DOE/ET/27196--T7

IMPERIAL COUNTY

MASTER

DOE/ET/27196--T7

DE82 019152

GEOHERMAL DEVELOPMENT

QUARTERLY REPORT

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

April 1 to June 30, 1982

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

CONTENTS

IMPERIAL COUNTY Geothermal Development Quarterly Report April 1 to June 30, 1982

INTRODUCTION.....	1
I. Geothermal Administration.....	1
A. Important Geothermal Events	
1. Salton Sea 10 MW Plant.....	1
2. Salton Sea KGRA Geothermal Zoning.....	2
3. Transmission Lines For Geothermal Development.....	3
B. Geothermal Waste Disposal.....	3
C. Grant Award For Geothermal Subsidence Detection Network Monitoring.....	3
D. Geothermal Development Meeting.....	4
E. Field Inspections and Status of Geothermal Development	
1. Power Plant Projects.....	4
2. Exploration Activities.....	6
3. Direct Heat Development.....	6
II. Geothermal Planning.....	7
A. Applications for Geothermal Permits.....	7
B. Processing of EIR's.....	7
C. Other Geothermal Planning Activities.....	8
III. Direct Heat Study.....	8
SUMMARY.....	8
APPENDIX 1: Subsidence Monitoring Network: Tentative Resurvey Areas	
APPENDIX 2: Meeting Summary: Imperial County Geothermal Development Annual Meeting	

IMPERIAL COUNTY
GEOTHERMAL QUARTERLY REPORT
April 1 to June 30, 1982

INTRODUCTION

→ This Quarterly Report will show the current progress on Cooperative Agreement DE-FC03-79ET27196 and the status of geothermal development in Imperial County. It was prepared by the Director of Public Works and the Geothermal Coordinator in partial fulfillment of this Cooperative Agreement. This report discusses the highlights of geothermal development activities during April, May and June, 1982. The report is organized into three sections covering Geothermal Administration, Geothermal Planning, and the Direct Heat Study.

Section I, Geothermal Administration, will address the activities of the Geothermal Office during the quarter. Topics include important geothermal events, geothermal waste disposal, a grant award by the California Energy Commission, the geothermal development meeting, and the current status of geothermal development in Imperial County.

Section II, Geothermal Planning, will address activities of the Geothermal Planner during the quarter, including processing of applications for geothermal permits, processing of EIR's, and other geothermal planning activities.

Section III, Direct Heat Study, will discuss the progress on the VTN direct heat study.

I. Geothermal Administration:

Geothermal administration is the task of the Geothermal Office based within the Department of Public Works, under the direction of the Director of Public Works. The office is responsible for investigations and activities in Imperial County to stimulate and support the growth of geothermal energy. The Geothermal Coordinator is responsible for monitoring geothermal development in Imperial County, addressing issues as they arise, collecting and developing information, and encouraging direct heat development.

A. Important Geothermal Events

1. Salton Sea 10 Megawatt Plant

The second Union/Southern California Edison 10 Megawatt Power Plant is preparing for startup in early July. Union has stated that this facility, located in the Salton Sea KGRA, is their last demonstration facility in Imperial County. Following a successful operation of this plant, efforts will be geared towards the construction of commercial scale plants.

2. Salton Sea KGRA Geothermal Zoning

On May 11, 1982 the Imperial County Board of Supervisors voted to increase the geothermal overlay zone in the Salton Sea KGRA from 20,000 acres to 107,444 acres. The expanded zone includes the offshore areas of the Salton Sea, although zoning of this area for geothermal development has been opposed by Fish and Game Representatives. In an extensive hearing, the Supervisors found that geothermal development will provide major socio-economic benefits to the County, and that mitigation of environmental impacts can be accomplished on a case-by-case basis as specific projects are permitted.

The designation of a "Geothermal Overlay Zone" indicates that the County considers an area appropriate for geothermal development subject to site specific analysis that will be addressed in each production permit approval process. Expanding the overlay zone has no adverse environmental impacts because individual environmental reviews for each proposed project will examine mitigation measures and alternatives.

Both the Geothermal Coordinator and the Geothermal Planner participated in the hearing before the Board of Supervisors. The Geothermal Coordinator presented information on the benefits to Imperial County of geothermal resource development. The Geothermal Planner presented information on the environmental impact report process as related to the zone expansion, the Master Environmental Impact Report which assesses the proposed action, and on the compatibility of the overlay zoning with the County Geothermal Element of the General Plan.

Members of certain fish and wildlife clubs have filed suit against the County to block the adopted zone expansion. In a suit filed June 16, 1982, the members claim that the Master Environmental Impact Report is inadequate for the purpose of assessing all adverse environmental impacts of the zone expansion, and that the County's zoning decision has significant adverse environmental impacts.

3. Transmission Lines For Geothermal Development

Southern California Edison held a series of seven public information meetings during May to discuss geothermal development and locations for related transmission lines. SCE explained that the proposed transmission line project was required to provide the capacity for handling the energy generated through geothermal development. The meetings solicited comments from the public about preferences for transmission line routing and facilities.

Edison representatives noted that they expect the Imperial Irrigation District (IID) to own the transmission lines and SCE to pay for use of the lines. However if IID cannot handle the transmission lines, SCE would have to establish lines; this series of meetings was to consider that contingency. The regulatory process for siting a transmission line takes approximately 5 years; Edison expects to need the lines in 1987 and is therefore starting the process now.

The public comments received express a variety of interests and concerns regarding the proposed transmission lines. The consensus was that transmission lines should avoid farm land and populated areas, and, when possible, existing lines should be upgraded rather than new lines constructed.

B. Geothermal Waste Disposal

A testing program to identify the most appropriate site or sites for future testing and eventual development for geothermal waste disposal was initiated during this quarter. Eleven proposals, received in response to a request for proposals, were reviewed and the contract for the testing program was awarded to Brown and Caldwell Consulting Engineers.

Testing began during the last half of June; Brown and Caldwell expects to complete field work during early July. A draft report will be completed and submitted in late September. The report will assess the apparent impacts of local geology and geohydrology on limiting the use of a site as a class II-1 disposal area and will identify geologic and geohydrologic constraints to development. Factors such as soils, ground water, surface drainage, flooding, potential for ground rupture, and seismicity will be included. The sites will be ranked as to their suitability and with respect to each other.

Following issuance of the final report, the report will be assessed by the Geothermal Coordinator and the Public Works Department Staff and recommendations made to the Board of Supervisors on which site or sites should be pursued for use as disposal sites.

