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ENVIRONMENTAL SUMMARY DOCUMENT FOR THE REPUBLIC GEOTHERMAL, INC.
APPLICATION FOR A GEOTHERMAL LOAN GUARANTY PROJECT

64 MW WELL FIELD AND 48 MW (net) GEOTHERMAL POWER PLANT

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July 1979

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64 MW Well Field and 48 MW (net)

Geothermal Power Plant on East Mesa

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Neil B. Crow, Paul H. Gudikson, and Yvonne E. Ricker

Lawrence Livermore Laboratory in cooperation with the U.S. Department of
Energy/San Francisco Operations Office, the U.S. Geological Survey, and
the U.S. Bureau of Land Management

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I. INTRODUCTION

The following document addresses the proposed Geothermal Loan Guaranty Application of Republic Geothermal Inc., (RGI) for a 64 MW well field and a 48 MW (net) power plant. This project represents the culmination of several years of exploration and development. Work related to the well field and power plant began after 3 geothermal lease tracts in the East Mesa known geothermal resource area (KGRA) were awarded to RGI after competitive bidding. Most of the initial activity related to the facility has involved the completion of temperature gradient wells, deep exploratory wells, production wells and injection wells. Environmental analyses have been prepared for those activities by the Area Geothermal Supervisor (AGS) of the U.S. Geological Survey (USGS). The Bureau of Land Management (BLM) has also prepared environmental analyses that concern the power plant. This summary document, while focusing attention upon the proposed loan guaranty application, also takes into account the impacts of important Federal actions that have preceded the loan guaranty project. The primary purpose of this document is to provide a comprehensive review and analysis of the environmental consequences of (1) guaranteeing a loan for the completion of the 64 MW well field and the 48 MW (net) power plant or (2) denying a guaranteed loan that is needed to finish the project (i.e., the no project alternative). To complete the analysis, extensive use has been made of existing documents involving the East Mesa KGRA and the effects of the power plant, its well field, transmission line, and related facilities.

II. PURPOSE AND NEED

The primary purpose of the Federal Geothermal Loan Guaranty Program is to encourage and assist the private and public sectors to accelerate development of geothermal resources by minimizing a lender's financial risk associated with development of new geothermal resources with environmentally acceptable processes. The Federal Geothermal Loan Guaranty Program was mandated by the Geothermal Energy Research Development, and Demonstration Act of 1974, Public Law 93-410. The proposed action assessed here is the guaranty of a loan for Republic Geothermal Inc. for a 64 MW well field and a 48 MW (net) geothermal power plant sited on Federal lands. Guaranty of the loan would result in the completion of a power plant and well field that could supply a significant portion of Imperial County's energy requirements.

III. ALTERNATIVES INCLUDING THE PROPOSED ACTION

This section provides a review of the environmental effects of previous leasing actions regarding the East Mesa KGRA where the proposed power plant will be located. It also describes and compares the important environmental consequences of approving the loan guaranty, and building the proposed power plant and well field, as well as denying the guaranty, and therefore eliminating the project.

3.1 Environmental Effects of Prior Leasing Actions

The proposed project has been preceded by a series of Federal actions which span almost a decade. The first major Federal action was the decision to lease Federal lands for geothermal development under provisions of the Geothermal Steam Act of 1970. A subsequent action was the selection of the actual tracts within the East Mesa KGRA to be presented for competitive bidding. The environmental consequences of leasing land were assessed in an Environmental Impact Statement (EIS) prepared by U.S. Department of the Interior (USDI, 1973). In 1974 an Environmental Analysis Record (EAR) (BLM, 1974) was prepared prior to leasing tracts on East Mesa for geothermal exploration, well field development and resource utilization. Three tracts were leased to RGI for geothermal exploration and development. After obtaining leases for the tracts, RGI proceeded with the drilling and testing of wells, all of which were assessed in a series of environmental analyses and approved by the Area Geothermal Supervisor (AGS). Adverse environmental impacts were avoided or minimized by adherence to the Geothermal Resource Operational

(GRO) Orders* (USGS, 1976a; 1976b; 1976c; 1977b) under the direction of the AGS. Special lease stipulations and permit conditions are also used to control operations.

The EIS (USDI, 1973) for the Geothermal Leasing Program assesses the kinds of impacts that can be expected from geothermal development of Federal land. This EIS addresses unavoidable adverse impacts associated with geothermal exploration, drilling, production testing and operation on Federal lands in the Imperial Valley. These impacts are summarized in Appendix A of this document.

The preleasing EAR (BLM, 1974) identifies and describes the impacts that could accompany geothermal development and operation on East Mesa KGRA. Included in the EAR are impacts to vegetation, land use, wildlife, aesthetics, historical and archeological resources, recreation, and various possible mishaps. Appendix A also contains a summary of those impacts.

3.2 Description of the Proposed Project

The proposed project is comprised of a 64 MW well field development and 10 MW (gross) turbine-generator and a 54 MW (gross) turbine-generator. After parasitic (internal) energy uses are accounted for, net output from both units will be 48 MW. The 10 MW unit will be built first as a

*The Geothermal Resource Operational Orders are on file and available at the Office of the Area Geothermal Supervisor, U.S. Department of the Interior Geological Survey, 345 Middlefield Rd., Menlo Park, California 94025.

research and demonstration facility. Later, when the 54 MW unit is installed, the two units will form an integrated system. In the integrated system, the 10 MW unit will supply power for internal needs. The geothermal well field supporting the power plant as now planned will consist of 19 production wells and 9 injection wells. A 161 kV transmission line will convey electricity to an existing 161 kV line that is to the south of the plant site. The project is located on Federal lands in the East Mesa KGRA.

3.2.1 Site Location

Figure 1 shows the location of the proposed area of operations as well as the lands leased by RGI (Republic Geothermal Inc.). The plant and well field are approximately 4 miles to the north of Interstate Highway I-8 and about a mile to the west of the East Highline Canal. Holtville, which is the nearest town, is about 8 miles to the west (see Figure 2). The Coachella Canal, which carries water from the All-American Canal to the Coachella Valley, is nearly 10 miles due east of the project.

3.2.2 Well-field

Layout of the proposed geothermal well-field is depicted in Figure 3. Development of the well field as proposed in a Plan of Development submitted to the USGS by Republic Geothermal Inc., (RGI, 1978) would involve the following major operations:

Figure 1. Location of the RGI lease tracts and proposed area of operations.

Figure 2. Location of the RGI leases with respect to Holtville, Sand Hill, and other geographic features.

Figure 3. Layout of the proposed geothermal well field for the 48 MW (net) geothermal power plant (RGI, 1978).

- Drill and complete 13 production wells and 7 injection wells.
- Test both exploratory and injection wells.
- Construct pipelines from production wells to separation facilities at the power plant site. Construct pipelines from the plant to injection wells.
- Install power lines to wells and pumps.
- Construct roads to wells.

Table 1 shows the status of all the proposed wells. Six production wells and 2 injection wells have already been completed. These wells were approved by the Area Geothermal Supervisor through Environmental Analyses (EA) 12, 29, 86, and 99-100 (USGS, 1975a; USGS, 1975b; USGS, 1978).

Changes in the number of wells and their locations may be made as more exploratory information is obtained. Such changes, however, will have to be addressed by additional environmental analyses.

Wells are completed according to requirements specified in GRO Order No. 2 (USGS, 1976a) that deals with the drilling, completion, and spacing of geothermal wells. Wells are cased and cemented to depths of

approximately 5000 ft or more. Casings are pressure tested to a minimum pressure of 1000 psi or .2 psi/ft of depth, whichever is greater.

Production casing is cemented to prohibit the communication of geothermal fluids with water in shallow aquifers. The initial testing of geothermal wells will result in the discharge of fluids to storage basins or sumps.

In well clean-out operations, discharges will consist of reservoir fluids that contain sand, drilling filtrates, and muds. Additional fluids are also discharged to storage basins during preliminary flow testing and

Table 1. Status of Wells for RGI's 48 MW (net) Power Plant

Status	10 MW (gross) facility	54 MW (gross) facility
Completed	16-29	38-30
production	16-30	78-30
wells	56-30	58-30
Planned	36-30	12-30, 14-30
production	76-30	18-30, 32-30
wells		34-30, 52-30
		54-30, 72-30
		74-30, 14-29
		18-29
Completed	18-28	
Injection	52-29	
wells		
Planned	56-29	16-20, 16-19
Injection		54-19, 58-24
wells		54-25, 58-25

sand clean out. Sustained production testing does not involve the use of storage basins. Instead, fluids are discharged to large steel tanks where they are held until they are injected back into the reservoir.

Fluids temporarily stored in the basins may be spread onto roadways and drilling pads for dust control. Drilling muds will be neutralized and then spread onto unsurfaced roads. If they cannot be neutralized, the muds will be transported to an acceptable waste disposal site. In addition to the liquid and solid wastes generated during production testing, there are gaseous effluents in the form of steam vented from wells and hydrocarbon emissions from diesel generators.

Each well site will require about 2 acres of land. The proposed pipelines to production and injection wells will be next to proposed roads. Construction of the pipelines and power lines to the wells would be along the access roads to each well. A 30 ft wide strip would be disturbed for construction access roads, pipe lines and power lines (Atlantis Scientific, 1978). At quarter mile intervals horizontal expansion loops would be installed. Pipelines will be buried where they cross roads, but elsewhere they will be elevated 1 ft above the surface. Power lines to wells will be strung on 30 foot poles at about 200 to 300 ft intervals.

The well field when completed will furnish the 48 MW (net) power plant with about 14 million pounds of 335⁰F geothermal fluids each hour. About 90% of those fluids will be disposed of through the 9 injection wells, the remaining 10% represents steam condensate that is evaporated

in cooling towers. The spent fluids will be injected at 150-500 psi above the static reservoir pressures at depths between 2000 and 5000 ft (USGS, 1979a).

3.2.3 Power Plant

The proposed power plant consists of two units. The first unit is a 10 MW (gross) turbine-generator. That unit would initially be a research and demonstration facility (USGS, 1978). After a second 54 MW (gross) unit is installed, the 10 MW unit would provide electricity for internal needs of the combined facility. Figure 4 is a diagram of the layout of the plant site. The site will require approximately 7 acres of land. The largest feature of the facility is the array of cooling towers.

Geothermal fluids from the 19 production wells will enter the site in 4 lines. The fluids will be discharged into 4 high pressure flash tanks. Steam produced from the tanks will be sent to the single inlet 10 MW turbine and the high pressure section of the 54 MW turbine. Fluids remaining after the high pressure flash are sent to low pressure separators where the fluids are flashed again. Steam from these separators is transported to the low pressure section of the 54 MW turbine. Residual fluids from the separators end up in a storage tank where they are held until they are injected. Steam from the turbines is exhausted to a direct contract barometric condenser. The condensed steam and cooling water are pumped to mechanical draft cooling towers. The towers will cool the 120°F water from the condenser to 90°F under normal load conditions. Because slightly more condensate will be

Figure 4. Diagram of the power plant site.

produced than is evaporated from the towers, no outside cooling water will be necessary to support the plant. Excess cooling water will be disposed through injection. Noncondensable gases will be removed from the condenser by vacuum pumps and then vented to the atmosphere. Gases will either be emitted from the cooling tower or a stack. A generalized flow diagram of the power plant conversion system is shown in Figure 5.

3.2.4 Transmission Line

A 161 kV transmission line will carry electricity generated by the power plant to an existing 161 KV line owned by the Imperial Irrigation District (IID). Figure 1 shows the proposed location of line. It will run directly south from the leasehold, parallel to an existing road leading from the area of operations. The line will be 4.8 miles long, poles will be set 300 to 500 ft apart with a 100 to 150 ft right of way, parallel and adjacent to the existing roadway.

3.3 Environmental Consequences of the Proposed Action

The environmental consequences of the proposed action are summarized in Table 2.

3.4 Environmental Consequences of No Action

The environmental consequences of no action are summarized in Table 3.

Table 2. Environmental Consequences of the Proposed Action

Environmental Parameter	Impact of Proposal	Cumulative Impact (Future)
Seismicity	Injection operations could induce seismicity and there is a potential for natural seismicity. Seismicity will be monitored and production and injection modified if necessary.	Unknown but None expected
Subsidence	Significant subsidence could adversely affect man-made facilities such as geothermal development and irrigation canals. Significant subsidence will be prevented by monitoring a gridwork of benchmarks and altering production and injection or any other necessary procedures to prevent subsidence.	None
Hydrology	The project would not adversely affect either surface or ground water because of design and procedure required by GRO Order Nos. 2, 3, 6 and CRWQCB Order No. 76-64.	None
Air Quality	Geothermal production will result in the release of noncondensable gases. The only gas of concern is H ₂ S which will be present in very low concentrations and air quality standards will not be exceeded. Dust will be controlled by watering.	Minor
Noise	There will be temporary high noise levels during drilling and construction operation. Operational noise will be within acceptable limits as set forth in GRO Order No. 4 section 11.	None
Biology	The project will eliminate 69 acres of Creosote bush scrub vegetation and wildlife habitat. The project will not threaten any rare or endangered species.	A total of 104 acres will be disturbed by geothermal development.
Cultural Resources	No cultural resources will be disturbed.	All cultural resources on the site have been recorded, collected, and curated.
Land Use	Use of 69 additional acres for geothermal development. Not significant impact.	Use of a total of 104 acres of land for geothermal development during the life of the project. Not a significant impact.
Socioeconomics	Minor provision of employment and need for housing.	Minor provision of employment and need for housing; not significant in terms of the general area.
Visual Impact	View of wells and power plant and transmission line contrasts with existing view.	View of 28 wells, pipe and power plant. Not a significant impact.
Use of Non-renewable Resource	No impact	No impact since geothermal heat would be dissipated over time without benefit if not used.

3.5 Comparison of Impacts: No Project and the Proposed Project with Mitigation Measures

A comparison of the environmental consequences of the proposed project with mitigation measures and no project is presented in Table 4.

Table 3. Environmental Consequences of No Action

Environmental Parameter	Impact of No Project
Seismicity	No impact
Subsidence	No impact
Hydrology	Minor impact
Air Quality	No impact
Noise	No Impact
Biology	No Impact
Cultural Resources	No Impact
Land Use	No Impact
Socio Economics	No Impact
Visual Impact	No Impact
Use of Non-renewable Resource	No Impact

Table 4. Comparison of Impacts: No Project and the Proposed Project with Impacts

Environmental Parameter	No Project Impacts	Proposed Project
Seismicity	No impact	Unknown but minor increase potential for seismic activity
Subsidence	No impact	Increase potential for minor subsidence; No significant
Hydrology	Minor Impact. Use of irrigation water in cooling tower of existing power plant.	No Impact
Air Quality	No impact	Minor impact
Noise	No impact	No permanent impact, only temporary impact during development phase.
Biology	No impact	Minor impact; disturbance of a total of 104 acres of creosote bush scrub vegetation and wildlife habitat.
Cultural Resources	No impact	No impact
Land Use	No impact	Utilization of 104 acres for geothermal development
Socioeconomics	No impact	Minor creation of employment and need for housing
Use of Non-renewable Resource	No impact	No impact since geothermal heat would not otherwise be used.

