEN PRIOR TO THE START OF THE PROPOSED ACTIVITY

This section should describe the program for characterizing the site and the surrounding region (including any rights-of-way related to the project) prior to the start of the proposed activity. The guide indicates general environmental factors to be evaluated and the parameters to be measured; the user should add any other factors necessary to provide reasonably complete baseline data against which to measure future impacts. Excellent guidance for developing an environmental measurements program is given in "Guidelines for Acquiring Environmental Baseline Data on Federal Geothermal Leases" (The Geothermal Environmental Advisory Panel, January 1977).*

The program for collection of initial or baseline environmental data prior to initiating the proposed activity should be described in sufficient detail to demonstrate that the user has established a thorough and comprehensive approach to data collection. The description of the program should be confined principally to technical descriptions of instrumentation, scheduling, technique and procedures.

Particular attention should be paid to the description of sampling design, sampling frequency, statistical methodology and validity (including calibration checks and standards) in order to justify the scope of the program and the timing and scheduling of data collection. Information should be provided on instrument accuracy, sensitivity and reliability. When standard analytical or sampling techniques are to be utilized, they need only be identified and referenced.

---

*Copies may be obtained from the Chairman, Geothermal Environmental Advisory Panel, 345 Middlefield Road, Menlo Park, CA 94025.

When information from the literature has been used, it should be concisely summarized and documented by reference to original data sources. When the availability of original sources that support important conclusions is limited, either extensive quotations or references to secondary sources should be provided. In all cases, information derived from published results should be clearly distinguished from information derived from the user's field measurements.

5.1.1 Surface Waters

When a body of surface water may be affected by the proposed activity, the report should describe the means by which the baseline conditions of the water and the related ecology were determined. Sufficient data should be gathered to permit verification of any predictive computations or models used in the evaluation of environmental effects.

The methods for measuring physical and chemical parameters of surface waters should be described. The user's sampling program should be outlined in sufficient detail to demonstrate its adequacy with respect to both spatial coverage (i.e., surface area and depth) and temporal coverage (i.e., duration and sampling frequency), giving due consideration to seasonal effects. The techniques used to investigate any condition that might lead to interactions with effluents (such as how the presence of impurities in a water body may react synergistically with heated effluent or how the heated effluent may restrict mixing and dispersion of pollutants) should be described.

Table 5 lists the important chemical species occasionally found in spent geothermal fluids. The physical properties of water likely to be affected by any geothermal effluent discharges are also listed. The monitoring program need not include all of these parameters but should cover those that are expected to significantly impair the quality of surface waters. Other important parameters not listed should be reported if unusual ambient conditions warrant their inclusion.

The report should describe any computational models used in predicting spatial and temporal changes in surface water quality and the dispersion characteristics of surface waters. The discussion should include the bases for these models, the means for their verification, and their validity and accuracy.

The user should describe the baseline program used to characterize aquatic systems in the project area. Details concerning the rationale, techniques, and equipment used for ecological assessments should be included. All sampling programs should be discussed in terms of the pattern and frequency of sampling and duration of observations, with emphasis on those procedures used to establish the presence and abundance of important species.

The methods of analysis and interpretations of field and laboratory data should be discussed. This discussion should include degrees of precision and accuracy of reported estimates when appropriate. Procedures for verification of taxonomic determinations should be discussed, either by reference to a collection of voucher specimens or other means whereby consistent identification of species is assured.

Table 5. Water Quality Parameters Associated With Geothermal Effluents

Chemical Parameters		
Ag	F	NH_4^+
As	Fe	Pb
B as H_3BO_3	HCO_3^-	Rb
Ba	Hg	Si as SiO_2
Br	H_2S	$SO_4^=$
Ca	I	Zn
CH_4	K	Alkalinity, acidity and pH
Cl	Li	Total dissolved solids
CO_2	Mg	Dissolved oxygen
Cs	Mn	BOD and COD
Cu	Na	Radioactivity
Physical Parameters		
Color		
Suspended solids		
Taste and odor		
Temperature		
Turbidity		
Atmospheric reaeration rate		
Evaporation rate		
Velocity (average)		

Rationale for predictions of any nonlethal physiological or behavioral responses of important species due to project-related impacts should be discussed. Parameters of stress for important species of the aquatic systems should be identified, including potential synergistic effects.

5.1.2 Groundwater

The monitoring program for detection of impacts on local groundwater should be described.

Required information concerning the properties and configuration of the local aquifers, spatial and temporal variations in groundwater levels and groundwater quality data should have been presented in sufficient detail in Chapter 3 to permit a reasonable projection of the effects of the proposed activity on groundwater. Methods (including instrumentation) used to obtain and reduce the data presented should be described. The monitoring program should include those chemical species and characteristics listed in Table 5 that are expected to significantly impair the quality of groundwater.

Models may be used to predict such effects as changes in groundwater levels, dispersion of contaminants, and eventual transport through aquifers to surface water bodies or wells. The models should be described and supporting evidence for their reliability and validity presented.

ATTACHMENT 4

NWC COMMENTS ON COSO MONITORING

Note: Comments are limited to Sec. 3.1

The major differences in the Harding-Lawson Coso Hot Springs Monitoring Plan and the NWC Monitoring program stem from the fact that the two have slightly different objectives. The NWC program is designed to document natural variance of the springs/mud pots and fumaroles, while the Harding-Lawson plan is designed to document this variance plus investigate the hot springs mechanism and to establish, if possible, the connection of the springs to the geothermal reservoir, a somewhat larger task.

Differences in the various studies of the two plans are:

1. Water Temperature
   The Harding-Lawson (H-L) plan proposes continuous water temperature recording; NWC has not considered temperature monitoring except quarterly temperature logging of wells.

2. Meteorological Stations
   The H-L plan proposes complete meteorological stations in the vicinity of the Hot Springs, the NWC program will monitor rainfall only.

3. Pan Evaporation Measurements
   The H-L plan considers evaporation studies, the NWC program does not.

4. Photographic Study of the Mud Pots
   Both the H-L plan and the NWC program require this study.

5. Water Level Recording
   Both the H-L and NWC programs require this study.

6. Water Sampling and Chemical Analysis
   Both programs require this study.

7. Run Off Determinations
   Only the H-L plan considers stream run off.

8. New Wells
   Both the H-L plan and the NWC program propose new wells, however the H-L plan proposes one new well in the alluvium to the west of the surface manifestations while NWC proposes a new well at the Wheeler Prospect, 3 miles south of the Resort. Both plans propose a new well in the alluvium to the east of the Hot Springs Fault. Any new drilling within the Historical Site may have difficulties.