C. Grant Award for Geothermal Subsidence Detection Network Monitoring

The Imperial County Public Works Department has received a grant under the California Energy Commission Geothermal Grant Program for Local Governments. The grant monies will fund necessary field survey work and related operating costs for a program to monitor portions of the geothermal subsidence detection network. The resurvey will be conducted during the 1982-83 winter, and will update survey data for areas which experienced the most movement following the 1979 earthquake and the areas where a geothermal project is operating or coming on-line in the near future. (See Appendix 1 for a tentative indication of areas the County is most interested in resurveying, and the relationship of these areas to current and proposed projects.)

The Geothermal Coordinator was the lead person in the preparation of the grant application, and will administer the grant for the County.

D. Geothermal Development Meeting

The Annual Geothermal Development Meeting was held May 13th and 14th, 1982. The format consisted of short presentations by a variety of organizations on their activities in Imperial County in the development of geothermal resources, resolution of technical issues, and regulation of geothermal development.

A number of presentations focused on development activities that are scheduled to begin or to continue in 1982. This indicates that geothermal utilization in Imperial County is finally in the development stage. We have three power plants on-line; two power plants to begin construction in Heber, a binary and a double flash plant; a 28 megawatt plant to begin construction at the Salton Sea, and an application for a permit for a 45 MW plant south of Brawley. Exploration in the Valley is also expanding and research is continuing. A number of presentations described direct heat utilization projects; we expect that next year more direct heat projects will be discussed. See Appendix 2 for a summary of the meeting and a list of speakers and attendees.

E. Field Inspections and Status of Geothermal Development

1. Power Plant Projects

- a. Magma Power is completing the refitting of the East Mesa 10 megawatt binary power plant. The new turbine is being tested and is expected to be installed during the next quarter. Magma expects the plant to be in operation by the end of the next quarter. The refitting is expected to result in increased reliability.
- b. The Union Geothermal/Southern California Edison 10 megawatt plant in Brawley closed in early May for maintenance and restarted in early June. The plant has experienced some problems with productivity of wells and has been performing well workovers during the past quarter.
- c. The Union/Southern California Edison/Southern Pacific 10 megawatt power plant at the Salton Sea is in the final stages of completion and is expected to begin operation during early July. Steam was put through the piping during late May, and systems were tested in June. Union has completed the installation of the subsidence monitoring system for the plant and has completed the first survey of the network. The seismic monitoring program for the plant has been submitted for County approval.

- d. Magma Power's 28 megawatt power plant at the Salton Sea is scheduled to begin construction in 1982. Magma anticipates completing engineering and beginning field work in about 3 or 4 months, depending on the development of a satisfactory financing package for the project.
- e. The Chevron/Southern California Edison 49 megawatt power plant in the Heber anomaly will begin construction in 1982. Design activities are proceeding, and plans for both the production and the injection islands are near completion. The resource delivery will use an island drilling concept where the hot fluid is produced from the center of the field and injection occurs on the periphery. Site work began in early 1982 and well drilling is expected to begin in July 1982 and will be completed in about 1 year. The start-up of the turbine is scheduled for May 1984.
- f. Construction of the Heber Binary Demonstration Project is scheduled to begin in late 1982. All of the major equipment is out for bid, or bids have been received and are being evaluated. The demonstration period for the project is scheduled to begin at the end of the first quarter of 1985.
- g. Republic Geothermal is still seeking funding for a 19 megawatt power plant at the East Mesa.
- h. MCR Geothermal and the California Department of Water Resources have submitted a permit application for a 49 megawatt power plant to be located south of the Brawley KGRA. The project area has not been classified as a KGRA, however USGS is moving towards the designation of the entire area. MCR is completing the design of a well test facility so that a 30-day production test can be run on the four existing wells. The objective of the testing is to develop information on steam and brine chemistry, steam reservoir characteristics, productivity of the wells, and injectivity of the brine. Methods for treating and controlling brine before reinjection will be tested. MCR hopes to begin this test in July.
- i. Magma Power's proposed 49 megawatt power plant in the Salton Sea KGRA is seeking a conditional use permit from the Imperial County Board of Supervisors. A hearing on this application is expected during the next quarter.
- j. Republic Geothermal is planning a geothermal power plant to be located southwest of Niland, California. Initial plant capacity starting in 1985 is to be 25 megawatts. Capacity will then increase to 49 megawatts within three years of initial plant startup. Republic expects

to apply for a production permit from Imperial County during July 1982. The permit would cover both plant and field development. In February 1982, Republic Geothermal and Southern California Edison signed a letter of intent for Edison to purchase electricity produced by Republic Geothermal from this power plant. Edison and Republic are now working on a heat sales contract for the project.

2. Exploration Activities

- a. Occidental Geothermal has two wells drilled in the East Brawley KGRA. They anticipate drilling one or more deep wells at the East Brawley lease in the future. Following drilling, Oxy will conduct brine handling tests and assess the reservoir to evaluate the suitability of the geothermal resource for electric power generation.
- b. Phillips' Petroleum is planning to drill one well in the Truckhaven prospect during August 1982. At East Brawley, Phillips' has drilled three wells and has done limited flow testing. Phillips' plans to construct a facility for more thorough testing.
- c. Republic's exploratory efforts in the Salton Sea KGRA, near Niland, are expected to culminate in an application for a geothermal production permit during the next quarter.
- d. Bear Creek Mining has begun construction of a barge to be used as a base for drilling off-shore temperature holes in the Salton Sea.
- e. Chevron is proceeding with the drilling of a number of exploratory holes throughout the County.

3. Direct Heat Development

- a. City of El Centro: Testing of the wells for the El Centro Community Center project was stalled when it was discovered that mud was blocking the bottom areas of the wells. Project managers are investigating costs and methods for unblocking these holes. The El Centro City Council has committed additional funds for the clearing of these wells so that the project can continue.
- b. Ultrasystems: Ultrasweet Limited and Ultrasystems Inc. propose to construct and operate a 16,000 bushel per day corn wet milling - high fructose corn syrup facility at the East Mesa. The project will use hot geothermal fluids produced by Union Geothermal. The refinery will produce high fructose corn syrup as a primary product, co-products include industrial grade alcohol, corn oil, corn gluten meal, corn gluten feed, and corn steep

liquor. Ultrasystems is pursuing a geothermal loan guarantee from the Department of Energy to be used for the design and construction of the facility.