IV. AFFECTED ENVIRONMENT

4.1 Geology

4.1.1 Regional Geologic Structure

The East Mesa site lies within the Salton Trough, a topographically low area extending northwestward from the Gulf of California. The Trough is essentially an extension of the depression occupied by the Gulf of California. It is bounded on the northeast and southwest by faults of the San Andreas system. To the north of the Salton Trough, the San Andreas fault zones are characterized primarily by right-lateral strike-slip movement, with relatively minor vertical movement. In the Salton Trough, however, vertical motion on the faults is also quite significant, and the relative vertical movement on the boundary faults of the Trough has resulted in the graben-like structure.

As much as 20,000 ft of sediment has been deposited in the Salton Trough since the Pliocene, indicating that it has been subsiding actively. The older sediments crop out on the border of the Trough and show folding and faulting.

The pattern of faulting in the Salton Trough is quite complex. While in many places fault zones have good surface expression, the faults underlying places with thick sedimentary sections are often masked by the alluvium. One mechanism in the masking is the fact that the deformation in the alluvium caused by movement on a fault takes place by plastic deformation rather than brittle fracture, so that the fault trace is

represented by a fold in the sediments rather than a clearly-developed fault. For this reason, surface expression of the deformation caused by active fault movement is likely to be subtle and easily destroyed (Sharp, 1977).

4.1.2 Lithology

The Salton Trough is filled with young sediments, deposited since Pliocene time. The maximum thickness is 19,000 - 20,000 ft. (Elders, 1975). On the flanks of the trough, in the Borrego area and near the Chocolate Mountains, the older sediments of the sequence crop out. In the Borrego area, there is considerable folding and faulting of the sediments, indicating continuous tectonic activity during deposition.

The Peninsular Ranges of California, bordering the Trough on the southwest, are composed primarily of granitic rocks of pre-Tertiary age. In the northern part of the Chocolate Mountains, which border the Trough on the northeast, the rocks are principally plutonic and metamorphic rocks of pre-Tertiary age; to the south, there are prominent Tertiary volcanic rocks.

The sediments deposited in the Salton Trough are primarily of three kinds: conglomerates, sands, and silts derived from the bordering mountains; sands, silts, and muds deposited on successive deltas of the Colorado River, which enters the Trough from the east; and lacustrine clays and silty clays formed in a series of lakes occupying the landlocked axial part of the Trough at various times. Locally, recent volcanic rocks are found. Some of the volcanics, such as those at the

Salton Sea field and at Cerro Prieto, are visible at the surface, while others are concealed and known only from subsurface and geophysical evidence. These volcanic rocks are believed to be the source of the heat in the major geothermal anomalies of the Salton Trough. Subsurface evidence indicates that high-temperature, low-pressure metamorphism--"baking"--of the sediments near these volcanics may result in alteration of soft sediment to hard, tough felsites (Muffler and White, 1969).

The sediments derived from the adjacent mountains are coarser near the mountains, grading to fine-grained sands, silts, and clays near the axis of the Trough. They have a characteristic grayish color. The sediments of the Colorado River deltas have a distinctive reddish-gray color; the rock fragments causing the color presumably are derived from the red rocks so common in the upper Colorado River basin in Utah and Arizona (Van de Kamp, 1973). The sands in these deltaic units are generally lenticular and interfinger complexly with clay and silt units. It is therefore very difficult to correlate them over any great distance. The lacustrine sediments were deposited in the still water of a series of lakes formed along the axis of the Trough. These lakes often were enclosed, so that the waters became brackish and alkaline; at higher stages the lakes overflowed south to the Gulf of California and thus remained fresh. These differences are reflected in the sediments. The lacustrine deposits are primarily silty clays, though sandy channel deposits would be found near the mouths of streams entering the lakes.

The near-surface sediments in the central Imperial Valley are largely lacustrine silty clays, deposited during recent periods when lakes

occupied the axis of the Salton Trough. Subsurface information from the East Mesa site, derived from test bores and the geothermal wells there, indicate that lacustrine sediments alternate with deltaic and locally-derived sands. This information suggests that during high lake stages the East Mesa area was beneath water, while during other periods it was exposed and the site of sand accumulation. Just to the west of the site, a linear north-trending deposit of gravel and coarse sand runs parallel to the edge of the lacustrine deposits of the Imperial Valley. These deposits are interpreted to have been formed on an ancient shoreline of Lake Cahuilla, the most recent natural lake in the region.

The proposed area of operations is underlain by 4-12 ft of wind blown sand (Woodward-Clyde Consultants, 1978a). Ground level is approximately 40 ft above mean sea level. Beneath this sand layer, dense, well-bedded sand extends to an elevation of about -35 ft. A relatively continuous layer of clay is included in this sand unit between 13 to 23 ft above sea level. Beneath the sand unit is a clay layer at -35 ft, and below that are alternating layers of sand, silt, and mudstone to a depth of -255 ft. A section of lacustrine sediments, predominately clay-rich mudstones, varying between 1700 - 1900 ft in thickness, underlies the sand, silts, and mudstone unit. Below the lacustrine unit lies deltaic sediments, primarily inter bedded sands and siltstones.

4.1.3 Seismicity and Subsidence

Many of the faults that are so prominent in the Salton Trough are active, as shown by seismological studies (Hill, et al., 1975; Johnson and Hadley, 1976; Johnson, 1977; Fuis and Schnapp, 1977). Most of the recent

activity has been along the Brawley fault-Imperial fault system from the south end of the Salton Sea, through Brawley and Holtville, and south into Mexico. Seismic surveys at the East Mesa site (Combs and Hadley, 1977) show that the level of seismic activity is quite low, especially notable in light of the high regional level of activity. Natural subsidence in the Imperial Valley has been measured through repeated levelings on the Imperial Valley Subsidence Detection Network (Crow and Kasameyer, 1978; Lofgren, 1978). Rates of subsidence gradually increase from the U.S. - Mexico Border to the area around the Salton Sea, where the highest rates are recorded. The rate of subsidence in the East Mesa area is approximately 0.5 in/yr.

4.1.4 Soils

Soil types in the area of proposed operations include loamy fine sands of the Superstition mapping unit (denoted as SS) and three kinds of fine sands associated with the Rositas unit (denoted as RO, ROB, and RT). The ROB unit includes most of section 30 where the geothermal well field will be established; the RO unit, on the other hand, underlies the power plant site. The SS and RT units underlie small parts of the well field. The Rositas sands have high permeabilities. Runoff from their soil surfaces is slow and erosion is minor. Their typical profile to a depth of 60 inches is usually a reddish yellow fine sand. The creosote bush community on East Mesa as well as other scrubs including white bursage, ephedra, desert buckwheat, and mesquite are supported by the Rositas sands (USGS, 1978).

4.2. Water Resources

4.2.1 Ground Water

Shallow aquifers underlying the leases owned by RGI are generally composed of alluvial and deltaic sands, gravel, and silts (Loeltz, et al., 1975). The sedimentary section begins with about 100 to 150 ft of sand deposits, followed by a 1700 to 1900 ft thick lacustrine interval of clay-rich mudstones (RGI, 1978). This stratigraphic unit represents the "cap rock" that separates the geothermal reservoir from the shallow sands. The primary source of recharge for aquifers on East Mesa is unlined canals. For shallow aquifers in the western part of lease CA-966, the unlined East Highline Canal would be the most important source of recharge. A second source of recharge would be the deep percolation of irrigation water beneath a citrus grove located on section 36 of T.15.S, R.16.E. In the area of proposed operations, only small changes in ground water levels took place during the years 1939-1960, according to Loeltz, et al. (1975). Three miles to the south, in the general area of Magma's 10 MW demonstration power plant, ground water fluctuations in most wells monitored by the IID since 1960 have also been minor (USGS, 1977a). The regional hydraulic gradient for East Mesa is about 5 ft/mi towards the middle of the valley (Loeltz, et al., 1975).

The quality of ground water varies greatly across the mesa. Sampling of shallow wells (i.e., less than 200 ft) during the early 1960's (Loeltz, et al., 1975) showed that concentrations of dissolved solids ranged from around 700 mg/l Total Dissolved Solids (TDS) to over 7000 mg/l TDS.

Table 5 shows the chemical composition of 3 wells in the vicinity of

RGI's lease No. CA-966. The location of the wells is shown in Figure 1. Ground water well 36E, which is next to the East Highline Canal, has the lowest TDS content, as would be expected. Salinities increase toward wells 24GI and Republic's shallow well. Table 6 presents the chemical analyses for 3 of RGI's geothermal wells. The analyses indicate that wells have similar chemical compositions. The major differences between the geothermal wells and the ground water wells appear to be the concentrations of silica and boron.

4.2.2 Surface Water

The only surface water near the proposed area of operations is a $\frac{1}{2}$ mile section of the East Highline Canal (see Figure 1). The canal conveys water imported from the Colorado River by the Imperial Irrigation District. That water contains between 800 and 900 mg/l TDS. Within the area of operations there are no significant stream channels. The primary reason for the absence of channels is the low frequency of runoff producing storms. This area receives less than 3 inches of rainfall annually, and when precipitation does occur, most of it enters sandy soils that have a high infiltration capacity. The runoff that might occur during high intensity storms could pick up some salts through sheet flow, but the water would still be low in TDS.

Table 5. Chemical Analyses of Local Ground Water Wells

Parameter	Well Identification		
	36E*	24GI*	WW-1**
Concentration in mg/l			
TDS	787	7110	1600
Silica	14	5	10
Calcium	8.2	384	.1
Magnesium	1.6	232	68
Bicarbonate	450	293	76
Sulfate	76	217	9
Chloride	159	4120	760
Flouride	3.0	----	.5
Boron	---	----	.9
Sodium & Potassium	300	2010	422

* Data for wells 36E and 24GI are from Loeltz, et al., (1975)

** Reported in RGI's Plan of Utilization (RGI, 1978)

Table 6. Chemical Analyses for 3 of RGI's Geothermal Wells*

Parameter	Well Identification		
	38-30	16-29	18-28
Concentration in mg/l			
TDS	1860	1761	1727
Silica	148.5	148.6	86.5
Iron	0.04	0.04	0.07
Calcium	2.1	2.6	3.2
Magnesium	0.3	0.1	0.2
Sodium	548	506	515
Potassium	28	28.5	14.8
Bicarbonate	530	530	537
Carbonate	0	0	0
Sulfate	150	83	165
Chloride	450	461	401
Flouride	2.8	3.3	4.0
Arsenic	.11	0.10	0.10
Boron	2.1	3.0	1.7
Bromide	.25	0.17	0.31

*From RGI's Plan of Utilization (RGI, 1978)

4.3 Air Resources

4.3.1 Atmospheric Transport Characteristics

The primary meteorological parameters of interest for characterizing the atmospheric transport properties over a region are wind velocity, atmospheric stability, and temperature inversion heights. The Imperial Valley is situated immediately east of the coastal mountain range, and is a part of California's southeastern desert. The area lies within the zone of prevailing westerlies and on the east side of the semi-permanent high pressure area of the northeast Pacific Ocean. Thus, the prevailing near surface flow over the valley is from the southwest through northwest during most of the year. In the summer, intense surface heating occurs over the desert, producing a thermal low pressure region over the area. Average daily surface temperatures during July are typically about 90°F. The dynamics of this thermal low pressure system produces an inflow toward the center of the thermal low. Hence, a southeasterly component is superimposed on the prevailing westerlies. The near surface wind speeds average about 7 mi/hr throughout the year.

Atmospheric stability provides a measure of the atmosphere's capability for dispersing pollutants. During the winter, Pasquill-Gifford stability category F is the most predominant, while during the summer the slightly less stable E category predominates. Inversion height and differential temperature measurements indicate that in general a surface based inversion predominates at night. By mid-morning it is destroyed or rises above .62 mi. The reverse process takes place during the early evening hours with reformation of the surface based inversion.

4.3.2 Baseline Air Quality

The gas of principal concern from a geothermal impact point of view is hydrogen sulfide. Ambient air monitoring was conducted at several sites within the Imperial Valley, including East Mesa, as part of the Imperial Valley Environmental Project. The results of this program indicate the H_2S concentrations measured throughout the valley were very low. The vast majority of the hourly averaged values are less than 10 ppb with a few periodic excursions above this value. These excursions seem to occur on a somewhat random basis, and at least in some part may be due to agricultural fertilizing operations. The upper extreme values generally range between 60-80 ppb with the exception at East Mesa where the maximum values rarely exceed 30 ppb. In fact, less than one percent of the daily maximum values measured at East Mesa exceed the State of California air quality standard of 30 ppb for 1 hr.

4.4 Noise

Background noise levels within the project area are generally quite low, as would be expected in uninhabited desert land at some distance from major population centers and transportation corridors. Occasional intrusive noise sources include aircraft overflights and off-road vehicles such as motorcycles and dune buggies. Geothermal development activities including road and drill pad construction, well drilling and testing, and accompanying vehicular traffic also cause elevated noise levels within the area from time to time.

No ambient noise measurements have been made in or near the project area. However, ambient noise levels were measured at several locations in the northern Imperial Valley as part of the IVEP investigations (Nyholm and Anspaugh, 1977; Leitner, 1979). These measurements were made in open-space areas used for agriculture and wildlife habitat. At some locations no man-made noise sources were audible, while at others distant aircraft, vehicular traffic, or farm machinery contributed to the measured noise levels. Most values were below 40 dB(A), although about one-third (9 out of 26) ranged from 41 to 50 dB(A). These levels should be representative of existing ambient conditions in the East Mesa project area (Table 7).

4.5 Biological Resources

4.5.1 Vegetation

(The following vegetation description is based upon USGS (1978) and an Imperial County EIR (Atlantis Scientific, 1978) on RGI's East Mesa 10 MW geothermal power plant, 1978).

Vegetation on the RGI leasehold is a creosote bush scrub plant community as described by Munz (1974). This community can be further subdivided into two habitat types: Sonoran Creosote Bush Scrub and Partially Stabilized Desert Dunes (Cheatam and Haller, 1975). The Partially Stabilized Desert Dunes is the habitat type which occurs primarily in the area of the proposed power plant and wells (Atlantis Scientific, 1978).