The H-L plan is definitely a more complete monitoring plan, however the NWC program will accomplish the Navy's objective at considerably less cost.

APPENDIX E

VISUAL RESOURCES

Please see the Draft Environmental Impact Statement for this Appendix.

APPENDIX F

LAND USE CLASSIFICATION AND METHODOLOGY

Please see the Draft Environmental Impact Statement

for this Appendix.

APPENDIX G

ELECTRICITY SUPPLY AND DEMAND

Please see the Draft Environmental Impact Statement for this Appendix.

APPENDIX H

GLOSSARY OF TERMS

ABORIGINAL: Original, as the original inhabitants of an area and their descendants.

AESTIVATE: Pass the summer in a dormant condition.

AEROSOL: A suspension of small particles in the atmosphere.

ALLUVIAL FAN; The land counterpart of a delta. It is composed of sediments deposited as a stream flows from steeper mountains to flatter valleys.

ALLUVIAL VALLEY: A valley filled with alluvium (see "alluvium").

ALLUVIUM; A general term for unconsolidated rock particles deposited during recent geologic time by running water as a sediment in the bed of a stream or on its flood plain or delta, or as a cone or fan at the base of a mountain slope.

ANNULUS; The space between the casing and the wall of a drill hole.

AQUIFER: A permeable material through which ground water moves. A water-bearing formation, commonly used in reference to a formation that is capable of yielding economically significant quantities of ground water.

ARCHAEOLOGICAL SURVEY: A field inventory designed to locate and record, from surface indications, the prehistoric and historic evidences (other than historic documents) of past human activities in an area. These include sites, artifacts, environmental data and other relevant data that can be used to reconstruct lifeways and culture history of past peoples.

ATMOSPHERIC LAPSE RATE: Rate of change of temperature as a function of elevation.

AUM: Animal unit month; measure of grazing capacity used by managers of range land.

AXIAL LOADS: Compressional forces acting on a rock mass.

A-WEIGHTED DECIBEL SCALE (dBA): Noise level weighted to human perception.

BACKGROUND: The area of a distance zone which lies beyond the foreground-middleground. Usually from a minimum of 3 to 5 miles to a maximum of about 15 miles from a travel route, use area, or other observer position. Atmospheric conditions in some areas may limit the maximum to about 8 miles or increase it beyond 15 miles.

BASALT: A fine-grained, dark colored, igneous rock composed chiefly of calcic plagioclase feldspar, magnesium and iron-rich silicates. The extrusive equivalent of gabbro.

BASEMENT ROCK: The crust of the earth below sedimentary deposits extending downward to the Mohorovicic discontinuity.

BASIC ELEMENTS: The four major elements (form, line, color, and texture) which determine how the character of a landscape is perceived.

BASIN AND RANGE: A physiographic province characterized by a series of tilted fault blocks forming long, asymmetric ridges or mountains and broad, intervening valleys.

BATHOLITH: A large, igneous rock mass that has more than 40 sq. mi (100 km^2) in surface exposure, increases in size downward, and has no determinable floor.

BEDROCK: A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.

BEDROCK ACCELERATION: Accelerations induced in bedrock resulting from earthquake energy release.

BIVOUACS: An encampment under little or no shelter, usually for a short time.

BLOWOUT: An uncontrolled, accidental release of geothermal fluid and gases from a geothermal well.

BRECCIA: A rock composed of angular and broken rock fragments cemented together in a finer-grained matrix.

CALDERA: A large, basin-shaped, volcanic depression, more or less circular in form.

CARAPACE;: A hard, protective outer covering.

CENOZOIC: The most recent era of geologic time. It consists of two periods, the Quaternary, which began about 1.5 to 2 million years ago, and the Tertiary, which began about 65 million years ago.

CHARACTERISTIC: A distinguishing trait, feature, or quality.

CINNABAR: Mercuric sulfide, the principal ore of mercury.

CLASTIC: A rock or sediment composed principally of broken fragments that are derived from pre-existing rocks or minerals and that have been transported individually from their place of origin.

COEFFICIENT OF STORAGE: For an aquifer, the volume of water released from storge in a vertical column of 1.0 sq. ft. when the water table or other piezometric surface declines 1.0 ft. In an unconfined aquifer, it is approximately equal to the specific yield.

COEFFICIENT OF TRANSMISSIVITY: In an aquifer, the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width under a unit hydraulic gradient; also embodies the saturated thickness and properties of the contained liquid.

COLOR: The property of reflecting light of a particular wavelength that enables the eye to differentiate otherwise unidentifiable objects.

CONGLOMERATE: A coarse-grained, clastic sedimentary rock composed of rounded to subangular fragments larger than 2 mm in diameter set in a fine-grained matrix.

CONTRAST: The effect of a striking difference in the form, line, color, or texture of the landscape features within the area being viewed.

CONTRAST RATING: A method of determining the extent of visual impact for an existing or proposed activity that will modify any landscape feature (land and water form, vegetation, and structures).

CORE (CORE TOOL): A tool made by knocking chips or flakes from a stone until it is of the desired size, shape and sharpness (see also flake tool).

CRITICAL VIEWPOINT: The point(s) commonly in use or potentially in use where the view of a management activity is the most disclosing.

CRUSTAL EXTENSION: Differential movement between two blocks of crustal material. This most often occurs along the active faults of continental or oceanic plate boundaries.

CULTURAL MODIFICATION: Any man-caused change in the land or water form or vegetation or the addition of a structure which creates a visual contrast in the basic elements (form, line, color, texture) of the naturalistic character of a landscape.

CULTURAL RESOURCES: Those fragile and nonrenewable remains of human activity, occupation, or endeavor (reflected in districts, sites, structures, buildings, oobjects, artifacts, ruins, works of art, architecture, and natural features) that were of importance in human events. These resources consist of (1) physical remains, (2) areas where significant human events occurred--even though evidence of the event no longer remains, and (3) the environment immediately surrounding the actual resource. Cultural resources, including both prehistoric and historic remains, represent a part of the continuum of events from the earliest evidences of man to the present day.

dBA: Logarithmic noise scale weighted to the response of the human ear.

DESERT PAVEMENT: A thin, smooth, or sheet-like, residual concentration of wind-polished, closely packed pebbles, boulders, gravel, and other rock fragments, mantling a desert surface. Wind action and sheetwash remove all smaller particles (sand and dust) which leaves a protective covering of larger material over the underlying fine-grained soil.

DISCHARGE: The rate of flow (of water) at a given moment in time, expressed as a volume per unit of time.

DISSECTION: The process of erosion whereby the continuity of a relatively even topographic surface is gradually sculptured or destroyed by the formation of gullies, ravines, canyons or other kinds of valleys.