- c. The County Office of Community Economic Development did not receive funding for preliminary development activities for a methane generation plan in Heber KGRA. The office intends to resubmit their application to the California Energy Commission during the next grant solicitation period.

II. Geothermal Planning

Geothermal Planning is the task of the Geothermal Planner based within the Planning Department under the direction of the Planning Director. The Geothermal Planner's responsibilities are to receive applications for geothermal projects; to review applications and arrange for hearings on these projects; to draft permits and conditional use permits for geothermal exploration, development, and production operations; to prepare or arrange for the preparation of environmental impact reports; to implement the Geothermal Element of the County General Plan; to inspect geothermal development areas for compliance with County permit conditions; and to participate in other geothermal activities.

A. Applications for Geothermal Permits

1. Republic Geothermal received a permit for four exploratory wells on June 9, 1982. Republic is attempting to locate an injection strata to use for their Niland project.
2. Bear Creek Mining received permits for 75 temperature observation holes during June 1982. Holes are to be located in and around the Salton Sea.
3. MCR Geothermal has applied for a geothermal production permit for their project site south of Brawley, as discussed above.

B. Processing of EIR's

1. The Geothermal Planner administered the contract for the Salton Sea Master Environmental Impact Report. This contract was successfully terminated with the certification of the MEIR by the Imperial County Board of Supervisors during May 1982.
2. The Planning Department has solicited proposals for a supplementary EIR for the IT Corporation Geothermal Waste Disposal Site. IT Corporation has applied for a conditional use permit to allow the acceptance of other types of waste at their geothermal disposal site. An award of the contract for the supplementary EIR is expected during early July.
3. The Geothermal Planner is developing a request for proposals for the environmental work in support of the MCR Project discussed above. Solicitation of proposals and selection of

a contractor will proceed during the next quarter.

C. Other Geothermal Planning Activities

1. The Geothermal Planner made a number of field trips during the quarter for the purpose of studying applicant sites, gathering report data, and observing compliance with conditions of County permits.
2. The Geothermal Planner made formal presentations on a number of topics to the Imperial County Fish and Game Commission, the State Fish and Game Commission, the Imperial County Board of Realtors, the Imperial County Geothermal Development Annual Meeting, and the Imperial County Board of Supervisors.
3. The Geothermal Planner responded to solicitations for comment from the Regional Water Quality Control Board, the Bureau of Land Management, the State Lands Commission, and the Minerals Management Service. Projects involved proposed leases, exploratory projects, and geothermal industrial projects.
4. The Geothermal Planner routinely consults with industry, realtors, prospective developers, the media, and the public. Topics include Imperial County Geothermal Policy, permitting procedures, and various impacts and benefits of geothermal development.

III. Direct Heat Study

The VTN project team is proceeding with work on Tasks 4, 5, and 6. On Task 4, the Imperial County Direct Heat Committee added a number of industry categories that will be included in the Dun and Bradstreet search process. VTN has contacted Dun and Bradstreet for guidance on selection on parameters for the industry search.

A presentation was made by members of the VTN project team at the Imperial County Geothermal Development Annual Meeting in May. The presentation covered the objectives of the study and discussed the results to date. The team requested information from Imperial County Geothermal Developers on their problems and successes, their suggestions for changes in County policies, and suggestions for new County policies or procedures that would assist in the implementation of direct heat projects.

SUMMARY

Geothermal development activities continue to be numerous and varied. Activities of the Geothermal Staff during the quarter have included participation in meetings and hearings, development and administration of grants and contracts for projects related to geothermal development, organizing and coordinating the Annual Geothermal Development Meeting, obtaining current information on geothermal development projects, and processing applications and environmental impact information on geothermal development projects.

The Salton Sea 10 MW power plant is in the final stages of preparation for start-up during early July. Geothermal zoning in the Salton Sea area was expanded during May when the Imperial County Board of Supervisors held hearings on the zoning expansion. Southern California Edison held a series of public meetings to consider locations for geothermal development-related transmission lines.

Testing of a number of sites to determine their suitability for the containment of geothermal waste was begun in the second half of June. Field work is to be completed during early July and a draft report is expected to be issued by the end of September.

Imperial County was awarded a grant for partial monitoring of the geothermal subsidence detection network by the California Energy Commission. Subsidence monitoring will be conducted over the 1982-83 winter in selected areas of the County.

The Annual Geothermal Development Meeting was held during May. Presentations discussed the status of geothermal development in Imperial County.

Geothermal development activities are continuing to increase. The East Mesa Binary Power Plant should resume operations during the next quarter, the new 10 MW flash facility at the Salton Sea will initiate operations, and the Brawley 10 MW power plant will continue operations. Construction is to begin during 1982 on a 28 MW power plant at Salton Sea, a 49 MW flash facility in the Heber Anomaly, and a 49 MW binary demonstration project also in Heber. An application for a permit for a 49 MW power plant to be located south of Brawley has been submitted by MCR Geothermal. This project could lead to the designation of an additional KGRA in Imperial County. Republic Geothermal is continuing planning for a geothermal power plant to be located southwest of Niland.

Geothermal Exploration activities are continuing, with active exploration programs conducted by Occidental Geothermal, Phillips' Petroleum, Republic Geothermal, Bear Creek Mining, and Chevron Geothermal.

The El Centro Direct Heat Project has had the well testing program delayed due to blockage of the bottom of the wells. Following clean out, the project is expected to continue. Ultrasystems, Inc. has continued efforts to locate a fructose corn syrup facility using geothermal fluids at the East Mesa.

Planning activities have also been varied. Exploration permits were issued to Republic Geothermal and Bear Creek Mining during the quarter. The Planning Department is processing MCR Geothermal's permit for a power plant to be located south of Brawley as discussed above. The Planning Department has completed the processing of the Salton Sea Master Environmental Impact Report and is involved in the selection of contractors to perform environmental studies for an amended conditional use permit for IT Corporation and the MCR project in south Brawley.

The Direct Heat Study is continuing with efforts to complete Tasks 4, 5, and 6 during the next quarter.

IMPERIAL COUNTY SUBSIDENCE DETECTION NETWORK

APPENDIX I TENTATIVE RESURVEY AREAS

IMPERIAL COUNTY GEOTHERMAL DEVELOPMENT
ANNUAL MEETING

IMPERIAL COUNTY AIRPORT CONFERENCE ROOM
MAY 13-14, 1982

MEETING SUMMARY

David E. Pierson, Director of the Department of Public Works of Imperial County, welcomed meeting attendees to the seventh annual meeting of Geothermal Developers, researchers, and Government representatives. The purpose of the meeting was to discuss the status of geothermal development in Imperial County, including a brief outline of each active project, the current status of the project, and future plans.