Table 7. Ambient Noise Measurements in Open-Space
Areas of Imperial Valley

Location	Range in Sound Pressure Level (dBA)	Number of Measurements
Imperial Wildlife Management Area		
Wister Unit	27 - 50	8
Finney-Ramer Unit	29 - 49	8
Salton Sea National Wildlife Refuge		
Headquarters Unit	38 - 44	6
South Unit	33 - 37	4

Sources: Nyholm and Anspaugh, 1977; Leitner, 1979.

The creosote bush scrub plant community is primarily composed of drought-evading annuals and desert scrubs. Across the site, creosote bush (Larrea tridentata) is the dominant scrub. An important subdominant is desert buckwheat (Eriogonum deserticola). Four-wing saltbush (Atriplex canescens) and burrobrush (Franseria dumosa) are also common shrubs of the area. The common annuals of the area include Spanish needles (Palaforia linearis), dune primrose (Oenothera deltoides) and lax flower (Baileya pauciradiata).

The creosote bush scrub community can be considered as being in the climax successional stage, a final, self-perpetuating community resulting from stable ecological factors.

Vegetation growth is greater on partially stabilized dune areas, with greatest growth density occurring in the central sector of Section 30 (Atlantis Scientific, 1978). In limited areas, the creosote bush cover approaches 75 percent. Within this habitat the creosote bush displays an irregular spatial arrangement. Data obtained from various sample plots, conducted throughout this habitat type indicate a range of 70 to 100 creosotes per acre (individual plants and dense clumps were each given a value of one). The relative spacing of individuals and clumps also varies widely throughout this habitat type (Atlantis Scientific, 1978).

Along the proposed electrical transmission line route vegetation is similar to the rest of the project area. Creosote bush is predominant and for the most part, the only scrubby species along the route. Its coverage is of low density, generally not exceeding 25%.

In contrast to the typical vegetation found in the RGI lease area, an anomalous vegetative feature created by human disturbance covers an area of about 20 acres in section 24 to the south of Holtville Outlying Field. Found in this irregular shaped area, is a very dense cover of tamarisk trees (Tamarix ramossissima), a native of the Mediterranean region, used in the U.S. primarily as an ornamental and wind break in desert regions.

(Rare, Threatened or Endangered Plants)

Plants listed as rare or endangered by both U.S. Fish and Wildlife Service and California Native Plant Society (CNPS) and that could potentially be found in the project area include Ammobroma sonorae, Croton wigginsii, Helianthus niverus var. tephrodes, Palafoxia linearis var. gigantes and Pilostyles thurberi (USFWS, 1976; Powell, 1974). Species listed only by CNPS are Astragalus magdelene var. piersonii, Astragalus lentiginosus var. borreganus and Eriogonum deserticola (Powell, 1974). Of these eight species, only Eriogonum deserticola was found in the lease area. Because of the intensive nature of the survey conducted for the other species during the spring of 1978, there is a high degree of certainty that they are not present in the lease area (Pritchett, 1978).

Eriogonum Deserticola (desert buckwheat) is a scrub which inhabits sandy washes and dune systems in Imperial County (Munz, 1974). During the 1978 field inventory, it was found to be abundant in the lease area and is an important subdominant species. Large populations of desert buckwheat have been observed on other areas of East Mesa, on the Algodones Dunes, on West Mesa, and on the Yuma Desert.

Within the RGI leasehold desert buckwheat covers an area of 858 acres (Atlantis Scientific, 1978). Field sampling done by Atlantis Scientific (1978) revealed an average density of 49.5 individuals per acre. The majority of this species found in the RGI leasehold is located in sections 19 and 30 and much smaller amounts are found in sections 20, 24, 25, and 29.

4.5.2 Wildlife

The RGI leaseholds and adjacent areas of East Mesa support a fairly uniform desert scrub plant community. The two major wildlife habitat types are Sonoran desert creosote bush scrub and partially stabilized desert dunes. A third habitat type of much smaller extent is the mesquite hummock. While only three mesquite hummocks are located within the proposed area of operations they are important wildlife habitat. Other habitats in the vicinity include about 20 acres of introduced tamarisk trees in a low-lying disturbed area south of the Holtville Outlying Field and a citrus orchard just to the southwest of the proposed area of operations. A narrow strip of riparian growth, including cottonwood trees and some scrubs parallels the East Highline Canal, which is located about 1 mi to the west. West of the canal are the irrigated farmland habitats of the Imperial Valley.

The diversity of wildlife within the proposed area of operations is relatively low because of the uniformity of the natural vegetation, its low biomass and productivity, and the lack of surface water sources. Faunal investigations have been carried out on East Mesa by Bureau of Land Management (BLM, 1977), Romney, et al., (1977), and Atlantis Scientific (1978).

More than a dozen reptile species are known or suspected to inhabit the proposed area of operations. Among the common diurnal reptiles are the Colorado desert fringe-toed lizard (Uma notata), common leopard lizard (Crotaphytus wislizenii), long-tailed brush lizard (Urosaurus graciosus), and side-blotched lizard (Uta stansburiana). Snakes characteristic of this habitat include the western shovel-nosed snake (Chionactis occipitalis) and the sidewinder (Crotalus cerastes).

Over 30 bird species have been identified on East Mesa. Many of these are migrants that use the area briefly for resting and feeding during fall and spring movements, while others may overwinter here. Only a few species nest in the desert scrub habitats; densities of breeding birds are given in Table 8.

The most abundant mammals within the proposed area of operations are small nocturnal rodents such as the desert and Merriam's kangaroo rats (Dipodomys deserti and D. merriami) and the little pocket mouse (Perognathus longimembris). The black-tailed jack rabbit (Lepus californicus) and round-tailed ground squirrel (Spermophilus tereticaudus) are also common throughout the area, while the white-throated woodrat (Neotoma albigula) is suspected to occur in mesquite hummock habitat. Predatory mammals include the coyote (Canis latrans), badger (Taxidea taxus), and kit fox (Vulpes macrotis). They feed primarily upon rodents such as kangaroo rats, mice, and ground squirrels.

The invertebrate fauna on East Mesa is represented by a number of species of scorpions, beetles, and ants. Although many of these species,

Table 8. Densities of breeding birds on East Mesa.

Species	Density: Number per 100 acres						
	Sonoran Creosote Bush Scrub				Partially Stabilized Desert Dunes		
	Plot Number				Plot Number		
	1	2	3	4	1	2	
Mourning Dove	4	8	-	-	-	-	
Lesser Nighthawk	-	8	4	4	-	-	
Horned Lark	-	-	-	4	-	-	
LeConte's Thrasher	-	-	4	-	-	4	
Black-tailed Gnatcatcher	9.3	8	8	-	8	-	
Loggerhead Shrike	-	-	4	-	-	-	
Total	13.3	24	20	8	8	4	

Source: BLM, 1977.

particularly harvester ants, may be important in the desert ecosystem no complete faunal inventory is available.

Wildlife habitat quality is generally good for a desert area of this type, although on-going geothermal operations and the recreational use of off-road vehicles (ORV) have resulted in some habitat loss and disruption. The Republic Geothermal development program has required vegetation removal and land disturbance on about 35 acres that are being used for roadways, well pads, and a construction yard. This is about 0.5% of the total area of Republic Geothermal's East Mesa leaseholds; populations of smaller wildlife species such as lizards and rodents have probably been reduced by a proportional amount. ORV traffic can have highly adverse effects on the desert habitat. Evidence of such disruption is especially obvious near the Holtville Outlying Field, which is used as a starting point for recreational ORV usage over much of East Mesa.

No wildlife species listed as endangered or threatened by the Federal government are found within the proposed area of operations. Nevertheless, several species with special status are known or have been thought to occur there.

Andrew's dune scarab beetle (Pseudocotalpa andrewsi).

This beetle is found only in the Imperial Sand Hills, approximately 9 mi to the east of the Republic Geothermal project area. Because the use of off-road vehicles is disruptive to its special habitat, the troughs of loose, drifting sand between dunes, the species was proposed as

threatened (USFWS, 1978). Critical habitat for this beetle is located well to the east of the proposed area of operations (Figure 6).

Kit fox (Vulpes macrotis)

The kit fox is given full protection under California law (Calif. DFG, 1973). The occurrence of kit foxes and their dens has been confirmed in the proposed area of operations.

Flat-tailed horned lizard (Phrynosoma mcallii)

This lizard has historically been found in sandy areas throughout the hot desert region of southeastern California, southwestern Arizona, and adjoining parts of Mexico (Figure 7). It has apparently always had a scattered distribution within this general region and has usually been difficult to collect in any numbers. Housing developments and other forms of habitat disturbance may have caused a population decline in the Coachella Valley at the northern end of its range. The effects of recreational ORV usage on flat-tailed horned lizard populations in other areas are essentially unknown, but there has been speculation that numbers may have decreased elsewhere under this type of impact. As a result of this concern, the status of the flat-tailed horned lizard was placed under status review to ascertain whether or not it should be proposed as threatened or endangered (USFWS, 1977b).

In April 1978, the Bureau of Land Management established a contract with the University of California to investigate the status of this lizard in portions of its range in southeastern California (Turner, et al., 1979).

Figure 6. Critical habitat of the Andrew's dune scarab beetle (*Pseudocotalpa andrewsi*) in relation to the Republic Geothermal project area on East Mesa.

Figure 7. Historic geographic distribution of the flat-tailed horned lizard (*Phrynosoma mcallii*) in California. The lizard was formerly found on lands that are now irrigated in the Coachella and Imperial Valleys; whether they still exist on these lands is undetermined.

Eight study sites were selected initially, including four on East Mesa; later a fifth East Mesa site was chosen within the Republic Geothermal area of operations. Moderate numbers of flat-tailed horned lizards were captured or observed on two sites, but the East Mesa areas yielded very little (if any) evidence of the presence of this species. The lizards appear to be present at very low densities on the Republic Geothermal leasehold. Additional studies are being carried out this year, in an attempt to locate areas that support relatively high populations and to understand the habitat factors that govern the abundance and distribution of the species.

The U.S. Fish and Wildlife Service status review is not expected to be complete for several months. New data gathered in the University of California study this year will probably be used to help decide whether or not the species should be proposed as threatened or endangered. If it is so designated, it is not clear whether the Republic Geothermal leaseholds at East Mesa would be included in the proposed critical habitats.

Six lizard species that occur on East Mesa, including the flat-tailed horned lizard, are protected by the California Department of Fish and Game (Calif. DFG, 1974). All are valuable for educational and commercial purposes and a collection limit has been placed on them to guard against further depletion of their populations.

These species are

Banded gecko	<u>Coleonyx variegatus</u>
Desert iguana	<u>Dipsosaurus dorsalis</u>
Colorado desert fringe-toed lizard	<u>Uma notata</u>
Leopard lizard	<u>Crotaphytus wislizenii</u>
Desert horned lizard	<u>Phrynosoma platyrhinos</u>
Flat-tailed horned lizard	<u>Phrynosoma mcallii</u>

Game birds and mammals

The mourning dove (Zenaida macroura) is the only game bird resident in the proposed area of operations. Gambel's quail (Lophortyx gambelii) may occur in the vicinity of the East Highline Canal.

Black-tailed jack rabbits are the most abundant mammalian game species. Audubon's cottontail (Sylvilagus audubonii) may be present near the East Highline Canal. The badger is classified as a fur-bearing mammal.

All resident game species and fur-bearers are protected by California Department of Fish and Game regulations, since their taking is subject to bag limits and is allowed only at specified seasons. Federal regulations also protect fur-bearing mammals and migratory birds.

4.6 Cultural Resources

4.6.1 Historic and Prehistoric Sites

There are no historical sites reported or evident within the RGI leasehold.

There have been several archeological studies and surveys in the project area. These surveys revealed about 20 archeological sites, of which all but three sites were isolated artifacts. The isolated artifacts were collected at the time of their discovery. The three sites containing concentrations of cultural materials have also been collected, recorded and curated recently.

A more detailed description of the archeological work conducted in the vicinity of the project has been excerpted and updated from (USGS, 1978) and is presented below.

*

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Several cultural resource field surveys of varying intensity have been conducted within the proposed area of operations, resulting in the recording of the following twenty-two archeological sites or loci: 4-Imp-125, 135, 307, 2933, 2934, 2935, 2936, 2937, 2938, 2939, 2940, 2941, 2942, 2943, 2944, 2945, 2946, 2947, 2948, 2951, 2952, and 2981. It is probable that 4-Imp-125 and 135, recorded in the 1920's, were relocated in later surveys and respectively assigned duplicate site numbers of 4-Imp-2947 and 2948.

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Archeological Research Inc., while conducting an extensive sample survey of the East Mesa in 1973, recorded one site, 4-Imp-307, within the proposed area of operations (Ellis and Crabtree, 1974). This site was relocated in a later survey and assigned the duplicate number of 4-Imp-2936.

Four field surveys of several proposed access routes and drill sites within RGI's geothermal leasehold were conducted by Imperial Valley College Museum (IVCM) in 1975 and 1977 (von Werlhof and von Werlhof, 1975; 1977a; 1977b). As a result of this work, two isolated stone tools and a locus of three sherds were found.

In March and April, 1978, IVCM conducted a complete archaeological survey of an area which encompasses the proposed area of operations. Coverage consisted of a close and intensive examination of areas between the 35.4 ft and 44.9 ft elevations and 29.5 to 49.2 ft transects throughout a large portion of RGI's geothermal leasehold at East Mesa. The area between the 35.4 and 44.9 ft elevations corresponds to the relict Lake Cahuilla shoreline, an area known to have been utilized aboriginally. The IVCM wrote an archeological report on this survey which is included in a USGS environmental analysis as an Appendix (USGS, 1978). Much of the following discussion on the cultural resources of both East Mesa and those discovered during this recent survey on RGI's leasehold is summarized from this IVCM report. For a discussion on the prehistory of the general region, see Weide and Barker (1974), Weaver (1977), and Ellis and Crabtree (1974). A "Cultural Resources Report for Republic Geothermal" compiled from several archaeological reports by the BLM Riverside District, is also available at the BLM and AGS offices.

A total of nineteen archeological sites, or loci, were located by IVCM's intensive survey. Sixteen of these (4-Imp-2933, 2934, 2935, 2938, 2940, 2941, 2942, 2943, 2944, 2945, 2946, 2947, 2948, 2951, 2952, 2981) were isolated artifacts or small lithic and sherd scatters. One of these, 4-Imp-2942, also contained a military bomb fuse box, probably associated with military exercises from the Navy's Holtville Outlying Field, north of the proposed area of operations. This same site also contained a small fish bone scatter.