DISTANCE ZONE: The area that can be seen as foreground-middleground, background, or seldom-seen.

DOME: (a) a large igenous intrusion whose surface is convex upward with the sides sloping away at low but gradually increasing angles; (b) an uplift or anticlinal with circular outline, in which rock dips gently away in all directions.

DOMINANT ELEMENTS: The basic elements (form, line, color, texture) in a particular landscape which exert the greatest influence on the visual character of the landscape.

DOWN-GRADIENT: See Hydraulic Gradient.

DRAINAGE BASIN: The whole area or tract of land that gathers water originating as precipitation and contributes it ultimately to a particular stream channel, lake, reservoir, or other body of water.

DRILLING DUMP: A slush pit dug specifically for the disposal of drilling mud and cuttings produced during drilling.

ECOSYSTEM: A system formed by a community of organisms (plants and animals) in interaction with their total environment.

ELECTRODIALYSIS: A method of separating compounds in solution by their differing rates of diffusion through a semipermeable membrane. This process is assisted by the application of an electromotive force to electrodes adjacent to the semipermeable membranes.

ENDEMIC: Restricted to a particular locality.

EN ECHELON: Geologic features that are in an overlapping, staggered or step-like arrangement, e.g., faults. Each segment is relatively short but collectively they form a linear zone.

EPICENTER: That point on the earth's surface which is directly above the focus of an earthquake.

EVAPOTRANSPIRATION: Loss of water from a land area through transpiration of plants and evaporation from land and water surfaces.

EXTRUSIVE: An igneous rock that has been ejected from molten rock material and solidified on the surface of the earth. Extrusive rocks include lava flows and detrital material such as volcanic ash. They generally are fine-grained.

FANGLOMERATE: A sedimentary rock consisting of slightly water-warn heterogeneous rock fragments of all sizes, originally deposited in an alluvial fan and cemented into a firm rock.

FAULT: A surface or zone of rock fracture along which there has been displacement, from a few centimeters to hundreds of kilometers in scale. Faults are classified according to the relative motion of the rock on each side of the fracture zone, or fault plane. These classifications are illustrated in the Technical Report.

FAULT BLOCK MOUNTAINS: Mountains bounded on at least two opposite sides by faults.

FAULT ZONE: A fault that is expressed as a zone of numerous small fractures, or of breccia or fault gouge. A fault zone may be a few meters to a few kilometers wide.

FAUNA: The animals or wildlife of a given region; used as a singular (plural: faunas or faunae); also a study decribing that wildlife.

FERAL: Having reverted to the wild state (formerly domesticated, for example).

FLAKE (FLAKE TOOL): A thin sharp chip struck from a core of rock for use as a tool (see also core tool).

FLORA: The plants of a given region (plural: floras or florae); also a study describing those plants.

FOCUS (of an earthquake): That point within the earth which is the center of energy release of an earthquake and the origin of its elastic waves.

FOREGROUND-MIDDLEGROUND: The area visible from a travel route, use area, or other observer position to a distance of 3 to 5 miles. The outer boundary of this zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape. Vegetation is apparent only in patterns or outline.

FORM: The mass or shape of an object or objects which appear unified, such as in the shape of the land surface or patterns placed on the landscape.

FROST HEAVING: The uneven lifting or upward movement, and general distortion, of surface soils, rocks, vegetation, and other structures, resulting from expansion due to freezing of water and growth of ice masses within other materials.

FUGITIVE DUST: Dust resulting from a non-localized emission source such as automobile traffic on unpaved roads or wind erosion of exposed areas.

FUMAROLES: A volcanic vent from which gases and vapors are emitted; it is characteristic of a late stage of volcanic activity.

GABBRO: A coarse-grained, igneous rock with the composition of basalt.

GEOLOGIC TIME: A chronological sequence of earth time. It is divided into four eras--the Precambrian, more than 570 million years go (mya); the Paleozoic, from 225 to 570 million mya; the Mesozoic, from 65 to 225 mya; and the Cenozoic, from the present to 65 mya.

GEOPHYSICS: The study of the earth by quantitative physical methods, especially by seismic reflection and refraction, gravity, magnetic, electrical and radiation methods.

GEOTHERMAL FLUID: Subsurface water or steam heated by internal processes within the earth.

GRADIENT HOLES (temperature): Holes that are drilled and constructed specifically to measure thermal gradients beneath the earth's surface.

GRANITE: A coarse-grained, intrusive igneous rock consisting essentially of light colored minerals, including feldspars and quartz.

GRANODIORITE; A coarse-grained, intrusive igneous rock intermediate in composition between granite and diorite.

GRAVITY SURVEY: Measurements of the gravitational field at a series of different locations. The objective in exploration is to associate variations in the gravity field with differences in the distribution of densities, and hence of rock types.

GROUND WATER: Subsurface water, especially that contained in a saturated zone or aquifer, including underground streams.

GROUND WATER BASIN: An area underlain by water-bearing materials capable of storing and yielding a ground water supply. In most cases, these materials would consist of unconsolidated or consolidated sediments, or a sedimentary reservoir.

HABITAT: The environment that is natural for the life and growth of a plant or animal.

HEAT FLOW: Dissipation of heat from within the earth by conduction, convection or radiation at the surface.

HEAT FLOW UNIT (HFU): A measurement of terrestrial heat flow equivalent to 10^{-6} cal/cm^2/sec.

HERPETOFAUNA: Reptiles and ambphibians.

HOLOCENE: An epoch of the Quaternary period, from the end of the Pleistocene (1.5 to 2 million years go) to the present.

HORST AND GRABEN STRUCTURES: An elongate, relatively depressed crustal unit that is bounded on both sides by faults (usually normal).

HYDRAULIC GRADIENT: In an aquifer, the rate of change of pressure head (height of a column of water that the pressure can support) per unit of distance of flow at a given point and in a given direction. It is usually expressed in meters per kilometer or feet per mile.

HYDROFRACTURING: Fracturing induced in rocks beneath the surface by injection of fluids at high pressures into drill holes.

HYDROLOGIC BUDGET: An accounting of the inflow to outflow from, and storage in, a hydraulic unit, e.g., drainage basin, aquifer or reservoir; the relationship between evaporation, precipitation, runoff and change in water storage is implied.

HYDROLOGIC STUDY AREA: The area enclosed by the watershed boundaries of Rose Valley, Coso Valley and Coso Basin and several smaller enclosed basins between Rose Valley and Coso Basin.

HYDROTHERMAL: Pertaining to heated water (or aqueous solution) or products resulting from heated water, i.e., alteration of rocks or minerals by reaction of hydrothermal water.