Heber Binary Project

Robert G. Lacy, San Diego Gas and Electric Company

The objectives of the Heber Project are to demonstrate the potential of moderate temperature resources in the production of electricity with a binary cycle, to evaluate the scale up of equipment, to determine the schedule, cost, performance, and environmental effects of binary cycle plants, and to resolve the uncertainties of reservoir and plant performance and economics.

Construction of the plant is scheduled to begin in late 1982, first brine delivery is in the third quarter of 1984, and the start of the demonstration period is scheduled for the end of the first quarter of 1985. All of the major equipment is out for bid, or bids have been received and are being evaluated.

Heber Projects

L. T. Elliot, Chevron Resources Company

The Chevron/Southern California Edison Project at Heber is a 52 megawatt (gross) double flash power plant operating on the Heber resource which is 350° F. A new PUC decision is expected in September 1982 and is the final major approval required for this project. Design activities are proceeding, and plans for both the production and the injection islands are near completion. Site work began in early 1982 and well drilling is expected to begin in July 1982 and will be completed in about 1 year. The start up of the turbine is scheduled for May 1984.

Edison's Activities in Imperial Valley

Norman J. DeHaven, Southern California Edison Company

Edison is involved in the development of the Brawley, Salton Sea, and Heber anomalies. Two years ago the first 10 megawatt power plant was put in operation in Brawley. The capacity factor at the Brawley plant since July of 1980 has been about 40%, but power plant availability has been close to 90%. Edison has just finished constructing a 10 megawatt gross, 9 megawatt net, plant at the Salton Sea. The plant is currently in the midst of start up, the first steam delivery will be in June, and commercial operations will begin in July. Both are flash plants, with

steam systems by Union Oil. Edison is working with Chevron Resources to develop a dual flash plant at Heber. Edison is hoping for a favorable decision from the PUC. The facility is to go into operation in August of 1984 as a commercial plant.

Brawley and Salton Sea Facilities

Olin D. Whitescarver, Union Oil of California

The Brawley 10 megawatt power plant has been on-line for 2 years. The plant is currently shut-down for maintenance and should be in operation again in about 20 days. The Salton Sea plant will start up at the end of June, 1982. At both of these facilities, Union drills the wells, produces the brine, and supplies clean steam to SCE. The condensate is returned to Union for reinjection. The projects are not making a profit, but progress in handling the brines has been made and Union eventually expects to be successful. Both plants reinject nearly 100% of produced brines, basically everything that is produced is reinjected. Union hopes to go to 80% reinjection eventually and use the remaining condensate for cooling. Irrigation water is currently used for cooling.

Review of Planning Activities

Richard D. Mitchell and Phillip R. Shafer, Imperial County Planning Department

The Planning Department and the Planning Commission are responsible for administering the development of "geothermal overlay zones," issuing geothermal exploratory well permits, issuing power plant permits for plants of 49 megawatt and less, and issuing building permits for all nonelectric parts of power plants.

County processing times for various kinds of permits:

- Temperature holes: approximately 10 days
- Exploratory permit, no EIR required: approximately 3 months
- Exploratory permit, with EIR: approximately 6 months
- Rezoning: approximately 6 to 18 months
- Production permits: approximately 6 to 18 months

Recent and Pending Changes in Federal Procedures/Organizations

Buford Holt, U.S. Minerals Management Service

On January 9, 1982, Secretary of the Interior James Watt moved the Conservation Division from the Geological Survey to the Minerals Management Service. This section will be responsible for regulating all operations on Federal leases. In spite of the organizational changes, no major changes that will effect geothermal operations are anticipated for at least one year. For operations on Federal lands, the Minerals Management Service should be the first contact and they will then direct you to other agencies.

Geothermal Direct Heat Study

John Sakaguchi & Carolyn Trindle, VTN Consolidated

The Geothermal Direct Heat Applications Study for Imperial County has four major objectives: identify potential uses, identify potential

users, inform potential users, and establish development procedures. The focus of the study is on developing a marketing plan for the County. The project team is soliciting input from geothermal developers on problems and successes, suggestions for changes in County policies, and suggestions for new procedures needed.

VTN has conducted an initial review of various plans, policies, and procedures which do effect or could effect the development of geothermal energy for direct heat use in Imperial Valley and is developing a plan for encouraging direct heat agricultural industry development.

Republic Geothermal Niland Development Project
William C. Hass, Republic Geothermal Inc.

In February 1982, Republic Geothermal and Southern Cal Edison signed a letter of intent for Edison to purchase electricity produced by Republic from a geothermal power plant to be located southwest of Niland. Edison and Republic are now working on a heat sales contract. Republic will be responsible for developing the resource and for constructing and operating the power plant. Initial plant capacity starting in 1985 will be 25 MW. Capacity will increase to 49 MW within three years of initial plant start up. The wells will produce from a fractured reservoir at a depth of 8,000 feet or greater. Reservoir temperature has been measured between 515 degrees to 560 degrees F. Dissolved solids are between 115,000 to 250,000 parts per million. Republic expects to apply for a production permit in July 1982. The permit would cover both plant and field development.

Direct Contact Binary Power Plant
Ken Nichols, Barber-Nichols Engineering

The Department of Energy funded direct contact pilot plant has been testing for over two years at the East Mesa geothermal test facility. The purpose of the pilot plant was to evaluate performance of the power system. All of the components of this system do perform at design standards. After two years of noncontinuous operation, the equipment inspection showed no corrosion, erosion, or scaling. The plant operates very reliably, there are no major problems. The basic process is proven, however study of process economics has not been completed. The direct contacter system was developed to handle higher salinity brines, but the process has never been tested on high TDS brines. The process is about ready for commercial application.

Update on Sperry Activities
Warren McBee, Sperry Corporation

The test of the down-hole heat exchanger process was delayed when the well collapsed last summer. No other well is currently available that is adequate for the testing of the pump system. The project is on hold while options for continuation are discussed with DOE and others. Some of those options appear very likely. An independent in-depth study of the technical and economic reliability of the process was done, this study substantiates the Sperry predictions.

Sperry Corporation intends to divest itself of the Sperry Vickers Division, and will be out of geothermal development. Mathews Geothermal Incorporated

will take on the Sperry patents and is seeking funding for the new company.