Each of these sixteen sites has been described, sketched, inventoried in field books, plotted on field maps, and collected. Each collected item has been numbered, cataloged, and stored at IVCM for full processing and further study. Collection of these isolated and widely scattered artifacts was carried out during the field survey because IVCM considered it necessary to collect and analyze a sample of the sherds before meaningful statements of significance could be made. Furthermore, all of these cultural materials had been affected by sheetwashing and other erosional processes to which they would continue to be subject if left in place. Beyond this, it is unlikely that many of them could have been relocated for collection at a later time.

Site 4-Imp-2936 (previously recorded as 4-Imp-307) is a surface scatter of over 1500 sherds with lithic debris, cores, scrapers, abraders, other tools, and thermal-fractured rock. Sites 4-Imp-2937 and 2939 are surface pottery scatters, each containing approximately 75 sherds. Only site 4-Imp-2939 lies within the proposed area of operations for the power plant.

Preliminary field inspections of the three larger sites (4-Imp-2936, 2937, 2939) revealed the presence of pottery types other than Salton Buff which may, along with material from the five previously excavated East Mesa sites, reflect a co-mingling of Kumeyaay with groups from the Colorado River (von Werlhof and von Werlhof, 1978). Such hypotheses, while reasonable, can be evaluated only through further study.

All but one of the sites recorded within the proposed area of operations cluster around the 35.4 to 44.9 ft elevation stands of Lake Cahuilla which appears to have filled the Salton Basin from about 300 A.D. to about 1500 A.D. This spatial pattern, together with the sparse nature of the cultural materials identified, suggests intermittent or seasonal exploitation of lacustrine and other resources along the shoreline. Considering the postulated 5.9 ft per year drop in the level of Lake Cahuilla, it is probable that these sites were occupied for only a few seasons.

Utilization of this area may have occurred during May and June when annual flooding along the Colorado forced the relocation of river Yuman groups to the East Mesa. The area may also have been utilized during the fall by Kumeyaay and river Yumans for the harvesting of mesquite beans, an important aboriginal food resource.

* * *

After submission of the necessary documentations to the State Historic Preservation Officer (SHPO) and the Keeper of the National Register of Historic places in accordance with 36 CFR 63, it was determined the three sites 4-Imp-2936, 2937, and 2939 are eligible for the National Register.

However, the sites were not included because they were collected and curated in the Imperial Valley College Museum by Mr. von Werlhof. Collection of these sites was deemed necessary and prudent to prevent non-professional collecting, vandalism, and inadvertant destructions by ORV.

4.6.2 Native American Concerns

In response to concerns formalized by the Native American Heritage Commission, BLM accepted the responsibility to ensure that projects or activites under its jurisdiction do not inadvertently damage or destroy sites of special religious or social significance to Native Americans.

The only organized tribal group of Native Americans in Imperial County is the Quechan, a group of Yuman Indians who live on the Fort Yuma Reservation. In connection with a previous survey for Magma Power Company's geothermal installation located approximately 2.5 miles south of RGI's leasehold, a response from this group was elicited. At the request of the SHPO in consultation with the Native American Heritage Commission, IVCM contacted the Quechan Tribal Council to determine whether that group had any sacred or religious attachment to the East Mesa parcels proposed for geothermal development. Quechan Tribal Council President Fritz Brown told IVCM that, since the East Mesa KGRA was 12 miles west of the tribal boundary, he did not believe that the Quechans held an interest in the property (von Werlhof and von Werlhof, 1978).

4.7 Land Uses

The location of Republic's lease tracts and proposed area of operations are shown in Figure 1. The well field and plant site are on Federal lands, withdrawn for the U.S. Bureau of Reclamation. The nearest private land to the project is section 36 of T.15 S., R.16 E. That particular section now supports a citrus orchard. Just to the north of the geothermal well field is the old Holtville airstrip, which is now used for recreational purposes by drag race, dune buggy, motorcycle, and hunting enthusiasts (USGS, 1978). About 3 miles due south of the area of operations is a 10 MW (net) geothermal power plant owned by Magma Power Company. The nearest recreational facility is the Gecko Campsite. It is about 4 miles to the northeast of the facility and is maintained by the Bureau of Land Management. The East Highline Canal forms the general boundary between the arid East Mesa and the irrigated lands of the central part of the valley.

4.8 Socioeconomics

Imperial Valley's economy is based on agriculture. There are over 450,000 acres of irrigated lands in the Valley. Major field crops like alfalfa, barley, cotton, sugar beets, and wheat account for slightly more than half of the gross revenue of the region. Other important components of the agricultural economy are livestock and vegetable crops. Table 9 summarizes the income from each of the major sources of agricultural activity. The next sections are taken from a USGS environmental analysis (1978) and describe the pertinent socioeconomic features of the area.

4.8.1 Population

Since 1970, the population in Imperial County has been growing at a relatively fast rate. The estimated midyear 1976 population for Imperial County was 83,800 persons, compared with 74,500 persons in 1970. The increase of 9300 persons represents a gain of 12.5% or an annual compound growth of 2.0%. As a comparison, population in California increased from 19,953,000 in 1970 to 21,570,000 in 1976, a growth of 7.9% or 1.2% on an annual basis.

Table 9. The Agricultural Production From Imperial County From 1971-1976.

(\$1000s)

<u>Crop</u>	<u>1976</u>	<u>1975</u>	<u>1974</u>	<u>1973</u>	<u>1972</u>	<u>1971</u>
Apiary	\$ 960	\$ 1,047	\$ 1,102	\$ 1,478	\$ 696	\$ 471
Field Crops	265,783	215,967	284,242	169,871	104,689	109,404
Fruit & Nut Crops	3,380	2,896	1,964	2,235	2,063	1,318
Livestock & Dairy	113,432	127,224	155,182	190,644	119,741	107,687
Seed & Nursery Crops	15,355	10,780	11,870	6,440	2,999	2,816
Vegetable Crops	<u>121,806</u>	<u>142,288</u>	<u>102,763</u>	<u>119,102</u>	<u>93,174</u>	<u>80,089</u>
TOTAL	\$520,716	\$500,202	\$557,123	\$487,770	\$323,362	\$301,785

Note: Totals represent gross income including all costs of production and harvesting.

Source: Imperial County, Office of the Agricultural Commissioner, 1976-1971 (ICAC, 1977).

The largest population in the project area is in the city of El Centro, which is 15 miles from the proposed project. The 1975 estimated population of El Centro is 21,300 residents. The next largest city in Imperial County is Brawley, located about 12 miles north-northwest of the proposed project site, with a 1975 estimated population of 14,010 residents.

Calexico, the third largest city in the County is located approximately 17 mi southwest of the proposed area of operations and had a 1975 population of 12,829. Since 1970, the population in Calexico has increased 20.7%, the fastest rate of the three major cities.

The city of Holtville, located about 8 miles west of the proposed area of operations, had an estimated population of 3,580 in 1975. Smaller communities in Imperial County include Imperial, Heber, Westmorland, and Calipatria (ICPC, 1976). Population data for Imperial County and major cities is shown in Table 10.

According to the 1970 population characteristics for Imperial County, the racial composition of the population included 46.4% White, 46% Spanish-American, 3.5% Black, 1.2% American Indian, and 2.9% other. The age group distribution in Imperial County during the 1970 census was 46.6%, 21 years or younger; 46%, 22 to 64 years old; and 7.4% were 65 years or older. The education level achieved by persons 25 years of age or older in Imperial County indicated that 43.1% of the population had graduated from high school and 7.3% were college graduates. Of persons aged 18 to 24, 55.3% were high school graduates and 28.4% of the total population had less than eight years of schooling (ICPC, 1973).

Table 10. The Population Growth Trends Of Imperial County
from 1970 to 1975

	<u>1975</u>	<u>1970</u>	<u>Percent Change</u>
County of Imperial	83,800 *	74,492	12.5%
El Centro	21,300	19,272	10.5
Brawley	13,940	13,746	1.4
Imperial	3,210	3,094	3.7
Calexico	12,829	10,625	20.7
Holtville	3,580	3,496	2.4

* 1975 County Planning Department Estimate

Source: Imperial County Planning Commission (ICPC, 1976).

Household size in Imperial County is above the average for California. Based on the 1970 census, the latest available information, the average household size in Imperial County was 3.52 persons. Household sizes in the cities are: El Centro, 3.32; Brawley, 3.51; and Calexico, 4.19. In 1970, average household size in California was 2.95 persons (USDC, 1970).

4.8.2 Employment

Employment in Imperial County is oriented toward agricultural production and services. Average employment in 1976 in Imperial County was 38,250 persons, a gain of 5.5% from the 1975 average of 36,250. Since 1972, wage and salary employment has been growing at a 5.7% annual rate. For the year 1976, employment in agricultural services and production averaged 15,100 or 39.5% of the County's total employment. Agricultural employment has been growing at a 6.8% annual rate since 1972.

Non-manufacturing employment, primarily federal, state, and local government and trade employment, both wholesale and retail, accounted for 21,000 employees or 59.2% of the total. Manufacturing employment accounted for 2,050 employees or 5.3% of the total employment in Imperial County.

Employment data for Imperial County are shown in Table 11.

Table 11. Employment for Imperial County from 1971-1976

	<u>1976</u>	<u>1975</u>	<u>1974</u>	<u>1973</u>	<u>1972</u>	<u>1971</u>	<u>% Change</u>	<u>4 Year Compound Rate</u>
All Industries	38,250	36,250	36,650	33,850	30,700		24.6%	5.7%
Total Agricultural	15,100	14,250	15,400	13,550	11,600	N/A	30.2	6.8
Agricultural Production	9,400	9,450	8,750	8,200	7,600		23.7	5.4
Agricultural Services	5,700	4,800	6,650	5,350	4,000		42.5	9.3
Total Non-Agricultural	23,150	22,000	21,250	20,350	19,100		21.2	4.9
Manufacturing	2,050	2,000	2,100	1,750	1,600	N/A	28.1	6.4
Non-Manufacturing	21,100	20,000	19,150	18,600	17,500		20.6	4.8

Note: Employment includes workers residing outside the county.

Source: from USGS, 1978

4.8.3 Housing

According to the 1970 U.S. Census of housing, there were 23,401 year round housing units in Imperial County. Most of these units (18,274) were single family units. Only 6% Of the housing inventory lacked some of or all plumbing facilities. More than one half of the housing units of the County (12,164) were owner-occupied, (8,866) or 38% of the units were renter-occupied, and 9% were for sale.

Current housing availability throughout the Valley and in the project area is described as "very tight" by most community officials. Temporary residence opportunities in the area of the proposed project are mostly in El Centro where there are twenty-three (23) motels and one hotel which cater to tourist trade in the winter months. These nightly and weekly lodgings provide a total of 1,000 rooms in the general El Centro area.

The County special census in 1975 found the town of Holtville to have a total of 1,395 housing units with thirty-five (35) vacancies. The Holtville area is also characterized by relatively high average person per household with 3.34 persons compared to a State average of 2.95 persons per household. The current need to expand sewer facilities has slowed proposed housing construction in Holtville.

4.8.4 Public Services

Police and fire protection in the unincorporated areas of Imperial County is provided by the County's Sheriff Department and County Fire Department. Corresponding protection within the cities is provided by

each municipality. The County and the cities operate on a mutual aid agreement for maximum community services.

Emergency services for the proposed area of operations would be provided by County fire services located in Holtville, and the Sheriff's facilities located in El Centro.

The nearest health services to the proposed project are centered in El Centro, which has the largest and most diversified population. There is a general hospital with 92 beds, and a convalescent hospital with 120 beds.

Elementary and secondary education facilities servicing the proposed area of operations are located primarily in Holtville. The Holtville school system operates two elementary schools, one junior high school, one general high school and one continuation high school. School enrollment for the Holtville Unified School District for kindergarten through twelfth grade is estimated to be 1,995 students for the 1977-78 school year. Post-secondary education in Imperial County is available at the Imperial Valley Community College, just west of El Centro (two-year program) and at San Diego State University, Imperial Valley Campus, in Calexico.

4.8.5 Public Utilities

Electrical power in the proposed area of operations is supplied by the Imperial Irrigation District. The District supplies all the major population centers and the unincorporated areas of the County with

electrical energy. Natural gas services are available in Imperial County from the Southern California Gas Company. Telephone services are supplied by the Pacific Telephone Company.

4.8.6 Public Revenue

Retail and taxable sales in Imperial County have been growing at a faster rate than in the State of California. Retail sales in Imperial County in 1976 totaled \$263.1 million, an increase of 8.6% over the 1975 total of \$242.3 million. Taxable sales increased from \$313.9 million to \$344.8 million, a 9.8% gain during this same time period. In the period 1971 to 1976, retail sales in the County increased at an annual rate of 16.2% while taxable sales have grown at a 16.5% compound rate. As a comparison, retail sales in California have increased at a 12.8% annual rate and taxable sales at a 12.4% compound rate.

4.8.7 Private Revenue

Personal income from all sources for residents of Imperial County increased at a 9.1% annual rate between 1970 and 1975. Wage and salary income accounted for slightly less than one half (48.7%) of the County's total income in 1975. Through the five-year period, wage and salary income has accounted for approximately 45% to 47% of total personal income.

The importance of agriculture to Imperial County can be seen from an analysis of personal income derived by farm proprietors. Although there has been some variation as a result of price fluctuations for the crops

grown, total farm income in Imperial County has increased from \$93.7 million in 1970 to \$177.6 million in 1975, an annual growth of 12.8%. During this period, farm proprietor income has averaged approximately 32% of total personal income in Imperial County.

During the period 1970-75, per capita personal income in Imperial County was approximately 2.0% more than in California; in 1975, per capita personal income in Imperial County was \$6,875 compared to \$6,573 in California. Per capita personal income in Imperial County grew at a 9.1% annual rate while it increased at a 7.9% rate in California.

V. ENVIRONMENTAL CONSEQUENCES OF GEOTHERMAL WELL FIELD
DEVELOPMENT AND OPERATION

5.1. Geologic Impacts

The potential geologic impacts associated with the extraction and injection of geothermal fluids are subsidence and induced seismicity. Withdrawals of geothermal fluids will reduce the pore pressure in the reservoir, resulting in the compaction of sediments. The amount of compaction depends upon the strength of the reservoir rocks. Some of that compaction will probably be translated to the surface as subsidence. Injection of residual fluids on the periphery of the geothermal reservoir will limit the extent of pore pressure declines, but in the immediate vicinity of the producing wells, pressure drops should not be greatly affected. Hence, any subsidence that does occur is likely to appear where the producing wells are situated. At this time it is not possible to accurately predict levels of future subsidence. Nevertheless, periodic surveying of the subsidence detection network will provide the data necessary to evaluate subsidence caused by geothermal fluid extraction as well as regional tectonics.