INTERBEDDED: Sedimentary rock layers laid between or alternating with others of different character.

INTERCEPTION: The process by which water falls on plant surfaces and is evaporated back into the atmosphere without reaching the ground surface.

INTRUSION: A feature (land and water form, vegetation, or structure) which is generally considered out of context because of excessive contrast and disharmony with the characteristics landscape.

INTRUSIVE: An igneous rock that has cooled, from magma, beneath the earth's surface. It is generally coarse-grained.

ION EXCHANGE: A chemical reaction involving the reversible replacement of certain ions by others, without loss of crystal structure.

KEY OBSERVER POSITION (KOP): One or a series of observer positions on a travel route or at a use area or a potential use area, that are used to determine seen area.

LACUSTRINE SEDIMENTARY: A sediment pertaining to, produced by, or formed in a lake or lakes.

LANDFORM: A term used to describe the many types of land surfaces which exist as the result of geologic activity and weathering, e.g., plateaus, mountains, plains, and valleys.

LAND PATENT: Title to land from a government agency, obtained through filing of a claim establishing productive occupancy of the land resource.

LAND CHARACTER: The arrangement of a particular landscape as formed by the variety and intensity of the landscape features and the four basic elements of form, line, color, and texture. These factors give the area a distinctive quality which distinguishes it from its immediate surroundings.

LANDSCAPE FEATURES: The land and water form, vegetation, and structures which compose the characteristic landscape.

LANDSCAPE MODIFYING ACTIVITIES: Any actions which change the land and water form or vegetation or places structures on the landscape.

L_{eq}: Measure of average decibel level.

L_{dn}, CNEL: Measures of average decibel level, weighted more heavily in the night and evening.

L_x: Sound decible level which is exceeded X percent of the time.

LINE: The path, real or imagined, that the eye follows when perceiving abrupt differences in form, color or texture. Within landscapes, lines may be found as ridges, skylines, structures, changes in vegetative types, or individual trees and branches.

LIQUEFACTION: The sudden large decrease of the shearing resistance of a cohesionless soil, caused by a collapse of the structure by shock or strain, and associated with a sudden but temporary increase of the pore fluid pressure. It involves a temporary transformation of the material into a fluid mass.

LITHOLOGIC: Description of rocks, especially sedimentary clastic hard speciment and in outcrop, on the basis of color, structure, mineralogic composition and grain size.

L_X: Decibel level which is exceed X percent of the time.

MAGMATIC WATER: Water contained in or expelled from magma.

MAGNITUDE (earthquake): A measure of the strength of an earthquake or the strain energy released by it, as determined by seismographic observation.

MELT: A liquid, fused rock.

METAMORPHIC ROCK: Includes all those rocks which have formed in the solid state in response to pronounced changes of temperature, pressure and chemical environment, which take place in general below the shells of weathering and cementation.

METASEDIMENTS: (a) A sediment or sedimentary rock which shows evidence of having been subjected to low-grade metamorphism; (b) a metamorphic rock of sedimentary origin.

METAVOLCANICS: See Metasediments.

MICROCLIMATIC VARIABLES: Localized climate parameters.

MICROSEISMIC DATA: Data on small earthquakes, or ground motions, which are detectable only with sensitive instruments.

MODIFICATION: To reduce in degree or diminish in harshness the degree of visual contrast of a cultural intrusion or improvement.

MODIFIED MERCALLI INTENSITY: One of the earthquake intensity scales based on human's perceptions of earth motions. It has 12 divisions ranging from I, which is barely perceptible to trained observers at rest to XII, which represents total destruction.

MUD POT: A type of hot spring containing boiling mud, usually sulfurous and often multicolored. Commonly associated with geysers and other hot springs in volcanic areas.

NATIONAL REGISTER OF HISTORIC PLACES: The official list, established by the Historic Preservation Act of 1966, of the nation's cultural resources worthy of national recognition. The Register lists archaeological, historic, and architectural properties (i.e., districts, sites, buildings, structures, and objects) nominated for their local, state or national significance by state and/or Federal agencies and approved by the National Register staff. The list is maintained by the U.S. Department of the Interior, National Park Service, with special responsibilities delegated to State Historic Preservation Officers (SHPOs) to develop and implement preservation plans for their respective states.

OBSIDIAN: A black or dark-colored volcanic glass.

OSMONIC PURIFICATION: A nonelectric process related to electrodialysis. It uses ionic and osmotic forces to separate salts from brine.

OSMOTIC MEMBRANE: A selective membrane that allows passage of some ions and not others.

OVERDRAFT: Withdrawal of ground water in excess of replenishment.

PENDANT: A downward projection of the country rock into the top of an igneous intrusion.

PERCHED GROUND WATER: Unconfined ground water separated from an underlying main body of ground water by an unsaturated zone.

PERLITIC: Said of the texture of glassy igneous rock that has cracked due to contraction during cooling.

PERMEABILITY: Ability of a rock, sediment or soil to transmit a fluid without impairment of the structure of the medium. A measure of the relative ease of fluid flow under unequal pressure. The customary unit of measurement is the darcy. It is equivalent to the passage of one cubic centimeter of fluid, of one centipoise, viscosity, flowing in one second, under a pressure differential of one atmosphere, through a porous medium having a cross-sectional area of one sq. cm. and a length of one cm.

PHREATOPHYTIC VEGETATION: A plant type that derives its water supply from the zone of saturation or through the capillary fringe and is characterized by a deep root system.

PHYSIOGRAPHIC MAP: A perspective symbolic map which shows local relief and other physical features.

PISCICULTURE: Fish culture, raising fish.

PLAYA LAKES: Dry, vegetation-free, flat-floored area composed of stratified sediments representing the bottom of a completely closed desert basin. As playas have no external drainage, they become filled with alluvium; sometimes they are partially filled with water, which quickly evaporates and leaves a mineral residue.

PLEISTOCENE: The epoch forming the earlier part of the Quaternary period, roughly 1 or 2 million years ago to about 10,000 years ago; during this epoch there was widespread glacial ice.

PLUG: (a) A vertical, pipe-like body of magma that represents the conduit to a former volcanic vent; (b) a crater filling of lava, the surrounding of which has been removed by erosion.

PLUGGING: (1) chemical precipitation of solids in a formation around a well bore resulting in clogging the pore spaces and/or fractures in which the fluid flows; (2) the process of stopping the flow of water in strata penetrated by a borehole or well so that fluid from one stratum will not escape into another or to the surface; especially the sealing up of a well that is dry and is to be abandoned.

PLUTON: An igneous intrusion.

PORE PRESSURE: The hydrostatic pressure of the water in the pore space of a soil.