DOE Plans and Programs

John Crawford, U.S. Department of Energy

Ted Mock, who is the new Division Director in Washington D.C., and Ron Toms, head of the Pacific Commercialization Team, wired a message for presentation at the meeting.

We are pleased and proud of the progress of geothermal development in Imperial Valley. A spirit of teamwork among federal, county, state, industry, and citizen groups have all worked to help develop geothermal. Today the Department of Energy no longer supports commercialization programs, instead the emphasis is on research and development. The Department will support high-risk, high-payoff, technology development to support the technological base for further private industry development.

Mining of Metals from Geothermal Brines

Ian Kennedy, Canadian Development Corporation, HSA Reactors Limited

HSA Reactors Limited of Toronto is currently producing units for waste stream processing of metal finishing wastes. This process may apply to geothermal waste products. Brine chemistry is extremely complex and, to date, although work has been done on recovering metals, there has been no successfully installed system. CDC hopes to get access to some of the brines to perform tests of the HSA recovery system.

Production of High Fructose Corn Syrup Utilizing Geothermal Energy

Dr. J. L. Prouty, Ultrasystems

Ultrasweet Limited and Ultrasystems Incorporated propose to construct and operate a 16,000 bushel per day corn wet milling-high fructose corn syrup facility in the Imperial Valley. The project will use hot geothermal fluid produced by the Union Geothermal Division as the source of process energy. The refinery will produce high fructose corn syrup as the primary product, coproducts will include industrial grade ethanol alcohol, corn oil, corn gluten meal, corn gluten feed, and corn steep liquor. Ultrasystems is actively pursuing a geothermal loan guarantee in the amount of \$46 million from the Department of Energy to be used for the design and construction of the facility.

Agriculture in a Geothermal Lease Area

Frank E. Robinson, University of California, Imperial County Agricultural Extension

When the development of geothermal power at the East Mesa began, the question of use of the geothermal water in agriculture was raised. If it can be used for agriculture, what would be the limitations? An agricultural area was developed out at the Republic lease on the East Mesa to explore these questions. The project involves the comparison of geothermal water with East Mesa ground water. Test results show that geothermal waters will work for some crops, although crops must be tested to determine possible metals content from the brines. Crops being investigated include sorghum, sugar beets, jojoba, dates, and olives.

Occidental's Geothermal Activities in the Imperial Valley
Neville Manderson, Occidental Geothermal, Inc.

Occidental's first geothermal test well in the East Brawley KGRA was spudded in January 1980. Oxy's second well was begun in March 1981 one-half mile east of the first well. Oxy anticipates the drilling of one or more deep wells at the East Brawley Lease in the future, which will be followed by brine handling tests and reservoir assessment to evaluate the suitability of the geothermal resource for electric power generation.

State Lands Geothermal Projects in Imperial County
Donald L. Hoagland, State Lands Commission

The State Lands Commission manages a scattering of lands throughout Imperial County, with 15,000 acres either under lease, permitted for prospecting, or with prospecting permits pending. A geothermal prospecting permit gives a permittee the exclusive right to explore an area for a period of two years. The permit usually carries a preferential right to convert the permit to a lease if commercial quantities of geothermal resources are discovered. Terms for royalties in any lease evolving from a prospecting permit are agreed upon before the permit is issued.

On the east side of the Salton Sea, drilling projects are to be located on private lands with slant drilling into the areas below State lands. The environmental impacts will be occurring on private lands, therefore the County will be the lead agency for environmental assessment.

Phillips' Activities in Imperial County
Don Harban, Phillips Petroleum Co.

Phillips' is exploring the Truckhaven Prospect and the East Brawley Prospect. Phillips' expects to drill one well in Truckhaven in August 1982, if results of this exploratory well are positive, Phillips' will take advantage of their other permitted well sites in the area. At East Brawley, Phillips' has drilled three wells, and has done some limited flow-testing in an attempt to evaluate the resource. Phillips' plans to construct a facility for more thorough testing, starting this construction during June 1982. Results will help determine future plans for the Prospect.

Current and Planned Geothermal Activities
David E. Pierson, Imperial County Public Works

County activities in preparing for geothermal development are varied: 1. One or more additional geothermal disposal sites are needed. The County is in the process of selecting acceptable sites for possible use for geothermal waste disposal. 2. One year ago Imperial County organized a resurvey of the subsidence network. This year we are asking the State Energy Commission for funds to resurvey portions of the network. County policy has been to institute programs to detect subsidence so that changes could be detected before they become serious. 3. We have prepared a benefits assessment of geothermal development which discusses the value of geothermal development to the County. This analysis included the jobs that geothermal creates in the County, the

tax benefits, and other benefits. 4. There has been a great deal of talk lately about a study of all water sources and uses in the Valley. We anticipate that a study will be a necessary project for the geothermal office during the next year.

C.D.O.G. Role in Geothermal Development

Dave Curtis, California Division of Oil and Gas

CDOG moved their geothermal office from Long Beach to El Centro in 1981. The Division can now give better service, reducing the cost to geothermal developers; increase field surveillance, especially in environmental monitoring; and work more closely with the County and with other agencies.

CDOG is in the process of setting up a "Spills Committee" composed of regulatory agency representatives and representatives from the geothermal industry. The purpose of the committee is to identify the appropriate response to a spill so that we are prepared to handle such an event, and to establish a fund so that clean-up can begin immediately following a spill, prior to the assignment of responsibility for the spill.

Besides regulatory authority, CDOG is involved in resource identification and management. CDOG recently started a baseline repetitive gravity study of the Heber field. This study will be useful in identifying subsidence, the degree of recharge of the reservoir, and identifying any mass changes.

Repetitive Gravity Survey at Cerro Prieto and Heber

Dr. Roswitha B. Grannell, Calif. State University, Department of Geology

Purposes of the gravity survey are: to monitor reservoir changes and their surficial manifestations; to assess the utility of the gravity method in trying to assess those changes; and to corrolate the results of surface subsidence measurements with mass changes.

The project at Cerro Prieto was initiated in the Winter of 1977-78 and has been repeated annually. In the future, the survey will probably be conducted in alternate years. The results at Cerro Prieto show some subsidence at Cerro Prieto in the magnitude of 3 or 4 inches over a two year period with no reinjection, but possibly some natural recharge. The Heber survey was initiated 1½ years ago. A second year gravity survey is being done by the staff of the local CDOG office, funded by the State. At this time the work in Heber is to establish baseline data to cover the KGRA and establish natural subsidence levels so that future changes can be identified.