If land subsidence due to geothermal operations does occur, the impacts will be minor since existing land uses in the area (i.e., geothermal exploration and development, recreation, and some agriculture) are not particularly sensitive to changes in land elevation. However, if at some point a significant hazard to nearby land uses did develop, GRO Order No. 4 (USGS, 1976b) permits the AGS to reduce production rates, increase the injection of waste or other fluids, or suspend geothermal production.

Other mitigating measures would involve the repair of subsidence related damage.

The second concern related to the operation of the well field is the possibility that seismic activity could be induced by the injection of waste geothermal fluids. Present information, though, suggests that induced seismicity is unlikely. One potential cause is injection; unusually high injection pressures could raise pore pressure in the reservoir so high that the rock particles would "float", causing lack of rock rigidity; such high pressures could also result in the lubrication of nearby fault planes by injection of water into the fault zone. If there is existing seismic stress, such weakening of the rock could result in induced seismic activity. To prevent the buildup of excessive injection pressures, GRO Order No. 6 requires the installation of pressure sensors that can activate cut-off values. Existing seismographs will be used to detect any earthquakes of 1.5 Richter Scale magnitude or greater in the region, and data will be analysed to determine if seismic events are increasing with injection activities. If hazardous increases are detected, GRO Order No. 2 provides for the alteration of injection and production rates, and, if necessary, changes in the location of injection wells. Some seismic data already have been collected at the nearby Bureau of Reclamation geothermal field on East Mesa; analysis by Combs and Hadley (1977) shows that seismicity did not change significantly during the withdrawal and injection of geothermal fluids.

Besides the potential effects of extracting and injecting geothermal fluids, the only other impact of note related to the well field is the disturbance of soils. A total of 104 acres of soils will eventually be

disturbed when the well field and power plant are completed. Alteration of the soils will increase the potential for wind erosion. Increased wind erosion results in abrasive damage to young plants. To stabilize the soils, disturbed areas should be revegetated when they are no longer needed for operations (USGS, 1978). Other areas needed for maintenance of the well field should be watered to reduce wind erosion.

5.2 Water Resources

5.2.1 Ground Water

It is unlikely that extraction and injection of geothermal fluids will significantly affect shallow ground waters. One potential mechanism for the mixing of geothermal fluids with water in shallow aquifers is leakage between casing strings or through the cement surrounding the casing. Such leaks could be detected by periodic well logging. If any are detected, the well can be removed from use until the casing is repaired. A second mechanism suggested for the mixing of geothermal fluids with ground waters is the upward movement of injected fluids through the overlying aquiclude. Under natural conditions it is reasonable to assume that no vertical movement between the geothermal reservoir and shallow ground waters occurs. Otherwise, hot water would not have accumulated in the reservoir. If vertical conduits do exist through the aquiclude, it is possible that excess pressure in the reservoir could drive fluids upward. Such vertical motion would require sufficient hydraulic head to overcome the force of gravity as well as friction in the overlying formation. The current plan for injection indicates that residual geothermal fluids will be injected at pressures in the range of 150-500

psi above static reservoir pressures. Some of this will be needed to overcome friction in the injection well, so only part of the added pressure will be available to move fluid into the reservoir.

Furthermore, fluid pressure would be expected to dissipate as fluids move into the injection zone. For these reasons, it is difficult to conceive of a case in which sufficient pressure would be available to force geothermal fluids through almost 2000 feet of cap rock, even if vertical fractures were present. The simplest way to avoid attaining the high pressures necessary to force fluids through the aquiclude is to monitor the injection pressures. GRO Order No. 6 (USGS, 1977b) requires that pressure sensors be installed on injection wells so that shut-in valves or relief valves can be activated if pressure build ups occur.

Even though there is a small possibility that geothermal fluids will mix with ground waters, it is still prudent to consider what the consequences would be if mixing did happen. To begin with, the shallow ground waters and the geothermal fluids are brackish. Ground water near the proposed well field contains 1600 mg/l TDS and the geothermal fluids contain over 1700 mg/l TDS (see Table 6). The geothermal fluids have higher levels of arsenic, boron, and flouride than does the ground water. Therefore, geothermal fluids would degrade the quality of the ground water for those 3 constituents if the two waters were mixed. The dilution effect of the ground water, though, would reduce the concentration of those constituents in the mixed fluid. Because the rate of ground water movement in the area is slow (probably less than 10 feet per year) the area affected by such mixing would be small. Monitoring wells installed near the well field in the direction that the ground water is moving may be able to detect the presence of geothermal fluids that have mixed with

local ground waters. In the event of failure of a well casing the lessee shall repair it without undue delay as required in GRO Order No. 4 Section 9, C (3).

5.2.2 Surface Water

Geothermal test fluids discharged to sumps will be spread onto road ways and well pads for dust control. Most of the spread water will be evaporated, leaving behind salts that would remain near the surface until flushed downward into the soil profile by heavy rains. According to Order No. 76-64 (Revised)* of California Regional Water Quality Control Board (CRWQCB, 1977), the volume of geothermal fluids spread onto the ground shall not exceed 126,000 gallons-per-operating day. The same order prohibits the active storage of fluids containing more than 2300 mg/l total dissolved solids, and hence the quantity of salts added to surface will be limited. Under the normal operation of the well field the surface hydrology of the mesa will not be affected. The one exception would be if a break or leak developed in either the production or injection pipelines. Geothermal fluid flowing from a leak or break would infiltrate into permeable sands. The primary source of protection against accidental spills are safety control devices defined in GRO Order No. 6 (USGS, 1977b). Control devices include both low and high pressure sensing devices that will activate valves that shut in production.

*Order No. 76-64 (Revised) is on file at the California Regional Water Quality Control Board, Colorado River Basin Region, 73-271 Highway 111, Suite 21, Palm Desert, California 92260.

5.3 Air Resources

During drilling and production testing, steam and various noncondensable gases will be vented to the atmosphere. However, no air quality standards will be exceeded.

5.4 Noise

Field development involves a number of activities which will increase noise in the project area. These activities and the expected range of sound pressure levels (SPL) are given in Table 12.

The highest SPL expected in the project area during field development are approximately 95 dB(A) and would be due to truck traffic and the

Table 12. Noise Levels Expected To Be Associated With The Various Stages of Field Development.

Activity	Expected Range of SPL dB(A) at 15.2 m (50 ft)
Construction of Roads and Well Pads	70 - 95
Drilling Wells	75 - 85
Testing Production and Injection Wells	80 - 90
Construction of Pipelines	80 - 90
Vehicular Traffic	70 - 95

Sources: EPA, 1971; Leitner, 1979; Neilson, 1977.

operation of heavy construction equipment. These levels would be reached only occasionally and would usually occur during daytime hours.

There are no sensitive noise receptor sites on or adjacent to the project area. The nearest residences are a few farm houses in the agricultural land 1.5 mi and more west and northwest of the Republic Geothermal leaseholds. The nearest population center is the town of Holtville about 8 mi to the west.

Noise levels at the nearest receptor can be predicted by the use of a noise attenuation model developed recently as a result of studies in The Geysers geothermal area (Bush, 1977). This model indicates a total expected attenuation of 50 to 55 decibels over a distance of 1.5 mi. Thus, noise from the loudest source expected in the project area (95 dBA) would be reduced to a SPL of about 45 dB(A). Although such a source might be audible under worst case conditions at a farm residence near the East Highline Canal, it is very close to usual ambient levels and should be well within acceptable range.

5.5 Biological Effects

5.5.1 Vegetation

The vegetational impact of well field development is the removal of approximately 60 acres of creosote bush scrub vegetation. The drilling of 20 new wells will disturb 40 acres and the construction of 5.6 miles of new service road will disturb another 20 acres. This 60 acres that will be affected is in addition to the 35 acres that have been disturbed to date by geothermal development.

The construction of roads can have a greater effect upon vegetation than just elimination of a certain portion of the native flora from a specific roadway (Johnson, et al., 1975). New roads provide avenues for the invasion of exotic species and can cause changes in the health and vigor of resident native plants. Roads with impervious surfaces can cause increased runoff and thereby result in erosion. However, the new service roads (5.6 miles within the well field) leading to the new wells will not be surfaced and therefore no appreciable increase in runoff or water erosion is expected. Some wind erosion will result from vegetation and soil disturbances but is not expected to be significant. Dust will tend to accumulate on vegetation from vehicular traffic on unpaved roads.

Pipeline construction to each of the new wells will occur almost entirely within the 30 foot-wide area disturbed by new road construction. Where expansion loops are installed, there will be an additional 200 to 400 square feet of disturbance.

Mud sumps and other waste disposal sites will be contained within the 2 acre area of disturbance around each well. Revegetation on drill muds and other wastes may not be possible because of residual contaminants. RGI will either neutralize waste materials and spread them on drill pads or dispose of them at an approved waste disposal site.

Blow-outs from geothermal wells would discharge effluents that could destroy vegetation through scalding. Salts would also be added to soils that could affect vegetation. However, Sec. 2 of GRO Order 2 (USGS, 1976a) requires the operator to install a blowout preventer on geothermal wells. Blowout preventers are successful in all but extreme cases.

The potentially adverse noncondensable emissions during the drilling operations are minimal and not expected to create any significant impacts upon vegetation (Atlantis Scientific, 1978).

Desert buckwheat (Eriogonum deserticola), listed as rare and endangered by the California Native Plant Society (CNPS) (Powell, 1974), is present in great numbers on RGI's East Mesa leasehold. Because Eriogonum deserticola is more widespread than originally thought, and its population appears to be at least stable, if not increasing, the Bureau of Land Management has suggested CNPS review the status of Eriogonum deserticola and possibly change its status to that of limited distribution.

The desert buckwheat, Eriogonum deserticola population on RGI lease property prior to geothermal development is estimated to be 42,471 plants covering an area of 858 acres (Atlantis Scientific, 1978). Based upon this information there have been 15.5 acres of desert buckwheat area disturbed thus far. Further well field development for the 48 MW power plant will disturb an additional 37.5 acres. Thus there would be a total disturbance of 53 acres.

Impacts to sensitive plant species have been rated as follows (USFWS, 1976): 1) a high impact is a severe threat to the viability of a species or population, with high probability that said species would be nearly or completely extirpated from the impacted area; 2) a moderate impact is a substantial and essentially permanent reduction in the abundance of a species, but not posing a serious threat to the survival of the population or species; and 3) a low impact is a minor alteration of the

structure of a species' population, but without substantial impairment of viability. Applying these criteria to desert buckwheat, the well field development and road construction will have a "low impact", and the actual impact may be less consequential than this.

5.5.2 Wildlife

The construction of roads, well pads, and pipelines will result in the additional loss of 60 acres of wildlife habitat or about 1% of the total leasehold area, or about 3% of the area of operation. This will cause proportional reductions in the size of resident animal populations and may cause lowered diversity as well.

Mitigation for wildlife losses due to habitat disturbance should first involve careful planning and facilities siting to minimize the area subject to temporary or long-term vegetation and soil removal. Disturbed areas that are no longer needed for project operations should be revegetated as soon as possible. Topsoil should be stockpiled and spread over the surface prior to revegetation. The best available techniques should be used, including native plant materials, applications of fertilizer and soil improvement additives where appropriate, and optimal watering schedules. Republic Geothermal has entered into a contract with the University of California to determine the best ways of achieving success with revegetation in a desert environment. This project began in July 1978 and will run for three years through July 1981.

Habitat types of high wildlife value, such as mesquite hummocks, should be avoided by construction activities.

The flat-tailed horned lizard populations within the area of operations may be adversely affected by habitat loss and road mortality due to vehicular traffic. However, it appears very unlikely that the field development project will have a significant impact such as jeopardizing the survival of the species or even of the population on the Republic Geothermal leaseholds. The species itself is widely distributed over a large desert area in California, Arizona, and Mexico. Recent evidence suggests that the area of Republic Geothermal's operations on East Mesa presently supports very few of these lizards (Turner, et al., 1979) and expected habitat loss amounts to only about 1% of the leasehold area. Mitigation measures will include raising production and reinjection pipelines 1 ft above the surface to allow mobility for this and other small wildlife species.

A meeting was held at Menlo Park, California on August 10, 1978 between representatives of the Bureau of Land Management (BLM), the Area Geothermal Supervisor's Office, The U.S. Fish and Wildlife Service (USFWS), and The California Department of Fish and Game (USGS, 1979b). The primary purpose of this meeting was to determine whether the initial 10-MW power plant would have intolerable impacts upon the flat-tailed horned lizard, the bobcat, and the Andrews scarab beetle. All parties believed that existing mitigating measures adequately protect the three species.

Should the operation happen to pose a threat to the species' existence, all parties agreed to the Area Geothermal Supervisor consulting with the BLM, USFWS, and CDFG and requiring the lessee to take appropriate mitigating measures (USGS, 1976a).

Any damage to vegetation outside the areas of direct habitat loss, whether due to increased water and wind erosion or ORV traffic, will reduce food and cover available to wildlife and decrease the carrying capacity of the remaining habitat. No significant changes in runoff or drainage patterns are expected, however. Unpaved roads will be watered regularly to keep down dust, using neutralized drilling fluids or geothermal fluids provided that they do not prove detrimental to vegetation. Republic Geothermal proposes to prohibit use of vehicles off established roads unless it is absolutely necessary. In the latter case, vehicles with wide-tread or balloon tires could be used to mitigate impacts to soils and vegetation.

Wildlife will be subjected to increased noise due to the operation of vehicles, construction machinery, and well-drilling and testing equipment. The effects of noise on wildlife are not well understood. High intensity noise can certainly cause hearing loss in small animals, but it is not clear that this would occur when escape into burrows or other quiet areas is possible. Masking of other environmental sounds by project noise sources may prevent wildlife from detecting predators and may adversely influence the reproductive behavior and success of resident bird species.

The loudest noise emissions associated with the field development project will be of short duration. In addition, Special Lease Stipulation 4 provides that noise emissions must be attenuated to a maximum of 65 dB(A) at 1500 ft from the source. This should provide adequate protection for wildlife.

Blow-outs from geothermal wells and accidental spills from the failure of production or reinjection pipelines could adversely affect wildlife populations. Small ground-dwelling and burrowing animals might be destroyed by hot water releases and the vegetative cover on which they depend could be killed.