POROSITY (EFFECTIVE): The ratio of the continuous void space (through which water can move) to total volume, measured at a point in a flow system.

POTASSIUM-ARGON (K-AR) AGE DATE: Determination of the age of a mineral or rock in years based on the known radioactive decay of potassium 40 to argon 40.

PRACTICAL SUSTAINED YIELD: The amount of water that could be extracted from a ground-water basin without detrimental effects.

PRECAMBRIAN: All rocks formed before Cambrian time.

PREHISTORIC: Pertaining to that period of time before written history. In North America, "prehistoric" usually refers to the pre-Columbian period.

PUMICE: A light-colored, vessiculalr glassy rock usually having the composition of rhyolite, formed from pyroclastic volcanic action.

PYROCLASTIC: Pertaining to clastic rock material formed by volcanic explosion or aerial expulsion from a volcanic vent.

QUATERNARY: The period of time from the present to 1.5 to 2 million years ago (see Geologic Time).

QUARTZ MONZONITE: A coarse-grained igneous rock containing major plagioclase, orthoclase, and quartz, with minor biotite, and other iron and magnesium-rich silicate minerals.

RAPTORIAL: Preying upon other animals.

RAPTORS: Birds of prey.

RECHARGE: The process involved in the absorption and addition of water to the zone of saturation.

RESERVOIR ROCK: A natural rock which contains liquids and/or gases. In general, the fluid is contained in pore spaces between rock grains or in fractures.

REVERSE OSMOSIS: Pure water is separated from a solution by using pressure to force the pure water through a selective membrane.

RHYOLITE: A group of extrusive igneous rocks, generally porphyritic and exhibiting flow texture, with phenocrysts of quartz and alkali feldspar in a glassy ground mass. The extrusive equivalent to granite.

RIGHT-LATERAL FAULT: A strike-slip fault where the opposite sides of the fault are offset to the right with respect to each other.

RIPARIAN: Occurring along the bank of a stream or other body of water.

ROTATIONAL SLIDE: A landslide in which shearing takes place on a well-defined, curved shear surface, concave upward in cross-section, producing a backward rotation in the displaced mass.

SATELLITES (BATHOLITH): A smaller, secondary body associated with a batholith.

SCALE: The proportionate size relationship between an object and the surroundings in which the object is placed.

SCENIC QUALITY: The degree of harmony, contrast, and variety within a landscape.

SCENIC QUALITY CLASS: The value (A, B, or C) assigned a scenic quality rating unit by applying the scenic quality evaluation key factors which indicate the relative visual importance of the unit to the other units within the physiographic region in which it is located.

SCHOOL LANDS: Public lands (normally the 16th and 36th sections of each township) originally granted to the State of California by the Federal government to use or dispose of for the support of public education; many of these sections have since been disposed of the state, although usually mineral rights were reserved.

SCORIA: Vesicular, cindery form of basaltic rock due to the escape of volcanic gases before solidification.

SEDIMENTARY RESERVOIR: See Ground Water Basin.

SEDIMENTARY ROCK: Rock formed from accumulations of sediment. Sediment may consist of rock fragments, the remains or products of animals or plants, the product of chemical action or evaporation, or combinations of these. Sedimentary rocks are characteristically deposited in horizontal layers.

SEISMICITY: The phenomenon of the earth's movements and vibrations, particularly earthquakes.

SELDOM SEEN: Portions of the landscape which are generally not visible from high and medium visual sensitivity level observer positions, and which are visible beyond approximately 15 miles from these positions.

SHEET EROSION: Erosion in which thin layers of surface material are gradually removed from an extensive area of gently sloping land by broad sheets of running water rather than streams.

SILICIC: A silica-rich igneous rock or magma.

SIMULATION: The realistic visual portrayal which demonstrates the perceivable changes in the landscape features of a proposed management activity through the use of photography, artwork, computer graphics, and other such techniques.

SOLUBILIZE: To make soluble or increase solubility of; to increase the amount of substance that will dissolve in a given amount of another substance.

SPECIFIC CAPACITY: The well discharge divided by the drawdown, expressed in English units as gallons per minute per foot drawdown.

SPECIFIC YIELD: The ratio of the volume of water, a given mass of saturated rock or soil will yield on the average and after a long period, by gravity to the volume of that mass.

STOCK: An igneous intrusion that is less than 40 sq. mi. in surface exposure, and resembles a batholith except in size.

STORAGE: Water naturally detailed in a drainage basin, e.g., ground water.

STRATIFICATION: The parallel layered structure of sedimentary rocks.

STRATIFIED RANDOM SAMPLE: A sample gathered so that each member of each defined sub-group within the population sampled has an equal chance of being included within the sample.

STRUCTURAL PROVINCE: A region whose geologic structure differs significantly from those of adjacent regions. It is generally very similar to a physiographic province.

SUBVENTION: An agreed-upon return by the state, of a portion of sales tax revenues, to the counties (and cities, if applicable) where it was collected.

TECTONIC STRESS REGIME: The combination of regional earth forces that control geologic processes such as faulting, folding, erosion, and resulting topographic features and geologic structures.

TERRESTRIAL: (a) Pertaining to the earth; (b) pertaining to the earth's dry land.

TERTIARY: The period of time from about 2 to 65 million years ago (see Geologic Time).

TEXTURE: The interplay of light and shadow created by the variation in the surface of an object; the visual result of the tactile surface characteristics.

THERMAL FEATURES: Natural features associated with heat, such as hot springs, geysers, fumaroles, steaming ground, volcanic gases, etc.

TUFF: A compacted pyroclastic deposit of volcanic ash and dust that may contain up to 50 percent nonvolcanic sediments.

UNDERFLOW: The flow of ground water through the soil or a subsurface stratum.

UP-GRADIENT: See Hydraulic Gradient.

VARIETY: The state or quality of being varied and have the absence of monotony or sameness.

VISUAL RESOURCE: The land, water, vegetative, animal, and other features that are visible on all lands (scenic values).

VISUAL RESOURCE MANAGEMENT CLASS: The degree of visual change that is acceptable within the characteristic landscape. It is based upon the physical and sociological characteristics of any given homogeneous area and serves as a management objective.

VISUAL RESOURCE MANAGEMENT (VRM): The planning, design, and implementation of management objectives to provide acceptable levels of visual impacts for all BLM resource management activities.

VISUAL SENSITIVITY LEVEL(S): An index of the relative degree of user interest in scenic quality and concern and attitude for existing or proposed changes in the landscape features of an area in relation to other areas in the planning unit.

VOLCANICS: Those igneous rocks that have reached or nearly reached the earth's surface before solidifying.