Legal Framework for County Geothermal Planning

James H. Harmon, Imperial County Counsel

Imperial County has been aware of a number of potential legal issues regarding geothermal development. Recently a number of these issues have begun to arise. For example, the recent consideration by the County Board of Supervisors of the question of the expansion of geothermal overlay zoning in the Salton Sea Resource area raised a number of concerns. The County Board of Supervisors took the position that the zoning expansion by

itself did not create any environmental impacts as zoning does not, under our regulations, allow any development. Development requires issuance of specific production permits.

In Imperial County, geothermal resource lands can be overlain by various kinds of ownership patterns: lands are owned by the Federal Government, State Government, and private citizens. Each ownership pattern is overlain by a different regime of laws. This creates tremendous jurisdictional confusion. Under the Federal Land Management Act local jurisdictions can urge the Federal Government to cooperate in management of lands.

Cerro Prieto Project Development

Ramiro Rivas, Comision Federal Electricidad

In April 1973, after 15 years of study, the first stage of the Cerro Prieto project began operation. The current capacity at Cerro Prieto is 180,000 kilowatts. The power plant system consists of 5 turbo-generators. Generators 1 thru 4 have a capacity of 37.5 megawatts each and are operated with high pressure steam. Generator 5 has a capacity of 30 megawatts and operates with medium and high pressure steam. In 1981, the construction of two additional geothermal power plants was begun, each will have a capacity of 220,000 kilowatts. Cerro Prieto 2 is to begin operation in 1983 and Cerro Prieto 3 in 1984. This will bring the generating capacity of the Cerro Prieto field to 620,000 kilowatts by 1984. The depth of the resource at Cerro Prieto 1 is 700 to 1,000 meters, Cerro Prieto 2 and 3 are deeper, approximately 2,500 meters. The temperature of the resource is 210 degrees to 350 degrees centigrade. Silica scaling is the main problem, and requires a substantial maintenance program.

Magma Activities in Imperial County

Tom Hinrichs, Magma Power Co.

Magma has made an agreement wherein Natomas will take over all Magma's Big Geysers interests and a new Magma Power Company will have all other assets of the old Magma operation. The corporate changes are to be completed on June 9 and the new Magma Power Company will begin to operate independently of Natomas. The biggest problem faced by the new company will be the lack of income-producing property until the Imperial Valley operations begin to produce income.

The East Mesa 10 MW binary facility shut down in October 1981 to rebuild some equipment that did not operate sufficiently reliably. The major problems were the heat exchangers and the main turbine. Magma anticipates going back on-line in early summer 1982 with a reliably operating plant. In the Niland area, Magma has a permit for a 28 MW plant. Magma anticipates completing engineering and beginning field work in about three or four months. This depends, of course, on Magma developing a satisfactory financing package. Magma was turned down by the Imperial County Planning Commission in an application for a 49 MW plant to be located in the Niland Area. This plant is to be the next phase in the development of Magma's resources in the Salton Sea area, so the denial for the permit was somewhat of a setback. The decision has been appealed to the Imperial County Board of Supervisors.

Status of the South Brawley Geothermal Exploratory Project
Dan Hoyer, MCR Geothermal

The South Brawley Prospect is not classified as a KGRA at this time, however tentative approval has been given by the U.S.G.S. to designate the entire area. We have approximately 11,000 acres under lease. We will first develop a 640 acre parcel in the northern part of the area. The initial work encompasses the exploration, development, and completion of a commercially viable geothermal field of sufficient size and quality to support a 49 megawatt power plant. We have 4 wells capable of commercial production, depth is approximately 13,500 feet. Results of short term production tests are encouraging. MCR is completing the design of a new well test facility for a 30 day production test to begin in July. MCR submitted a permit application to Imperial County on May 12, 1982. MCR proposes to request a geothermal overlay zone for the 11,000 acre South Brawley Prospect, this will require a master EIR. MCR hopes to complete the environmental review and permitting process by the end of the first quarter of 1983. The final power plant design will then start in 1983 and well-field and power plant construction be completed by 1986.

New Policy on the Salton Sea

Dick Daniel and K. B. Lal, California Department of Fish & Game

The Department position is not against geothermal development, although it advocates equal consideration of the fish and wildlife resource by the County. The Department believes that rezoning must be done in a manner that is fully compatible with past, present, and future uses of the Salton Sea area and not at the expense of another resource. The Department is willing to work with the industry and the County on any proposal for the protection of the fish and wildlife resource, by finding objectives and providing general guidelines to the industry that would prevent unnecessary and avoidable adverse impacts in the future. The Department considers the Salton Sea a unique biological resource of the State. Economically the sea is great asset to the County and should continue to be so in the future.

COMMENTS BY OBSERVERS

1. David E. Pierson, Director of Public Works, Imperial County

Geothermal is really moving here. Exploration is expanding. I've always felt that the whole Valley from the mountains west of us to the mountains east of us is one large anomaly. The resources that we've identified so far are those that happen to lie closer to the surface. If you have the money to drill deep enough (if the economics are right) you'll find geothermal just about anywhere in this Valley.

Research is continuing, even with the Department of Energy backing out of anything except futuristic research. Research seems to be pointed more at economics, coming up with more efficient ways to use the resource.

Direct heat development is underway. There have been some presentations at this meeting, there were others in the past. I expect that next year we will have many people to talk about their direct heat project either underway or in planning.

We have had our first environmental confrontation - on the potential for subsidence. This is a frightening thing in this County and yet, in preparation for that, we have instituted a network of subsidence monuments that pretty much put those fears to rest. This network was accomplished with all of us working together. The important point is that the people who make the decisions, the Board of Supervisors, know what is going on, they know the safeguards that are there and that the County is aware of the potential problems.

2. John Crawford, Department of Energy

I've observed that most of us here are in our shirt sleeves. This meeting, for the past three years that I have attended, has been of people that are working in the field, not necessarily the directors or the administrators from headquarters. That is important, it gives us an opportunity to talk to each other.

3. Tom Hinrichs, Magma Power Co.

I am pleased to see a power plant on-line at the Salton Sea. That facility of Union's will certainly be very important from the standpoint of utilizing those Salton Sea brines. We now have a pilot plant at the Brawley anomaly, one at the Salton Sea anomaly and one at the East Mesa anomaly. We have two full size facilities to go in at Heber. There are activities now, as we look to these first generation plants, in each of the four major anomalies.