Blow-outs are unlikely on East Mesa due to the low pressure of the geothermal resource. Installation of required blow-out prevention equipment will serve to minimize this potential hazard further. The possibility of spills of geothermal fluid or reinjectate resulting from pipeline failure can be minimized by use of corrosion-resistant materials and of control equipment that will shut down all flows in case of a pipeline break. Even if a release occurred, heat damage would be the main effect because the geothermal fluid has a low level of dissolved salts and other substances that could harm wildlife.

Since no toxic materials are to be used in the drilling muds, it should not be necessary to take any special precautions to keep wildlife from entering the mud sumps at the various well pads.

5.6 Cultural Resources

5.6.1 Historic and Prehistoric Sites

Well field development will not have a significant impact upon any historic sites since none are present in the RGI leasehold.

The project will not have any adverse impact upon prehistoric resources because all prehistoric cultural materials have been collected, mapped, recorded, and curated at the Imperial Valley College Museum (von Werlhof, 1979). Under present conditions the data retrieval program was considered the only viable alternative to prevent the ongoing impact from artifact collection by amateurs, from vandalism, and from Off Road Vehicle (ORV) use. The alternative of fencing and monitoring the sites was considered less desirable because it would be likely to attract vandals and amateur collectors.

5.6.2 Native American Concerns

The President of the Quechan Tribe Council, Mr. Fritz Brown was contacted regarding any Native American concerns that would be connected with the RGI leasehold property. Although the Quechan Tribe territory does not include the RGI lease property it represents the nearest Native American group. It appears that the Quechan Tribe does not have concerns relating to the RGI lease property (von Werlhof, 1977).

5.7 Land Uses

Table 13 shows how much land will be disturbed by the power plant constructions and well field development. The primary disturbances associated with the well field are the construction of roads, drilling pads, and sumps. The acreage affected by those activities amounts to about 80% of all disturbance associated with the project. Lands used for the project should not interfere with existing or proposed land uses in the area.

5.8 Socioeconomics

The labor force during drilling operations will consist of four crews of 8 to 10 men, working eight hour shifts on a rotating basis. Most of the full time workers will be from local communities. Workers from outside the Valley will probably stay in El Centro (USGS, 1975a). The socioeconomic effects of such a work force will be inconsequential.

Table 13. Land Disturbed By The Proposed 48 MW (net) Power Plant

Acres Disturbed		
Source of disturbance	Existing	Future
Roadways	16.5	20.0
Well Sites	11.5	40.0 *
Construction yard	7.0	—
Transmission line	—	2.0 **
Power plant site	—	7.0
Subtotals	35.0	69.0
Total	104	

*Future well sites are estimated to disturb 2 acres each, including adjacent sumps.

**A maximum of 2 acres of permanent disturbance is expected from the placement of power poles.

VI. ENVIRONMENTAL IMPACTS OF POWER PLANT CONSTRUCTION,
OPERATION, AND POWER TRANSMISSION

6.1 Geologic Hazards

The potential geologic hazards to the power plant consist of natural seismic events and active faults. Most of the historic seismic events in the Imperial Valley have taken place along the Brawley -- Imperial faults systems, extending from the south end of the Salton Sea, through Brawley and Holtville, and south into Mexico. The earthquakes are usually small to moderately high in magnitude. In 1940 the largest earthquake ever recorded in the Valley reached a magnitude of about 7 on the Richter Scale. Its epicenter was about 11 miles southwest of the proposed project site (Atlantis Scientific, 1978). Compared to the central portion of the Valley, seismic activity is much lower on the Mesa. During a ten year period (1961 to 1971), only 3 earthquakes of about magnitude 3 occurred in the general vicinity of the plant (Combs and Hadley, 1977). Despite the low levels of seismic activity, seismic design criteria have been developed by Woodward-Clyde Consultants to be incorporated in the construction of power plants because of the relatively high amount of seismic events in the Valley. A second possible hazard to the proposed project would be movement of an active fault beneath the power plant. Two studies by Woodward-Clyde Consultants (1978a and 1978b), however, could not verify the presence of any faulting across the proposed power plant site.

6.2 Water Resources

There are no significant hydrological impacts associated with the construction and operation of the power plant and related facilities. Safety devices, as stipulated in GRO No. 6, should protect against inadvertent releases of fluids. All residual fluids from the operation of the power plant, including excess water from the cooling system and geothermal fluids, are disposed of by injection to the geothermal reservoir.

6.3 Air Resources

The air quality impact of the proposed Republic Geothermal 48 MW geothermal power plant at East Mesa is expected to be minor. The principal impact will be due to the release of noncondensable gases into the atmosphere. These emissions will mostly consist of CO_2 , but other gases will also be present. Table 14 shows the emissions of noncondensable gases. From an air quality and regulatory point of view, the only gas of concern is H_2S . The other gases, including CO_2 , CH_4 , Hg, Rn, NH_3 , etc., do not represent a significant impact. Those gases will not exceed any known Federal or State Standards. Using the maximum H_2S emission rate of 0.291 kg/hr ($8.1 \times 10^4 \mu\text{g/s}$) presented in BLM Addendum to EA-99-100 (USGS, 1979b), a 30 m release height, an annual average wind speed of 3 m/s (measured at East Mesa by the Imperial Valley Environmental Project), and a Pasquill-Gifford E Stability category, we have calculated, by means of a Gaussian dispersion model, the expected downwind surface air concentrations of H_2S . These are shown in Figure 8. Note the maximum surface concentrations of H_2S ,

Table 14. Anticipated Noncondensable Gas Emissions For Republic Geothermal, Inc.'s

Proposed 48-MW (net) Power Plant at East Mesa, Imperial County, California

(from RGI, 1978).

Noncondensable Gases Identified in East Mesa Production Fluid	Ratio of Noncondensable Gases in Production Fluid		Projected Noncondensable* Gas Emission Rate			
<u>Name (Symbol)</u>	<u>Weight Percent</u>		<u>Pounds/Hour</u>		<u>Kilograms/Hour</u>	
	<u>Minimum</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Maximum</u>
Carbon Dioxide (CO ₂)	94.452	95.038	12,136	12,212	5,505	5,539
Nitrogen (N ₂)	3.571	3.972	459	510	208	232
Methane (CH ₄)	0.374	1.123	48.1	144	21.8	65.4
Argon (Ar)	0.121	0.145	15.5	18.6	7.05	8.45
Ethane (C ₂ H ₆)	0.061	0.139	7.83	17.9	3.56	8.10
Propane (C ₃ H ₈)	0.084	0.114	10.8	14.6	4.90	6.64
Benzene (C ₆ H ₆)	0.015	0.065	1.93	8.35	0.874	3.79
Hydrogen (H ₂)	0.005	0.006	0.642	0.771	0.291	0.350
Hydrogen Sulfide (H ₂ S)	0.000	0.005	0.000	0.642	0.000	0.291
Toluene (C ₆ H ₅ CH ₃)	<u>0.000</u>	<u>0.004</u>	<u>0.000</u>	<u>0.514</u>	<u>0.000</u>	<u>0.233</u>
Total Noncondensable Gases	--	--	Approximately 12,850		Approximately 5,828	

*The calculation of noncondensable gas emission rates is based on the following assumptions:

- Geothermal fluids from Well Nos. 16-29 and 38-30 are characteristic of the geothermal reservoir.
- Noncondensable gas content of the geothermal fluid is 0.094 percent by weight.
- Up to 97.5 percent of the noncondensable gases in the geothermal fluid will volatilize and be released to the atmosphere.
- Noncondensable gas concentration of the geothermal reservoir is spatially and temporally constant.
- Geothermal fluid flow rate for the power plant is approximately 14.02 million pounds per hour.

Emission Rate** = (0.00094) (0.975) (weight fraction**) (14.02 x 10⁶ lbs/hr).

Conversion: Kilograms/hour = 0.4536 lbs/hr

**Noncondensable gas of interest

Figure 8. Concentrations of H_2S at different points downwind from the proposed 48 MW (net) geothermal power plant. Concentrations were computed using a Gaussian diffusion model. Input data include: Stack height = 30 m, receptor height = 1 m, wind-speed = 3 m/s, stability class = E, and source strength = .291 Kg/hr.

occurring at about 1 km (.62 mi) downwind from the power plant, are roughly an order of magnitude less than the State of California air quality standard of $42 \mu\text{g}/\text{m}^3$ (0.03 ppm) for one hour. In addition, we have estimated, in Figure 9, the H_2S concentrations during very stable nighttime conditions by using the same source configuration but a wind speed of 1 m/s (2.24 mi/hr) and an F stability category. Again, the air quality standard was not exceeded. Thus, on the basis of these extremely conservative assumptions, it is reasonable to conclude that the impact to ambient air quality due to the operation of this power plant will be minor.

Air quality regulations do not apply to benzene, but it is covered by Federal occupational health standards. To ensure the emissions of benzene do not pose a health risk to workers, the benzene content of noncondensable gases will be analyzed during start up operations, and if necessary, ambient levels at the plant site should also be monitored.

6.4 Noise

The construction and operation of the power plant and transmission line involve a number of activities which will increase noise in the project area. These activities and the expected range of sound pressure levels (SPL) are given in Table 15.

As is the case with field development the highest SPL expected in the project area during this phase of the project are approximately 95 dB(A) and would also be due to truck traffic and construction equipment. These levels would be reached only occasionally and would usually occur during daytime hours.

Figure 9. Concentrations of H_2S at different points downwind from the proposed 48 MW (net) geothermal power plant. Concentrations were computed using a Gaussian diffusion model. Input data include: Stack height = 30 m, receptor height = 1 m, wind-speed = 1 m/s, stability class = F, and source strength = .291 Kg/hr.

Table 15. Noise Levels Expected to be Associated with the Various Stages of Construction and Operation of Power Plant and Transmission Line.

Activity	Expected Range of SPL dB(A) at 15.2 m (50 ft)
Construction of Power Plant	70 - 95
Construction of Transmission Line	70 - 95
Operation of Power Plant	75 - 85
Vehicular Traffic	70 - 95

Sources: EPA, 1971; PG&E, 1977.

The noise attenuation model developed by Bush (1977) predicts a reduction of 31 to 36 decibels at a distance of 1500 ft from a source. Thus, it should be feasible for even the loudest noise sources to meet the requirements of Special Lease Stipulation 4 which places a limit of 65 decibels at a distance of 1500 ft. The nearest noise receptor sites are farm houses about 2 mi to the west and southwest of the power plant site and transmission line corridor. Even during the noisiest operations, SPL from project sources should be less than 45 dB(A) at these locations. Normal operational noise from the power plant should not be audible at any point west of the East Highline Canal.

6.5 Biological Resources

6.5.1 Vegetation

The vegetational impact resulting from the power plant and transmission line will be the removal of about 9 acres of creosote bush scrub vegetation. The nature of this impact is described in section 5.5.1. Power plant construction will disturb about 7 acres of the area populated by desert buckwheat, Eriogonum deserticola. This will increase the area of new disturbance from 37.5 acres to 44.5 acres for the completed project. In terms of total disturbance to this species resulting from all geothermal development there will be about 60 acres.

The construction of a 4.8 mile loop of 161 kV power transmission line will have minimal permanent impact upon vegetation. The major impact of power line construction results from access road construction. The proposed power line would utilize the existing access road that also serves as an access road to the RGI well field. To construct the power line loop a row of poles would be placed along either side of the access road. Depending upon the spacing there would be 100 to 170 poles. Power line construction results in temporary disturbance of vegetation at each pole and temporary disturbance between poles as a result of trampling during line stringing operations (Vasek, et al., 1975a). Disturbance ceases after construction. Vasek, et al., (1975b) have found a variable, but fairly regular road edge enhancement of vegetation along access roads and a slight enhancement of vegetation between power poles. It was also found that drastic vegetation disturbance around power pylons substantially recovered after about 33 years although recovery was not

complete. Special Lease Stipulation 5 prohibits wholesale clearing of vegetation for power lines by limiting clearing to power poles. Careful power pole placement and power line construction can substantially reduce vegetation disturbance. A maximum of 2 acres would be permanently disturbed during power line construction. An alternative transmission line route was analyzed by the USGS in Environmental Analysis 67 Supplement (USGS, 1977c). The transmission line went directly west of the proposed area of operations, crossed the East Highline Canal, entered agricultural lands, and then turned south to join the existing 161 kV line. That route was considered to be environmentally inferior because it would result in the extensive disruption of prime agricultural lands.

Boron is contained in the geothermal fluids produced at the RGI well field. Boron is very toxic to plants, collects in the soil, and sterilizes the soil for an unknown length of time. Excessive amounts of boron can preclude revegetation. RGI proposes to use geothermal fluids for dust control on roads and cleared areas. These geothermal fluids used for dust control will contain less than 4 mg/l of boron, as stipulated in special conditions by AGS (USGS, 1978).

Acid washes from "scaled" machinery during maintenance operations will contain salts and other toxics. RGI will dispose of these materials in the future class II-1 dump (restrictive dump used for containment of radioactive and heavy metals) that is anticipated for operation in two or three years. During the interim period any toxic materials will be transported to an acceptable disposal site. There is a class II-1 dump about 120 miles from the project in San Diego County.

Vegetation could be impacted by noncondensable gases. However, the emission of H_2S is extremely low, and the impact of noncondensable gases upon vegetation is expected to be minimal. Further discussion of gaseous emissions can be found in section 6.3. Cooling towers will emit about 4.6 lbs/hr of salts into the atmosphere and they will be deposited on soils in the vicinity of the power plant. The cumulative impact on vegetation is expected to be minor.

There will be little or no vegetational impact from ORV because RGI proposes to prohibit ORV use except where it is absolutely necessary.

6.5.2 Wildlife

The construction of the power plant and associated transmission lines will result in the unavoidable loss of approximately 3.6 hectares (9 acres) of wildlife habitat or about 0.1% of the total leasehold area.

Special Lease Stipulation 5 will restrict clearing of vegetation within the transmission line right-of-way to the immediate vicinity of pole locations only. Any cleared areas not needed for project operations should be revegetated as indicated in Section 6.5.1.

Construction activities may result in noise and disturbance that could temporarily displace some wildlife from the vicinity of the power plant site and the transmission line corridor. Operational noise emissions from the power plant will be of moderate intensity and are not expected to adversely affect wildlife.

The transmission line from the power plant and the distribution lines to individual well pads pose a potential threat of electrocution to raptors and other large birds. To mitigate this potential impact, Special Lease Stipulation 6 requires that all lines be constructed according to the pole designs and arrangements outlined by the Rural Electrification Bulletin 175 or the Raptor Research Foundation (RRF, 1975).