WATER TABLE: The surface between the zone of saturation and the zone of aeration. Often this is the water level in a well.

GPO 689-866/10

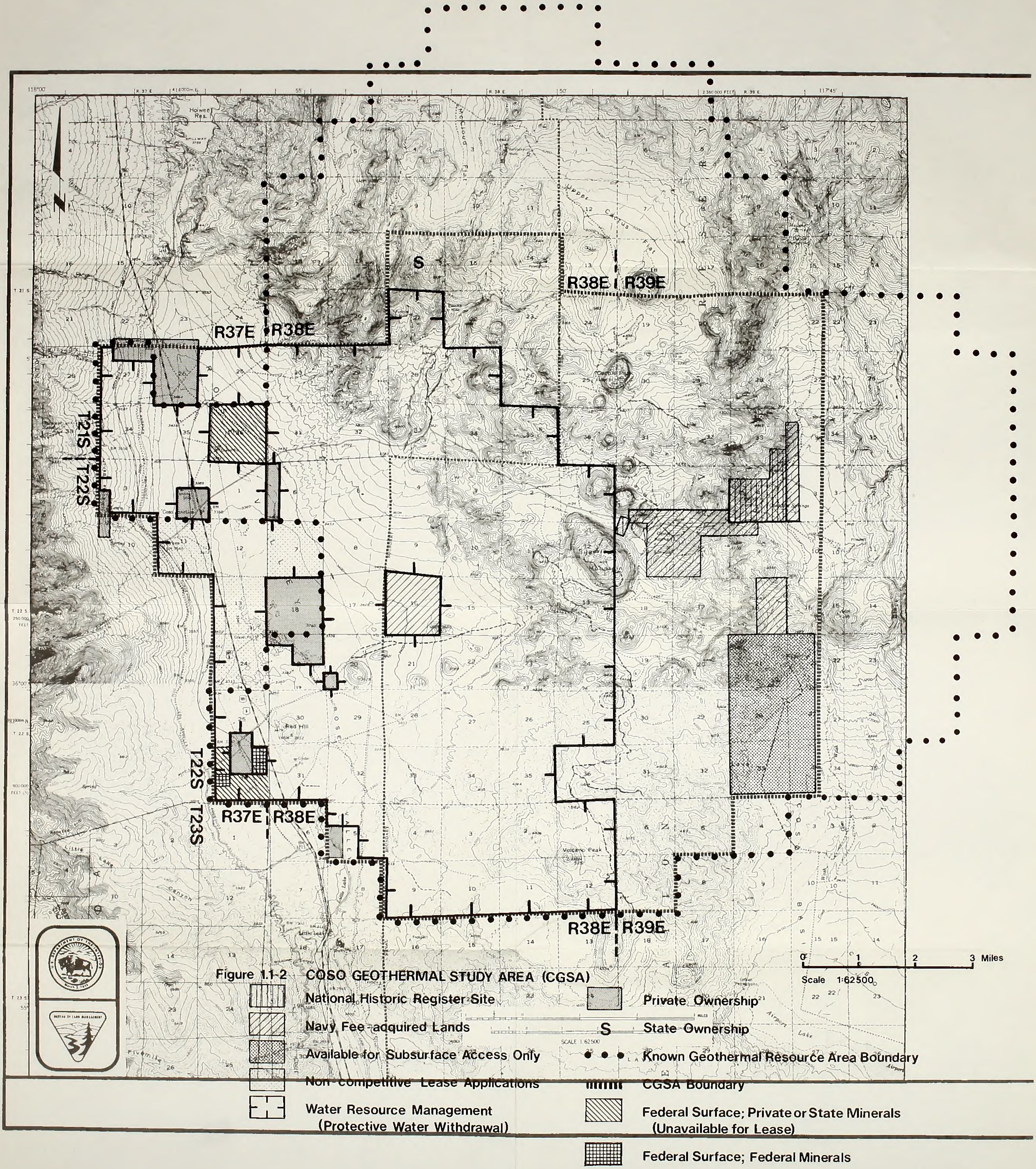


Figure 2.5.1-2 EAST-WEST SECTION ACROSS THE CGSA