I suspect that progress will not be quite as fast as we have anticipated or as some of us have hoped for. The SCE/Union plant at Brawley has now been on-line for two years, our plant at East Mesa has been on-line about that same amount of time. If after 2 years of operation everything was rosy, both SCE and ourselves would be building 50 megawatt plants in these anomalies, so there still are problems.

I appreciate the Fish and Game people for being here. I think through the hearings that we have had on the overlay expansion that proponents of geothermal development realized that there are other concerns that are going to be involved as geothermal development moves on. We need an arena of discussion outside of the hearing room process. Concerning the Salton Sea policy and the Fish and Game Commission, my observation is that we are somewhat polarized. I would hope that through the discussions we can begin to work together. I feel that the geothermal development associated with the Salton Sea and the preservation of the Fish and Wildlife resource can go together.

IMPERIAL COUNTY GEOTHERMAL
DEVELOPMENT MEETING
MAY 13-14, 1982

LIST OF SPEAKERS

Barber-Nichols Engineering Co.
Kenneth E. Nichols
6325 W. 55th Avenue
Arvada, CO 80002

State of California
State Lands Commission
Don Hoagland
1807 13th Street
Sacramento, CA 95814

State of California
Department of Fish and Game
Dick A. Daniel
1416 9th Street
Sacramento, CA 95814

State of California
Department of Fish and Game, Region 5
Krishan B. Lal
350 Golden Shore
Long Beach, CA 90802

State of California
Division of Oil and Gas
David E. Curtis
485-B Broadway
El Centro, CA 92243

California State University
Department of Geology
Dr. Roswitha B. Grannell
Long Beach, CA 90840

Chevron Resources Company
L.T. Elliott
P.O. Box 3722
San Francisco, CA 94119

Comision Federal Electricidad
Ing. J. Ramiro Rivas,
P.O. Box 248
Calexico, CA 92231

Imperial County
County Counsel
James Harmon
Courthouse
El Centro, CA 92243

Imperial County
Department of Public Works
David E. Pierson
Courthouse
El Centro, CA 92243

Imperial County
Department of Public Works
Margaret J. Rands
Courthouse
El Centro, CA 92243

Imperial County
Planning Department
Richard D. Mitchell
Courthouse
El Centro, CA 92243

Imperial County
Planning Department
Philip R. Shafer
Courthouse
El Centro, CA 92243

HSA Reactors Limited
Ian T. Kennedy
10, 44 Fasken Drive
Rexdale (Toronto), Ontario
Canada M9W 5M8

Imperial Magma
Thomas C. Hinrichs
P.O. Box 2082
Escondido, CA 92025

MCR Geothermal Corp.
Dan Hoyer
10880 Wilshire Blvd.
Los Angeles, CA 90024

Minerals Management Service
Buford Holt
345 Middlefield Rd.
Menlo Park, CA

Occidental Geothermal, Inc.
Neville J. Manderson
5000 Stockdale Highway
Bakersfield, CA 93309

Phillips Petroleum Company
Donald C. Harban
655 E. 4500 South
Salt Lake City, UT 84107

Republic Geothermal, Inc.
William C. Hass
P.O. Box 3388
Santa Fe Springs, CA 90670

San Diego Gas & Electric
Robert G. Lacy
P.O. Box 1831
San Diego, CA 92112

Southern California Edison
Norman J. DeHaven
2244 Walnut Grove Ave.
Rosemead, CA 91770

Sperry Research Center
Warren McBee
100 North Rd.
Sudbury, MA 01776

Ultrasystems, Inc.
James L. Prouty
2400 Michelson Drive
Irvine, CA 92715

Union Geothermal Division
Olin D. Whitescarver
P.O. Box 1805
Indio, CA 92201

University of California
Frank E. Robinson
1004 E. Holton Road
El Centro, CA 92243

U.S. Department of Energy
John E. Crawford
1333 Broadway
Oakland, CA 94612

VTN Consolidated, Inc.
John L. Sakaguchi
P.O. Box C-19529
Irvine, CA 92713

VTN Consolidated, Inc.
Carolyn E. Trindle
P.O. Box C-19529
Irvine, CA 92713

IMPERIAL COUNTY GEOTHERMAL
DEVELOPMENT MEETING
MAY 13-14, 1982

LIST OF ATTENDEES

B & P Enterprises
Rod Pittman
697 West Main Rd.
El Centro, CA 92243

Bear Creek Mining Co.
Larry L. Grogan
2502 N. Huachuca Drive
Tucson, AZ 85745

Bechtel Group, Inc.
Frank Cochrane, Ph. D
P.O. Box 3965
San Francisco, CA 94119

Bechtel Group, Inc.
Jerome W. Hankin
P.O. Box 3965
San Francisco, CA 94119

Bechtel Group, Inc.
Victor A. Perry III, P.E.
P.O. Box 3965
San Francisco, CA 94119

State of California
Department of Conservation
Esther Maser
1416 Ninth Street, 13th Floor
Sacramento, CA 95802

State of California
Department of Water Resources
Al E. Lewis, Jr.
P.O. Box 388
Sacramento, CA 95802

State of California
Regional Water Quality Control Board
Wilburn C. Ponder
730271 Highway 111, Suite 21
Palm Desert, CA 92260

State of California
Regional Water Quality Control Board
J. Harry Hanson
73-271 Highway 111, Suite 21
Palm Desert, CA 92260

Comision Federal Electricidad
Jorge Gutierrez
P.O. Box 248
Calexico, CA 92231

D'Appolonia
Jeff Wiegand
17500 Redhill Ave., Suite 202
Irvine, CA 92714

Geothermal Energy Corp.
Ed Kalankiewicz
1433 Oliver St. #5
San Diego, CA 92109

Gibbs & Hill, Inc.
Thomas A. Seese
226 W. Brokaw Rd., Suite 200
San Jose, CA 95110-1098

The Ben Holt Co.
Ben Holt
201 South Lake Avenue
Pasadena, CA 91101

City of Holtville
Fred Shaw
121 W. 5th St.
Holtville, CA 92250

IT Corporation
Ralph DeCori
P.O. Box 158
Westmorland, CA 92281

City of Imperial
Patricia Burk
420 South Imperial Ave.
Imperial, CA 92251

Imperial County Airport
Daniel Pavao
Courthouse
El Centro, CA 92243

Imperial County Assessor's Office
Mike Smith
Courthouse
El Centro, CA 92243

County Administrative Officer
Susanna Lydick
Courthouse
El Centro, CA 92243

Imperial County
Division of Economic Development
Robertta Burns
Courthouse
El Centro, CA 92243