6.6 Cultural Resources

There is no impact to cultural resources resulting from the power plant and transmissions line.

6.7 Land Uses

The actual construction of the power plant will only consume 7 acres of land. Land uses under the transmission lines would be restricted.

6.8. Socioeconomics

The most important socioeconomic impact of the proposed 48 MW (net) power plant will involve the temporary housing of construction workers. During the height of construction activity approximately 250 people will be on site. That level of employment, however, will last only a few weeks. To accommodate workers from outside of the Valley, three types of lodging are available: motels, apartments, and mobile homes. For workers with families, mobile homes are probably the most viable source of housing because of the general shortage of apartments. Some workers are expected to be residents of San Diego County and will commute or temporarily stay

in the vicinity of the project. Motels in the El Centro area would probably accommodate most of the temporary workers. However, during the winter months when housing shortages are worst, there may not be enough motel rooms. When the power plant is completed, only 13 people will be permanently employed to run it. Table 16 shows the personnel requirements of the facility. No significant housing problems are expected with the operation of the plant.

Other socioeconomic effects of the proposed power plant will also be minor. Revenues from the plant, in the form of royalties to the Federal government and local taxes, should cover the level of public services required. This is especially important in the post-Proposition 13 era in which reduced property tax revenues have inhibited the ability of local governments to supply various kinds of services. The power plant will have a minor aesthetic effect on the area because of the presence of a cooling tower plume during some meteorological conditions.

Table 16. Anticipated Personnel Requirements for the 48 MW Power Plant

<u>Function</u>	<u>Frequency</u>	<u>Personnel</u>
1. Overall Management	1 Shift/5 Days	Manager
2. Clerical	1 Shift/5 Days	Clerk
3. Supervise Operation and Maintenance	3 Shifts/7 Days	Supervisor
4. Operate Control Board	3 Shifts/7 Days	Operator
5. Equipment Inspection	3 Shifts/7 Days	Ass't. Operators (3)
6. Chemical Analysis of Process Fluid	1 Shift/7 Days	Ass't. Operator
7. Chemical Treatment	As Required	Ass't. Operator
8. Maintenance	1 Shift/5 Days	Maintenance Staff (2)
9. Ancillary Services	As Required	Ancillary Staff

Source: Republic Geothermal, Inc. (RGI, 1978).

VII. MITIGATION MEASURES

7.1 Geologic Impacts

7.1.1 Seismicity

Seismic activity will be monitored to determine if there is any change caused by the project. If seismicity is determined to be a significant hazard, the Geothermal Supervisor may require remedial action including but not limited to reduced production rates, increased injection of waste or other fluids, or suspension of production in accordance with GRO Order 4, Sec. 8D (USGS, 1976b). The spent fluids will be injected at 150-500 psi above the static reservoir pressure at a depth of 2000 to 5000 feet. Excessive injection pressures that could increase the potential seismic hazard will be avoided by installing automatic high-low pressure shut off valves as specified in GRO Order No. 6 (USGS, 1977b).

7.1.2 Subsidence

The proposed project includes plans to reinject about 90% of the geothermal fluids that are withdrawn. This could substantially reduce the potential for subsidence. In addition, subsidence will be monitored by placing a series of bench marks at the well sites and periodically surveying them for any changes as specified by GRO Order No. 4, Sec. 8 (USGS, 1976b).

7.2 Water Resources

Any significant risk of shallow ground water contamination will be eliminated by well drilling and construction requirements set forth in GRO Order No. 2 (USGS, 1976a) and well plugging and abandonment requirements set forth in GRO Order No. 3 (USGS, 1976c).

Potential contamination of surface water will be prevented or limited by GRO Order No. 6 (USGS, 1977b) and Order No. 76-64 (Revised) of the California Regional Water Quality Control Board Colorado River Basin Region (CRWQCB, 1977). This latter order prohibits surface runoff of geothermal fluids and restricts the quality and volume of fluids and drilling muds that can be released on the surface. Drilling muds and fluids will be contained in storage basins or sumps at each well site and after neutralization they can be used on unpaved roads. Order No. 76-64 also restricts the quantity of geothermal fluid that can be applied to roadways (for dust control) both on a daily basis and over the entire life of the project. This order also requires a monitoring and reporting program, and the reinjection of spent geothermal fluids.

GRO Order No. 6 (USGS, 1977b) specifies that pipelines and surface production facilities are to be designed and constructed to minimize or eliminate the risk of surface spills or accidental discharges. Thus a potential for surface water contamination is reduced.

7.3 Air Resources

The project will not generate a significant amount of air pollutants, and no air quality standards will be exceeded. Air pollution emissions must

comply with Federal, State, and regional air pollution standards, as specified by GRO Order No. 4, Section 9A (3) (USGS, 1976b). Dust control is included in item C5a of RGI's Plan of Development (POD) and special condition 3 of EA 12 (USGS, 1975a) and 29 (USGS, 1975b).

7.4 Noise

The greatest sound levels are expected during drilling and construction operations. Noise level restrictions and abatement requirements are set forth in GRO Order No. 4 section 11 (USGS, 1976b). Further, noise levels will be in conformance with Standards of Imperial County, Bureau of Land Management, and Occupational Safety and Health Administration as indicated by item C5b of Republic Geothermal Inc. Plan of Development (RGI, 1978).

7.5 Biological Resources

Unnecessary disturbance of vegetation and wildlife habitat will be avoided as specified in Section 2 of GRO Order No. 4 (USGS, 1976b). The 69 acres that will be disturbed by the project, together with the existing 35 disturbed acres will be revegetated or allowed to revegetate at the end of the project as per GRO Order No. 4 section 6 (USGS, 1976b). Special Lease Stipulations and Conditions for RGI's geothermal lease prohibit clearing of ground cover for power transmission lines except for towers or poles. Further, the Special Lease Stipulations and Conditions require that all power and transmission lines will be designed to minimize loss of raptor and other large birds by electrocution.

Nonspecular conductors may be required by the Supervisor for lines crossing Federal Lands.

The surface discharge of geothermal fluids is prohibited by Order No. 76-64 California Regional Water Quality Control Board, Colorado River Basin Region (CRWQCB, 1977). Risk of biological damage resulting from well blowout will be reduced or eliminated by installing blowout prevention equipment and establishing procedures as specified in GRO Order No. 2, section 2 (USGS, 1976a). Environmentally harmful substances will be removed from mud sumps called for in GRO Order No. 4, section 9A (4) (USGS, 1976b).

Provisions for rare and threatened species are contained in GRO Order No. 4, section 6 (USGS, 1976b).

Injection and production pipe lines will be elevated an average of one foot off the ground so they do not become a barrier to small mammals and reptiles (Carey, 1979).

7.6 Cultural Resources

All of the cultural resources on the site have been collected, recorded and curated. Thus cultural resource impacts have already been mitigated.

7.7 Land Uses

The 104 acres of land directly utilized by geothermal development will be reclaimed and returned to pre-project or near pre-project conditions as

stated in GRO Order No. 4, section 2 (USGS, 1976b). The restriction of access during the operation and development of the project cannot be mitigated.

7.8 Socioeconomics

The project would not have any adverse socioeconomic effect, and therefore no mitigation measures are necessary. The visual impact of well field and power plant development could be mitigated by painting structures with natural colors, and if necessary, screening with native landscaping.

VIII. ALTERNATIVES AND THEIR IMPACTS: A COMPARISON

The alternatives to the proposed Loan Guaranty Application are: 1) rejection of this application which is tantamount to "no project"; 2) acceptance of the application with mitigation conditions to minimize the impacts.

The impact of the proposed project has been described previously in this report and is summarized in Table 2. The impact of the no project alternative is summarized in Table 3 and a comparison of the two alternatives is shown in Table 4. The following is a comparison of the two alternatives.

It should be kept in mind while reading this section that the proposed project would generate 48 MW of power that would be sold to the IID or other utilities. This supplemental power supply would provide an opportunity to reduce the use of fossil fuels and the associated emission of air pollutants.

The first nine environmental parameters discussed below, seismicity, subsidence, hydrology, biology, land use, socioeconomics, noise, cultural resources, and air quality have only minor or no differences in the impacts from the two alternatives. However, in the case of the last environmental parameter, use of a non-renewable resource, the no project alternative would have a greater adverse impact than the proposed project.

The proposed project could result in an unknown but minor potential increase of seismic activity while the no project alternative would not

affect seismic activity. Similarly, the proposed project could potentially result in subsidence (although no significant subsidence is expected because of reinjection requirements) while the no project alternative would not have any potential for causing subsidence. Neither the proposed project nor the no project alternative will have a significant impact upon ground or surface water. However, if the completion of the proposed project results in the decrease of power generation from conventional plants, then fresh water resources normally used for cooling will be conserved. The proposed project would have a minor impact upon vegetation and wildlife habitat by the elimination of an additional 69 acres bringing the total disturbed area to 104 acres. This compares to no impact from the no project alternative.

The proposed project would have a minor impact upon land use, consisting of utilization of an additional 69 acres for geothermal development, the no project alternative would not have a land use impact. In contrast, the proposed project would have a minor beneficial impact to employment by creating jobs but the no project alternative would not have a beneficial impact.

The proposed project would not generate noise in excess of acceptable levels during its operation as stated in GRO Order No. 4, section 11 (USGS, 1976b). The no project alternative would not generate any additional noise. Similarly, neither the proposed project nor the no project alternative would result in adverse effects to cultural resources.

Air quality effects of the no project alternative would not be significantly different than with development of the project.

Lastly the no project alternative would perpetuate the use of non-renewable fossil fuels consumption whereas the proposed project would afford use of geothermal heat energy that would not otherwise be used.

IX. UNAVOIDABLE ADVERSE IMPACTS

9.1 Geologic Impacts

It appears that land subsidence could be an unavoidable impact. If surface contours change with subsidence, drainage would be altered on the Mesa. Increased erosion potential would result from increased slopes near the geothermal well-field but effects would be localized.

9.2 Air Resources

During the development phase of the project there would be dust and particulates generated by engine exhaust, grading and vehicle traffic on unpaved roads. During the power plant operation there will be water vapor, low quantities of salts, and hydrogen sulfide released into the atmosphere. Emissions from the power plant would not exceed any local, state or federal air pollutant standards. The project would not have a significant adverse impact upon air quality.

9.3 Noise

There will be relatively high temporary noise levels at each well site during well field development and at the power plant site during its construction. Operational noise will not be excessive, and there are no sensitive receptors in the area. There will not be a significant adverse noise impact.

9.4 Biological Resources

The project will directly impact approximately 69 acres of creosote bush scrub vegetation of which 39.5 acres support desert buckwheat (Eriogonum deserticola) a plant listed as rare and endangered by the California Native Plant Society in 1974 (Powell, 1974). This species occurs in great number in the project area and the 39.5 acres impacted by the project represents less than 7% of the populations found in the RGI leasehold, and a much smaller percentage of the total population in the area. Because desert buckwheat is much more wide spread than was originally thought, the impact to this species would be low or minimal. Other vegetational impacts from blow-outs, cooling tower or turbine exhaust vent emissions, or dust along unpaved roads are not expected to be significantly adverse.

The project would result in the loss of 69 acres of wildlife habitat. Species of special concern that could be affected by the project are kit fox (Vulpes macrotis) and flat-tailed horned lizard. The impact to the kit fox is not expected to be significant. The flat-tailed horned lizard is not classified as a rare or threatened species although its status is currently under review. This species is known to occur throughout the hot desert regions of southeastern California, southwestern Arizona, and adjoining parts of Mexico, of which the RGI leasehold is a small part. Within the RGI leasehold about 1% of the area or 69 acres would be disturbed. This disturbance is not expected to jeopardize the existence of the species.

X. THE RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY.

The short-term use that is being proposed is the development of a 64 MW well field and a 48 MW (net) geothermal power plant. This use involves commitment of geothermal heat, geothermal fluid, and of land necessary for construction of the well field, power plant, and transmission line. The extent and nature of these commitments and an assessment of their potential environmental impacts is presented earlier in this report. It is very important to recognize that geothermal heat is a "wasted" resource, that will dissipate from the earth's surface over time with little identifiable benefit, if it is not utilized.

The increasing demands for electric power are well documented both in the region and elsewhere. While the proposed power plant will only serve to supplement the existing power generation system, it will replace an equivalent amount of electricity that would otherwise be produced by steam electric systems using fossil or nuclear fuels. The use of these fuels imposes greater adverse environmental effects than would result from use of the proposed geothermal resources. The adverse effects from using fossil or nuclear fuels include air pollution, water pollution, radioactive wastes, thermal waste discharge to water or air and disturbance from mining.

The project is estimated to have an operational life of 30 years based upon the time necessary to amortise the capital investment, however, the actual life of the project could be longer. At the end of the life of the project most of the affected area will be returned as closely as

possible to the desert habitat that existed prior to geothermal development. There may be some residual soil alterations that limit or prevent revegetation in limited areas. The project and its utilization of geothermal resources will not narrow future options for the use of the area.

If the proposed power plant proves highly successful, it may lead to accelerated development of geothermal resource in the East Mesa area as well as elsewhere in Imperial County. The project represents about 10% of the estimated producing capability of the East Mesa KGRA.

XI. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Assuming that the heat source is regional and due to crustal thinning in a rift zone, the life of the heat source could be from hundreds to millions of years. The project could extract geothermal energy at a rate that is greater than the natural terrestrial heat flow. In this case the temperature of the geothermal fluids would be lowered over a long period of time. Although the terrestrial heat source will continue indefinitely, the use of the stored energy could be considered a depletion of the thermal resource over the short-term.

Approximately 10% to 15% of the geothermal fluid will be evaporated from cooling towers rather than reinjected. Recharge of the geothermal reservoir is not well understood but it is presumed to be part of the normal hydrologic cycle. Since this geothermal fluid would eventually be replenished and water is a renewable resource the evaporation would not be an irreversible commitment of a resource.

Compaction and subsidence that could result from withdrawal of geothermal fluid would be an irreversible process resulting in loss of storage capacity in the geothermal reservoir. Such compaction and subsidence would be mitigated by the proposed reinjection plan.

The capital and labor required for the geothermal development represents an irretrievable commitment of those resources, because installations would have little salvage value when the geothermal resources are exhausted.

Vegetation and wildlife habitat eliminated by the project can potentially be regenerated and does not represent an irreversible change. At the end of the life of the project, the affected area will be returned to as near pre-project conditions as possible. However, some residual soil conditions may prevent fast or total reestablishment of vegetation and wildlife habitat. The project would not threaten any species with extinction.