Figure 3.3 EAST-WEST SECTION ACROSS THE CGSA

Figure 2.5.1-3 NORTH-SOUTH SECTION ACROSS ROSE VALLEY Figure 3.4 NORTH-SOUTH SECTION ACROSS ROSE VALLEY

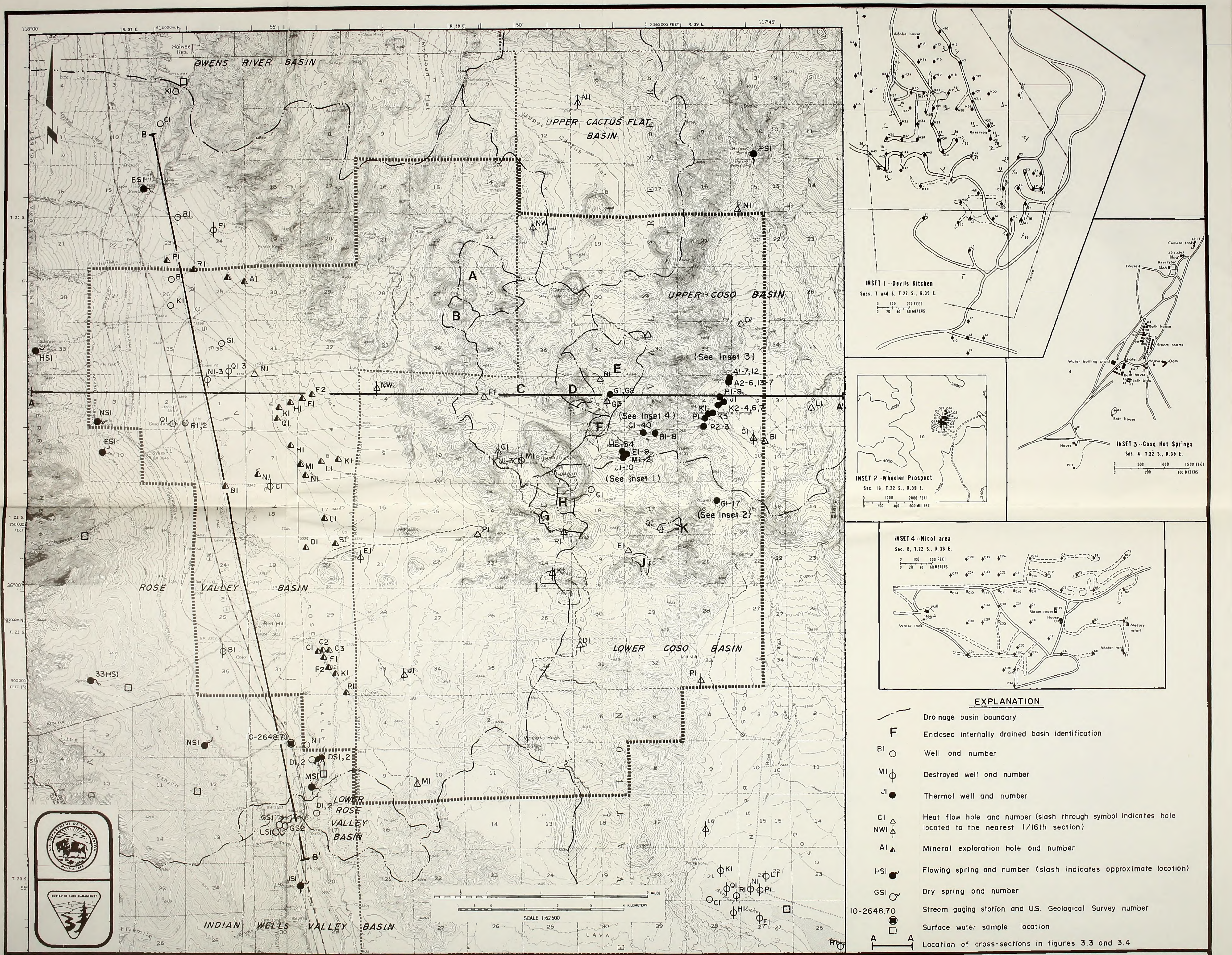
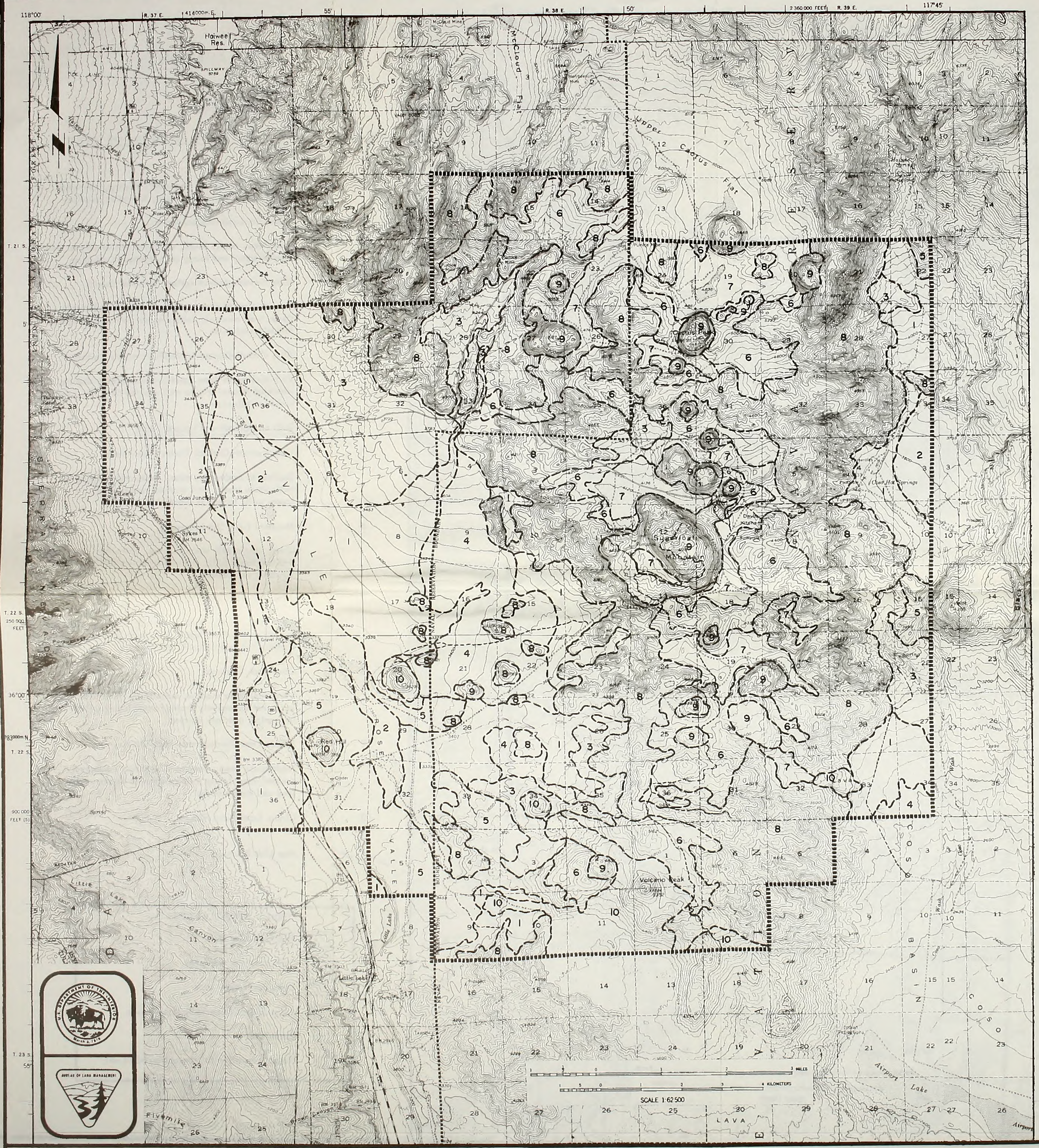