Imperial County
Division of Economic Development
Steve Settimi
Courthouse
El Centro, CA 92243

Imperial County Public Works
S. Harry Orfanos
Courthouse
El Centro, CA 92243

Imperial County Public Works
Jean Mavity
Courthouse
El Centro, CA 92243

Imperial Irrigation District
D.A. Twogood
333 E. Main St.
Imperial, CA 92251

Imperial Irrigation District
Jerry Moore
333 E. Main St.
Imperial, CA 92251

Imperial Valley College
Phil Champagne
P.O. Box 158
Imperial, CA 92251

KEY-TV, Channel 9
Jami Fosgate
P.O. Box 29
El Centro, CA 92244

Lake County Planning Department
Alex Hinds
255 N. Forbes
Lakeport, CA 95453

City of Los Angeles
Department of Water & Power
Dawson Dong, P.E.
111 North Hope St., Room 1132
Los Angeles, CA 90054

City of Los Angeles
Department of Water & Power
Richard H. Higuera, P.E.
111 North Hope St., Room 604
Los Angeles, CA 90051

City of Los Angeles
Department of Water & Power
Frank Salas
111 North Hope St., Room 632
Los Angeles, CA 90051

MCR Geothermal Corp.
Cliff M. Webb
10880 Wilshire Blvd.
Los Angeles, CA 90012

Magma Electric Co.
Russ L. Tenney
P.O. Box 325
Holtville, CA 92250

Martin Pump, Equipment Co.
Dale Martin
521 So. "K" St.
Imperial, CA 92251

Morrison-Knudsen Company, Inc.
Stephen E. Schumacher
P.O. Box 7808
Boise, Idaho 83729

Morrison-Knudson Company, Inc.
Tom McCreedy
P.O. Box 7808
Boise, Idaho 83729

National Supply Company
John W. Hooper, Jr.
P.O. Box 1912
El Centro, CA 92244

Occidental Geothermal, Inc.
Graeme R. Driver
5000 Stockdale Highway
Bakersfield, CA 93309

Occidental Research Corporation
Phillip N. LaMori
P.O. Box 19601
Irvine, CA 92713

Phillips Petroleum-Geothermal
Ed Merrihew
655 E. 4500 S.
Salt Lake City, Utah 84107

Plant & Field Service Corp.
William Cohee
P.O. Box 1412
Brawley, CA 92227

Robert Prater Associates
Mike Bemis
10505 Roselle Street
San Diego, CA 92121

Republic Geothermal, Inc.
Don A. Campbell
11823 E. Slauson Avenue
Santa Fe Springs, CA 90670

Republic Geothermal, Inc.
Carl E. Fisher
P.O. Box 806
Holtville, CA 92250

Republic Geothermal, Inc.
Dr. Donald E. Michels
11823 E. Slauson Avenue
Santa Fe Springs, CA 90670

Republic Supply Company of California
Don Rudesill
P.O. Box 1476
National City, CA 92050

San Diego Gas & Electric
Harry Compton
P.O. Box 1831
San Diego, CA 92112

Security Pacific Bank
Becky Flammang
P.O. Box 39
Brawley, CA 92227

Southern California Edison Co.
Raymond Cedillo
P.O. Box 800
Rosemead, CA 91770

Southern California Edison Co.
James S. Ellinor
25770 San Bernardino Avenue
San Bernardino, CA 92408

Southern California Edison Co.
Emil C. Hutchins
P.O. Box 788
Rialto, CA 92376

Southern California Edison Co.
W. E. Moss
P.O. Box 800
Rosemead, CA 91770

Southern California Edison Co.
Ronald D. Nunnally
P.O. Box 800
Rosemead, CA 91770

Southern California Edison Co.
Thomas R. Sparks
2244 Walnut Grove Avenue
Rosemead, CA 91770

Sperry Research Center
Hugh B. Matthews
100 North Road
Sudbury, Mass 01776

Standard Oil Co. of California
Douglas E. Grauel
555 Market Street
San Francisco, CA 94105

Stearns-Roger
Martin R. DeBusman
P.O. Box 5888
Denver, CO 80217

TECK Research, Inc.
Brian Keevil
Suite 7000
1 First Canadian Place
Toronto, Ontario, M5X 1G9

TECK Research, Inc.
B.E. St. John
Suite 7000
1 First Canadian Place
Toronto, Ontario, M5X 1G9

Union Geothermal
Jodie E. Fisher
461 W. Main St.
Brawley, CA 92227

Union Geothermal
Joel P. Robinson
P.O. Box 7600
Los Angeles, CA 90017

Union Geothermal
Thomas L. Waggoner
461 W. Main St.
Brawley, CA 92227

U.S. Bureau of Reclamation
Kristie Jennings
137 N. 15th Avenue
Yuma, AZ 85364

U.S. Bureau of Reclamation
Dennis E. Watt
3800 Avenue 3 E
Yuma, AZ 85364

U.S. Department of Agriculture
Lee F. Hermsmeier
4151 Highway 86
Brawley, CA 92227

U.S. Mineral Management Service
William Levine
345 Middlefield Road MS 92
Menlo Park, CA 94025

U.S. Navy-EI Centro Public Works
Chris Dawkins
NAF EI Centro
EI Centro, CA 92243

Well Production Testing
Robert Stiger
P.O. Box 69
Carlsbad, CA 92008

Wendell Transport Co.
Bill Wendell
P.O. Box 247
Imperial, CA 92251

WESTEC Services, Inc.
William R. Eldredge
3211 Fifth Avenue
San Diego, CA 92103

WESTEC Services, Inc.
Frank L. Enos
1655 River Drive
Brawley, CA 92227

WESTEC Services, Inc.
Willard E. Johnson
3211 Fifth Avenue
San Diego, CA 92103

WESTEC Services, Inc.
Christopher K. Lane
3211 Fifth Avenue
San Diego, CA 92103

WESTEC Services, Inc.
Bob Sones
P.O. Box 823
Westmorland, CA 92281

Woodward-Clyde Consultants
Latif Hamdan
3467 Kurtz Street
San Diego, CA 92110

Woodward-Clyde Consultants
Victor F. Viets
Three Embarcadero Center
Suite 700
San Francisco, CA 94111