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APPENDIX A - ENVIRONMENTAL EFFECTS OF PRIOR
LEASING ACTIONS

The Federal action assessed here involves guarantying a loan for a 64 MW well field and a 48 MW (net) geothermal power plant to be sited on Federal lands and operated by Republic Geothermal, Inc. This proposed action has been preceded by other important Federal decisions regarding the leasing lands on East Mesa, California where the project is to be located. The first major Federal action was the decision to lease lands for geothermal development by competitive bidding under provisions of the Geothermal Steam Act of 1970. A subsequent action was the selection of the actual tracts within the KGRA to be presented for competitive bidding. The decision to lease lands was assessed in 1973 by an environmental impact statement prepared by the U.S. Department of the Interior. In 1974 an Environmental Analysis Record (EAR) was prepared prior to the leasing of tracts on East Mesa for geothermal exploration, well field development and resource utilization. After 3 of the tracts were leased to Republic Geothermal, Inc., geothermal development activities such as the drilling and testing of wells were approved by the Area Geothermal Supervisor (AGS) of the U.S. Geological Survey via several environmental analyses. It is the responsibility of the AGS to ensure that all geothermal operations associated with the proposed project adhere to Geothermal Resources Operational (GRO) Orders that are designed to protect the environment from adverse impacts.

The environmental impact statement (EIS) for the Geothermal Leasing Program assessed the kinds of impacts that could be expected to occur with geothermal development on Federal Lands that are part of Known

Geothermal Resource Areas (KGRAs). Alternatives that were addressed in the 1973 EIS (USDI, 1973) included: 1) Promulgation of leasing and operating regulations, 2) Alternatives for leasing geothermal resources, 3) Alternatives for exploration and development, and 4) Alternative sources of electric energy. Further, specific alternatives for the Imperial Valley KGRAs were discussed and included: 1) No leasing, 2) Leasing only those lands that could or should be developed jointly with adjacent Private lands, 3) Leasing only in the East Mesa KGRA, and 4) Leasing only lands of lowest environmental sensitivity in all KGRA's. The following sections are taken from the 1973 EIS (USDI, 1973) on the leasing program, and they summarize the unavoidable, adverse impacts that would be associated with geothermal exploration, drilling, production testing and operation on Federal lands in the Imperial Valley.

A. Exploration Phase

Exploration activities will involve physical presence upon the land which may result in damages to the land and resources thereon. Exploration activities include, but are not limited to, geophysical operations, drilling of shallow temperature gradient wells, construction of access roads or trails, and cross-county transit by foot, animals, or vehicles.

Even though persons conducting exploration operations comply with all of the general and specific terms and conditions of the "Notice of Intent to Conduct Exploration Operations," including the restoration of areas as near as possible to their original condition, some adverse impacts still may result. Examples are:

(1) Vehicle travel will result in dust, exhaust gases, noise, disturbance of wildlife, injury or killing of wildlife, accidents, etc. When existing roads are used, such impacts would be minimal since they primarily would be the result of increased traffic. Advance approval will be required for construction of new roads or trails to assure proper construction and restoration but impacts will result from vegetation removal and soil movement, even though adequate mitigating measures are taken. There will be a certain amount of disturbance of vegetative cover and soil surface from cross-country travel on roads or trails that can have temporary impacts until cover is restored and the soil is stabilized. Evidence of such roads or trails may remain for several years which could be conducive to casual use by others that could result in damage. Failure to comply with regulations or exploration stipulations could result in similar impacts, but damages could be more significant, particularly if such improper use was not promptly detected and corrected. No serious unavoidable adverse environmental impacts are expected.

(2) Drilling of shallow holes or blasting may be necessary which may result in minor vegetative and surface disturbance in the immediate area of activity. All drill holes will be small and shallow and are to be capped when not in use so no damage is anticipated from such holes. If not capped, small animals could fall into the holes and perish. Large animals or man could step on open holes and be injured.

(3) Exploration of geothermal resources will have some unavoidable impacts upon the vegetal communities within the Salton Sea, Glamis, Dunes and East Mesa KGRA's. The impacts, of course, will vary depending upon

the nature of exploration activities or the composition of the vegetal community. Those communities containing shrub species in moderate to heavy densities would be the most effected. In the creosote and bajada types, there could be some destruction of vegetation and compaction of soils, on those sites occupied by drilling rigs and roads.

B. Test Drilling Phase

Following award of leases, heavy equipment capable of drilling to depths of several thousand feet would be required. The enlargement and improvement of existing roads or construction of new roads to provide access for drilling equipment and supplies to the drilling site would involve unavoidable impacts from vegetative cover removal and surface disturbance. At each drilling site a level area of approximately one-half to one acre is required for drilling operations. While compliance with lease and GRO orders will prevent serious adverse impacts, some minor impacts still will result. Most of the potential impacts listed under exploration could be expected with some intensification in areas of heavy activity.

During drilling operations, moderate levels of noise from equipment operations would be unavoidable. Even where special noise control measures are required, noise levels will be above natural levels.

Physical land modification will increase at this stage which could result in loss of wildlife forage and wildlife habitat value in the areas of operation. Such impacts generally would be of a temporary nature. There could be some reduction of public use of areas for recreation, hunting,

etc., during periods of test drilling activities to protect equipment and facilities, and to reduce hazards to the public. Surface disturbance scars would be large and possibly permanent in nature.

Well blowouts could result in venting of steam, and associated gases and saline water to the atmosphere, ground area and surface water, creating air and water contamination as well as high noise levels and exposure of individuals to possible injury.

Adverse impacts would continue until the blowout is controlled. The severity of the incident could range from minor to serious, depending upon location.

C. Production Testing Phase

In a hot-water dominated reservoir at the Salton Sea, Glamis, Dunes or East Mesa KGRA, production testing requires production of the formation fluid over an extended period. Disposal of produced brine would have an environmental impact if released to the surface environment as discussed above. Large volumes of liquids could be involved. If not properly contained or reinjected, they could seriously impact surface water quality and related fish, wildlife, or other water-related values.

D. Full-Scale Operation Phase

Full-scale operation will require complete development of well and steam transmission systems, power generation facilities, brine disposal facilities, transmission lines, permanent roads, etc. Many of the

potential unavoidable adverse impacts associated with exploration and testing will no longer exist but other impacts may increase in proportion to the scale of development. Each well will involve clearing, grading, and improvements. Steam pipelines connecting wells to the generators likewise require clearing and grading. During construction, there will be considerable activity, noise, movement of earth, dust, etc. After construction is completed and all necessary environmental protection measures are taken, the nature of the site will be changed from its former state to an industrial complex. Cleared areas, buildings, power lines, brine ponds, etc., will represent permanent changes in the landscape.

Even with adequate controls, full-scale operations will involve higher than natural noise levels, emission of steam and other gases to the atmosphere, disturbance from operational activities, additional vehicle traffic, etc. Transmission lines will be a hazard to some wildlife as they may result in electrocution of small numbers of eagles, hawks, and other birds. Transmission lines damaged from storms or other causes can result in personal injury but to no greater extent than lines built in connection with other power systems under similar conditions.

Potential adverse impacts would be introduced during full-scale operation from possible land subsidence or increased seismic activity. However, a significant impact from these causes would not be expected until major production begins and appropriate mitigating measures would be taken as soon as monitoring indicates a need for such actions.

If reinjection of wastes does not successfully maintain fluid pressures in the geothermal aquifer system where extractions are undertaken, some subsidence can be expected even if operations are discontinued.

Some of the potential adverse effects on recreational use, natural values and aesthetics as discussed in previous chapters would occur. Though noise and gas emissions can perhaps be limited or avoided, little can be done to prevent the change from a wide-open natural setting to a partial industrial complex. There would be some reduction in outdoor leisure activities.

Leasing and operating regulations and GRO orders will provide the necessary control mechanisms and safeguards to assure that environmental impacts of an adverse nature will be held to acceptable levels, but such levels will involve some adverse impacts.

The preleasing EAR (BLM, 1974) prepared by the Bureau of Land Management (BLM) for the East Mesa KGRA also identified and assessed a number of impacts and alternatives that could accompany geothermal development and operation on the Mesa. The alternatives include: 1) Unrestricted leasing and geothermal development, 2) Restrictions of geothermal leases on all Federal lands, and 3) Restricting geothermal development on environmentally sensitive lands. Those impacts considered in the EAR are described below:

A. Vegetation

Total development of the geothermal resource could have varying impacts on the creosote community. The impact on the vegetation would be

greatest at drilling pads, power plant and access roads, where the vegetation would be completely removed.

B. Land Use

Land use will be changed considerably as a result of the development and operation phases of the geothermal operation. If an economically productive field is established, with one well per 40 acre tract, it is probable that a generating plant will be constructed on each section or facsimile, utilizing the geothermal energy of about 16 wells. In addition, additional wells will be drilled to reinject brine back into the earth. Insulated surface pipelines will be constructed from each well head to the generating station, as well as reinjection pipelines. Roads to each generating plant and well will be necessary. Transmission lines will be constructed to transmit the electric energy from each generating station. Other facilities necessary for the development and operation of a field, such as parking areas, maintenance facilities, etc., will also be constructed.

Archeological sites will be more severely impacted than by the exploration phase for the same reasons. (Since the EAR was written, cultural materials have been collected and curated.)

In short, because of the physical characteristics of a geothermal power operation, land use (with the probable exception of wildlife) will be more or less single use in nature.

C. Wildlife

Development and operation of geothermal fields would result in the destruction of vegetation which provides food and cover for several species of wildlife. Some animals would probably move out of the area upon construction of physical facilities and occupancy by humans.

Developments adjacent to the East Highline Canal would result in the reduction of populations of various species of wildlife such as doves, quail, and rabbits. Related hunting opportunities would also be decreased.

D. Aesthetics

Recreational use of the East Mesa area is low in comparison with Imperial Sand Dunes and other areas of the California Desert. Motorists using I-8 would see an industrial scene on what was previously a desert vista. Steam lines and reinjection lines would not be seen except from a short distance. Any noise or gaseous emissions could have an undesirable impact on anyone using the area.

E. Archeological and Historical Resources

Prehistoric and historical occupation of the East Mesa KGRA was most intensive in specific localities. The old shoreline immediately east of the Highline Canal reveals deposits of Yuman and earlier occupations. This shoreline sector extending from north of Holtville Air Strip southward to over one mile below route 80 is an area of intensive recreational use, especially north of the highway. As a result of

off-road vehicular traffic traversing the area, the cultural deposits are heavily mixed with approximately 70% of the artifactual materials out of original cultural context. In addition to off-road vehicle usage, quarrying operations are intensive in five separate areas. Private citizens also utilize the lacustrine deposits here for fill and transport same elsewhere. This action leaves huge cuts in the area exposing cultural materials.

East of the shoreline on the mesa proper, surface sites are abundant, reaching eastward for over 2½ miles in the southern sections. In the lower western portions of East Mesa KGRA archeological sites abound as in selected portions of the southern sector.

Disturbance of any natural or cultural resources during development of geothermal facilities has essentially the same effect on archeological materials and historic features. The intensity of development relative to the location of archeological and historic values will determine the degree of impact which may range from little or no significance to total destruction of such values.

F. Recreation

Complete development of the area for the geothermal resource would reduce off-road vehicle use and also reduce the hunting opportunity along the East Highline Canal. Limiting the recreational use of the area would be inconsequential since more desirable areas are in the vicinity.

Controlled visitor use in the area to view the developed and operating project is a possible recreational opportunity.

Any noise or gaseous emissions could have an undersirable impact on anyone using the area.

G. Mishaps

There would always be the potential for well blowouts and accidental brine spills. Such mishaps could occur at any stage of the operation and could have adverse impacts on the resources of the East Mesa KGRA, such as: impaction of sand and gravel deposits, destruction of vegetation, soil sterilization, loss of wildlife habitat, destruction of archeological sites, and contamination of fresh water supplies.

The potential for impacts resulting from land subsidence and seismic activity is present whenever fluids are extracted from a ground-water reservoir. That is, whenever withdrawals exceed the recharge and the reservoir pressures continue to decline -- land subsidence may occur.

Based on the environmental analyses of the KGRA, several parcels of land were excluded from leasing, primarily for archeological, ownership, and land use reasons. The EAR also recommended these special lease stipulations to protect the environment:

- a. No exploration, development, or operation work phases shall be conducted until a Plan of Development is prepared by the Lessee and approved by the Authorized Officer.

b. All operations shall be conducted in compliance with Federal, State, and local laws, ordinances, or regulations which are applicable to the area of operations including, but not limited to, those pertaining to fire, sanitation, air and water pollution and wildlife. All operations hereunder shall be conducted in a prudent manner.

c. All pits, ponds, and water holding facilities will be lined with impervious material and constructed to the satisfaction of the Authorized Officer. All pits, ponds, and water holding facilities may be covered when determined necessary to protect wildlife.

d. When practicable, working areas will be designed to have irregular shaped boundaries. The maximum amount of perennial vegetation will be left within the working area. These actions will facilitate site restoration after abandonment.

e. All waste geothermal fluids will be reinjected into sub-surface formations as directed by the Authorized Officer.

f. The use of wide or balloon tired vehicles and helicopters in place of track laying, narrow tired or 4-wheel drive vehicles is encouraged and may be required by the Authorized Officer to protect the soil surface and resources.

g. All road construction will be designed to minimize damage to native vegetation as deemed necessary by the Authorized Officer. This may require meandering roads and restrictions on road width and surfacing materials.

h. No well sites or physical structures shall be located within $\frac{1}{2}$ mile of the All American and East Highline Canals and Interstate Highway 8. Any geothermal fluid development in these areas shall be by slant drilling.

i. Where geologic formations allow, slant (directional) drilling should be done so as to reduce the number of drill pads, access roads and pipeline clearing areas.

j. Temporary roads, drill sites, etc., when no longer needed, shall be restored as directed by the Authorized Officer.

k. During any phase of geothermal operations the Lessee shall notify the Authorized Officer when any cultural resources are uncovered so that the Authorized Officer may provide for immediate salvage of such resources by a competent archaeologist so as to not impede geothermal operation any more than necessary.

l. No clearing of transmission line rights-of-way, except for tower or pole pads, shall be allowed.

m. All transmission lines will be designed to minimize loss of raptors and other large birds by electrocution. Non-specular conductors may be required by the Authorized Officer for lines crossing Federal lands.

n. Prior to any surface disturbance the Lessee shall contract with a scientific institution or archaeologist approved by the Bureau of Land Management for an archaeological inventory and salvage of all areas to be disturbed.

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