PLATE 2.5-1 Well and Spring Locations-CGSA

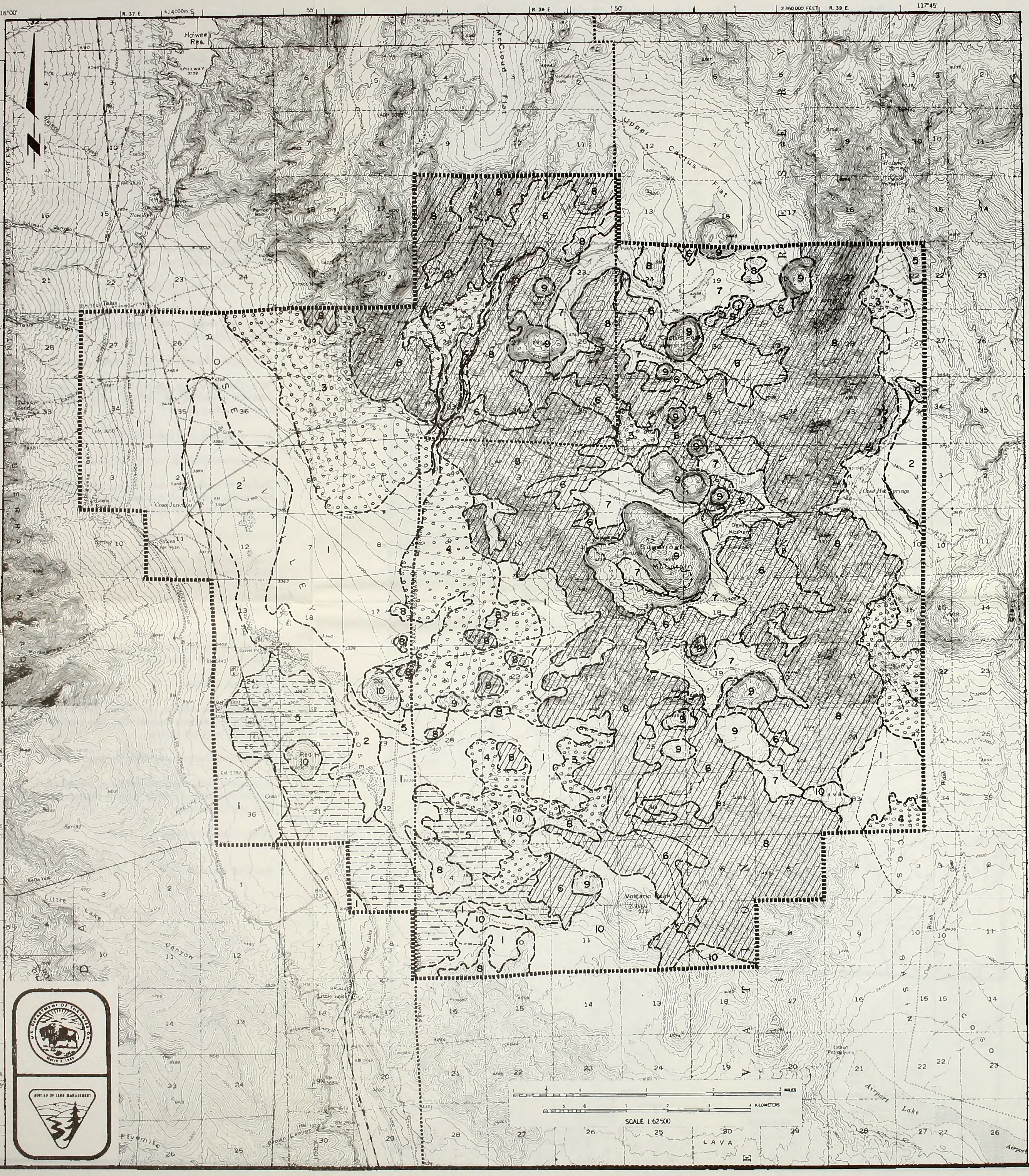


EXPLANATION

DESCRIPTION

Map Symbol	Description
	Soils on Valley Floors, Alluvial Fans and Terraces
1	Dunmovin Deep, nearly level to moderately sloping, somewhat excessively drained sandy soils; formed in alluvium
2	Dunmovin-Lavic-Wasco Variant Very deep, nearly level, somewhat excessively to well drained sandy and loamy soils; formed in alluvium
3	Alko Variant-Joshua Variant-Nebona Variant Very shallow to deep, gently sloping to moderately steep, well drained, cobbly sandy soils with hardpans; formed in alluvium
4	Alko Variant-Dunmovin Variant-Nebona Variant Very shallow to deep, gently to moderately sloping, somewhat excessively to well drained soils with hardpans; formed in alluvium
	Soils on Uplands and Upland Basins
5	Gass Variant-Garlock Variant-Sparkhule Shallow to moderately deep, moderately sloping to moderately steep, well drained cobbly sandy and loamy soils; formed in basalt and cinders
6	Maynard Lake-Stumble, steep Deep, moderately steep to steep, somewhat excessively drained sandy soils; formed in rhyolite tuff and volcanic ash deposits
7	Maynard Lake-Stumble, sloping Very deep, nearly level to strongly sloping, somewhat excessively drained sandy soils; formed in alluvium from rhyolite tuff and volcanic ash deposits
8	Coso-Rock Outcrop Very shallow to shallow, moderately steep to steep, somewhat excessively drained stony loamy soils; formed in granite; and rock outcrop
9	Rubble Land-Torriorthents-Rock Outcrop Moderately deep, steep to very steep, excessively drained stony loamy soils on rhyolite domes; rubble land and rock outcrop
10	Cinder Land-Lava Flows
- - -	Map Unit Boundary

PLATE 2.6-1 GENERAL SOILS MAP



EXPLANATION

DESCRIPTION

Map Symbol	Soils on Valley Floors, Alluvial Fans and Terraces
1	Dunmovin
	Deep, nearly level to moderately sloping, somewhat excessively drained sandy soils; formed in alluvium
2	Dunmovin-Lavic-Wasco Variant
	Very deep, nearly level, somewhat excessively to well drained sandy and loamy soils; formed in alluvium
3	Alka Variant-Joshua Variant-Nebona Variant
	Very shallow to deep, gently sloping to moderately steep, well drained, cobbly sandy soils with hardpans; formed in alluvium
4	Alko Variant-Dunmovin Variant-Nebona Variant
	Very shallow to deep, gently to moderately sloping, somewhat excessively to well drained soils with hardpans; formed in alluvium
	Soils on Uplands and Upland Basins
5	Gass Variant-Garlock Variant-Sparkhule
	Shallow to moderately deep, moderately sloping to moderately steep, well drained cobbly sandy and loamy soils; formed in basalt and cinders
6	Maynard Lake-Stumble, steep
	Deep, moderately steep to steep, somewhat excessively drained sandy soils; formed in rhyolite tuff and volcanic ash deposits
7	Maynard Lake-Stumble, sloping
	Very deep, nearly level to strongly sloping, somewhat excessively drained sandy soils; formed in alluvium from rhyolite tuff and volcanic ash deposits
8	Coso-Rock Outcrop
	Very shallow to shallow, moderately steep to steep, somewhat excessively drained stony loamy soils; formed in granite; and rock outcrop
9	Rubble Land-Torriorthents-Rock Outcrop
	Moderately deep, steep to very steep, excessively drained stony loamy soils on rhyolite domes; rubble land and rock outcrop
10	Cinder Land-Lava Flows
	Map Unit Boundary

SOIL SENSITIVITIES

- Highly erosive soils
- Soils overlying hardpans
- Expansive clayey soils
- Areas subject to periodic flash floods
- Landslides
- Playas - sensitive to compaction when wet

PLATE 2.6-2 SOIL SENSITIVITIES